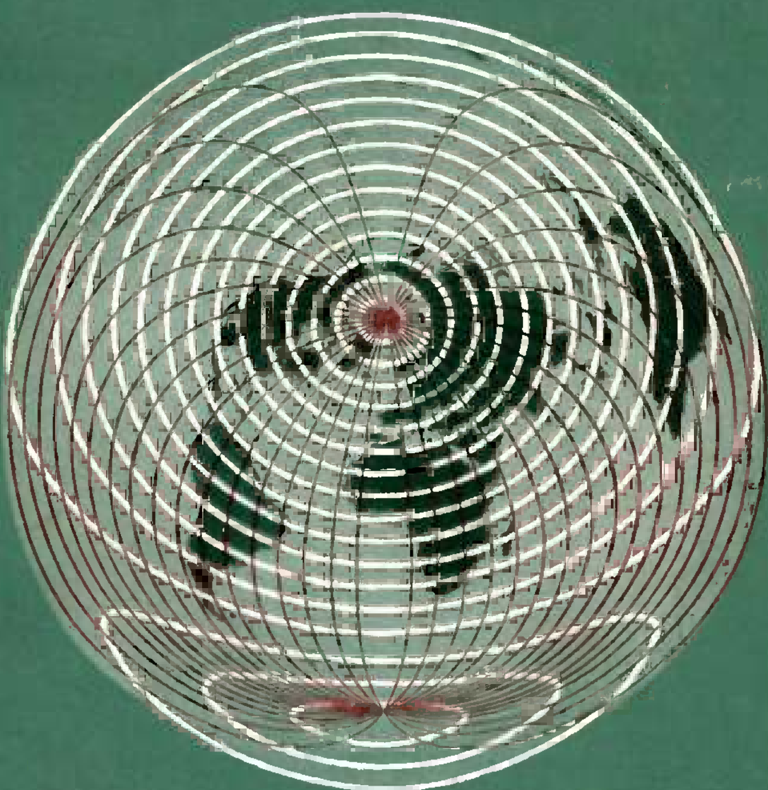
MARCH 1960 TWO SHILLINGS

Wireless World

ELECTRONICS
Radio · Television



FORTY-NINTH YEAR OF PUBLICATION

Wireless World

ELECTRONICS, RADIO, TELEVISION

MARCH 1960

VOLUME 66 NO. 3

PRICE: TWO SHILLINGS

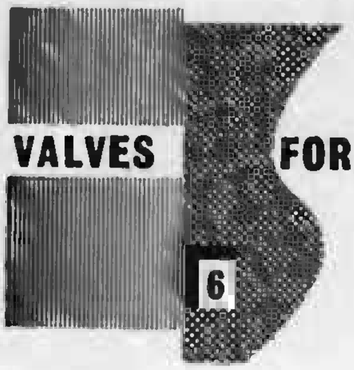
FORTY-NINTH YEAR OF PUBLICATION

Offices: Dorset House, Stamford Street, London, S.E.1

Please address to Editor, Advertisement Manager, or Publisher, as appropriate

PUBLISHED MONTHLY (4th Monday of preceding month) by ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (65 lines). *Telegrams:* " Ethaworld, Sedist, London." *Annual Subscriptions. Home and Overseas,* £1 15s. 0d. *Canada and U.S.A.*, $5.00. Second-class mail privileges authorised at New York, N.Y. BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2. *Telephone:* Midland 7191. *COVENTRY:* 8-10, Corporation Street. *Telephone:* Coventry 25210. *GLASGOW:* 26B, Renfield Street, C.2. *Telephone:* Central 1265. *MANCHESTER:* 260, Deansgate, 3. *Telephone:* Blackfriars 4412. NEW YORK OFFICE: *U.S.A.:* 111, Broadway, 6. *Telephone:* Digby 9-1197.

FRAME GRID VALVES FOR TELEVISION



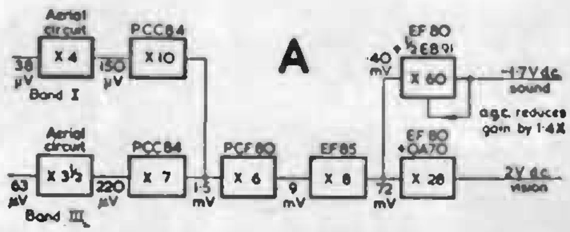
With a suitable valve line-up, receivers with two i.f. stages can be designed for various degrees of improved performance. Frame grid valves can be used throughout the tuner and i.f. stages, or some conventional valves can be retained, depending on the sensitivity required. Two classes of receiver satisfy all U.K. requirements: one for good signal strength areas, and a more sensitive receiver for difficult areas.

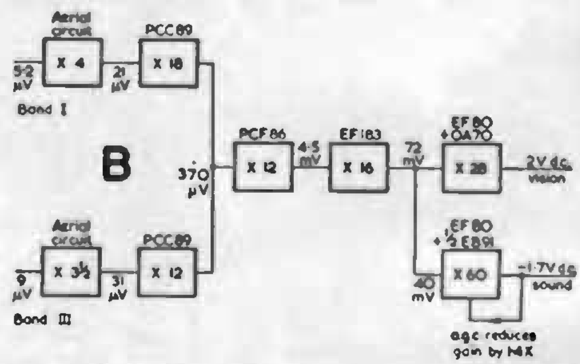
Reception is practicable at vision carrier levels down to 20µV r.m.s., with enough gain to give 2V d.c. at the detector. To ensure this sensitivity and to allow for deterioration, a fringe receiver should be designed round a nominal sensitivity of 10µV.

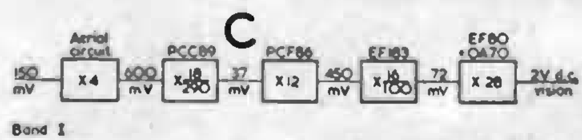
Signal levels in a conventional receiver are shown on line-up 'A'. The Band III sensitivity of 63µV falls short of the 10µV requirement by 16dB. Since frame grid valves have a gain advantage of about 6dB over conventional valves, this deficiency can be made up by the use of three frame grid valves.

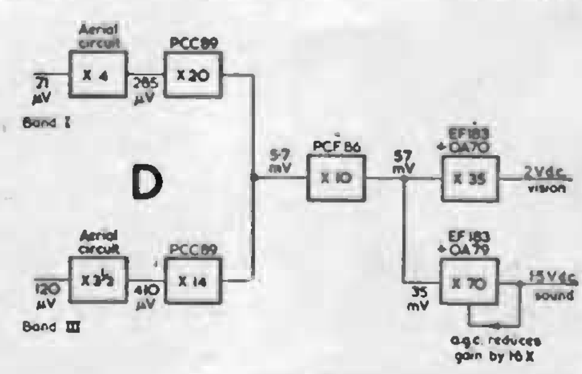
The PCC89 gives improved gain, it has a better noise factor than the PCC84, and it can handle an input signal five times greater without cross-modulation. Thus one of the frame grid valves is used in the r.f. amplifier. The other two should be in stages which are common to sound and vision, so that maximum benefit can be obtained. In line-up 'B' the PCF86 is used in the mixer and the EF183 in the common i.f. stage. The EF80 is retained in the separate i.f. stages. The most severe requirements are met, and the maximum usable gain for low signal levels is provided. In normal service areas, the gain is reduced by a.g.c. for large signals, as shown for Band I at 'C'. Rather greater signals than 150mV can be handled.

A receiver for high signal strength areas does not require 10µV sensitivity, and all requirements can be met by receiver 'A'; but frame grid valves would give the required gain with one less i.f. stage. Line-up 'D' uses the same tuner as the high-sensitivity receiver; but there is no common i.f. stage, and the EF183 is used instead of the EF80. The performance shown is for maximum sensitivity. A signal of 225V r.m.s. can be handled. All normal service area requirements are met, and the receiver is economically attractive. The EF184 can be used in place of the EF183, giving 2dB more gain; but the signal which can be handled is reduced.









MULLARD LIMITED, MULLARD HOUSE, TORRINGTON PLACE, LONDON, W.C.1

MVM431

MARCH 1960
Vol. 66 No. 3

Wireless World

Transistor Reliability

IN theory a transistor should last for ever. There is nothing obviously expendable in it as there is in the hot cathode of a valve. The crystal lattice of the solid-state semiconductor remains, under normal operating conditions, a fixed framework through which electrons and holes circulate under the influence of applied fields to and from the external connections of the device. Although the charges associated with individual atoms may change temporarily, and the current carriers may leave with greater energy than that with which they entered, there is no net gain or loss of material, and the chemical nature and physical arrangement of the atoms remain unchanged.

We said "in theory" and "under normal operating conditions." In practice, of course, transistors sometimes fail and in the early days failures were frequent and of many kinds. Indeed there grew up a whole descriptive pathology of transistor diseases such as "sleeping sickness" leading to "slow death" or "sudden death." Some of these were peculiar to the first point-contact transistors and were accounted for by mechanical disturbance of the contact wires. In junction transistors most of the early troubles were due to contamination of the outer surface, particularly by moisture, which gained access, in spite of encapsulation in plastic, through incomplete bonding with the leads or the slight bulk permeability of the best synthetic resins then available. Silicone greases and varnishes in conjunction with low-temperature glass seals or cold metal-welding techniques have since mastered the moisture problem.

Given sound mechanical construction to ensure freedom from catastrophic failure through breakages at the lead-out connections and with the flanks safely guarded from surface contamination, deterioration or failure can only occur on the main fronts of the transistor action. Could a breakdown occur as the result of penetrating radiation, for example, cosmic-ray particles? All the evidence is against this as a significant possibility. Irradiation by gamma rays has caused failure in germanium transistors in 5 seconds, and in 30 seconds in silicon, but the failure was due primarily to surface effects and not to bulk effects involving the crystal structure*.

The worst enemy of the transistor is temperature, which is in effect vibration of the crystal lattice. If this becomes too severe dislocations may occur and the distribution of impurity atoms, so essential to the proper functioning of the junctions, may be permanently disturbed. Whatever the explanation may be, the fact remains that the performance deteriorates as temperature increases, and the deterioration may be permanent if the maker's recommended junction temperatures are exceeded. On the other hand, if the circuit conditions are such as to ensure a conservative rating, there seems no reason to doubt that the life expectation of a transistor may well be 50 to 100 times that of a valve and that it will outlive many of the components with which it is associated.

Space Experiments

NOW that argument in Parliament and in the Press about the propriety of accepting a lift in an American "satellite vehicle" has subsided, it is gratifying to learn that matters have been settled and that the first launching of a satellite from a "Scout" four-stage solid-fuel test vehicle is scheduled for the latter part of 1961. It is even more gratifying to learn that the experiments which have been planned come very close to our interests and will be concerned with the ionosphere, and in particular its outer limits where the terrestrial atmosphere merges into that of the sun.

The long tradition of British interest and achievement in ionospheric research, and especially recent experience in launching ionization experiments in "Skylark" rockets, together with the original laboratory work on ionized gases conducted by research groups under Prof. J. Sayers at Birmingham and Drs. R. L. F. Boyd and A. P. Willmore at University College, London, no doubt influenced the choice.

Experiments planned are based on the Langmuir probe (which measures the rate of change with voltage of current due to impinging ions) and on the measurement of the complex dielectric properties (at 10 Mc/s) of the gaseous medium between parallel plates. These will give information on the identity of heavy ionized particles as well as on the density and temperature of the electron population of the fully ionized plasma at high altitude.

We know that the equipment will be well made and carefully prepared and it only remains to keep our fingers crossed for a successful launch.

* "Transistors Can be Reliable" by C. H. Zierdt, Jr. *Electronic Design*, 1st April 1957.

Improving the Dynamic Range of

USE OF A PILOT TONE TO COMPENSATE FOR MANUAL COMPRESSION OF THE INPUT

By ***L. H. BEDFORD,*** *C.B.E., M.A., B.Sc. (Eng.), F.C.G.I., F.I.R.E., M.I.E.E., M. Brit. I.R.E.*

THE dynamic range of the domestic tape recorder is nearly but not quite good enough. A signal/noise ratio of 50 dB is frequently claimed, and more usually 40 dB is attained. This is to say that the maximum undistorted signal is 50 to 40 dB above the noise level. Even the latter figure suffices for the recording of low-contrast subject matter such as speech and some types of music. Other types of music, in particular orchestral, organ and even pianoforte, themselves extend over a dynamic range of 40 dB, and so are clearly not directly acceptable to the tape system; for this would imply that the reproduction of pianissimo passages must occur at unity signal/noise ratio.

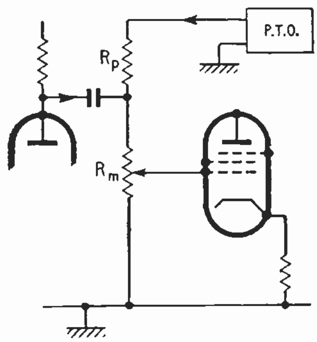


Fig. 1. Basic method of providing a pilot tone with a level proportional to the recording gain control level.

The solution commonly adopted is precisely the same as that in any other communication system of restricted signal/noise ratio, namely that the input signal is *compressed* by " monitoring "; the monitor manipulates a gain control so as to hold the fortissimo passages below the distortion level and the pianissimo passages suitably above the noise level.

This process is quite justifiable from an engineering standpoint because, once the signal/noise ratio has been thus maintained, the subject matter can be " de-compressed " by manual operation of the gain control on reproduction; this process could be called " de-monitoring." However, such an operation is little more than a theoretical possibility, since not only is the gain-control manipulation an intolerable burden but the information required for correct operation is lacking. Attempts to perform this process automatically, but still in the absence of the correct information, have appeared under the descriptive title " expander circuits "; these are now quite properly in disfavour.

So long as the monitoring process remains a manual operation, and there are good reasons why this should be the case, there is no possibility of automatic " de-monitoring " unless the monitoring gain control history can be conveyed as such to the de-monitor.

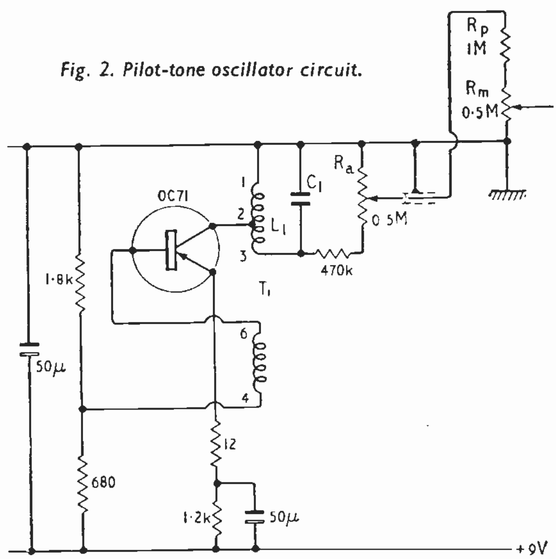
The device now to be described allows just this and so is quite distinct from an " expander." On recording, the monitoring history is written in terms of a superposed pilot tone whose amplitude is subjected to the same monitoring process as the signal. On reproduction, an a.g.c. circuit holding constant the amplitude of the reproduced pilot tone constitutes a perfect de-monitor. By this combination, the monitoring operations are precisely " unwound". The original contrast is restored and only the signal/noise advantage of the monitoring process is retained.

With this arrangement a new situation arises. The monitor, who hitherto may (or may not) have felt restricted by some artistic considerations, can now go to work to his heart's content, finally throwing aside all decent restraint, confident in the knowledge that his every effort to destroy the music will be exactly defeated.

The pilot-tone operated gain control is by no means a new idea, but it may be well to describe it basically in the present context.

In Fig. 1 is shown the part of the recorder amplifier around the monitoring gain control potentiometer R_m. The top of R_m is connected through a resistance R_p to a pilot-tone oscillator (P.T.O.). The latter provides a constant signal of a frequency outside the audio range but within the recording capability of the tape system; which in practice

Fig. 2. Pilot-tone oscillator circuit.



Tape Recording

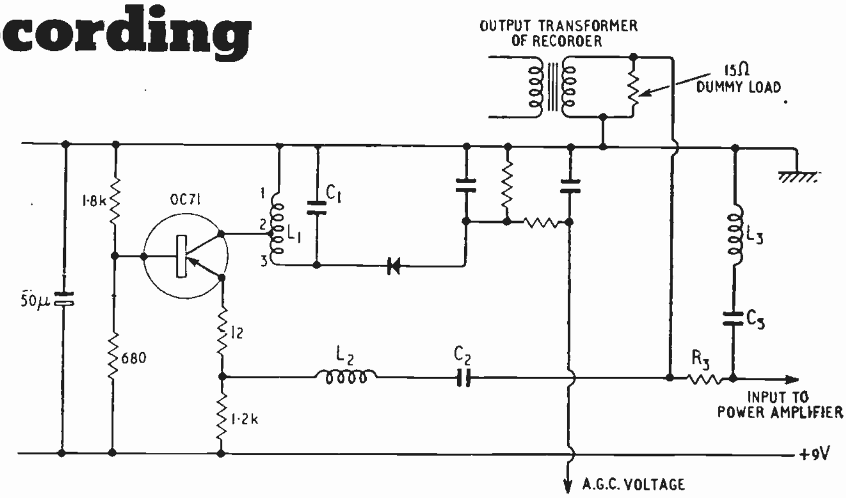


Fig. 3. Selective pilot-tone play-back amplifier for providing an a.g.c. voltage to correct the play-back level.

implies a frequency slightly *above* the required audio range.

The pilot tone thus applied is subject to exactly the same monitoring variations as the signal, it being understood that monitoring takes place exclusively by means of the gain-control potentiometer R_m. If then on reproduction the pilot tone is separated out by a frequency-selective circuit and used as input to an a.g.c. circuit controlling the audio gain, the monitoring operations are "unwound" to an accuracy defined only by the perfection of the a.g.c.

The following particulars relate to an experimental application of this principle to a domestic tape recorder which has worked with somewhat spectacular results. Some 15 dB stretch of the dynamic range has been obtained.

The pilot-tone frequency was selected at 13.5 kc/s, this being considered the lowest frequency that could be filtered out without detriment to the music. This implies working with a tape speed of 15in per second with a normal R/P head, but will allow 7.5in per second with a modern high-resolution head.

Only a minute power output is required from the pilot-tone oscillator, which suggests a simple form of transistor circuit. This is shown in Fig. 2. The transistor is an OC71 used in the grounded-emitter condition, but for the 12-ohms emitter-follower resistor. The circuit operates at 9 V, 6 mA total, of which the transistor current is 2 mA approx. (It will in fact oscillate and produce adequate power output down to much lower voltages.)

For play-back the same transistor and most of its circuit is used to form the selective pilot-tone amplifier. The arrangement is shown in Fig. 3. In this case, the transistor operates as a grounded-base amplifier.

Input is taken to the emitter through the 13.5 kc/s series-tuned circuit L_2C_2, which is fed from the 15-ohms output of the normal playback amplifier in the recorder. This series-tuned feed, together with the parallel-tuned collector circuit, provide adequate selectivity at 13.5 kc/s. The collector-tuned circuit now feeds a diode and can produce some 12 V of a.g.c. linearly related to the 13.5 kc/s input. In practice the a.g.c. potential will not exceed 8 V.

It remains only to suppress the transmission of 13.5 kc/s pilot tone to the final amplifier, which would otherwise be objectionably audible to those of sufficiently-low age group. Series-tuned circuit L_3C_3 and resistance R_3 perform this function, it being understood that the system will invariably work through a power amplifier and not directly through its own speaker.

Finally, Fig. 4 shows the practical arrangement of the complete de-monitor unit in which it only remains to invoke a relay for the purpose of changing over the circuit from its Record to its Play-back function. This relay is operated by the h.t. feed current to the normal bias oscillator. Thus no extra switching is involved and the only adjustment required is the pre-setting of the pilot tone amplitude control R_a.

In Fig. 4 is shown also a skeleton circuit of the basic play-back amplifier in order to clarify the connection of the de-monitor unit to it. It will be seen that the a.g.c. voltage is applied as grid bias to a single stage. The behaviour of this circuit under this somewhat peculiar condition is shown in the following table.

Bias (V)	*Input at* MJ *(mV)*	*Loss (dB)*	*Remarks*
0	2.5	0	
− 5.9	5	6	
− 6.8	10	12	
− 7.4	20	18	
− 7.8	40	24	
− 8.1	40	30	Distortion observable
− 8.4	40	36	"

The maximum undistorted tape signal at MJ in Fig. 4 being approximately 25 mV, we see that it is possible to operate over a range of 18 dB monitoring compression with an output range of 20 log (7.8/5.9)= 2.5 dB. This is to say that a monitoring range of 18 dB has been reduced by 15.5 dB.

After the adjustment of the three pilot-frequency tuned circuits there remains only one operational adjustment, namely the pilot-tone amplitude control R_a. The setting of this controls the dynamic range of the de-monitoring. The value 15.5 dB referred to above was obtained with the pilot voltage (viewed at the anode of the audio output valve) set to approximately one-third of the nominal distortion point audio voltage. This adjustment should be made with the gain control R_m set to its maximum intended value,

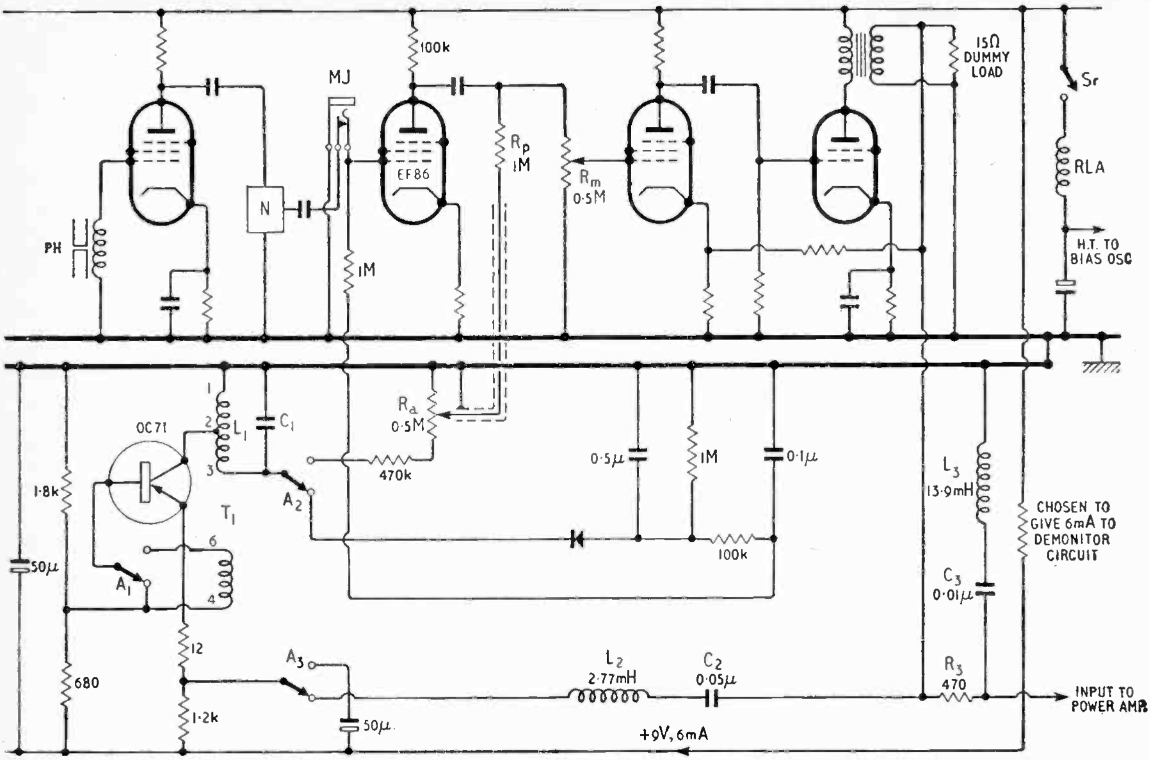


Fig. 4. Practical arrangement of pilot-tone oscillator and selective play-back amplifier and their connections to skeleton circuit of basic play-back amplifier.

KEY

PH	Play-back head
N	Frequency-correcting network
MJ	Microphone jack
RLA	Relay winding, 400Ω, 45 mA
A_1, A_2, A_3	Relay change-over contacts, shown in un-energised condition (Play-back)
S_r	Switch on "Record" button (shown in Play-back condition)
T_1	Pilot-tone oscillator transformer Winding 1, 2, 3 — 0, 50, 280 turns total 1, 3 — 40 mH nominal (L_1) 4, 6 — 4 turns (32 s.w.g. Lewmex wire on LA1 Ferroxcube core)
C_1	3470 pF nominal (to tune with L_1 for 13.5 kc/s)
L_2	2.77 mH (60 turns of 22 s.w.g. on LA7)
C_2	0.05µF nominal (to tune with L_2)
L_3	13.9 mH (165 turns of 28 s.w.g. on LA1)
C_3	0.01µF nominal (to tune with L_3)
Diode	Crystal diode, ≮ 25V p.i.v.

which will in general be its extreme maximum value.

It may be remarked that when the demonitor circuit is in operation the gain control R_m becomes inoperative as such in the play-back condition because the a.g.c. circuit acts to oppose it. It does, however, control the range over which the demonitor works and will therefore normally be set at maximum on play-back. If it is turned down by some 25 dB with a compensating (but far smaller) increase of gain in the power amplifier, the reproduction becomes un-demonitored. This is a useful test or demonstration procedure.

The circuit can be built up in compact form and will usually be small enough for installation *inside* an existing tape recorder. The likelihood of this is increased by the fact that anyone who is sufficiently quality-conscious to wish to try this arrangement is liable to have remoted the power pack in aid of hum reduction!

In conclusion, we may usefully examine the "economics" of the device. Assessing it in the form described, which by no means carries the idea to its limit, we see that we gain 15 dB of dynamic range for an increase of tape speed which may for practical reasons need to be 2 to 1. This increase of tape speed by itself would *theoretically* offer us 3 dB, so we have picked up a net 12 dB by means of the device. For this we have paid a capital investment of one transistor, three pilot-frequency tuned circuits and a relay; surely a nice bargain for the Communication Engineer! Unfortunately on the domestic front the situation is not so good. As already pointed out the existing dynamic range is *nearly* good enough. Thus the domestic user may not be interested in a further 12 dB even at so trivial a capital cost.

A 16⅔ r.p.m. record was recently released by Rank Records. This is similar to an ordinary l.p. but recorded and replayed at half speed. In addition, a bass cut and mid-frequency boost are superimposed on the standard recording characteristic, and the recording level is about 5dB lower than usual. The upper recorded frequency limit is about 5kc/s, and the total playing time for a 12in record one hour and thirty-five minutes.

Geneva Conference

FINDINGS OF THE I.T.U. MEETINGS ON FREQUENCY ALLOCATIONS

AT Geneva on December 21st representatives of 89 countries signed the new International Telecommunication Convention and a new set of Radio Regulations which come into operation in May, 1961. These two documents were the outcome of two conferences—the Ordinary Administrative Radio Conference and the Plenipotentiary Conference—organized by the International Telecommunication Union which together lasted over four months. The main task of the Administrative Radio Conference was to apportion internationally frequencies between the various "services" and users—maritime and aeronautical mobile, maritime and aeronautical radio navigation, meteorology, amateur, land "fixed" and "mobile," broadcasting, etc. This necessitated a complete overhaul of the Atlantic City (1947) allocations and, as with most international conferences, because of the expansion of some services and the growth of the "younger" countries, it was a tug-of-war between the "haves" and the "have nots". In addition to the growing demands of expanding services provision also had to be made for the requirements of new "services" such as space communication, radio astronomy, and tropospheric and ionospheric scatter. Whereas in the Atlantic City regulations the table of frequency allocations did not go above 10,500Mc/s the new table extends to 40Gc/s (40,000Mc/s).

The demands for frequencies in some sections of the radio spectrum have been so great, and are likely to become even greater, that in order to reduce the demands on the 3-30Mc/s band and prevent interference with long-distance radio-communications "administrations are encouraged to use, whenever practicable, any other possible means of communication." It was undoubtedly this h.f. band which posed some of the biggest problems the conference had to solve. So great were they that a small panel of specially-chosen "experts" is being set up to investigate them with a view to reducing the present congestion. Also an entirely new procedure has been adopted for the registration of frequencies. The International Frequency Registration Board, which comprises eleven elected members each of a different nationality but acting as impartial advisers and custodians, has been given the task of preparing a new Master International Frequency Register. So far as broadcasting stations are concerned the broadcasting authorities have been asked to submit four operational schedules each year covering the summer, winter and the two equinoctial seasons. This information will be combined into a Tentative Schedule which will reveal incompatabilities in frequency assignments.

Whilst on the subject of broadcasting we would mention that no changes have been made in the frequency bands, but it is good to know that provision has been made just below the television Band I for the ionospheric scatter stations, some of which have been operating on frequencies in the lower channels of the band. Ionospheric scatter stations designed to operate over distances exceeding 800km must confine their transmissions to the following bands: 32.6-33, 34.6-35, 36.2-36.8 and 39-39.4Mc/s.

The use of broadcasting stations, both television and sound, "on ships or aircraft outside national territorial waters is prohibited."

New frequency tolerances for broadcasting stations are to come into force in January, 1966. In the 10-1605kc/s band it will be reduced from 20c/s to 10c/s, in the 1605-4000kc/s band from 50 to 20 parts in 10^6 and in the 4-29.7Mc/s band from 30 to 15 parts in 10^6. There have also been closer limits imposed on the television and sound broadcasting stations in the v.h.f. and u.h.f. bands.

An interesting aspect of the Regulations is the provision for communication between "space" vehicles and earth-to-space services for research purposes. The frequencies (Mc/s) allocated are 10.003-10.005, 19.990-20.010, 183.1-184.1, 1700-1710 and 2290-2300. One of the hundreds of documents circulated during the conferences dealt with telecommunications and the peaceful uses of outer-space vehicles. It covered not only the telecommunication needs of space craft both for their remote control and for transmission of information but went on to say "artificial satellites will undoubtedly be used in the near future to establish new telegraph and telephone connections . . . and . . . sound and television broadcasting services." In 1963 a special conference will be called to consider the problems of space communication.

The frequency allocation table has been called the regulation with a 1,000 footnotes for there are so many variations from and modifications and exceptions to the basic plan. Another point of interest about the plan is that it defines for the first time priorities where a number of services share a band of frequencies. Services are defined as primary, permitted or secondary. The first two have equal rights except that a primary service has a priority in the choice of frequencies. Stations in the third category must not cause harmful interference to or claim protection from either of the others.

So far as amateurs in Region I, which includes the U.K., are concerned, the only changes in their frequency allocations were a loss of 50kc/s in the 7Mc/s band and a reduction in the width of the 420-450Mc/s band to 430-440Mc/s.

A world-wide reservation of the following bands has been made "for the use and development of airborne electronic aids to air navigation":—960-1215, 1535-1660, 4200-4400, 5000-5250 and 15400-15700Mc/s. The frequency of 243Mc/s has been allocated to survival craft.

It has been impossible within the limitations of this short article to give an exhaustive survey of the Radio Regulations, which cover some 600 pages; moreover, some of the regulations or recommendations are of interest to only a comparatively small section of the radio fraternity. However, we propose to publish from time to time items of interest to particular sections of the diverse readership of *Wireless World.*

How Long Will a Transistor Live?

ADVICE TO THE USER GAINED FROM RECENT EXPERIENCE

By ***R. BREWER****

IT is natural that with many commercial products we ask the question, "What is its expected life?" Transistors belong to this class of products, and even the non-technical user is beginning to ask, "How long will a transistor live?"

This article has been prepared to give guidance in a problem that appears simple, but which is really quite complex, and the basic information is given for a broad, but realistic, approach to the general question of transistor life.

The simple question, "How long will a transistor live?" has no simple answer, because it begs another question: "When is a transistor dead?" When the problem is put this way we are led to the answer of a rather different question that is probably more important to the user of transistors than the question first asked. It is also worth remembering that, as with human beings, living conditions strongly influence the length of life!

A transistor dies either when a catastrophic event, such as a short-circuit between elements, occurs, or when an electrical characteristic has deteriorated to a point that is unacceptable in the circuit *in which the transistor is being used.* The definition of death is thus closely linked to the conditions of use; only the catastrophic type of failure is unambiguous and valid for all circuits.

Comparison with Valves.—It is useful to compare the life patterns of transistors with those of thermionic valves, because these also have catastrophic and deterioration type failures. Apart from the generally much lower rate of catastrophic failures in transistors, the most striking difference between the life characteristics of the two types of device is that for many valves the deterioration process, which is gradual in the early stages, may later become so rapid as to cause system breakdown almost regardless of differences in circuit conditions. In other words, once a valve has started to "nose dive" it is more or less unacceptable in any circuit.

By comparison, the deterioration process in many types of transistors is extremely gradual, and after an initial "settling-down" period, subsequent changes may be small. The two characteristics most likely to change during life are current gain and leakage current. Fig. 1 shows a typical record of gain in a sample of GET103 transistors which have been on life test for 20,000 hours (nearly 2½ years). These transistors are running at a junction temperature of 65°C, a figure which is fully adequate for applications such as portable personal radio receivers. It is worth noting that in apparatus of this type, where the duty may average about 5 hours a day, it would take about 11 years to build up a total operating time of 20,000 hours.

It must be remembered that transistor manufacturers are constantly striving to improve the quality of their products, including the life characteristics. Long-term life test evidence inevitably lags behind the latest production processes, and records such as that shown in Fig. 1 cannot reflect recent improvements resulting from increased production experience. Since this life test started, the introduction of better techniques has enabled the maximum junction temperature of the GET103 transistor to be raised from 65° to 85°C. Changes of this kind depend on a thorough appraisal of all the many factors involved, including extensive life test evidence, but another two years must elapse before the 20,000-hours performance at the higher junction temperature has been confirmed. At present there are no reliable, well-established techniques for accelerating transistor life effects—we have no substitute for time.

Pattern of Transistor Life.—Many of the early

* Research Laboratories, General Electric Company.

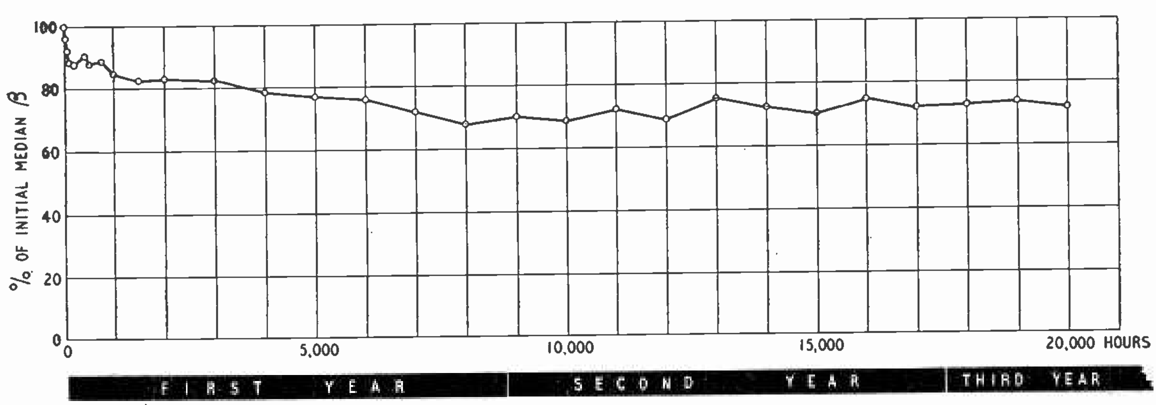


Fig 1. Change during life of median value of β for a sample of fifteen GET103 transistors manufactured in May 1957. Junction temperature during electrical life test is approximately 65°C; while β is measured at 25°C.

junction transistors exhibited the degradation type of life failure due to imperfect manufacturing techniques, but major improvements in this respect have been made in recent years. The characteristic "nose dive" seen in many valves is generally absent in transistors, but there may be fairly large differences in the rate of change among individual specimens of similar transistors. While there is little reason to expect any tendency towards major changes in the average characteristics late in life, this fact has yet to be proved.

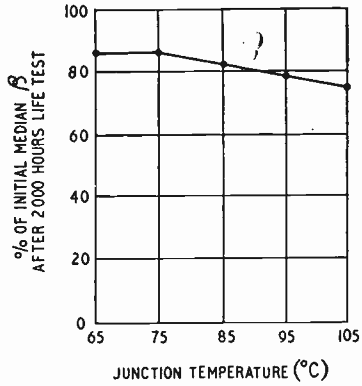
A study of the evidence from life tests such as that referred to above suggests that transistors in general may be capable of outliving the equipment in which they are incorporated. It must not be assumed, however, that all the transistors in a batch will have identical survival characteristics. Like every other mass-produced article, the transistor is subject to chance variations in manufacture that can cause an unpredictable breakdown during life, or an unusual change in gain or leakage current, and it is the incidence of troubles of this kind, rather than a general end of life having been reached, with which we are really concerned. For the operators of equipment using large numbers of transistors the question is therefore not so much "How long will a transistor live?" as "How often will chance failures occur?"

Time Between Failures.—The last question is one to which some provisional answers can be given, though they do not necessarily apply to all types of transistor, and it has yet to be shown that the failure rate is the same throughout life. Evidence from various types of transistor equipment, and from life tests involving many millions of transistor-hours, indicates that the failure rate for low-frequency germanium transistors of the GET103 type, for example, is in the region of 0.05 to 0.01% per thousand hours. With this information we can immediately work out the mean time between failures (M.T.B.F.) for an equipment, and this is something we really want to know. For example, assuming a rate of 0.05% per 1,000 hours, the M.T.B.F. in a unit using 1,000 transistors of the same type would be 2,000 hours. This order of reliability applies to germanium transistors working in ambient temperatures up to 40° to 60°C, and with junction temperatures in the region of 70° to 85°C.

Guidance to Users.—It may be held that the rapidity of technical advances in the industry, and the lack of sufficient time for long-term effects to have become manifest, make it unwise to forecast the ultimate reliability of transistors at the present time. Against this is the fact that transistors are already being used in equipment where long life is a major requirement, and it therefore seems advisable to give users some guidance on the best approach to the subject in the light of present knowledge.

The failure rate figure given above is a realistic one for several types of low-frequency germanium transistors now in production, but in considering it, a number of important reservations must be made. First, very wide differences may exist in the life characteristic of types of transistors that are superficially similar. Also it must be realized that some of the latest types of high-frequency transistors are made by advanced techniques which may produce

Fig. 2. Change in current gain of GET103 transistor after 2,000 hours electrical life test at five junction temperatures. Sample size of 20 at each temperature; β measured at 25°C.



life characteristics differing from those associated with the more well-established techniques used for low-frequency devices. Secondly, circuit characteristics and operating conditions can have far-reaching effects on the reliability achieved in practice. This cannot be stressed too strongly. Such matters are obviously absent in any general statement, and it is therefore essential to consider the details in each application. As an illustration, Fig. 2 shows how current gain can be affected by junction temperature, and it will be seen that at the higher junction temperatures greater circuit tolerance is necessary. This subject has been dealt with more fully in a paper† which is now in course of publication and should be available in the near future.

Circuit Design Factors.—The foregoing comments show how important are the details of operating conditions when considering statements about the life and reliability of transistors. Reliability information in these circumstances may easily be misconstrued, and general statements, such as have been given here, serve only as landmarks.

The designers and operators of equipment using transistors have a large part to play in determining the M.T.B.F. of the transistors used in the systems with which they are concerned, and their contribution to transistor reliability will be most effective if the following precepts are remembered:

(1) Survey the electrical and environmental conditions under which the transistors will be used, paying particular attention to the extreme values of supply voltages and temperatures likely to be encountered. The possibility of voltage transients and oscillations should also be checked.

(2) Employ tolerant circuit arrangements so that changes in transistor characteristics during life have a minimum effect on system performance.

(3) Consult the transistor manufacturer for advice if necessary.

(4) Watch for accidental misuse as a cause of transistor failure. An increasing body of information suggests that high early failure rates in transistors are due to faulty installation and maintenance procedures.

If these points are kept in mind when new equipment is being designed or installed, the chances of realizing the low failure rate of which the transistor is capable will be significantly increased.

†"A Reliability Appraisal of Semiconductor Devices," by R. Brewer and W. W. D. Wyatt, presented at the I.E.E. International Convention on Transistors and Associated Semiconductor Devices, May 1959.

Transformerless Circuits for Broadcast Receivers

NEW CIRCUITS DISPENSE WITH A VARIETY OF CIRCUIT ELEMENTS

By R. C. V. MACARIO*, Ph.D. and N. E. BROADBERRY*, Grad.Brit.I.R.E.

CONSTRUCTION of the electronic circuit can be made simpler when transformers and other wire wound components do not form part of the circuit. This may be regarded as being due to the greater versatility of the more compact circuit elements such as the resistor, the capacitor and the transistor, which together lead to neat circuit arrangements. The modern trend of electronics towards the solid state circuit also favours the use of this type of component, to which may be added other solid state components such as the ceramic i.f. transformer[1].

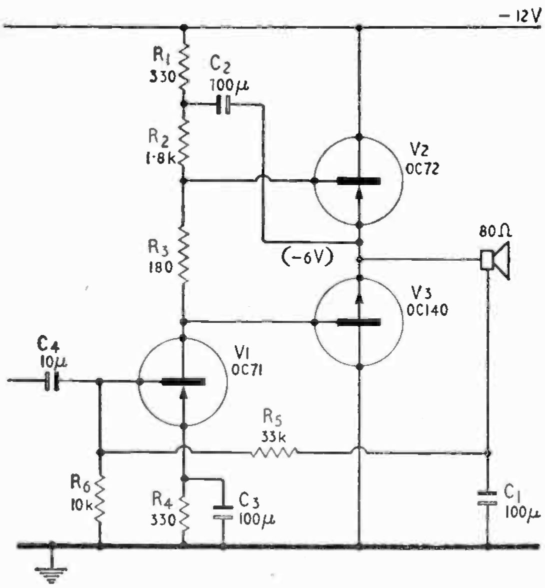


Fig. 1. Audio amplifier and 150-mW output stage for portable receiver using 12-volt two-terminal supply.

However, a review of the extensive literature on the modern transistor broadcast receiver suggests that the circuits used today are not of this type; unfortunately they make use of components other than the recommended ones. In this article alternative circuit arrangements are introduced designed to match in with the above ideas.

Portable-receiver A.F. Stage.—For the small portable receiver Class-B operation is essential unless one of the more esoteric forms of signal-controlled Class-A circuits is introduced. The complementary n-p-n/p-n-p arrangement clearly provides the simplest design without a driver transformer for a Class-B circuit. The criterion for a good design would appear to be a maximum power output with minimum distortion and minimum complexity. This suggests the use of a common-emitter stage driving a common-collector pair. A discussion of this type of transistor amplifier is to be found, for instance, in the *Handbook of Semiconductor Electronics*[2]. In a final form the circuit leads to a fairly straightforward design as shown in Fig. 1.

A description of the circuit behaviour to d.c. is as follows: the forward bias of V1 is set so that its collector potential is quiescent at -6V with the d.c. collector load $R_1+R_2+R_3$. This bias depends on the current through R_4, the emitter resistor, and the base potential determined by the potential divider R_5 and R_6. The collector of V1 is coupled directly to the bases of V2 and V3; thus the connection common to the emitters of V2 and V3 assumes a potential almost identical with that of V1 collector (emitter-follower action). To prevent a flow of d.c. through the load its "earthy" connection may be taken either to a centre tap on the battery or to earth through a d.c. blocking capacitor (C_1). When a blocking capacitor is used the p.d. across C_1 follows V1 collector potential; therefore, if the potential divider R_5, R_6 is fed from this point, a direct-coupled negative-feedback loop is closed, a loop which helps to maintain equal potentials across V2 and V3.

Turning now to the a.c. or signal conditions; the collector of V1 drives the bases of V2 and V3, which conduct on alternate half cycles, V2 on the negative and V3 on the positive half cycles. R_3 provides a small forward bias for the output pair of transistors, to eliminate crossover distortion. As R_5 is taken from the "earthy" end of the loudspeaker there is no signal feedback. If, on the other hand R_5 is taken from the "live" end of the loudspeaker there is feedback and the power gain of the stage falls by about 10dB. There is, nevertheless, some feedback due to the fact that the full output voltage of V1 is not applied between the base and emitter of the output transistor because of the presence of the load in the emitter circuit, but this has been corrected by including the bootstrap circuit C_2, R_1. The overall voltage gain of the stage is about 44dB and the input impedance is about 1kΩ.

In order to estimate the correct conditions for the driver transistor the following method may be used. Considering the half cycle when V2 conducts, the peak output current occurs when the driver just cuts off and at this instant all the base current i_{bV2} of V2 is supplied by R_2. The voltage which drives this current will be equal to 6 volts which is the supply voltage across V2, and this drive will also have to overcome the input impedance R_{in} of V2 and

* Plessey Co. Ltd.

the reflected load $\beta_{V2}.R_L$, where β is the common-emitter current gain.

$$\therefore (R_2+R_{in}+\beta_{V2}.\,R_L).\,i_{bV2}=6\text{ V} \quad \ldots. \quad (1)$$

i_{bV2} in turn will be equal to $1/\beta_{V2}$ times the peak load current,

$$\therefore i_{bV2}=(1/\beta_{V2}).\sqrt{(2\times\text{peak power}/R_L)} \quad .. \quad (2)$$

Considering a current gain $\beta=50$ and for 100 mW output it follows that:—

$$i_{bV2}=1\text{ mA}$$
$$R_2+R_{in}=2\text{ k}\Omega.$$

Since R_{in} is only about 100 ohms, R_2 should be slightly less than 2,000 ohms. Alternatively, if $\beta=100$ and for 150 mW output:—

$$i_{bV2}=0.61\text{ mA}$$
$$R_2+R_{in}=1.8\text{ k}\Omega.$$

It is clear that to increase the output power the β of the output stages should be increased. On the other hand, to increase the output power by reducing the speaker load leads, unfortunately, to excessive current consumption by the driver stage (because R_2 would have to be reduced) and this would reduce markedly the battery life.

The correct collector current for V1 is estimated from

$$i_{cV1}=6/(R_1+R_2+R_3/2)=2.75\text{ mA}$$

The linearity of the output is shown in Fig. 2 and indicates the circuit operates satisfactorily up to outputs of approximately 150 milliwatts. A 12-volt battery supply has been used as this allows a much greater degree of flexibility throughout the design of the receiver circuits; this may be slightly higher than normal but it is single-ended.

Detector Stages.—The output stage just described may be driven directly from a detector stage using the conventional series-diode circuit. However, this form of detection may not always be the most efficient type because of the series resistance of the diode. The following measurements were made to compare the performance of series-diode, shunt-diode, and transistor-detector circuits. Fig. 3 shows the three circuits that were explored and in circuits (i) and (ii) the transistor is the final i.f. amplifier and the diode detects; each circuit was adjusted for maximum performance. In (i) and (ii) a ceramic wave-filter element can be connected across the collector load of the transistor if increased i.f. selectivity is required. However, a comparison of the voltage conversion gain from i.f. to a.f. suggests firstly, that the shunt-diode is more efficient than the series connection, and secondly, the transistor detector is more attractive as a diode is not used.

In Fig. 3(iii) the transistor acts both as the a.f. amplifier and the rectifying amplifier[3]. R_1 mainly determines the direct potential on the collector as the effective load is the input impedance of the next stage. The emitter current is adjusted by varying the forward bias on the base until maximum sensitivity is obtained, noting that the current required for optimum detector efficiency is usually lower

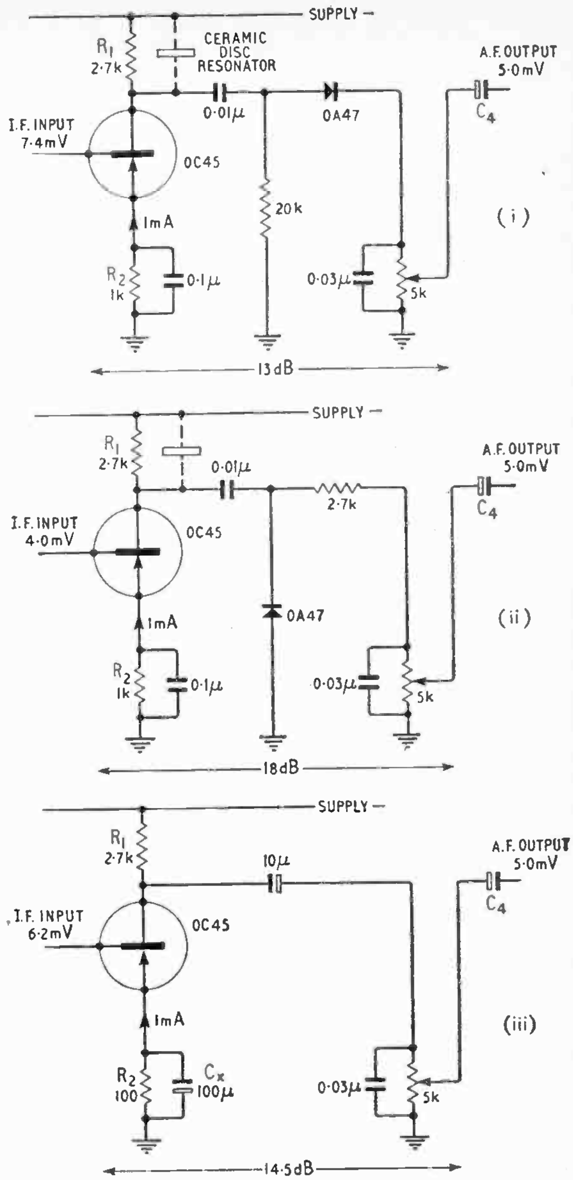


Fig. 3. Series (i)- and shunt (ii)- detector circuits and their final i.f. amplifiers compared with transistor-detector equivalent (iii). I.F. input (modulated 30% at 400c/s) shown produces 10mW a.f. output in 1-kΩ following load.

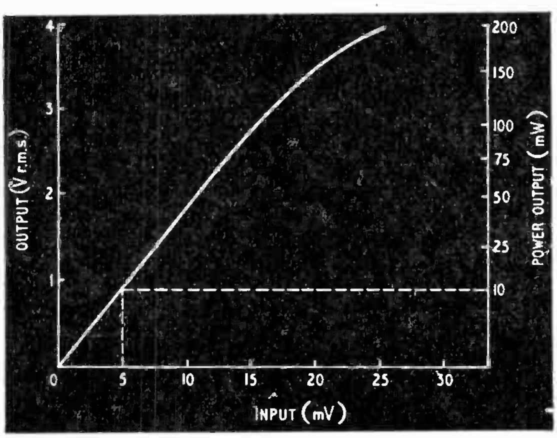
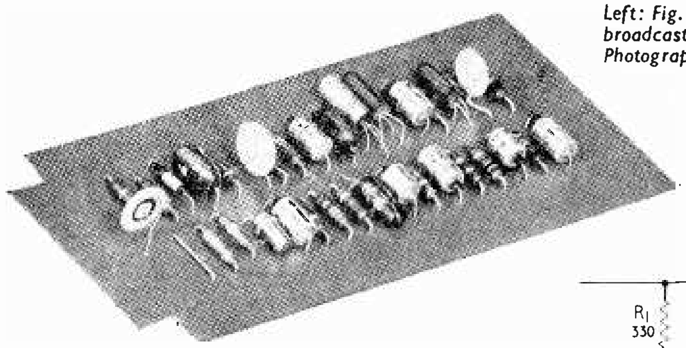
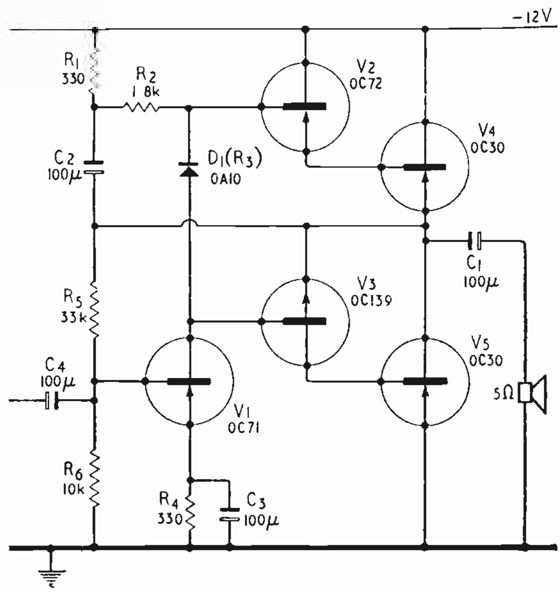


Fig. 2. Input/output characteristic of audio-frequency amplifier and power output stage shown in Fig. 1.

Left: *Fig. 4. Photograph of i.f., detector and a.f. stages of broadcast receiver assembled on a printed-circuit board. Photograph is about half-size: i.e. board is under 6-in long.*



Below: *Fig. 5. Medium-power (2-W) a.f. amplifier and output stage using 150-mW amplifier of Fig. 1 as basis of driver stage.*



than that required for maximum β. R_2 is included to provide d.c. and thermal stability; the value chosen is such that when a signal is present it does not unduly disturb the operating conditions. The stage also produces amplified a.g.c. and the preceding i.f. stage can be so biased that an overload-protection diode is no longer necessary[4]. The emitter bypass capacitance C_X is shown as an electrolytic in Fig. 3(iii): $0.1\mu F$ may be used at the expense of slight reduction of a.f. gain, but this gives the advantage of a.f. negative feedback.

Practical Construction.—To illustrate the simplicity of construction of the type of circuit just described, Fig. 4 shows a half-scale photograph of a printed-circuit-board assembly containing the a.f., detector and i.f. stage of a standard receiver. The a.f. and detector circuits are as described in Fig. 1 and Fig. 3(iii). The two small discs at the left-hand end of the board are piezoelectric ceramic i.f. transformers[1].

Higher Power Audio Stage.—For the better quality receiver, a higher-power a.f. stage is essential and power outputs of up to 2 watts may be desired. This would include both the car radio and f.m./a.m. home use where, on certain types of programme, strong peaks that would almost certainly be distorted by the 150-milliwatt stage occur even in low-level listening.

Fig. 5 shows the circuit and component values of the complete a.f. stage that will deliver 2 watts into a 5-ohm load. It will be observed that Fig. 5 is an extension of Fig. 1 and again represents a circuit which aims at the best output for the simplest design. The circuit may be described by extending the description of the previous audio stage. The complementary pair V2 and V3, acting as phase splitters, now drive the p-n-p output transistors V4 and V5: hence the last two stages both operate in a Class-B mode. The junction of C_2 and R_5 and the output terminal is again held at -6 volts by the feedback through R_5 controlling the current through the transistor V1. The small forward bias for both pairs of Class-B transistors is again derived in V1 load; but R_3 has been replaced by a junction diode which has a negative temperature coefficient and hence improves the temperature-stability factor of the overall circuit. R_1 and C_2 again form the bootstrap circuit enabling the full output of the driver to be applied to both halves of the following stages. The final stages V4 and V5 are also driven from low-impedance sources and this reduces the effect of current-gain fall-off at large drive currents. Consequently the proportion of distortion components in the output is reduced.

The design procedure is exactly similar to the previous amplifier. Here, however, as the driver only "sees" the loudspeaker through V2 and V4, β_{V2} of expressions (1) and (2) becomes $\beta_{V2}.\beta_{V4}$, whilst the input impedance of V2 is now much higher, at about $1k\Omega$, because of the emitter load.

Thus for 2 watts into a 5-ohm loudspeaker:—

$$i_{bV2}=(1/50.30)\sqrt{(4/5)}=0.6 \text{ mA},$$

$$\therefore \quad R_2+R_{in}=2.5 \text{ k}\Omega,$$

$$\therefore \quad R_2=1.5 \text{ k}\Omega. \text{ (A higher } \beta \text{ would increase the estimate).}$$

A 1.8 kΩ resistor was used in the practical circuit, the correct d.c. for the driver is then again 2.75 mA. This current is set by R_5. The bleed current through R_5 should be high relative to $I_{c0}+I_c/\beta_{V1}$ to minimize temperature drift effects and the unbalancing action of the circuit due to differences between individual transistors.

The quiescent current for the complete stage is about 5 milliamps, whilst a musical programme may average about 50 mA. The battery supply is again a single-ended 12-volt source.

Further Improvements.—Although there is no detectable distortion on a.m. reception at high listening levels using the circuit shown in Fig. 5, the amplifier may be elaborated to give even better quality if it is used, say, for f.m. receivers. The frequency response appears adequate, but for wider bandwidths the higher harmonics of distortion may become noticeable. Possible extensions of the design would be the inclusion of resistors across the base-emitter junction of V4 and V5 to reduce the variation in input impedance of the final stages; also a resistor could be inserted in series with the emitter of V3 to balance the impedance seen by V1 on both halves of the signal cycle. The capacitance of C_1 would obviously have to be increased to make full use of the bass response, but listening to the amplifier with the loudspeaker mounted on a large baffle indicates that most of the low frequencies are reproduced.

On the other hand, if cost is important the following modifications can be made. The speaker can replace R_1, thereby dispensing with R_1 and C_1, provided the feedback in Fig. 1, introduced by connecting R_5 to the emitters of V2 and V3 and the d.c. through the loudspeaker can be tolerated and, secondly, R_4 and C_3 may be left out if a much lower value for R_6 is acceptable.

REFERENCES

[1] "Ceramic I.F. Filters Match Transistors," D. Elders and E. Gikow, *Electronics*, p. 59, April 25, 1958: (Vol. 31).
[2] *Handbook of Semiconductor Electronics*, Ed. L. P. Hunter. McGraw Hill, 1956.
[3] "Transistor-Amplified A.G.C.," W. Woods-Hill, *Wireless World*, February, 1958: (Vol. 64, p. 94).
[4] "Transistor A.G.C. Circuits," *Wireless World*, November 1959: (Vol. 65, p. 508).

Manufacturers' Products

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Transistor Control Relay

IN some control systems it is necessary to use either very light or high-resistance contacts. In the first case even slight arcing can damage seriously the device and, with high-resistance contacts, it is often difficult to provide easily for satisfactory operation. The Electro Methods Control Relay Type 273B uses a maximum control-circuit power of less than 5mW, and this sensitivity is achieved by the use of a transistor which switches the current through the coil of a mechanical relay. The control circuits are completely isolated from the mains supply (200 to 250V, 50 to 60c/s) which powers the Control Relay. Indicator lamps, denoting the state of the relay, are fitted.

The load-switching capacity of the main relay is 15A at 250V a.c. (non-inductive) and the connections can be arranged so that the unit "fails safe." Manufacturers: Electro Methods, Ltd., Caxton Way, Stevenage, Hertfordshire.

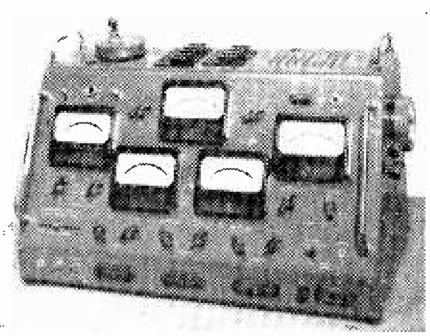
Valve Analyser and Bridge

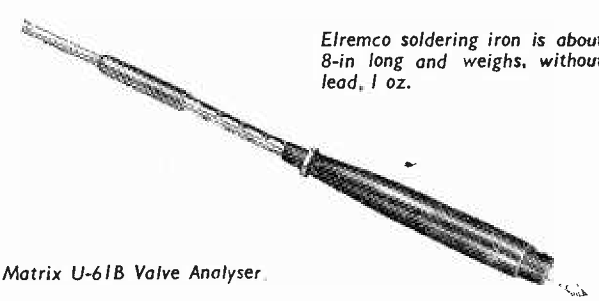
DESIGNED for laboratory investigations rather than the quick checking of valves in a servicing workshop, the main feature of the Metrix Type U-61B valve analyser is that valve-electrode potentials and currents may be indicated simultaneously and separately on five large-scale meters. Four, separate, independently-variable, stabilized power supplies feed a maximum of two screen-grid, one anode and one control-grid electrodes and heater supplies between 1.1V, 3A and 117V, 0.15A are available. Due to the provision of stabilized supplies it is possible to plot manually a valve's static characteristics with the minimum of incidental readjustment of electrode potentials. These supplies may also be used for the energizing of apparatus external to the tester: sockets for output are provided on the front panel. An unusual point is that the multitude of seldom-used sockets fitted to most valve testers is avoided by the provision of individual plug-in panels carrying one or two sockets. With the addition of the Valve Bridge Type 661 (which can be used independently) dynamic characteristics can be measured at a variety of electrode potentials.

The Valve Analyser costs £275 and the Bridge £370: both are available from Metrix Instruments, Ltd., 59 Victoria Road, Surbiton, Surrey.

Lightweight Low-Voltage Soldering Irons

THE Elremco soldering iron Type SMS is available in several ratings between 10W and 75W at 20V. Primarily designed for use with the Elremco low-voltage bus-bar installation, the high bit temperature makes possible soldering direct to equipment chassis, large solder lugs, etc., without changing to an iron of higher rating than that used for wiring. Twenty standard bits are available with tip diameters from $\frac{1}{16}$-in to $\frac{5}{16}$-in and the bit and metal stem are electrically isolated from the element and it connections, so making the iron particularly suitable for work on transistor equipment. The moulded-plastics handle has a hexagon-shaped section, which reduces to a minimum the chances of rolling when set down: the weight of the iron, without cable, is about 1oz, and the price is 11s 10d each for quantities of 100 and over. Manufacturers: Electrical Remote Control Co. Ltd., The Fairway, Bush Fair, Harlow, Essex.





Elremco soldering iron is about 8-in long and weighs, without lead, 1 oz.

Left: Matrix U-61B Valve Analyser

WORLD OF WIRELESS

E.F.F.I. Conference

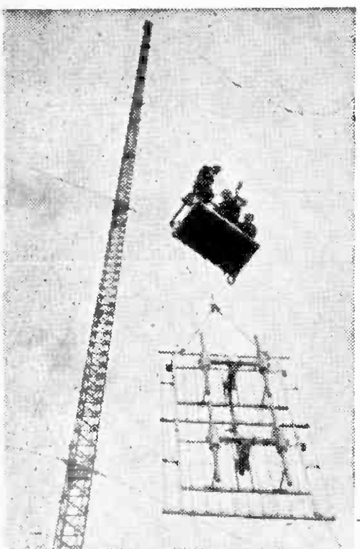
THE Electronic Forum for Industry, consisting of associations with common aims in making better known the developments and applications of electronics in industry, is to hold a three-day conference at Olympia, London, during the forthcoming Instruments, Electronics and Automation Exhibition. Details of the conference, which will be held on May 24th, 25th and 26th, will be announced later, but, broadly, the three sessions will cover practical experience of data processing, factory applications (including machine tool control) and instrumentation.

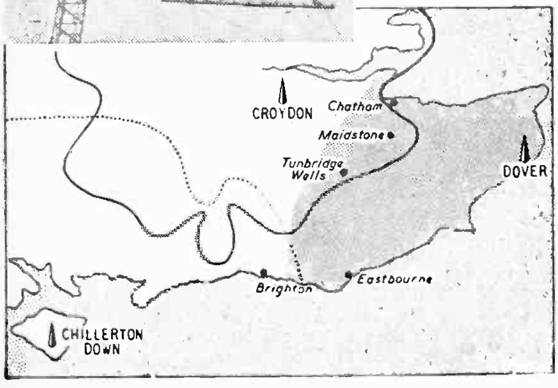
A prospectus and form of application will be available shortly from the E.F.F.I., c/o The Electronic Engineering Association, 11 Green Street, London, W.1.

Domestic Receiver Production

DESPATCHES of both television and sound radio receivers were at record levels in 1959, according to provisional figures based on returns supplied by members to the British Radio Equipment Manufacturers' Association, which gave the net figures of deliveries by manufacturers to the home trade, including those to rental and relay companies.

The year's despatches of TV receivers totalled 2,745,000, which was 36% above 1958, the previous highest year. The total of 1,551,000 for sound receivers was 19% more than that for 1958 and 14% above 1957, the previous highest year. Despatches of radiogramophones at 187,000 were 14% lower than for 1958 and 30% below 1957.





***Estimated service** area of the new I.T.A. station at Church Hougham, near Dover, is shown (shaded) in relation to the 0.5mV/m contours of the London and Isle of Wight stations. Inset, riggers are shown ascending the 750-foot mast (erected by B.I. Callender's) with the channel 10 aerials (designed by E.M.I.). The aerials are screened to reduce to a minimum radiation towards France. Transmissions are vertically polarized with a vision e.r.p. of 100kW in the direction of maximum radiation. The transmitters and associated equipment were installed by Marconi's and the station is operated by Southern Television in conjunction with the Chillerton Down station.*

1961 Computer Exhibition

ALTHOUGH the 1958 exhibition of electronic computers was intended to be a "once only" show, the joint organizers, the Electronic Engineering Association and the Office Appliance and Business Equipment Trades Association, have been encouraged to hold another. It will be held in the National Hall, Olympia, London, from October 4th to 12th next year. A business computer symposium will again be held concurrently with the exhibition.

Audio Fair

DEMONSTRATION rooms have been booked by nearly all the 70 or more exhibitors with stands at the forthcoming Audio Fair to be held in the Hotel Russell, London, W.1, from April 21st to 24th. We hope to publish a list of exhibitors in our next issue.

As in past years, free admission tickets will be available from the organizers (Audio Fairs, Ltd., 22 Orchard Street, London, W.1), exhibitors, audio dealers and *Wireless World*. As some of the tickets are for specific days, it would help if applicants stated their day of preference, and they are also asked to enclose a stamped addressed envelope.

P.A. Show.—Twenty exhibitors have taken space at the exhibition being arranged by the Association of Public Address Engineers at the King's Head Hotel, Harrow-on-the-Hill, Middx., on March 9th. In the morning admission is restricted to A.P.A.E. members and the Press, in the afternoon to the trade, but from 5.0 to 7.30 the public will be admitted. Free tickets are obtainable from Alex J. Walker, 394 Northolt Road, South Harrow, Middx.

The Electronic Organ Constructors' Society, proposed in a letter from A. Le Boutillier in our September, 1959, issue, has now been formed. Its objects are to "encourage and assist amateurs in the construction of organs [electronic and pipe] and to provide opportunities for the exchange of ideas and technical information." Alan Douglas is president, L. W. Roche, chairman, and A. Le Boutillier, whose address is 26 St. Catherine's Road, Chingford, London, E.4, is secretary.

B.A.R.T.G.—A change of title without altering the initials has been made by the British Amateur Radio Teletype Group since their attention has been drawn to the fact that the word "Teletype" is a registered trade mark. The word "teleprinter" has been substituted.

Transistors and transistor parts may now be imported from the Dollar Area without a Board of Trade Licence. Imports of Japanese transistors and transistor sets are still subject to control.

"Rocket and Satellite Instrumentation" is the title of a one-day symposium being organized jointly by the Society of Instrument Technology and the British Interplanetary Society for September 1st in London. Subjects it is proposed to cover include a design study of a communications satellite; a digital data reduction system for use in the static testing of rocket motors; transducers for rocket motor testing; and the measurement, transmission and recording of data in the Skylark missile.

Non-Destructive Testing.—The general theme of a joint meeting between the Non-destructive Testing Group of the Institute of Physics and the Société Francaise de Métallurgie, to be held in London from May 2nd to 4th, will be the relationship between structure and physical properties of metals. Details of the programme, which will include papers on recent advances in non-destructive testing techniques, are obtainable from the Institute, 47 Belgrave Square, London, S.W.1.

Ten Million.—Last year's increase of 1,215,352 in the number of combined TV/sound licences in the U.K. brought the total at the end of the year to 10,114,419. The first million television licences was reached in 1951—five years after the introduction of television licences—and since 1953 the average annual increase has been about 1,200,000.

Italian V.H.F.—Reference was made in January (page 12) to the rapidly increasing number of v.h.f. sound broadcasting stations in Italy. The story is going around that when the European Broadcasting Union asked the Italian broadcasting organization how many v.h.f. stations they had in service, on December 31st, they asked if they wanted the morning or evening total!

B.A.T.C. Convention.—The fifth Amateur Television Convention arranged by the British Amateur Television Club will be held on September 10th, in the Conway Hall, London, W.C.1. Details will be available later from D. S. Reid, 149 Ongar Road, Brentwood, Essex.

R.S.G.B. Officers.—The new president of the Radio Society of Great Britain is W. R. Metcalfe (G3DQ) of Whitby, Yorks. The executive vice-president is H. A. Bartlett (G5QA), who was president in 1955. The four ordinary members of the council elected at the recent annual general meeting are: C. H. L. Edwards (G8TL), R. C. Hills (G3HRH), A. O. Milne (G2MI) and G. M. C. Stone (G3FZL).

Relay Services Association.—Sir Walter Womersley, Bart., president of the Relay Services Association since 1948, has again been re-elected. J. W. Kinsman (Relay Exchanges) has become chairman of the council with B. R. King (British Relay Wireless) as deputy chairman.

B & K Laboratories, who have for the past five years organized an international instruments show in London, have decided not to hold one this year. When their show was conceived all the existing major exhibitions were national rather than international in character. This is no longer true. In making this announcement B & K Laboratories state, "We are not exhibition organizers and we hope that specialists in this field will continue the trend towards larger and better *international* exhibitions."

An international festival of sound is being held in Paris from March 18th to 23rd. Organized by the Syndicat des Industries Electroniques de Reproduction et d'Enregistrement (S.I.E.R.E.), it includes an exhibition, demonstrations of equipment, conferences and demonstrations of stereo f.m. transmissions by the French broadcasting authority, R.T.F.

A Moscow exhibition of British scientific instruments is being organized by the Scientific Instrument Manufacturers' Association for June 16th to 26th.

"Marine Electrics."—Electronic and electrical equipment from the aircraft carriers *Victorious* and *Hermes* will be included in the "Marine Electrics" feature at the 9th National Electrical Engineers Exhibition at Earls Court from April 5th to 9th.

Dip. Tech. Awards.—Sir Harold Roxbee Cox, who has succeeded Lord Hives as chairman of the National Council for Technological Awards, presenting a Diploma in Technology to Ian Stanley (A.E.I. Research Laboratories), one of the first five successful candidates from the Northampton College of Advanced Technology, London. Other recipients, all of whom had completed a four-year sandwich course in applied physics which is heavily biased in electronics, were: Edward Feakes (R.A.E.), Frank Jacob (Vickers Armstrong), John Swain (A.W.R.E.) and Shirley Wallis (R.A.E.), the first woman to receive the Diploma.

Education and Training.—"The changing pattern of electrical engineering education and training" is the theme of a conference to be held at the Polytechnic, Regent Street, London, W.1, on the morning of March 8th. Particulars of the conference, of which R. E. Burnett, managing director of Marconi Instruments, is chairman, can be obtained from the Regional Advisory Council for Technological Education, Tavistock House South, Tavistock Square, London, W.C.1.

Teacher Training.—Many of the 2,000 or more teachers recruited each year for technical colleges join the staffs direct from industry. Special one-term courses aimed at improving the quality of teaching are now being provided for such teachers at four colleges. Course will start after Easter at the three Technical Training Colleges—Bolton, Huddersfield and Garnett College, London—and the College of Technology, Wolverhampton.

Vacation Courses.—Sound radio and TV servicing and telecommunication engineering are among the wide variety of subjects listed in the "Programme of Short Courses" for teachers and others in the educational service arranged by the Ministry of Education for the Easter and Summer vacations. The 30-page booklet is obtainable from the Ministry, Curzon Street, London, W.1.

A two-day conference on "The training of the industrial physicist" is being held by the Institute of Physics in Birmingham on April 21st and 22nd. Detailed programmes and registration forms are available from the Institute, 47 Belgrave Square, London, S.W.1.

Analogue Computing Techniques.—A five-day introductory course on analogue computing techniques is being conducted at the Loughborough College of Technology, Leicestershire, from April 11th. The fee for the course is 10 gns, plus 5 gns for residence.

Personalities

The Hon. R. T. B. Wynn, C.B.E., M.A., M.I.E.E., Chief Engineer of the B.B.C. since 1952, is retiring on April 19th. Educated at Uppingham School and Trinity Hall, Cambridge, he received his engineering training with Siemens Bros. In 1922 he joined the staff at Marconi's experimental station at Writtle, Essex, where he was associated with the early broadcasts. He joined the B.B.C. in 1926 as head of the Technical Correspondence Department. Mr. Wynn, who is 62, has successively been head of the Operations and Maintenance Department and assistant chief engineer. **F. C. McLean,** C.B.E., B.Sc., M.I.E.E., Deputy Chief Engineer of the B.B.C., succeeds Mr. Wynn. The post is being redesignated Deputy Director of Engineering and the post of deputy chief engineer is being abolished. Mr. McLean, who is 56, joined Standard Telephones & Cables in 1925 after graduating at Birmingham University. He left S.T.C. to join the B.B.C.'s Planning and Installations Department in 1937. He headed various groups within the Engineering Division prior to his appointment in 1952 as Deputy Chief Engineer. He has been a member of the Radio Research Board since 1958.

F. C. McLean

K. G. Smith

K. Graham Smith, this year's vice-president of the Radio and Electronic Component Manufacturers' Federation, has been appointed deputy managing director of N.S.F. Ltd. He joined the company nearly 20 years ago as chief engineer and has been a member of the board since 1947. He has represented N.S.F. on the council of the R.E.C.M.F. for some years and was chairman in 1958/59. N.S.F., who are members of the Simms Motor and Electronics Corporation, also announce the appointment of **Percy C. D. Mace** as a director. He was for some years works manager of Welwyn Electrical Laboratories, and since March 1958 has been general manager of the N.S.F. works at Keighley, Yorks.

S. R. Wilkins, who, as announced in "News from the Industry," succeeds **J. H. Rawlings** as managing director of Avo Ltd., joined the company (then known as the Automatic Coil Winder and Electrical Equipment Company) in 1934. Six years later he was appointed chief electronic engineer and manager of the electronic instrument section in charge of design and production. He became technical director in 1956.

W. P. Rowley, M.B.E., M.Brit.I.R.E., has joined W.S. Electronics Ltd., a wholly owned subsidiary of K.G. (Holdings) Ltd., as assistant managing director. During the war he was commissioned in the Royal Corps of Signals and after a period as lecturer in radio at No. 1 Radio Mechanics School, was appointed Staff Officer (Wireless) to the Signal Officer in Chief, G.H.Q., Home Forces. He later held a similar appointment with S.H.A.E.F.

W. P. Rowley

E. A. W. Spreadbury

E. A. W. Spreadbury, M.Brit.I.R.E., who, as announced briefly last month, has succeeded **E. M. Lee,** of Belling and Lee, as chairman of the Radio Trades Examination Board, has been associated with the work of the Board since 1943 when he was appointed an examiner and a member of the examinations committee. Mr. Spreadbury represents the Brit.I.R.E. on the Board's council of management. Since 1941 he has been technical editor of *Wireless & Electrical Trader,* which he joined in 1937 after spending 14 years in the radio industry.

Air Commodore W. E. G. Mann, C.B., C.B.E., D.F.C., M.I.E.E., R.A.F. (Ret.), Director-General of Navigational Services in the Ministry of Transport and Civil Aviation since 1950, recently retired. At one time during the war he was Chief Signals Officer, **R.A.F.,** Middle East, and since joining the Ministry in 1945 as Senior Signals Officer and U.K. Representative, Middle East, had held several administrative telecommunications posts.

R. H. Vivian, B.Sc., A.M.I.E.E., has joined Wireless Telephone Company, Ltd. as chief engineer. For many years he was development engineer in charge of transistor investigations and applications with **A. C.** Cossor Ltd. and since 1957 has been resident consultant with Associated Industrial Consultants Ltd.

R. H. Vivian

R. C. Parry

Roy C. Parry has joined Mullard Ltd. to take over the duties of Government Liaison Officer, covering valves, tubes, semiconductors and components. He was previously with Marconi's W/T Co., where he led a section engaged in the design of naval radar equipment. Before joining Marconi's he served for a number of years in the Royal Navy.

Consequent upon the setting up of five new divisions under the reorganization of the A.E.I. group (see January, page 16), a number of appointments have been made. Four of the new divisions—telecommunications, radio and electronic components, cable and construction —are managed by A.E.I. (Woolwich) Ltd., previously Siemens Edison Swan. The board of directors of A.E.I. (Woolwich) includes **Lord Chandos** (chairman), **Dr. J. N. Aldington** (group managing director), **Dr. T. E. Allibone** (director of research), **L. S. Crutch** (director engineering, telecommunications). **G. W. Giffin** and **J. T. Thornhill** (directors of manufacture), **B. A. Hensler** (director, export), **J. W. Ridgeway** (commercial director), **A. Whitaker** (director of engineering, radio), **S. E. Goodall** (director of engineering, cable), **R. L. Basset** and **A. F. Street.** Except for the resignation of Sir Alexander Sim and the inclusion of S. E. Goodall (formerly chief engineer of Henley's Telegraph Works), the board is unchanged from that of Siemens Edison Swan. In the Radio & Electronic Components Division **C. C. McCallum,** A.M.I.E.E., becomes general manger. He joined Metropolitan-Vickers radio department in 1928 and two years later transferred to Edison Swan's

A. Whitaker

C. C. McCallum

radio valve department and was for ten years service department manager at the Cosmos works, Brimsdown. **A. G. Everett,** divisional manufacturing manager, has been with the organization since 1920 when he joined Metro-Vick as a college apprentice. He was appointed a director of Edison Swan Electrical Co. in 1948. **J. Donegan,** B.Sc., A.C.G.I., D.I.C., engineering manager (development), was a valve development engineer, becoming chief engineer valves and c.r. tubes on the merger of Siemens and Edison Swan. He is vice-chairman of the engineering advisory committee of the British Radio Valve Manufacturers' Association. **C. L. Hirshman,** A.C.G.I., D.I.C., now engineering manager (consultative), has been at the organization's Brimsdown applications laboratories since 1931. The divisional sales manager is **P. V. Lister.**

The following appointments are announced in the Telecommunications Division: **W. G. Patterson** (general manager); **J. M. Wilcox** (manufacturing manager); **F. G. Pheazey** (chief engineer); **T. J. Scudder** (production engineering manager); and **D. J. Green** (commercial manager). In the Cable Division the general managers are **J. S. A. Bunting** and **E. J. Vidler;** manufacturing managers, **V. L. J. Flascott** and **S. J. Wilson;** chief engineers, **W. G. Hawley** and **J. H. Savage;** sales manager, **H. D. Parsons;** and commercial manager, **F. V. Vaissiere.** In the Construction Division, **A. V. Burnett** is general manager; **W. Sim,** chief engineer; and **L. F. Capeling,** commercial manager.

B. C. Cook has joined Wolsey Electronics Ltd. as technical consultant Vision Network Systems. He has for many years been with Belchers Ltd.

T. Kilburn, D.Sc., Ph.D., M.A., M.I.E.E., reader in electronics at Manchester University, has been appointed to the newly created post of Professor of Computer Engineering in the University. Dr. Kilburn, who was at the R.R.E., Malvern, from 1942 to 1946, co-operated with Professor F. C. Williams, head of the electrical engineering laboratories, Manchester University, in building in 1948 the University's first computer, on which was based the Ferranti Mark I. He later worked on the prototype of the Mercury computer and since 1957 has been engaged on the transistorized computer to be known as Muse.

Harry Cartwright, M.B.E., M.A., A.M.I.E.E., the new Director of Industrial Power in the Atomic Energy Authority's development and engineering group at Risley, Derbyshire, was with the English Electric Co. immediately prior to joining the Atomic Energy Division of the Ministry of Supply (forerunner of the A.E.A.) in 1949 and was previously with the Decca Navigator Co. Mr. Cartwright, who is 40, took a first class honours degree in the mechanical sciences tripos at St. John's College, Cambridge, in 1940 after which he was a signals officer at R.A.F. ground radar stations He has successively been chief engineer and deputy director of the group of which he is now appointed director.

OUR AUTHORS

L. H. Bedford, C.B.E., M.A., B.Sc.(Eng.), F.C.G.I., F.I.R.E., M.I.E.E., M.Brit.I.R.E., director of engineering at the Guided Weapons Division of the English Electric Co., writes in this issue on an aspect of one of his hobbies—tape recording. Mr. Bedford, whose name is associated with the elevation attachment which he produced for the early gun-laying radar equipment, started his industrial career with the Western Electric Co. and spent some months at the Bell Telephone Laboratories in America. He joined A. C. Cossor in 1931 to initiate their development and manufacture of cathode-ray tubes. He stayed with that company until 1947 when he joined the English Electric group as chief television engineer of Marconi's W/T Co. Mr. Bedford was president of the Brit.I.R.E. from 1948 to 1950 and was appointed a member of the technical sub-committee of the Government's Television Advisory Committee in 1955.

Ralph Brewer, who was for some years in charge of the valve life-testing department of the G.E.C. Research Laboratories, is now concerned with the study of the survival characteristics of transistors and related semiconductors, and contributes an article on this subject on page 108. Mr. Brewer, who is 45, joined the Research Laboratories in 1937 and during the early part of the war worked on the development of magnetrons. He received an award for his paper on life testing of valves read at the 1958 National Symposium on Reliability and Quality Control in Electronics in the United States.

R. C. V. Macario, B.Sc., Ph.D., Grad.I.E.E., joint author of the article in this issue on transformerless broadcast receivers, graduated in 1953 at King's College, London, where in 1956 he completed post-graduate studies concerned with the propagation of very low-frequency radio waves. Subsequently he spent some time at the A.E.I. Research Laboratories on semiconductor devices, and in 1958 joined the Plessey Company, where he is working on solid-state magnetic and dielectric devices.

N. E. Broadberry, Grad.Brit.I.R.E., who with Dr. Macario contributes the article on p. 110, attended the Institute of Science and Technology, Dublin, specializing on receiver design and after spending a year with Pye (Ireland) and nearly three years as a civilian radio and radar specialist on a military aerodrome, joined Murphy Radio (Ireland) for three years. In 1953 he became a lecturer at his former college. He joined Pye (Cambridge) in 1955, and last year was appointed a senior electronic research engineer with Plessey.

Physical Society's Exhibition

NEW TECHNIQUES IN ELECTRONICS AND MEASUREMENT

THERE are very few fields today in which electronics does not play some part: it has seemed even as if electronics were becoming a hydra-headed monster, judging by the complexity of some sections of the art. However, following last year's trend, many of the exhibits suggested by their ingenious simplicity and application of first principles that the monster is being changed into a well-mannered pet. A selection of these items is described in the following report.

The exhibition itself was even more crowded than it was last year and the organizers were unable to accommodate thirteen would-be exhibitors who had applied for space.

INDUSTRIAL ELECTRONICS

Electrical Power from Heat, without the usual intermediate mechanical stage, was the theme of a display on the stand of the United Kingdom Atomic Energy Authority.

Two working demonstrations were shown—a thermionic method using a diode, and a semiconductor thermojunction heated by steam. The diode used a bright-emitter tungsten filament and a caesium-vapour filling—this latter neutralizes the emission-inhibiting effect of the space charge which gathers round the cathode of an unsaturated diode—and produced a small but nevertheless useful current. Although the diode is primarily a d.c. generator it is possible that, by modulation of the gas discharge, a.c. may be produced. Of course, the power input to the demonstration model was far greater than its power output, but the eventual hope for this means of power generation lies in the use of hot fuel rods (at about 2,000°C) of an atomic pile as the cathodes, the physical construction being such that individual diodes are connected in series so generating high potentials. The thermojunction—really a modern version of the thermocouple—used bismuth telluride semiconducting elements. Again the power output was far smaller than the input, but this method may be economical for "mopping up" waste heat from an atomic reactor.

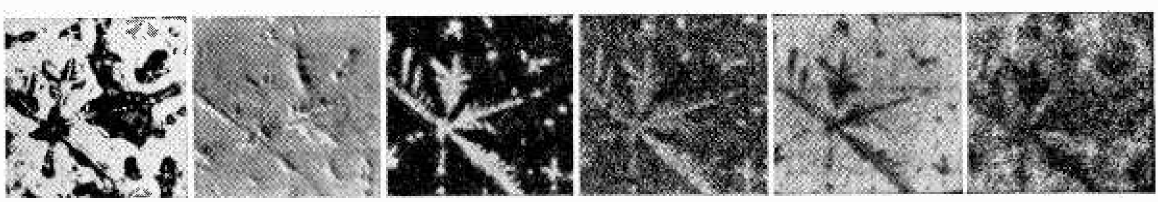
The magnetohydrodynamic method uses a jet of ionized gas to replace the moving conductors of a conventional generator and the power developed is "picked out" by electrodes placed in the gas flow. The practical application of this principle awaits the introduction of materials suitable for temperatures of about 2,000°C.

Associated with the display was a mechanical analogue (after Kaye of M.I.T.) of a diode valve. Delightfully clear in its presentation, a rotating ridged roller shot steel ball bearings up a plane with a double incline to represent work function and space charge. The balls with sufficient energy to reach the top of the plane ran down a shute (representing the external circuit) and rotated a small paddlewheel before returning to the "cathode." The paddlewheel formed part of a generator whose output deflected a galvanometer.

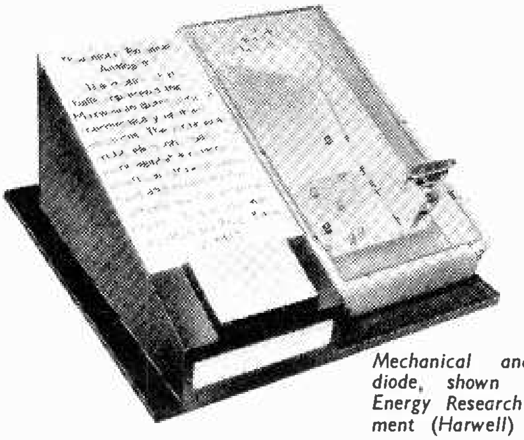
Radio Frequency Spectroscopy is employed for the routine analysis of free radicals (uncombined particles of the material)* in the Newport Instruments electron paramagnetic resonance spectrometer. As this instrument is designed for laboratory use it incorporates a large electromagnet and elaborate stabilization arrangements for the power supply to ensure a uniform (1 part in 10^4), constant and controllable field of between 150 and 8,000 gauss is achieved. The field is adjusted to bring the resonance being studied to 9.5Gc/s (9,500Mc/s) and elaborate precautions are taken in the waveguide assembly to ensure that accurate results are obtained—for instance, the klystron local oscillator is mounted in a constant-temperature oil bath. In operation the field is varied either at l.f. by coils on the pole pieces or at r.f. (100kc/s) by a single-turn coil round the specimen. The klystron output is thus modulated as the resonance in the sample passes through the local-oscillator frequency: but, to improve accuracy over the detection of a change of amplitude the local oscillator and "returned from sample" signals are mixed in a waveguide bridge and their relative phase is detected.

Microanalysis of Metallic Alloys by a technique originally developed in France by R. Castaing and applied by the Cambridge Instrument Company uses a 10^{-6}m.-diameter electron spot to scan a 0.5×10^{-3}m. square area of the sample. The beam is produced by an ordinary triode gun and focused by a double magnetic lens in the manner of an electron microscope. The etched

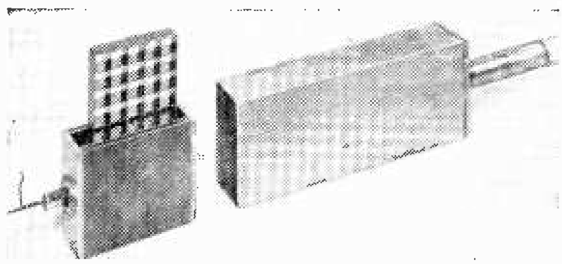
* For a fuller account of electron spin and nuclear magnetic resonances see *Wireless World*, p. 68, February, 1960.



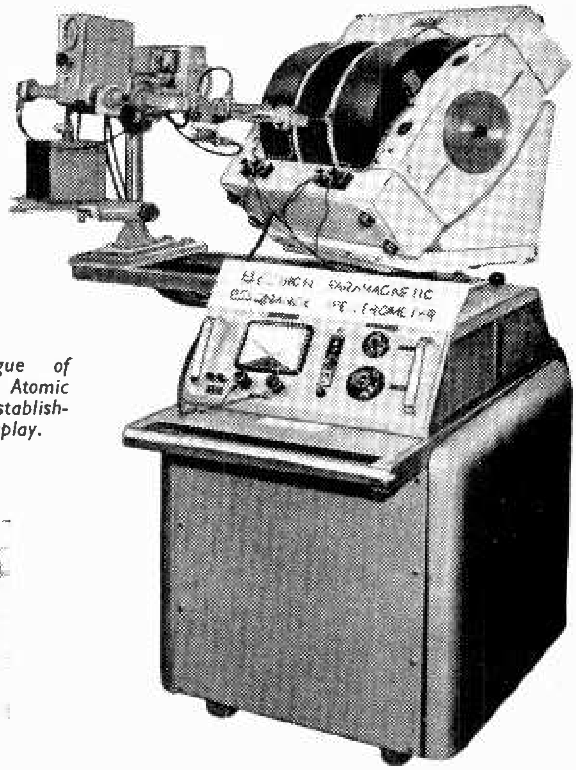
Images obtained with Cambridge Instruments Electron-probe X-ray Microanalyser during preliminary investigation of copper(70%)—nickel-tin-iron (10% each) alloy. L to R: optical, electron and X-ray(iron, nickel, copper, tin) images.



Mechanical analogue of diode, shown in Atomic Energy Research Establishment (Harwell) display.



"Exploded" view of Penning ion pump (Mullard Ltd.).



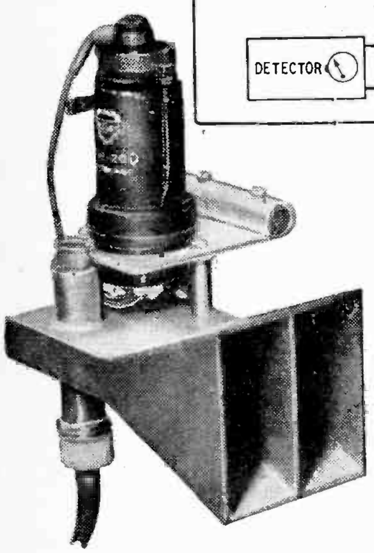
Newport Instruments electron paramagnetic resonance spectrometer, showing magnet and power supplies; also wave-guide bridge.

surface of the sample reflects some electrons and these cause the emission of light from a phosphor mounted near the sample; a photomultiplier produces from the light a signal which modulates the beam current of a cathode-ray tube, scanned in synchronism with the analyser beam. Thus an "electron picture" of the sample is built up. X-rays produced by the electrons that penetrate the surface of the sample strike an analysing crystal (gypsum or lithium fluoride) which "bends" them into a proportional-counter detector. The electrical signal from this is similarly used to produce an X-ray microgram. The wavelength of the X-rays produced by different metals varies, so that the angle through which the spectrometer crystal bends them also varies: thus by rotating the crystal the distribution of different metals in an alloy can be seen.

High-vacuum Maintenance is one of the problems associated with many electron devices and, whilst many ingenious approaches have been devised, few have the simplicity of the Penning ion pump. "Pump" is, perhaps, a misnomer, for the Penning gauge and the pump derived from it bear little resemblance to any of the commoner evacuating devices. The basic gauge is a cold-cathode discharge tube and the small current which flows under high potential is a measure of the pressure. The principle of operation of the pump is similar: a magnetic field causes electrons to take up a spiral path between the electrodes. This increases the volume swept out and hence the chance of ionization. Sputtering of the titanium electrodes occurs, so causing the titanium to act as a continuous getter. Two firms, Mullard and Edwards, were showing pumps based on the Penning-gauge principle. The Edwards pump was cylindrical in form with two cathode discs on either side of a wire-ring anode. A 500-gauss field and 3 to 5kV are applied, the current ranging from 0 to 15mA and depending naturally on the degree of ionization. The Mullard pumps use a horseshoe magnet producing some 1,000 gauss and the anode is made up as a rectangular honeycomb structure; also a small getter filament is included. Pumping speeds of 1 to 5 litres/sec and pressures down to 10^{-9} torr (mm of mercury) have been reached with Penning pumps.

Microscopic Measurements made by the use of a calibrated vertical traverse on the microscope are limited in accuracy to far below the maximum possible resolution of the microscope. However, Wayne Kerr have developed a technique using their B721 Electronic Micrometer which is a transformer-ratio bridge capable of measuring minute changes of capacitance. The microscope is fitted with a Baker interference objective (which makes exact focusing easy) and a non-contacting probe connected to the micrometer. In use the microscope is focused in turn on to the points representing the top and bottom of the "depth" to be measured, and the distance of the probe from the specimen is measured by the micrometer. Repeated measurements of the depth of the etching of photogravure printing plates gave results with a standard deviation of 5×10^{-6}in on a 2×10^{-3}in mean.

Displacement Measurement—Nearly all semiconductors increase in resistance when they are placed in a magnetic field. The use of this magnetoresistive effect, as it is called, to detect displacements down



Below: Doppler sensing head of Burndept press-output counter.

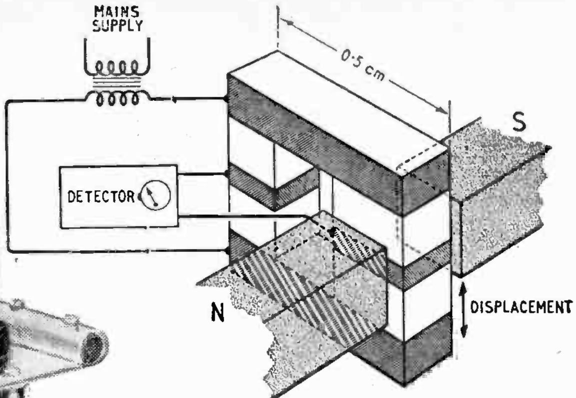


Diagram of the National Research Development Corporation magneto-resistive effect displacement meter. The soldered contacts are shown line-shaded and the direction of motion indicated by the arrows.

to about 10^{-8}cm was demonstrated by the National Research Development Corporation. The semiconductor used is indium antimonide (InSb), since in this the effect is relatively large. Four contacts are soldered on to InSb elements so that the resistances between these contacts form a Wheatstone bridge. Following normal practice, this bridge is energized from an a.c. supply across one pair of opposite contacts, and any out-of-balance signal detected between the other pair of opposite contacts. Two of the InSb resistors are arranged to be partially in a 10,000-gauss field produced by a permanent magnet, so that relative motion between the InSb and magnet in one direction moves one of these resistors further into the field and the other resistor further out of the field. The magnetoresistive effect then increases the value of the resistor which moves further into the field and decreases the value of the resistor which moves further out of the field. This unbalances the bridge and the out-of-balance signal gives a measure of the displacement of the InSb relative to the magnet.

Strain Gauges take many forms, but an unusual type was an "acoustic" gauge shown on the Acoustics Group stand. This consists of a length of ferromagnetic wire stretched between two massive supports on the body under test. Placed near the wire at its centre are two coils, one connected to the input of an amplifier and the other to the output. The connections are phased so that positive feedback takes place which results in oscillation at the resonant frequency of the wire. If the strain on the wire is altered, its frequency alters: thus the strain is given by measuring the frequency of oscillation.

Tachometer—A method of measuring rates of rotation shown by the National Research Development Corporation utilizes the magnetic field induced when a conducting cylinder rotates in a magnetic field. This induced field is at right angles to the original field, so it may be distinguished from the original field and measured by a detector, such as the fluxgate used, which measures only the component of the total field in the direction of the induced field. This method can be used to measure rotation rates as slow as 0·1 r.p.m.

A Doppler-radar Sensing Head was demonstrated with the Burndept BE250 press-output counter. The output from a small 3-cm klystron is fed into half of a waveguide horn radiator: in the other half is a mixer crystal. When a moving object passes the horn the radiation reflected from it beats with the klystron frequency at the mixer crystal, producing an a.f. pulse at the Doppler frequency. The sensitivity is such that the movement of a 2-BA washer one foot away can trigger the counter. Although this may sound an expensive method, it should overcome most, if not all, of the disadvantages of cutting beams of light or producing pulses in coils as oil and dirt should not affect it, and it will detect any object giving a reflection.

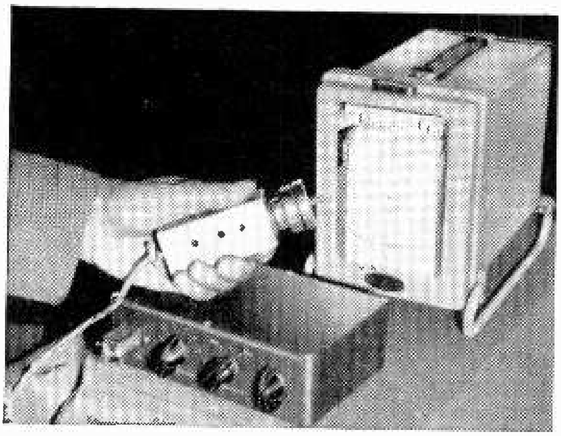
Ultrasonics are playing an increasing part in industrial measurement and test. An example of the measurement of fluid velocity in a pipe was shown on the B.S.I.R.A. stand. In this method two transducers are mounted in line along the outside of the pipe so that the beam transmitted by one is reflected from the opposite pipe wall and received by the second. As the propagation speed depends on the flow speed, the time difference between pulses travelling in each direction will represent the flow velocity. A novel feature of the arrangement is that, as both transducers operate simultaneously, the "forward" and "backward" waves travel the same path, thus eliminating any temperature effects. Slightly different frequencies centred on 5Mc/s are used so that the two sets of information may be separated and a phase-sensitive detector (operating at a low frequency) triggers a flip-flop, or bistable, circuit which generates pulses whose area is thus equivalent to flow velocity. A moving-coil meter indicates the average area under the pulses and gives a direct flow reading.

MEDICAL ELECTRONICS

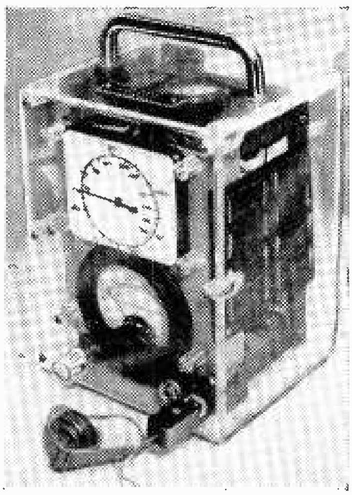
Medical Manometry.—The first British "radio pill," soon to be manufactured in quantity, was shown by the Medical Research Council. It is a subminiature radio transmitter, encased in a cylinder 1.9cm long and 0.8cm in diameter, which signals pressure (or temperature) values during its passage through the gastro-intestinal tract. A 400-kc/s transistor oscillator using a Gouriet circuit is modulated in frequency by the pressure transducer. This consists of a pot-cored inductor, forming the tuning inductance of the oscillator, with its magnetic circuit including a small ferrite disc which is attached to a flexible diaphragm. Pressure variations applied to the diaphragm therefore change the inductance and vary the frequency of the oscillator. The whole assembly, including the sealed Mallory battery, is completely potted, and the oscil-

(Continued on page 121)

Right: Capacitance-type transistor pressure gauge (Medical Research Council).



Below: Photocell-powered medical pulse meter shown by University of Edinburgh.



lator is switched on by giving a shake to the "pill" to operate an inertia mercury switch. The maximum frequency deviation is 35kc/s. At the receiver, a superheterodyne system provides an output signal which varies between 0 and 35kc/s. The cycles of this are converted into square pulses of regular width and amplitude, which are passed to a pen recorder. The integrating effect of the pen recorder mechanism on the pulses then provides a pen deflection which is proportional to their frequency, and hence to the pressure.

Another transistorized device on the same stand was a miniature capacitance-type pressure gauge using a diaphragm of aluminized Terylene as the pressure-sensitive element. It was notable for having the frequency-modulated oscillator and discriminator all built into the body of the gauge, thereby reducing drift and avoiding trailing r.f. cables.

Reduction of drift was also the object of a recording manometer based on a servo or follower principle which was shown by Edinburgh University. Pressure is applied to one arm of a flexible U-tube containing liquid. Increasing pressure therefore causes the level of the liquid in the other arm (which has a transparent glass section) to rise. By raising this transparent arm, however, the liquid in it can be brought back to its original level—the amount of movement required being proportional to the increased pressure. The object of the follower system is to detect the initial movement of the liquid level from a reference position in the transparent arm, then to raise or lower the arm, by means of a carriage and rail system, until the level returns to the reference position. Direction of liquid movement is detected by one phototransistor in the carriage, while two others, and their associated circuitry, respond to acceleration in either direction. Appropriate signals control a motor which drives the carriage up or down in a correcting sense, and the movements of the carriage are transferred by a cord system to a pen on a recording chart which indicates the pressure.

Edinburgh University also displayed a transistorized medical pulse meter, using a carbon resistance transducer for strapping to the thumb, which was made portable and reliable by the use of light energy to provide the power via rechargeable sealed cells. A bank of eight selenium cells in series gives the charging current for the battery, which will operate the pulse meter (1-2mA drain) for 50 hours without recharging. A diode prevents discharge of the battery through the selenium cells when the instrument is left in the dark.

TEST AND MEASURING GEAR

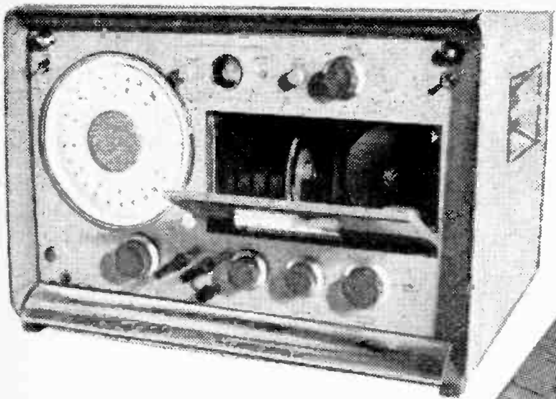
Sine-Wave Generators. Several new transistor oscillator circuits were shown by the Royal Radar Establishment. Two of these utilized so-called class-D push-pull operation. This combines the half-cycle current flow in each transistor of class-B operation, with the nearly zero voltage drop across the transistor during the whole of current-flow period of class C. This retains the advantages of both class-B and class-C operation without their respective disadvantages of finite average voltage drop during current flow and less than half current on/off ratio. The nearly zero voltage drop across the transistor results in a high efficiency, and the half-cycle conduction period in relatively low distortion. The transistors are driven by a current switched alternately into one base or the other. One of the class-D circuits shown was a tape erase and bias oscillator. This used two OC24's to provide 3.5 W output at 35kc/s with a second harmonic distortion of less than 0.1%.

Another new transistor circuit shown by R.R.E. is the equivalent of a well-known valve circuit often used to provide very-low frequency oscillations. This circuit consists of a phase invertor followed by two similar virtual-earth Miller integrators. This provides a total phase shift of 360° at one frequency, so that when the output is fed back to the input oscillations at this frequency are produced. The output from the first integrator is limited and used to provide positive feedback at the phase-invertor input so as to stabilize the oscillation amplitude. Since the 360° phase shift and consequent oscillations are only produced at one frequency, the fact that the positive feedback consists of a limited and thus distorted sine wave does not increase the oscillation distortion.

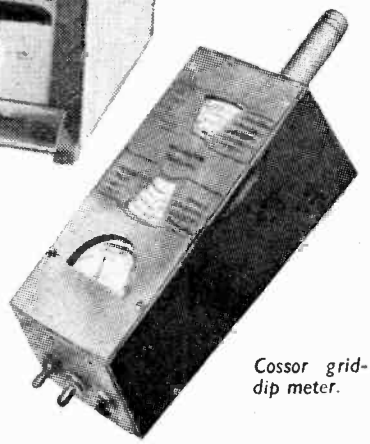
A transistor b.f.o. was also shown by R.R.E. Here a 100kc/s oscillator is switched between a load and output at a frequency variable between 80 and 100kc/s. This produces a b.f.o. in the output which is variable in frequency up to 20kc/s. Since all spurious frequencies produced by the switching are at least as high as 80kc/s, they may be readily removed.

An unusual feature of the Solartron DO905 is that the cable supplied has no effect on the output level, since level-stabilizing feedback is taken from the end of this cable.

A grid-dip meter with plug-in coils



Left: Advance mechanical-optical very-low frequency waveform generator.



Cossor grid-dip meter.

covering 220kc/s to 300Mc/s in all was shown by Cossor (Model 1461). Such a device comprises a calibrated oscillator with a meter which reads grid current. It can thus be used either simply as an oscillator or, by noting the frequency at which an externally connected passive circuit produces a sharp dip in the grid current, as a resonance absorption detector. By switching the oscillator valve to act as a diode, it can also be used as an absorption meter by determining the frequency at which a peak in the meter current is produced.

The Dawe Type 1208, when fed with a sinusoidal signal in the frequency range from 5c/s to 5kc/s, produces a frequency differing from the input by an amount which can be fixed between 0.5 and 2.5c/s. This fixed difference-frequency output is for feeding a stroboscopic lamp so as to produce a slow-motion effect with objects vibrating at the original input frequency. The input is fed to two groups of phase shifters, each of which consists of a passive CR network connected between the anode and cathode of a concertina phase splitter. The first group contains four such phase shifters connected in series and tuned to produce 45° phase shift at 5, 50, 500 and 5,000 cycles respectively: the second group contains three such phase shifters in series tuned to the geometric means of these frequencies, i.e. 15.8, 158 and 1,580c/s. The phase difference between the outputs from the two groups of phase shifters is then within 5° of 90° for any input frequency between 5c/s and 5kc/s. By the use of two additional phase invertors, four outputs spaced at 90° phase intervals can then be obtained for any input frequency between 5c/s and 5kc/s. These outputs are fed to four equally-spaced tappings on a circular potentiometer whose wiper rotates at the required difference frequency. The output between the wiper of this potentiometer and any of the four tappings then has a phase difference with respect to the original frequency which increases at a constant rate of 360° per potentiometer wiper revolution period. This variable-phase output can be shown to be equivalent to a constant phase output differing from the input frequency by the rate at which the potentiometer wiper rotates.

Pulse Group Generator—To select and observe special types of nuclear particles or radiation, elaborate types of pulse groups produced by these particles or radiation may have to be dealt with by the apparatus used. Complex pulse groups may also be needed in physiological work. Specialized pulse generators are thus required for testing such nuclear and physiological equipment.

An example of such a specialized generator shown by Nagard, their Type 5101, produces groups of pulses in which the group length, and group and individual pulse repetition rates are all independently variable, subject to the proviso that, for convenience, only a whole number of pulses is produced in each group. A variable-frequency multivibrator triggers a variable-length flip-flop to provide the variable-rate and length group pulse. This group pulse is specially shaped and fed to trigger on and off a second variable-frequency multivibrator working at the individual pulse rate: the group pulse shaping being such as to only trigger on and off the individual-pulse generator at the beginning and end of a pulse.

Function Generator—The new Advance Type SG88 uses a mechanical-optical system to repeat any required waveform at any rate between 0.005 and 50 times per second. A rotating transparent disc is partially blacked out so that the remaining transparent area corresponds to the waveform to be generated expressed in polar co-ordinates. The disc is illuminated, and the light transmitted through the disc and a fixed radial slit is focused by a cylindrical lens on to a phototransistor. As the disc rotates, the fixed slit thus scans the waveform to be produced so that the output of the phototransistor reproduces this waveform. The rise time of the device is limited by the slit thickness and varies from 300msec at 0.005 waveforms/sec to 0.3msec at 50 waveforms/sec. An integral triggering device can be used to decrease these rise times to less than 3μsec for square waves at all repetition rates.

Noise Generator—A simple device for producing a broad band of noise centred on 1,500c/s for acoustic calibration purposes was shown by Dawe. This Type 1417 generator contains about 6,800, 0·06-in diameter, steel ball bearings. These fall through an aperture onto an anvil which deflects them on to a vertical mica plate where they produce the required noise output. About three-quarters of the bearings strike the mica in the useful measurement period of about 5 seconds. The noise is 3dB down at 750 and 3,000c/s and its intensity 90 ± 1dB at a distance of 8 cm from the mica.

Acoustic Measurement—A method of finding the radiation impedance on a rigid piston was shown by the Admiralty Research Laboratory. An acoustically simple source is used consisting of a longitudinally excited piezoelectric crystal cemented to a glass head. Except for the end face of the glass, this source is covered by a watertight container. The whole source is immersed in water or any other medium with a high acoustic resistance but low viscosity. All parts of the source then work into air except for the face of the glass in contact with the water. The only significant acoustic loading is thus that produced by the water on this face. The radiation reactance on this face can then be obtained from the change in the resonant frequency of the source when it is immersed in water, and the radiation resistance from the Q of the resonance in water.

Magnetic Measurements—The measurement of susceptibilities down to about 5×10^{-7} c.g.s. units (about that of pure water) was demonstrated by the National Research Development Corporation. An extra soft-iron pole piece containing an indium-antimonide Hall-effect magnetic-field detector is placed between the two normal soft-iron pole pieces of a permanent magnet. If the magnetic reluctances of the two gaps so formed between the extra pole piece and the two normal pole pieces are equal, no flux will be produced in the central pole piece containing the magnetic-field detector. If then a sample is introduced into one of the gaps, the reluctance of this gap is altered, the two gap reluctances become unequal, and a magnetic flux is produced in the pole piece containing the magnetic field detector. The detector output can then be shown to be proportional to the susceptibility of the sample.

A vibrating reed magnetometer for measuring the saturation magnetization of ferromagnetic materials was shown by the G.E.C. Research Laboratories. A sample of the material is attached to one end of a flat non-magnetic reed, the other end of which is rigidly clamped. The sample is placed in a non-uniform magnetic field across the width of the reed. The force on the saturated sample due to the non-uniform magnetic field is then proportional to the product of the magnetic moment of the sample and the rate of change with distance of the field strength, and this force is in the direction of the stronger field. With hemispherical pole pieces, the non-uniformity is such that this rate of change is proportional to the displacement of the sample from the central position. This adds to the force produced on displacement by the elasticity of the reed so as to alter the reed's natural resonant frequency. Attached to the reed are two barium titanate transducers; one is driven by a variable frequency oscillator so as to cause the reed to vibrate, and an increase in output from the other is used to indicate the reed's resonant frequency. The change in resonant frequency with and without the magnetic field is proportional to the saturation magnetization of the sample. The instrument is calibrated using a nickel sample for which the saturation magnetization is accurately known. The measurement can be shown to be unaffected by the size of the sample apart from a small error produced by the slight curvature of the field lines. By applying the field across the reed width, any attraction of the sample to one pole piece is counteracted by the much greater stiffness of the reed to motion in the direction of this attraction.

Microwave Measurements—An automatic complex reflection-coefficient plotter was shown by the G.E.C. Research Laboratories. Three probes spaced equally along a guide between 1/8 and 3/16 of a guide wavelength apart each feed a square-law bolometer detector. It can then be shown that if the differences between the outer probe detector outputs and between the middle and the mean of the two outer probe detector outputs are fed to the Y and X plates of an oscilloscope respectively, the c.r.t. spot is deflected to a point corresponding to the complex reflection coefficient of the impedance at the end of the guide. Because of the restriction on the spacing between the probes to between 1/8 and 3/16 of a guide wavelength, three fixed probes can only be used over a ± 20% range of guide wavelengths. There are, however, no inherent frequency-range limitations in the display unit.

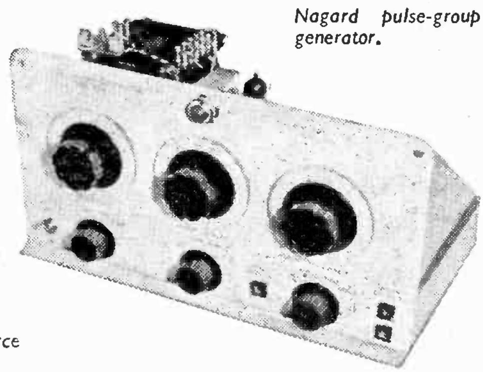
An exhibit of the A.E.I. Research Laboratories showed how large frequency differences (e.g. 1kMc/s in 35kMc/s) could be measured to a high resolution (e.g. 1Mc/s). The signal input feeds a section of waveguide which contains three phase detectors spaced at 120° intervals and which is terminated by a long length of short-circuited delay line. Any slight change in wavelength of the standing-wave pattern is added up in the long length of delay line to produce a considerable shift in the pattern, and this shift is measured by the three detectors. The three detector d.c. outputs are amplified and fed one to each of the three coils of a desyn. It can then be shown that the angular rotation of the desyn magnet pointer is proportional to the product of the frequency change and delay line length. By attaching a revolution counter to this pointer, large frequency changes can be measured.

Frequency Meters—An often-used type of circuit first transforms the input to a square wave which is then used to pass a fixed charge every cycle into a capacitor. The charge current, being proportional to the input frequency and independent of the input waveform shape, thus gives a measure of the frequency. Both the Venner Type TSA501 and the Solartron "f—C" meter used this basic type of circuit. The latter instrument can also measure capacity by means of an internally-generated input of known frequency, since the charge current is also proportional to the capacity.

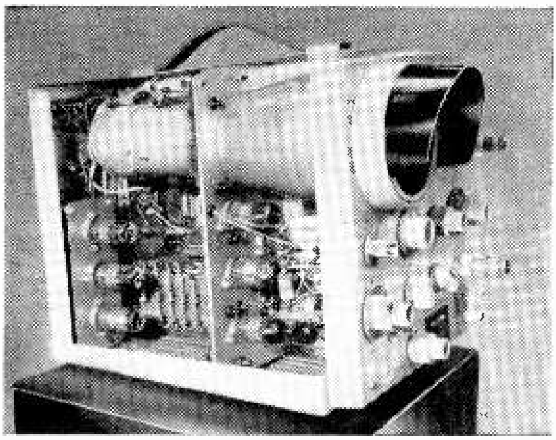
Phase Meter—In the Dawe transistorized Type 630, the two signals whose phase difference is to be measured are limited, the resulting square waves differentiated, and the positive going pulses so produced used to trigger on and off a bi-stable circuit. The mean d.c. output of this circuit is indicated by a meter. This output is proportional to the "on" over "on-plus-off" current ratio of the bi-stable circuit and this is equal to the phase difference required divided by 360°.

Incidentally, Ekco, for transistor convertors, have adopted a simple method of obtaining three phases from two single-phase supplies. Known as a Scott transformer, it entails only the connection of one supply to the centre tap of the other. As long as the phase difference be-

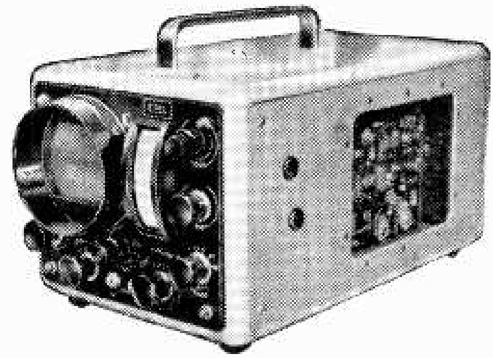
Dawe falling-ball noise source for acoustic calibration.



Nagard pulse-group generator.



Solartron portable double-beam oscilloscope.



Electronic Tubes transistor oscilloscope designed to illustrate the use of their CR132 cathode-ray tube.

tween the single-phase supplies is held at 90° and the correct voltage ratio is achieved, a balanced, stable three-phase supply is developed between the free ends of the single-phase windings.

Logarithmic Amplifier—In the Solartron model TA965, the logarithmic characteristic is obtained simply by making use of the logarithmic forward voltage/current characteristic of a thermionic diode under low-current temperature-limited conditions. The diode is used as the anode-to-grid feedback resistance in a virtual-earth type of amplifier. Since the gain of this amplifier is proportional to this feedback resistance, this gain is also proportional to the logarithm of the input current.

Clip-on D.C. Milliameter—In a transistorized instrument shown by Solartron, their model AM1002, the magnetic field produced by the current to be measured is collected by a Mumetal clip round the wire and measured using a Hall-effect device. This device, together with as much as possible of the magnetic clip circuit, is magnetically shielded from stray fields. The effect of the earth's field near the current-carrying conductor is cancelled out by extending the magnetic circuit on the other side of the Hall-effect device away from the current carrying conductor in such a way that the earth's field there induces an equal cancelling field in the Hall-effect device. The Hall-effect device is energized at 40kc/s and the output amplified, rectified and indicated on a meter. A fraction of the rectified output is fed back to coils wound on the clip so as to produce a field opposing the detected field. This feedback linearizes the instrument against changes in the reluctance of the movable parts of the magnetic clip circuit. The feedback coils are wound on copper cylinders to provide short-circuited turns which greatly reduce the inductive reaction on the circuit being measured. The instrument is calibrated by means of a standard current.

Oscilloscopes—For illustrating the use of their CR132 c.r.t., a transistor oscilloscope was shown by Electronic Tubes. This uses 21 transistors to achieve a sensitivity of 75mV/cm from d.c. to 20Mc/s (3dB down), and an input impedance of 250kΩ. The total power consumption is 2.5W, of which the c.r.t. heater uses 1W. To achieve the relatively-high deflection voltages required, two transistors are used in series across the supply in what was termed a "beanstalk" circuit.

A new range of portable test and measuring instruments in attractive two-tone pastel colours introduced by Solartron included a double-beam oscilloscope (Model CD1014). This has a bandwidth from d.c. to 5Mc/s (3dB down) at a sensitivity of 100mV/cm. Time and voltage measurement to within at least ± 5% are possible.

A two-channel oscilloscope introduced by Nagard, their Model 311, has a sensitivity as high as 100μV/cm with a bandwidth from d.c. to 250kc/s (3dB down). An internal square-wave generator with nine alternative outputs allows voltages to be measured to within ± 2%. Time intervals can be measured to the same accuracy using the calibrated sweep speeds available.

By changing to a slightly different type of storage tube like that described in our review of the 1958 Physical Society exhibition (May 1958 issue, p. 221), Cawkell have been able to increase the maximum writing speed on their Type S01 Remscope by a factor of about 20. The trace persistance time can also now be varied between one second and two minutes, and the trace intensity varied to allow the reproduction of half tones. The new tube is also much more difficult to damage by operating the oscilloscope incorrectly.

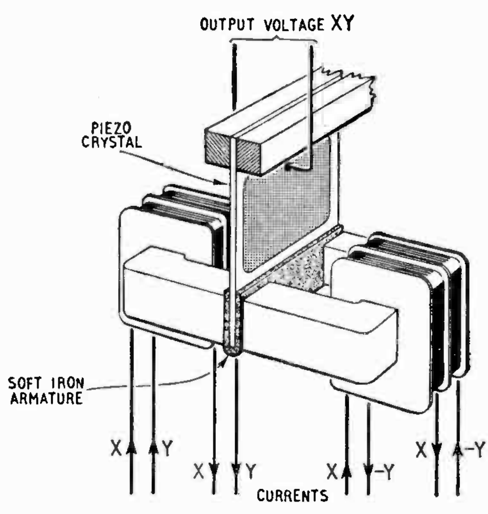
COMPUTERS

Piezoelectric Multiplier, a small and relatively simple device for analogue computing and other uses, was presented as an alternative to the Hall-effect multiplier by Imperial College on the N.R.D.C. stand. The device produces a voltage which is proportional to the product of two input currents, by using the currents to energize electromagnetic actuators which apply mechanical forces to the piezoelectric crystal. The currents, x and y, are applied to the coils of the actuator as shown in the diagram, so that the m.m.f. in one of the C-shaped cores is proportional to $x+y$ and the m.m.f. in the other core is proportional to $x-y$. The resulting forces applied to the crystal (a bender type) through the soft-iron armature are proportional to $(x+y)^2$ and $(x-y)^2$ respectively. Since these two forces are applied so as to oppose each other, the actual force on the armature and crystal is their difference, proportional to $(x+y)^2-(x-y)^2$. On the basis of the well-known relation $(x+y)^2-(x-y)^2=4xy$, this difference force produces an output voltage from the crystal proportional

(*Continued on page* 125)

to xy. A displacement of the armature of less than one micron gives an output of about 1 volt. The output for $x=y=5$mA is 250mA. Almost perfect linearity in terms of either x or y is claimed, while the response is said to be independent of input-current frequency between 15c/s and 500c/s. Extension of the frequency range up to 50kc/s is thought to be possible, giving up to 10^5 analogue multiplications per second with an accuracy of better than 0.5%.

Magnetic Thin-Film Stores for digital computers based on materials with rectangular hysteresis loops have been under development for some time (see *W.W.*, July/August issue, p. 312) because of the possibilities they offer of high switching speeds and high-density storage of binary digits. Most of the experimental stores have used arrays of separate spots of magnetic film, each capable of being switched from one direction of magnetization to the other; but the Royal Radar Establishment were showing that the basic principle could also be applied to a continuous film of material. Their store consisted of an evaporated film of nickel-iron, 1200 Ångstroms thick, surrounded by an array of one-turn driving coils. The film has a preferred direction of magnetization (obtained by applying a magnetic field during deposition) and binary digits are stored at individual positions by the driving coils causing local reversals of magnetization. These reversals take place by rotation of the direction of magnetization in the plane of the material like a compass needle. The fact that a selected area of film could be switched without affecting neighbouring areas was demonstrated by photographs in which domain walls had been made visible after local reversals of magnetization. Switching speeds are capable of dealing with pulses of 5mμsec duration, and a storage density of over 200 binary storage "cells" on a 3in×3in film is possible. Additional coils at right angles to the drive coils are needed to provide "bias" fields so that the initial direction of magnetization is slightly displaced angularly from the preferred direction of the material. Currents applied to the drive coils can then rotate this "vector" to either of two directions, thereby making possible binary storage in each "cell" formed at the intersection of a drive conductor and a "bias" conductor. Mullard also showed work in this field, using separate spots of nickel-iron film and conductors formed by printed-circuit flexible layers.



Imperial College piezoelectric multiplier (shown on N.R.D.C. stand)

COMMUNICATIONS

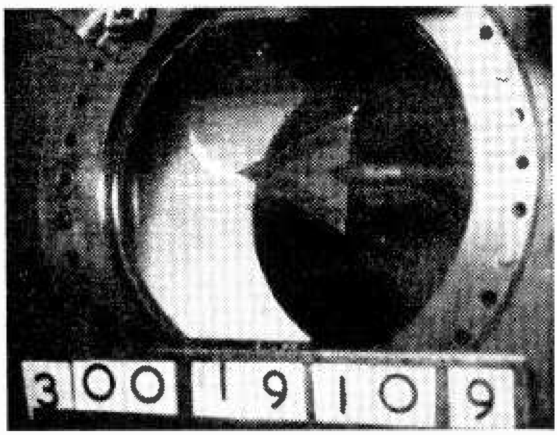
Hall-effect Modulator working at 5Mc/s was a feature on the A.E.I. (Metrovick) stand. Care in the alignment of the leads to the crystal, and their arrangement, helped to reduce the carrier break-through in the double-sideband suppressed-carrier modulator but a correcting coil, carrying d.c. bias and wound on the ferrite-core, allowed a fine adjustment to compensate for errors in the positioning of the connections to the crystal, resulting in a final rejection ratio of 60dB. Associated with the modulator was a wide-band transformer to match the low impedance of the indium arsenide crystal, the whole covering 100kc/s to 20Mc/s at the −3dB points. The demonstration included a c.r.o. display of the modulated output: the bow-tie pattern typical of suppressed-carrier modulation displays was produced with the good linearity expected of a Hall device.

Fast-wave Electron-Beam Parametric Amplifiers.—Since in the wave of space-charge density modulation of an electron beam which travels faster than the beam itself, the fast-wave, the mean energy is greater than the d.c. energy of the beam, prospects are offered of absorbing the excess energy corresponding to noise density modulations in this wave. In the case of the more commonly used slow-wave, the mean energy is less than the d.c. energy of the beam, so that noise could only be eliminated by adding equal noise energy to the beam, and this in practice would be impossible.

A fast-wave amplifier in which a longitudinal magnetic field causes the electrons in the beam to spiral from the inuput to the output, and in which the spiral amplitude corresponds to the signal strength was shown by English Electric (Type N1036). This valve is similar to that described in "Technical Notebook" in our November 1958 issue (p. 555). It has the valuable property of amplifying in one direction only so that feedback from the output to the input with consequent instability is eliminated. In addition, the tube protects the following stages, since it acts as a limiter for excessively large inputs, the maximum power output being 50μW. A noise figure of 2dB at a signal frequency of 200Mc/s is quoted for this valve. Only a relatively small magnetic field of 70 gauss is required and the highest direct potential in the tube is also only 100V. Beam currents and voltages are also very low, typical figures being 30μA and 6V respectively. A 600Mc/s tube is in development.

The G.E.C. Research Laboratories demonstrated fast-wave amplification by passing a beam through two cavities into which the signal and pump frequencies were fed so as to modulate the beam, as in a klystron. A movable cavity tuned to the signal frequency was used to show the increase in the signal level along the beam.

Noise Reduction in Backward-wave Oscillators.—Due to residual gas ions, backward-wave oscillators normally exhibit peaks of noise at sideband frequencies of the order of 1Mc/s. This noise restricts their use as local oscillators to receivers with an inconveniently high intermediate frequency. However, an exhibit of the Mullard Research Laboratories showed that this sideband noise can be considerably reduced either by reducing the residual gas pressure below its normal value between 10^{-7} and 10^{-8}mm of mercury down to about 10^{-9}mm, or alternatively by draining off the gas ions by means of a trans-



Untouched photograph of plume discharge from tip of earthed electrode in wind tunnel (R.A.E.).

Crown Copyright Photograph

verse electric field across the beam. This transverse field need only be of the order of 10V/cm.

Corona Discharge from radio aerials on aircraft at great heights is a serious problem because not only does it result in a power loss in the discharge, but also the discharge produces a serious mismatch at the aerial, further reducing radiated power and upsetting operation of the transmitter. A combined exhibit from R.A.E. and Sheffield University showed some of the approaches to the investigation of the problem. A $\lambda/4$ radiator on a ground plane was enclosed in an evacuated bell jar and an r.f. output applied. At first the discharge started, as would be expected, round the high-potential point at the tip of the radiator; but, above a certain power level, the discharge produced such a mismatch that it moved to the lower part of the aerial, so wasting more than half the transmitter power. One detection method used is to modulate the r.f. with square waves: mounted in the tip of the radiator is a small capacitance "microphone" whose resonant frequency corresponds to the modulating frequency. At the onset of corona the potential gradient changes sharply, altering the force on the diaphragm; this results in a change of output.

A display of photographs (taken at R.A.E.) of earthed electrodes in a wind tunnel revealed an interesting phenomenon. At high speeds (Mach 1.9), low pressures ($\frac{1}{10}$ atmospheric) and in the presence of water vapour, a plume of corona discharge takes place against the air stream from a sharp point on the leading edge of an earthed electrode. Although still under investigation it is thought that this is due to the gathering up of charges from the air.

COMPONENTS

Microwave Components.—It was surprising to find three new components produced by novel methods rather than merely by the usual adaptation of existing methods to new frequency bands. These new components were shown by Mullard for the $2\frac{1}{2}$ mm band.

The first of these components, a variable attenuator, is restricted to use at such high frequencies. It consists of an intrinsic region of semiconductor material placed across the guide between two heavily doped p- and n-regions outside the guide. By applying a forward voltage between the p- and n-regions, electrons and holes are injected into the intrinsic region where they absorb a fraction of any incident microwave power. For correct operation of this device, the intrinsic region cannot be made much wider than 10^{-2}cm, so that the new waveguide must be tapered even at $2\frac{1}{2}$ mm wavelengths.

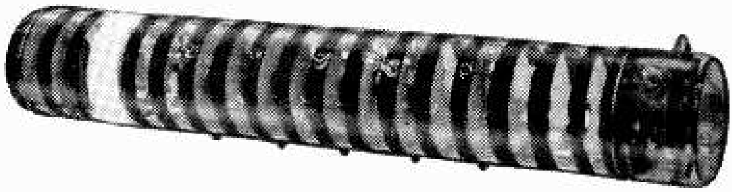
Another of the new components shown by Mullard was a variable directional coupler in circular waveguide. A long strip, one end of which is fixed, is placed centrally in the guide. If the other end of the strip is rotated, incident radiation which is plane polarized at right angles to the initial plane of the strip has its plane of polarization gradually rotated as it passes by the strip. Depending on the angular rotation of strip end, a variable fraction of this incident radiation can then be coupled out via a probe parallel to the initial plane of the strip. Any reflected radiation, since it consists of the reflected portion of the incident radiation not coupled out by the probe, has its plane of polarization at right angles to the coupling probe and is thus not coupled to this probe. Attached to the movable end of the absorbing strip in the same plane as this end is a flat tapered absorbing vane. This absorbs the same fraction of the reflected radiation as is coupled out from the incident radiation. This vane is at right angles to the rotated plane of polarization of the incident radiation so that it does not absorb any of the incident radiation.

The third new component shown by Mullard was a variable impedance, also in circular waveguide. This consists of a flat tapered absorbing vane attached to a movable metal plunger filling the guide. The component of the incident radiation whose plane of polarization is parallel to the vane is totally absorbed by the vane, whereas the component at right angles to this vane is totally reflected by the plunger. Thus, by rotating the vane and moving the plunger along the guide, any required complex reflection coefficient can be obtained. A second fixed flat tapered absorbing vane perpendicular to the plane of the incident radiation absorbs any interfering reflected power polarized at right angles to the incident radiation.

A simple type of waveguide to coaxial directional coupler was shown by Decca. This consists of a piece of strip line inclined to the guide length near one narrow guide wall, the signal being coupled out from the strip at its end furthest from the incident radiation. The strip occupies a space of one quarter of a wavelength along the guide: its width and distance from the guide wall effect the match and coupling. This type of coupler can be made with a performance which compares favourably with that of a normal two-slot waveguide coupler.

A self-calibrating coaxial line wavemeter consisting of a movable short circuit which was shown by Flann illustrates how it is possible to obtain very wide bandwidths using coaxial line: in this case the bandwidth is from 800 to 9,000Mc/s. The distance moved by the short circuit between two adjacent resonance positions is half a line wavelength.

A slot-array aerial for X-band was shown by Elliott. This consisted of eight rows of eight slots in the single metal ground plate of a strip transmission line, the whole aerial being about seven inches square. The strip transmission line is divided up rather like a family tree to provide radiators opposite the slots. This type of aerial possesses a number of advan-

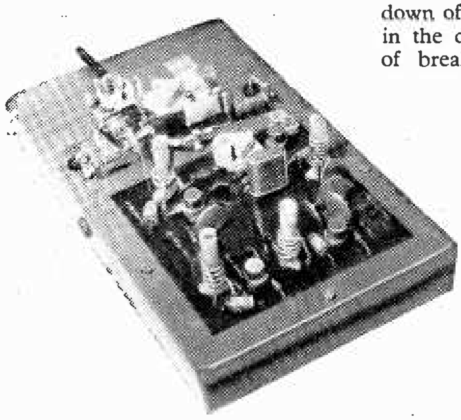


20th Century image-intensifier tube. Note ring accelerator electrodes on inside of glass envelope.

tages over the normal paraboloid, for it is smaller and lighter, and the feed does not obstruct the aerial radiation. Such slot aerials can be easily reproduced since the strip line and slotted ground plate can be printed on dielectric slabs of the correct thickness to provide the required line-to-plate spacing.

V.H.F. Transistors operating at over 100Mc/s are now beyond the development stage and are available as commercial products. As an example, Texas Instruments demonstrated a diffused-base germanium transistor of "mesa" construction operating at 200Mc/s in a 50mW power output stage of a transmitter. Another "mesa" transistor was shown operating in a decade counter of 10Mc/s p.r.f., while other similar types on view, both germanium and silicon, were intended for amplification in the 100-150Mc/s region. Mullard have a v.h.f. transistor made by the alloy diffusion process with a cut-off frequency of 100Mc/s, but they also showed an experimental type of similar construction which would amplify at this frequency. It was demonstrated in a series of 100Mc/s amplifiers, each using two transistors in push-pull giving an output of 0.5W. A silicon "mesa" transistor with a cut-off frequency of 80Mc/s (in the common base connection) represents the first essay of Ferranti's in the transistor field. It is an n-p-n type and the method of construction is shown in the diagram. A slice of the n-type silicon which subsequently forms the collector has a layer of p-type material diffused into it (providing the base), and then, by means of masking techniques, a small n-type layer (the emitter) is diffused into a part of the p-type base. The "mesa" or raised structure (named after a flat-topped steep-sided mountain) has the object of reducing collector capacitance, and is formed by etching away the surrounding silicon. Metallizing is applied to the base and emitter for contacts, while the collector connection is made through a large metal support on which the collector is mounted.

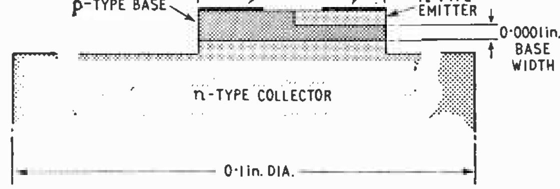
Transistor transmitter producing 50mW at 200Mc/s. Texas Instruments "mesa" transistor is used in output stage.



Current Regulating Semiconductor diode demonstrated by G.E.C. Research Laboratories is a counterpart of the well-known Zener diode voltage regulator. The principle of control is the constriction of the current carrier path through the semiconductor by two space-charge regions, rather as in the Tecnetron and other field-effect devices. A somewhat complex structure is used, in which the widening space-charge regions are produced by the voltage drop sustaining the current flow through the device. The two regions actually meet at a certain applied voltage, the "pinch-off" voltage. Thereafter the current is limited to a constant value with increasing voltage until a breakdown of the reverse-biased junctions in the device allow a sudden surge of breakdown current. A typical value for the "pinch-off" voltage is 5V, and the current after this is limited to 5mA until the breakdown occurs at 100V. A voltage regulating circuit giving 6 volts output was demonstrated in which the new device formed a series element while a Zener diode provided a shunt element. Variations of 50% in supply voltage produced output variations of only ±0.005%.

Image Intensifiers normally work by the acceleration of photo-electrons from a photo-emissive layer and by the concentration of the image into a smaller area. A new intensifier tube shown by 20th Century Electronics accelerates the electrons from the photocathode in the normal way, but provides additional gain by using five electron multiplier stages of the transmission type. In these the electrons pass through a thin layer of alkali halide on an alumina support, and after multiplication are accelerated by ring electrodes (metallized on the inside of the glass envelope) to the next stage. There is a total electron gain of 2,000 in the multiplication system, while the overall light gain from photocathode to fluorescent screen (15kV potential) is of the order of 50,000. The image remains the same size throughout, and the electron rays are kept parallel by enclosing the tube in a magnetic focusing solenoid.

Last year Siemens Edison Swan showed an image intensifier for electron microscope work which used a photoconductive pick-up tube to give television-type pictures (March, 1959, issue, p. 133). This year A.E.I. (as they now are) were demonstrating a modified version for light amplification. Electrons from the photocathode are imaged by an electrostatic lens system on to the front of the selenium photoconductive layer of the pick-up tube. The resultant charge pattern at the rear of the layer is then scanned in television fashion by a low-velocity electron beam. Sensitivity is such that about 5 incident photons on the photocathode

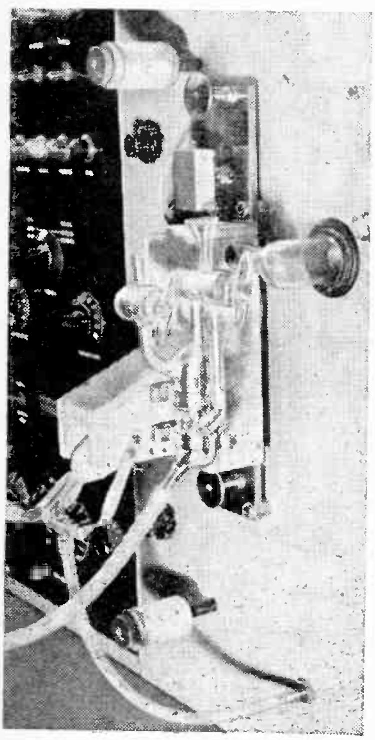


Cross-section of Ferranti h.f. transistor, showing "mesa," or plateau, form of construction.

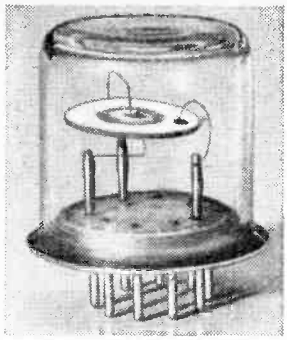
will give a visible spot on the display monitor.

Storage Tubes, which hold information as patterns of electrostatic charges, were shown in both the display and non-display types by various firms. A new non-display tube by Mullard uses a single electron gun for both "writing" and "reading" on to the magnesium fluoride storage surface and is notable for its small dimensions of about 1½in diameter and 7in long. It has a resolution of 600 lines and operates with an anode voltage of about 300V. The Vidicon type of television pick-up tube is often criticized because of the storage properties of its photoconductive light-sensitive layer, but E.M.I. were showing a version in which this effect had been deliberately enhanced for the purpose of holding images. Storage time was in the region of 1-3 minutes, depending on image brightness.

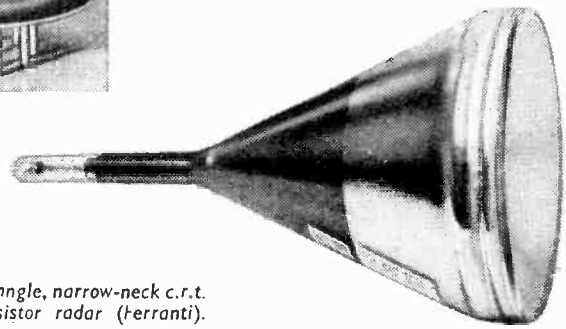
7-in Radar C.R. Tube developed primarily for transistor equipments was shown on the Ferranti stand. It has a narrow deflection angle of about 30° and a narrow diameter neck (23mm), both of which facilitate scanning by low-power transistor circuits. This firm was also showing a new 6-inch c.r.t. of high sensitivity and brightness specially designed for displaying characters for xerographic printing (as used for computer output data). The well-known 1CP1 c.r.t. with the 1-inch screen was shown by Electronic Tubes in a new version which requires an anode voltage of only 350V, thereby allowing it to be operated from normal h.t. supplies.



Machine by G. V. Planer, Ltd., for the application of resistive oxide films to glass fibre. Whole machine is complete in one cabinet, including instrumentation and control apparatus.



Above: Plessey experimental ceramic i.f. filter element showing ring and dot connections.



Narrow-angle, narrow-neck c.r.t. for transistor radar (Ferranti).

Digital Display Tube working on a new principle was shown in experimental form by G.E.C. Research Laboratories. It is basically a small c.r. tube and the numerals are formed as the shadows of shaped wire electrodes in the path of an "unfocused" electron beam which floods the whole area of the 1½-inch fluorescent screen. Ten such electrodes, shaped respectively 0-9, are provided and each one is selected for display by applying to it a negative voltage of about 60V. This repels the electrons in the beam close to the wire and so forms the shadow of the selected numeral on the screen. The shadows are very clearly defined and the only limitation appears to be in the precision and artistry with which the wire numerals can be shaped. An anode voltage of 600V is required.

Ceramic I.F. Transformers were shown by Plessey in the form of small circular discs of lead titanate zirconate. This material exhibits piezoelectric properties and, when a circular disc is excited in the radial mode the performance resembles that required of an i.f. transformer for transistor applications. The disc (about the size of a sixpence) is metallized to provide contacts—one side completely and the other with a ring and dot—and the input, at an impedance of about 5kΩ, is applied between the dot and backing. The element works on the first overtone of 160kc/s (its fundamental resonance) which is 455kc/s and the output, at an impedance of about 1kΩ, appears between the ring and backing. The characteristics of the radial-mode resonances are such that, by pairing a fundamental-frequency resonator with one operating on its first overtone, the overtones do not coincide. Consequently out-of-band responses are not troublesome; also the selectivity curve is improved.

Oxide-film Resistance Elements are used in new components by G. V. Planer Ltd. The component is a tilt-sensing device giving a continuous response. It consists of two shaped stannic-oxide films coated onto the inside of a sealed glass tube in which a drop of mercury runs, joining the two "stripes". To avoid contamination of the mercury by metallic contacts the oxide films are brought out through the glass of the seal to contacts outside.

The continuous coating of oxides on to 10^{-3}-in diameter glass fibre, which can subsequently be wound on a bobbin to produce a resistor, is performed by a machine developed by Planer. This comprises precision winding gear for passing the fibre through the coating furnace and an automatic speed control system to ensure the deposition of correct film thickness. After leaving the lower bobbin the fibre is first sprayed with the mixture of salts. It then passes through a furnace to fire and oxidize the film, and on leaving for the take-up spool it passes through two mercury cups, the resistance between which governs the drive speed. Values as high as 2MΩ per linear inch of fibre are achieved.

Signal-Flow Diagrams

2.—Application to the Schmitt Trigger Circuit Using Valves

By THOMAS RODDAM

LAST month I discussed the general principles of signal-flow diagrams, the maps which frequently show useful short-cuts to the solution of complicated circuits. The rules for drawing maps and for simplifying them were described and a not particularly illuminating example was used to illustrate the application of the method. It was not particularly illuminating because it was too simple: you don't draw a map when you want to say "Turn left at the end of the road and it's there on your left." This month we can consider something more ambitious which really gives the method a chance. I had thought of tackling the transistor Schmitt trigger, but I have decided to take the valve version which is used as an example by J. G. Truxal in "Automatic Feedback Control System Synthesis" (McGraw-Hill, 1955). My reason is that he goes on to discuss a whole lot of other developments, such as impedance determination and return difference evaluation, and although I do not propose to discuss these topics, this article will break the ground for any of you who want to go further by consulting this book.

The circuit is shown in Fig. 1. It is a two-stage d.c. amplifier with positive feedback produced by the common-cathode resistor. To avoid using primes in the analysis we shall assume that

$$1/R_1' + 1/R = 1/R_1$$

so that R_1 is the effective anode load of the first stage. In a practical case R is usually so much bigger than R_1 that within the usual tolerances we can take the anode resistor as the total load.

We are treating this circuit in its a.c. application as a limiter, not in its on-off large-signal application. The usual problem then is to find the conditions for just snapping over. Signal-flow diagrams are concerned with linear differential equations, so we must assume that the circuit is somehow poised at mid-travel, either because it has not enough feedback to make it unstable, or because we have caught it in mid-travel. All our terms are small signals, not the fixed biases and standing currents.

The starting point for the map is e_{in} and I have begun Fig. 2 by putting in the first move, e_{in}. The first equation which springs to mind is the obvious one:

$$e_{in} = e_{g1} + e_k$$

Like this the equation would have two branches, from two new nodes, leading to the input node e_{in}. This is not considered good practice, so we rewrite the equation as

$$e_{g1} = e_{in} - e_k \quad .. \quad .. \quad (1)$$

mark in the nodes e_{g1} and e_k and draw the two unit arrows shown in Fig. 2(a). At this point Truxal decides to put e_k down below the main horizontal line. One application of the circuit is as a phase-splitter, the long-tailed pair, with the anode-grid coupling as an extra something—positive feed-forward one might call it—to push up the gain. This interpretation makes us think of the second stage as fundamentally grounded-grid, with e_k as the drive, and so I shall keep e_k on the line.

The anode current of the first valve is given in the usual way by

$$i_1 = (\mu_1 e_{g1} - e_k)/(\rho + R_1)$$
$$= \left(\frac{\mu_1}{\rho + R_1}\right)e_{g1} - \left(\frac{1}{\rho + R_1}\right)e_k \quad .. \quad (2)$$

This adds a new node i_1 and two new branches leading to it from e_{g1} and e_k. These are shown in Fig. 2(b), where the new branches are the heavy lines: in each following figure the latest additions will be identified in this way.

The drive to the second valve, in my view, comes from e_k, which is the drop across the cathode resistor due to both anode currents. Thus

$$e_k = i_1 R_k + i_2 R_k \quad .. \quad .. \quad (3)$$

We need to mark in the new node i_2 and then we can add the local map representing this equation to give us Fig. 2(c).

Before we can write an equation for i_2 we need to know something about the feed-forward path. Clearly

$$e_{a1} = -R_1 i_1 \quad .. \quad .. \quad (4)$$

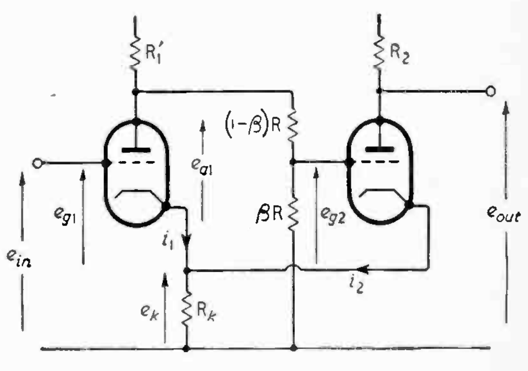
and this equation is shown by the new heavy branch in Fig. 2(d).

We now need to find out what happens in the second valve. The grid to cathode signal is quite clearly given by

$$e_{g2} = \beta e_{a1} - e_k \quad .. \quad .. \quad (5)$$

and we can establish the new point e_{g2} in Fig. 2(e) by this equation.

Fig. 1. Schmitt Trigger Circuit.



ordinary valve equation for the second valve

$$i_2 = (\mu_2 e_{g2} - e_k)/(\rho + R_2)$$
$$= \left(\frac{\mu_2}{\rho + R_2}\right) e_{g2} - \left(\frac{1}{\rho + R_2}\right) \cdot e_k \quad .. \quad (6)$$

This equation makes its appearance in the next figure, Fig. 2(f).

Now all we need is to know e_{out}, which is given by

$$e_{out} = -i_2 R_2 \quad .. \quad .. \quad (7)$$

and leads us to Fig. 2(g).

Quite obviously the signal-flow diagram of Fig. 2(g) is a complicated affair, but the original circuit, as anyone who has ever carried out the solution by algebra knows, is by no means as simple as one might expect from five resistors and two valves. In the form of Fig. 2(g) the diagram is not of much use to anyone, so we must settle down to the task of simplifying it.

We take a new sheet of paper and begin Fig. 3(a). A first step is to notice that we do not really care about the point e_{a1} and we can go straight from i_1 to e_{g2} by a branch $-R_1\beta$. Sheer laziness makes me leave out the diagram with this reduction in it, because I can also see that the signal which flows from e_k through e_{g2} to i_2 can be written as a contribution directly from e_k to i_2 of size $-1 \times \mu_2/(\rho + R_2)$ and then I can get e_{g2} out of the picture as well. These steps are all combined to give Fig. 3(b).

The two parallel branches in the same direction from e_k to i_2 can be added together, but before we do this in Fig. 3(c) let us notice also that we have another easily seen step in the reduction. There is a flow of signal from e_k to i_1 by way of e_{g1} which we can replace by a direct path. This direct path, which will have transmittance $-1 \times \mu_1/(\rho + R_1)$ is in parallel with the existing direct path $-1/(\rho + R_1)$ and these two can be combined together. The result of these various operations is shown in Fig. 3(c).

To make the figure look a little neater it is re-arranged in Fig. 3(d) and the point e_{g1} is dropped altogether.

The next stages in the reduction require a certain amount of care to avoid throwing the baby out with

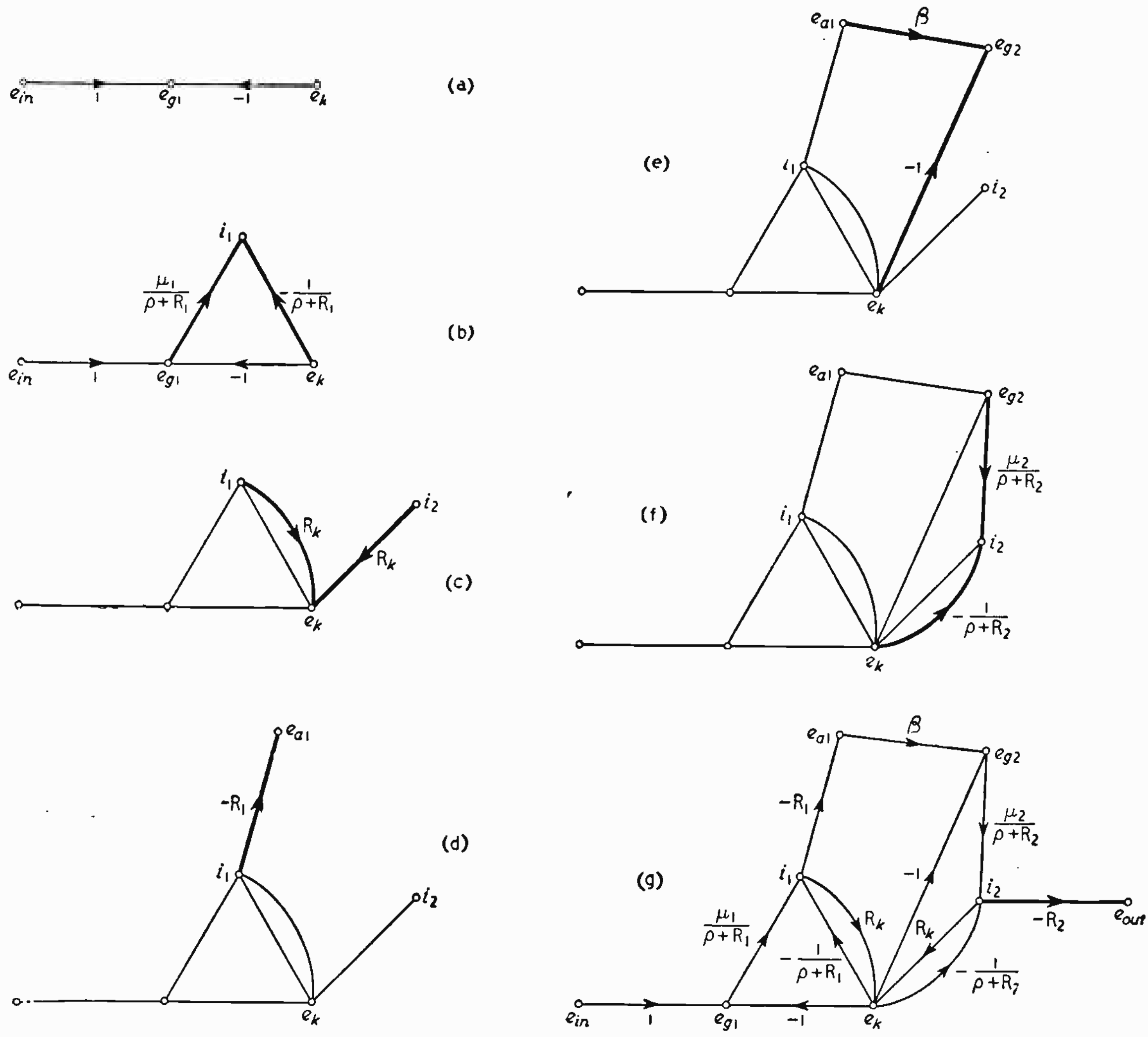


Fig. 2. Signal-flow diagram for the circuit of Fig. 1 obtained step by step. Heavy lines indicate the additions corresponding to successive equations.

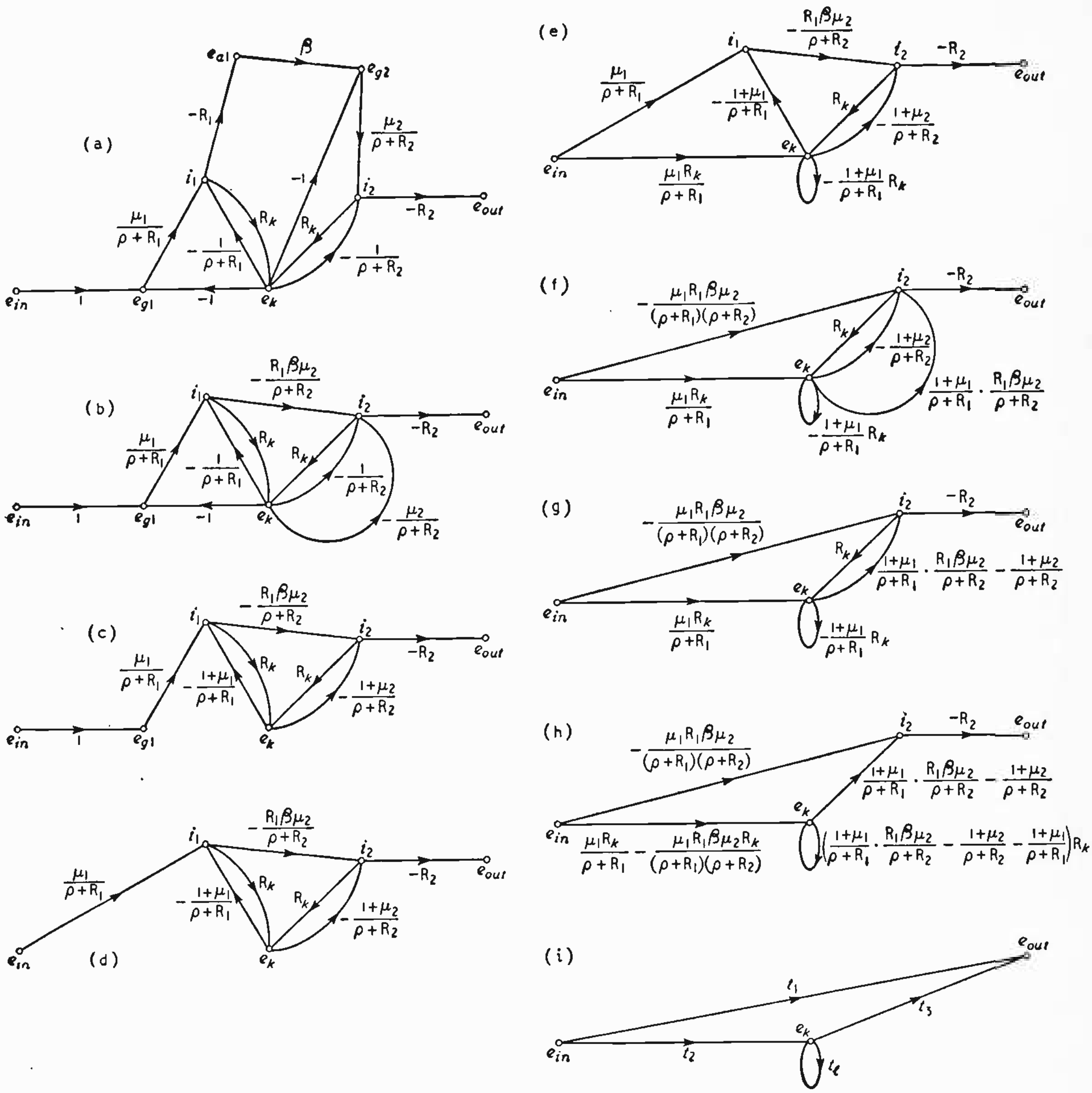


Fig. 3. Stages in the reduction of the signal-flow diagram for the circuit of Fig. 1.

the bath-water. Let us focus our attention on the flow of signal from e_{in} to e_k. There is a contribution through i_1 which is clearly of total transmittance $[\mu_1/(\rho + R_1)] \times R_k$. We can therefore construct a direct branch from e_{in} to e_k and cross out the i_1 to e_k branch of transmittance R_k. When we do this, however, we are breaking the loop e_k to i_1 to e_k, of transmittance $[-(1 + \mu_1)/(\rho + R_1)] \times R_k$, and we must put in the corresponding self-loop. But the signal from e_k to i_1 also contributes to the path i_1 to i_2, and it is not legitimate to drop the e_k to i_1 branch. The reduction therefore gives us Fig. 3(e).

Now we consider the contribution made by e_k to i_2 by the route e_k to i_1 to i_2. The transmittance is $[(1 + \mu_1)/(\rho + R_1)] \times [R_1\beta\mu_2/(\rho + R_2)]$, with two minus signs disappearing together. We can make this a direct contribution, when we no longer need the point i_1. This leads us to Fig. 3(f) and, immediately, to Fig. 3(g).

Again we consider the flow of signal from e_{in} to e_k and we see there is a path via i_2 with a transmittance

$$\frac{-\mu_1 R_1 \beta\mu_2}{(\rho + R_1)(\rho + R_2)} \times R_k$$

and that this will introduce another self-loop at e_k of transmittance

$$\left(\frac{1 + \mu_1}{\rho + R_1} \cdot \frac{R_1\beta\,\mu_2}{\rho + R_2} - \frac{1 + \mu_2}{\rho + R_2}\right) \times R_k$$

Fig. 3(h) shows the effect of this change on the diagram.

In the final diagram, Fig. 3(i), the point i_2 has been eliminated in the obvious way, to leave us with what is called an essential diagram of order one. Once you get the trick of it the steps described above can be carried out very quickly. In the same way you can go on to reduce the essential diagram to a single branch joining input to output and having a transmittance

$$t_1 + t_2 t_3/(1-t_1)$$

Each of these t's is an expression as long as your arm, which is why I have not written them out in full. For specific problems you may not want to do this anyway. As an example, the determination of the conditions in which the circuit will just turn over, implying infinite gain, are seen to be that the term t_1 should be unity. We know, in any practical case, the values of μ_1, μ_2, ρ, R_1, R_2. We may wish to make β unity and find R_k, or to fix R_k and find β. But the expression for t_1 is greatly simplified by putting in numbers. In fact, as you will see if you consult Truxal (loc. cit.) you can carry numbers all the way through to considerable advantage.

The only way in which you can get the full benefit of this method of handling circuits is by practice. Once you get the swing of it you will find that it really does help enormously to be able to concentrate on one limited aspect of your circuit equations and to ease that bit a step or two towards the final solution. This discussion is only an introduction to the method, which can be extended to the determination of input and output impedances, to the effects of reactances, and to the whole field of linear circuit problems. For complex problems it seems to be an extremely useful method for those who want to keep their eye on what is happening as they solve their equations.

BOOKS RECEIVED

Stereo Handbook, by G. A. Briggs. Wide survey of fact and opinion on the methods and results of stereophonic sound reproduction. Takes the form of an inquiry in which awkward questions were posed to a number of experts and from which some sound sense has been distilled by the author. Topics considered include pickups, record wear, loudspeakers, room acoustics and broadcasting. Pp. 146; Figs. 88. Price 10s 6d. Wharfedale Wireless Works, Ltd., Idle, Bradford.

Stereo Record Guide, by Edward Greenfield, Ivan March and Denis Stevens. Collection of critical assessments of existing stereo gramophone records, as regards both musical content and recording quality. Arranged under composers' names and with entries up to the end of 1959. (Supplements are to be issued.) Pp. 320. Price 21s. The Long Playing Record Library, Ltd., Squires Gate Station Approach, Blackpool, Lancs.

Stereo and Hi-Fi as a Pastime, by Douglas Gardner. Layman's introduction to the technicalities of disc, tape and broadcast sound reproduction. Pp. 147; Figs. 15, and illustrations of typical commercial installations. Price 15s. Souvenir Press, Ltd., 94, Charlotte Street, London, W.1.

Mullard Circuits for Audio Amplifiers. Designs for power amplifiers and pre-amplifiers for mono and stereo sound reproduction from microphone, tape, gramophone disc and radio signals. Includes dimensions of suggested chassis and general notes on construction and assembly. Pp. 136; Figs. 160. Price 8s 6d. Mullard, Ltd., Mullard House, Torrington Place, London, W.C.1.

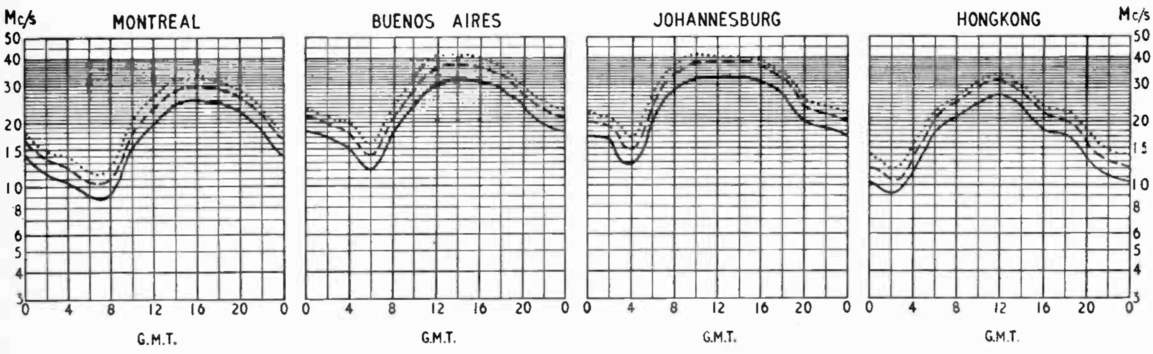
The Practical Hi-Fi Handbook, by Gordon J. King, Assoc. Brit.I.R.E. Introduction to high-quality sound reproducing equipment written with the needs of the service technician in mind. Pp. 224; Figs. 158. Price 25s. Odhams Press, Ltd., Long Acre, London, W.C.2.

The Conversion of Ionospheric Virtual Height/Frequency Curves to Electron Density/Height Profiles, by J. O. Thomas, M.A., Ph.D. (Cavendish Laboratory, Cambridge) and M. D. Vickers, B.Sc. (D.S.I.R., Radio Research Station, Slough). D.S.I.R. Special Report No. 28 on a digital computer programme and the basis of its formulation, with appendices including an extensive bibliography. Pp. 48; Figs. 10. Price 3s 6d. H.M. Stationery Office, Kingsway, London, W.C.2.

From Microphone to Ear, by G. Slot. Second edition of a Philips Technical Library review of modern sound recording and reproducing techniques, now including a long chapter on stereophony. Pp. 268; Figs. 110. Price 21s. Cleaver-Hume Press, Ltd., 31, Wright's Lane, London, W.8.

SHORT-WAVE CONDITIONS

Prediction for March



THE full-line curves indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during March.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

•••••••••• FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

— — — PREDICTED MEDIAN STANDARD MAXIMUM USABLE FREQUENCY

———— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

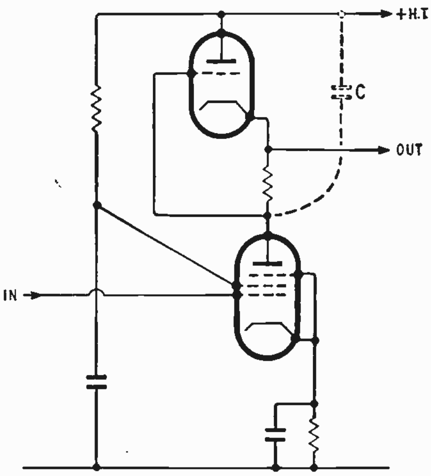
LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

"Economical High Gain A.F. Amplification"

MUCH as I admire the ingenuity of your contributor Arthur R. Bailey in devising the circuit described in the article in the January issue, I must point out that he has omitted mention of the most important features of this circuit. In respect of gain, hum and noise level, and low output impedance, two R-C coupled pentodes with voltage negative feedback can compare favourably with this circuit. In my opinion the principal advantages of the circuit described are that it lends itself readily to direct coupling, and that this circuit has effectively only one stray capacitance.

At the low anode current mentioned by the author (0·1mA) the cathode bias resistor for the triode can be of the same order as the anode load of the pentode,



(G.J. TILY)

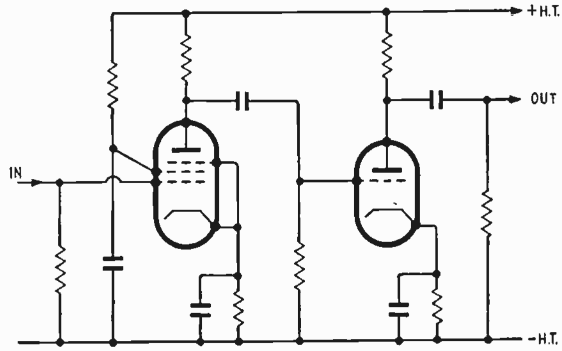
and one resistor can be used for both functions as in the accompanying diagram. A possible use for this arrangement is deflection amplification for a cathode ray tube.

The single stray capacitance can be an important factor if this circuit is used as the amplifying stage in a feedback amplifier, as it restricts the phase shift to 90°, which ensures stability in such circuits.

Hounslow, Middlesex. G. J. TILY.

FEW readers will fail to sympathise with Mr. Bailey's aim " to obtain the maximum amplification from the minimum number of components " (January issue, p. 25). But it is to be doubted whether his circuit represents a marked advance in this direction. Seven resistors and four capacitors are employed in the basic circuit (Fig. 2 of the article) and the gain of a practical version is given as 3500. If we take as a figure of merit the gain divided by the number of components, we get 3500/11 = 318. The completely conventional circuit shown here in diagram (A) uses 13 components, and taking Mr. Bailey's own figures for the gain of the pentode without any fancy business (200) and the gain of the triode (40), it provides, by cascading a gain of 8000. So its figure of merit is 8000/13 = 615, which is nearly twice as good as that of the unconventional circuit. If valves, valveholders and decoupling components are counted, the conventional circuit shows up rather better.

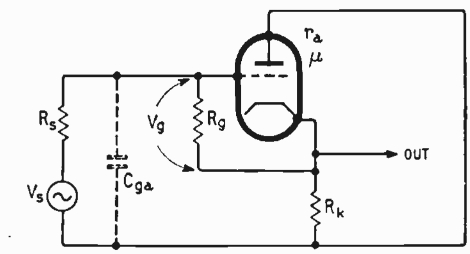
Moreover, some of Mr. Bailey's statements do not



(G.W. SHORT (A))

bear examination. He rightly gives the effective first-stage output resistance for a response 3dB down at 10kc/s, with 5pF strays, as $10/\pi$ MΩ, and this value is indeed attained with an 8-MΩ anode load in parallel with a 5-MΩ anode impedance. But taking the capacitance as 10pF (which is a reasonable figure allowing for wiring strays), the required effective output resistance becomes $10/2\pi$ MΩ, or 1.59 MΩ. To obtain the required value of 1.59 MΩ, the anode load resistance must be reduced to 2.3 MΩ in contrast with Mr. Bailey's value of 4MΩ. The gain is then reduced to about three-quarters of the original amount.

Mr. Bailey refers to the output stage as a cathode-follower, but this is not correct. Disregarding supply voltages and biasing arrangements, the circuit reduces to diagram (B), where V_s, R_s represent the signal source, R_g is the physical grid-cathode resistance, and R_k is the load resistance. If the effect of C_{ga} is ignored, and if



(G.W. SHORT (B))

R_g approaches infinity, then R_s can be removed without materially affecting the output impedance, which is then R_k in parallel with r_a. In other words, it is the same as that of a normal triode amplifier stage with an anode load equal to R_k. The circuit is then a " bootstrap " amplifier. To make it into a cathode-follower R_s must be small, but this is not so in Mr. Bailey's circuit, where it is 5MΩ, the anode resistance of the preceding pentode stage. The output impedance is actually $r_a (R_s + R_g)/[r_a + R_s + R_g (1 + \mu)]$, in parallel with R_k, which comes to roughly $\frac{r_a}{2}$ in the practical circuit.

In so far as the circuit behaves as a bootstrap amplifier, the effective size of C_{ga} is increased as a result of Miller effect. The voltage acting upon C_{ga} is $V_g + V_{out}$, which is $V_g(1 + A)$ as in a normal triode stage.

Finally, it is perhaps worth remembering that, with a.f. amplifiers as with h.f. amplifiers, the product of gain and bandwidth obtainable with a given valve is a constant. If a gain of 3500 and a bandwidth of 10kc/s are to be attained, then the gain-bandwidth product must be 35Mc/s. While good h.f. pentodes may be expected to have gain-bandwidth products running into hundreds of Mc/s, it must be remembered that in h.f. amplifiers the full rated mutual conductance can be achieved, whereas in an audio stage, operating with low current into a resistance load, the actual g_m is only a small fraction of the normal value, and the gain-bandwidth product is correspondingly reduced.

Croydon. G. W. SHORT.

A. R. BAILEY'S article on high-gain a.f. amplification reminded me of some experiments I carried out on the Jeffery circuit. The final modification to the Jeffery circuit (*Wireless World*, Aug., 1947, p. 274) used direct coupling (inspired by D. T. N. Williamson's phase splitter) of the pentode anode to the triode grid, so saving three resistors and three capacitors. The pentode was biased back so that it drew only a small anode current, and this current, flowing through the triode grid leak (50 to 100kΩ), provided the correct grid bias for the triode. However, this was in the days of Government-surplus EF36 and 6J5 valves, and the circuit was never applied successfully because it suffered from a high hum level and excessive h.f. losses. To reduce the hum to a tolerable level much negative feedback was necessary; but the application of this was precluded by the combined phase-shifts of the phase splitter and the particular amplifier used. Also the heater-cathode insulation of the triode was too highly stressed (at under half h.t.) unless a separate supply was used; this offsets the saving of a valve. As most of these disadvantages can be overcome with modern valves and techniques this circuit might bear re-examination.

But what happens if we apply these ideas to Bailey's circuit? A saving of two resistors and one capacitor is made, and the result looks very much like a straightforward bootstrap. Another point to be considered is heater-to-cathode potential limits for the triode: just under h.t. potential is applied. The writer's (sad) experiences indicate that it is unwise to exceed 100V or so for long-term reliability. In fact, the only superiority of Bailey's circuit may lie in the tape pre-amplifier, where the very high impedances make it easy to obtain a low l.f. boost roll-off point.

Surbiton, Surrey. E. MANSFIELD.

"Subjective Colour Tests"

IN your article on this subject in the January issue it was reported that a Land-colour rendering of the scene was obtained when the two photographs were viewed by displaying one to each eye with the appropriate filter in the light path to one eye. I find it difficult to understand this statement as I have found a very different effect. If the two photographs are viewed in a stereoscope with a red filter over the appropriate eyepiece, there is almost a complete absence of the colours seen during projection in the normal manner. When the two transparencies are projected through Polaroid filters and viewed through Polaroids, so arranged that each eye sees one of the images, there is a very marked decrease in coloration, although more colour may be seen than when using a stereoscope. This may be due to imperfections of the projection system and screen which results in incomplete channel separation, for it can be shown that even a small difference in the wavelength-intensity distributions of the two lights used for projecting the transparencies can give rise to Land colours. Thus, when using a 300 watt and a 1000 watt projector, without any filters, Land colours may be observed owing to differences in the colour temperatures of the two light sources.

When photographs of a test chart containing 24 areas of different colours against a neutral background are viewed in a stereoscope with a red filter over the appropriate eyepiece, most subjects report absence of colour other than reds, whites and pinks. Some subjects, however (including myself), observe that one of the test areas has a bluish-red or purple appearance. This area is seen as green in the original display and is reported as blue-green when viewed in the conventional Land manner. With continued viewing in the stereoscope, retinal rivalry is observed. In this case there is a slow oscillation between seeing mainly what is fed to the left eye or mainly what is fed to the right eye.

Thus it appears likely, to me, that the Land colours are due mainly to processes in the retina and not in the brain as suggested in your article. The effects due to retinal rivalry are, on the other hand, due to activity in the brain, as they can be controlled by attending to one eye or the other. This effect is similar to that encountered when using a microscope when it is possible to keep both eyes open without interference from the eye which is not looking through the microscope.

Whilst not wishing to over-emphasize the importance of Land's work in relation to colour television, it should be pointed out that all colours are, in a sense, subjective. The objective stimulus is light of a certain wavelength-intensity distribution. It may be seen differently in terms of colour by different observers and the colours may appear different to the two eyes of the same observer if he is colour defective in one eye. In colour television it is unlikely that the amount of light leaving the screen will ever approximate to the amount of light being reflected from the objects which are being recorded by the television camera. In order to make the picture appear like the display, changes are necessary in the tricolour specifications of individual areas to allow for the increases in saturation, and possibly changes in colour, due to the decreased level of illumination of the screen. The Land process tends to desaturate colours (whilst the trichromatic system tends to oversaturate them), and to some extent this is a desirable characteristic. As the display which is televised has other attributes than that of colour which are at present relatively imperfectly reproduced, it may well be that, with a fixed available bandwidth, a two-channel system would give a satisfactory compromise between definition, clarity of movement, and colour.

C. E. M. HANSEL,
Department of Psychology,
Manchester, 13. University of Manchester.

Early Public Address

IT may interest Mr. Haydon G. Warren (Dec. 1959 issue) to know that in 1919 or 1920 when I was with the Western Electric Company at North Woolwich we received from America a p.a. equipment of no mean performance. Associated with the rather enormous amplifier was a stretched diaphragm carbon microphone. A battery of balanced-armature loudspeakers with corrugated Bakelized linen diaphragms provided a considerable volume of good quality speech. I toted this lot about the country and had a lot of fun with it, for it was new and exciting. I even took it to sea for trials of gun control but, alas, the first round blasted the diaphragms beyond repair. On the mess-decks the matelots had other means of damping the output!

On another occasion I remember we stopped the traffic in Birmingham while doing tests prior to a visit by the then Prince of Wales, later Edward VIII.

Those were the days!

Walmer, Kent. S. G. KNIGHT.

Editors and Editing

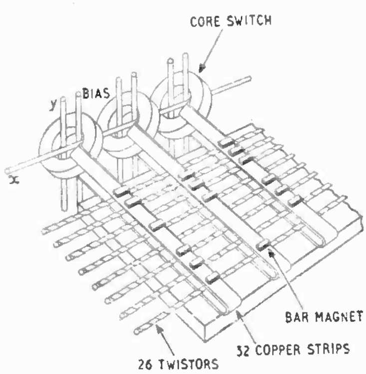
I TAKE it that Mr. Waldron, whose letters you published in the January and February issues, will not be contributing to the Indian radio journal whose editor frankly warns intending authors of his right "to suppress, revise, alter or mend each or any para of the article"!

London, S.E.22. J. P. HAWKER.

Technical Notebook

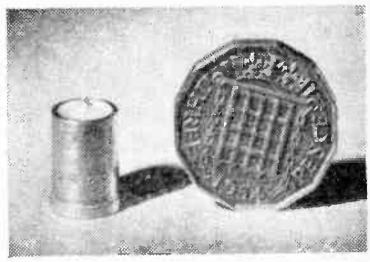
Television Aerial Design is a field in which many specialized problems have to be solved—for instance, the making of an aerial which responds efficiently to one channel in Band I and one in Band III. One of the earliest methods of doing this was by the addition to the Band-I dipole of $\lambda/4$ (at the Band-III frequency) rods, or "twigs" as they became known, in such a way that, when excited by the Band-III signal, they acted as "metallic insulators" or short-circuited $\lambda/4$ stubs. These reflect a high impedance at the ends of part of the dipole, so forming a $\lambda/2$ or $3\lambda/2$ Band-III radiator. J. D. Burke has discovered that the function of the "twigs" may be carried out by ferrite beads or sleeves round the dipole elements (Prov. Pat. Spec. 17109/59) in much the same way that small ferrite beads are used for decoupling in place of wound r.f. chokes in valve heater circuits, etc. The sleeves may be placed either $\lambda/4$ or $3\lambda/4$ from the feeder connections to the dipole and they appear to act in much the same manner as the "twigs" in that Band-I performance is not materially altered. Burke points out that a similar technique may be useful for "tuning" the metal legs of a television receiver, so that they can act as a resonant aerial.

Magnetic "Punched Cards", or permanent information stores, from which programme data can be electrically fed into computers much faster than from conventional punched cards, have been developed by Bell Telephone Laboratories in the U.S.A. and prepared for mass-production by the associated Western Electric Company. Whereas a punched card stores information by the positions of the punched holes, the new medium stores it by the positions of tiny "bar magnets" etched from a continuous magnetic film on a plastic card. The new units are not read by being fed through a machine but are kept stationary in close proximity to wire-grid sensing planes, and a complete store consists of a whole stack of alternate magnet-cards and sensing grids. In each sensing grid the wires running in one direction are "Twistors" (see January, 1958, issue, p. 32), while those in the other direction are ordinary conductors. The Twistors have a spiral wrapping of magnetic tape round a copper wire, providing a helical magnetic path, and are embedded in a strip of Mylar film. The other co-ordinate of the grid is made up of strips of copper foil 0.060in wide, also embedded in a Mylar film. This film is folded over the Twistor strip so that one complete loop is formed, each loop of copper strip providing a single-turn coil at right-angles to the Twistors. For access to the store, each copper-strip coil, or "word coil", is connected to a biased square-loop ferrite-core switch. This provides a means of selecting a particular "word coil" out of a matrix of such coils. Reading out from the store is accomplished by pulsing the copper-strip "word coils" by means of the ferrite cores, and the action of the "bar magnets" is to magnetically inhibit the effect of this pulsing on the Twistors. If there is no magnet at a given intersection of "word coil" and Twistor, a pulse is generated in the Twistor and is read out. If a magnet is present, its field prevents the production of the Twistor pulse, and no signal is read out. The pulse from the Twistor is about 6mV and 1μsec in duration. Speed of reading has not been stated precisely but is presumably of the order of 10^6 binary digits per second. The magnet cards can be changed easily when a new programme is required.



Irasers, Lasers and Rasers are similar to masers except that they operate at infra-red, light and radio frequencies respectively, rather than at microwave frequencies as does the maser. Since the first letter of the word maser stands for its operating frequency, this letter has been changed in the names of these three varieties of maser to correspond to their different operating frequencies. According to *Electronic News* for June 22, 1959 (p. 5) the operation of irasers will depend on transitions between electron spin quantum energy levels in the same way as masers. Rasers, on the other hand, because of their lower operating frequency, must use smaller energy differences than those which can be obtained between electron spin levels. These required smaller energy differences can be obtained between nuclear spin quantum levels. It is proposed to induce transitions between suitable nuclear spin quantum levels by means of electron spin transitions.

Variable Capacitance Diodes are used in parametric amplifiers for operation in the u.h.f. and s.h.f. region because they have the necessary speed of response for variable-reactance elements at these frequencies. A diode with the required properties has now been put on the market in Britain by G.E.C.



Suitable for use in radar and communications systems, it will operate at frequencies up to about 4 Gc/s. It is mounted in a coaxial structure for direct insertion into coaxial and waveguide circuits, and has the very low series inductance of 0.5mμH. Because of its very low forward impedance and very high reverse impedance, the device can be used as a microwave switch. Another application is as a frequency multiplier—an important aid to the design of microwave receivers based entirely on solid state devices.

Figure of Merit for audio output valves suggested by R. M. Mitchell in *Audio* for November, 1959 (p. 40), is power output × damping factor × efficiency × maximum possible grid circuit resistance ÷ (input voltage × harmonic distortion × price), the harmonic distortion and input voltage being taken at the stated power output. A high maximum possible grid resistor and low input voltage are desirable so as to make the valve easier to drive. The effect of feedback and qualifications to this figure of merit (such as weighting individual items) required for particular types of circuit are discussed in the article.

Elements of Electronic Circuits

11.—TRIGGERED TWO-STATE CIRCUITS

By J. M. PETERS, B.Sc. (Eng.), A.M.I.E.E., A.M.Brit.I.R.E.

A COMMONLY used two-state circuit which requires only one valve is the transitron, shown in Fig. 1. It consists of a pentode with suppressor and screen grids linked by a capacitor, and it behaves as a single-stage amplifier with feedback from screen to suppressor. It possesses only one stable state followed by one unstable one; does not freely run (as in the case of the multivibrator); and requires a trigger or initiating signal to maintain the action. The action will be described with reference to Fig. 2 and will be divided into three main intervals.

Interval 1:

(a) Initially the circuit is in a stable state with I_a and I_{g2} flowing. $V_{g3} = 0$ and C is charged.

(b) A positive-going sync voltage applied to V_{g1} causes I_a and I_{g2} to rise. V_{g2} and V_a therefore fall. As g_3 is connected to g_2 by C the instantaneous potential change is conveyed directly to g_3, which consequently follows and V_{g3} goes negative. I_a is therefore reduced and I_{g2} increases. A further reduction in V_{g2} results in a corresponding fall in V_{g3}. This action is cumulative and ends when I_a is cut off and all the space current flows to the screen.

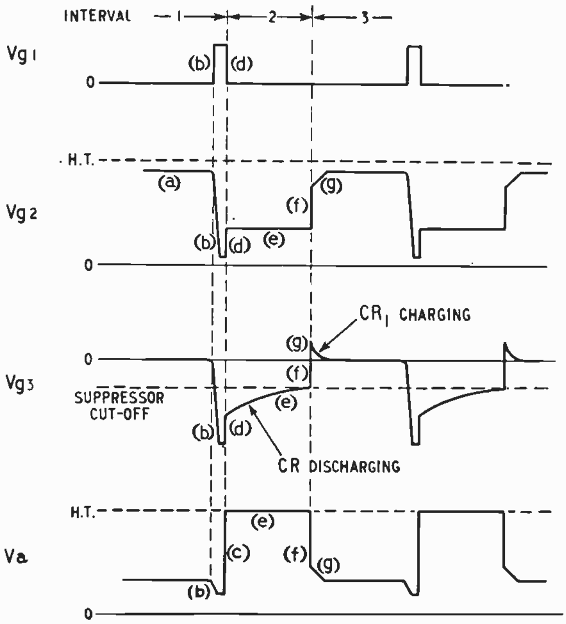


Fig. 2

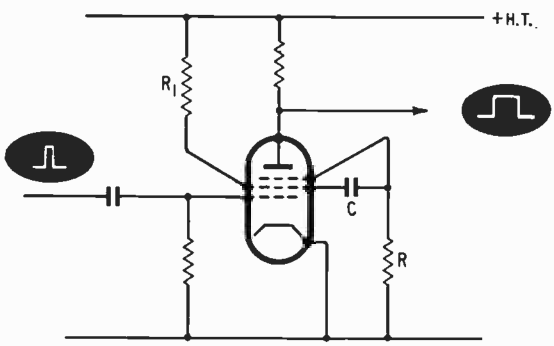


Fig. 1

(c) After the initial drop, V_a very quickly rises to h.t. potential.

(d) The first stage terminates when V_{g1} drops to zero. I_{g2} drops and V_{g2} and V_{g3} rise, but I_a remains cut-off. This is because g_3 was driven sufficiently negative during the first stage and is still well beyond suppressor cut-off voltage.

Interval 2:

(e) During the next interval C discharges through V and R with time constant CR ($R \gg R_1$), and the voltage on g_3 rises towards suppressor cut-off.

(f) I_a begins to flow, V_a drops and I_{g2} is reduced. V_{g2} increases, a further rise in V_{g3} is caused; I_a increases, causing a further drop in V_a. This action is cumulative and the circuit returns to its stable condition.

Interval 3:

(g) V_{g3} follows the rise in V_{g2} and, due to its positive excursion, I_{g3} flows, causing C to charge rapidly through R_1. This flow of current through R_1 produces an irregularity in the anode and screen grid waveforms at the trailing edge of the output pulse.

The duration of the output pulse from the anode depends on the time constant CR, and since the anode voltage is only indirectly affected by the charging and discharging of C, the waveform is square. Instead of applying a positive-going sync pulse to g_1 it is possible to trigger the circuit by a negative-going pulse either at g_2 or g_3. The action is similar, although the sync pulse must be of larger amplitude.

It may also be noted that, under certain conditions, provided that the sync pulse is of sufficient amplitude and duration, the cumulative actions described above can be initiated by a negative-going sync pulse applied to the control grid.

The control of I_a by V_{g3} requires the creation of a space charge ("virtual cathode") between g_2 and g_3. Under these conditions the pentode may be regarded as a pair of triodes with cathode, g_1 and g_2 as one valve; and with "virtual cathode", g_3 and anode as the other.

The Reflectometer

By "CATHODE RAY"

Principles of a Measuring Device Used on Lines and Waveguides

A READER, sharing my dislike for hazy or uncertain ideas, has cited the reflectometer as an example. He has seen a number of treatises on it, all of which failed to convey to him how it works. On the assumption—which I, knowing him, regard as most reasonable—that if he is puzzled others will be, he has urged me to do something about it.

Students of *Q.S.T.* and the A.R.R.L. Handbook (for 1957 thru 1959, as they say over there) will know the reflectometer better as the Monimatch. It has also been called the Directional Coupler. Whatever the name, its purpose is to enable r.f. power travelling along a line or waveguide to be sorted out according to direction of flow, so that the direct and reflected power can be measured separately. This obviously enables the standing-wave ratio* to be calculated. In turn this indicates the ratio of mismatch at the far end of the line, which is what one wants to know when setting up a transmitter for maximum efficiency or when measuring v.h.f. impedances.

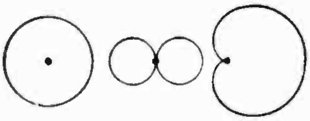


Fig. 1. Polar diagrams showing the directivity of (a) an ordinary vertical aerial, (b) a loop aerial, and (c) the well-known direction-finding aerial in which (a) is added to (b)—one loop of (b) being negative.

The more familiar method of measuring s.w.r. is to have a slot cut along more than half a wavelength of the line, through which a suitable voltmeter probe can be slid. The maximum and minimum readings give the ratio directly. The sliding process is not always very convenient; and if the source of power is a magnetron, which is apt to generate undesired frequencies when badly adjusted, it can happen that the best s.w.r. is indicated when the power is divided up amongst the greatest number of such frequencies —quite the reverse of the general intention. The reflectometer, on the other hand, can be fixed at any convenient point in the line, and indicates the reflected power directly—either in total, or frequency by frequency, according to the type of detector. It is also very easy and cheap to make. Between them, published designs of reflectometer cover frequencies at least from 2 to 3,300 Mc/s, but the most usual applications seem to be in the v.h.f. band.

At first thought it may appear rather a difficult thing to tell how much of the r.f. power is going each way when it is going both ways at once. Come to that, it's not altogether obvious how to tell which way it is going even when it is all going one way. The ordinary loop aerial can show the line of travel but not the direction along it. Readers familiar with radio direction finding, however, will remember the old dodge of combining a loop aerial with an ordinary vertical aerial giving the same amount of output. With the combination aerial facing one way, these two outputs are out of phase and cancel one another; facing the opposite way, they add up to give a maximum. Plotted on a polar diagram, the combined output yields a cardioid or heart-shaped diagram, compared with the ambiguous figure-eight of the loop alone and the omnidirectional result with the vertical aerial alone—Fig. 1.

Essentially the same principle is used in the reflectometer. Whether the line has a central conductor (coaxial) or not (waveguide), the space inside is being swept by the electric and magnetic fields which together make up the electromagnetic wave-train conveying the power along it. Now we know (if we don't, we shall in a moment) that the directions of these two component fields and the direction in which the waves are travelling are all three at right angles to one another. This is a thing that fairly shouts to be illustrated by an animated diagram in colour, but with a little imagination Fig. 2 should convey the essential facts. The invisible fields are here represented in the usual way by "lines of force," which are fair enough so long as they don't give anyone the idea that the lines really exist or that the fields act only along the lines and not in the spaces between. The electric field is represented by continuous lines and the magnetic field by broken ones. And, of course, the directions marked are those established arbitrarily by convention. The direction of wave motion is at right angles to both sets of lines, (a) towards or (b) away from you.

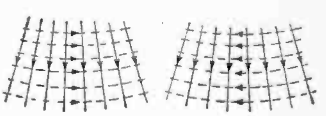


Fig. 2. The continuous lines represent the electric field, and the broken lines the magnetic field, together making an electromagnetic wave travelling at right angles to them, (a) towards you, and (b) away from you.

The novice might ask why it should be the magnetic field that has been reversed in (b). The answer is that it would be equally correct to show reversed electric field. At any given place along the line, these two alternatives alternate at the frequency of the waves. And at any given instant of time, the same two alternatives alternate at half-wavelength distances along the line. If the directions of *both* fields in either (a) or (b) were reversed it would not affect the direction of wave motion.

Another fundamental point is that in so far as power is being conveyed either way the two fields are in phase with one another.

What the problem boils down to, then, is to find which way across the cable or waveguide the magnetic field is directed, relative to the direction of electric field. If one places oneself so that the electric field

* Incidentally, why is the term "v.s.w.r." (voltage standing-wave ratio) so often used where there is no point in emphasizing voltage particularly? The current ratio is the same, so why not just "s.w.r."?

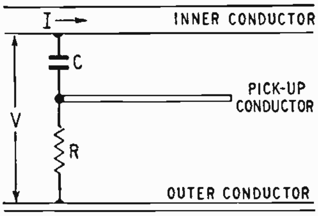


Fig. 3. The basic principle of a reflectometer is the coupling of a pick-up conductor to both electric and magnetic fields in such a way that the two effects cancel out for either direct or reflected wave as desired.

at any instant is downward, then if the magnetic field at the same instant is from left to right the waves are coming towards one; if from right to left, they are going away.

A reflectometer must be made so that it responds to both fields equally. Then if these responses add up to give a double measure from a wave going wholly one way, they will cancel out and give no response at all to a wave going wholly the opposite way.

The essential feature of all reflectometers, then, is a device for responding simultaneously to electric and magnetic fields. It has appeared in two main forms. In one (which includes the Monimatch) there is a short length of rod or wire fixed parallel to the inner conductor of the coaxial line, so that it is magnetically coupled to the said inner conductor and a.c. flowing therein generates an e.m.f. in it. Being located in the electric field between inner and outer conductors, it also has an e.m.f. between it and the outer conductor. This pick-up rod is dimensioned and connected so that the two e.m.fs equally operate on a suitable indicator, either in phase or 180° out of phase.

Constructional details vary, but they have to take account of the fact that the e.m.f. induced by magnetic coupling is proportional to the mutual inductance and the *rate of change* of current flowing in the "primary." So its peak is displaced 90° from the current peak. And because the voltage between the two line conductors is *in* phase with the current through them, the pick-up circuit must be arranged to give a 90° phase shift between the line voltage and the resulting voltage fed to the indicator. The usual way of doing this is shown in Fig. 3. The pick-up conductor is connected to the inner conductor through a small capacitance C—its self-capacitance is usually enough—and to the outer conductor through a resistance R which is very low in comparison with the reactance of C. The phase of the current driven by V through C and R in series is therefore determined almost entirely by the reactance, so it leads V by nearly 90°. So it is nearly in phase, or 180° out, with the e.m.f. induced in the pick-up conductor by I. Provided that the length and spacing of the pick-up are right, these two voltages are equal, so the voltage between the pick-up and outer conductor is a measure of the power travelling along the line in one direction only. Power in the other direction makes the voltages cancel out, to give no reading.

It will be obvious that Fig. 3 is rather too theoretical. For one thing, if C is self-capacitance it will be distributed all along the pick-up. And what about the indicator?

Fig. 4 shows a practical design for 4–15 Mc/s, described by O. Norgorden in U.S. Naval Research Laboratory Report No. 3538 of 1949. The coaxial line has half of the outer conductor cut away

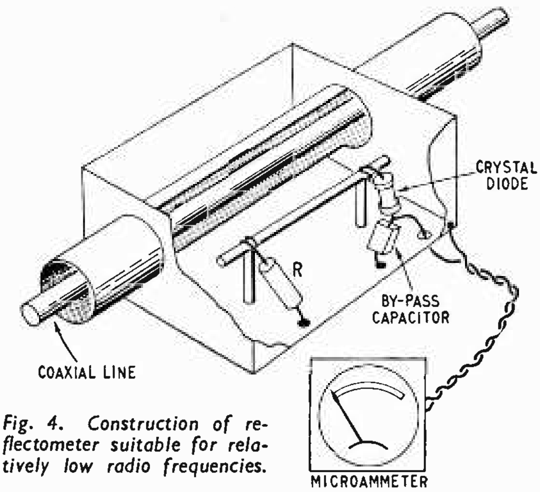


Fig. 4. Construction of reflectometer suitable for relatively low radio frequencies.

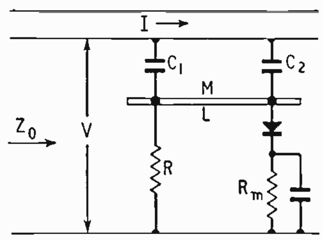


Fig. 5. Approximate equivalent circuit diagram of the Fig. 4 type of reflectometer.

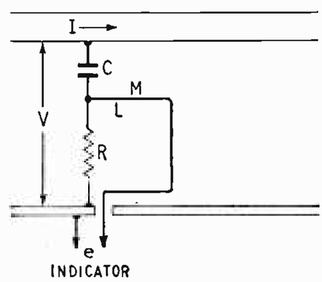


Fig. 6. Circuit diagram of loop type of reflectometer.

for a distance which is a small fraction of the wavelength. The screening is maintained by a surrounding metal box, inside which is installed the pick-up unit shown, differing from Fig. 3 only in C being distributed over the whole length of the conductor, and the addition of a crystal diode and microammeter as an indicator. R is of the order of 100Ω, and the resistance R_m of the meter is chosen to give it a suitable range in relation to the r.f. power used. For purposes of analysis the distributed capacitance between pick-up and inner conductor is assumed to be concentrated at the points where the connections are made, as in Fig. 5. This assumption seems to be justified in practice. So as not to interrupt ourselves with a lot of algebra at this point, the working has been exiled to an appendix. The upshot of it all is that the condition for no meter reading, when all the power is flowing in the direction causing the inductive and capacitive responses to oppose one another, is

$$M \simeq RCZ_0$$

where M is the mutual inductance between the

For instance, over a 2 : 1 frequency band the lowest frequency gives a response 6 dB less than the highest. And there is loss in the pick-up. Allowing, say, a total of 75 dB, the reflected-wave voltage picked up from 10 watts with a s.w.r. of 1.05 in a 70-Ω line comes out at 4.7mV. This is really too small for a crystal and microammeter.

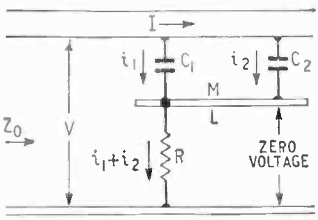
A sensitive measuring gear using a radio receiver is shown by W. H. Elkin in *Marconi Instrumentation*, Dec. 1956. Fig. 8 is fairly self-explanatory. It can be worked with an oscillator uncalibrated for output level, but does call for a calibrated piston attenuator with which to measure the ratio of direct to reflected power giving equal receiver output. Alternatively if an output-calibrated signal generator is available the input can be varied by its attenuator to get equal receiver response with the reflectometer loop in its two set positions.

Anyone whose thirst for information on reflectometers, especially their practical details, has not yet been slaked should refer to this and other literature I have mentioned, and perhaps also an earlier paper by H. R. Allan and C. D. Curling, in *Proc. I.E.E.*, Jan. 1949, which deals particularly with 10cm. waveguide technique.

APPENDIX

If the reflectometer is properly made it will give zero reading with power flowing along the line in one direction. In that case the voltage across the detector in Fig. 5 is zero and that arm of the circuit can be omitted, as in Fig. 9. The voltages across C_1 and R must add up to V;

Fig. 9.



the voltage across C_2 must be the same; and the voltage across the rod and that across R must add up to zero:

$$\frac{i_1}{j\omega C_1} + (i_1 + i_2)R = V \quad .. \quad .. \quad (1)$$

$$\frac{i_2}{j\omega C_2} = V \quad .. \quad .. \quad .. \quad .. \quad (2)$$

$$(i_1 + i_2)R + i_2 j\omega L - Ij\omega M = 0 .. \quad (3)$$

$$V = IZ_0 \quad .. \quad .. \quad .. \quad .. \quad (4)$$

The value of i_2 found from (2) is substituted in (1), from which i_1 is found, and both are substituted in (3), where I is replaced by V/Z_0 from (4). After a bit of manipulation this yields

$$\frac{M}{Z_0} = R(C_1 + C_2 - C_1\omega^2 LC) + j\omega\left(C_2 L - C_1 R\frac{M}{Z_0}\right) .. \quad (5)$$

To make this possible, the "j" term must be zero; i.e.,

$$C_2 L = C_1 R \frac{M}{Z_0}$$

$$\text{or } \frac{M}{Z_0} = \frac{C_2 L}{C_1 R}$$

The factor $\omega^2 LC_2$ in (5) is the ratio of the reactance of L to the reactance of C_2, and in practice this is much less than 1. (In other words, the pick-up is much too small to resonate at the working frequency). So $C_1\omega^2 LC_2$ can be neglected in comparison with $C_1 + C_2$. With these amendments, (5) boils down to

$$\frac{M}{Z_0} = \frac{C_2 L}{C_1 R} \simeq R(C_1 + C_2) \quad .. \quad (6)$$

This states how the circuit must be proportioned if the reflectometer is to ignore waves travelling in one of the two directions through it. When the position of the detector, or the loop itself, is reversed, M in (3) is reversed in sign and a reading is given. The current in the detector circuit is then proportional to the current in the line (1) and therefore to the square root of the r.f. power. (There is, of course, mutual inductance between the pick-up and outer conductor, so M is really the coupling to the inner conductor minus that to the outer.)

The type of instrument shown in Fig. 4 is reasonably well covered by (6) if $C_1 = C_2$ and $C_1 + C_2 = C$, simplifying it to

$$\frac{M}{Z_0} = \frac{L}{R} \simeq RC$$

In the loop type with capacitance concentrated mainly at one end (Fig. 6), on the other hand, $C_2 = 0$ and $C_1 = C$; adapting (5) accordingly gives

$$\frac{M}{Z_0} = \frac{RC}{1 + j\omega CR}$$

and since R is made much smaller than the reactance of C, $j\omega CR \ll 1$ and

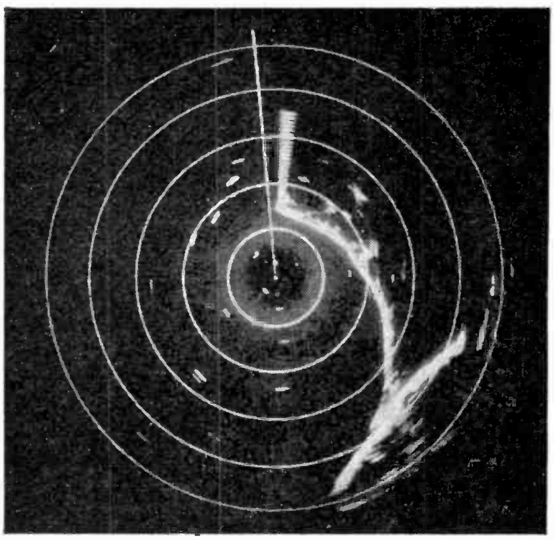
$$\frac{M}{Z_0} \simeq RC$$

which is the same as with Fig. 5 except that there is no stipulation about L. Note that within the limits of the approximations the balance condition is independent of frequency, so the setting up is effective over a wide frequency band.

Secondary Radar For Marine Use

THE correlation of radar paints and a navigation chart is eased by the use of secondary radar, as transponder-carrying "targets" will give a strong identified response. RACON is one such transponder beacon for marine use: it produces, when triggered by a ship's radar transmission, a chain of impulses corresponding to 15 to 20 dots extending over the equivalent of four miles of the p.p.i. screen on the bearing, and starting at the range, of the beacon-equipped object. The transponder sweeps the allocated band of frequencies once in 75 sec during 5-min operating periods between 5-min intervals. RACON is made by Kelvin & Hughes (Marine) Ltd. to a Trinity House specification and is, at the moment, undergoing trials.

Response (to right of radial marker) from RACON transponder at about two-miles range.



inner and pick-up conductors, $C=C_1+C_2$, and Z_0 is the characteristic impedance (=V/I) of the line.

A procedure for achieving this condition is to terminate the line with an accurately matched load and feed it with power. The spacing between conductors (which determines M and C), or R, is then varied to give zero reading.

The instrument having been set up correctly, any reading indicates reflected power. To indicate direct power for comparison, the mutual inductance must be reversed in sign. This could obviously, but inconveniently, be done by reversing the whole reflectometer in the line. The same effect is produced by interchanging R and the indicator. In the Monimatch it is done by having two reflectometer units and switching the microammeter from one to the other. Details of a construction in which the pick-up wires are mounted end-to-end, with a common resistor R in the middle, are given by L. G. McCoy in *Q.S.T.*, Oct. 1956, and in the 1957 A.R.R.L. Handbook, p.516. A more compact version, with separate wires lying head-to-tail on opposite sides of the inner conductor, is described in *Q.S.T.*, Feb. 1957, and in the 1958 Handbook, p.530. A still more compact version, in which the first arrangement is adapted to a length of flexible coaxial cable wound into a hank, and balance is obtained by varying R, is shown in the 1959 Handbook, p.530.

The other main variety is the rotatable loop type, which is tending to supersede the foregoing, presumably because it is more suitable for higher frequencies and is applicable to waveguides. It is also easier to adjust. But the differences are more mechanical than electrical. Fig. 6 shows that electrically it is essentially the same as Fig. 5, except that the loop may be shaped to put extra capacitance at one end. The algebra used for Fig. 5 can easily be adapted for Fig. 6 by putting $C_2=0$ and $C_1=C$, and the result is the same, apart from quantities small enough to neglect. Mechanically, the loop is arranged so that it can be rotated from outside through 180°. So its kinship with the d.f. aerial is more obvious.

This continuous rotability makes it easier to tell whether the capacitive and inductive couplings are equal. If C is too small or too large in relation to M, either there will be two zero readings each side of the position where the loop lies along the line, as in Fig. 7(a), or no zero at all, (b). These diagrams, incidentally, are just cartesian versions of what come out as cardioids in the polar form (Fig. 1).

Besides being proportioned for equal capacitive and inductive e.m.fs, a reflectometer pick-up device must extend along the line for only a small fraction of a wavelength—which means a very small loop in centimetre waveguides—and not be large enough to cause appreciable reflection or absorption of the transmitted power itself. At the same time it must be sensitive enough to indicate small amounts of reflected power.

Suppose, for example, that standing-wave ratios at least down to 1.05 are to be measurable. That is to say,

$$\rho = 1.05 = \frac{V+v}{V-v}$$

where ρ is the s.w.r. and V and v the voltages of the direct and reflected waves. From this we get

$$\frac{v}{V} = \frac{\rho-1}{\rho+1} = 0.0244$$

The ratio of reflected to direct power is equal to the square of this, 0.0006. The power taken by the reflectometer ought not to be more than a like fraction of this power, or 0.00000036; in other words, a loss of at least 65 dB between the lowest power to be monitored and that available for the indicator. If the reflectometer is to be used over a band of frequency there is a further loss, because the voltages picked up are proportional to the rate of change, and hence the frequency, of the wave voltage and current.

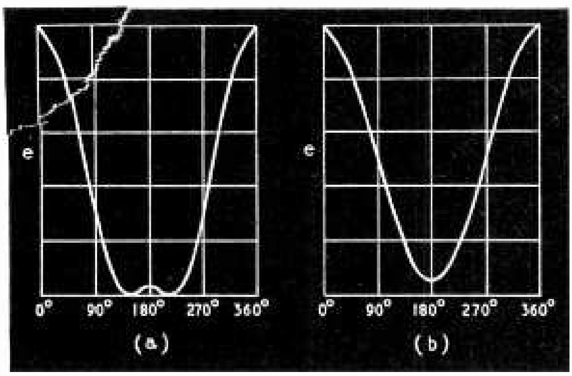


Fig. 7. Variation of response as the loop in Fig. 6 is rotated through one whole turn, with the magnetic coupling (a) too tight, (b) too loose, compared with the electric.

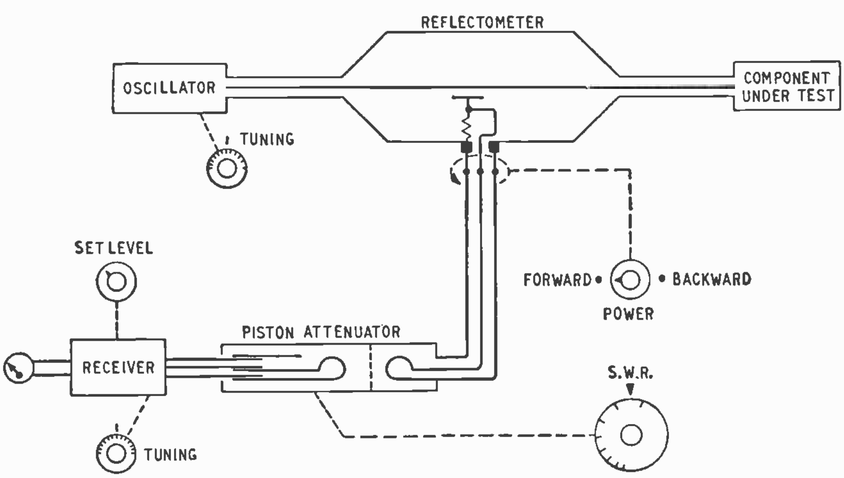


Fig. 8. Diagram of apparatus using a reflectometer for measuring standing-wave ratio and hence the impedance of line terminations.

THE SMITH CHART

By R. A. HICKSON*

3.—Matching Transmission Lines to Aerials and Uses of Stubs

(*Concluded from page 85 in the February issue*)

CONTINUING with our study of the applications of the Smith Chart we will now consider one of the most common requirements, namely matching transmission lines to aerials and how mismatch can be corrected by means of stubs.

Matching a Resistive and a Reactive Impedance.—Normally this means matching a load such as an aerial, to a transmission line, and the problem will be discussed in these terms. Various matching elements may be used, such as:—

(*1*) Matching stub connected in parallel with the load.
(*2*) Matching stub which can be located at any point on the line.
(*3*) Matching stubs which are located at fixed points on the line.
(*4*) L-networks.
(*5*) Series elements, such as quarter-wavelength transformers, in conjunction with phasing sections. A phasing section is a length of line between the load and the transformer, used to convert the load impedance to a resistive value. A more practical embodiment of this idea is the slug tuner, which is a quarter-wavelength long metal or dielectric sleeve, sliding on the inner conductor of a coaxial line. The double-slug tuner has two independent sleeves and will match a wide range of impedances. A full description can be found elsewhere[7].

In order to avoid losses in the stubs, they are normally terminated in a short circuit and their length is adjusted to obtain the required reactance. Capacitive terminations are used on occasion, for example, when the transmission line is also used to supply low-frequency de-icing current to an aerial.

A useful discussion of various matching methods in relation to their performance over a wide band of frequencies is contained in reference 8.

Stub in Parallel With the Load.—This is best treated on an admittance basis, since two admittances add when connected in parallel. Consider the admittance curve of a simple dipole, resonant at 56Mc/s, Fig. 18. If the tolerable v.s.w.r. is 2, then the bandwidth of the dipole is 5Mc/s. The effect of adding susceptance is to shift each point on the curve along the line of constant conductance. Thus point A, at the intersection with the $G = 0.5$ circle can be moved at $0.5 + j0$ by the addition of $+j0.48$. Similarly point B can be moved to $0.5 + j0$ by the addition of $-j0.88$. Intermediate points will require correspondingly smaller susceptances to bring them within the " v.s.w.r. $= 2$ " circle.

The susceptance of a short-circuited quarter-wavelength stub, resonant at a frequency between 52Mc/s and 60Mc/s, will provide the required compensation. In general, the susceptance variation of a simple dipole is such that it can be compensated by a stub of this sort. As is well known, the two elements of a simple dipole may be bent over to form a Vee, imparting some directional properties to the aerial. If the elements are bent further than usual, so that they tend to become parallel, the similarity of the aerial to the quarter-wavelength open-circuited section of transmission line can be readily seen. Its susceptance variations are accordingly such as to be compensated by a quarter wavelength short-circuited section.

The resonant frequency of the stub is found by an approximate method which depends on the fact that the variation of susceptance with frequency is very nearly linear in the region of the resonant frequency. For a frequency change of $60 - 52 = 8$Mc/s the normalized susceptance changes by $0.88 + 0.48 = 1.36$. The change in frequency for a change in susceptance of 0.48 is therefore

$$8 \times 0.48/1.36 = 2.825\text{Mc/s}.$$

The resonant frequency of the stub is, $60 - 2.825 = 57.175$Mc/s and the electrical length of this stub at 60Mc/s is $0.25 \times 60/57.175 = 0.2625$ wavelength.

The susceptance of a stub of the same characteristic impedance as the transmission line at 60Mc/s is given by moving 0.2625 wavelength towards the load from the point of infinite susceptance. This brings us to $+j0.082$. We need $+j0.48$, therefore the impedance of the stub must be $(0.082/0.48)Z_0$ or $0.171Z_0$. As the chart is normalized to 75 ohms, the stub impedance required is 12.8 ohms. (In Fig. 18 the movement is in the direction "Towards Generator" because the short-circuited end of the stub is electrically further from the generator than the actual load which is to be matched.)

Calculations for the other frequencies may now be carried out on this basis. The procedure is:—

(*1*) Calculate the stub length in wavelengths at the required frequency.
(*2*) Determine from the Smith chart the susceptance of the stub if its characteristic impedance is equal to Z_0.
(*3*) Multiply this susceptance by 75/12.8 to obtain the susceptance of the 12.8-ohm stub.
(*4*) Add this susceptance to the aerial by moving the point the required distance along the circle of constant conductance.

The result is as shown in Fig. 18. The bandwidth for a v.s.w.r. of 2 is now 8Mc/s, an increase of 60%. A greater improvement could be obtained by selecting a 50-ohm feeder. This would shift the whole curve downwards, so that a greater proportion of it could be folded into the " v.s.w.r. $= 2$ " circle by adding reactance. This is of course not practical for the television receiving installation but has applications elsewhere.

The only admittances which can be matched by

* Belling and Lee Ltd.

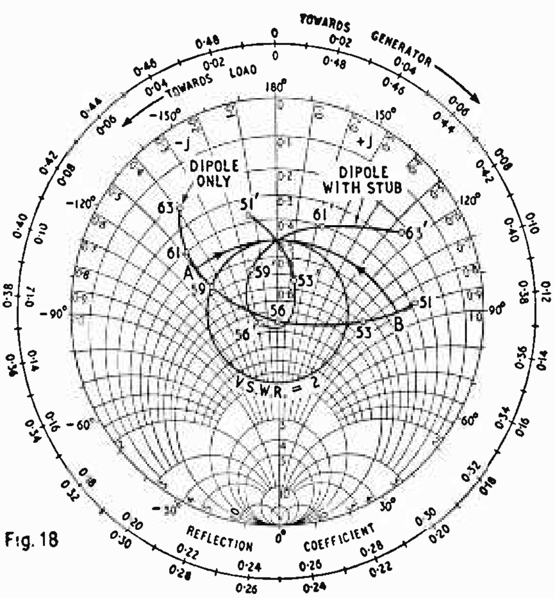


Fig. 18

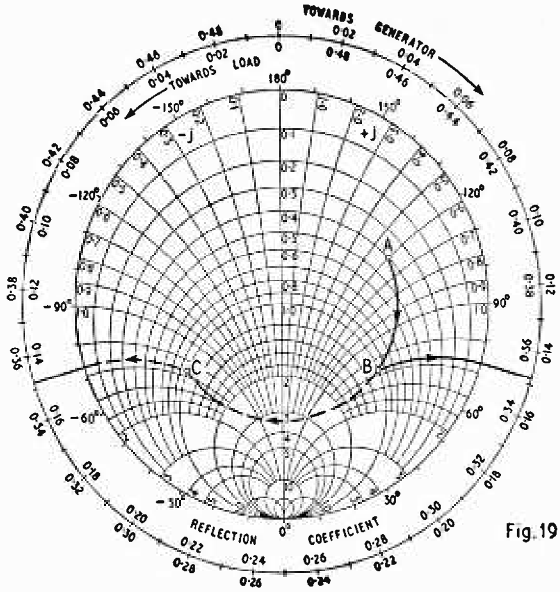


Fig. 19

Fig. 18. Use of a stub in parallel with an aerial to increase the useful frequency range.

Fig. 19. Use of a sliding stub to match the load at a single frequency.

this technique are those lying within the crescent defined by the circles of constant conductance which are tangent to the circle of constant v.s.w.r. within which the admittance is required to fall. Such admittances can always be matched at one frequency, but matching over a band may not always be possible. (See Ref. 8.)

Stub at any Point on the Line.—This technique makes use of the fact that the impedance of a mismatched line varies along its length. It can be applied to any load and is in principle carried out in two steps:—

(*1*) Move along the line away from the load to reach a point at which the conductance is unity.

(*2*) Add a stub to cancel the susceptance present at this point.

On the Smith chart we plot the normalized load admittance and draw the arc of a circle centred on the centre of the chart, moving clockwise through the load to intercept the circle of unity conductance. There will be two interceptions and normally the one nearer the load is chosen. However, the other may lead to a shorter stub, which may be preferable in some applications. The required stub susceptance will be equal and opposite to that of the line at the point of intersection with the circle of unity conductance.

As an example we may consider a load of $0.4 + j0.6$, point A, Fig. 19. Moving 0.062 wavelength along the line brings the admittance to $1 + j1.33$. The length of a short-circuited stub having a susceptance of $-j1.33$ is found by moving along the circle of constant susceptance $-j1.33$ to the edge of the chart and thence along the edge, i.e. the circle of pure susceptance, to the short circuit, which is the point of infinite susceptance. The stub length is 0.102 wavelength.

The same load may also be matched by moving 0.234 wavelength along the line to bring the admittance to $1 - j1.33$. The stub length required now is 0.398 wavelength.

The technique is suitable for single-frequency operation with a constant load, or for experimental work with open-wire lines. For most other purposes, the disadvantage of providing a sliding contact on the transmission line is found to be excessive. The variation in matching with frequency is therefore of little interest.

Matching Stubs at Fixed Positions on the Line.—This system allows a greater range of load impedances to be matched than does the single stub in parallel with the load, and it does not require the provision of sliding or movable contacts on the line. Two stubs will allow most loads to be matched, and the two-stub system will be described in detail. Three stubs will allow all loads to be matched; they are commonly spaced ⅛-wavelength apart and their operation is the same in principle as that to be described for the two-stub system.

One stub is connected in parallel with the load, the other at a distance of ⅛ or ⅜ wavelength along the line. So far as the remainder of the line is concerned the effective load is formed by the two stubs, the section of line between them, and the load, all taken together. The stub, nearest the generator, therefore, can only be used to cancel susceptance. The stub at the load is adjusted so that the resultant admittance produced by this stub in combination with the load, when transformed by the intermediate section of line, falls on the circle of unity conductance. The addition of susceptance by the second stub will then result in a pure conductance of the required value. The admittance of the actual load in parallel with the load-end stub must lie on a point which can be reached by travelling ⅛ (or ⅜) of a wavelength towards the load from the circle of unity conductance. In other words, it must lie on a circle of the same diameter as the circle of unity conductance, rotated bodily through ⅛ (or ⅜) of a wavelength about the centre of the chart. These circles are shown in Fig. 20(a).

The load admittance, therefore, must have a conductance component which will allow the point representing it on the chart to be moved on to the transformed unity-conductance circle by the addition of the susceptance of the load-end stub. An examination of the chart shows that this condition can be met for all loads except those within the circle of "conductance = 2," which is shaded. Such loads may be inverted by a quarter-wave section line, i.e. the load-end stub may be placed a quarter-wavelength from the load. In fact, the circle representing the loads which cannot be matched may be placed at any position round the edge of the chart by choosing the appropriate length of line between the load and the load-end stub.

The choice of spacing between the two stubs arises from the facts that (*a*) any closer spacing than ⅛ wavelength would lead to field distortion and would effectively place the two stubs in parallel: (*b*) the use of spacings between ⅛ and ⅜ wavelength would increase the area on the chart representing loads which could not be matched. At ¼-wavelength spacing, loads within the circle of unity conductance could not be matched. A spacing of ⅜ wavelength may be used where ⅛ wavelength is mechanically inconvenient. Wider spacings than ⅜ wavelength would offer no electrical advantage; a spacing of ½ wavelength, for example, would be equivalent to placing the two stubs in parallel.

As an example, we will match the load $0.6 + j0.6$, point A on Fig. 20(b), using one stub in parallel with the load and the other stub ⅜ wavelength along the line. The first stage is to select the susceptance of the load-end stub so that the resultant load lies on the rotated circle. There are two choices, points B and C, where the "conductance = 0.6" circle intersects the rotated circle. When transformed through the ⅜-wavelength section of line, the admittances become points D and E. From either of these points, the addition of susceptance by the generator-end stub will result in a completely matched system.

L-Network Design.—Matching with an L-network, using the Smith chart, follows similar lines to matching with a stub of adjustable position. In this case, however, the impedance-transforming property of a length of line is not used, a reactive element being placed in series with the line instead, and accordingly the chart must represent impedance as well as admittance.

There are two general types of L-network, as shown in Fig. 21. Considering first the type A network, the resultant admittance of $X_2 + Z_L$ must lie on the circle of unity conductance, so that susceptance only need be added to complete the matching process, exactly as in the case of single-stub matching. In other words the resultant impedance of $X_2 + Z_L$ must lie on the circle surrounding area B. To be matched by a type-A network, therefore, the load impedance must be such that, by adding or subtracting reactance, we can reach the circle surrounding area B. The shaded area A on Fig. 21 defines the loads which cannot be matched by a type-A network. Similar reasoning shows that the loads which cannot be matched by a type-B network are those defined by the shaded area B on Fig. 21.

As an example of the design of an L-network, we will match an impedance of $20 + j50$ ohms to a 50-ohm line with a loss-free type-A network. The procedure can be followed on Fig. 22. The normalized impedance is $0.4 + j1.0$ (point A). The series element will be a capacitor of reactance equal to $1.49Z_0$ at the operating frequency. This produces a resultant impedance as shown at point B, corresponding to the admittance (relative to 20 millimhos) shown at point C. The addition of inductance of susceptance equal to $1.25Y_0$ at the operating frequency results in complete matching.

If losses in the inductor or capacitor are not negligible an allowance must be made for them. Considering the inductor first, let $G = -B/Q$ so that a susceptance of -1.0 will involve a conductive component of $+1/Q$. The resultant admittance of load and capacitor combined must now lie on the line

Fig. 20 (a). Limits within which the double-stub matching method can be applied.

Fig. 20 (b). Matching with two stubs spaced at 3λ/8.

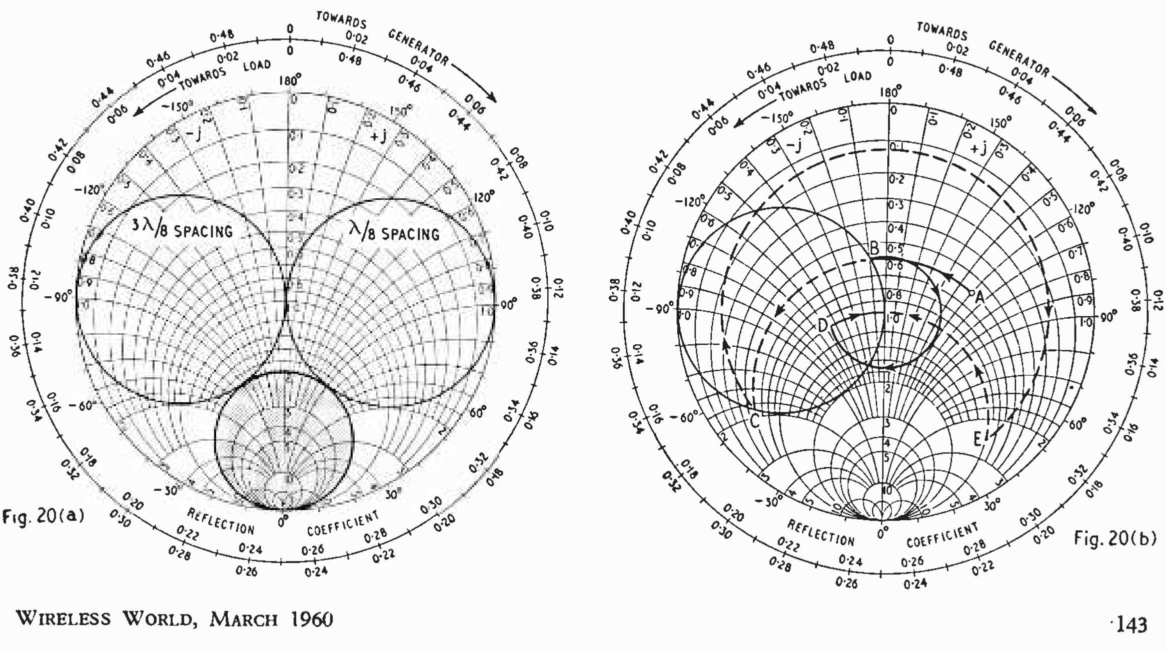


Fig. 20(a)

Fig. 20(b)

$1 - B/Q + jB$, where B is the required susceptance. For example, if $Q = 10$, this line will pass through the points $1 + j0$, $0.9 + j1$, $0.8 + j2 \ldots\ldots 0 + j10$; it is, in fact, a circle, the centre of which can be found by laying off arcs from three or more points such as those calculated above. The corresponding circle for the resultant impedance of load and capacitor combined is now readily drawn. Any losses in the capacitor may be taken into account without a geometrical construction by remembering that for every unit of reactance (movement along a line of constant resistance) we must add $1/Q$ units of resistance. As $1/Q$, which is virtually equal to the power factors, is about 0.0005 for a ruby-mica dielectric and about 0.0001 for air dielectric, correction is not often needed for capacitor losses.

The same load (point A) can be matched with an all-capacitor network. The series capacitor should now have a capacitance equal to $0.51Z_o$ at the operating frequency. This produces the resultant impedance shown at point B′, corresponding to the admittance shown at point C′. The addition of a

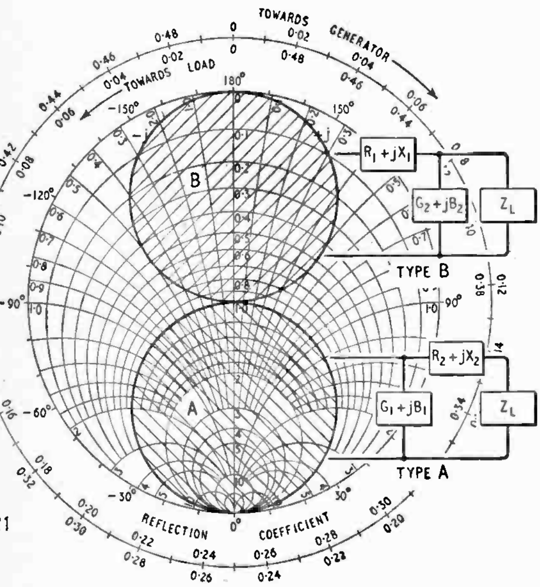


Fig. 21

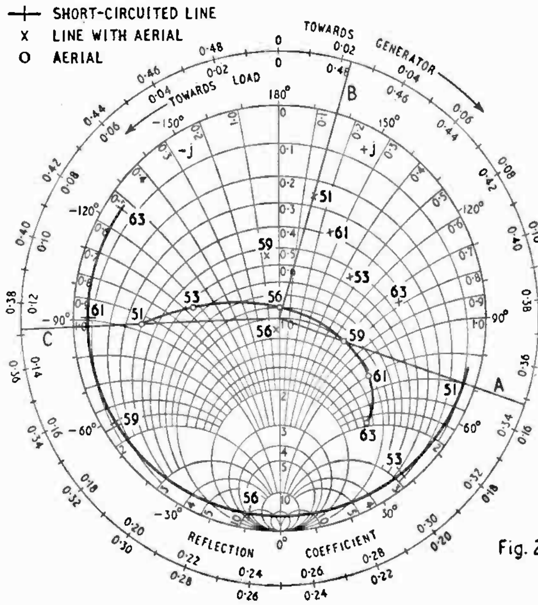


Fig. 23

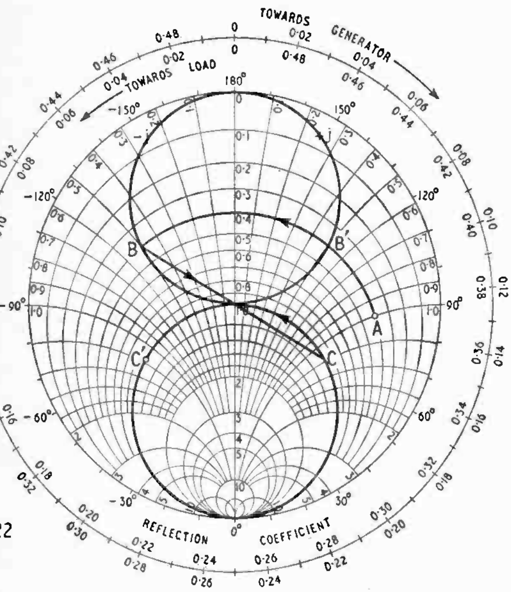


Fig. 22

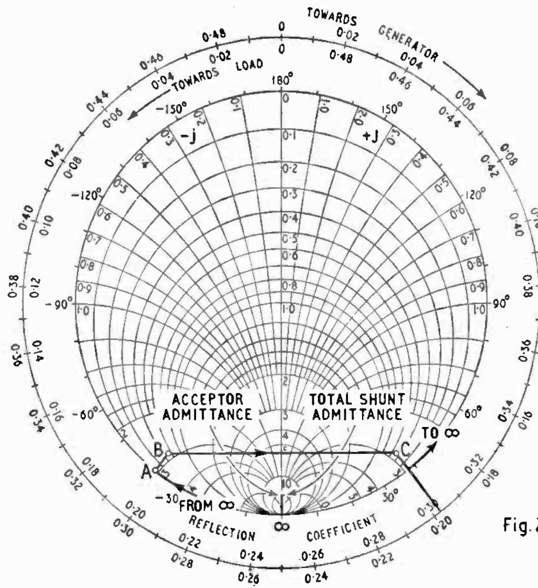


Fig. 24

Fig. 21. The two basic types of L-network, showing the load impedances (shaded) for which each is not applicable.

Fig. 22. Matching with a loss-free type A L-network.

Fig. 23. Allowing for the effect of the line on the apparent impedance of a dipole at various frequencies.

Fig. 24. Single-frequency acceptor-circuit wavetrap, with compensation.

shunt capacitor of susceptance equal to $1.25Y_o$ at the operating frequency results in complete matching (Fig. 22).

Effect of Line Length in Measurements.—The effect of line length on the apparent impedance of an aerial has been discussed by Strafford[9] whose example, a Channel-3 dipole, will be used here. The principle applies to any type of load.

The first step is to measure the input impedance of the line with a short circuit in place of the unknown load, at the frequency of interest. The result might be, for example, $0.1-j1.4$. As we started with a short circuit, $0+j0$, the effect of the line has been to move the point on the chart 0.151 wavelength clockwise and 0.32dB radially inwards. Therefore, when the short circuit is replaced by the unknown load, the apparent impedance must be moved 0.151 wavelength counter-clockwise and 0.32dB radially outwards, to obtain the true load impedance. This procedure must be repeated at each frequency. It must be borne in mind that, while 0.151 wavelength always corresponds to the same angle (109°) on the chart, the radial distance represented by 0.32dB depends on the point at which the " Effect of Line Attenuation " scale is entered and must be evaluated afresh with this scale for each new point.

Point A in Fig. 23 represents the input impedance of the short-circuited line. Point B represents the input impedance of the line with an aerial connected in place of the short circuit. Point C is the actual impedance of the aerial, obtained as described above. The construction is shown for one frequency only, 51Mc/s. At this frequency the effective length of the line is 0.151 wavelength. The point B, representing the input impedance of the line with the aerial at 51Mc/s must therefore be moved 0.151 wavelength counter-clockwise, from 0.477 to 0.128 on the " Wavelengths towards Load " scale. At the same time the loss of 0.32dB in the line is allowed for by moving the point the correct radial distance outwards, as described above.

Compensated Coaxial-Stub Acceptor Circuit.—In cases where two frequencies are present on a transmission line, one of which is undesired, this frequency can be considerably attenuated by a coaxial stub which is one half-wavelength long at the undesired frequency and is short circuited at the free end. This stub will " repeat the load " and will short circuit the line at its resonant frequency. It will also present a susceptance across the line at the signal frequency, and this susceptance may be cancelled by a second stub of suitable length.

Certain special cases must be distinguished. If the desired frequency is an integral multiple of the undesired frequency, the stub will short circuit both signals impartially. If, on the other hand, the undesired frequency is exactly twice the desired frequency, the acceptor stub will be a quarter-wavelength stub at the desired frequency and no compensation will be needed.

Suppose that the two frequencies are F_D and F_u. The electrical length of F_D of a stub which is one half-wavelength at F_u will be $0.5F_D/F_u$ wavelengths. The problem is best handled on an admittance basis so we start at the infinity point on the chart and move clockwise round the edge of the chart for the distance $0.5\ F_D/F_u$ wavelengths. The point so reached is the susceptance placed across the line at the desired frequency. To reduce this susceptance to zero, we must add an equal and opposite susceptance. We therefore locate the required point on the chart and move counter-clockwise round the edge of the chart to the infinity point. The distance travelled in wavelengths is the length of the required compensating stub. The compensating stub, of course, presents a certain susceptance at the undesired frequency, but this is of no importance, as it is in parallel with a much greater susceptance. The effect of losses in the stubs may be taken into account by using the " Effect of Line Attenuation " scale.

As an example (Fig. 24) we will consider interference at 38Mc/s to a signal at 42Mc/s. The electrical length of the acceptor stub at the signal frequency will be $38/2 \times 42 = 0.5527$ wavelength. Moving this distance from the infinity point in a clockwise direction round the edge of the chart we reach point A, $0 - j2.9$. Assuming that the stub has an attenuation of 0.4dB, we move radially inwards by the distance indicated on the " Effect of Line Attenuation " scale to point B, $0.5 - j2.85$. The compensating stub must have a susceptance of $+j2.85$ to cancel this, and will have very nearly the same attenuation. Its admittance is therefore located at point C, which is the mirror image of point B in the pure conductance scale, and its length is found by moving 0.4dB radially outwards to the edge of the chart and thence counter-clockwise to the short-circuit (infinity susceptance) point. The length is 0.447 wavelength.

The admittance of the acceptor stub at the undesired frequency is not infinite, but is reduced by the attenuation of the cable used to make the stub. The actual admittance is found by moving radially inwards by the distance indicated on the " Effect of Line Attenuation " scale. Therefore, to the admittance thus found, $20 + j0$, must be added the admittance $0.5 + j2.85$, corresponding to point C, making the total shunt admittance due to the pair of stubs $20.5 + j2.85$ at the undesired frequency. It will be seen that the effect of the compensating stub at this frequency is negligible. The ratio of the admittance of the cable following the acceptor circuit to the combined admittance of the stubs is 1 to 20.7. The interfering signal power is therefore divided between the two paths in the ratio 428 to 1, corresponding to an attenuation of 26.3dB.

SYMBOLS

e = Effective relative permittivity (dielectric constant) of the dielectric.
F = Frequency Mc/s.
L = Physical length of line in metres.
l = Length of line in wavelengths
= $FL\sqrt{e}/300 = FL/300v$.
v. = Velocity factor of line = $1/\sqrt{e}$.
Y = Load admittance.
Y_o = Line admittance.
y = Normalized load admittance, = Y/Y_o.
Z = Load impedance.
Z_o = Line impedance.
z = Normalized load impedance, = Z/Z_o.

REFERENCES

[7] " Transmission and Propagation." Volume 5 of the Services Textbook of Radio, H.M.S.O., 1958, pp. 117-119.

[8] C. H. Westcott and F. K. Goward. " The Design of Wide-Band Aerial Elements for 500-600 Mc/s Ground Radar." I.E.E. Paper No. 732, Radio Section, *Proc.*

I.E.E. Volume 96, Part III, No. 39, January 1949, pp. 41-51.

[9] F. R. W. Strafford. "Measuring TV Aerial Performance; Part 3, Impedance Measurements," *Wireless World*, Volume 64, No. 6, pp. 295, 296, June 1958.

ADDENDUM

Since publication of the first two parts of the article it has been pointed out that certain statements and equations need clarification.

On page 7 second column of the January issue the statement that the v.s.w.r. is simply related to the load does not apply where the load comprises both reactance and resistance; S should then equal r not z.

As derived $$S = \frac{1 + |K|}{1 - |K|}$$

Now $K = \frac{z - 1}{z + 1}$ and if $z = r + jx$

$$K = \frac{r - 1 + jx}{r + 1 + jx}$$

Since the modulus of a complex number is equal to the square root of the sum of the squares of the real and imaginary parts:—

$$|K| = \left[\frac{(r - 1)^2 + x^2}{(r + 1)^2 + x^2}\right]^{\frac{1}{2}}$$

If the load impedance is resistive ($x = 0$) this simplifies to:—

$$|K| = \frac{r - 1}{r + 1}$$

So that:— $$S = \frac{1 + \frac{r-1}{r+1}}{1 - \frac{r-1}{r+1}} = \frac{r + 1 + r - 1}{r + 1 - r + 1} = r$$

The statement at the end of this section that the decibel may be used only when . . . " voltages are developed across identical impedances " should read . . . " across impedances having the same resistive component."

In Appendix 1, page 8, January issue, the fourth line from the bottom of the second column should read:—

$$u^2 - \frac{2ru}{1 + r} + \frac{r}{1 + r} = \frac{1}{1 + r} - v^2$$

while the penultimate line should read:—

$$u^2 - \frac{2ru}{1 + r} + \frac{r^2}{(1 + r)^2} = \frac{1}{(1 + r)^2} - v^2$$

In the February issue page 83, second column, line 12 the equation " attenuation (dB) = $k\sqrt{\text{frequency}}$ " is given without specifying that k is a constant. It could be re-written " attenuation dBα frequency."

On page 84, first column, line 10, the derivation of the equation for velocity factor is as follows:— The electrical length (l) of the line is given by:—

$$l = \frac{L}{\lambda} \ldots\ldots\ldots\text{(wavelengths)}$$

where:— L is the physical length in metres,

λ is the wavelength in metres, given by $\lambda = 300v/F$ metres,

300 is the (approximate) velocity of electromagnetic waves in free space in megametres/second,

v is the velocity factor of the line,

F is the frequency in Mc/s.

$$\therefore l = \frac{FL}{300v} \ldots\text{(wavelengths) and } v = \frac{FL}{300l}$$

Let the electrical length be l_1 at F_1 and l_2 at F_2. Then:—

$$v = \frac{F_1 L}{300 l_1} = \frac{F_2 L}{300 l_2} = \frac{(F_1 - F_2)L}{300(l_1 - l_2)} = \frac{\delta F L}{300 \delta l}$$

In Fig. 15 on page 84 the direction of movement from the short-circuit should be towards the generator as stated in the text (page 85 column 1), indicating a load impedance of $1 + j0.6$.

"ELECTRONIC COMPUTERS"

SINCE the first edition of this *Wireless World* book came out just over three years ago it has been reprinted once and also translated into Russian and republished by the Soviet authorities. Technical developments in the computer field have been so rapid, meanwhile, that a second edition of the book has become necessary, and this is now available from our publishers. The opportunity has been taken to improve the exposition of basic principles which is the main purpose of the book, and it has, in fact, been largely rewritten. Three new chapters, on analogue computer circuits, programming of digital computers and the future development of "intelligent" machines, have been added, together with new illustrations throughout the book, which now contains 263 pages, including 32 plates. As before, the new edition covers the principles and applications of both analogue and digital machines, and is suitable as an introduction to the subject for students, technicians or laymen with some knowledge of radio and electronic techniques. "Electronic Computers," by T. E. Ivall, 2nd edition, can be obtained from any bookseller, price 25s, or direct from the publishers, Iliffe & Sons Ltd., at 26s by post.

CLUB NEWS

Birmingham.—A 160-m mobile rally has been organized by the South Birmingham Radio Society for 10.30 a.m. on March 6th, at Lickey Beacon, Rednal. At the club meeting at 9.30 on March 17th at Friends Meeting House, 220 Moseley Road, Birmingham, 12, G. E. Simonite (G3JAO) will speak about the electronic equipment at Birmingham University.

The March meetings of the Slade Radio Society include a Mullard film show in the Bennett Hall, Y.M.C.A., Snow Hill at 7.45 on the 4th. At the meetings on the 11th and 25th, which will be held at 7.45 at Church House, High Street, Erdington, the subjects of v.h.f./f.m. reception and electronic digital computers will be dealt with respectively.

At the meeting of the Midland Amateur Radio Society on March 3rd D. Edwards (G3DO) will talk on DX working, and at the meeting on the 15th, R. Rew (G3HAZ) will deal with v.h.f. reception. The society meets at 7.0 at the Midland Institute, Paradise Street.

Bradford.—J. C. Belcher (G3FCS) will discuss interference in relation to sound and vision reception at the March 8th meeting of the Bradford Amateur Radio Society. The club meets on alternate Tuesdays at 7.30 at Cambridge House, 66 Little Horton Lane.

Cleckheaton.—Dr. N. H. Chamberlain, of Leeds University, will speak on electronics in industrial research at the meeting of the Spen Valley Amateur Radio Society at 7.30 on March 30th at the George Hotel.

Leeds.—The month's meetings of the Leeds Amateur Radio Society include lecture-demonstrations of photoelectric devices by E. Sollitt, the president (2nd), of hi-fi equipment by Fane Acoustics (16th), and a home-built table-top transmitter by W. Ripley (23rd). Meetings are held at 7.45 at Swarthmore Education Centre, 4, Woodhouse Square.

News from the Industry

J. Langham Thompson Group, which includes Datum Metal Products Ltd. and Automation Systems & Controls Ltd., was recently acquired from the Camp Bird Group by Ether Ltd. of Erdington, Birmingham. The title of the company holding the entire share capital of Ether Ltd., its wholly owned subsidiary Electro Methods Ltd., and the J. Langham Thompson Group is now Ether Langham Thompson Ltd. The chairman and managing director is F. B. Duncan. Other members of the board are C. E. Blunt and F. Coulling (directors of Ether Ltd.), and J. Langham Thompson and Rear Admiral Sir Philip Clarke (directors of the J.L.T. Group).

The Decca Record Company, the parent company of the Decca group, records a trading profit of £3,305,313—an increase of £352,774 over the previous year. The net profit of £1,031,205 was £100,221 up on last year. Exports during the year reached the record total of £5,860,000 including £1,380,000 to the U.S.A. and Canada. The chairman, E. R. Lewis, stated that during the ten years to last March, the company had produced 41M long-playing records, 150M 78 r.p.m. records and 33M 45 r.p.m. records.

I.C.T.—The trading profit of International Computers and Tabulators Group up to September 30th, which includes a year's operation of B.T.M., but only nine months of Powers-Samas, was £2,328,000. The joint figure for the previous year's operation of the two former groups was £2,020,000. Taxation absorbs £1,025,000 of last year's profit.

S.T.C. are developing tunnel diodes and in order that circuit designers may familiarize themselves with the new properties and obtain early experience with the circuit performances achievable, the company is offering sample devices. Details of the samples and of the proposed range of diodes for use at v.h.f. are obtainable from Standard Telephones and Cables, Ltd., Transistor Division, Footscray, Kent.

B.T.H. Sound Equipment Ltd.—Under the general reorganization scheme of the A.E.I. Group the name of this company has been changed to A.E.I. Sound Equipment, Ltd. The company's office is still at Crown House, Aldwych, London, W.C.2.

Radio Resistor Co., wholesale distributors of Morganite products, are assuming exclusive wholesale distribution of Electrosil resistors, made by James A. Jobling & Co., of Sunderland. The company's new address is 9-13 Palmerston Road, Wealdstone, Middx. (Tel.: Harrow 6347.)

KOVO of Czechoslovakia.—Nash and Thompson were recently appointed agents in the U.K. and certain other countries for KOVO, the organization for marketing Czechoslovakian instruments. In their announcement (page 490 of our November issue), Nash and Thompson stated in error that they were agents for the Commonwealth, whereas in Australia, Jacoby, Mitchell & Co., of Sydney, have, in fact, been the exclusive agents for some years.

Multisignals Ltd., the recently formed television relay company, announces that Ultra have joined the enterprise, with which Ekco and Thorn are already associated. A. V. Edwards, managing director of Ultra, has been appointed to the board of Multisignals.

Hacker Radio, Ltd., formerly a sales company, is being developed by R. H. Hacker and A. G. Hacker, until recently joint managing directors of Dynatron Radio, Ltd., to manufacture high-quality radio and electronic equipment. A new factory is being built at Norreys Drive, Cox Green, Maidenhead.

Non-destructive Test Equipment.—An agreement has been concluded between Kelvin & Hughes Ltd., and the Curtiss-Wright Corp., of America, for the exclusive right to manufacture and sell the non-destructive testing equipment of the other partner. This includes instruments for the inspection and measurement of materials, and industrial ultrasonic equipment. Kelvin Hughes will represent both interests in the U.K., the Commonwealth (except Canada) and Europe, and Curtiss-Wright in North America.

Avo and Taylor.—Changes in the boards of Avo and Taylor Electrical Instruments, both members of the Metal Industries Group, have been announced. Because of indisposition J. H. Rawlings has relinquished the position of managing director of Avo Ltd., but he is remaining on the board as deputy chairman, and also on the board of Brookhirst Igranic Ltd. Succeeding him as managing director of Avo is S. R. Wilkins who also joins the board of Taylor Electrical Instruments. E. Strauss has been appointed director and general manager of Taylor's and also joins the board of Avo.

EXPORT NEWS

U.S.-Bahamas forward-scatter link, providing 72 trunk telephone circuits, which came into operation in January, employs at the Nassau terminal equipment manufactured by Standard Telephones & Cables. At Nassau two 10-kW transmitters, operating in the 2,000-Mc/s band, feed into two 30-ft diameter paraboloids. Two dual-diversity receivers provide quadruple diversity reception. S.T.C. also supplied line-of-sight microwave equipment linking the forward-scatter station to the telecommunications centre in Nassau City.

Sweden.—The first of three Decca D.A.S.R.1 air surveillance radar installations for use at major Swedish airports has been installed at Arlanda, Stockholm's new airport. The D.A.S.R.1 employs duplicate 800-kW transmitters feeding into separate aerial reflectors which are mounted back-to-back on top of a 90-foot cylindrical tower. The beams are staggered in elevation. The transmitters operate on about 3,000 Mc/s in the S-band.

Colour television equipment, including the latest E.M.I. camera (using three vidicon tubes) and control equipment and a Rank-Cintel large-screen colour projector, has been exported to China. The equipment forms a complete closed-circuit installation.

Computers.—International Computers and Tabulators Ltd. have received orders from three commercial concerns in France for their medium-sized general-purpose computer, the I.C.T. Type 1202. The capital value of the machines and ancillary equipment is of the order of £60,000 in each case. Last October SAMAS, previously the French subsidiary of Powers-Samas Accounting Machines, became I.C.T.—France.

V.H.F. equipment manufactured by Pye Telecommunications, is to be installed by the Suez Canal Authority for communication with its vessels in the Canal.

Cyprus.—Equipment for the sound reinforcing and language interpretation systems in the new House of Representatives in Cyprus is being installed by Tannoy.

India.—Sundeep Electronics Corporation, of New Delhi, wish to get in touch with British manufacturers of components and equipment with a view to representing them in India and possibly undertaking the manufacture of certain items under licence. Their technical representative is visiting this country and can be contacted at 8, Crescent Road, London, N.8. The firm's headquarters are at Gurdwara Road Crossing, Karol Bagh, New Delhi, 5.

East Pakistan's port of Chittagong is to be equipped by Marconi's with v.h.f. radio-telephone transmitters and receivers at two base stations. Also mobile installations are being supplied for harbour tugs and a pilot launch. The order was placed by the Port Commissioners with International Industries Ltd., of Karachi, Marconi's agents.

A linear accelerator designed for X-ray treatment of deep-seated tumours, has been ordered from Mullard by the Soviet Union for installation in Moscow.

Western Germany.—A. B. Metal Products Ltd., manufacturers of Clarostat controls and resistors, whose new address is Walkden House, Melton Street, Euston Square, London, N.W.1, have appointed Heinz Michalski, Myliusstrasse 54, Leverkusen 3/Rhld, to represent them in Western Germany.

Anglo-Canadian Agreement.—Television broadcasting equipment manufactured by E.M.I. will be distributed and serviced in Canada by the Canadian General Electric Co.

MARCH MEETINGS

Tickets are required for some meetings: readers are advised therefore to communicate with the secretary of the society concerned.

LONDON

1st. I.E.E.—"Digital computer developments at Manchester University" by Dr. T. Kilburn (with supporting papers) at 5.30 at Savoy Place, W.C.2.

1st. Association of Supervising Electrical Engineers.—"Silicone rectifiers" by D. R. Coleman (S.T.C.) at 7.30 at Windsor Castle Hotel, 134 King Street, Hammersmith, W.6.

3rd. Brit.I.R.E.—"Time sharing in on-line computer applications" by A. St. Johnston at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

4th. I.E.E.—Medical Electronics Group discussion on "Direct writing oscillographs" opened by A. J. Smale and S. N. Pocock at 6.0 at Savoy Place, W.C.2.

7th. I.E.E.—"An introduction to the theory of masers with particular reference to the travelling-wave maser" by Dr. P. N. Butcher at 5.30 at Savoy Place, W.C.2.

7th. Society of Instrument Technology.—"Data reduction for guided weapon trials at Aberporth" by A. S. Younger, G. C. Morgan and E. S. Mallett at 7.0 at Manson House, 26 Portland Place, W.1.

9th. Association of Supervising Electrical Engineers.—"Cathode-ray tubes" by C. H. Gardner (Mullard) at 7.45 at Eltham Green School, Queenscroft Road, Eltham, S.E.9.

10th. Physical Society.—"Electronic music" by Dr. J. Bowsher at 5.30 at Imperial College, Prince Consort Road, S.W.7.

11th. Television Society.—"Television receiver production" by S. T. Palmer (G.E.C.) at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

14th. I.E.E.—Discussion on "Should engineers be encouraged to take up administrative positions early in their careers?" opened by K. E. Greene at 6.0 at Savoy Place, W.C.2.

14th. Brit.I.R.E.—Discussion on "Short-range navigational aids" at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

15th. British Computer Society.—"Axis transformation using analogue equipment" by N. Doveton (E.M.I.) at 2.30 at the Northampton College of Advanced Technology, St. John Street, E.C.1.

15th. I.E.E.—"Fast-response transistor chopper-type amplifier with low carrier frequency" by I. C. Hutcheon and D. Summers at 5.30 at Savoy Place, W.C.2.

18th. B.S.R.A.—"Problems of reviewing tuners" by R. S. Roberts at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

23rd. I.E.E.—"The challenge of the propagation medium to the radio engineer" by G. Millington at 5.30 at Savoy Place, W.C.2.

24th. Brit.I.R.E.—"The continuous recording of heart activity" by Dr. I. Boyd and W. R. Eadie at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

24th. Television Society.—"Operating a commercial television station in the U.S.A." by J. H. Battison (Associated Rediffusion) at 7.0 at 164 Shaftesbury Avenue, W.C.2.

25th. R.S.G.B.—"High-fidelity sound reproduction for the amateur" by H. A. M. Clark at 6.30 at the I.E.E., Savoy Place, W.C.2.

28th. Radar & Electronics Association.—"Computers: some design problems" by Peter D. Hall (Ferranti) at 7.30 at the Royal Society of Arts, John Adam Street, W.C.2.

29th. Society of Instrument Technology.—"Application of transistors in instrumentation" by G. G. Bloodworth at 7.0 at 26 Portland Place, W.1.

30th. Brit.I.R.E.—"Silicon photovoltaic cells for instrumentation and control applications" by Dr. V. Magee and Dr. A. A. Shepherd at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

31st. I.E.E.—The Fifty-first Kelvin Lecture on "Cosmic radiation" by Professor C. F. Powel at 5.30 at Savoy Place, W.C.2.

ARBORFIELD

21st. I.E.E. Graduate and Student Section.—"Inertial navigation systems" by Wing Commander E. W. Anderson at 7.0 in the R.E.M.E. Assembly Hall.

BARNSLEY

16th. I.E.E.—"The reliability and life of impregnated-paper capacitors" by J. P. Pitts at 7.0 at the Arcadian Restaurant.

BELFAST

8th. I.E.E.—"The recognition of moving vehicles by electronic means" by T. S. Pick and A. Readman at 6.30 at the David Keir Building, Queen's University, Stranmillis Road.

BIRMINGHAM

8th. Brit.I.R.E.—"Transistor power amplifiers" by F. Butler at 7.15 at the Matthew Boulton Technical College.

11th. Society of Instrument Technology.—"Reading with electronics" by I. Merry at 7.0 in the Lecture Theatre of the Byng Kendrick Suite at The Gosta Green College of Technology, Aston Street.

28th. I.E.E.—"Television on tape" by W. Silvie at 6.0 at the James Watt Memorial Institute.

BRISTOL

30th. Brit.I.R.E.—"Training for operating and maintaining television studio broadcasting equipment" by Dr. K. R. Sturley and A. E. Robertson at 7.0 at the School of Management Studies, Unity Street.

BRADFORD

10th. Association of Supervising Electrical Engineers.—"H.F. heating" by M. R. Padget (Radyne) at 7.30 at The Midland Hotel.

CARDIFF

16th. Brit.I.R.E.—"Recent developments in printed and potted circuits" by H. G. Manfield at 6.30 at the Welsh College of Advanced Technology.

CATTERICK

29th. I.E.E.—"Progress on problems in ionospheric propagation during the International Geophysical Year" by W. R. Piggott at 6.15 at Headquarters Mess, School of Signals, Catterick Camp.

CHELTENHAM

4th. Brit.I.R.E.—"The use of radio aids in the control of modern transport aircraft" by K. Fearnside at 7.0 at the North Gloucestershire Technical College.

COLCHESTER

11th. Institution of Production Engineers.—"Numerical control of machine tools from the production engineer's point of view" by O. S. Puckle at 7.30 at Britannia Works Canteen, Davey Paxman & Co., Ltd.

DUBLIN

10th. I.E.E.—"Aviation communications and navigational systems" by G. E. Enright and G. Jones at 6.0 at the Physical Laboratory, Trinity College.

EDINBURGH

25th. Brit.I.R.E.—"Radio guidance in the automatic landing of aircraft" by J. Shayler at 7.0 at the Department of Natural Philosophy, the University, Drummond Street.

FAWLEY

4th. Society of Instrument Technology.—"Transistors as applied to control equipment" by R. J. Miles at 5.30 at the Administration Building, Esso Refinery.

GLASGOW

24th. Brit.I.R.E.—"Radio guidance in the automatic landing of aircraft" by J. Shayler at 7.0 at the Institution of

Engineers and Shipbuilders, 39 Elmbank Crescent.

HANLEY
8th. I.E.E.—Faraday Lecture on "Electrical machines" by Professor M. G. Say at 7.30 at the Town Hall.

HULL
31st. I.E.E.—"Recent developments in colour television" by I. J. P. James at 6.30 at the Y.E.B. Offices, Ferensway.

LEEDS
1st. I.E.E.—"The transmission of news film over the transatlantic cable" by C. B. B. Wood and I. J. Shelley at 6.30 at the Leeds and County Conservative Club, South Parade.
7th. Association of Supervising Electrical Engineers.—"Two-channel stereo sound systems" by D. Humphries and F. H. Brittain (G.E.C.) at 7.30 at the Great Northern Hotel.

LIVERPOOL
10th. I.E.E.—Faraday Lecture on "Electrical machines" by Professor M. G. Say at 6.45 at the Philharmonic Hall.

MALVERN
7th. I.E.E.—"Masers" by Dr. M. H. Oliver at 7.30 at the Winter Gardens.
29th. Brit.I.R.E.—"Microwave propagation" by M. W. Gough at 7.0 at the Winter Gardens.

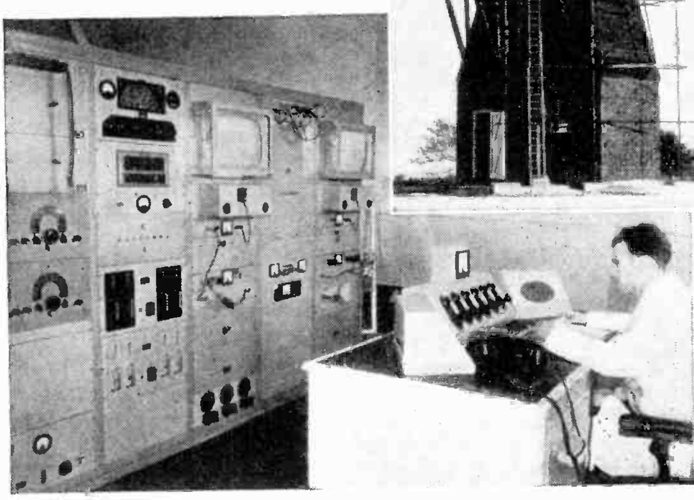
MANCHESTER
3rd. Brit.I.R.E.—"Electronics in oceanography" by M. J. Tucker at 6.30 at Reynolds Hall. College of Technology, Sackville Street.
16th. I.E.E.—"Data processing" by J. C. Gladman at 6.15 at the Engineers' Club, Albert Square.
21st. Institute of Physics.—"Astronomical and atomic time" by Dr. L. Essen (N.P.L., Teddington) at 7.0 at the University.

NEWCASTLE-ON-TYNE
9th. Brit.I.R.E.—"Silicon photovoltaic cells in instrumentation and control" by Dr. A. A. Shepherd at 6.0 at the Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road.
14th. I.E.E.—Discussion on "Component reliability" at 6.15 at the Rutherford College of Technology.

SHEFFIELD
21st. Institution of Production Engineers.—"Electronic control mechanism" by O. S. Puckle at 6.45 at the Devonshire Room, Grand Hotel.

WORKINGTON
8th. I.E.E.—"The reliability and life of impregnated-paper capacitors" by J. P. Pitts at 7.0 at Workington College of Further Education.

REDIFFUSION.—A variety of aerial arrays sprout from Ripple Mill, near Deal, Kent, for it is now used by Rediffusion as a receiving centre for its sound and vision distribution system in the area. Two Band I aerials and a Band II aerial surmount a corner reflector array for Band III. Until the opening of the Dover station I.T.A. transmissions were received from London by means of a microwave link (the paraboloid can be seen on the outrigging) from another reception site at Thanet, 20 miles away. The control room is housed in the mill.



RANDOM RADIATIONS

By "DIALLIST"

The Colour Mix-up

QUITE a bit more evidence has come my way about different kinds of apparatus imported from West Germany, whose triple flex leads don't conform to our standards. One kind reader reports electric clocks with the red wire connected to the metal cases. From others and from dealers whom I've visited have come tales of spin-driers, food-mixers and other domestic gear with red earth wires. I therefore make no apology for mentioning the matter again. The risk is great, for if any of this apparatus were connected according to British conventions to a 3-pin plug, a severe shock would inevitably be received by anyone who touched the casing. And that's just what people *would* do when the thing didn't function—as, of course, it wouldn't with its "works" connected across neutral and earth. It's almost instinctive when nothing happens after switching on to get hold of whatever it may be to see what's amiss. I do beg anyone who contemplates buying apparatus of foreign origin to make sure that it's not potentially lethal by getting the dealer to test for continuity between the green wire and the casing. If possible, he should insist on seeing it tried out in the shop.

A Spectacle Question

AN optician, I read, has suggested that special glasses are advisable for watching TV. If he's correctly reported, he holds that the normal viewing distance is about six feet and that that doesn't fit in with either reading or distance glasses. The former normally focuses at about 14 inches; the latter's name is self-explanatory. I suppose that the screen most widely used today is the 17-inch and the minimum viewing distance for that is a good bit over six feet. I've worn glasses for some years now and my experience is that so long as you don't sit too close to the screen, distant lenses give you as good a picture as you could wish for from a 405-line system. Have your eyes too close to the screen and you get undue lininess. Anyone who wants to watch a 17-inch screen with glasses focusing sharply at six feet needs to have not his eyes, but his head examined!

Piped TV

THE G.E.C., I see, is to take a financial and technical interest in General Piped Television, which intends to provide services in places where poor reception is obtained in the ordinary way. One of the strong points of this and similar schemes is that any make of receiver can be used. "The new service," it was said, "finishes at the plug-in point." I've always been in favour of piped TV for several good reasons. First, it does away with the necessity for aerial arrays, which can't be claimed by anyone to add to the good looks of houses. Then, it means that good reception is assured. It's a great thing to be sure at all times of a good picture, free entirely from the effects of interference. And I do like the idea that you can choose any kind of receiver you care for, for that means a free hand not only for set owners, but also for manufacturers and dealers. Piped TV has expanded rapidly since it first came along, though there has been some opposition to systems requiring special receivers. I forecast that "any-set" piped services will spread over much of this country in the next few years.

We Did It First

THE Germans are a little late with their claim that the *Medizinische Tonbandzeitung* (*Tape - recorded Medical Journal*) conducted by the Kongressgesellschaft für Arztliche Fortbildung, or congressional society for medical advanced studies, is the first of its kind in this field. Our British College of General Practitioners has been running a tape-recorded service for its members for some time now. The college organizes lectures and discussions to keep G.P.s up to date with the latest developments. These are normally held in London, and any country doctors who are unable to attend them can obtain the tape-recordings on loan. It would be no bad thing if some other institutions adopted a similar system, for many of their members can't always manage to get to meetings that they'd like to attend and might appreciate such a service.

Gale Casualties

ON the East Coast this winter we've had even more than our normal ration of gales and casualties among television and v.h.f. aerial arrays, especially those of the less-robust makes, have been many. From the window of the room where I'm writing I can see three which have suffered. One looks like a complete write-off, another has lost one half of its director and the opposite half of its reflector; the third is pretty bady buckled. That sort of thing is, I suppose, only to be expected, for some of the gusts have been terrific—strong enough to make it difficult to keep on your feet when you are out and about. What I'd like to have is a ferrite aerial mounted in the attic. One knows how effective built-in ferrite aerials can be; but the trouble with them, if you use your set in a ground-floor or first-floor room is that they pick up a good deal of interference which you don't want as well as the signals which you do want. So far as I know, no maker has produced a compact ferrite aerial working at high enough frequencies, though I don't see why in time it couldn't be done. I'm sure there would be a good demand for them in exposed, windy places if they were available.

Well Equipped

WHEN the fitting out of the recently launched Orient Line's s.s. *Oriana* is completed a bit later in the year she will be the most fully equipped passenger ship in the world from the television point of view. Her Marconi installation will enable her to receive programmes on Band I and III from transmitters in almost any part of the world when she's within their range, for it can handle 405-, 525- and 625-line signals. I write "almost any part of the world" because it won't handle the French 819-line pictures—still, one can't expect everything! Dual standard receivers for 525 and 625 lines will be installed in public rooms and first-class cabins. Incoming 405-line signals will be converted to 625 lines in the ship's central TV control room. Where alternative programmes are available passengers will be able to switch from one station to another. There'll be 60-odd sets to begin with, but the number can later be increased to nearly 400 without any basic alteration. And there will also be TV available for those who want it when the ship is beyond the range of transmitters ashore, for she will have a comprehensive closed-circuit installation. This will enable films chosen from the ship's extensive library of reels to be used and it will also make live TV broadcasts possible—simple studio sequences, interviews and so on. Dare I say that I hope there'll also be TV-free rooms, to which those who want a holiday from the daily ration of television at home can retire?

UNBIASED

By FREE GRID

Pædiatric Peepboxes

IN the Building Exhibition which was held at Olympia last December, one of the exhibiting firms provided what was called "a glimpse into the future"—in which various domestic applications of television and telearchics were shown. I must confess, however, that I did not see a great deal beyond an elaboration of things that have already been done in simpler form.

Thus the famous and now ubiquitous Baby Alarm, which first appeared in the Readers' Problems section of this journal well over thirty years ago, has now been elaborated into a closed-circuit television outfit; but I award full marks for it.

TV in the bathroom is, of course, something I installed long ago and described in these columns. I seldom use it as I always feel uncomfortable when a female television announcer gazes at me from the screen as I lie full length in the bath. Perhaps a psychiatrist could explain this.

The photograph with which I illustrate this note is of the actual bathroom television installation shown at Olympia. To forestall enquiries I would hasten to add that the YL demonstrating the apparatus is unknown to me. The photograph came from the exhibitors, Laconite, Ltd., manufacturers of the wall surfaces, with whom you should communicate if you want further information about her or the unit.

This electronic baby-watching craze seems to have spread to the world of bowling alleys, for in the one opened recently in North London a closed-circuit pædiatric peepbox has been installed by Pye, Ltd., to enable parents to keep an eye on their children parked in an adjoining room. The 625-line camera is remotely controlled so that general views of the nursery or close-ups of individual children can be seen in the bowling alley where there are two 21-in monitors.

Not Dead Yet

A FEW weeks ago, a B.B.C. speaker warned listeners of the danger of going to sleep with an electric blanket switched on, especially after taking sleeping tablets. I have done both these things without coming to any harm for over thirty years, but, be that as it may, my reason for mentioning the matter is because of the interference caused by the older type of blanket.

In publicizing this warning the B.B.C. really fouls its own nest since, by inference, it is obviously intended that the blankets should be switched on early in the evening; in other words during the peak listening hours when the clicking on and off of the unsuppressed thermostats of the older type of blanket will provide an irritating background to the programmes.

Of course, this clicking interference is not nearly as bad as it was 24 years ago when I made my first protest about it in these columns. It was so bad during the war years that I always thought that, despite the blackout, Hitler's bombers would know when they were over a large city because of the ambient cloud of clicks which "blanketed" each large centre of population. Doubtless the bombers' radio operators were briefed to keep a special look out for these betraying signals. As so many of our pre-war blankets were of German origin, it is probable that the far-seeing Führer gave instructions for special interference-producing thermostats to be fitted to all those intended for export.

Be that as it may, it is clear that the B.B.C. speaker regards the heat-regulatory thermostats of modern electric blankets as so unreliable that they will not cut out at the pre-set temperature, with the result that the sleeping user will roast in his bed. During 30 years I have tried out many types and will admit that on one occasion I did find that a thermostat let me down. But despite my sleeping tablet, the undue warmth soon roused me.

Nowadays, of course, blankets are far more reliable. The one I use at present is not fitted with a thermostat, it being of a type supplied for every bed in a well-known hospital for the very purpose of being left switched on continuously.

The B.B.C. speaker may, of course, have envisaged a lethal shock being received by a sleepy wife upsetting the early-morning cup of tea brought up to her by a dutiful husband, which could effectively reduce the contact resistance between her torso and any faulty insulation in the blanket. What a suggestion for a henpecked husband toying with the idea of lawproof uxoricide! However, the heater element of a modern blanket is waterproof as well as fireproof; one firm even invites you to test their product by dropping it in the bath. But nervous people *do* exist, and I think the B.B.C. might have pointed out that it is possible to buy a 24-volt blanket for use with a transformer on a couple of car batteries.

Closed-circuit TV from the front and back doors (with intercom. facilities) and a B.B.C./I.T.A. receiver are incorporated in this bathroom outfit.

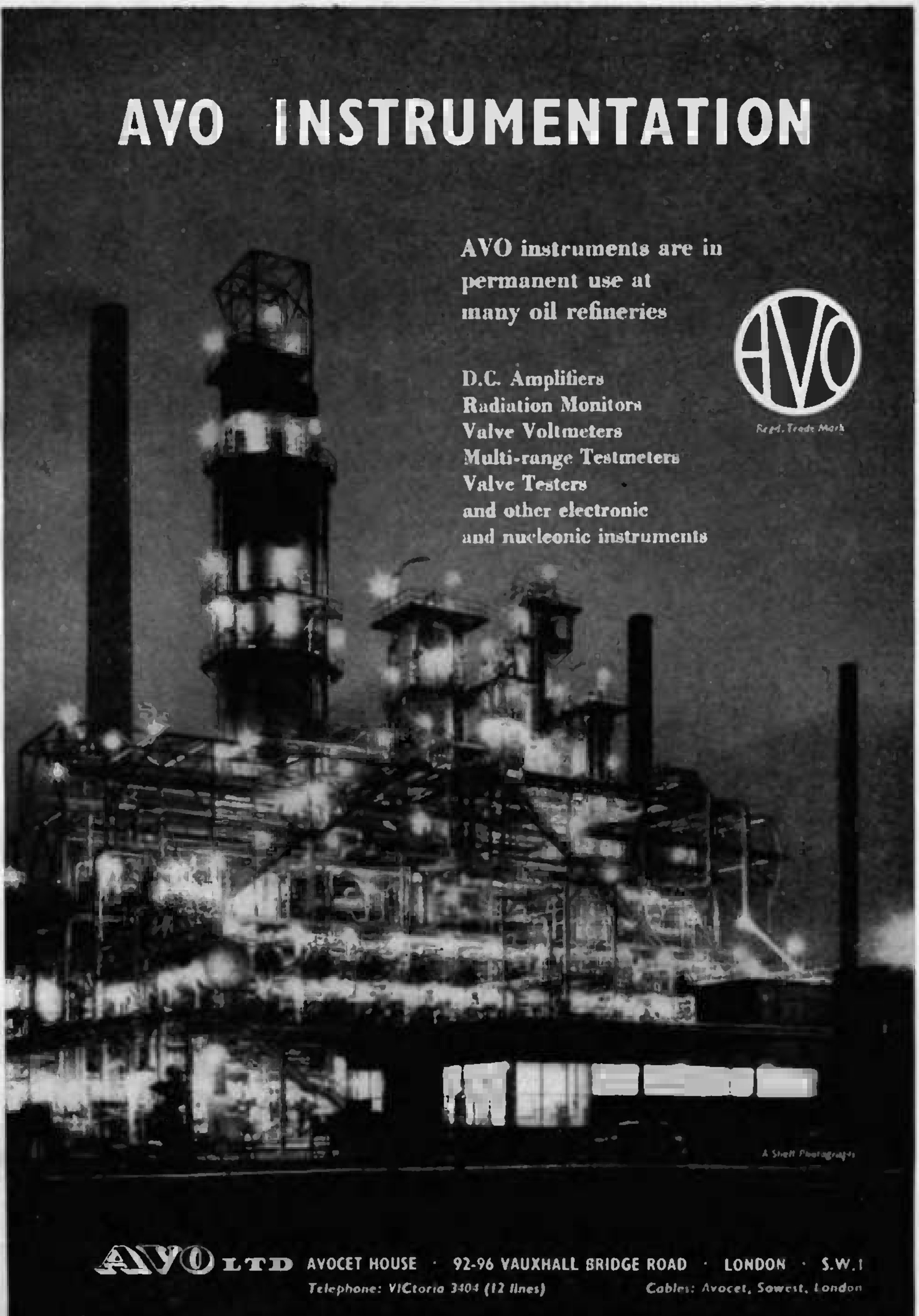
Babelissimo

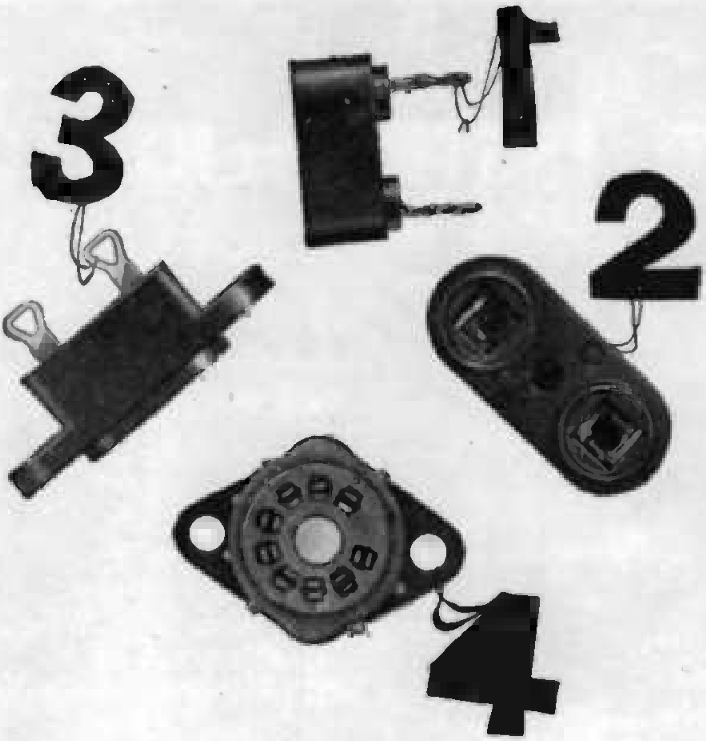
JUST forty years ago I recollect standing on the summit of what was then America's tallest structure, namely the 792-foot-high Woolworth building. One of the officials of the building pointed out to me with pride how puny the 612-foot Singer building and other neighbouring skyscrapers looked beside the structure which its owner had fancifully called "The Cathedral of Commerce."

I tried to deflate his ego by pointing out that America was still nearly 200 feet behind Europe with its 984-foot Eiffel Tower which, apart from its other functions, was then the tallest radio mast in the world. I was, however, reckoning without the resiliency of Americans as he was in no way abashed, but promptly prophecied that the U.S.A. would soon have a radio mast far higher than any in Europe.

It was a wild boast that came true not so many years afterwards when a radio mast was erected on the Empire State Building making the overall height 1,250-feet above the sidewalk.

When the height of the mast at the recently opened I.T.A. station at Mendlesham, Suffolk, was announced (1,000ft) it was thought to be the tallest in Europe. However, Sweden justifiably lays claim to this "honour," for the mast carrying the television and v.h.f. sound aerials for the new Hörby station is 320 metres (c.1,050 ft.).


AVO INSTRUMENTATION
AVO instruments are in permanent use at many oil refineries
D.C. Amplifiers
Radiation Monitors
Valve Voltmeters
Multi-range Testmeters
Valve Testers
and other electronic and nucleonic instruments
AVO
Regd. Trade Mark
A Shell Photograph
AVO LTD AVOCET HOUSE · 92-96 VAUXHALL BRIDGE ROAD · LONDON · S.W.1
Telephone: VICtoria 3404 (12 lines) Cables: Avocet, Sowest, London


3
1
2
4

Backward Wave Oscillators

Mullard now have available a range of O-type backward wave oscillators covering operation in the S, X and J bands.

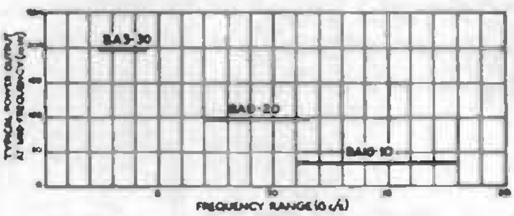
The mechanical design allows substantial cuts in maintenance costs to be effected as the focusing system may be re-employed should the valves need to be changed. The valves are supplied pre-aligned in a protective capsule which automatically locates in the focusing system and any replacements may be made quickly and easily without need for focusing adjustments. Both electro-magnet and permanent magnet focusing systems are available.

BA16-10 demounted from electromagnet focusing system

Where modulation of the valve output is required this can be readily achieved by modulating the appropriate electrode. The output connection is isolated from the delay structure so that the valve may be operated with its cathode earthed and consequently high modulation frequencies may be used. These specialised microwave valves make possible the design of wide frequency range microwave instruments, microwave search receivers and f.m. carrier systems. Write to the address below for full details of these and other Mullard microwave valves.

Abridged data

Type No.	Frequency Range (Gc/s)	Power Output over Frequency Range (mW)	Delay Structure Voltage Range (V)	Sensitivity at Mid-frequency (Mc/s per V)	Cathode Current max (mA)
BA3—30	2.4 to 4.5	30 to 500	150 to 1600	3.0	50
BA9—20	7.0 to 11.5	20 to 180	250 to 1400	5.0	28
BA16—10	11 to 18	10 to 70	500 to 2500	3.5	13



Mullard

GOVERNMENT AND INDUSTRIAL VALVE DIVISION

MULLARD LIMITED

Mullard House, Torrington Place, London, W.C.1

Telephone: LANgham 6633

MVT363a

AN ANNOUNCEMENT OF IMPORTANCE TO ALL TAPE RECORDER USERS

Now available:
the complete range of
professional-quality

audiotape

TRADE MARK

...on the sensational C-SLOT REEL!

AUDIOTAPE, manufactured in the U.S.A. by Audio Devices, Inc., is known the world over for its flawless perfection of sound reproduction throughout the entire audio range, and its *consistent, uniform quality* from reel to reel and from one type to another. Available in eight different types, with a base material and reel footage to meet every recording requirement, AUDIOTAPE has only *one* standard of quality—the finest obtainable. This sterling performance reflects Audio Devices' more than 10 years of experience in magnetic tape manufacture, and more than two decades of practical experience in the sound recording art.

All 5in. and 7in. reels of AUDIOTAPE are supplied on the exclusive C-Slot Reel—the fastest-threading tape reel ever developed. The tape end, dropped into a slot in the hub, anchors itself automatically at the first turn of the reel. AUDIOTAPE is also available on the popular-size 3in., 3¼in., 4in. and 5¾in. reels.

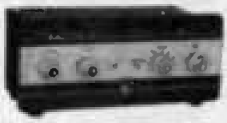
For the truest sound that your recording equipment can produce try AUDIOTAPE. *It speaks for itself!*

AUDIO DEVICES Inc., New York, N.Y.

Concessionaires to the United Kingdom and Eire.

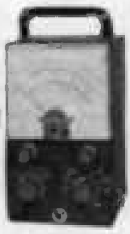
LEE PRODUCTS (G.B.) LIMITED.
"Elpico House", Longford Street, London, N.W.1.
Tel: EUSton 5754 (all lines) Telegrams: Leprod, London.

Technically Heathkit DAYSTROM **excellent**



6 WATTS STEREO AMPLIFIER KIT Model S-33

A versatile high-quality self-contained STEREO/MONAURAL Amplifier with adequate output for a living room—or with which to convert a favourite (monaural) radiogram into a stereo-radiogram. 3 watts per channel; 0.3% distortion at 2.5 w/chnl.; 20 dB N.F.B., inputs for Radio (or Tape) and Gram., Stereo—or Monaural; Ganged controls.
Sensitivity 100 mV. **£11.8.0**

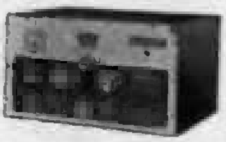


VALVE VOLTMETER KIT Model V-7A

The world's most popular valve voltmeter, with printed circuit and 1 per cent. precision resistors to ensure consistent laboratory performance. It has 7 voltage ranges measuring respectively d.c. volts to 1,500 and a.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance measurements from 0.1 ohm to 1,000 M ohms with internal battery. D.C. input impedance is 11 Megohms and dB measurement has a centre-zero scale. Complete with test prods, leads and standardising battery ... **£13.0.0**

R.F. PROBE KIT Model 309-CU

This complete probe kit will extend the frequency range of the V-7A Valve Voltmeter to 100 Mc/s, and will enable useful voltage indication to be obtained up to 300 Mc/s. **£1.5.6**



AMATEUR TRANSMITTER KIT Model DX-100U

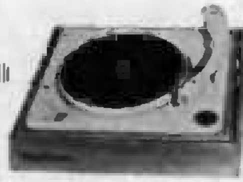
The world's most popular "Ham" TX Kit

- Completely self-contained, compact "Ham" Transmitter.
- Built-in, highly stable VFO and all Power Supplies.
- TVI: Careful design has reduced TVI to a minimum by use of effectively screened frequency-generating stages and pi tuned circuits at the input and output of the PA stage, and by 11 chokes and pi network filters to all outlets from the cabinet. No fewer than 35 disc ceramic- by-pass capacitors help to achieve the exceptional stability and high-performance for which this Transmitter is noted.
- The KT88 high-level anode and screen modulator stage gives over 100 watts of audio from less than 1.5 mV. input.
- Adjustable drive and clamp control ensure that valves are only driven sufficiently to maintain the required output.
- Keying on CW is via the VFO and buffer amplifier cathodes; the other RF valves are biased beyond cut-off. When zero-beating the TX with incoming signals, the exciter stages only may be run without the final amplifier being switched on.
- Provision has been made for remote control operation.
- VFO slow-motion drive is very smooth and back-lash free.
- Covers all Amateur bands up to 30 Mc/s, phone or CW.
- VFO or Crystal control. **£78.10.0**

MATCHED HI-FI STEREO KIT

4-speed Transcription Record Player Model RP-1U	£12 10 0
6 w. Hi-Fi Amplifier, Model S-33	£11 8 0
Twin Stereo Speaker Systems Model SSU-1 ...	£20 11 0
Total cost if purchased separately	£44 9 0

YOURS for £42/10/- if all ordered together or £8/8/- deposit and 9 monthly payments of £4/3/-. Pedestal speaker legs £2/14/- optional extra.

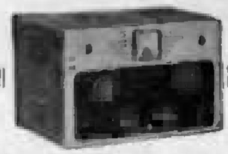


TRANSCRIPTION RECORD PLAYER Model RP-1U

With 4-speed A.C. motor unit and Stereophonic Pick-up completely assembled on plinth.

High performance at low cost.

This attractive Transcription Record Player incorporates many new features which make it suitable for all types of recordings on discs. It has the new Collaro RP.594 unit with the Ronette Stereo Pick-up and gives excellent results on stereo or mono (33, 45 L.P. or 78 r.p.m.) gramophone records. **£12.10.0**



"HAM" TRANSMITTER KIT Model DX-40U

Covers all amateur bands from 80 to 10 metres. Power input 75 watts C.W. 60 watts peak controlled carrier phone. Output 40 watts to aerial. Provision for V.F.O. Filters minimise T.V. interference. **£29.10.0**

AUDIO VALVE MILLIVOLTMETER KIT

Model AV-3U. 1mV to 300V A.C. 10 c/s to 400 kc/s. **£13.18.6**

—★—

Our Technical Consultation and Service Departments are always ready to help in the unlikely event of your experiencing any difficulty.

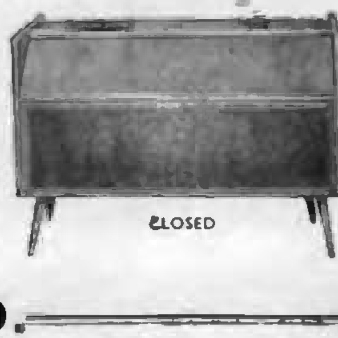
GLOUCESTER

a superbly designed stereo cabinet kit

OPEN

Specially developed to meet the varying needs of different homes. It will house Tape Deck and/or Record Player, F.M. Tuner and Stereo Amplifier. In addition for the convenience of those to whom space is an overriding consideration, it is possible to house speaker systems at each end. For this purpose a loudspeaker kit, comprising two 4in. plus 8in. speaker systems, balance unit, speaker grille, cutting template, padsaw and mounting details is also available. Neutral hardwoods have carefully been selected so that the finished product can be stained and polished to individual choice. There is storage space for records, etc., also for power amplifiers.

Mk. I for Tape Deck or Record Player	£15 18 6
Mk. II for both T/D and R/P	£17 8 6



CLOSED

DAYSTROM LTD.

DEPT. W.W.3, GLOUCESTER, ENGLAND

A MEMBER OF THE DAYSTROM GROUP MANUFACTURERS OF

thoroughly **Heathkit** DAYSTROM **dependable**

COTSWOLD SPEAKER SYSTEM KIT

This acoustically designed enclosure measures 26 x 23 x 15½in. and houses a special 12in. bass speaker with 2in. speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 30-20,000 c/s. Its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, Tygan grille cloth, etc. Left "in the white" for finish to personal taste, all parts are pre-cut and drilled for ease of assembly. **£19.18.6**

HI-FI F.M. TUNER

Tuning range 88-108 Mc/s. Flywheel tuning. Attractive Plastic Front Panel in two-tone grey with golden trim, surround and motif. Thermometer type visual tuning indicator. Pre-aligned I.F. transformers (eliminates adjustment). Three I.F. Stages. Wide-band low distortion. Ratio Detector. Complete R.F. Unit, wired, tested and pre-aligned (ready for mounting to chassis). Printed Circuit for I.F. Amplifiers and Ratio Detector, for ease of assembly. No alignment necessary after assembling. Built-in power supply. Output sockets for stereophonic adaptor (for stereo transmission when available).

TUNER UNIT Model FMT-4U (incl. 16/11 P.T.) £3 2 0 with 10.7 Mc/s. I.F. output.

I.F. AMPLIFIER Model FMA-4U complete with case and valves £10 10 6

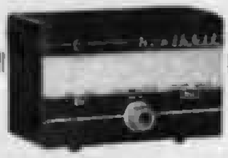
Sold separately ....Total... £13 12 6

CAPACITANCE METER KIT
Model CM-1U

This Direct-Reading Capacitance Meter is a very low priced, time-saving instrument which is so useful that it should be part of the general equipment of every electronic laboratory and production line. Easily built in a few hours. 0–100 µµF, 0–1,000 µµF, 0–0.01 µF, 0–0.1 µF. The meter has 4½in. scale and can be used by an unskilled operator after a few minutes' instruction. **£14.10.0**

★ FREE ON REQUEST ★

A copy of our (British) Heathkit Catalogue. Prices include free delivery in U.K.



STEREO-HEAD BOOSTER KIT
Model USP-1

Hi-Fi Stereo Pre-Amplifier for low-output Hi-Fi P.U.s. Input 2 mV. to 20 mV. Output adjustable from 20 mV. to 2 V. 40–20,000 c/s. Also suitable as low-noise R.C.-Coupled high-gain monaural amplifier **£5.19.6**

AUDIO SIGNAL GENERATOR KIT
Model AG-9U

10 c/s. to 100 Kc/s., switch selected. Distortion less than 0.1%. 10 v. sine wave output metered in volts and dB's.......... **£19.3.0**

● Deferred Terms available on orders over £10 ●

HI-FI SPEAKER SYSTEM KIT
Model SSU-1

Ducted-port bass reflex cabinet, "in the white." Frequency response to 40–16,000 c/s. Power rating 25 watts. Matched speaker units 8in. high flux (12,000 lines) with hyperbolic cone and 4in. wide angle dispersion type for higher frequencies. With legs £11/12/6.......... **£10.5.6**

Please tick the items in which you are interested and we will send you full details.

	S-88	Hi-Fi Stereo Amplifier Kit		UJR-1	Dual-Wave Transistor Radio Kit
	S-33	6-Watts Stereo Amplifier Kit		S-3U	Electronic Switch Kit
	UXR-1	Transistor Portable Kit		309-CU	R.F. Probe Kit
	DX-40U	"Ham" Transmitter Kit		DX-100U	Amateur Transmitter Kit
	O-12U	5in. Oscilloscope Kit		—	Matched Hi-Fi Stereo Kit
	V-7A	Valve Voltmeter Kit		RP-U1	Transcription Record Player
	SSU-1	Hi-Fi Speaker System Kit		—	Gloucester Stereo Cabinet Kit
	AG-9U	Audio Signal Generator Kit		—	Cotswold Speaker System Kit
	C-3U	Resistance-Capacitance Bridge Kit		—	Hi-Fi F.M. Tuner
	VF-1U	Variable Frequency Oscillator Kit		CM-1U	Capacitance Meter Kit
	USP-1	Stereo-Head Booster Kit		MA-12	12 w. Monaural Amplifier Kit
	USC-1	Stereo Control Amplifier Kit		MM-1	Multi-range Meter Kit
	OS-1	3in. Service Oscilloscope Kit		—	Tape Deck "Package deals"
	B-1U	Balun Coil Unit Kit		AW-1U	Audio Wattmeter Kit
	DC-1	Decade Capacitor Unit Kit		AV-3U	Audio Valve Millivoltmeter Kit

NAME .... ADDRESS..........

(In CAPITAL letters please) ....

W.W.3

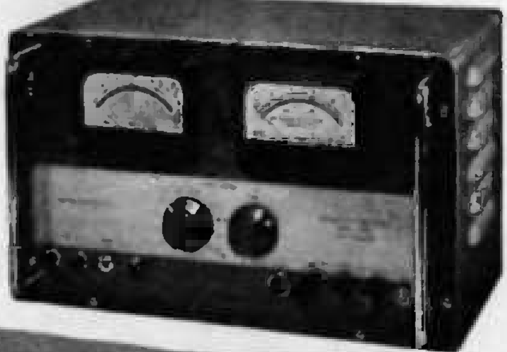
DAYSTROM LTD.

DEPT. W.W.3, GLOUCESTER, ENGLAND

THE WORLD'S LARGEST-SELLING ELECTRONIC KIT-SETS

Transistorized Power Units

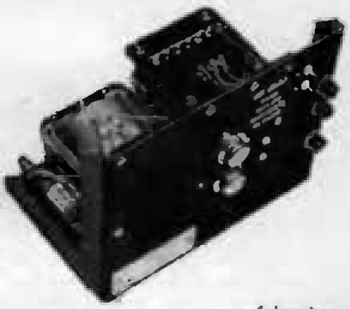
HIGHLY STABILIZED OUTPUT
VERY LOW OUTPUT IMPEDANCE
VERY SMALL RIPPLE CONTENT



MODEL 1328 LABORATORY POWER UNIT

Model 1328 provides a continuously variable output monitored by two front-panel, mirror-scale, voltage and current meters. It is eminently suitable for use in the design stage of transistor circuits where a power supply of high purity is essential.

Output: 0-30V at 1A.



(*chassis mounting*)

MODELS 1326 & 1329 LOW VOLTAGE POWER UNITS

The 6V Transistorized Power Unit Model 1326 is an ideal supply for transistor d.c. amplifiers, transistor pulse-technique circuits and filaments of thermionic valve amplifiers, particularly in low-level microphone stages.

MODEL 1326
Output: 6V at 0-2A.

MODEL 1329
Output Voltage: Continuously variable 5V-10V.
Output Current: 0-1A in range 5V-9V
0-0.5A at 10V.

MODEL 1327 BATTERY ELIMINATOR

The Battery Eliminator Model 1327 has been designed primarily to power the Cossor Pre-amplifiers, Models 1430, 1434 and 1440, but it can be used in many other applications requiring a power unit to provide high and low tension supplies.

L.T. Supply: Output 6V-6.5V at 1.7A.
H.T. Supply: Output 120V at 15mA.

Please send for the latest Cossor Catalogue or ask for a representative to call and discuss your special requirements.

COSSOR INSTRUMENTS LTD

The Instrument Company of the Cossor Group

COSSOR HOUSE, P.O. BOX 64, HIGHBURY GROVE, LONDON, N.5.

Telephone: CANonbury 1234 (33 lines). Telegrams: Cossor, Norphone, London. Cables: Cossor, London. Codes: Bentley's Second

TAS/CL.18

Mullard Alloy

brings you high frequency

The need for the new technique

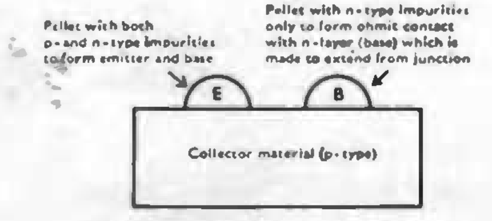
Demands for devices which will operate at higher and higher frequencies have been made ever since the transistor was first introduced.

So far as the normal p-n-p germanium alloy transistor is concerned, the OC44 with its average frequency cut-off of 15 Mc/s probably represents the upper limit of frequency attainable in quantity production. A major factor limiting the high frequency performance is the transit time of the minority carriers between the emitter and collector junctions. It is possible, by adding an "accelerating" or "drift" field to the OC44, to increase its high frequency performance by a factor of about 2 or 3, but the thickness of the base layer prevents a more fundamental reduction in transit time.

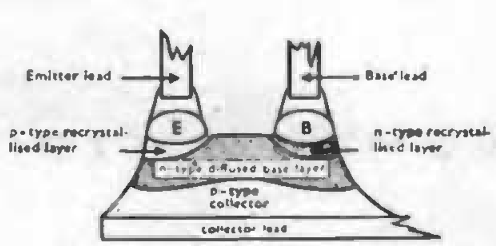
Using the alloy diffusion technique it is possible to make, on a large scale, transistors with a base of only a few microns thickness and with a correspondingly high frequency performance. The diffusion produces a drift field which also contributes to the favourable high frequency characteristics.

The new technique in practice

The alloy diffused transistor is built up on a wafer of p-type germanium which forms the collector. Two metal pellets for the base (B) and emitter (E) are placed close together on one side of the wafer. Pellet B contains only n-type impurities, while pellet E contains both n *and* p types.



Basic components of alloy diffused transistor before heating (NOT TO SCALE)

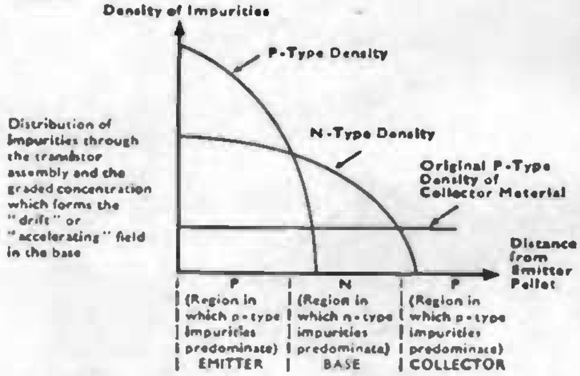


Simplified transistor assembly after alloying and etching (NOT TO SCALE)

When this assembly is heated to an appropriate temperature in a gaseous atmosphere, germanium dissolves into the metal pellets until saturation is reached.

If the temperature is maintained, the impurities in the pellets B and E diffuse into the germanium wafer.

However, the p-type impurities in pellet E diffuse very slowly and they penetrate only a negligible distance into the wafer.



On the other hand, the n-type impurities in both pellets E and B have a fast speed of diffusion. These penetrate the wafer and form an n-type layer, and since diffusion also takes place via the gaseous atmosphere the layer extends to the exposed surface of the germanium between the two pellets.

The diffused n layer forms the base of the transistor, which by specialised manufacturing techniques can be controlled to a thickness of only 5 microns. The concentration of impurities in this layer is graduated between the emitter and collector junctions, and it is this gradient that produces the "accelerating" field.

When the assembly is cooled, a layer of germanium recrystallises from the pellets as with normal alloy techniques.

The recrystallised layer beneath pellet E is p-type as the p-type element chosen has a greater solubility in the recrystallised germanium than the n-type impurity which is also present in this pellet. The p-type material forms a p-n-p junction with the diffused n-type layer and the original p-type collector wafer.

The recrystallised layer under pellet B is n-type, and forms an n-n (non-rectifying) junction with the n-type base layer which extends from the p-n-p junction between emitter and collector. Pellet B is thus used for making the ohmic contact to the extremely thin base.

After etching away the base layer where it is not part of the junction and where it does not form the ohmic contact with the base pellet, the assembly is ready for final processing and encapsulation.

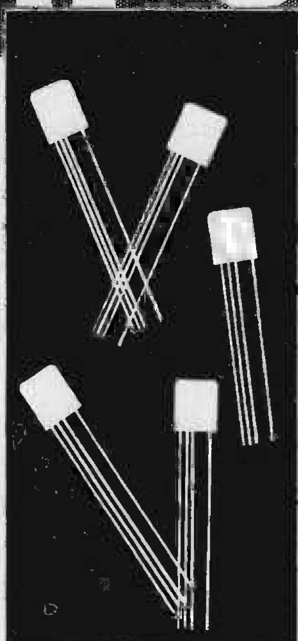
Diffusion Technique

transistors at economic prices

One of the most important recent advances in transistor technology is the alloy diffusion technique used by Mullard. This technique not only provides transistors with uniform high frequency characteristics—it provides a method of producing transistors at prices economic to the user.

OC170

First in the NEW Mullard high frequency range



Abridged Data

P-N-P Germanium alloy diffused transistor suitable for use as mixer-oscillator in short wave receivers and as i.f. amplifier in f.m. and a.m./f.m. receivers.

f_1 min	40 Mc/s
f_1 average	70 Mc/s
V_c max.	−20 V
I_c max.	10mA

Typical Operating Conditions

V_{ce}	−6.0 V
I_c	1.0 mA
Ideal unilateralised power gain at f = 10.7 Mc/s	32 db

MULLARD LIMITED · SEMICONDUCTOR DIVISION
MULLARD HOUSE · TORRINGTON PLACE · LONDON · W.C.1
TELEPHONE: LANGHAM 6633

Mullard

industrial semiconductors

MIS 11a

Complete Coverage from 7·5 Mc/s to 230 Mc/s

fm

am

TYPE S.G.63A FM/AM SIGNAL GENERATOR

Here, within this one modestly priced instrument, are the essential facilities and the essential accuracy demanded for servicing radio and television receivers on bands I, II and III. The S.G.63A provides:

- Frequency range 7.5 Mc/s to 230 Mc/s.
- Crystal Calibrator checks at 5 Mc/s points (accuracy ± 0.03%).
- F.M. at 1,000 c/s fixed ± 22.5 kc/s and ± 75 kc/s.
- Wide deviation at line frequency variable 0 to ± 200 kc/s.
- A.M. at 1,000 c/s fixed 30%.

Full technical details in Leaflet W61 available on request.

NETT PRICE IN U.K. **£90**

Advance

— to be sure !

THIS INSTRUMENT IS ALSO AVAILABLE WITH OUTPUT IMPEDANCE OF 50 OHMS

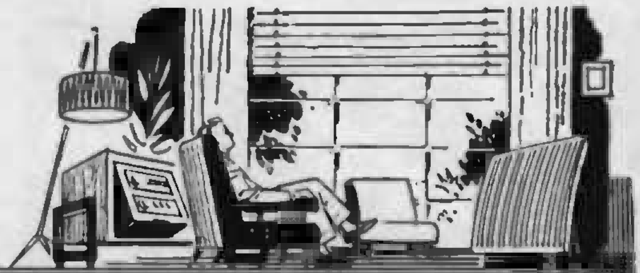
Advance COMPONENTS LIMITED

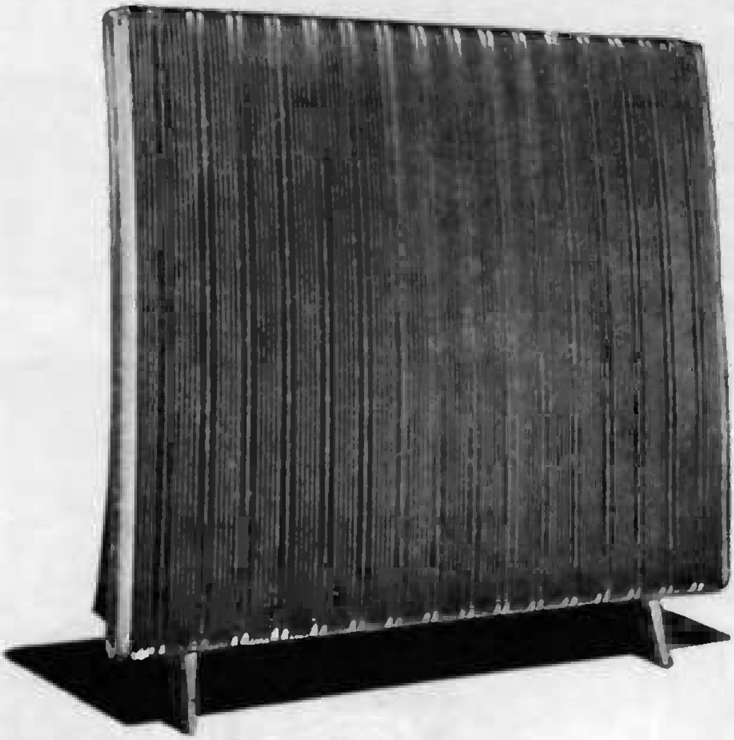
INSTRUMENTS DIVISION

ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX TELEPHONE : HAINAULT 4444

GD 87

A higher standard of listening enjoyment and satisfaction in the home





QUAD

ELECTROSTATIC LOUDSPEAKER

'For the closest approach to the original sound'

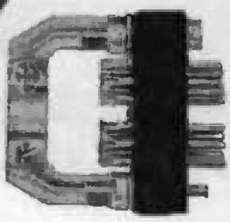
The Quad Electrostatic Loudspeaker is essentially an instrument designed for the home* of the music-lover with every emphasis towards the natural quality desirable for serious listening to music of all types. Of modest size, this loudspeaker is suitable for use in the average-sized lounge; it is capable of providing distortionless reproduction under such conditions up to a volume level similar to that experienced in the concert hall.

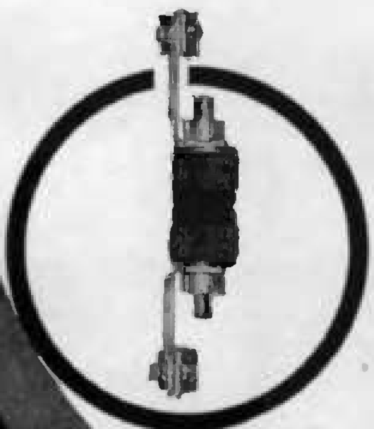
**Increasingly used in studios, monitor rooms and wherever standards have to be set—and maintained.*

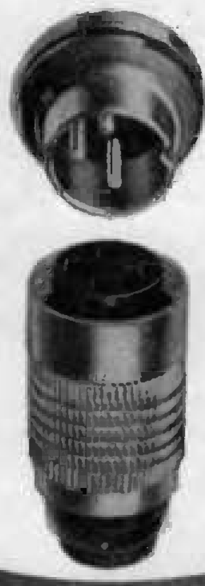
Send a postcard marked W.W. for illustrated booklet.

ACOUSTICAL MANUFACTURING COMPANY LTD., HUNTINGDON, HUNTS. *Huntingdon 361*

a firm GRIP on complex connection







From their wide selection of plugs and sockets, MODAC offer a standard range of rectangular and circular miniature connectors, to which is soon to be added a sub-miniature range with combinations of 10, 16, 28 and 34 contacts.

The main feature of this advanced design is the independently sprung, multi-point contact which provides self-cleaning, low contact resistance and is ideal under conditions of vibration.

MODAC is equipped for the design of connectors to customers' specifications and to supply any of their range as cable assemblies.

They are more than willing—at any time—to come to grips with your general wiring problems.

Modac miniature and sub-miniature connectors

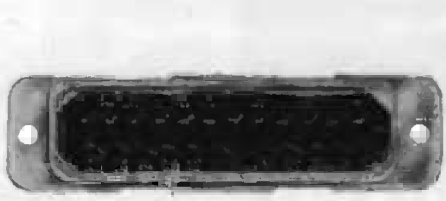
'Modac' is a Registered Trade Mark

for further information and a copy of the 'Modac' catalogue, please contact:

Wiring & Connectors Division

THE PLESSEY COMPANY LIMITED

Cheney Manor · Swindon · Wiltshire · Swindon 6251

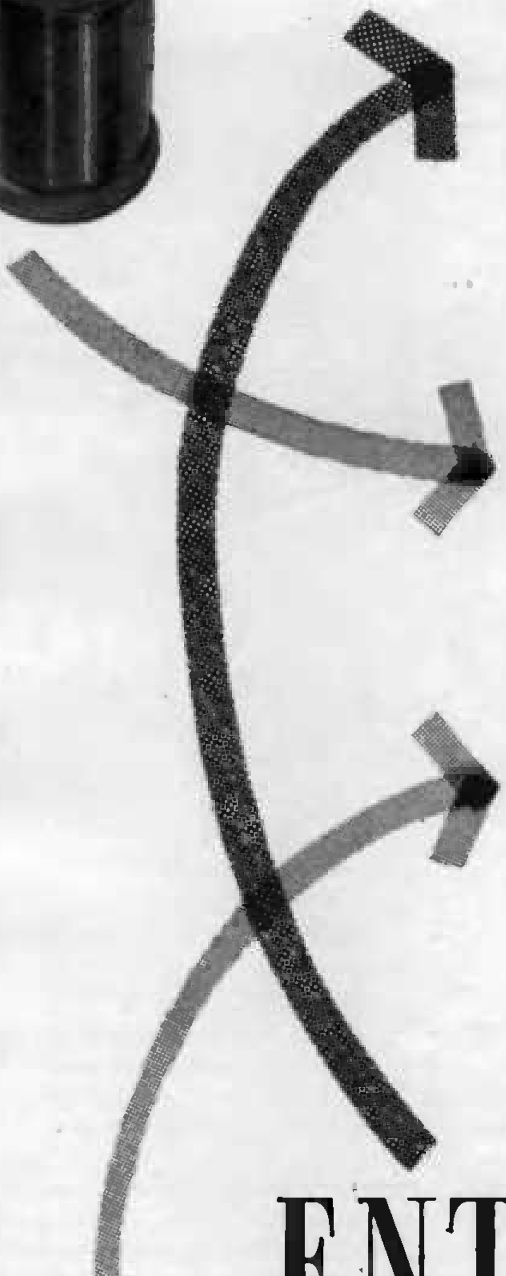


Agents for British Commonwealth Countries: Plessey International Limited · Ilford · Essex · Ilford 3040

MAL 2a

well connected with . . .

Superspeed



Superspeed Cored Solder, incorporating Enthoven's unique 6-channel stellate core, is unchallenged as the most efficient cored solder wire for general assembly work on radio, television, electronic and telecommunication equipment. It speeds production, reduces costs and makes a vital contribution to the dependability of your products.

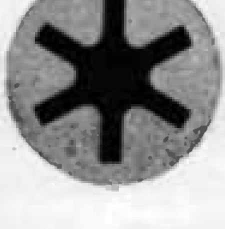
Not only Superspeed. The knowledge that you rely on Enthoven for *all* your solder requirements cannot fail to enhance your prestige and increase confidence in your products. It is a name that represents 150 years experience in non-ferrous metals and an incomparable record in research and development.

SUPERSPEED CORED SOLDER
for normal electrical assembly work

SUPERSPEED 'XX' CORED SOLDER
specially developed to solder tarnished, plated, and/or oxidised surfaces easily

ENTHOVEN

SOLDER PRODUCTS



ENTHOVEN SOLDERS LIMITED
Sales Office & Works: Upper Ordnance Wharf, Rotherhithe Street, London, S.E.16. Telephone: BERmondsey 2014

Head Office: Dominion Buildings, South Place, London, E.C.2.
Telephone: MONarch 0391

–for Industrial Research

A new simultaneous dual-channel tape recorder

Series 3C/FN

THE Ferrograph Series 3C/FN, illustrated here, is a simultaneous dual-channel instrument, using staggered heads, which offers special facilities to those engaged in medical, aeronautical and other scientific research. Besides the normal ability to record simultaneously time pulses on one track and intelligence on the other, it becomes immediately obvious that many forms of comparative measurement, stereophonic sound, or indeed, any two activities capable of being translated into electrical phenomena (within its frequency and phase shift limitations) can be recorded simultaneously and replayed when required. Thus, the scope of such an instrument, when used for Research purposes, is almost unlimited.

Our wide experience in the design, manufacture and application of high precision magnetic tape recording equipment in Industry will be made freely available to you on request.

The Incomparable **Ferrograph**

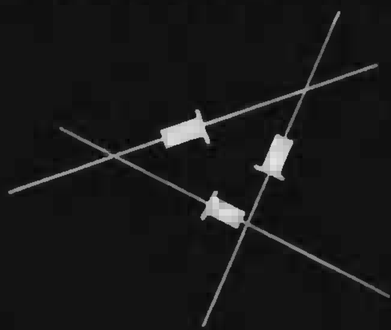
BRITISH FERROGRAPH RECORDER CO. LTD., 131 Sloane Street, London, SW1. Tel: SLOane 2214/5 & 1510

A Subsidiary of Ferrograph Company Ltd.


FREQUENCY AND TIME MEASURING EQUIPMENT TSA3.HF.


FOR
MEASUREMENT
OF TIME
AND VOLTAGE
THE S31
The type S31 Oscilloscope is an improved version of the now famous Serviscope.
It is extremely compact (8¼in. x 6¼in. x 13in.) and has a performance and specification unequalled by many much larger instruments.
The D.C. coupled amplifier (-3db at 6 Mc/s), voltage calibration, wide-range calibrated time base (·5 sec. to 1μ sec. per cm.) and a precision flat-faced C.R. Tube are only a few of the features that put the S31 far ahead of any other portable scope.
TELEQUIPMENT LTD
313 Chase Road · Southgate · London N.14

hats off to



SIMET SILICON RECTIFIERS

First again!

Complete range of **TYPE APPROVED**

Medium Power Top Hat

RECTIFIERS

from

100 P.I.V. to **800** P.I.V.

0·75 AMP AT 25°C — 0·5 AMP AT 100°C

E.V. SPECIFICATION	P.I.V.	COMMERCIAL EQUIVALENTS
CV 7030	800v	8G7
CV 7029	600v	6G8
CV 7028	400v	4G8
CV 7027	200v	2G8
CV 7026	100v	1G8

SIMET

"G" Series Rectifiers, which is the range from which these Type Approved devices have been developed, offer high temperature operation —250mA, at 150°C up to 600 P.I.V. —and high voltage operation up to 1000 P.I.V. —and are available from stock

Plessey

COMPONENTS GROUP

Semimetals Division
The Plessey Company Limited
Woodburcote Way Towcester Northants
Telephone: Towcester 312

Overseas Sales Organisation
Plessey International Limited Ilford Essex
Telephone: Ilford 3040

PORTABLE LOUD SPEAKING EQUIPMENT

Pye Portable Public Address equipment is transistorised for maximum portability and minimum current consumption. It is the perfect answer to all situations where mobility, temporary use or lack of power supplies make it impractical to use more conventional systems.

Ideal for police, fire services, political meetings and electioneering vehicles, garden fetes and sports meetings, touring coaches and all types of ships, passenger and freight control on railways, building operations and many others too numerous to mention. Intrinsically safe versions of this equipment are available which have been certified as suitable for use in methane and pentane atmospheres by the Ministry of Power and the Ministry of Labour Factory Inspectorate.

3 WATTS The Hand Portable Electronic Megaphone weighs only 5 lb. The transistor amplifier gives more than 3 watts output. It uses standard torch batteries which last about six months.

The Portable Electronic Megaphone with adjustable stand and separate microphone is suitable for all temporary occasions. It can be stood, mounted at an angle or easily carried. It is similar to the Hand Portable and is completely self-contained.

10 WATTS The Portable Transistor Amplifier weighs only 5½ lb. and measures 8″ x 3½″ x 6″. It will deliver 10 watts output for a consumption of 1.8 amps from a 12 volt battery. It is ideal for use in moving vehicles or on sites where a mains supply is not available. A comprehensive selection of microphones and loudspeakers is available.

PYE TELECOMMUNICATIONS LTD.

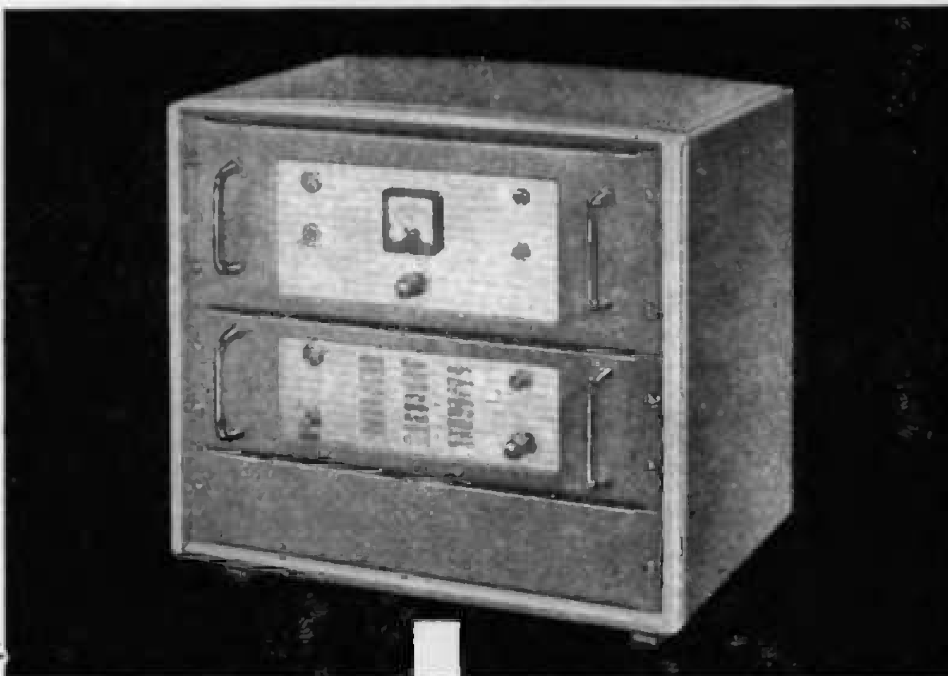
NEWMARKET ROAD · CAMBRIDGE

Telephone: Teversham 3131 Telegrams: Pyetelecom Cambridge

PYE PANORAMA

FEATURING PYE TELECOMMUNICATIONS EQUIPMENT

BY APPOINTMENT
TO H.R.H. DUKE OF EDINBURGH
SUPPLIERS OF
RADIO TELEPHONE EQUIPMENT
PYE TELECOMMUNICATIONS LTD.



Ranger '450' Radiotelephone Fixed Station

The Pye PTC 8710 Fixed Station has been designed to provide reliable communications in the 450—470 Mc/s band. Both the transmitter and receiver are fitted with temperature-controlled crystal units to ensure an exceedingly high frequency stability over a wide temperature range. All the materials used have been chosen to ensure reliable operation under a wide range of climatic conditions.
Additional control equipment is available for operating the Station at distances of up to 200 feet or, via telephone lines, over greater distances.
A switchboard Termination Unit is also available for working the Station into a manual or automatic telephone switchboard.

Brief specification:

Frequency Range:	450—470 Mc/s.
R.F. Output:	5 watts
Channel Spacing:	50 or 60 Kc/s.
Modulation:	F.M.
Service:	F 3 telephony
Operation:	Single or double frequency simplex or duplex.
Power Supply:	100—150 and 200—250 volts A.C. 40—60 c/s.

PYE TELECOMMUNICATIONS LIMITED

NEWMARKET ROAD · CAMBRIDGE

Telephone: Teversham 3131 Telegrams: Pyetelecom Cambridge.

Pye MICROWAVE Portable Links

Type PTC M1000

This transportable long-range television link is suitable for use with 405, 525 or 625 line systems. A sub-carrier f.m. music link circuit is incorporated. The normal frequency range is 6575 to 7425 Mc/s or 5925 to 6425 Mc/s. The RF power output is one watt.

The equipment can be operated back-to-back as a demodulating repeater for short haul multi-hop links. Dependent on siting, each link is capable of transmitting over a distance of 50 miles or more.

Transmitter and receiver as well as power supplies and monitor circuits are all contained in four lightweight luggage-type cases. Parabolic reflectors are available in 2, 4 and 6 foot diameters, and all ancillary equipment can also be supplied.

Please write for details.

As supplied to:

ASSOCIATED TELEVISION LTD.
SCOTTISH TELEVISION LTD.
TYNE-TEES TELEVISION LTD.
CENTRAL REDIFFUSION SERVICES LTD.
PORTUGUESE TELEVISION SERVICE
ATOMIC WEAPONS RESEARCH ESTABLISHMENT
and many other users

PYE

MICROWAVE LINKS

Pye Telecommunications Limited · Newmarket Road · Cambridge · Telephone : Teversham 3131 · Telegrams : Pyetelecom Cambridge

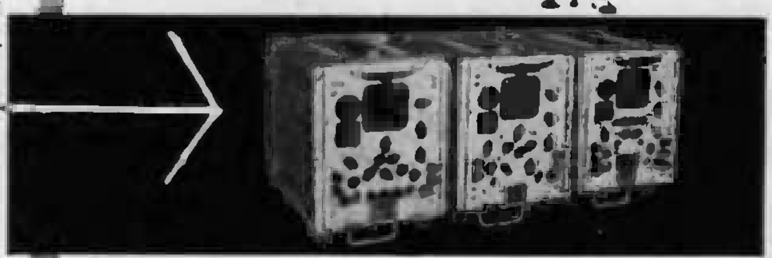
ELEMENTARY...

"Telegraph signals are characterised by intervals of time of duration equal to, or greater than, the shortest or elementary interval."

This shortest element forms the basis of the unit of speed of operation of telegraph equipment and channels; the telegraph engineer faced with the problem of transmitting intelligence between two points is deeply concerned with any alteration or distortion of this elementary interval.

Unlike Sherlock Holmes, a master of deduction from the slenderest clues, whose only tools were a magnifying glass and a razor sharp brain, the modern telegraph engineer has at his command a range of electronic tools capable of showing him exactly what is happening at any instant to each element of the telegraph signal.

At last he is able to make observation on working circuits without interruption, to see immediately the results of any adjustment that he makes. A.T.E. Telegraph Distortion Measuring Equipment provides him with a specialised, compact range of instruments for every purpose.



Write for the full descriptive brochure to:

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.

STROWGER HOUSE, ARUNDEL STREET
LONDON, W.C.2

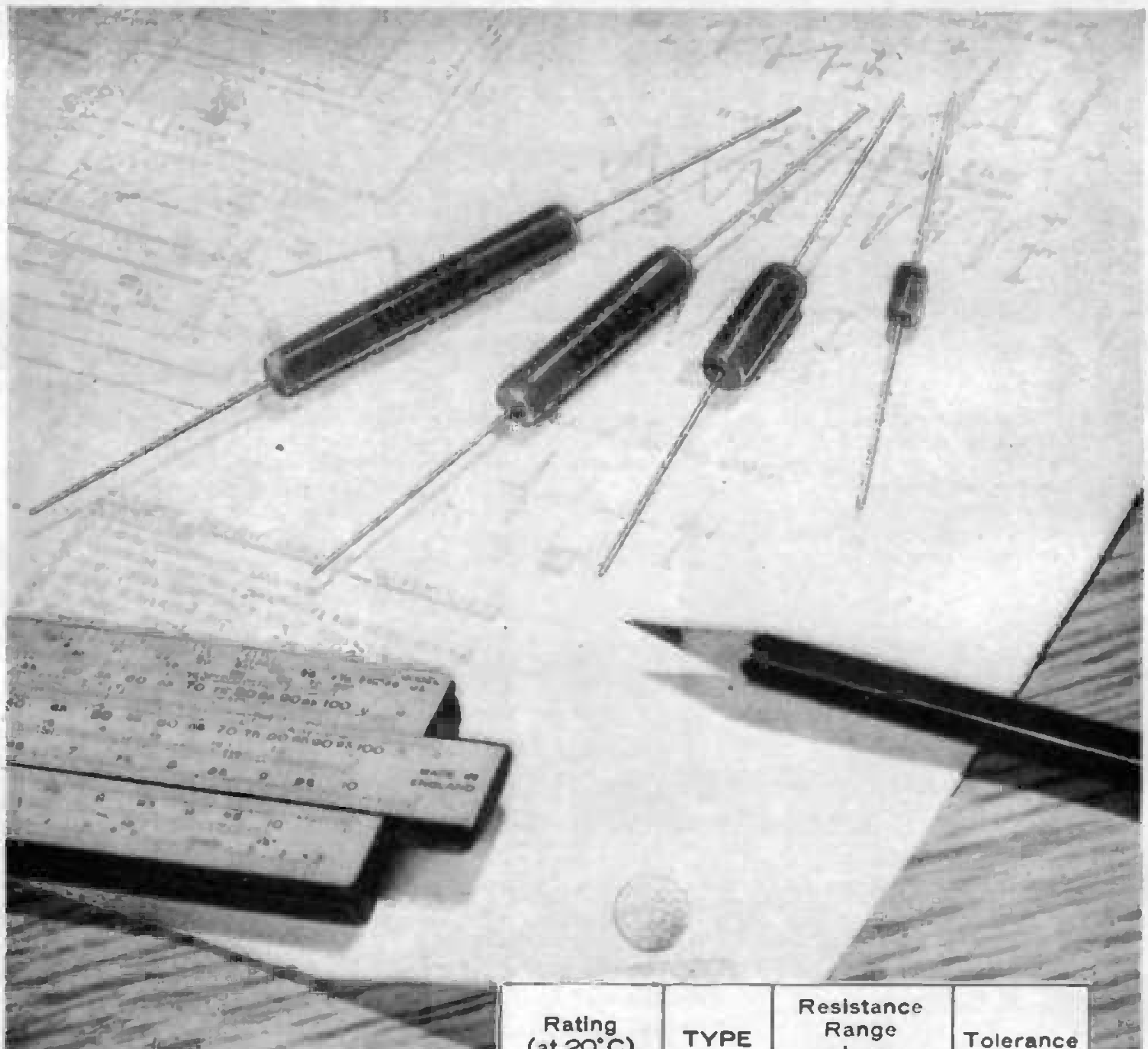
The Transmitter TDMS 5BV
Provides telegraph test signals with or without distortion at speeds of 40-100, 160-180 and 180-200 bauds.

The Receiver TDMS 6BV
Enables a telegraph circuit to be monitored without interruption. The signal can be displayed against a circular or spiral time base, each characteristic instant of modulation being shown as a bright dot on the screen. Speeds of 40-100, 160-180 and 180-200 bauds.

The Telegraph Signal Display Unit TDU2
A specialized oscilloscope, having a linear timebase of good short term stability and long term accuracy, for examination of the d.c. telegraph wave form against a continuous or a start stop timebase. Valuable features of the instrument are an X shift calibrated in terms of code element transitions and an X expansion control. Speed ranges 40-100, 160-180 and 180-200 bauds.

AT14001

PAINTON Miniature Vitreous Wirewound Resistors



Rating (at 20°C) Watts	TYPE	Resistance Range ohms		Tolerance
		Min	Max.	
4	MV1A	1 10	9·9 6,800	10% 5%
7	301A	2	68,000	5%
10	302A	4	140,000	5%
5	306A	1	33,000	5%

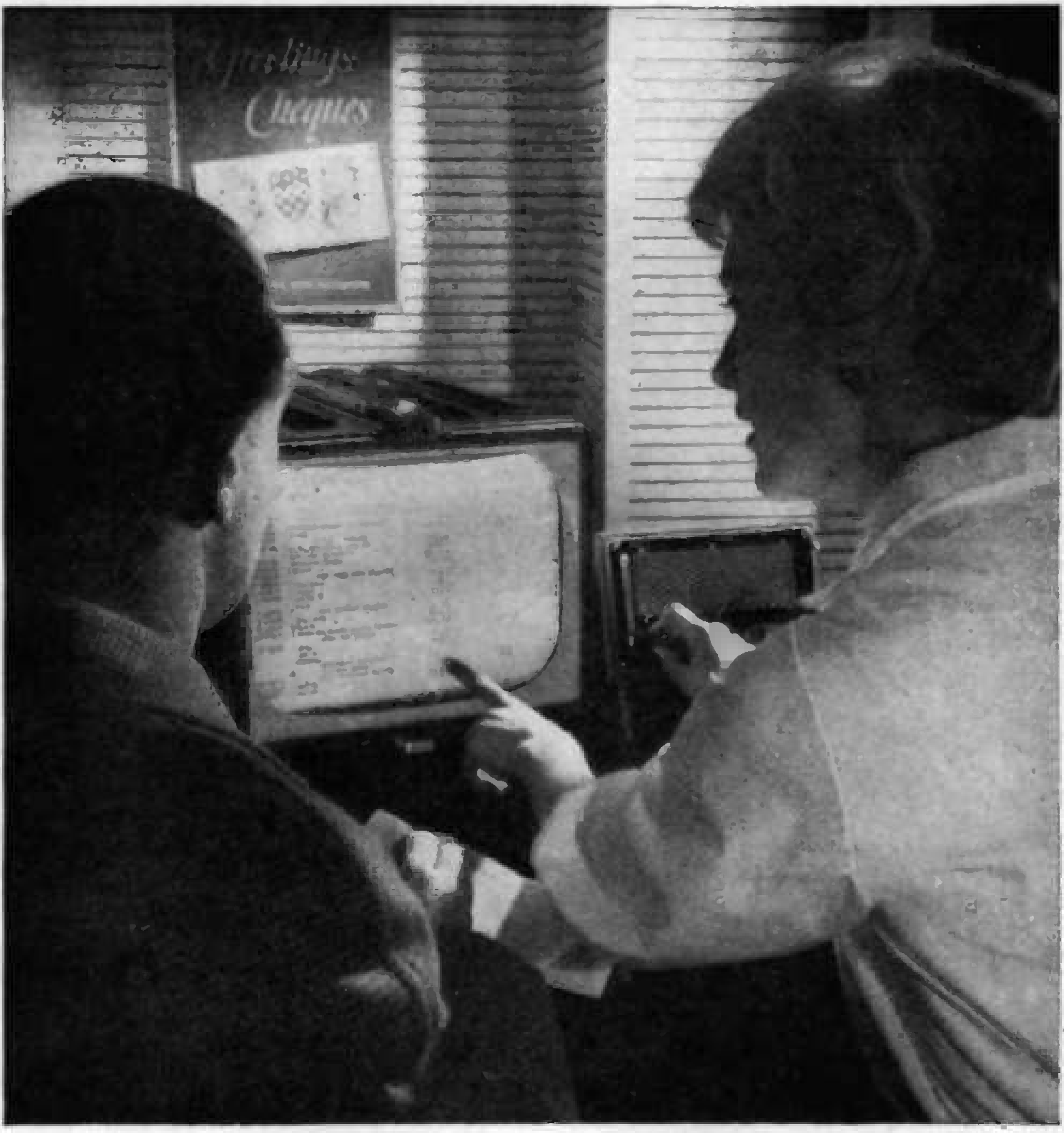
Protected by Patent Nos. 626128 & 676279

PAINTON

★ **Fully Type Approved to RCS 111**
★ **Top Quality** ★ **Quick Delivery**
★ **Competitive Prices**

Always specify Painton Wirewounds

Painton & Co. Ltd.
KINGSTHORPE NORTHAMPTON
Tel: 34251 (10 Lines) Telegrams: 'Cell Northampton'.



Westminster Bank uses Pye Television

The Pye Industrial TV Division, a member of the Pye Instrument Group, has supplied all the television equipment to the Westminster Bank for the first inter-branch TV network. The new system which makes centralised book-keeping possible has been brought about by the closest co-operation with the GPO who have supplied Post Office lines to carry the signals. The illustration shows a customer checking his banking account.

The Pye Instrument Group consists of: Pye Atomics Division, Pye Industrial Television Division, Faraday Electronic Instruments Ltd., Labgear Ltd., W. G. Pye & Co. Ltd., Pye Telecommunications Ltd., Unicam Instruments Ltd., W. Bryan Savage Ltd., W. Watson & Sons Ltd.

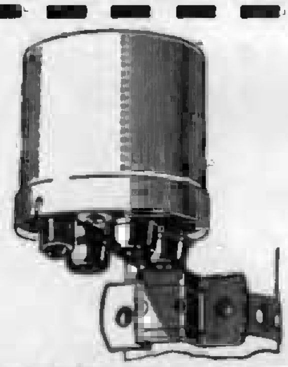
NEW DIPLEXERS *by* ANTIFERENCE

INCORPORATING 'HIGH-Q' CIRCUITS EMPLOYING 'OPEN' COMPONENTS FOR MAXIMUM ATTENUATION OF UNWANTED SIGNALS WITH MINIMUM INSERTION LOSS.

INDOOR MODEL

Fully insulated cream polystyrene snap-on cover of attractive design. Easy cable connections.

Y5 *complete with standard coaxial plug (RECMF specification)* **10/6**



OUTDOOR MODEL

Fully weatherproofed by one-piece seamless canister and detachable waterproof universal grommets, complete with perforated strip for mast mounting, may also be mounted on to any flat surface. Easy cable connections.

Y6 . . . 12/6

OTHER ANTIFERENCE AERIAL ACCESSORIES

INDOOR TRIPLEXER

COMPLETE WITH Coaxial plug

Y3 13/6

Single COAXIAL OUTLET BOX

Complete with Coaxial plug

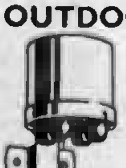
COB/1 4/6

Also NEW

SPLITTER BOXES

enabling two RECEIVERS TO BE USED INDEPENDENTLY OF EACH OTHER

OUTDOOR TRIPLEXER



Fully weatherproof mast or surface mounting.

Y4 17/6

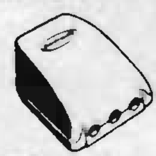
Coaxial PLUGS & SOCKETS

TVP/1

Efficient in use. Easy to fit.

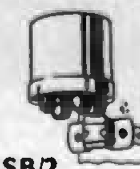
BOTH 8d. EACH TVS/1

INDOOR MODEL



SB/1 6/6

OUTDOOR MODEL



SB/2 8/6

ANTIFERENCE LIMITED

AYLESBURY, BUCKS. *Tel. Aylesbury 2511 (6 lines)*

DHB/7729

SUPPLIED ONLY THROUGH THE TRADE

RADIO TUBES

EXPORT ONLY

Great strides are being made in all branches of the electronic Industry and they are based in the main on the Radio Tube.

HALTRON have not lagged behind in this development, for we are daily adding to the number of types stocked, so that today we carry over 3,000 types of Radio Receiving, Transmitting and Special Purpose Tubes, together with Transistors.

Nowhere else can one organisation take care of the whole of your requirements. Our new price list is now ready.

HALTRON tubes are more competitive today than ever before and your interest is welcomed.

We have AIR REGISTRATION BOARD approval and where called for certificates under this registration can be issued.

Supplies to all departments of governments in all parts of the world.

HALL ELECTRIC LTD

HALTRON HOUSE, ANGLERS LANE, LONDON N.W.5.

Tel.: Gulliver 8531 (10 lines) Telex 2-2573 Cables: "Hallectric London"

meter menu

Anders Electronics supply meters very much "*à la carte.*" It is the speciality of the house to provide non-standard—often quite exceptional—meters of all types without delay.

Avo, Crompton, E.A.C., Elliott, Pullin, Taylor, Turner, Weir, Weston, and other makes : Moving iron, moving-coil, thermo couple, electrostatic : Square, circular (flush or projecting), rectangular or industrial : Any required range, calibrated to B.S.89 : Catering for any number—from individual meters to large parties.

Standard range from stock.
Special meters 7-14 days.

Meters, Electronic and Test equipment to individual specifications

Anders electronics LTD

103 Hampstead Road, London, N.W.1.
Tel.: EUSton 1639

Contractors to G.P.O. and Government Departments DGI/Ministry of Aviation approved

MAXI-Q HOME CONSTRUCTOR CHASSIS SERVICE

Our chassis are made with new 16 s.w.g. heavy-duty bright aluminium. Front panels in 19 s.w.g. steel with attractive hammered gold finish and clearly marked with neat control positions; all finishes and construction are made to enable constructors to match one unit with another.

MULLARD CHASSIS

	s.	d.
"5-10" Amplifier Chassis, base, screen and screws	19	6
"5-10" Slim Line Chassis, without control positions, complete with base and screws	19	6
Complete Metalwork for the 5-10 T.C.C. printed circuit	15	0
Four-Channel Input-Mixing Pre-Amplifier Chassis, printed front panel and screws	18	6
Type "A" Pre-Amplifier Chassis and front panel (unprinted)	8	6
Type "B" Pre-Amplifier Chassis and front panel (unprinted)	12	6
2 Valve Pre-Amplifier Chassis complete with printed, hammered gold finished front panel and screws	16	6
3 Valve Pre-Amplifier Chassis, complete with printed, hammered gold finished front panel and screws	19	6
3 Valve, 3 Watt Hi-Fi Amplifier Chassis	10	6
20 Watt Amplifier Chassis, base, transformer covers, transformer adaption plate and screws	68	6
20 Watt Pre-Amplifier Chassis	25	0
Mullard Tape Recorder, type "A" amplifier chassis	31	6
Mullard Tape Recorder, type "B" amplifier chassis	31	6
Mullard Tape Recorder, type "C" and new type "C" amplifier chassis	32	6
Mullard Tape Recorder, power pack chassis	11	6
7 Watt Stereophonic Amplifier Chassis, printed front panel and screws	24	6
3 Valve Stereophonic Amplifier Chassis and printed front panel	22	0
Stereophonic Pre-Amplifier Chassis, printed front panel and screws	24	6
Mullard 7 Watt D.C./A.C. Amplifier Chassis with Paxolin and bracket	20	0

Note: Transformer holes are not drilled in the above chassis excepting for the 20-watt amplifier.

MULLARD FRONT PANELS

	s.	d.
Type "C" Tape Pre-Amp. with EM81 escutcheon cut-out, 11½ x 4½in.	8	0
"5-10" Amplifier, 15 x 5in.	7	6
Type "A" Pre-Amplifier, 4½ x 2½in.	2	6
Type "B" Pre-Amplifier, 10½ x 2½in.	3	6
WF1388 push pull bias and erase Tape Deck Oscillator Coil for the Mullard type "C" Tape Pre-Amplifier	29	6
Treble lift inductor for the Mullard type "C" Tape Pre-Amplifier	22	6

GENERAL CATALOGUE covering full range of components, send 1/4 in stamps or P.O. PLEASE SEND S.A.E. WITH ALL OTHER ENQUIRIES.

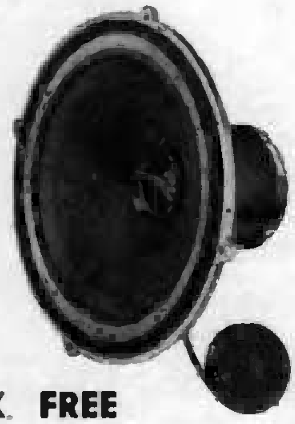
DENCO (CLACTON) LTD.
(Dept. W.W.), 357/9 Old Road,
Clacton-on-Sea, Essex

HIGH QUALITY SPEAKERS with foam surrounds by WHARFEDALE

HERE ARE FIVE FROM THE LARGE RANGE OF MODELS IN PRODUCTION

COAXIAL 12

COMPLETE WITH TWEETER VOLUME CONTROL



SPECIFICATION

MAIN CONE
Magnet gap diameter, 1¾in. Flux density, 14,000 gauss. Total Flux, 155,000 maxwells. Foam surround. Copper voice coil. Fundamental resonance 25–30 c/s.

TWEETER ASSEMBLY
Magnet gap diameter, 1in. Flux density, 13,200 gauss. Total Flux, 44,000 maxwells. Foam surround. Aluminium voice coil and centre dome.

PRICE £25 TAX FREE

COLUMN 8/145
Bass Resonance, 45/55 c/s.
Flux Density, 14,500 gauss.
Total Flux, 60,000 maxwells.
Price (inc. P.T.) £6/19/11

W15/FS
Bass Resonance, 25/30 c/s.
Flux Density, 13,500 gauss.
Total Flux, 180,000 maxwells.
Price (tax free) £17/10/-

SUPER 12/FS/AL
Bass Resonance 30/38 c/s.
Flux Density, 17,000 gauss.
Total Flux, 190,000 maxwells.
Price (tax free) £17/10/-

SUPER 3
Flux Density, 14,500 gauss.
Total Flux, 60,000 maxwells.
Price (inc. P.T.) £6/13/3

FOAM SUSPENSION reduces the incidence of distortion at low frequencies, and the softness improves dissipation of middle and high frequency vibrations at the edge of the cone, resulting in all-round improvement in the smoothness of response.

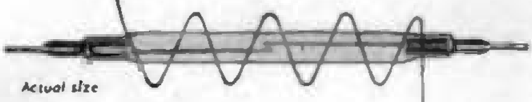
Illustrated, descriptive leaflet and cabinet construction sheet free on request.

Wharfedale
WIRELESS WORKS LTD
IDLE BRADFORD YORKS

Telegrams: 'Wharfdel' Idle, Bradford
Telephone: Idle 1235/6

XS2 Dry Reed Relay Insert

A gold plated relay contact hermetically sealed in inert gas for absolute reliability, high speed and low contact bounce.



maximum current... ...	250 mA
maximum resistive load ...	15 W
maximum closed resistance...	50 mΩ
minimum open resistance ...	$5 \times 10^{11}\Omega$

nominal operate ampere turns	120 AT
nominal release ampere turns	60 AT
operate time less than ...	2 mS
bounce time less than ...	0.5 mS
release time less than ...	0.5 mS

our Technical Service Department is ready to provide further details of characteristics or application.

Hivac Limited

STONEFIELD WAY · SOUTH RUISLIP · MIDDLESEX

A member of the Automatic Telephone & Electric Group Ruislip 3366

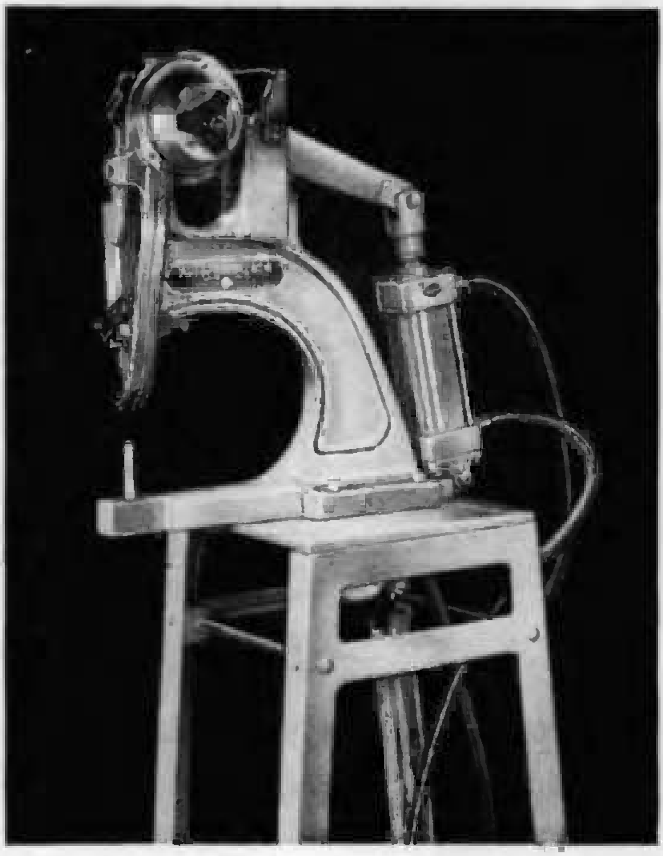
S.J.

Phœnix

EYELETTING and light PUNCHING MACHINES

AUTOPHOENIX No. 6A. A new and improved air-operated machine for the automatic insertion and closing of eyelets. The deep throat, high vertical gap and projecting base make this an ideal machine for the eyeletting of components in radio chassis even in the closest corners and, of course, for spinnings, cylinders and plastic mouldings.
It can be supplied with built-in air compressor.

We manufacture a large range of hand and automatic Eyeletting and Piercing Machines and also stock eyelets which we can supply in small or large quantities.
Full illustrated brochure of the "Phoenix" machines, write for leaflet W.W.2.



HUNTON LTD.

PHOENIX WORKS, 114-116 EUSTON ROAD, LONDON, N.W.1

Tel.: EUSton 1477 (3 lines) Grams.: Untonexh, London

- No exposed metal parts other than terminations, which are clean solder coated, thereby ensuring easy soldering.
- Body and terminations free of wax coating or any other low melting point material.
- Long life without voltage derating.
- Designed to meet the requirements of British Joint Service Standards RCS 131 and BS 2131 with humidity classification H.2.
- Solid construction eliminates internal movement, preventing damage by severe vibration.

DUBILIER ENCAPSULATED PAPER DIELECTRIC TUBULAR CAPACITORS HAVING OUTSTANDING CHARACTERISTICS

The Dubilier Capacitor Type 560 is a new approach to capacitor requirements for all radio and electronic applications. It is constructed to meet long and arduous service conditions. The paper dielectric element is impregnated with a plastics material to produce a solid unit. The terminations are of great mechanical and electrical strength and the assembled element is sealed in an encapsulated mineral loaded epoxy resin so that there are no parts capable of movement, making the capacitor completely immune to shock and all normal atmospheric conditions.

Capacitance Tolerance; ±20% normal ±10% by selection. Power Factor; Less than 1% at 1,500 c/s. Insulation Resistance; Better than 20,000MΩ at normal temperature. Voltage Application; From −40° to +125°C for d.c. and from −40° to +70°C for a.c.

CAPACITANCE	VOLTAGE RATINGS			DIMENSIONS	
μF	d.c. Wkg. at −40°C to +125°C	d.c. Test at 20°C	a.c. Wkg. r.m.s. at −40°C to +70°C and up to 60 c/s	Diameter +0.020" −0	Length ±0.040"
0.001	1,000	2,500	250	[illegible]	1
0.002	1,000	2,500	250	[illegible]	1
0.005	1,000	2,500	250	[illegible]	1
0.01	1,000	2,500	250	[illegible]	1[illegible]
0.02	750	2,250	250	[illegible]	1[illegible]
0.05	500	1,500	250	[illegible]	1[illegible]
0.1	350	1,000	180	[illegible]	1[illegible]
0.1	500	1,500	250	[illegible]	1[illegible]

DUBILIER

DUBILIER CONDENSER CO. (1925) LTD., DUCON WORKS, VICTORIA ROAD, NORTH ACTON, LONDON W.3.
Telephone: ACOrn 2241 (5 lines) Telegrams: Hivoltcon London Telex
Cables: Hivoltcon London Telex: 25373

DN 242B

TELENG

DOING TWO JOBS BETTER—SIMPLER

DOUBLE CHANNEL AMPLIFIER TYPE U30 D

A Television Boost Amplifier for

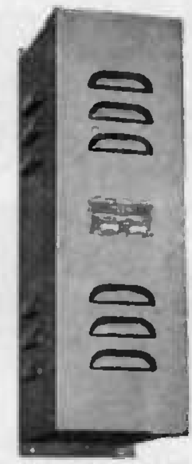
SHOWROOMS
REPAIR SHOPS
or COMMUNAL
AERIAL SYSTEMS

Two Amplifiers for the price of one

Gain 30 db on each of any two channels to your choice in Bands I and 3. Internally combined output up to 150 m/V each channel for up to 40 outlets.

Net Trade Price £14

For V.H.F.—the U30 FM at £13 net trade, matches and couples to the U30D without external combining units and losses.



HOUSED IN STRONG METAL CASE

Write for fully descriptive leaflet to :—

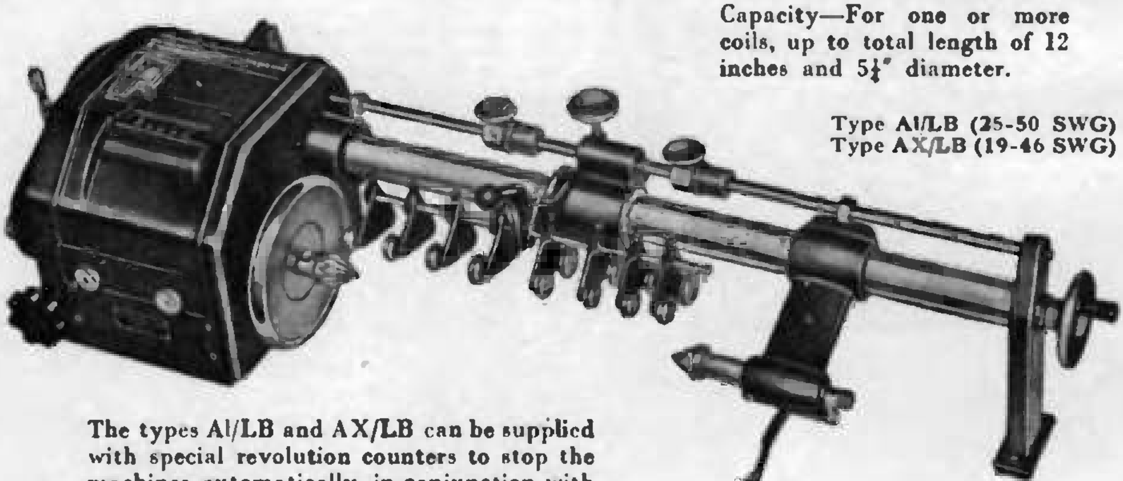
TELENG LIMITED

TELENG WORKS, CHURCH ROAD, HAROLD WOOD, ROMFORD, ESSEX. Telephone: Ingrebourne 42901

KOLECTRIC AUTOMATIC COIL WINDING MACHINES

Capacity—For one or more coils, up to total length of 12 inches and 5½" diameter.

Type AI/LB (25-50 SWG)
Type AX/LB (19-46 SWG)



The types AI/LB and AX/LB can be supplied with special revolution counters to stop the machines automatically, in conjunction with a solenoid mechanism on the A.C. motor, when the required number of turns have been wound.

Full details on request.

KOLECTRIC LTD

73 UXBRIDGE ROAD, EALING, LONDON, W.5. Telephone: Ealing 8322

A REVOLUTIONARY NEW BRITISH INVENTION!

- ★ Uses standard tapes
- ★ Plays at 7½" per. sec. or 3 other speeds
- ★ Records direct from radio or microphone
- ★ Erase and fast rewind

FULLY GUARANTEED

Instantly turns any gramophone into a first-class Tape-Recorder

and back into a record-player in a moment!

Gramdeck is completely *new* . . . a revolutionary and ingenious invention that instantly turns your gramophone into a tape-recorder and back into a gramophone at will! Slip the Gramdeck on to your turntable and you have the finest tape-recorder you've ever heard! Lift it off . . . your gramophone is ready to play records again. There are no motors or valves to go wrong—and *you get a quality of reproduction that has to be heard to be believed!*

£13-12-0

Special moving-coil microphone and tape extra.

EASY TERMS

"Ingenious—simple . . . why on earth did no one think of it before!"—THE TAPE RECORDER.
"Ingenious and robust." — BRITISH SOUND RECORDING ASSOCIATION JOURNAL.
"Quality of reproduction excellent . . . real hi-fi results . . . potential is tremendous . . . both designer and manufacturer should be congratulated." —BRITISH RADIO & T/V RETAILERS' REVIEW.
"Better than many so-called hi-fi recorders . . . robust . . . carefully designed . . . excellent value." —AMATEUR CINE WORLD.

Gramdeck
GRAMOPHONE TAPE RECORDER
HIGH QUALITY TAPE-RECORDING FOR EVERY HOME

Free!

Everyone is praising the Gramdeck. "*The quality is at least equal to that obtained from a good microgroove disc,*" says a leading professional journal.

WORKS FROM ANY RECORD PLAYER OR RADIOGRAM

Gramdeck records and reproduces with a wonderful depth and breadth of tone. Because it uses equipment that is already in your gramophone it only costs a fraction of the high-quality tape-recorder you would normally require. Full details, specifications, photographs, easy terms, etc., are given in the Gramdeck Book. Send for your FREE copy, today.

MADE BY THE FIRM THAT MAKES RADAR EQUIPMENT FOR VISCOUNTS AND BRITANNIAS

FREE BOOK—POST NOW!

I would like to know how to turn any gramophone into a first-class tape-recorder . . . please send me the Gramdeck Book—FREE and without obligation.
(Write if you prefer not to cut page.)

NAME ....

ADDRESS ....

....

....

Gramdeck (Dept. WW 807) 29 Wright's Lane Kensington, London, W.8

GRAMDEC TURNS A URNTABLE INTO A APE RECORDE

The very best connections

...secured by Plessey

SUB-MINIATURE COAXIAL CONNECTORS

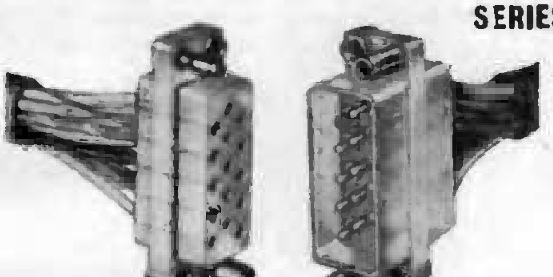
Approximately twice life size

As a contribution towards increasingly compact equipment, Plessey have introduced this new, highest quality and fully comprehensive range to allow a new approach on applications hitherto restricted by the limitations of existing connectors.

Designed for the matched impedance coupling of high frequency coaxial cables operating in the super high frequency bands, these connectors—

* have a working voltage of 650 volts Peak at sea level, and matched impedance coupling of 50 ohm lines is accommodated.
* have hard gold plated contacts on silver plate to give maximum performance with minimum voltage drop.

SERIES '110' (15- and 30-way) MINIATURE RECTANGULAR CONNECTORS



Developed specifically by Plessey to meet the demand for a safe, inexpensive connector for commercial applications, this new series embodies excellent electrical and mechanical characteristics, and the many unique features that make it really outstanding include :—

* Plug pins and socket inserts are polythene shrouded to dispense with gaskets and ensure insert anchorage.
* Mismating is prevented by corner pins and corner sockets.
* Extreme simplicity of wiring, demands less-skilled operation than the orthodox methods of soldering pins *in situ*.

For further information, please write for Publication numbers 128 and 114.

Plessey

WIRING & CONNECTORS DIVISION · THE PLESSEY COMPANY LIMITED

CHENEY MANOR · SWINDON · WILTS · TELEPHONE: SWINDON 6251

Overseas Sales Organisation: PLESSEY INTERNATIONAL LIMITED · ILFORD · ESSEX

CW6a

8 WAY | 18 WAY

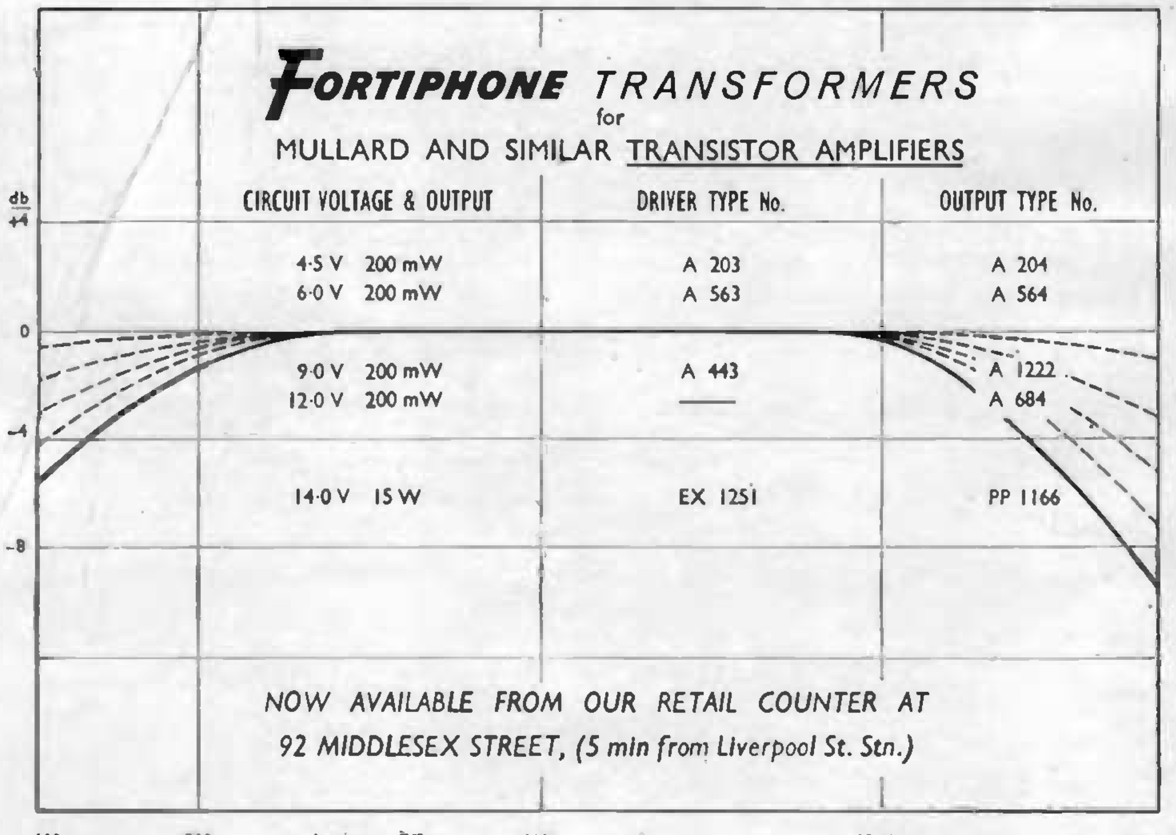
12 WAY | 25 WAY

Sturdy, Reliable and Inexpensive
Nylon—PF mouldings. Silver plated contacts. Solid drawn aluminium cans. Positive locking mechanism.
Breakdown voltage 3.5kV.

Send for full details to :—

THE McMURDO INSTRUMENT CO. LTD.
ASHTEAD, SURREY. Telephone: Ashtead 3401

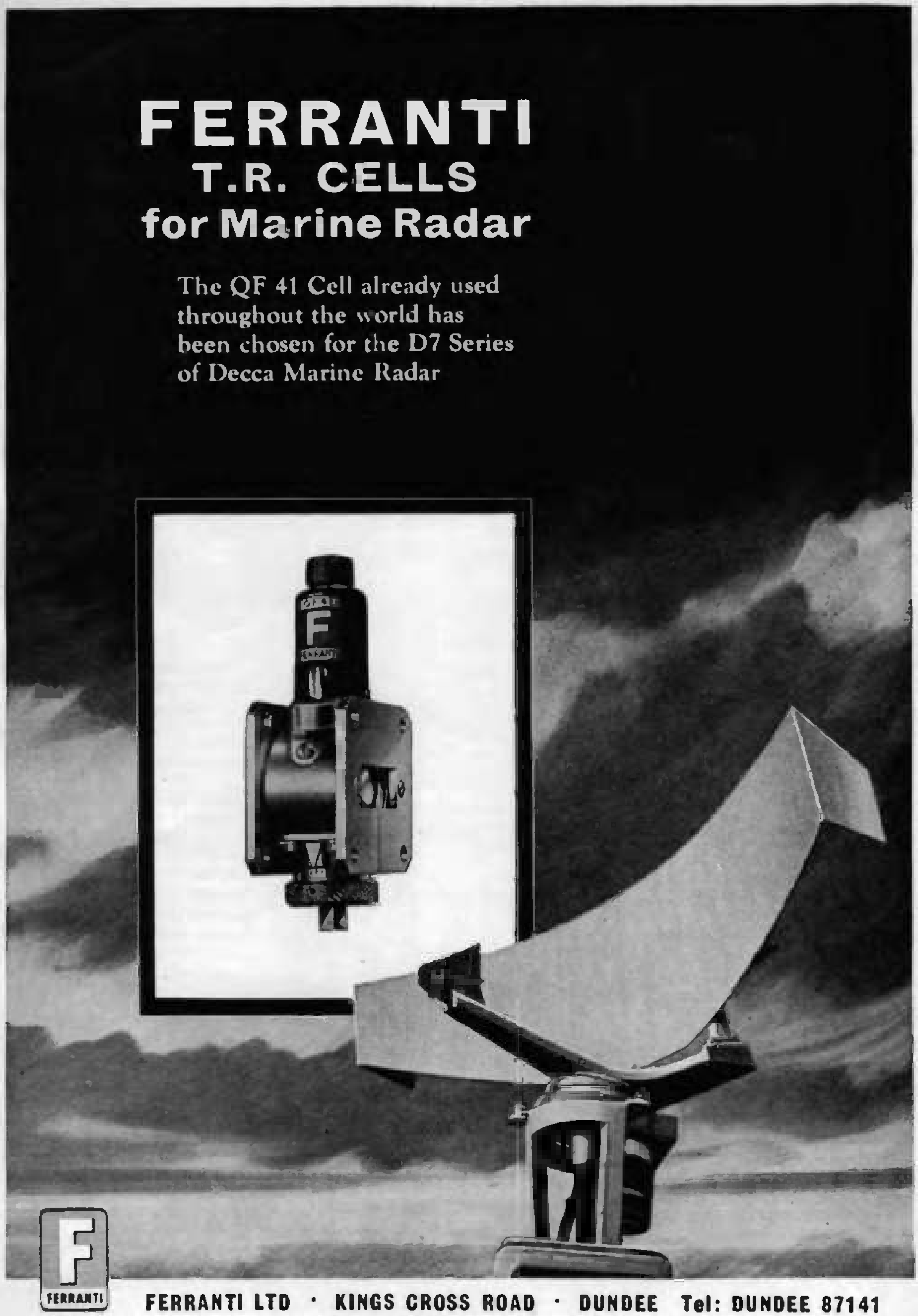
S646



FORTIPHONE TRANSFORMERS
for
MULLARD AND SIMILAR TRANSISTOR AMPLIFIERS

CIRCUIT VOLTAGE & OUTPUT	DRIVER TYPE No.	OUTPUT TYPE No.
4·5 V 200 mW	A 203	A 204
6·0 V 200 mW	A 563	A 564
9·0 V 200 mW	A 443	A 1222
12·0 V 200 mW	—	A 684
14·0 V 15 W	EX 1251	PP 1166

NOW AVAILABLE FROM OUR RETAIL COUNTER AT
92 MIDDLESEX STREET, (5 min from Liverpool St. Stn.)



FERRANTI LTD · KINGS CROSS ROAD · DUNDEE Tel: DUNDEE 87141

DS/T61

SEI GECALLOY TOROIDAL CORES

for high quality inductors

GECALLOY CORED INDUCTORS HAVE THE OUTSTANDING QUALITIES OF:—

1. High stability of inductance with time.
2. Magnetic stability, i.e., Small change of inductance after subjection to saturation flux density.
3. Low loss—high Q.
4. Low harmonic distortion.
5. Low temperature coefficient of about 120 parts/10^6/°C.
6. Almost zero temperature coefficient of frequency when used in a tuned mesh with a polystyrene capacitor.
7. Negligible external field.

DIMENSIONAL DATA

CODE	OUTSIDE DIA. MM	INSIDE DIA. MM	THICKNESS MM
G 29	20·40	12·70	6·35
G 31	25·40	12·70	12·70
G 32	31·80	15·90	9·52
G 33	33·00	22·20	10·00
G 3	38·10	26·00	10·15
G 34	40·00	26·00	12·00
G 4	42·50	28·00	8·60
G 4A	42·50	28·00	14·50
G 8	47·00	29·00	15·50
G 1	50·50	30·00	17·00
G 1A	50·50	30·00	13·50

NOM. µ 12, 25, 50, 90, 140

CODE	OUTSIDE DIA. MM	INSIDE DIA. MM	THICKNESS MM
G 1B	50·50	30·00	10·00
G 2	58·00	35·00	17·50
G 6	70·00	46·00	20·00
G 9	80·00	48·00	29·00
G 60	12·70	7·62	4·75
G 59	20·32	12·70	6·35
G 58	22·86	13·97	7·62
G 57	26·92	14·73	11·18
G 56A	33·02	19·94	10·67
G 56	33·02	19·94	11·18
G 55	34·29	23·37	8·89

G 1B–G 9: NOM. µ 12, 25, 50, 90, 140
G 60–G 55: NOM. µ 14, 26, 60, 125, 140

Full details of range available on request.

GECALLOY CORES ARE IDEAL FOR:—

Filter Applications — Audio Frequency Tuned Circuits — Choke Coils — Transistor Invertor Transformers — Interference Suppressors.

Stabilising Chokes for Fluorescent Lamps used at Audio Frequencies.

Inductor Design and Winding Service available if required.

Polystyrene capacitors are available for use with the toroidal cores.

SALFORD ELECTRICAL INSTRUMENTS LIMITED
TIMES MILL · HEYWOOD · LANCASHIRE Tel: Heywood 6868
London Sales Office: MAGNET HOUSE KINGSWAY W.C.2 Telephone: Temple Bar 4668
A Subsidiary of THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

LONDON'S LEADING STOCKISTS OF

EQUIPMENT • ACCESSORIES • MATERIALS

GOODS SENT TO ALL PARTS OF THE WORLD

HI-FIDELITY STOCKISTS

Including equipment by

• ACOUSTICAL • ARMSTRONG • AVANTIC • CHAPMAN • COLLARO • GARRARD • GOODMANS • JASON • LEAK • LENCO • PILOT • ROGERS • W.B. • WESTREX • WRIGHT AND WEAIRE • WHAREFDALE

LARGE STOCKISTS OF

COMPONENTS & EQUIPMENT

by well known Manufacturers including:—

• A.B. METAL PRODUCTS • AVO • BELLING-LEE • BULGIN • COLVERN • DUBILIER • ERIE • MORGANITE • MULLARD • PAINTON • T.C.C. • WELWYN • WESTINGHOUSE.

The Connoisseur's Tape Equipment

MASTERLINK TAPE UNIT M2A AND COLLARO "STUDIO" DECK

Build your own Hi-Fi Tape Equipment using our tape pre-amp and the new Collaro deck. INC. PRICE £44. Carr. extra. Complete with instructions.
The M2A is complete with external power pack and is also suitable for use with Wearite and Brenell decks. C.C.I.R. Characteristic. PRICE 27 Gns. Plus P. & P. 4/-. Leaflet on request.

"ALFA" TEST METER OFFER

6/12/60/300/1,200 v. A.C., ditto D.C., 0-20k, 0-2 megohm, 300 microA, 30mA, 300 mA — 20 to +23dB, +20 to +37dB. Accuracy ± 3% D.C. ± 4% A.C. Multi-range, 5½in. x 3½in. x 1½in. Large clear dial. Leads £5/19/6. (P. & P. 2/-).

PNEUMATIC LID STAY with pressure adjuster. Heavy duty, 10/- complete.

66 Page Catalogue Listing over 800 items of our extensive stocks. 1/- plus P. & P. 6d.

ROTARY WAFER SWITCHES
A.B. Metal and N.S.F. Made to order. Price List free on request.

STEEL METER CASES

4 x 4 x 4in. Sloping Front		9	5
5 x 5 x 8in. Sloping Front		14	11
6 x 6 x 12in. Sloping Front		24	9
4 x 4 x 2½in. Rectangular		6	8
6 x 4 x 3in. Rectangular		8	10
8 x 6 x 3in. Rectangular		11	0
10 x 6 x 2½in. Rectangular		13	3
10 x 7 x 7in. Alum. Panel	£1	4	9
12 x 7 x 7in. with Alum. Panel	£1	11	5
14 x 7 x 7in. with Alum. Panel	£1	15	9
14 x 9 x 8in. with Alum. Panel	£2	5	8
16 x 9 x 8in. with Alum. Panel	£2	9	6
16 x 11 x 8in. with Alum. Panel	£2	16	8
19 x 11 x 10in. with Alum. Panel	£3	3	10

ALSO FULL RANGE OF CHASSIS
Chassis and Case List Free on request.

SIMPLEX TIME SWITCH
200/250 v. 20 amp. Fitted with Smiths Electric clock. Price 69/6. P. & P. 3/3.

SPECIAL OFFERS!

1. Mains Transformer 550-0-550 v. 150 mA. 6 v. 3 A., 4 v. 3 A., 110 v. Primary £1.
2. Mains Transformer (Potted) 350-310-0-310-350 v. 220 mA. 6.7 v. 5 A., 6.3 v. 3 A., 6.3 v. 1 A., 5 v. 3 A., 6 v. 3 A., 6.3 v. 1 A., 230 v. Primary. Size 7½in. high x 5½in. x 4½in. £2/10/-. P. & P. 7/6.
3. Mains Transformer, Weyrad Drop through. Shrouded. 250-0-250 v. 100 mA. 6.3 v. 3½ A. Tapped Primary 200-240 v. 18/9.
4. Choke 10H 250 mA. Potted "C" Core, 25/-.
5. Choke 20H 50 mA. Potted, 15/-.
6. Choke 16H 120 mA. Potted "C" Core, 20/-.
7. Choke 5H 100 mA. Potted, 5/6.
8. Choke 5H 300 mA., Potted, 12/6.
9. Rectifier 300 v. 300 mA., 13/6.

Immediate dispatch of goods available from stock. Carriage charged extra at cost.

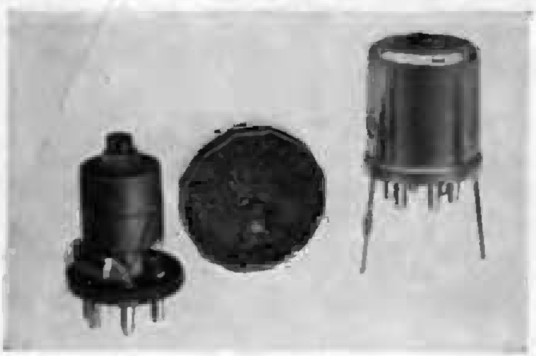
TELE-RADIO (1943) LTD

189 EDGWARE ROAD, LONDON, W.2

Our only address. ● Few mins. from Marble Arch ● Open all day Sat. Well-equipped demonstration room ● *Phone: PAD 4455/6.*

WEYRAD P.50 TRANSISTOR COILS AND I.F. TRANSFORMERS

FOR 2-WAVE PORTABLE WITH PRINTED CIRCUIT AND ROD AERIAL



P50/1AC M.W. OSCILLATOR COILS. For 176pF TUNING CONDENSER .... PRICE **5/4d.**

P50/2CC 1st and 2nd I.F. TRANSFORMER. 470 Kc/s. OPERATION. "Q" = 150 .... PRICE **5/7d.**

P50/3CC 3rd I.F. TRANSFORMER. 470 Kc/s OPERATION. "Q" = 170 .... PRICE **6/0d.**

RA2W L.W. and M.W. ROD AERIAL 6in. long. flying-lead connections. For 280pF TUNING CONDENSER........................ PRICE **12/6d.**

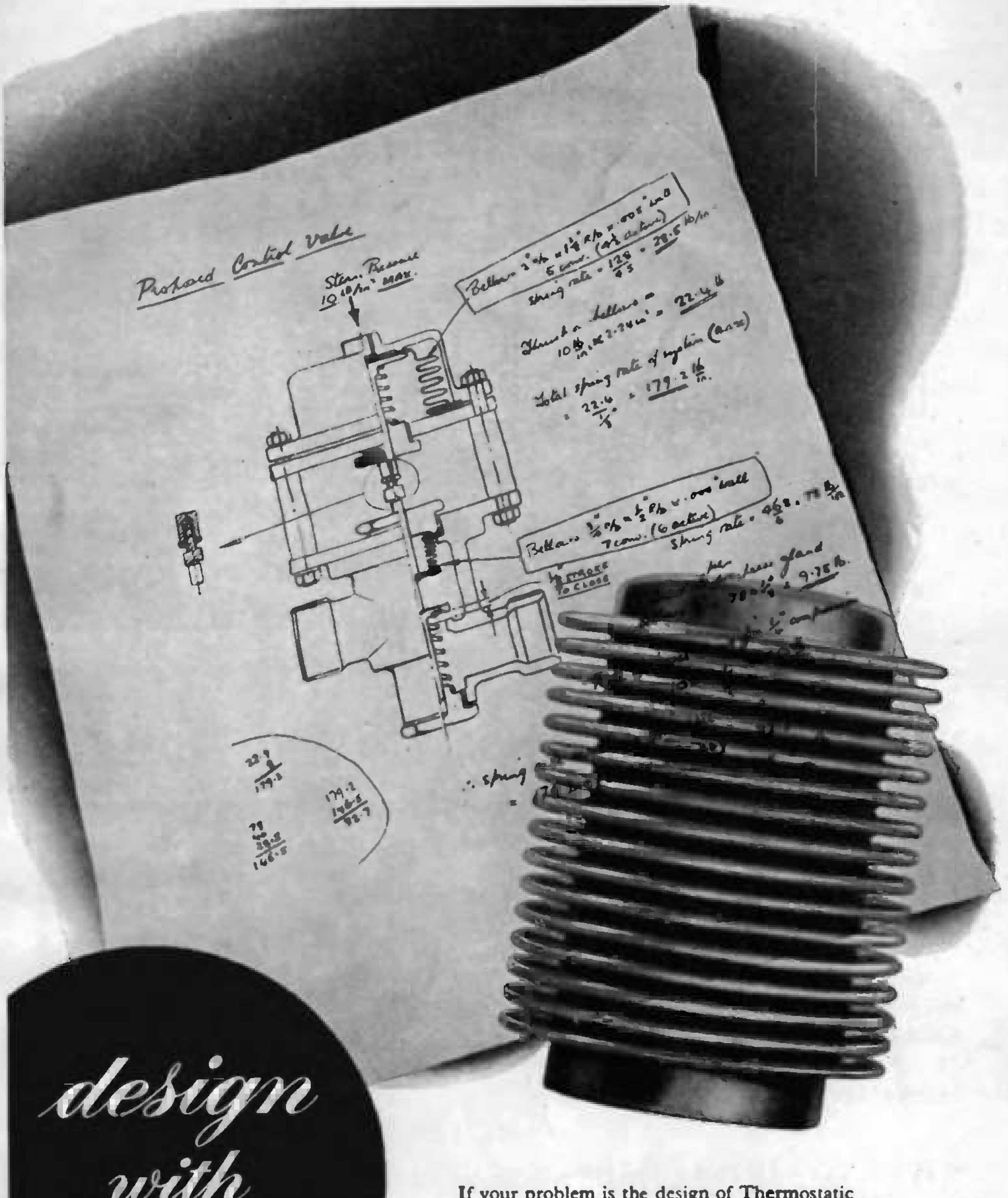
LFTD2 DRIVER TRANSFORMER. Split Secondary Type, semi-shrouded. With 6 connecting tags PRICE **9/6d.**

PCA1 PRINTED CIRCUIT PANEL. 2¾ x 8½in. ready drilled with component positions and references printed on rear........................ PRICE **9/6d.**

BOOKLET OF DETAILED ASSEMBLY INSTRUCTIONS AND CIRCUIT DIAGRAMS FOR 6-TRANSISTOR LONG AND MEDIUM WAVE SUPERHET .... PRICE **2/0d.**

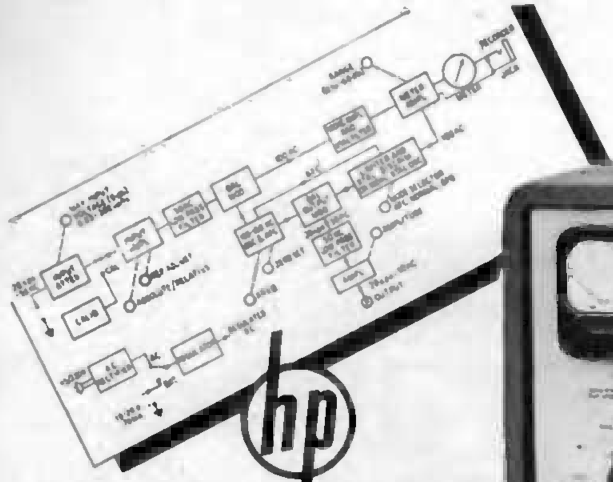
ALL IN BULK PRODUCTION—TRADE ENQUIRIES INVITED

WEYMOUTH RADIO MFG. CO. LTD., CRESCENT STREET, WEYMOUTH, DORSET



If your problem is the design of Thermostatic or pressure sensitive systems, small shaft couplings, pressure seals or vacuum seals, then the versatile metal bellows will provide the solution. HYDROFLEX are, of course, to be preferred. Please write to the Bellows Division for your copy of the catalogue, quoting reference "WW".

DRAYTON REGULATOR & INSTRUMENT CO. LTD.
West Drayton, Middlesex. *West Drayton 4012*



HEWLETT PACKARD 302A WAVE ANALYZER

ADVANTAGES: No calibration or stabilization needed • Direct readings; accurate • Measures frequencies 20 cps to 50 KC • Completely transistorized • Battery or ac powered • Hum free • Low power consumption • No warm-up needed • Very sharp acceptance circuits • AFC • Also frequency restorer circuit • Compact, rugged, versatile.

New Model 302A Wave Analyzer represents a significant improvement in wave analyzer design. Completely transistorized, sophisticated in design, highly selective, free of tedious calibration and stabilization before use—these are but a few of the important convenience and accuracy features in the new 302A. Other exceptional features are low power consumption (in the order of 3 watts), provision for battery operation (18 to 28 volts) as well as ac line power, and elimination of warm-up time.

SPECIFICATIONS:—

Frequency Range: 20 cps to 50 KC.

Frequency Calibration: Linear graduation 1 division per 10 cycles. Accuracy ± (1% × 5) c/s.

Voltage Range: 3μv to 300v.
Ranges provided by an input attenuator switch and a meter range switch in steps of 1 : 3 or 10 db. Meter range is indicated by a dial mechanically linked to input attenuator. An absolute-relative switch, in conjunction with a variable 10 db control is provided for adjustment of intermediate values.

Warm-Up Time: None.

Voltage Accuracy: ±5% of full scale value.

Residual Modulation Products and Hum Voltage: Greater than 75 db down.

Intermediate Frequency Rejection: Intermediate frequency present in input signal rejected by at least 75 db.

Selectivity: ±3½ cycle bw—at least 3 db down.
±25 cycle bw—at least 50 db down.
±70 cycle bw—at least 80 db down.
beyond ±70 cycle bw—at least 80 db down.

Input Impedance: Determined by setting of input attenuator: 100,000 ohms on 4 most sensitive ranges, 1 megohm on remaining ranges.

Selected Frequency Output: 1v open circuit at output terminal for full scale meter deflection. Output level control provided. Frequency response ±1 db. 20 cps to 50 KC. Output impedance approximately 600 ohms.

B.F.O. Output: 1v open circuit at output terminals. Output level control provided. Frequency response ±1 db, 20 cps to 50 KC. Output impedance approximately 600 ohms.

Automatic Frequency Control: Range of frequency holding is ±100 cycles minimum.

Power: 115/230v ±10%, 50/1600 cycles, 3 watts (approx.) Terminals provided for powering instrument from external battery source. Battery supply range 28v to 18v.

Weight: Net 43 lbs. Shipping 63 lbs. (cabinet mount). Net 35 lbs. Shipping 55 lbs. (rack mount).

Dimensions: Cabinet Mount: 20½" wide; 12½" high; 14½" deep. Rack Mount: 19" wide; 10½" high; 13½" deep.

Price: Delivered U.K. and exclusive of duty—where payable
£605 (cabinet mount)
£598 (rack mount)

Continuous progress in design may affect the above specification which is therefore subject to change without notice.

LIVINGSTON LABORATORIES LTD.

RETCAR STREET · LONDON · N.19 Telephone ARChway 6251

we can get you out of a wide band problem

And if you're in a rage over rectifiers or in a diode of despair—don't worry. We'll get you out of that too. (Why, we've made some of our customers actually beam at tetrodes!) It's because we've experienced over 40 years bottling up valves—Tx, Rx, rf, audio, hard, soft, gov't., special—that problems like this no longer hold any terrors for us. Also, we've everything on the research and production side you could possibly wish for. So the next time you're enveloped in a valve problem, let us know.

TYPE	gm (mA/V)	Ca — all less g1 (pF)	Cg1 — all less a (pF)	ρa (pF)
Z319	19	3	8	2.5
Z759	15	3	13	5
417A	25	0.35	6.5	4
R5559	25	5	12	4.5
A2674	32	3.5	15	4.5

Many other types, for all applications — Let us know what you're interested in and we will be pleased to send you details.

G.E.C. valves are obtainable from

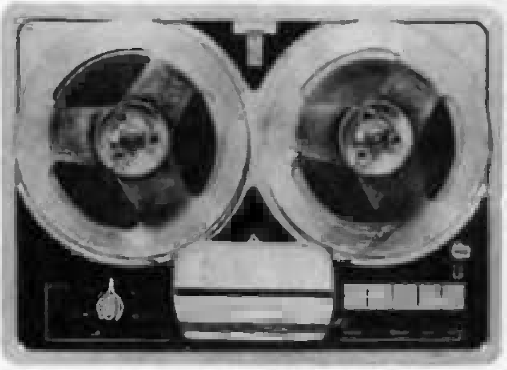
THE M-O VALVE CO. LTD

BROOK GREEN · HAMMERSMITH · LONDON W.6.

A subsidiary of the General Electric Co. Ltd

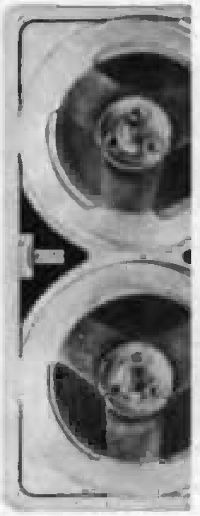
the NEW MOTEK K10 3 SPEED TAPE DECK

Patents pending



Incorporating many new features and a greater frequency response

Look



Now restyled in two tones of grey—you must see the new, attractive Motek K.10.

★ Frequency response better than 40 c/s.—12,000 c/s at 7.5in. per sec. with extremely low hum pick-up.

★ Enlarged drive wheel on the rev. counter ensures accurate tape positioning.

Please send for brochure of K.10.

MOTEK 21 GNS

makes a better Recorder

MODERN TECHNIQUES

Wedmore Street, London, N.19. Tel: ARChway 3114

More and more manufacturers are installing Motek Tape Decks in their recorders.

M. R. SUPPLIES, LTD.

(Established 1935)

We offer only first-class material at the most attractive prices and with prompt delivery. Careful packing. Satisfaction assured. Prices nett.

SYNCHRONOUS TIMERS (by well-known British maker—brand new). Good news for those who applied too late for first supply—a limited new delivery now available. 200/250 v. 50 c. Providing any "on" period between 5 mins. and 8 hours, switching "off" at the end of the set period. Made for electric cookers and suitable for many other purposes—tape recorders, immersion heaters, etc. Capacity 20 amps, fitted neon indicator. Housing 6in. sq. by 3½ in. **£4/12/6** (despatch 3/-).

LABORATORY COMPRESSORS. New range available, example 15 lb. sq. in., 720 cub. ins. per minute. Motorised 200/250 v. A.C. **£14/15/-**. Further details on request.

SYNCHRONOUS ELECTRIC CLOCK MOVEMENTS. 200/250 v. 50 c. Fitted with spindles for hours, minutes and seconds hands. Self-starting, central hole fixing. Dia. 2¼in., depth behind dial only 1in. Very latest model. With dust cover, **29/6** (despatch 1/6). Sets of three hands to fit, in good style, for 5/7in. dial, **2/6** set, for 8/10in. dial, **3/6** set.

SYNCHRONOUS TIMER MOTORS (Sangamo). 200/250 v. 50 cycles. Self-starting, 2in. dia. by 1½in. deep, 1 r.p.m., 1 r.p.h. and 12 r.p.h., any one **37/6** (des. 1/-). Also high torque model (G.E.C.) 6 r.p.m., **57/6** (des. 1/-). These are suitable for display turntables.

SYNCHRONOUS TIME SWITCHES (Sangamo) for accurate pre-set switching operations on 200/250 v. 50 c. Providing up to 3 on-off operations per 24 hours at any chosen times, with day-omitting device (use optional). Capacity 20 amps. Compactly housed 4in. dia., 3½in. deep. With full instructions. **£5/8/6** (despatch 2/6). Also Smith's Relyon Twin-circuit model, 20-amp. switching. **£7/8/-** (des. 2/6).

SHORT INTERVAL TIME SWITCHES (Smith's). Spring driven. Closed circuit period continuously adjustable from 1 to 15 minutes. 15 amp. (230 v. A.C.) switching. 2in. dia. by 2½in. long. Not calibrated. **17/6** (despatch 1/6)-.

HIGH SPEED MOTORS (Delco). 1/10th H.P., 200/250 v. A.C./D.C., 10,000 r.p.m. Body 4½in. by 3in. with ¼in. shaft proj. 1½in. Made for spin driers and ideal for drills, sanders, mixers, etc., new, **47/6** (despatch 2/-).

AIR THERMOSTATS (Kleft-Pullin). Adjustable range 30/90 deg. F. Switching capacity up to 15 amps. A.C. In smart Ivorine [illegible] 4½ x 3 x 2in. Easily installed, [illegible] with each. Right for greenhouses, rooms, [illegible], etc., **45/6** (despatch 2/-).

EXTRACTOR FANS. A very popular line. Well-made units at much lower than normal prices. 200/250 v. A.C. induction motor, silent running, no interference. With mounting frame and back grille, ready for easy installation. With 8in. impeller (10in. overall dia.), 200 C.F.M., **£5/5/-**. 10in. impeller (12in. overall), 240 C.F.M., **£5/12/6**. Also minor model, 6in. overall dia., 75 C.F.M., **£4/12/6** (despatch any one 3/-).

COOLING OR EXTRACTOR FANS with open type S.P. induction motor, 200/250 v. A.C., 3½in. by 2½in. by 1½in., with 6in. plastic 3-blade impeller. Also suitable for projector lamp cooling and convector heaters. Selling very fast at only **22/6** (despatch 2/9).

COMPLETE SEWING MACHINE MOTOR OUTFITS. No better job obtainable at any price. 200/250 v. A.C./D.C. Fitted latest radio/T.V. suppressors. Comprising motor with fixing bracket foot control and switch, needle light with switch, belt, etc., and instructions for easy fixing to ANY machine. The complete outfit still **£6/15/-** (despatch 3/-).

M.R. SUPPLIES, Ltd., 68 New Oxford Street, London, W.C.1

(Telephone: MUSeum 2958)

Quartz Crystals of any shape and size cut and ground precisely to specification and coated, if required, with Gold, Silver or Aluminium, etc.

BROOKES CRYSTALS LTD

Suppliers to Ministry of Supply, Home Office, B.B.C., etc.

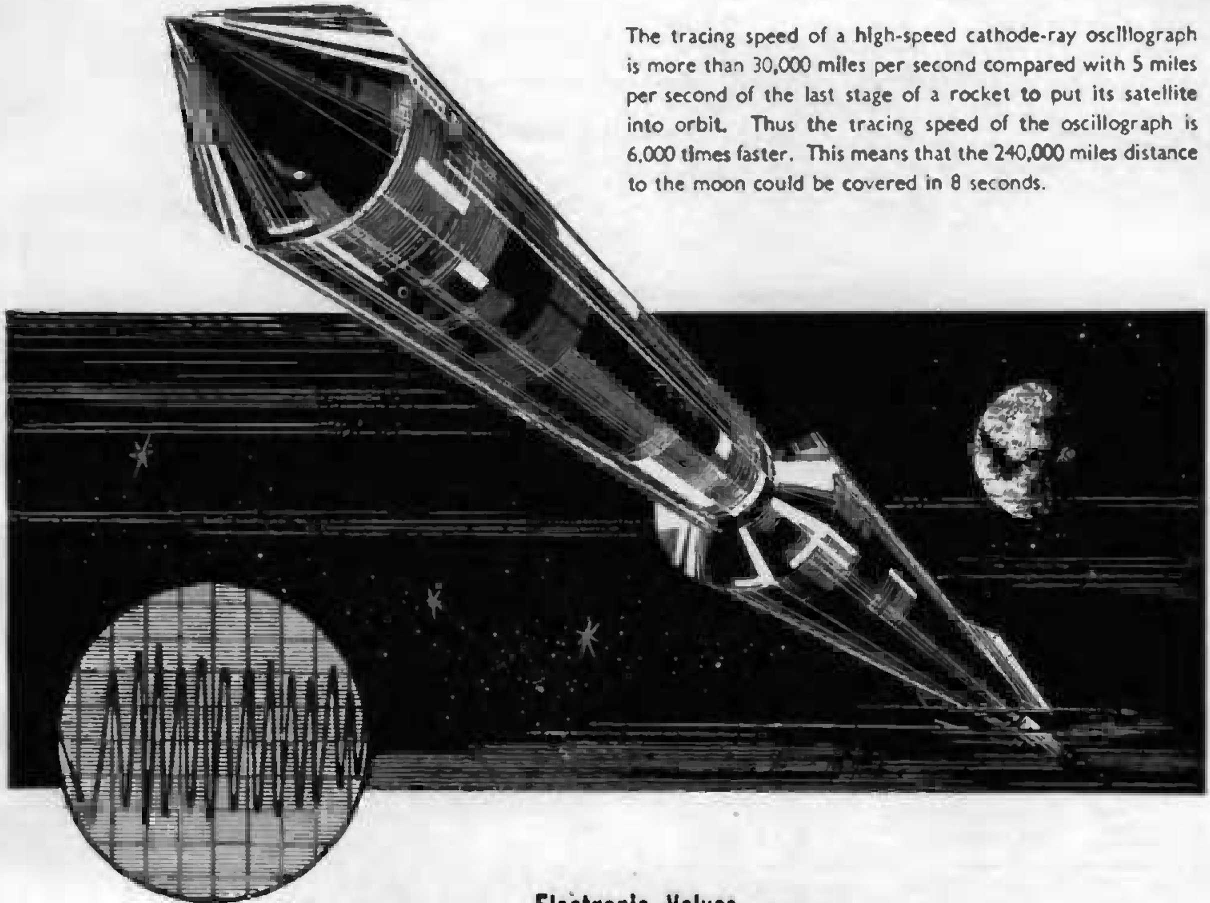
LASSELL STREET, GREENWICH, S.E.10

Phone: Greenwich 1828/4482

Grams: Xtals, London, S.E 10 — *Cables:* Xtals, London

6,000 Times Faster than a Space Rocket

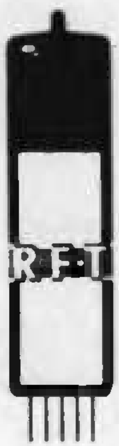
The tracing speed of a high-speed cathode-ray oscillograph is more than 30,000 miles per second compared with 5 miles per second of the last stage of a rocket to put its satellite into orbit. Thus the tracing speed of the oscillograph is 6,000 times faster. This means that the 240,000 miles distance to the moon could be covered in 8 seconds.



Efficient–

Modern–

Reliable



Electronic Valves—
The Decisive Components of Modern Measuring Instruments

In countless laboratories and workshops rapidly changing electric processes are traced with cathode-ray oscillographs. The quality of its electronic valves determine its efficiency and performance. Measuring instruments are of greatest importance to science and industry, and with each year more and more of them are being produced and consequently the demand for electronic valves and tubes is constantly increasing. Trade with these vital components has developed into an important business on the world market. The valve and tube manufacturers of the German Democratic Republic are in a position to supply you with high-quality receiver valves, long-life valves, oscillograph tubes, thryatrons, and stabilisers for all purposes.

RÖHRENWERKE

Agents for England: The Winter Trading Co., Ltd., 6, Harrow Road, London, W.2.

RFT Röhrenwerke,
Berlin-Oberschöneweide,
Ostendstrasse 1-5

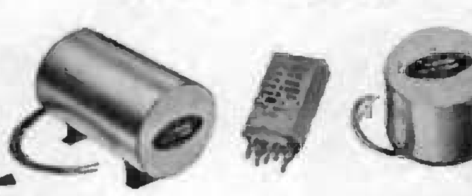
COUPON

Please send me free of charge and without obligation catalogue "Special Tubes"

Name.................................... Firm....................................

Address.................................... Country....................................

Remarks..



LEVELL PORTABLE INSTRUMENTS

TRANSISTOR TESTER

TYPE TM5

Measures the current gains of PNP and NPN transistors, the values of resistances, and the leakage currents of diodes, transistors and low voltage electrolytic condensers.

Collector Current Ranges: 0.5, 5, 50, 500 mA.

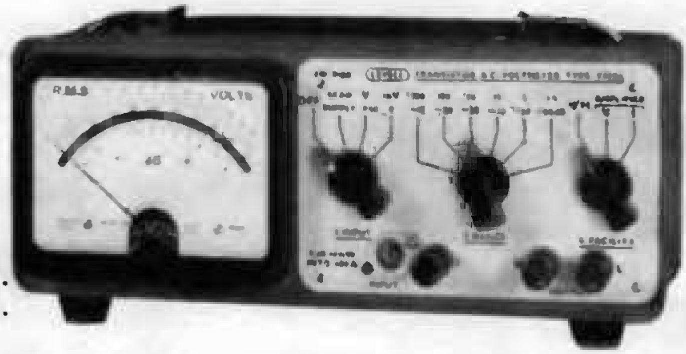
Current Gain Ranges: 100, 250, 500.

Resistance Ranges: 0-50kΩ, 0-500kΩ.

Price with batteries: **£17.0.0**

A.C. MILLIVOLTMETER

TYPE TM2A



Measures 50μV to 500V on 12 ranges. Response ± 0.1dB from 30 c/s to 30 kc/s. High input impedance. Output for C.R.O. Gain up to 80 dB available with 2 V. output. Low noise level. Low microphony. No hum.

Price with batteries: **£36.0.0**

LEVELL ELECTRONICS LTD.
10-12, St. Albans Road, Barnet, Herts.
Telephone: BARnet 5028

AN EXCELLENT RANGE OF MOULDINGS FROM STOCK

Embellished types for domestic equipment

Instrument types for modern apparatus

WE ARE ACTUAL IMPORTERS of the popular "Pekalit" range and maintain adequate stocks of the more widely used patterns

UNCLES BLISS & CO., LTD.
CHERRY ORCHARD RD, EAST CROYDON, SURREY
TELEPHONE: CROYDON 3379/6390

Valradio

The first name you think of for

DC/AC CONVERTERS

TRANSISTORISED, ELECTRONIC AND VIBRATOR MODELS

available for operating practically anything—from an electric shaver to a television—from battery or DC Mains supply.

Valradio

Dept. WW/C, Browells Lane, Feltham
Middlesex Feltham 4242
London Office:
57 Fortess Rd., N.W.5 GULliver 5165

FOR INSTRUMENT TUBES check with the ETEL range

It is more than likely that your instrument tube requirements can be met by the present comprehensive range now available from Electronic Tubes Limited. Economy with performance is characteristic of this range which is the outcome of years of specialisation in the design and production of instrument cathode ray tubes.

Brief details of the range are given here—for full data please use the coupon at the foot of the page.

ABRIDGED DATA—Typical operation

TUBE	1CP1 Monitor	3AFP1 General Purpose	3AZP1 Double Gun*	4EP1 General Purpose	4LP1 Split Beam	5BKP1 Helical P.D.A.	5BUP1 General Purpose	5BVP1 High Writing Speed	5BVP1A High Writing Speed	5CLP1 High Sensitivity
V_{a1} . . . . (kV)	0.5	1.0	1.5	2.0	1.5	1.4	2.0	4.0	1.5	1.5
V_{a3} . . . . (kV)	0.5	1.0	1.5	2.0	1.5	1.8	2.0	4.0	4.0	1.5
V_{a4} . . . . (kV)	—	—	—	4.0	3.0	4.0	4.0	8.0	8.0	15
V_{a5} . . . . (kV)	—	—	—	—	—	10	—	—	—	15
Y scan . . . . . . (mm)	28	55	70	80	75	60	95	95	95	60
Y sensitivity . . (V/cm)	45	11.5	16	23	27	12.5	17.5	36	36	2.7
X scan . . . . . . (mm)	28	55	90	90	90	95	115	115	115	100
X sensitivity . . (V/cm)	53	20	23	36	27	26.5	29	60	60	11.2
Screen diameter (mm)	30	71	94	108	108	137	137	137	137	137
SCREEN TYPES:										
Medium persistence . .	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Long afterglow	No	Yes	Yes	Yes	Yes	Yes	To order	To order	To order	To order
Blue photographic . . .	To order	To order	Yes	Yes	Yes	To order	To order	To order	To order	To order
Short persistence	To order	No	No	To order	No	No	No	To order	To order	No

* *Data is given for each gun.*

Please send me data on the types ticked

Name ....

Position ....

Company ....

Address ....

....

....

1CP1 ☐ 5BKP1 ☐
3AFP1 ☐ 5BUP1 ☐
3AZP1 ☐ 5BVP1 ☐
4EP1 ☐ 5BVP1A ☐
4LP1 ☐ 5CLP1 ☐

ETEL

Electronic Tubes Limited
Kingsmead Works · High Wycombe · Bucks
Telephone: High Wycombe 2020

ETL 16a

Arcolectric

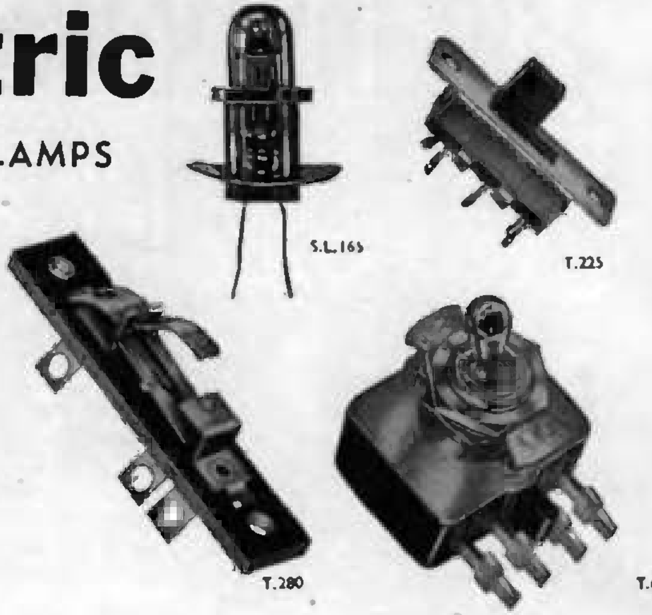
SWITCHES & SIGNAL LAMPS

T.225: Miniature Slide Switch
Ideal T.V. mains switch

S.L.166: Very small low cost
mains neon indicator

T.280: Sensitive Snap Action Switch
Popular switch for tape recorders

T.626: Double pole 3-AMP switch
with tags to fit printed circuit boards



Write for Catalogue No. 132

ARCOLECTRIC SWITCHES · LTD

CENTRAL AVENUE, WEST MOLESEY, SURREY. Tel.: MOLESEY 4336

The Best Manufacturers use Grey & Marten

'Amalgam' solder

Grey & Marten make solders *specifically* for the Radio, Television and Electronic industries.

Amalgam 'Resinact' Cored Solder with specially activated resin flux, to specification DTD 599, and B.S.441.

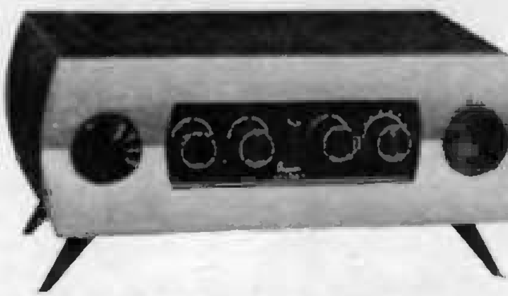
Amalgam P.C. Alloys for dip-tinning printed circuits (free service for checking analyses of metal in customers' baths).

Amalgam Fusible Alloys, made in all forms, for all uses. Fully approved A.I.D., C.I.A., G.P.O., I.R.C.S.C. and M.O.S.

GREY & MARTEN LIMITED

City Lead Works, Southwark Bridge, London, S.E.1. Tel: HOP 0424
and at Birmingham, Manchester and Ipswich

Chapman Stereo



Elegance coupled with outstanding performance have already earned an enviable reputation for the Chapman 305 Control Unit (Illustrated above) and 305 Power Amplifier.

- ★ 8 watts per channel at 0.1%.
- ★ Direct from Tape Head CCIR.
- ★ Any low output magnetic P/U RIAA.
- ★ Distortion negligible all levels.
- ★ Spare power for Tuner.
- ★ Main Amplifier only 12 × 7 × 5in.
- ★ Separate balance control.
- ★ Elegant in black and gold.
- ★ For shelf or cabinet mounting.

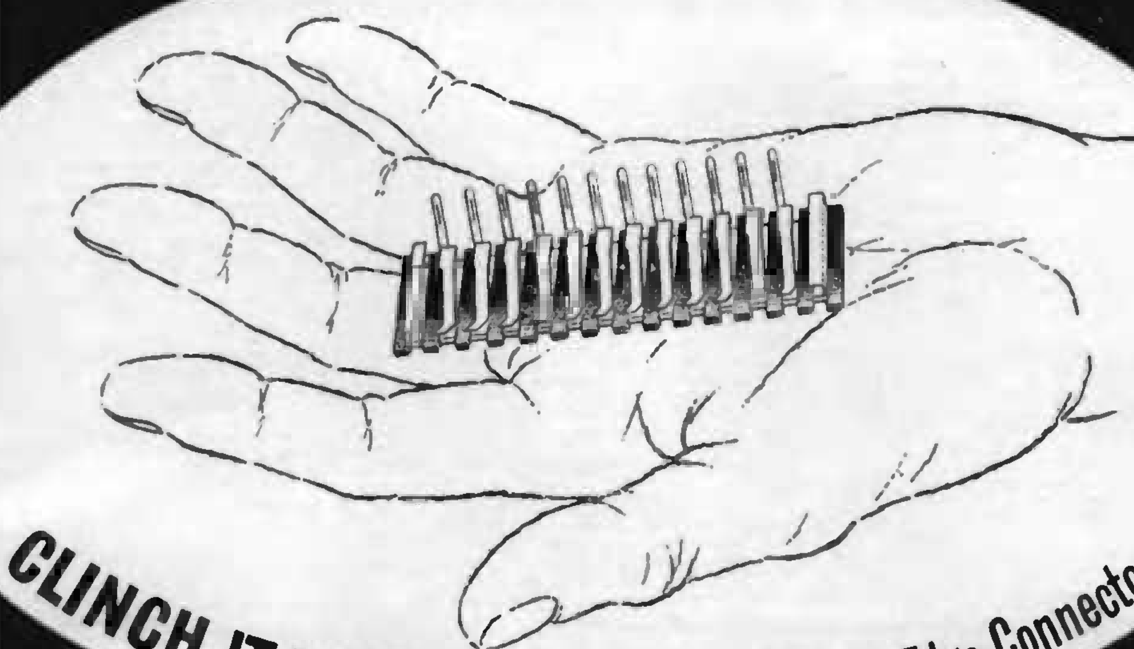
305 Control Unit 18 gns. Main Amp. 20 gns. Matching FM or AM/FM Tuners available.

Full specification from your hi-fi dealer or

C. T. CHAPMAN (Reproducers) LTD.

HIGH WYCOMBE · BUCKS.

Telephone: High Wycombe 2474



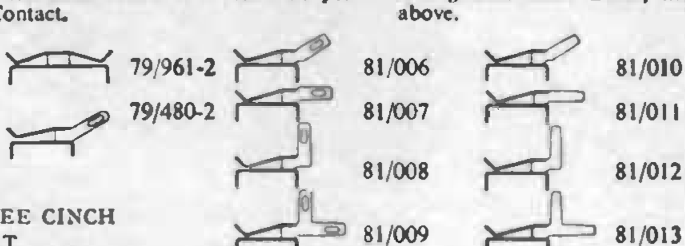
CLINCH IT WITH CINCH Printed Wiring Edge Connectors

FAST, LOW COST ASSEMBLY

SPECIFICATION

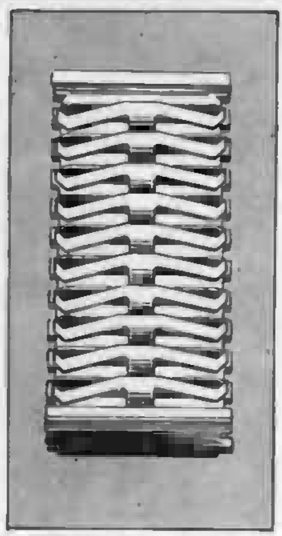
Available in: Any no. of ways up to 40.
Centres: 0.150" or 0.156" as specified.
Current rating: 5 Amps at 500 V.D.C. wkg.
Voltage proof: 2 K.V/D.C.
Contact resistance: < 5 mΩ after 1,000 sizings and exposure to DEF.5000 tropical conditions.
Withdrawal force: 4 to 6.5 ozs. per Contact.

Contacts: Phosphor Bronze, finished Gold plate on Silver, Silver or E.T.
Note: 79/480-2 & 79/961-2 Brass only; finish as above.
Laminate: Best quality Commercial Grade, Grade II; Fibreglass to order. (Fibreglass 0.150" ctrs. only).
End guides: Hard Brass; finish as above.



Tails accept Amp 98 Taper Tab

Tails accept Amp 78 Taper Tab



Double Edge Connector using 79/961-2 Contacts

SEE CINCH AT
Stand R.184 at the Instruments Electronics and Automation Exhibition, 23-28th May, 1960 at Olympia.

Cinch

Carr Fastener Company Ltd

STAPLEFORD, NOTTINGHAM.
197 GREAT PORTLAND STREET, LONDON, W.1
(Langham 3253)

AUTOMAT

High-Stability RECTIFIERS

TRANSFORMERS · D.C. EQUIPMENT

Specially designed to your requirements

SPEEDY DELIVERIES

Send now for your copy of Technical Bulletin 58/1

AUTOMAT · MOORSIDE · SWINTON · MANCHESTER · TEL · SWINTON 4242/4

Issued by Northworks Ltd

a new

STEREO HANDBOOK

by G. A. Briggs

Technical Editor R. E. Cooke, B.Sc. (Eng.)

Presents information on domestic stereo in a straightforward manner; relieved by humorous touches.

144 pages 88 illustrations
Fine art paper. Cloth bound

15 chapters including-Pickups, Loudspeakers, Amplifiers, Stereo Tapes, Recording Techniques, Record and Stylus Wear, Stereo Broadcasting, Room Acoustics, Concert Halls.

Published by

Wharfedale
WIRELESS WORKS LTD
IDLE BRADFORD YORKS

PRICE 10/6
(Post paid 11/6)

Telephone: Idle 1235/6

Grams.: 'Wharfdel' Idle Bradford

ATTENTION:

OWNERS OF TAPE RECORDERS

Here is an opportunity to learn foreign languages with your tape recorder. Full elementary courses in Italian, Spanish, German, French and Russian. Full recorded tape together with instruction book 29/6.

Trade enquiries invited

Please apply for explanatory leaflets to your nearest retailer or direct from

FISHER ELECTRONICS CO. LTD.,
NATIONAL HOUSE,
WARDOUR STREET, LONDON, W.1.
Telephone: REG 7597

The Ferranti 3 DIGIT VOLTMETER Type D101

The need for instruments capable of measuring voltages with a high degree of accuracy and with a fast reading time has long been apparent. The Ferranti 3 digit voltmeter has been developed to meet this requirement. The advantages of this precision instrument will undoubtedly prove attractive to those engaged in the fields of automatic testing and monitoring, analogue to digital conversion, calibration of moving pointer instruments and many similar applications.

Special Features

- Automatic Ranging and Polarity
- High Accuracy and Resolution
- Fast Reading Time
- Complete Reliability

SPECIFICATION

Display	Three digit plus automatic polarity indication and automatic decimal placement.
Automatic Ranges	D.C. Volts in 3 ranges 0.01 — 9.99 V 10.0 — 99.9 V 100V — 999 V
Accuracy	0.1% of full scale reading on any range.
Average Reading Time	0.7 seconds.
Input Impedance at Balance	10 Megohms.
Input	110 — 250V A.C.50—60 c/s 50W.
Weight	50 lbs. approximately.
Style	Bench cabinet 17" x 13" x 10½" high with optional brackets for standard rack mounting.

In view of continuing development, the right is reserved to alter the specification or design of this instrument.

FERRANTI LTD · FERRY ROAD · EDINBURGH 5

Telephone: DEAn 1211

ES/T64

Wireless World

ELECTRONICS, RADIO, TELEVISION

MARCH 1960

Managing Editor:

HUGH S. POCOCK, M.I.E.E.

Editor:

F. L. DEVEREUX, B.Sc.

Assistant Editors:

H. W. BARNARD

T. E. IVALL

VOLUME 66 NO. 3

PRICE: TWO SHILLINGS

FORTY-NINTH YEAR OF PUBLICATION

Offices: Dorset House, Stamford Street, London, S.E.1

Please address to Editor, Advertisement Manager, or Publisher, as appropriate

PUBLISHED MONTHLY (4th Monday of preceding month) by ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1. *Telephone:* Waterloo 3333 (65 lines). *Telegrams:* "Ethaworld, Sedist, London." *Annual Subscriptions. Home and Overseas,* £1 15s. 0d. *Canada and U.S.A.,* $5.00. Second-class mail privileges authorised at New York, N.Y. BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2. *Telephone:* Midland 7191. *COVENTRY:* 8-10, Corporation Street. *Telephone:* Coventry 25210. *GLASGOW* 26B, Renfield Street, C.2. *Telephone:* Central 1265. *MANCHESTER:* 260, Deansgate, 3. *Telephone:* Blackfriars 4412. NEW YORK OFFICE: *U.S.A.:* 111, Broadway, 6. *Telephone:* Digby 9-1197.

FRAME GRID VALVES FOR TELEVISION 6

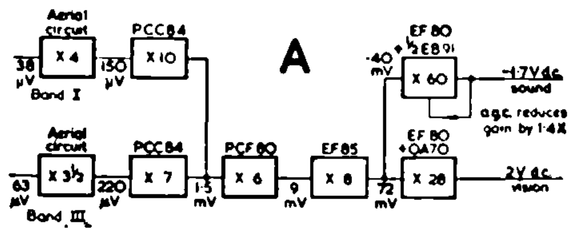
With a suitable valve line-up, receivers with two i.f. stages can be designed for various degrees of improved performance. Frame grid valves can be used throughout the tuner and i.f. stages, or some conventional valves can be retained, depending on the sensitivity required. Two classes of receiver satisfy all U.K. requirements: one for good signal strength areas, and a more sensitive receiver for difficult areas.

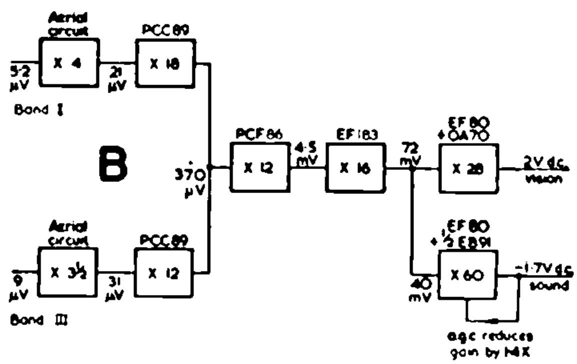
Reception is practicable at vision carrier levels down to 20μV r.m.s., with enough gain to give 2V d.c. at the detector. To ensure this sensitivity and to allow for deterioration, a fringe receiver should be designed round a nominal sensitivity of 10μV.

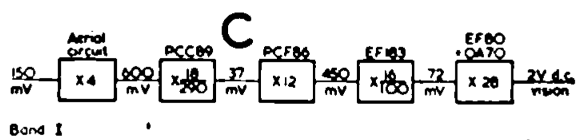
Signal levels in a conventional receiver are shown on line-up 'A'. The Band III sensitivity of 63μV falls short of the 10μV requirement by 16dB. Since frame grid valves have a gain advantage of about 6dB over conventional valves, this deficiency can be made up by the use of three frame grid valves.

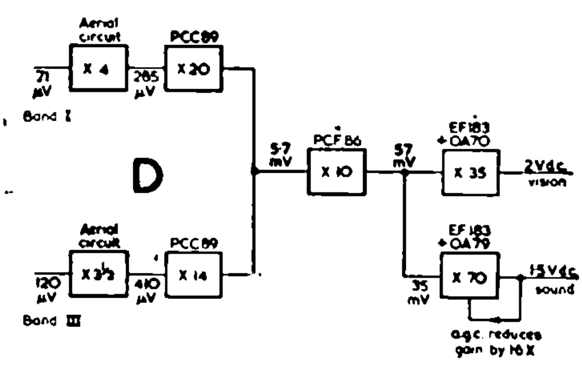
The PCC89 gives improved gain, it has a better noise factor than the PCC84, and it can handle an input signal five times greater without cross-modulation. Thus one of the frame grid valves is used in the r.f. amplifier. The other two should be in stages which are common to sound and vision, so that maximum benefit can be obtained. In line-up 'B' the PCF86 is used in the mixer and the EF183 in the common i.f. stage. The EF80 is retained in the separate i.f. stages. The most severe requirements are met, and the maximum usable gain for low signal levels is provided. In normal service areas, the gain is reduced by a.g.c. for large signals, as shown for Band I at 'C'. Rather greater signals than 150mV can be handled.

A receiver for high signal strength areas does not require 10μV sensitivity, and all requirements can be met by receiver 'A'; but frame grid valves would give the required gain with one less i.f. stage. Line-up 'D' uses the same tuner as the high-sensitivity receiver; but there is no common i.f. stage, and the EF183 is used instead of the EF80. The performance shown is for maximum sensitivity. A signal of 225V r.m.s. can be handled. All normal service area requirements are met, and the receiver is economically attractive. The EF184 can be used in place of the EF183, giving 2dB more gain; but the signal which can be handled is reduced.









"BELLING-LEE" NOTES

No. 14 of a Series

Some aspects of G

In the last issue we wrote that this rather big subject could best be dealt with under four headings, (1) Steady acceleration, (2) Vibration, (3) Shock, (4) Bumping and we dealt superficially with Steady acceleration which is generally considered to be in the region of say 20G.

Let us now look at Vibration which is a periodic phenomenon which may be expressed in cycles per second. In an aircraft the vibration of the structure varies considerably in different parts. It is likely to be of a complex nature due to variation of response to the many frequency components fed in e.g. four engines and buffeting of the control surfaces by the airstreams. It is similar to the diaphragm of a loudspeaker, except that in an aircraft there are many sources (or moving coils) feeding in vibrational energy. This energy contains many frequencies. Any one portion of the aircraft may respond to a few of the many frequencies giving appreciable vibration. For example, the larger amplitude vibration in the wing-tips or tail sections will have quite a different period from those experienced in the cockpit. You have only to move a cup of coffee to different parts of a table to see the different vibration patterns appear on the surface of the liquid.

Now these vibrations may affect any part of any equipment free to move and let us say here and now that the movement in an assumed rigidly constructed equipment, vibrated and viewed under stroboscopic light, has to be seen to be believed. But as component manufacturers we are more concerned with the behaviour of components. First of all, there are those whose design calls for resilience and these include plugs and/or sockets. Yes, a resilient plug can be made to vibrate violently in a socket. So the design must be such that this cannot happen at the mechanical frequencies at which the plug or socket is expected to operate, otherwise intermittent contact will result. Relays, of any kind, thermal delay switches and any component containing springs must be checked to ensure that they will not cease to function under the influence of vibration. Other hazards are fuses: where the fuse wire might have become embrittled through an overload, the element will sometimes fracture "under false alarm" through continued vibration at the right (or wrong) frequency.

We have mentioned vibrations set up in the frame of an aircraft, but of course we have also to consider vibrations peculiar to tanks, fighting vehicles and ordinary motor cars or lorries. Vibration tests are carried out on a piece of apparatus which is virtually a large moving coil loudspeaker energized by a low frequency amplifier capable of producing vibrations from 10 to 10,000 cycles per second.

Shock Test

Under this heading come the conditions brought about say in a crash landing of an aircraft, or a collision, or the firing of a gun. It is a very severe condition and may in unusual cases amount to something like 500/1,000G. Such a shock may be considered as an acceleration of the duration of a few milliseconds. Unless an equipment is designed to take the shock, the effect will most likely be catastrophic, as comparatively heavy components such as transformers would come adrift and carry all before them. Some anti-aircraft shells have a radar transmitter receiver incorporated in the nose cap, and this must survive the shock that drives the shell up to 50,000 feet.

Under the influence of shock, unretained fuses or valves will fly out of their holders and delicate mechanisms would be destroyed. The test rig for shocks is a device rather like a pile driver. A very heavy weight is used as the vehicle, this is lifted up to a predetermined height and allowed to fall freely. To ensure controlled results, the bottom of the weight or vehicle has a specially designed spike which plunges into a pot of solid lead which takes the part of the hard rubber in the bump test.

Bump Test

This is usually described as a succession of shocks of lesser magnitude. A bump test rig is generally a cam-operated device which lifts a "vehicle" of predetermined weight and allows it to drop freely on to a bed of hard rubber of known resistance. The frequency of operation can be controlled so that secondary shocks caused by bouncing are eliminated. It is an essential feature of such controlled tests, that the weight of the "vehicle" is heavy compared with the weight of the articles being tested.

The standard test delivers a series of bumps having a peak value of 38-42G.

The three articles on the Smith Chart by Mr. R. A. Hickson of this Company will be available in reprint form, and a copy will gladly be sent to readers of this column on request to Belling & Lee Ltd.

Advertisement of
BELING & LEE LTD.
Great Cambridge Road, Enfield, Middx.

"BELLING-LEE"

MINIATURE COAXIAL

Plugs & Sockets

L.1417/FP/Au or Ag.
MINIATURE FREE PLUG

L.1417/FS/Au or Ag.
MINIATURE FREE SOCKET

This is a miniature version of the coaxial connectors L.734/P and L.734/J, for use with cables having an outside diameter of 0.16 in. This connector has a robust cable clamp intended for use in miniaturized equipment where reliability is a prime consideration. Available with contact surfaces either gold-plated (/Au) or silver-plated (/Ag). They can be mated with the coaxial inserts in the miniature unitor range L.1391.

Max. Working Voltage: 200 V. d.c.
Voltage proof: 1,400 V. d.c.
Cable Size:
Outside dia. 0.16 in.
Max. dia. over outer conductor ⅛ in.
Max. dia. over inner conductor 0.033 in.
Finish:
Inner conductor, gold-plated brass.
Outer conductor, aluminium alloy.
Dielectric, P.T.F.E.
Circlip (L.1417/FS), Nylon.
Weight:
1.3 gm. (0.05 oz.).

L.1417/CS.
MINIATURE CHASSIS SOCKET

This socket accepts the plug L.1417/FP described above. It has a nylon circlip, insulated body, and the socket is available gold-plated (/Au) or silver-plated (/Ag). Weight 0.7 gm. (0.02 oz.).

Most "Belling-Lee" products are covered by patents or registered designs, or applications.

BELLING & LEE LTD
GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX, ENGLAND
Telephone: Enfield 3322 · Telegrams: Radiobel, Enfield

Aspects of design

20 EFFICIENCY DIODES FOR TV LINE OUTPUT STAGES

This is the Twentieth of a series of special features dealing with advanced problems in television and radio circuit design to be published by The Ediswan Mazda Applications Laboratory. We will be pleased to deal with any questions arising from this or other articles, the twenty-first of which will appear in the April 1960 issue.

During the line flyback interval the deflector coil current in a television line output stage executes slightly more than half a cycle of a cosine oscillation from a high value in one direction to a similar high value in the opposite direction. The purpose of the efficiency diode is to terminate the flyback interval by coming heavily into conduction shortly after the reverse peak of current is established. This conduction returns the energy in the coil to a storage capacitor where it serves to boost the HT supply and in so doing it provides the first part of the following scanning stroke.

In the course of the flyback oscillation the diode is subjected to a high peak voltage in the reverse direction. This, together with the heavy conduction at the beginning of the scanning stroke represents a very exacting condition of operation and every effort must be made to see that the limiting ratings are not exceeded.

In domestic television receivers the diode is generally used in the auto-transformer circuit of which the relevant part is shown in Fig. 1(a) (See also Aspects of Design No. 8). Occasionally, in special equipment, the diode may be connected to a separate winding on the line transformer, Fig. 2(a). The limiting ratings of the valve are published to cover both uses.

In the auto-transformer circuit, the diode anode is connected to the HT supply and during the flyback interval the cathode receives the high voltage positive pulse. During the whole of the scanning stroke the cathode usually remains at or near HT potential.

In most receivers the diode heater is connected near the high potential end of an a.c./d.c. series heater chain and in consequence the whole heater may swing as much as 300 volts positive and negative to chassis during the a.c. supply voltage cycle. These conditions are shown diagrammatically in Fig. 1(b).

If the diode is connected to a separate winding the working conditions are different. The diode cathode is connected to the boosted HT potential and during the flyback interval the diode anode receives a high voltage negative pulse. During the scanning stroke the diode anode is at or near boosted HT potential. Again the heater swings positive and negative of chassis potential during the supply voltage cycle. These conditions are shown diagrammatically in Fig. 2(b).

In order to explain the limiting ratings applying to this class of valve, consider the Ediswan Mazda U191. Here the relevant ratings are:

Max Peak Inverse Anode Voltage	(kV)	5.0	
Max Anode Current (mean)	(mA)	120	150
Max Anode Current (peak)	(mA)	600	450
Max Heater-Cathode Voltage (heater −ve, d.c.+peak a.c.)	(volts)	900	
Max. Heater-Cathode Voltage (heater −ve, pulse)	(kV)	5·0	
Max Heater-Anode Voltage (heater+ve, pulse)	(kV)	3·0	

These ratings should be considered from the point of view of 1) Current and 2) Voltage.

1. Current Ratings.

First consider the current ratings. These two ratings must be used together. If the working mode of the timebase is such that the peak to mean ratio of the diode current is 5·0 then a mean current of 120 mA and a peak current of 600 mA must not be exceeded. If however we are using a timebase with long diode conduction, as is usually the case in present-day European practice, the peak to mean ratio may be only 3·0 and a mean current of 150 mA and a peak current of 450 mA must not be exceeded.

2. Voltage Ratings.

Next consider the voltage ratings. A Maximum Peak Inverse Voltage of 5·0 kV is quoted. This is a Design Centre Rating and refers to Maximum Peak Voltage between anode and cathode in the reverse direction. An Absolute Maximum figure is also given for this rating. This must not be exceeded even under the most adverse conditions, i.e. high mains voltage, limit components, no synchronising signal and hold control at the most adverse end of its working range.

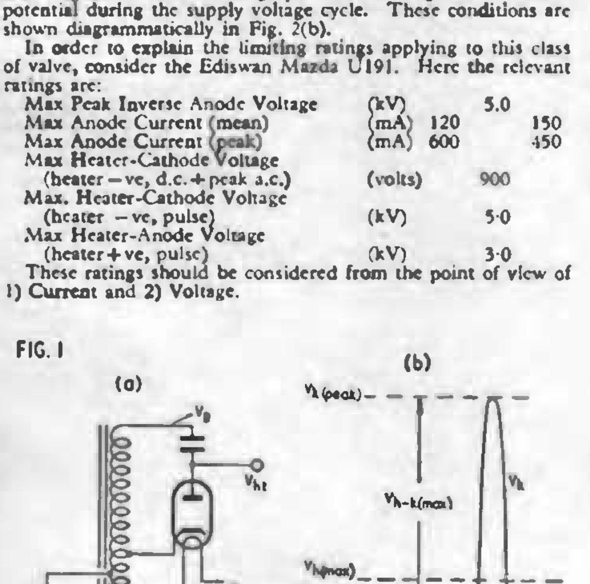
The Peak Inverse Anode-Cathode Rating is a fundamental feature of the valve but in efficiency diode circuits, unlike conventional rectifier circuits, it is rarely the rating which first imposes a limitation on the designer.

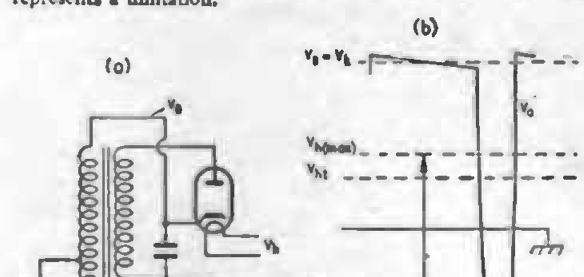
In auto-transformer connection the Maximum Heater-Cathode Voltage (pulse) with heater negative is more likely to set the limitation. This refers to potential difference between cathode when at the positive maximum of the flyback voltage and the heater when at the negative minimum of the supply voltage cycle (Fig. 1b). The table gives an absolute maximum value for this rating.

With the diode on a separate winding the most probable limiting factor is the Maximum Heater to Anode Voltage. This refers to the potential difference between the anode when at the negative peak of voltage during flyback and the heater when at the positive maximum of the supply voltage cycle. Now the valve is primarily designed with auto transformer operation in mind and the cathode is therefore connected to the top cap. This allows a higher voltage rating between cathode and heater than between anode and heater (Fig. 2b).

The rating Maximum Heater-Cathode Voltage (heater negative, d.c.+peak a.c.) is of greater consequence in the circuit of Fig. 2(a). As the cathode is connected to the boosted HT supply voltage, there is a high d.c. plus low frequency a.c. voltage between heater and cathode. The insulation requirements for this voltage stressing differ from those for pulse voltages, so a separate rating is given. In an auto-transformer circuit this rating refers to voltage between cathode and heater during the long forward stroke of the timebase but this rarely represents a limitation.

FIG. 1





Associated Electrical Industries Ltd
Radio and Electronic Components Division
Technical Service Department
155 Charing Cross Road, London, W.C.2
Tel: GERrard 8660. Grams: Sieswan, Westcent, London

EDISWAN MAZDA 10L14

The 10L14 is a VHF Twin Triode with separate cathodes, for use as RF Amplifier and Self Oscillating Mixer in FM broadcast a.c./d.c. receivers. The RF amplifier ensures a low noise input stage and reduces the radiation from the local oscillator. Great care has been taken in the design of this valve to provide effective internal screening between the two sections.

Heater Current (amps)	I_h	0.1
Heater Voltage (volts)	V_h	26

Tentative Ratings and Characteristics

MAXIMUM DESIGN CENTRE RATINGS

Anode Dissipation (either section) (watts)	$p_{a(max)}$	2.5
Total Anode Dissipation (watts)	$p_{(a'+a'')\,max}$	4.5
Anode Voltage (volts)	$V_{a(max)}$	250
Heater to Cathode Voltage (volts rms)	$V_{h-k(max)\,rms}$	90
Cathode Current (mA)	$I_{k(max)}$	15

INTER-ELECTRODE CAPACITANCES (pF)

Grid to Cathode, Heater and Shield (each section)	$c_{g-k,h,s}$	3.0
Grid to Anode (each section)	c_{g-a}	1.5
Anode to Cathode, Heater and Shield (each section)	$c_{a-k,h,s}$	1.2
Anode to Cathode (each section)	c_{a-k}	0.18
Anode' to Anode"	$c_{a'-a''(max)}$	<0.04

Inter-electrode capacitances measured in fully shielded socket.

CHARACTERISTICS (EACH SECTION)

Anode Voltage (volts)	V_a	170
Anode Current (mA)	I_a	10
Grid Voltage (volts)	V_g	−1.5
Mutual Conductance (mA/V)	g_m	6.2
Amplification Factor	μ	50

TYPICAL OPERATION AS RF AMPLIFIER

Supply Voltage (volts)	V_b	170	170
Anode Load (kΩ)	$R_{a'}$	1.5	1.3
Anode Voltage (volts)	$V_{a'}$	155	160
Anode Current (mA)	$I_{a'}$	8.7	6
Grid Bias Voltage (volts)	$V_{g'}$	−1.4	−2
Mutual Conductance (mA/V)	g_m	6	4.7
Valve Anode Resistance ($\delta v_a/\delta i_a$) (kΩ)	$r_{a'}$	8.4	10.5
Equivalent Grid Noise Resistance (Ω)	R_{eq}	500	650

TYPICAL OPERATION AS SELF OSCILLATING MIXER

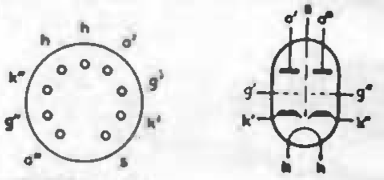
Supply Voltage (volts)	V_b	170	200
Anode Load (kΩ)	$R_{a''}$	4.7	8.2
Grid to Cathode Resistance* (MΩ)	$R_{g''-k''}$	1	1
Anode Current (mA)	$I_{a''}$	4.8	5.2
Peak Heterodyne Voltage (volts)	$V_{het(pk)}$	4	4
Conversion Conductance (mA/V)	g_c	2.2	2.3
Valve Anode Resistance ($\delta v_a/\delta i_a$) (kΩ)	$r_{a''}$	16	15

*IF feedback voltage tends to stabilise oscillator performance and permits this relatively high grid leak.

Note: It is recommended that the triode on pins 6, 7 and 8 should be used as the RF amplifier and that on pins 1, 2 and 3 as the self oscillating mixer.

BASE

B9A (NOVAL)

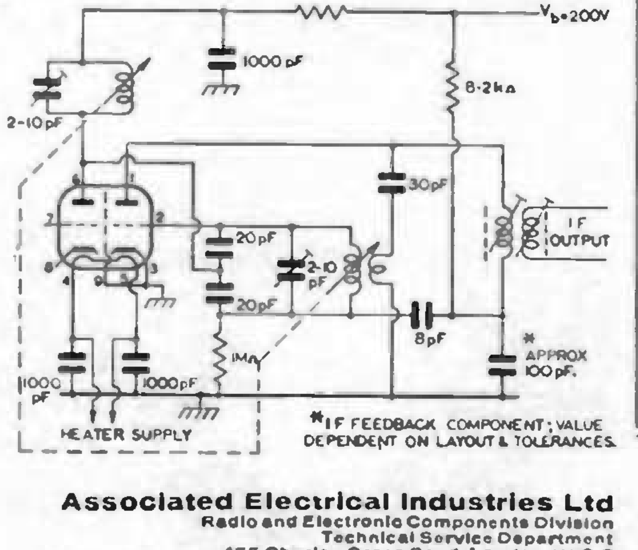


VIEW OF FREE END

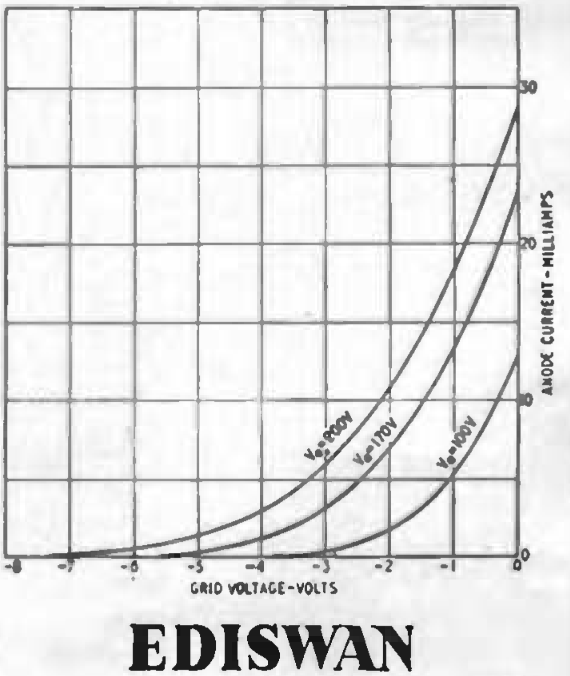
MAXIMUM DIMENSIONS (mm)

Overall Length	56
Seated Height	49
Diameter	22.2

Typical Circuit of 10L14 as Self-Oscillating Mixer



Characteristic curves of Ediswan Mazda Valve Type 10L14 (each section)



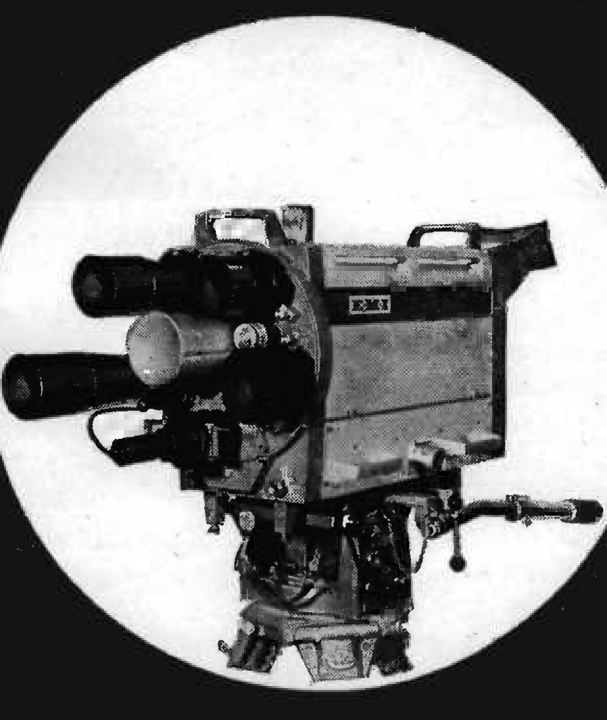
Associated Electrical Industries Ltd
Radio and Electronic Components Division
Technical Service Department
155 Charing Cross Road, London, W.C.2
Tel: GERrard 8660. Grams: Sieswan, Westcent, London

EDISWAN

MAZDA

CRC 15/53

For versatility in camera channels



E.M.I. ELECTRONICS LTD

The E.M.I. Camera Channel Type 203 is unique in possessing the following features:

* Designed to operate with 4½ inch Image Orthicon pick up tubes with the facility of rapid interchange to 3 inch Image Orthicon or C.P.S. Emitron pick up tubes if required.
* Five position turret including one special position providing facilities for: easy withdrawal of pick up tube through turret without opening camera sides; and mounting of diascope or non standard type of lens.

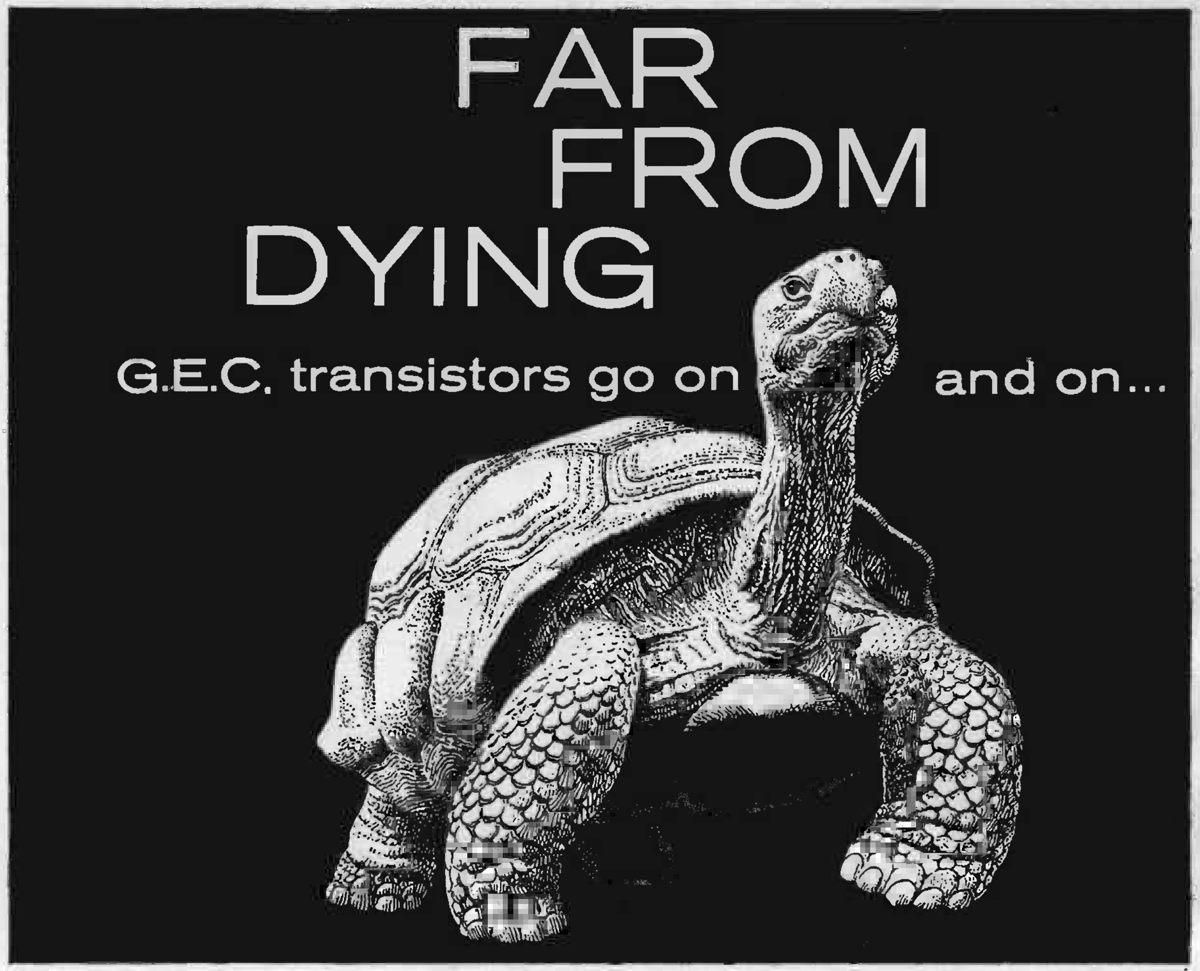
E.M.I.'s new 203

* Will accommodate TTH Studio Varotal or Zoomar Zoom lens without modification.
* Operation on any one of the following systems by simple change of plug connectors:
  625 lines to CCIR/OIR Standards
  525 lines to IRE/EIA Specifications
  405 lines to BBC TV80 Specification
* Extensive use of plug-in printed wiring units provides very good accessibility, and ease of maintenance.
* Special quality valves and high stability circuits eliminate need for adjustment over long periods of operation.
* Remote control of lens apertures by easily detachable servo mechanism.
* Optional preset filter wheel, electronic Image Orbiting and hour meter.

For full technical details, or for a demonstration, get in touch with us.

EMI

EE53



The Giant Tortoise—renowned for its longevity.

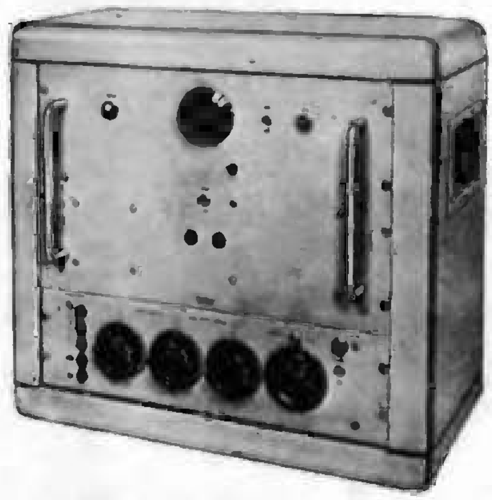
Vortexion
quality equipment

Model W.V.A.

TAPE RECORDERS

The W.V.A. tape recorder now has provision for Stereo plug in heads to enable this recorder to replay Stereo. The regular models are retained with additions and improvements. Our high standard which has made these recorders famous has been maintained, resulting in their being chosen for the foremost musical centre in this country.

120/200 WATT AMPLIFIER



Will deliver 120 watts continuous signal and over 200 watts peak Audio. It is completely stable with any type of load and may be used to drive motors or other devices to over 120 watts at frequencies from 20,000 down to 30 cps in standard form or other frequencies to order. The distortion is less than 0.2% and the noise level —95 dB. A floating series parallel output is provided for 100-120 V. or 200-250 V. and this cool running amplifier occupies 12½ inches of standard rack space by 11 inches deep. Weight 60lb.

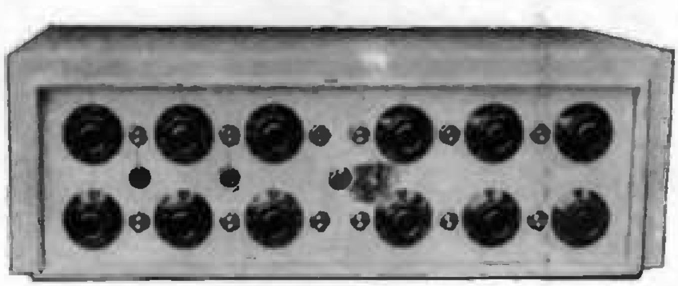
30/50 WATT AMPLIFIER

Gives 30 watts continuous signal and 50 watts peak Audio. With voice coil feedback distortion is under 0.1% and when arranged for tertiary feedback and 100 volt line it is under 0.15%. The hum and noise is better than—85 dB referred to 30 watt.

It is available in our standard steel case with Baxendale tone controls and up to 4 mixed inputs, which may be balanced line 30 ohm microphones or equalised P.U.s to choice.

12-CHANNEL ELECTRONIC MIXER

This is similar to the 4-channel, but is fitted with 12 hermetically sealed controls, 12 balanced line microphone transformers potted in mu-metal boxes, and a mains transformer also potted in mu-metal. All components which can affect noise are tested and selected before insertion. It is supplied in standard steel case or 7in. rack panel.

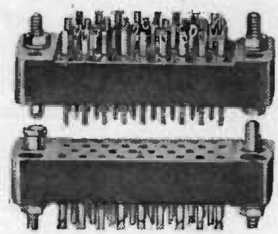


Full details and prices of the above on request

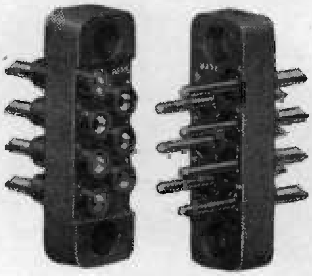
VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, London, S.W.19

Telephones: LIBerty 2814 and 6242-3 Telegrams: "Vortexion, Wimble, London."

HERMETIC SERIES



SUB-MINIATURE SERIES

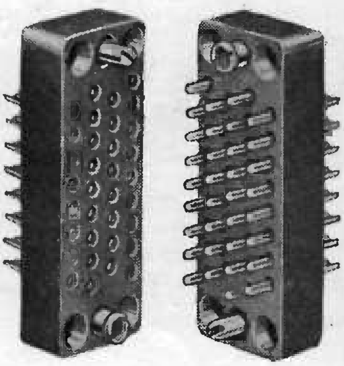


POWER SERIES

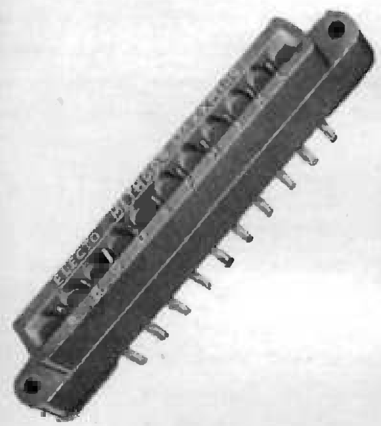
ELECTRO METHODS LTD

Electrical Connectors

* *Precision Mouldings*
* *Gold-plated Contacts*

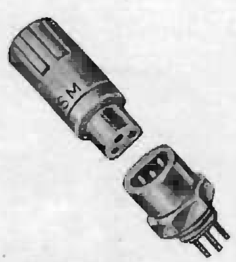


HEAVY-DUTY MINIATURE SERIES

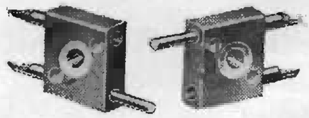


PRINTED-CIRCUIT SERIES

MINIATURE ROUND SERIES



SUB-MINIATURE ROUND SERIES



STACKABLE SERIES

Illustrated technical data sent on request:

ELECTRO METHODS LTD., Electrical Connector Division,

HITCHIN STREET, BIGGLESWADE, BEDS. : Telephone: Biggleswade 2086 (3 lines)

Amplifiers that are acclaimed throughout the world*

* *LEAK Amplifiers are the choice of professional engineers such as the B.B.C. (over 500 delivered), the South African Broadcasting Corporation (600), ITV and many other Commonwealth and Overseas broadcasting and TV systems, who use them for transmitting and/or monitoring the broadcasts to which you listen. Also many of the gramophone records to which you listen are cut via LEAK Amplifiers.*

Extract from Test Report by J. C. G. Gilbert reprinted from the Music Trades Review, also reprinted in our advertisement in the October issue of this magazine. The full two-page Test Report and an illustrated brochure on the amplifiers will be sent you on request.

The "Point-One Stereo" pre-amplifier is designed so that it can be used with any Leak monaural power amplifier or a combination of any two Leak monaural power amplifiers additionally to its more normal use with the "Stereo 20" or "Stereo 50."

"The Point-One Stereo" pre-amplifier is probably the most comprehensive unit in existence covering every requirement for stereo tape, disc and radio plus monaural amplification for any form of input signal . . . it is difficult to think of any additional requirement that one would ever wish. The equipment performs with the high performance always associated with the tradition of Leak equipment. It is a fine example of design and construction, and the pre-amplifier can be used with any other Leak main amplifiers. How the pre-amplifier can be sold for a little as £21 can be answered only by Harold Leak . . .

Summing up, therefore, one can highly recommend the Leak stereo system for use with any current monaural or stereo input whether it be from pickup, tape, radio or microphone."

Ask your Dealer to show you Leak Equipment.

Monaural

- VARISLOPE III PRE-AMPLIFIER
- TL/12 PLUS POWER AMPLIFIER
- SOUTHDOWN CABINET

TOTAL £55 : 13s.

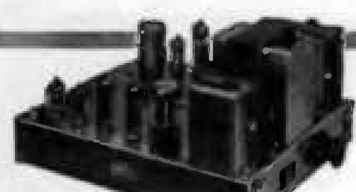
Stereo

- POINT-ONE STEREO PRE-AMPLIFIER
- STEREO 20 POWER AMPLIFIER
- SOUTHDOWN CABINET

TOTAL £72 : 9s.

TL/12 Plus Amplifier 18 gns.

Point-One Stereo Pre-Amplifier £21.



Stereo 20 Amplifier 29 gns.

LEAK

the first name in High Fidelity since 1934

H. J. LEAK & CO. LTD., BRUNEL RD., WESTWAY FACTORY ESTATE, LONDON, W.3

Telephone: SHEpherds Bush 1173/4/5. *Telegrams: Sinusoidal, Ealux, London.*

Please send me Test Report ☐

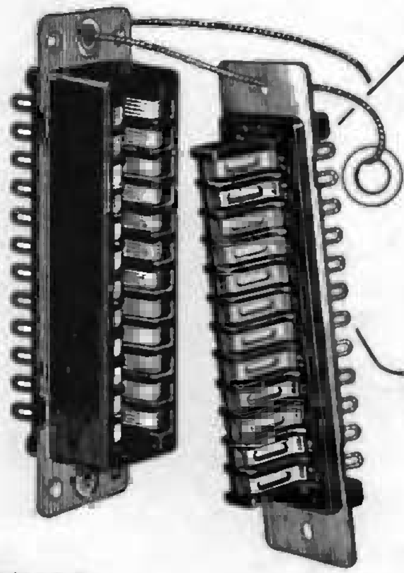
Brochures ☐

NAME ....

ADDRESS ....

....

.... WW 3/60



24 WAY CONNECTOR

McMURDO Red Range Connectors

- Gold plated Contacts
- Nylon loaded P.F. mouldings
- Easy insertion and withdrawal

8 WAY
16 WAY
24 WAY
32 WAY

Send for full technical information to

THE McMURDO INSTRUMENT CO. LTD., ASHTEAD, SURREY Telephone: ASHTEAD 3401

5650

The Inventor of the Sterophoner, Dr. Hermann Scherchen, the famous orchestral conductor.

Send for your Sterophoner now, while delivery is still from stock. If you wish you can order C.O.D. (2/- extra, U.K. only), or ask your local Radio Dealer to order and to connect it for you.

Demonstrations by appointment.

TRADE ENQUIRIES INVITED

Convert to STEREO REALISM

The "Symphony" STEROPHONER has caused a bigger stir in the Press and the Trade than even we anticipated. Many are whole-heartedly enthusiastic. Some remain unconvinced. And some bold grimly to the opinion that it is impossible!

But in audio matters, hearing is believing, and the facts are that while argument rages, more and more people every day are hearing the STEROPHONER for the first time, believing the evidence of their own ears, and even writing, uninvited, to tell us how pleased, delighted and astonished they are with results!

for only

£4.19.6

Plus cost of second loudspeaker

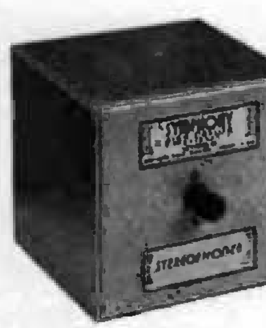
STEROPHONER

. . . gives a new realism and presence FROM ANY MONAURAL SOURCE, HI-FI AMPLIFIER, TAPE RECORDER, RADIO, RADIOGRAM. Satisfaction guaranteed. No maintenance required—lasts indefinitely.

Price only £4:19:6 plus postage 2/6.
Overseas £5:10:0 or $16:00 post paid.

For illustrated literature, reviews, reports, etc., send us a postcard mentioning this magazine.

Accredited dealers required for closed territories throughout Gt. Britain.



NORTHERN RADIO SERVICES (LONDON) LTD.

11 King's College Road, Swiss Cottage, N.W.3. Telephone: PRImrose 3314

BENTLEY ACOUSTIC CORPORATION LIMITED

The Valve Specialists — 38 CHALCOT ROAD, LONDON, N.W.1

Telephone: PRIMROSE 9090 — Nearest Underground: Chalk Farm

EXPRESS POSTAL SERVICE! ALL ORDERS DESPATCHED SAME DAY AS RECEIVED.
TELEPHONE AND TELEGRAM ORDERS FOR CASH ON DELIVERY SERVICE ACCEPTED UP TO 3.30 P.M.

ANY ORDER UP TO £10 INSURED AGAINST DAMAGE IN TRANSIT FOR ONLY 6d. EXTRA. ORDERS OVER £10 INSURED FREE

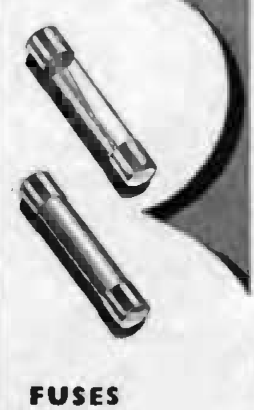
0A2 .. 17/6	6AM6 8/6	6L19 23/3	12AH8 12/6	30PL1 11/6	D77 .. 8/6	EC54 6/-	EF91 6/6	KT33C 10/-	PEN46 7/6	U31 .. 9/6	UL44 20/-
0B2 .. 17/6	6AQ5 8/6	6LD20 19/11	12AT6 7/6	35A5 21/3	DAF91 7/6	EC70 12/6	EF92 6/6	KT36 29/10	PL36 14/-	U33 .. 26/6	UL46 14/6
0Z4 .. 6/-	6AT6 8/6	6N7 .. 8/-	12AT7 6/-	35L6GT 9/6	DAF96 9/-	EC92 12/3	EF97 12/3	KT41 28/6	PL38 26/6	U35 .. 26/6	UL84 9/6
1A5 .. 6/-	6AU6 10/6	6P25 12/6	12AU6 23/3	35W4 7/6	DD41 13/11	ECC31 15/-	EK32 6/6	KT44 18/-	PL81 12/6	U37 .. 26/6	UM4 17/6
1A7GT 21/11	6AV6 12/7	6P28 20/6	12AU7 7/6	35Z3 10/6	DF66 15/-	ECC32 10/6	EL32 6/6	KT61 12/6	PL82 8/-	U43 .. 9/6	UM80 18/3
1C5 .. 12/6	6B8G 4/6	6Q7G 8/-	12AV6 12/7	35Z4 6/6	DF70 18/-	ECC33 8/6	EL33 12/6	KT63 7/-	PL83 9/-	U45 .. 9/6	UR1C 9/-
1D5 .. 9/-	6BA6 7/6	6R7G 10/-	12AX7 8/-	35Z5GT 8/-	DF91 6/-	ECC34 24/7	EL34 16/-	KT66 16/-	PL820 18/7	U50 .. 6/-	UU9 24/6
1D6 .. 10/6	6BE6 7/6	6SA7GT 8/6	12BA6 8/-	43 .. 12/6	DF96 9/-	ECC35 8/6	EL36 26/6	KTW61 6/-	PM24M 21/6	U52 .. 6/6	UY1N 16/7
1H5GT 11/-	6BG6G 28/6	6SL7GT 8/-	12BE6 10/-	50C5 12/6	DF97 9/-	ECC81 8/-	EL41 9/-	KTW62 6/-	PX4 10/6	U76 .. 6/6	UY21 16/6
1L4 .. 6/-	6BH6 6/-	6SN7GT 6/6	12BH7 21/6	50CD6G	DH63 8/-	ECC82 7/6	EL42 13/11	KTW63 6/-	PX25 39/9	U107 10/7	UY41 7/6
1LD5 6/-	6BJ6 7/6	6SQ7GT 8/-	12J7GT 10/6	38/6	DH76 6/6	ECC83 8/-	EL81 12/6	KTZ41 6/-	PY31 10/7	U191 10/7	UY85 7/-
1LN5 6/-	6BQ7A 15/-	6U4GT 12/6	12K8 17/11	50L6GT 8/6	DH77 6/6	ECC84 9/6	EL84 9/6	KTZ63 10/6	PY32 17/11	U251 14/-	VP4(7) 15/-
1N5GT 11/-	6BR7 23/6	6U5G 7/6	12K7GT 6/6	53KU 19/11	DK40 21/3	ECC85 8/6	EL85 13/11	LA2 .. 9/-	PY80 7/6	U281 19/11	VP4B 23/3
1R5 .. 7/6	6BW6 10/6	6V6G 7/-	12K8GT 10/-	72 .. 4/6	DK91 7/6	ECC88 23/11	EL91 6/-	MU14 9/-	PY81 9/-	U282 22/7	VP23 6/6
1S4 .. 9/-	6BW7 7/-	6V6GTG 8/-	12Q7GT 6/6	78 .. 8/6	DK92 10/6	ECF80 11/6	EL95 10/6	MX40 15/-	PY82 7/-	U301 21/6	VR105/30
1S5 .. 7/6	6BX6 7/-	6X4 .. 6/6	12SA7 8/6	80 .. 8/-	DK96 9/-	ECF82 10/6	EM34 10/-	N37 19/11	PY83 8/6	U329 14/-	9/-
1T4 .. 6/-	6C4 .. 7/-	6X5GT 6/-	12SK7 8/6	83 .. 15/-	DL64 15/-	ECH21 23/6	EM71 23/3	N78 19/11	PZ30 19/11	U339 16/7	VR150/30
1U4 .. 12/6	6C9G 6/6	6/30L2 10/-	12SQ7 12/6	83V .. 12/6	DL66 15/-	ECH35 8/6	EM80 9/6	N108 19/11	QP21 7/-	U404 8/6	9/-
1U5 .. 10/-	6CD6G 26/6	7B6 .. 21/6	14S7 27/10	85A2 18/-	DL92 7/6	ECH42 10/6	EM81 9/6	N308 20/7	QP25 15/-	U801 29/10	VT501 5/-
2X2 .. 4/6	6CH6 12/6	7B7 .. 8/6	19AQ5 10/6	150B2 18/-	DL94 7/6	ECH81 8/-	EM84 10/6	N339 29/10	QS150/15	UABC80 9/-	W76 .. 6/6
3A4 .. 7/-	6E5 12/6	7C5 .. 8/-	19BG6G 23/3	485BT 33/3	DL96 9/-	ECH83	EN31 37/-	OA70 4/-	10/6	UAF42 9/6	W77 .. 8/6
3A5 .. 10/6	6F1 .. 26/6	7C6 .. 8/-	20D1 15/3	185BTA 33/6	DL816 10/6	13/11	EY51 9/6	OA81 4/-	R12 .. 9/6	UB41 12/-	W81M 6/-
3B7 .. 12/6	6F6G 7/-	7H7 .. 9/-	20F2 24/6	807 .. 7/6	DM70 7/6	ECL80 10/6	EY83 16/7	OC71 16/-	R18 .. 14/-	UBC41 9/6	X81 .. 26/6
3D6 .. 6/-	6F12 6/6	7S7 .. 10/6	20L1 26/6	4033L 12/6	EA50 8/-	ECL82 10/6	EY86 10/-	OC72 17/-	R19 .. 18/11	UBC81 11/6	X41 .. 18/-
3Q4 .. 7/6	6F13 11/6	7Y4 .. 8/-	20P1 26/6	5763 13/6	EA76 8/6	ECL83 10/3	EZ40 7/6	PABC80	SD6 .. 15/-	UBF80 9/-	X61 .. 12/6
3Q5GT 9/6	6F32 10/6	8D3 .. 8/6	20P3 23/3	AC6PEN 7/6	EABC80 9/-	EF22 14/-	EZ41 7/6	13/11	SP41 3/6	UBF89 9/6	X63 .. 10/-
3S4 .. 7/6	6F33 7/6	9BW6 18/3	20P5 23/3	ATP4 5/-	EAC91 7/6	EF36 8/-	EZ80 7/-	PCC84 8/-	SP61 3/6	UCC84 16/7	X65 .. 12/6
3V4 .. 7/6	6G6 .. 6/6	10C1 12/-	25A6G 11/-	AZ31 10/-	EAF42 8/6	EF37A 8/-	EZ81 7/-	PCC85 9/6	SU25 30/6	UCC85 9/-	X66 .. 12/6
5R4GY 17/6	6H6GT 3/6	10C2 26/6	25L6GT 10/-	AZ41 13/11	EB34 2/6	EF39 6/6	FC4 15/-	PCC88 23/11	SU61 6/6	UCF80 16/7	X76M 14/-
5U4G 9/6	6J5G 5/-	10F1 17/6	25Z4G 9/6	B36 .. 24/7	EB41 6/6	EF40 15/-	GU50 28/-	PCC89 14/-	T41 .. 23/3	UCH42 9/6	X78 .. 21/3
5V4G 11/-	6J6 .. 5/6	10F9 10/6	25Z5 10/6	B142 7/6	EB91 5/6	EF41 9/6	GZ30 10/6	PCF80 8/-	TP22 15/-	UCH81 9/6	X79 .. 21/6
5Y3G 8/-	6J7G 6/-	10LD3 9/6	25Z6G 10/-	CBL31 23/3	EBC33 7/-	EF42 11/6	GZ32 15/-	PCF82 11/6	TP25 19/6	UCL82 11/6	XD(1.5) 6/6
5Z3 .. 12/6	6K6GT 8/-	10LD11	27SU 19/11	CCH35 23/3	EBC41 8/6	EF80(A) 7/-	GZ33 19/11	PCL82 15/6	TY86F 15/6	UCL83 15/3	XFG1 18/-
5Z4G 10/6	6K7G 5/-	19/11	28D7 7/-	CL33 10/3	EBC81 3/-	EF80(B) 8/-	GZ34 14/-	PCL83 11/6	U12/14 12/-	UF41 9/-	XFY12 8/6
6A8 .. 10/-	6K8G 8/-	10P13 15/6	30C1 8/-	CV63 10/6	EBF80 10/-	EF54 8/-	HABC80	PCL84 12/6	U16 .. 12/-	UF42 15/6	XFY34 17/6
6AB8 10/6	6K25 19/11	10P14 19/3	30F5 7/-	CY1 .. 18/7	EBF83 13/11	EF73 10/6	13/6	PEN36C	U18/20 9/-	UF80 10/6	XH(1.5) 6/6
6AC7 6/6	6L1 .. 23/6	12A6 6/6	30FL1 10/-	CY31 16/7	EBF89 9/6	EF50 7/-	HL23 10/6	10/6	U19 .. 30/-	UF85 10/6	Y63 .. 7/6
6AG5 6/6	6L6G 9/6	12AC6 15/3	30L1 8/-	D1 .. 3/-	EBL21 23/3	EF85 7/-	HVR2 20/-	PEN45 19/6	U22 .. 9/-	UF86 17/11	Z63 .. 10/6
6AK5 6/-	6L7GT 12/6	12AD6 17/3	30P12 8/-	D15 .. 10/6	EBL31 23/3	EF86 12/6	HVR2A 6/-	PEN383	U24 .. 29/10	UF89 9/-	Z66 .. 30/6
6AL5 6/6	6L18 12/-	12AE6 13/11	30P16 9/-	D43 17/6	EC92 5/6	EF89 9/-	KT2 5/-	23/3	U26 .. 10/-	UL41 9/-	Z77 .. 6/6

Terms of business:—Cash with order or C.O.D. only. Post/Packing charges 6d. per item. Orders over £3, post free. C.O.D. 2/6 extra. We are open for personal shoppers. Mon.-Fri. 8.30-5.30. Sats. 8.30-1 p.m.

Latest catalogue of over 1,000 different valves, also metal rectifiers, volume controls, electrolytic condensers, transistors, germanium diodes, valve holders, and Ilivac miniature valves, price 6d.

All valves new, boxed and subject to makers' full guarantee. First grade goods only, no seconds or rejects. Please enquire for any type not listed. S.A.E. please.

SPECIALISTS IN COMPONENTS



Fuselinks with glass or ceramic bodies provide a wide choice of characteristics, including those needed in electronic circuitry, in circuits carrying momentary surges or high prospective overloads, and in aircraft electrical equipment. Fuseboxes and fuseholders of many types are also available.

FUSES & FUSE HOLDERS

Regd.

BELLING & LEE LTD
GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX., ENGLAND

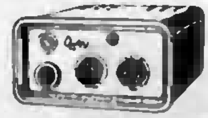
Telephone: Enfield 3322 · Telegrams: Radiobel, Enfield

TRANSISTORISED POWER AMPLIFIERS

PORTABLE, MOBILE, MAINS

FOR ALL RADIO, AMPLIFIER & SOUND INSTALLATIONS

ENQUIRIES:—



Audix

STANSTED, ESSEX. STANSTED 3132

VALVE BASES (Stems)

In Lead and Hard Glass

VALVE SLEEVES

QUARTZ CRYSTAL CONTAINERS

FILAMENTS (HEATERS) SINTERED OR UNSINTERED

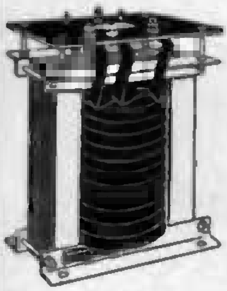
We specialise in short runs to customers' specifications. We invite your enquiries, also for other Glass Parts for the Electronics Industry.

DAY-IMPEX LIMITED

Progress Works, Brunel Road
Eastwood Industrial Estate, Southend-on-Sea, Essex
Telephone: EASTWOOD 525296/7

TRANSFORMERS

All for 240 V Input, other Supply Voltages as Required
CONTINUOUS RATING Short Rating Transformers also available



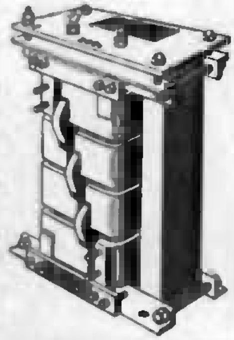
5 V 140 A	£11
110-120 V 10 A	£15
40 V 25 A	£15
5 V 300 A	£20
6-12 V 50 A	£10
12 V 60 A	£10
12 V 100 A	£16
50 V 60 A	£25
10-15-25 V 100 A	£26
6-12-18-24-30 V 12 A	£11
110 V Centre Tapped 55 V 25 A	£26
6-8-10-18-24 V 100 A	£32

EACH TRANSFORMER IN THIS GROUP
£8-10-0

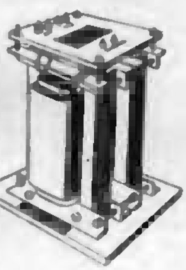
OUTPUTS

5 V	80 A
12 V	40 A
24 V	30 A
30 V	25 A
18 V	30 A
110-120 V	4 A
4 V	100 A
60 V	7 A
17.5 V	40 A
55 V	15 A

4 V 5,000 A	£100
2 V 10,000 A	£98
3.5 V 20,000 A	£127
2 V 30,000 A	£130
10 V 2,000 A	£103
10 V 1,000 A	£59
10 V 500 A	£38
10 V 750 A	£48
10 V 300 A	£28
10 V 900 A	£50
12 V 1,000 A	£64
15 V 1,000 A	£75
20 V 800 V	£80
5 V 1,000 A	£39



TRANSDUCTORS



Saturable Reactors for controlling AC currents up to 220 A 100 kVA. Available for all standard AC supply voltages. Single-phase and three-phase. Standard DC control volts: 12, 24, 36 110 and 240 V.

AUTO-TRANSFORMERS

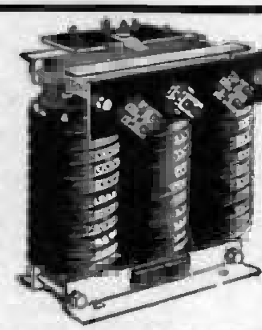
230-115 V 5 A	£8
250-240-230-220 120-115-110-105 V 12 A	£13
250-240-230-220-120-115-110-105 V 60 A	£35

HIGH-VOLTAGE TRANSFORMERS

4,250-4,750 V 25 mA	£14
2,050-4,000 V .5 A	£27
2,500-0-2,500 V 250 mA	£27
10 kV Ignition	£12

THREE-PHASE TRANSFORMERS

Input 400/440 V 40 V 60 Amps 3-Phase	£30
230 V 50 Amps 3-Phase	£78
110 V 100 Amps 3-Phase	£90
4 V 5,000 Amps 3-Phase	£130



These and other Transformers can be supplied for 3-phase, 6-phase and 12-phase Rectifiers.

CONSOLES

AC and DC Supply Units with infinitely variable or tapped output. Manual or remote control with full instrumentation. The Console illustrated has a stabilized 230 V AC supply as well as several low voltage heavy current sources. Each source is independent of the others but where called for, interlocking, and protection devices can be included.

VOLTMOBILE

VOLTAGE REGULATING AUTO-TRANSFORMERS

Range from zero volts to supply volts in 64 steps.
Change per step 1.6% ON LOAD SWITCHING.

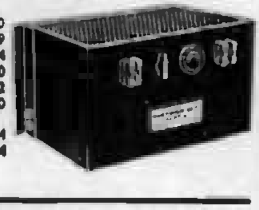
VOLTMOBILES can be used by themselves or in the primary of another transformer to give very fine changes of output.

	INPUT 240 V OUTPUT 0/250 V	INPUT 420 V OUTPUT 0/440 V
30 A	£32	£37
60 A	£62	£73
100 A	£98	£111

RECTIFIER SETS

For 200/250 V A.C. Also available for 3-phase supply

6.3 V DC 13 A	£13
12/25 V DC 12 A with Choke Regulator	£18
12 V DC 210 A	£110
24 V DC 20 A	£26
24 V DC 26A with stabilizer	£49
24 V DC 105 A	£110
34 V DC 10 A	£30
36 V DC 50 A	£51
110/120 V DC 10 A	£34
110/120 V DC 25 A	£60
200/250 V DC 6 A	£39
200/250 V DC 10 A	£44
200/250 V DC 18 A	£60
220 V DC 110 mA	£12
1,200 V DC 200 mA	£40
Fitted Ammeters and Voltmeters, per meter	£4
Built-in Rheostats	£4



SPECIFIC ENQUIRIES are invited for Transformers and Rectifiers. We specialize in HEAVY CURRENT EQUIPMENT.

HARMSWORTH, TOWNLEY & CO.
2 JORDAN STREET, MANCHESTER 15. CENTRAL 5069

New

ELAC speakers

RETAIL PRICE LIST

TYPE	FLUX	POWER RATING PEAK	PRICE	P'TAX
8 x 3G	6500g	2.5 WATTS	19/6	6/3
8 x 3C	8500g	2.5 WATTS	22/6	7/3
7 x 4G	6500g	3 WATTS	18/6	5/11
7 x 4C	8500g	3 WATTS	21/6	6/11
5G	6500g	3 WATTS	18/6	5/11
5C	8500g	3 WATTS	21/-	6/9

8" × 3"

7" × 4"

ELECTRO ACOUSTIC INDUSTRIES LTD., Stamford Works, Broad Lane, Tottenham, N.15

Tel: Tottenham 0505/9 (5 lines)

Tubes

Carr. & Ins. 12/6

GUARANTEED

MOST MULLARD, MAZDA, COSSOR, EMITRON, EMISCOPE, BRIMAR, FERRANTI TYPES PROCESSED IN OUR OWN FACTORY.

New Mullard, Mazda & U.S.A. tubes used.

NEW 108K (Equiv. 3/16) 59/-

	6 Months RE/ACUUMED	12 Months REGUNNED	12 Months NEW TYPES
9/10in.	£2-10-0	£4-10-0	MW 31/74 £6-10-0
12in.	£2-15-0	£4-17-6	
14in.	£3- 5-0	£5- 7-6	MW 36/24 £7-19-0
15/17in.	£4- 0-0	£6- 7-6	
21in.	£5- 0-0	£8- 5-0	MW 43/64 £8-15-0

13 CHANNEL TV's

TABLE MODELS, FAMOUS MAKES. Complete with all valves and tubes. These sets are unequalled in value due to huge purchase direct from source. They are untested and are not guaranteed to be in working order.

12" — £3. 19.

14" — £7. 10.

ALSO 12" 5 CHANNEL TV's

Complete Table Models including valves and tubes untested. 55/-

ALL CARRIAGE FREE

SINGLE RECORD PLAYERS

COLLARO 4-speed 4/546 ..	£8	19	0
GARRARD 4-speed 4SP	£7	7	6
GARRARD 4-speed TA MKII	£8	19	0
GARRARD 4-speed 4HF ..	£17	15	0
10 RECORD AUTOCHANGERS			
GARRARD RC120D MKII ..	£9	7	6
GARRARD RC121/4 MKII ..	£9	19	0
B.S.R. Monarch	£6	15	0
COLLARO CONQUEST	£7	15	0

B.S.R. TAPE DECKS £9/10/-

4-SPEED RECORD PLAYERS

Latest Turntable, together with lightweight Stax Galaxy dual sapphire crystal turnover pick-up head. Amazing value. (Pick-up only 19/-) £3/10/- Carr. 3/-

TRANSISTORS: RED SPOT 4/6

R.F., L.F. and Output up to 800 kc/s. 4/- each, in dozens. WHITE SPOT. R.F. and I.F. 2.5 Mc/s. 6/6. 69/- per dozen.

CO-AXIAL CABLE

Semi-air spaced, low loss. 30 yard drums 22/3, carr. 2/-. 6 drums 125/-, carr. 5/-.

RECTIFIERS: For Chargers—selenium, full wave bridge, 12 volt 3-4 amps., 9/6. Carr. 1/-. £5 per doz.

250 v. 60 mA., 5/-. RM1, 6/6; RM2, 8/-; RM3, 9/-; RM4, 15/6; RM5, 21/-. 14A86, 17/-; 14A97, 23/-; 14A100, 28/-.

100 CONDENSERS 10/-

A must for your spares box. A well-balanced assortment of miniature silver mica and ceramic condensers. 3-10,000 PF. List value over £5.

VALVES

BY RETURN OF POST

GUARANTEED 3 MONTHS

NEW LOW PRICES

10% DISCOUNT SPECIAL OFFER TO PURCHASERS of any SIX VALVES marked in black type (15% in dozens). Post: 1 valve, 6d.; 2-11, 1/-.

FREE TRANSIT INSURANCE. All valves are new or of fully guaranteed ex-Government or ex-equipment origin. Satisfaction or Money Back Guarantee on goods if returned unused within 14 days.

0Z4	8/-	6K8G	6/-	20P1	13/6	EB34	2/0	EN31	10/-	T41	7/6
1A7GT	12/6	6K8GT	11/-	20P3	12/6	EB41	7/-	EY51		U14	8/-
1C5GT	11/6	6K25	7/6	20P4	17/-	EB91	5/0	SMALL	9/-	U18	8/6
1H5GT	9/9	6L1	12/6	20P5	14/-	EBC33	6/-	EY86	9/-	U22	8/9
1L4	3/6	6L6	9/9	25A6G	6/-	EBC41	8/6	EZ40	7/3	U24	7/6
1N5GT	9/9	6L6G	7/6	25L6G	6/6	EBC81	7/9	EZ41	7/6	U25	12/6
1R5	6/9	6L7	9/-	25L6GT	9/-	EBF80	8/6	EZ80	6/9	U26	12/-
1S4	9/9	6L18	9/-	25Z4G	8/-	EBF89	8/9	EZ81	7/6	U31	8/6
1S5	6/-	6L19	11/6	27SU	16/-	EBL21	10/-	GT1C	7/-	U33	11/-
1T4	4/9	6LD20	8/6	30F5	7/-	EBL31	16/-	GZ32	8/9	U35	9/6
2D21	4/6	6P25	9/-	30FL1	9/6	EC53	8/6	GZ34	12/6	U37	20/6
3A4	5/6	6P28	9/-	30P4	12/6	ECC31	6/6	HABC80	9/6	U50	6/6
3Q4	7/6	6Q7G	6/9	30P12	8/-	ECC33	4/-	HL41DD	9/6	U52	6/6
3S4	6/6	6Q7GT	9/3	30PL1	10/6	ECC34	9/-	HVR2	7/6	U191	9/6
3V4	7/6	6SA7	5/6	35L6GT	9/-	ECC35	6/6	KT33C	6/6	U281	9/6
5R4G	12/-	6SG7	4/9	35W4	6/6	ECC81	6/-	KT36	9/-	U282	12/-
5U4G	6/6	6SH7	4/6	35Z4GT	6/-	ECC82	6/6	KT44	9/6	U301	14/-
5V4G	9/-	6SJ7	6/-	50CD6G	16/-	ECC83	7/6	KT45	8/6	U309	12/6
5Y3G	6/-	6SK7	5/3	50L6GT	8/3	ECC84	8/9	KT61	9/-	U329	12/6
5Y3GT	6/6	6SL7GT	6/6	615PT	11/-	ECC85	8/3	KT66	12/6	U339	11/-
5Z4G	8/6	6SN7GT	4/6	80	6/6	ECF80	10/3	KT81	14/-	U403	9/6
5Z4GT	11/-	6SQ7	8/3	90AV	4/6	ECF82	8/6	KTW61	6/6	U801	17/-
6A8G	9/6	6SS7	6/6	185BT	16/-	ECH21	14/-	KTW63	6/6	UABC80	8/6
6AC7	4/6	6U4GT	10/6	807A	6/-	ECH35	7/6	KTZ63	6/9	UAF42	8/-
6AG5	4/3	6V6G	5/6	807E	6/6	ECH42	8/9	MU14	8/-	UB41	8/-
6AG7	8/6	6V6GT	6/9	953	6/6	ECH81	8/3	N37	11/-	UBC41	8/6
6AK6	6/9	6X4	6/-	956	2/6	ECL80	8/3	N78	15/-	UBC81	10/-
6AL5	5/6	6X5G	5/6	2063	8/6	ECL82	10/-	P41	4/6	UBF80	8/6
6AM6	3/6	6X5GT	5/6	9001	4/-	ECL83	14/6	P61	2/3	UBF89	8/6
6AQ5	6/-	7B6	9/6	9003	4/-	EF22	12/-	PABC80	11/-	UBL21	14/6
6AT6	7/-	7B7	7/6	ATP4	2/9	EF36	3/6	PCC84	7/9	UCH21	14/6
6AU6	8/6	7C5	7/9	AZ31	9/-	EF39	4/3	PCC85	9/3	UCH42	8/6
6B8G	2/6	7C6	7/3	B36	6/6	EF40	12/6	PCC88	12/9	UCH81	9/-
6BA6	6/-	7H7	7/6	B65	6/6	EF41	8/9	PCF80	7/6	UCL82	11/9
6BE6	6/6	7S7	8/6	CBL31	23/3	EF42	7/6	PCF82	8/6	UCL83	13/6
6BG6G	12/6	7Y4	7/6	CY31	9/6	EF8-BRI	[illegible]	PCL82	9/3	UF41	6/6
6BW6	8/6	10C1	11/-	D63	1/6	EF50-ARM	2/6	PCL83	11/6	UF42	7/9
6BW7	7/-	10C2	13/6	DA90	8/6	EF54	3/6	PCL84	9/9	UF80	9/-
6C4	6/6	10F1	6/9	DAC32	9/9	EF80	6/9	PEN25	4/6	UF85	9/-
6C6	4/3	10F9	10/3	DAF91	6/-	EF85	7/-	PEN45	7/3	UF86	14/6
6C9	9/6	10P13	8/6	DAF96	8/3	EF86	11/-	PEN46	6/3	UF89	7/6
6CD6G	12/6	10P14	9/6	DF33	9/9	EF89	8/-	PL33	9/-	UL41	7/6
6CH6	9/3	12AH8	9/9	DF91	6/-	EF91	3/9	PL36	12/-	UL44	12/6
6D6	4/6	12AT6	7/9	DF96	8/3	EF92	4/9	PL38	14/6	UL46	9/6
6F1	6/9	12AT7	6/-	DH77	7/-	EL32	4/9	PL81	10/6	UL84	8/-
6F6G	6/3	12AU7	6/6	DK32	12/6	EL33	6/-	PL82	7/6	UM80	9/6
6F13	6/9	12AX7	7/6	DK91	6/9	EL35	11/6	PL83	8/-	UU6	12/6
6F14	8/6	12J5GT	3/6	DK92	8/6	EL37	11/6	PL84	11/-	UU7	9/6
6F15	9/6	12K7GT	6/-	DK96	8/3	EL38	12/6	PY31	8/9	UY1N	11/-
6H6	3/-	12K8GT	11/-	DL33	8/6	EL41	8/-	PY32	11/-	UY41	6/6
6J5G	3/6	12Q7GT	6/-	DL35	11/6	EL42	8/6	PY80	7/-	UY85	7/-
6J5GT	3/6	12SK7	6/6	DL91	8/6	EL84	8/-	PY81	7/-	VR100/30	[illegible]
6J6	4/-	12SN7GT	8/6	DL92	6/6	EL91	4/9	PY82	7/-	X65	11/-
6J7G	8/3	14S7	14/6	DL94	7/6	EM34	8/6	PY83	8/-	X66	11/-
6J7GT	7/6	19BG6G	16/-	DL96	8/3	EM80	8/6	PZ30	16/-	X78	14/6
6K6GT	6/6	20D1	8/6	EA50	2/-	EM81	8/3	R19	12/6	X79	18/6
6K7G	2/3	20F2	8/6	EABC80	7/6	EM84	8/9	SP41	3/6	Y63	6/3
6K7GT	5/-	20L1	9/6	EAF42	8/6	EM85	10/6	SP61	2/6	Z66	7/6

Post: 2 lbs. 1/6, 4 lbs. 2/-, 7 lbs. 2/9, 15 lbs. 3/6. No C.O.D.
List of 1000 Special Offers 6d. Callers always welcome.

TECHNICAL TRADING CO.

350-352 FRATTON ROAD, PORTSMOUTH

Cooper-Smith

HIGH FIDELITY AMPLIFIERS

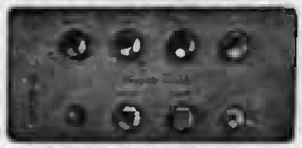
REALISTIC SOUND— REALISTIC PRICES!

SUPPLIED DIRECT TO HI-FI ENTHUSIASTS ALL OVER THE WORLD

GUARANTEED 3 YEARS

LABORATORY BUILT OR IN DO-IT-YOURSELF KIT FORM

STEREO/MONAURAL



MAIN AMPLIFIER

6W. Per Channel Distortion 0.15% Freq. 30-30K c.p.s. Hum and Noise —80dB. Output Imp. 3Ω, 8Ω, and 15Ω.

BUILT £15 15 0
KIT.................... £12 12 0

CONTROL UNIT

Inputs: Gram (3mV.) Radio Tape (100mV.) Hum and Noise —70dB. Also suitable for use with two B.P.I.

BUILT £18 0 0
KIT £13 13 0

MODEL B.P.I. 10-12 WATT AMPLIFIER

Freq. 30-30K c.p.s. Distortion 0.1%. Hum and Noise —80dB. Output Imp. 3Ω. 15Ω

BUILT £14 5 0
KIT.................... £12 5 0

CONTROL UNIT Mark II

Inputs: Gram (3mV.) Mic. (1.5 mV.) Radio and Tape (100mV.). Hum and Noise —70dB. Switched Filter.

BUILT £10 17 6
KIT.................... £7 17 6

"BANTAM" 3-4 W. INTEGRATED AMP. & CONTROL UNIT

Bass and Treble Controls. Spare Power: 250V. 40mA. 6.3V. 2A. O.I. 3Ω. 15Ω.

BUILT £8 5 0
KIT.................... £7 10 0

"PRODIGY" 6-8 W INTEGRATED AMP. & CONTROL UNIT

Distortion 0.15%. Inputs Gram. Radio, Tape, Spare Power 250V. 40mA. 6.3V. 2A. O.I. 3/8/15Ω.

BUILT £16 15 0
KIT.................... £12 10 0

Full details and stage-by-stage building instructions 2/6 each, post free ("Bantam" 1/6) or free with each unit.

H. L. SMITH & CO. LTD. 287-289 EDGWARE RD., LONDON, W.2. Telephone: PAD 5891-7595

C.C.GOODWIN (SALES) LTD

WORLD WIDE EXPORTERS

AMPLIFIERS · TUNERS · SPEAKERS · MOTORS · PICK-UPS

★ OVERSEAS ORDERS SENT FREE OF PURCHASE TAX AND SHIPPED PROMPTLY AT MINIMUM COST ★

U.S.A. & CANADA EXPORT EXAMPLES			PACKED INSURED & CARRIAGE PAID
	DECCA Stereo pick-up with arm type fiss	$46.20 (£16/9/6)	
	GARRARD 301 transcription motor with Stroboscope	$56.00 (£19/19/6)	
	LEAK TL12 Plus Amp. with Varislope III	$104.50 (£37/7/6)	

Reduced transit rates for British and Allied Forces Overseas.
Enquiries welcomed for all types of Hi-Fi Equipment.

(Dept. W.6.) 7, THE BROADWAY, WOOD GREEN, LONDON, N.22 Tel. BOWes Park 0077/8.

THE ONLY

SUB-MINIATURE
"3000 TYPE" RELAY

Made in England

The Hopwood—Par Type P3 relay, although miniature retains every possible feature of the "3000 Type" plus ceramic insulation and hermetic sealing.

It can have up to 6 poles; twin or HD contacts and tags for PRINTED CIRCUITS.

Sole Distributors
D. ROBINSON and COMPANY
7/7 LONDON ROAD, HOUNSLOW, MIDDLESEX.

Telephone: HOUnslow 6266/7 & 8336

WRITE FOR LIST WJ

C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit and for C.R. Tubes with failing emission. Full instructions supplied.
Type A. Low Leakage windings. Optional Boost 25% and 50%. Tapped mains primaries.

2 volt	12/6 each
4 volt	12/6 each
6.3 volt	12/6 each
10.8 volt	12/6 each
13.3 volt	12/6 each

OUR LATEST SUPERIOR PRODUCT. Type A2. High Quality. Low capacity. 10/16pf. Optional boost 25%, 50%, 75%. **16/6** each

Type B. Mains input. Low capacity. Multi Output 2, 4, 6.3, 7.3, 10 and 13 volts. Optional boost 25% and 50%. Suitable for all Cathode Ray Tubes. 21/-.

RESISTORS. All preferred values. 20% 10 ohms to 10 meg. ¼ w., 4d.; ½ w., 4d.; 1 w., 6d.; 1½ w., 8d.; 2 w., 1/-. HIGH STABILITY. ½ w., 1%, 2/-. Preferred values 100Ω to 10 meg. Ditto 5%, 9d., 100Ω to 5 meg.

5 watt / 10 watt / 15 watt — WIRE-WOUND RESISTORS 25 ohms—10,000 ohms — 1/3 / 1/6 / 2/-
15,000 ohms—50,000 ohms 5 w., 1/9; 10 w. 2/3

WIRE-WOUND POTS, 3 w. Pre-set Min. T.V. type Knurled Slotted knob. All values 25 ohms to 25 K., 3/- ea., 30 K., 50 K., 4/-. Ditto, ¼ w. Carbon Track 50 K. to 2 Meg., 2/-.

WIRE-WOUND POTS, 4 w. Standard size Pots, long Spindle High Grade. All values 100 ohms to 50 K., 6/6; 100 K., 7/6. W/W EXT. SPEAKER CONTROL 10Ω 3/-.

O/P TRANSFORMERS. Heavy Duty 50 mA. 4/6. Multi-ratio push-pull, 7/6. Miniature 3V4, etc., 4/6. Hygrade Push-pull 10 watts, 15/6. MULLARD "510" 6k or 8k 30/-. L.F. CHOKES 15/10H 60/65 mA., 5/-. 10H 85 mA., 10/6. 10H 150 mA., 14/-.

MAINS TRANSFORMERS 200/250 v. A.C.

STANDARD 250-0-250, 80 mA., 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a. tapped. 5 v. or 4 v. 2 a. Ditto 350-0-350 .... 22/6
MINIATURE 230 v. 20 mA., 6.3 v. 1 a. 10/6
MIDGET, 250 v. 45 mA., 6.3 v. 2 a. 15/6
SMALL, 260-0-260 100 mA., 6.3 v. 3.5 a. 19/6
STANDARD, 250-0-250, 65 mA., 6.3 v. 3.5 a. 17/6
HEATER TRANS., 6.3 v. 1½ a., 7/6. 3 amp. 10/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 A. 22/6

ALADDIN FORMERS and cores, ¼in., 8d.; ⅜in., 10d. 0.3in. FORMERS 5937 or 8 and Cans TV1 or 2, ½in. sq. x 2⅛in. or ⅝in. sq. x 1¼in., 2/- with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
TYANA. Midget Soldering Iron, 230 v. 40 w., 16/9.
REMPLOY INSTRUMENT IRON. 230 v. 25 w., 17/6.
MAINS DROPPERS. 3 x 1¼in. Adj. Sliders. .3 amp. 1,000 ohms, 4/3. .2 amps., 4/3. .1 amp 2,000 ohms, 5/-.
LINE CORD. .3 amp., 60 ohms per foot. .2 amp., 100 ohms per foot, 2 way, 6d. per foot. 3 way, 7d. per foot.

CRYSTAL MIKE INSERT by Acos 6/6

Precision engineered. Size only 1 x 1⅛in.
ACOS CRYSTAL DESK MIKE. Bargain 35/-.

MIKE TRANSF. 50 : 1, 3/9 ea.; 100 : 1 Potted, 10/6.
LOUDSPEAKERS P.M. 3 OHM. 5in. Rola, 17/6. 8in. x 4in. Rola, 18/-. 7in. x 4in. E.A., 21/-. 10in. x 6in. Rola, 27/6. 8in. Plessey, 19/6. 6½in. Rola, 18/6. 4in. Rola, 21/-. 10in. E.A., 30/-. HI-FI TWEETERS, 4in., 25/-. 12in. Plessey, 30/-. 12in. Baker 15 wt. 3 ohm and 15 ohm models, 105/-. 12in. Baker foam suspension 12 w, 15 ohm, £8. 12in. 15 ohm Plessey 10 wt., 45/-.

I.F. TRANSFORMERS 7/6 pair

465 kc/s, slug tuning miniature can 2⅛ x 1 x 1in. High Q and good bandwidth. By Pye Radio. Data sheet supplied.
Wearite M800 I.F. Miniature 465 kc/s, 12/6 pair.
Wearite-550 I.F. Standard 465 kc/s., 12/6 pair.

CRYSTAL DIODE G.E.C., 2/-. GEX34, 4/-. 40 Circuits, 2/-.
H.R. HEADPHONES, 4,000 ohms, brand new, 15/6 pair.
SWITCH CLEANER Fluid, squirt spout, 4/3 tin.
TWIN GANG CONDENSERS. 365 pf Miniature, 1⅜in. x 1⅜in. x 2⅛in., 10/-. .0005 Standard with trimmers, 9/-; less trimmers, 8/-. Midget, 7/6; Single 50 pf., 2/6; 100 pf., 150 pf., 7/-. Solid dielectric 100, 300, 500 pf., 3/6.
VALVE HOLDERS. Paz int. Oct., 4d. EF50, EA50, 6d. B12A, CRT, 1/3. Eng. and Amer., 4, 5, 6, 7 pin, 1/-.
MOULDED Mazda and Int. Oct. 6d., B7G, B8A, B9G, B9A, 9d. B7G with can, 1/6; B12A, 1/3. B9A with can, 1/9.
CERAMIC, EF50, B7G, B9A, Oct., 1/-; B7G, B9A Cans, 1/-.
SPEAKER FRET. Gold Cloth 17in. x 25in., 5/-. 25in. x 35in., 10/-. Tygan 54in. wide, 10/- ft. 27in. wide, 5/- ft. Samples, S.A.E.

WAVECHANGE SWITCHES.
2 p. 2-way, 2 p. 2-way, short spindle 2/6
3 p. 4-way, 2 wafer, long spindle 3/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle 3/6
1 p. 4-way, 1 p. 12-way, long spindle 3/6
Wave change "MAKITS" 1 wafer 8/6; 2 wafer, 12/6; 3 wafer 16/-; 4 wafer 19/6; 5 wafer 23/-; 6 wafer 26/6.
TOGGLE SWITCHES. S.P., 2/-; D.P., 3/6; D.P.D.T., 4/-.
MORSE KEYS, good quality, 2/6.
SUB-MINIATURE ELECTROLYTICS (15 v.), 1, 2, 4, 5, 8, 25, 50 mfd., 100 mfd., 3/- each.

EDISWAN TRANSISTORS JUNCTION TYPE P.N.P.

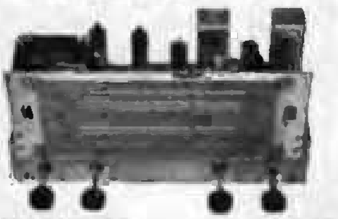
AUDIO XB102, for amplifiers and output stages up to 250 milliwatts in push-pull. PRICE **10/-**

R.F. XA104 frequency changer up to 6 Mc/s. **18/-**

XA103 IF amp. etc. up to 2 Mc/s. **15/-**

Goltop Power V15/10P, up to 10W with heat sink, 20/-.

1960 RADIOGRAM CHASSIS



THREE WAVEBANDS — FIVE VALVES
S.W. 16 m.—50 m. — LATEST MULLARD
M.W. 200 m.—550 m. — ECH81, EF89, EBC41,
L.W. 800 m.—2,000 m. — EL84, EZ80.

12 month Guarantee. A.C. 200/250 v. 4-way switch. Short-Medium-Long-Gram. A.V.C. and Negative Feedback, 4.2 watts. Chassis 13½in. x 5½in. x 2¼in. Glass Dial Size 10 x 4½in. horizontal or vertical. Two Pilot Lamps. Four Knobs. Walnut or Ivory. Aligned and calibrated. Chassis isolated from mains.

BRAND NEW £9. 10. 0. Carr. 4/6.

TERMS: Deposit £5/5/- and 6 monthly payments of £1. MATCHED SPEAKERS 8in. 17/6; 10in. 25/-; 12in. 30/-.

DULCI FM-AM MODEL H3

Six Mullard Valves, ECC85, ECH81, EF89, EABC80, EL84, EZ80. V.H.F. 105-97 Mc/s, Med. 190-550 m. Long 1000-1,900 m. Gram input. Ready for use. A.C. Mains 200-250 v. Isolated chassis. Output point for use as Hi-Fi Tuner. 12 month guarantee. Circuit supplied. Leaflet S.A.E.

£19. 17. 6.

★ GARRARD 4-SPEED RECORD CHANGERS RC121/D MKII MODELS ★

Brand new and fully guaranteed 12 months.

AUDIO PERFECTION

Designed to play 16, 33, 45, 78 r.p.m. Records 7in., 10in., 12in. With plug-in GC8 NORMAL HEAD.

OUR PRICE **£10. 10. 0.** STEREO HEAD £2 extra

LATEST COLLARO AUTOCHANGER

£7.19.6

STUDIO Pick-up

4 Speeds—10 Records

Or with Portable Cabinet, Amplifier & Speaker

£11.19.6. Carr. 5/6

B.S.R. MONARCH UA8 4-SPEED AUTOMATIC RECORD CHANGERS

Brand new and fully guaranteed 12 months

OUR PRICE **£6.19.6.** post free

STEREO MODELS UA8, £7/19/6 UA12, £10/10/-

AUTOCHANGER ACCESSORIES

Suitable player cabinets (uncut boards)... 49/6
Amplifier player cabinets with cut boards 63/-
2 valve amplifier and 6½in. speaker for above 79/6
3 valve amplifier and 6½in. speaker for above 95/-
Wired and tested ready for use.

★ GARRARD 4-SPEED SINGLE RECORD PLAYER TA MK II ★

£8.10 AUDIO PERFECTION STEREO WIRED

With plug in GC8 Normal heads / Stereo Heads
MODEL 4 HF £18 / £2 extra

BATTERY-MAINS POWER PACK

For "96" Range Valves

Same size as batteries B126 and AD35. 90 v. H.T., 1½ v. L.T. 150 mA., only 1/- a year to run on A.C. 200/250 v. Made by COSSOR. List 53/-, our price 39/6.

THE HI-GAIN BAND 3 PRE-AMP

Cascode circuit using Valve ECC84. 17db gain. Kit 29/6 less power; or 49/6 with power pack. Plans only 6d.
Also Band I version same prices.
(PCC84 Valve if prefered)

LATEST "E.M.I." 4 SPEED SINGLE RECORD PLAYER

Acos 73 HI-FI Stereo and normal xtal pick-up for 7in., 10in. and 12in. records. Silent motor, heavy turntable. Auto-stop fitted.
Special offer £6/19/6.

VOLUME CONTROLS

Midget size.
Long spindle. Guaranteed 1 year. All values 5 K. ohms up to 2 Meg.

No switch	D.P.Sw.
3/-	4/9

Linear or Log Tracks.

80 ohm Cable Coaxial

Semi-air spaced, ¼in. dia.
Ideal Band III 6d. yd.
Losses cut 50%
Post 1d. per yard extra.
FRINGE QUALITY
AIRSPACED .... 1/- yd.

COAXIAL PLUGS .... 1/- LEAD SOCKETS 2/-
PANEL SOCKETS .... 1/- OUTLET BOXES.... 4/6
BALANCED TWIN FEEDER per yd. 6d., 80Ω or 300Ω
TWIN SCREENED BALANCED FEEDER 1/6 yd., 80 ohm.

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled with 4 sides, riveted corners and lattice fixing holes, with 2½in. sides, 7 x 4in., 4/6; 9 x 7in., 5/9; 11 x 7in., 6/9; 13 x 9in., 8/6; 14 x 11in., 10/6; 15 x 14in., 12/6 and 18 x 3in., 10/6.

BLACK CRACKLE PAINT. Air drying, 3/- tin.
P.V.C. CONN. WIRE, 8 colours single or stranded, 2d. yd.
NEON MAINS TESTER SCREWDRIVERS, 5/-.
CORED SOLDER RADIOGRADE, 4d. yd., 1lb., 2/6.
PAXOLIN 1/16in., 6in. x 10in., 1/6. ION TRAPS 5/-.

"FAMOUS MAKE" Long Play Plastic Tape.

1,700ft. 7in. Reel 35/-. 850ft. 5in. Reel 21/-.
SUPERIOR 1,200ft. 7in. Plastic Tape 24/-. 600ft. 5in. 15/-. All Spare Reels 3/- each.
LONG PLAY 5¾in. 1,200ft. 28/-. 3in. 225ft. 7/6.
"INSTANT" Bulk Tape Eraser and Head Demagnetiser 200/250 v. A.C. 27/6.

MAINS TYPE. RM1, 125 v., 60 mA., 5/-; RM2, 100 mA., 6/-; RM3, 120 mA., 8/-; RM4, 250 v. 275 mA., 16/-.
MINIATURE CONTACT COOLED RECTIFIERS. 250 v 50 mA., 7/6; 60 mA., 8/6; 85 mA., 9/6; 200 mA., 21/-; 300 mA., 27/6; Full Wave 250v, 120 mA., 15/-.
COILS. Wearite "P" type, 3/- each. Osmor Midget "Q" type adj. dust core from 4/- each. All ranges.
TELETRON. L. and M. T.R.F. with reaction, 3/6.
FERRITE ROD AERIALS. M.W., 8/9; M. & L., 12/6.
T.R.F. COILS. A/HF. 7/- pair. H.F. CHOKES, 2/6.

JASON F.M. TUNER COIL SET, 26/-. H.F. coil, aerial coil, Oscillator coil, two I.F. transformers 10.7 Mc/s. Detector transformer and heater chokes. Circuit and component book using four 6AM6, 2/6. Complete kit FMT1 with Jason Calibrated dial and 4 valves £6/15/-. With new Jason Cabinet, FMT3, 20/- extra.

CONDENSERS. New Stock. .001 mfd 7kV. T.C.C., 5/6. 20kV. 9/6. .1 mfd 7kV., 9/6. 100pf. to 500 pf. Mica, 6d. Tubular 500 v. .001 to .05 mfd., 9d.; .1, 1/-; .25, 1/6; .5, 1/9; .1/350 v., 9d.; .01/1,000 v., 1/9; 0.1 mfd. 2,000 v., 3/6; .001 mfd., 2,000 v., 1/6.
CERAMIC CONDS. 500 v. .3 pf to .01 mfd., 9d.
SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf., 1/-; 600 pf to 3,000pf, 1/3.
CLOSE TOLERANCE (± 1 pf.) 1.5 pf. to 47 pf., 1/6. DITTO 1% 50 pf to 815 pf., 1/9; 1,000 pf. to 5,000 pf., 2/-.
TRIMMERS. Ceramic, 30, 50, 70 pf. 9d.; 100 pf., 150 pf., 1/3. 250 pf., 1/6. 600 pf., 750 pf., 1/9. Philips, 1/- ea.

NEW ELECTROLYTICS. FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	64/300 v.	5/6	8/500 v.	3/-
2/450 v.	2/3	100/25 v.	3/-	16/500 v.	4/-
4/450 v.	2/3	250/25 v.	3/-	32/350 v.	4/-
8/450 v.	2/3	500/12 v.	3/-	100/270 v.	5/6
8/500 v.	2/9	8 + 8/450 v.	4/6	2,500/3 v.	4/-
16/450 v.	3/6	8 + 8/500 v.	5/-	5,000/6 v.	5/-
16/500 v.	4/-	8 + 16/450 v.	5/-	8 + 16/500 v.	7/-
32/450 v.	5/6	8 + 16/500 v.	5/6	32 + 32/450 v.	6/6
25/25 v.	1/9	16 + 16/450 v.	5/6	60 + 60/350 v.	7/-
50/25 v.	2/-	16 + 16/500 v.	6/-	64 + 120/350 v.	11/6
50/50 v.	2/-	32 + 32/350 v.	4/6	100 + 200/275 v.	12/6

FULL WAVE BRIDGE/SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6; 6 a., 22/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v for charging at 2, 6 or 12 v. 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6.
Charger circuit free. AMMETERS, 4 a., and 5 a., 14/6.

NEW and boxed VALVES 90-day guarantee

1R5	8/6	6L6G	10/6	EA50	1/6	EY51	12/6
1S5	8/6	6N7M	7/6	EABC80	10/6	EZ81	8/6
1T4	8/6	6Q7G	10/6	EB91	8/6	HABC80	12/6
2X2	2/6	6SA7M	10/6	EBC33	8/6	HVR2A	7/6
3S4	8/6	6SJ7M	10/6	EBC41	10/6	MU14	10/6
3V4	8/6	6SN7	8/6	EBF80	10/6	P61	8/6
5U4	8/6	6V6G	7/6	ECC84	12/6	PCC84	12/6
5Y3	8/6	6X4	7/6	ECF80	11/6	PCF80	11/6
5Z4	10/6	6X5	7/6	ECH42	10/6	PCF82	11/6
6AM6	8/6	12A6	8/6	ECL80	12/6	PCL83	11/6
6BE6	7/6	12AT7	10/6	ECL82	12/6	PEN36	8/6
6BH6	10/6	12AU7	8/6	EF39	7/6	PL82	10/6
6BW6	10/6	12AX7	8/6	EF41	10/6	PY80	8/6
6D6	7/6	12BA6	8/6	EF50	8/6	PY81	10/6
6F6G	7/6	12BE6	8/6	EF80	10/6	PY82	8/6
6H6GT	8/6	12K7	8/6	EF86	14/6	SP61	8/6
6J5M	8/6	12Q7	8/6	EF91	8/6	UBC41	10/6
6J6	7/6	35L6	8/6	EL32	8/6	UCH42	10/6
6J7G	8/6	35Z4	8/6	EL41	10/6	UF41	10/6
6K6GT	8/6	80	10/6	EL84	10/6	UL41	10/6
6K7G	8/6	807	8/6	EZ40	8/6	UY41	8/6
6K8G	8/6	954	1/6	EZ80	8/6	U78	10/6

RADIO COMPONENT SPECIALISTS

48 HOUR MAIL ORDER
337 WHITEHORSE RD. WEST CROYDON

POSTAL SERVICE 1/-, OVER £2 FREE. C.O.D. 1/6 (EXPORT C.W.O. POST EXTRA.) Wed. 1 p.m.

THO. 1665. Buses 133 or 68

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables. SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

UNIVERSAL AVOMETER MODEL "D"

D.C. VOLTS	A.C. VOLTS	D.C. Current	A.C. Current
150 mv.	7.5 v.	15 ma.	75 ma.
300 mv.	15 v.	30 ma.	150 ma.
1.5 v.	75 v.	150 ma.	750 ma.
3 v.	150 v.	300 ma.	1.5 amp.
15 v.	300 v.	1.5 amp.	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	Resistance
300 v.	1,500 v.	30 amp.	1,000Ω
750 v.			10,000Ω
1,500 v.			

Supplied reconditioned as new, with internal battery. Instructions and leads £8/19/6 each. P/P. 3/6.

WESTON MODEL 772 TESTMETER

A.C. VOLTS	D.C. CURRENT	A.C. CURRENT
2.5 v.	100 micro/a.	500 ma.
10 v.	1 ma.	1 amp.
50 v.	10 ma.	5 amp.
250 v.	50 ma.	RESISTANCE
1,000 v.	100 ma.	100 ohms
D.C. VOLTS	500 ma.	1,000 ohms
2.5 v.	OUTPUT METER	100k. ohms
10 v.		10 megohms
50 v.		
250 v.		
1,000 v.		

Supplied in perfect working order complete with internal batteries. £7/10/-. P/P. 4/-.

FIELD TELEPHONES TYPE F. Generator bell ringing. Supplied complete with batteries, fully tested, and complete with wooden carrying case. 59/6 each. P/P. 3/6.

24 AMP. VARIAC TRANSFORMERS. 230 v. input. Variable output 185-250 volts or 185-250 volts input, 230 volts out. £12 10/- each. P/P. 10/-.

MUIRHEAD PRECISION STUD SWITCHES. 4 bank, 4 pole, 24 positions. New, boxed, 17/6 each. P/P. 1/3.

AR 88. 1st I.F. Transformers 3/6. P/P. 1/-.

2 v. 3AH. ACCUMULATORS. Lead Acid, unfilled. 12 for 21/-. P/P. 4/6.

E.M.I. POTTED MIC. INPUT TRANSFORMERS. High quality, 50 : 1 ratio, 4/6 each. P/P. 9d.

LEACH 12 VOLT AERIAL CHANGE-OVER RELAYS. Double pole, 7/6 each. P/P. 9d.

AMERICAN H.T. BATTERIES. Tapped 90 v., 67½ v., 45 v., 22½ v. New 5/- each. P/P. 2/-.

8 RANGE SUB-STANDARD D.C. AMMETERS. Ranges, 1.5 3, 7, 15, 30, 60, 300 and 450 amps. 8in. mirror scale. Meter housed in polished teak case. Supplied complete with all shunts and leather carrying case. £15 each. P/P. 7/6.

1,000 WATT MAINS ISOLATION TRANSFORMERS. 230 to 230 volts. Heavy duty, ex-Admiralty. New boxed, £5 each. P/P. 10/-.

750 WATT AUTO TRANSFORMERS. Tapped from 110 to 230 volts. Fine heavy duty type, 69/6 each. P/P. 5/-.

DEAF-AID EAR-PIECES. 250 ohm imp. 4/6; 1,000 ohm imp. 7/6. P/P. 6d.

R.C.A. PLATE TRANSFORMERS. Input 200/250 volts 50 cycles. Output 2,000/1,500/0/1,500/2,000 volts 500 m/a. Supplied brand new in transit cases, £6/10/- each. P/P. 10/-.

R.1155 RECEIVERS MODEL B. Perfect working order, fully tested, £7/19/6 each. P/P. 7/6. Combined power pack and output stage, 85/- extra.

AR.88 WAVE CHANGE SWITCH ASSEMBLY. Brand new with screens. 17/6 each. P.P. 2/6.

R.1155 N TYPE DRIVES. Improved geared version now, 12/6 each. P/P. 1/6.

POST OFFICE TELEPHONE HANDSETS. Std. type. new boxed. 12/6 each. P/P. 1/6.

METER BARGAINS

25 microamp D.C. M/C flush rd. 2½in.	69 6
25 microamp D.C. M/C. proj. rd. 2½in.	69 6
50/0/50 microamp D.C. M/C., flush rd. 2½in.	79 6
50 microamp D.C. M/C. proj. rd. 2½in.	49 6
100 microamp D.C. M/C. flush rd. 2½in.	62 6
500/0/500 microamp. D.C. M/C. proj. rd. 2½in.	19 6
1 milliamp D.C. M/C. flush sq. 2in.	22 6
1 milliamp. D.C. M/C. flush rd. 2½in.	25 -
1 milliamp. D.C. M/C. flush rd. 3½in.	50 -
1 milliamp. D.C. M/C. flush sq. 4in.	69 6
200 milliamp D.C. M/C. flush rd. 2½in.	9 6
30 amp D.C. M/C. flush rd. 2½in.	9 6
15 volt D.C. M/C. flush rd. 1½in.	10 6
150 volt D.C. M/C. flush rd. 2½in.	32 6
300 volt A.C. M/I. flush rd. 2½in.	25 -
300 volt A.C. M/C. rect. flush rd. 2½in.	25 -
500 volt A.C. M/I. flush rd. 2½in.	25 -

CR.100 SPARES KIT. Contains 15 valves, resistors, pots, condensers, output trans., etc. All brand new, 59/6. P/P. 3/6.

DYNAMO EXPLODER UNITS. For detonating explosive charges. Hand generator operation. Brand new 29/6 each. P/P. 3/6. Hide leather cases 19/6 extra.

MARCONI TF.428 B/I VALVE VOLTMETERS. 5 ranges A.C. and D.C. 1.5, 5, 15, 50 and 150 volts. Operation 200/250 volts A.C. Supplied brand new complete with internal HF probe. £17/10/- each. P/P. 10/-.

EX-ADMIRALTY 12 VOLT D.C. MOBILE AMPLIFIERS. Std. mic. or gram. input. Push pull 10 watt output matched to 3 or 15 ohms. Good working order, £8/19/6 each. P/P. 6/6.

MARCONI TF-373 IMPEDANCE BRIDGE. Reconditioned to maker's specification. 1,000 c/s. Ranges: 100 henry; 100 mfd.; 1 megohm; 100 Ω. 200/250 volts A.C. operation. £35 each.

CRYSTAL MICROPHONE INSERTS, 4/6 each. P/P 6d.

MARCONI STANDARD SIGNAL GENERATOR TF-144G. 85 Kc/s. to 25 Mc/s. Output 1 microvolt to 1 volt. 200/250 volts A.C. operation. Reconditioned to maker's specification. £55 each.

AVO METER MODEL 7 MULTIPLIER. Extends 1,000 volt range to 4,000 volt. New 5/6 each. P/P. 1/-.

FURZEHILL BEAT FREQUENCY AUDIO OSCILLATORS. Frequency range 0-10,000 c.p.s. Output 10 or 600 ohms. Separate 50 c.p.s. check. Set zero control. 200/250 volt A.C. operation. Supplied in perfect working order. £9/19/6 each. P/P. 10/-.

CV.967 1 IN. CR TUBES. 4 volt heater suitable for 'scope, new, 19/6 each. P/P. 1/6.

230 VOLT A.C. MOTORS. Ideal for fan or blower. 15/6 each. P/P. 1/3.

R.1294 V.H.F. COMMUNICATION RECEIVERS. 500 to 3,000 mc/s. Perfect condition with handbook. £25. P/P 10/-.

MARCONI TF-329 "Q" METERS. Range 0 to 500 Q. Frequency 50 kc/s. to 50 mc/s. Re-conditioned to maker's specification. 200/250 volts A.C. operation. £65 each.

GRESHAM POTTED L.T. TRANSFORMERS. 230 volts input. Secondary tapped 70, 75 and 80 volts 4 amps. New boxed, 42/6 each. P/P 3/6.

FERRANTI FILAMENT TRANSFORMERS. Two types, both 200/250 volt input. Type 1: 6.3 volt CT, 5.6 amp., 6.3 volt CT, 4.5 amp., 6.3 volt CT, 1 amp., 19/6. Type 2: 6.3 volt CT, 3.3 amp., 6.3 volt CT, 1 amp., 6.3 volt CT, .9 amp., 6.3 volt CT, .6 amp. 15/6. P/P. 2/-, both types.

G.E.C. SELECTEST MULTI-RANGE TESTMETERS

D.C. Volts.	A.C. Volts.	D.C. Current	A.C. Current
150 mv.	7.5 v	15 ma.	75 ma.
300 mv.	15 v.	30 ma.	150 ma.
1.5 v.	75 v.	150 ma.	750 ma.
3 v.	150 v.	300 ma.	1.5 amp.
15 v.	300 v.	1.5 amp	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	Resistance
300 v.	1,500 v.	30 amp.	1 K. ohm
750 v.			10 K. ohm
1,500 v.			

Incorporated overload trip and special safety interlocking switches. Supplied in perfect condition with leads and battery at £7/10/- each. P/P. 3/6.

BC 221 HETERODYNE FREQUENCY METERS

125 kc/s to 20 mc/s

Complete with all valves, crystal, headset and instruction book, but less calibration charts. 100% condition.

SPECIAL PRICE **£14-10-0** each

Carriage 7/6 extra

VALVE VOLTMETER

Electronic Type 165-A

D.C. ELECTRONIC VOLTMETER.

6-Ranges. 0–3–10–30–100–300 and 1,000 volts. Input res: 11-meg. constant on all ranges. Sensitivity: 3,666,666 ohms per volt on 3 v. scale.

A.C. VOLTMETER.

5-Ranges: 0–10–30–100–300–1,000 volts. Sensitivity: 1,000 ohms per volt.

ELECTRONIC OHMMETER.

6-Ranges, from 0.1 ohms to 1,000 megohms. Movement. 200 microamperes. D.C. accuracy ±2%.

COMPLETE WITH INSTRUCTION BOOK AND TEST PRODS. BRAND NEW.

Input 110-250 volts A.C.

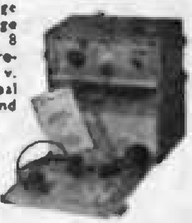
ONLY **£12/10/0** P.P. 3/6

SPECIAL PURCHASE · LIMITED STOCKS

TRANSMITTER/RECEIVER

Army Type 17 Mk. II

Complete with Valves. High Resistance Headphones, Handmike and Instruction Book and circuit. Frequency Range 44.0 to 61 Mc/s. Range approximately 3 to 8 miles. Power requirements: Standard 120 v. H.T. and 2 v L.T. Ideal for Civil Defence and communications.



BRAND NEW

45/- P.P. 5/-

44-61 Mc/s. Calibrated Wavemeter for same. 10/- extra. P.P. 2/-

T/X TYPES AND SPECIAL PURPOSE VALVES

EF91	5/-	705A	15/-	807	7/6	1625	5/-	5800	45/-
EF92	5/-	725A	35/-	872A	15/-	8582	15/-	5829	10/-
813	65/-	726A	15/-	2K25	65/-	1838	25/-	5839	35/-
832	30/-	726B	15/-	19G3	15/-	1632	6/-	5840A	30/-
832A	35/-	723A/B	55/-	WL860	30/-	1644	12/6	5852	22/6
829B	40/-	2J54	35/-	TZ40	35/-	5638	15/-	5932	30/-
QVO4/7	15/-	2J54	35/-	CV129	45/-	5692	30/-	5931	35/-
TT15	45/-	803	22/6	CV2161	25/-	5703	8/6	6004	17/6
446A	12/6	805	35/-	CV100	15/-	5722	17/6	9005	15/-
446B	12/6	35T	15/-	CV85	15/-	5726	8/6	CK5785	8/6

NEW FREE LIST OF OVER 600 TYPES OF VALVES AND TUBES

A.C., D.C., R.F. METERS

0–15 v.	2½in.	M.I. (A.C) F.R.	8/6
0–40 v.	2in.	M.C. (DC) F.S.	7/6
0–150 v.	2½in.	M.C. (DC) F.R.	12/6
0–200 v.	2½in.	M.C. (DC) F.R.	12/6
0–600 v.	2½in.	M.C. (DC) F.R.	12/6
0–300 v.	5in.	M.I. (AC) P.	50/-
0–1½ kv.	2½in.	M.C. (DC) P.	15/-
0–2½ kv.	2½in.	M.C. (DC) P.	15/-
0–500 UA	3½in.	M.C. (DC) F.R.	59/6
0–400 UA	3½in.	M.C. (DC) F.R.	59/6
2½–0–2½ mA	2½in	M.C. (DC) F.R.	12/6
0–100 mA.	2in.	M.C. (DC) F.S.	10/-
0–150 mA	2in.	M.C. (DC) F.S.	7/6
0–500 mA	2½in.	M.C. (DC) F.R.	12/6
0–750 mA.	2in.	T.C. (RF) P.	6/-
0–1 amp.	2in.	T.C. (RF) P.	6/-
0–3 amp.	2in.	T.C. (RF) F.S.	6/-
0–12 amp	2½in.	T.C. (RF) P.	10/-
0–20 amp.	2in.	M.C. (DC) P.	7/6
0–30 amp.	2in.	M.C. (DC) F.S.	7/6
5–0–5 amp.	2½in.	M.C. (DC) P.	10/-
0–10 amp.	4in.	M.C. (DC) P.	25/-

FREE COMPLETE LIST ON REQUEST

V.H.F. TRANS/RECEIVER TYPE 1986

10-channel crystal controlled. 124.5 to 156 Mc/s nominal coverage. 9.72 Mc/s. I.F., 23 kc/s bandwidth. Unit complete with 21 valves. 24 volt power unit. circuit diagrams, etc. Contained in metal case. New condition. p.p. 10/6. **£7.19.6**

V.H.F. TRANS/RECEIVER TYPE 1986

★ 9.72 MC/S I.F.
★ 23 KC/S BANDWIDTH
★ 10-CHANNEL CRYSTAL CONTROLLED
★ 124.5 to 156 MC/S COVERAGE

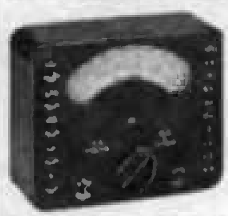
Sub-units	Type	With valves	Less valves	P.P.
TRANSMITTER	81	60/-	25/-	2/6
RECEIVER	114	25/-	7/6	2/6
IF Amplifier	476	32/6	12/6	2/6
Modulator	105	20/-	—	2/6
24 v. Rotary unit	3	15/-	—	2/6
10-way Control unit	382	6/-	—	9d.

All the above are in absolute new condition. Full circuits available, 1/9 post free.

TR 1920 TX/RX

4-channel Xtal controlled. 100 to 120 mc/s. New condition. £6/10/-, p.p. 10/6.

AVO MINOR TESTMETER



AC/DC volts.
0-500 volts.
D.C. mA.
0-500 mA.
RESISTANCE
0-20 K.

COMPLETE WITH LEADS AND LEATHER CASE **79/6** P.P. 2/-.
FULL GUARANTEE.

MARCONI No. 19 SET CRYSTAL CALIBRATOR

CRYSTAL CONTROLLED OSCILLATORS: 10 Kc/s., 100 Kc/s. and 1 Mc/s. On/Off MODULATOR. With handbook. Unused. ONLY 79/6. P.P. 2/6.

QUARTZ CRYSTALS

FROM **5/-** EACH

From 6 Kc/s–47 Mc/s. FT243, FT241, 10XJ and B7G.
All types for all purposes.
Send for free list.

CATHODE-RAY TUBES

(IDEAL FOR 'SCOPES)

2AP1	2in.	25/-
VCR139A	2½in.	35/-
3BP1	3in.	30/-
3FP7	3in.	12/6
3AP1	2½in.	30/-
Mullard DG7/5	2½in.	45/-
5FP7	5in.	20/-
VCR517C	6in.	30/-
VCR97	6in.	40/-
Screens for VCR97		7/6

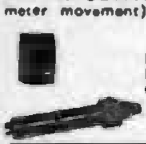
P.P. 2/- any type. ALL GUARANTEED
FREE LIST and Data on request.

— PIRANI HIGH VACUUM TEST EQUIPMENT —

PIRANI CONTROL UNIT (1.2mA meter movement). (85/-, p.p. 5/-.)

PIRANI DIFFERENTIAL LEAK DETECTOR. (45/-, p.p. 5/-.)

PYE SCALAMP GALVANOMETER (Type 2000). (£15, p.p. 3/6.)



PIRANI GAUGE HEAD WITH CALIBRATOR

COMPLETE VACUUM TESTING EQUIPMENT (5 ITEMS AS SHOWN) NEW IN ORIGINAL CARTONS.

£25 - 0 - 0 p.p. 10/- *INCLUDING OPERATING INSTRUCTIONS*

(SPARE PIRANI GAUGE HEADS, EDWARDS TYPE M6, LESS CALIBRATOR. 15/- EACH.)

HENRY'S RADIO LTD.

5, HARROW ROAD, PADDINGTON, W.2
(AT JUNCTION OF EDGWARE RD. AND HARROW RD.) PAD 1008/9

LASKY'S RADIO

FINEST RANGE OF GRAM AMPLIFIERS IN GT. BRITAIN

We have the type you need. Come and see our range or write for special Amplifier List. Two examples:—

3-WATT GRAM AMPLIFIER
2 valve, ECL 82 and EZ80 rectifier, double wound mains transformer 100-250 A.C., tone control, record equalisation switch. Size 7¾ × 3¼in. max. height 4¾in. Controls mounted separately. **LASKY'S PRICE** complete with knobs. **55/-** Post 3/6

MATCHED PAIR FOR STEREO...... **5 Gns.** Post 5/-

2-WATT GRAM AMPLIFIER, uses UCL83, contact cooled rectifier.
LASKY'S PRICE 35/- Post 2/6

The VERDIK "Quality 10" Hi-Fi Amplifier

10 watt p.p., ultralinear, complete with Pre-Amplifier, 5 inputs, bass and treble controls, grey enamel finish. List £21.
LASKY'S PRICE £14.19.6 Carr. 7/6.

"LINEAR" AMPLIFIERS

"DIATONIC" 10-14 watt **12 Gns.**
"CONCHORD" 30 watt **15 Gns.**
L45 4-5 watt Amplifier **£5/19/6**
LT45 Tape Deck Amplifier **12 Gns.**
L50 50 watt Amplifier **19 Gns.**
L10 10-12 watt with pre-amplifier **15 Gns.**
L3/3 Stereo Amplifier **7 Gns.**
All other types in stock.

MULLARD 5-10 KIT

All specified components and your choice of transformers and chokes by Partridge, Haddon, W/B, Ellison or Gilson.
COMPLETE KIT and printed circuit as low as **£9.9.0**
Details on request.
Printed Circuit separately 22/6.
Also available built ready for use. Price according to transformers.

BUILD THE 3-3 AMPLIFIER

Complete kit of parts with 3 Mullard valves EL84, EF86 and EZ81, **£6.19.6** Post free.
All components available separately.

BARGAINS IN 4-SPEED MIXER AUTO-CHANGERS

B.S.R. 4-spd. mixer Auto-Changer type UA8, complete with latest B.S.R. "ful-fi."
Carr. & Pkg. 5/-. **£6.19.6**

Ditto, wired for Stereo and with Stereo cartridge, £7/19/6.

COLLARO. Incorporating auto and manual control. Complete with Studio crystal p.u. and sapphire stylus. LIST £13/17/-.
LASKY'S PRICE £7.19.6 Post 3/6

B.S.R. Latest Type UA12

4-spd. Wired for STEREO, complete with stereo cartridge. Post 5/-. **£8.19.6**

GARRARD 4-SPEED MIXER AUTO-CHANGERS

Model 121. Mk. II......	£10/10/0
121, Mk. II STEREO	£11/10/0
121, Mk. II, with monaural and Stereo heads	£12/10/0
RC.88......................	£12/19/6
RC.88, STEREO	£13/19/6

All the above Auto-Changers are new and unused in maker's cartons.

SINGLE PLAYERS

Auto start and stop, complete with pick-up and crystal cartridge.
COLLARO 4/564, £6/9/6. Post 5/-
GARRARD 4SP., £6/9/6. Post 5/-

GARRARD TA Mark II, wired for stereo, plug-in head. £8/9/-. Post 5/-.

SINGLE STEREO PLAYER

E.M.I. 4-spd., wired for Stereo and fitted with Acos stereo t.o. cartridge.
£6.19.6 Post 5/-

STEREO CARTRIDGES

ACOS type 73-1A turnover, list 52/6.
LASKY'S PRICE 29/6 Post 1/-
All makes and types in stock. Write for our bargain list.

PICK-UP CARTRIDGES

ACOS type **HGP.59** or **HGP.37** turnover crystal cartridge with L.P. and standard styli. List 39/7.
LASKY'S PRICE 18/- Post free.

BUILD A BATTERY TRANSISTOR RECORD PLAYER

at the amazing low price of only £8/19/6 plus 5/- post.

★Push pull 500 milliwatts output.
★Smart carrying case, 11 × 8½ × 5in.
★Garrard Turntable and P.U. type BA1, (45 r.p.m.).
★4 Transistor Amplifier on Printed Circuit (ready built).
★7 × 4in. 30 ohm. loudspeaker.
★Uses two 4½ v. AD.28 batteries.

CONVERT YOUR ALL-DRY PORTABLE RADIO TO MAINS 200-250 v.

with the **COSSOR BATTERY ELIMINATOR.** Two separate units identical in size to the B126 and AD35 batteries. 1.5 v. L.T., 90 v. H.T. Suitable for the latest low consumption valves, fully stabilised. New in original cartons. Listed at 63/-.
LASKY'S PRICE 37/6 Post 1/6

A TRANSISTORISED RADIO FOR 25/10

The "**DIODEON**"—a high-efficiency 2-stage receiver using crystal diode detector and transistor in cascade. Covers 200-500 meters (medium wave). Chassis shows pictorially all components and connections. Built in minutes! Complete parcel including two U16 batteries. **25/10** Post free.

EARPHONES. High imp., 14/6. Low imp., 7/6. Post 1/6.

P.M. SPEAKERS

ROUND

3½in.	4in.	5in.	6½in.	8in.
17/6	19/6	14/6	18/-	16/6

ELLIPTICAL

7×4	9×6	10×2½	10×6	10×7
15/6	27/6	27/6	25/-	32/6

Post Extra.

GRAM LID STAYS, pneumatic, adjustable and self closing. 9/11 pair. Post 1/6.

STANDARD JACK PLUGS, each 2/6. Post 6d.

LONDON'S LEADING Hi-Fi SPECIALISTS

Visit either of our addresses for selective Demonstrations of the very latest Hi-Fi Equipment.

AMPLIFIERS
QUAD, ROGERS, LEAK, RCA, JASON, LINEAR, PAMPHONIC, DULCI, W/B, AVANTIC, ARMSTRONG, etc.

SPEAKERS
WHARFEDALE, GOODMANS, LOWTHER, G.E.C., LORENZ, PHILIPS, TANNOY, etc.

PICK-UPS
COLLARO, GARRARD, CONNOISSEUR, LEAK, B/J, ORTOFON, GOLDRING, etc.

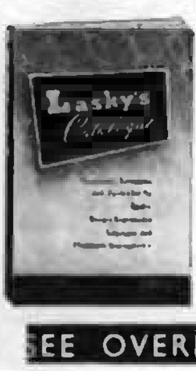
TRANSCRIPTION TURNTABLES
COLLARO, GARRARD, LENCO, CONNOISSEUR.

TAPE RECORDERS
GRUNDIG, ELIZABETHAN, BRENELL, TRUVOX, SOUND, VORTEXION, FERROGRAPH, FIDELITY, HARTING, KORTING, REFLECTOGRAPH, SIMON, STUZZI, TANDBERG, TELEFUNKEN, STELLA, WALTER.

F.M. TUNERS
DULCI, QUAD, LEAK, JASON, ROGERS, etc.

CABINETS
Wide choice including W/B PRELUDE, G-PLAN, NORDYK and CAPRIOL.

Our Technical and Mail Order Depts are at your service.



GET YOUR COPY PER RETURN!

THE FINEST COMPONENTS CATALOGUE

produced for the "ham" or service man. **OVER 100 PAGES, SIZE 8½in. x 5½in. COPIOUSLY ILLUSTRATED.**
Price **2/-** Post 6d.

Our latest 12-page "BARGAIN BULLETIN" free with each copy or available separately by post, price 6d.

SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO

LASKY'S RADIO

GREAT REDUCTIONS IN TRANSISTORS

P.N.P. Junction types.

AUDIO, suitable for high gain and low freq. amplifiers, and for output stages up to 250 milliwatts. Double spot—yellow and green. Each **5/-**

R.F. suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers (1.5 to 8 Mc/s). Double spot—yellow and red. Each **7/6**

Type T81. Suitable for all audio applications. Each Post 6d. **3/6**

Special prices quoted for large quantities.

OC44 15/-; OC45 15/-; OC70 8/6; OC71 8/6; OC72 15/- (Matched Pair 30/-). OC73 14/-; OC16 54/-.

EDISWAN MAZDA TRANSISTORS. The very latest types. XB/102 10/-; XB/103 10/-; XC/101 12/6; XA/101 15/-; XA/102 17/6.

SPECIAL OFFER. Set of 7 Ediswan Transistors: XA/101, XA/102, 2 XB/102, XB/103, 2 matched XC/101. Price 79/6.

CRYSTAL DIODES. General Purpose GEX00, each 1/-. Per doz. 9/-. All other types in stock.

"GOLDTOP" POWER TRANSISTORS

All types in stock. Example:—
V15 10P. Ideal for output stage of car radio, will give approx. 3 watts operating from 12 v. Each 15/- post free.
Suitable Output Transformer for above, correct ratio, matched to 3 ohms, 9/6. Post 1/-.
Driver Transformer, 9/6. Post 1/-.

RESISTORS. The largest stocks of all types, high stability, wire wound, carbon, vitreous enamel, miniature and submin. Millions in stock. Why buy unwanted assortments? We will send you the types and values you actually want.

SUB-MIN. RESISTORS, ⅛th watt, most values available. Each 3½d., per doz. 2/6.

COSSOR Model 701K VHF/FM RADIO KIT

Everything to build a VHF/FM radio receiver for 200-250 v. A.C./D.C. mains. All components, printed circuit, valves and Goodmans 10 x 6in. elliptical speaker, in makers' carton with full assembly instructions. Valve line-up: UCC85, two UF89, UABC80, UL84, UY85. Complete Kit, listed at 15 gns.
LASKY'S PRICE Post 2/6. **£8.19.6**

LASKY'S HIGHLY EFFICIENT EASY-TO-BUILD SETS : TUNERS : AMPLIFIERS

Circuit Diagram and Building Instructions, 1/6 each, post free.	COMPLETE PARCEL
7-TRANSISTOR PORTABLE, 250 milliwatts p.p. output. **NEW CIRCUIT**, medium and long wave.	£10/10/- Post 3/6
TRANSISTOR SUPERHET TUNER, uses 3 R.F. transistors, 1 germanium diode, etc. Printed Circuit 3⅞in. x 3⅛in.	£5/12/6 Post 3/6
4-TRANSISTOR AUDIO AMPLIFIER, Mk. II, 200/250 milliwatts, with 2 OC72 and 2 yellow/green. Size 5½ x 2 x 1⅛in.	£3/19/6 Post 3/6
4-VALVE ALL-DRY SUPERHET PORTABLE. Medium and long wave. Mains/battery £8/19/6. Battery version	£7/7/- Post 3/6
MIDGET T.R.F. for 200-250 v. A.C. mains. Uses two latest double-purpose valves. Plastic case, 8½ x 4½ x 5in.	£4/19/6 Post 5/-
LASKY'S F.M. TUNER. Printed Circuit version of the G.E.C. 912 "F.M. Plus," using 5 valves.	£7/19/6 Post Free

LASKY'S CAR RADIO

CAN BE BUILT ABSOLUTELY COMPLETE FOR **£12.19.6**

- ★ Small size. Will fit any car
- ★ 12 volt operation
- ★ New Hybrid circuit
- ★ Transistor output
- ★ New type Brimar valves
- ★ No Vibrator, 12 volt H.T. & L.T.
- ★ T.C.C. Printed Circuit and Condensers
- ★ Tuned R.F. stage
- ★ Medium and long waves
- ★ Permeability tuning
- ★ 7in. x 4in. elliptical speaker.

Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list price 2/6 post free (returned if you order).

BUILD A COMPLETE TAPE RECORDER for £28.19.6

Carr. 10/-

Using a brand new COLLARO STUDIO DECK, READY-BUILT AMPLIFIER and complete with SPEAKER, MIKE AND TAPE (or with B.S.R. Deck, approx. 20 gns.). Send for details. Suitable Carrying Cases, various types, from 50/- extra.

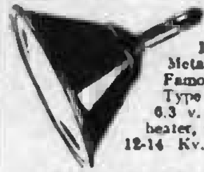
NEW POCKET TRANSISTOR S/HET RADIO

I.F. 470 Kc/s. Medium waveband. Printed circuit. Uses 4 transistors and 1 diode, 2½in. speaker, Ferrite slab aerial, etc., in leatherette case 6 x 3½ x 1⅞in. Weight 17 oz. Automatic gain control. Uses PP4 9-volt battery. CAN BE BUILT FOR **£7.19.6** Post 3/6.

Full details on request.

C.R. TUBE BARGAINS

NEW, UNUSED AND TAX FREE



16in. Metal Cone. Famous make. Type T901/B. 6.3 v. .3 amp. heater, ion trap. 12-14 Kv. E.H.T.

LASKY'S PRICE £6.9.6
Carr. and Insur. 21/-.

FERRANTI, 9in. type T9/3. 4 v. heater, triode, octal base, standard deflection LIST 9 GNS.
LASKY'S PRICE 50/- Carr. & Insur., 12/6.

FERRANTI 12in., types T12/44 and T12/54.
LIST £12. **LASKY'S PRICE 84/-** Carr. & Insur., 12/6

FERRANTI 17in. type TR17/10. 6.3 v. .3 amp. heater. Brand new and unused.
LASKY'S PRICE £7.19.6 Carr. & Insur., 12/6.

JUST ARRIVED!

17 in. 90 degrees C.R. TUBES

Seconds but in perfect working order and guaranteed. Price on request.

RE-GUNNED C.R. TUBES

GUARANTEED FOR 12 MONTHS

Type	Price	Carr. & Ins.
12in. round	£6 10 0	12/6
14in. rect.	£6 10 0	12/6
15in. round	£6 19 6	21/-
17in. rect.	£6 19 6	21/-
21in. rect.	£7 19 6	25/-

20,000 VALVES

Mullard, Brimar, G.E.C., Mazda, Cossor, E.M.I., Philips, Pinnacle, Telefunken, etc. Send for our New List of manufacturers' surplus, ex-Govt. and imported Valves at lowest prices.

5-milliamp **METER RECTIFIERS.** Special offer of limited number at only **8/6** Post 9d.

SPEAKER COVERINGS

Large stocks of "Tygan" and "Some-weave." Any size piece cut. Sample and prices post free.

SPECIAL OFFER OF SOLDER

1lb. reels of Ersin 5-core "Savbit" SOLDER. List 18/-. LASKY'S PRICE **10/-** Post 1/4.

ALL TYPES OF CHASSIS

Leading makes, including ARMSTRONG, DULCI, EMPRESS, etc.
A.M. chassis (l.,m.,s.) from 7 GNS.
A.M./F.M. chassis from 14 GNS.
A.M./F.M. STEREO from 22 GNS.

OPEN ALL DAY SATURDAY
Early Closing Thurs., 1 p.m.
(Both addresses)

TWO ADDRESSES FOR PERSONAL SHOPPERS

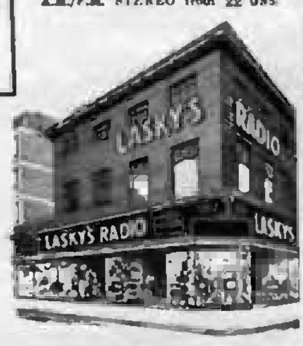
207 EDGWARE ROAD, W.2

PADdington 3271/2. Few yards from Praed Street.

42 TOTTENHAM COURT ROAD, W.1

Nearest Stn.: Goodge Street. MUSeum 2605

Please address Mail Orders to Lasky's (Harrow Road) Ltd., Dept. W, 207 Edgware Road, London, W.2.



SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO

STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification

MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2-stage preamplifier (described below) with which an undistorted power output of up to 10 Watts is obtained. This combination is thoroughly recommended for "HI-FI" enthusiasts who contemplate a versatile and very high quality home installation. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER (which has extra Power available to drive Radio Tuner) and the choice of the latest Ultra-Linear PARMEKO or the PARTRIDGE Output Transformer.

Price: COMPLETE KIT (Parmeko O/put Trans.) **£10.0.0**

Alternatively we supply ASSEMBLED AND TESTED **£11.10.0**

ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.

MULLARD'S PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves, and designed to operate with the Mullard 3-3 and 5-10 MAIN AMPLIFIERS, but also perfectly suitable for other makes.

Our kit is strictly to MULLARD SPECIFICATION and incorporates:

- Equalisation for the latest R.I.A.A. characteristics.
- Input for Crystal Pick-ups, and variable reluctance magnetic types.
- Input. (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
- Sensitive Microphone Channel.
- Wide range BASS and TREBLE Controls.

Price: COMPLETE KIT OF PARTS **£6.6.0** Alternatively we supply ASSEMBLED AND TESTED **£8.0.0**

(Carriage and Insurance 3/- extra.)

SPECIAL PRICE REDUCTIONS

(c) The COMPLETE KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-Stage Pre-Amplifier Control Unit **£15.15.0**

(d) The "5-10" and the 2-Stage Pre-Amplifier both Assembled and Tested **£18.18.0**
H.P. TERMS: Deposit £3 10/- and 12 months of £1/7/8.

(e) The COMPLETE KIT OF PARTS to build the Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit........ **£21.10.0**

(f) The Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested **£25.0.0**
H.P. TERMS: Deposit £5 and 12 months of £1/16 8.

(g) The COMPLETE KIT OF PARTS to build one "5-10" Main Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier Control Unit **£21.10.0**

(h) One "5-10" Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier both Assembled and Tested........ **£25.0.0**
H.P. TERMS: Deposit £5 and 12 months of £1/16 8.

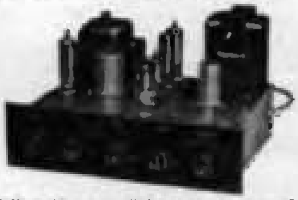
(i) COMPLETE KIT OF PARTS to build Two "5-10" Main Amplifiers (incorporating Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit **£31.0.0**

(j) Two "5-10" Amplifiers (Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested **£36.0.0**
H.P. TERMS: Deposit £7/4/- and 12 months of £2 12/-.

Carriage and insurance 7/6 extra.

Prices quoted are subject to £1 6/- extra for Partridge Trans.

COMPLETE MULLARD 5-10 AMPLIFIER



The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 Watts high quality reproduction. Input channels for high output pick-ups and all modern Radio Tuning Units only.

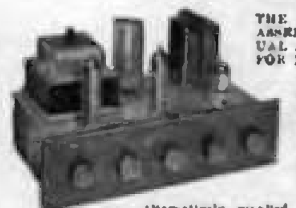
Specified Components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE ULTRA Linear Output Transformers. Adequate power available to drive Radio Tuner. Price: COMPLETE KIT, Parmeko Transformer **£11.10.0**

Alternatively we supply ASSEMBLED AND TESTED **£13.10.0**

Hire Purchase (Assembled Amp. only). Deposit £2 14/-, 12 months at 19/10.
ABOVE incorporating PARTRIDGE OUTPUT TRANSFORMER £1 6/- extra.

COMPLETE MULLARD 3-3

THE COMPLETE ASSEMBLY MANUAL AVAILABLE FOR 1/6.



A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT OF PARTS **£7.10.0**
(Plus 6/6 carriage and insurance.)

Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 6/6 carriage and insurance)........ **£8.19.6**
H.P. TERMS: Deposit £2 and 8 monthly payments of £1.

Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.

MULLARD—STERN STEREO DESIGNS

Model 3-3 M/S

DUAL "3-3" MAIN AMPLIFIER

Comprises two "3-3" MAIN AMPLIFIERS on one chassis and is designed to operate with our DUAL CHANNEL PREAMPLIFIER for both STEREOPHONIC or MONAURAL operation.

Price: COMPLETE KIT OF PARTS **£10.0.0**

Alternatively ASSEMBLED AND TESTED **£11.15.0**

H.P. Terms Deposit £2/7/-, 12 months at 17/4.

Its output power is 6 Watts (3 Watts per channel) and together with our PREAMPLIFIER provides a first class STEREO installation.

DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 2-Valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREOPHONIC or MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 m/v.

Price: COMPLETE KIT OF PARTS .. **£12.10.0** Alternatively ASSEMBLED AND TESTED **£15.0.0**

H.P. Terms £3 Deposit and 12 months of £1/2/-.

Perfectly suitable for MONAURAL only operation, with one "3-3" or one "5-10" MAIN Amplifier to which the second Main Amplifier can at any time be added thus very easily providing for both STEREO or MONAURAL reproduction.

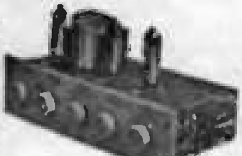
Recommended combination for STEREO operation:

(a) The DUAL CHANNEL PRE-AMPLIFIER together with the Dual "3-3" MAIN AMPLIFIER

(b) The DUAL CHANNEL PRE-AMPLIFIER together with two "5-10" MAIN AMPLIFIERS. Assembly Manual is available for 3/- or send S.A.E. for Descriptive Leaflet. When ordering please advise MAKE and MODEL OF AMPLIFIER in use.

Only New HIGH GRADE Specified Components and MULLARD VALVES are supplied in all these models.

COMPLETE STEREO AMPLIFIER



A thoroughly recommended design that very effectively meets the many requests for a low priced but good quality DUAL CHANNEL STEREOPHONIC AMPLIFIER

Price: COMPLETE KIT OF PARTS **£8.10.0**

Alternatively ASSEMBLED AND TESTED...... **£10.10.0**

Two Mullard ECL82 Triode Pentode Valves are incorporated in the design, they form a "CLASS A" single ended output stage in each channel. The input sensitivity is 300 m/volts, therefore when used with most STEREO Crystal Pick-ups, or Radio Tuning Units, an output of 2 Watts per channel is achieved, or similarly when switched to MONAURAL Pick-up position a combined output of 4 Watts is produced.

Please enclose S.A.E. if ILLUSTRATED and DESCRIPTIVE LEAFLETS are required . . . alternatively the COMPLETE ASSEMBLY MANUALS containing component Price Lists and practical Drawings, etc., are available at 1/6 each.

! ! HOME CONSTRUCTORS ! !

A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS

Designed by the W.B. "STENTORIAN" COMPANY for "HI-FI" Loudspeaker systems or to accommodate high quality equipment. The acoustically designed Bass Reflex Cabinets containing the very successful "Stentorian" Speakers give really first-class reproduction and are well recommended. Models are also available to accommodate high-quality Amplifiers, Preamplifiers, Tuning Units, Record Players, etc. All models are very easily assembled, in fact only a screwdriver is required.

Fully illustrated leaflets are available including complete specifications of the various STENTORIAN LOUDSPEAKERS. Please enclose S.A.E.

THE "ADD-A-DECK"

Incorporating the

NEW B.S.R. "MONARDECK"

and MATCHED PREAMPLIFIER

£17.17.0 Deposit £3/12/-. 12 months £1/6/2. (Plus 7/6 carr. and Ins.)

Designed to operate through the Pick-up Sockets of the standard RADIO RECEIVER through which first-class results are obtained. It consists of a single speed Twin Track Tape Deck, incorporating matched Preamplifier, and operates at 3¾in./sec. speed. It uses 5in. Tape Spools, thus providing up to 1½ hours' playing time on L.P. Tapes or 1 hour on the standard 6in. Tape Spools.

The equipment is supplied fully tested and completely assembled on an attractive wood plinth. It can therefore be "dropped" directly into an existing cabinet and only requires connections to the mains supply and the Pick-up Sockets, for which purposes "floating" leads are incorporated on the Preamplifier.

STERN RADIO LTD. DEPT. W. 109 FLEET ST., LONDON, E.C.4

Telephone: FLEET STREET 5812/3/4

Stern's "fidelity" TAPE RECORDERS

Each Model incorporates the highly successful HF/TR3 Amplifier (described opposite), thus ensuring truly "Hi-Fi" record and playback facilities.

All prices quoted provide for the COMPLETE RECORDER including CRYSTAL MICROPHONE and 1,200ft. Spool of Tape.

There are no "better value for money" Tape Recorders on the market—if you can't call and hear them—send S.A.E. for fully descriptive leaflets.

BEFORE YOU BUY–YOU SHOULD HEAR THESE RECORDERS—THEY ARE COMPARABLE TO THE MUCH HIGHER PRICED MODELS

MODEL CR3/S. Incorporates the New COLLARO "STUDIO" TWIN TRACK 3-speed Deck £41.0.0
H.P. Terms: Deposit £8/4/- and 12 months of £3/0/2.

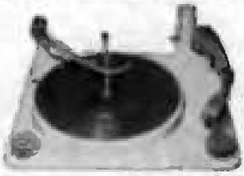
MODEL CR3/T. Incorporates the very popular 3-speed COLLARO MK. IV "TRANSCRIPTOR" Deck, which has both upper and lower tape tracks £49.10.0
H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7.

MODEL TR3/Mk. VI. Incorporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck £49.10.0
H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7.

! ! RECORD PLAYERS ! !

The LATEST MODELS are in Stock. Many at REDUCED PRICES!!!

Send S.A.E. for ILLUSTRATED LEAFLET



B.S.R. MONARCH UA8 4-spd. Mixer Autochanger with Crystal Pick-up. £6.19.6

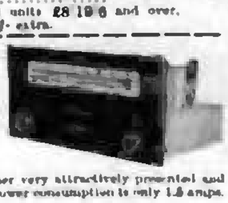
The COLLARO "CONQUEST" 4-spd. Autochanger, Studio "O" Pick-up. £7.10.0

The latest COLLARO "CONTINENTAL" 4-speed MIXER Autochanger, Studio "O" Pick-up.... £8.10.0

The NEW COLLARO model RP594, 4-speed Single Record Player, Studio Cartridge £9.18.9
The COLLARO model 4/564 4-speed Single Record Player, Studio Pick-up £6. 6.0
THE NEW B.S.R. model UA12 is in stock. A 4-"SPEED" MIXER AUTOCHANGER £8. 7.6
UA12 is also available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 records £10.10.0
GARRARD RC121/4 4-speed Autochanger fitted with latest Crystal Pick-up £10. 0.0
The latest GARRARD TRANSCRIPTION MOTOR "301" with Stroboscopically marked turntable £23.18.4
The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 Pick-up arm and G.C.8 Crystal Cartridge £18. 7.6
GARRARD Model TA/MK. II Single Record Player fitted with high output Crystal Pick-up, detachable head £8.10.0

HIRE PURCHASE TERMS available on all units £8 19 6 and over. Carriage and insurance on each above 5/- extra.

STERN'S MK. II "fidelity" F.M. TUNING UNIT

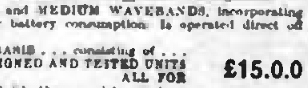


(Plus 5/- carr. and ins.) PRICE £14.5.0
HIRE PURCHASE: Deposit £2 17/- and 12 months of £1/0/11. Incorporates the latest MULLARD PERMEABILITY TUNING HEART and the corresponding MULLARD VALVE LINE UP comprising ECC85, 2 type EF85s (or EF89s), EM84, Tuning Indicator, plus 2 type O.A. 79s Germanium Diodes. A really first-class Tuner very attractively presented and comparable to many offered at much higher prices. Power consumption is only 1.5 amps. at 6.3 volts and 25 m.a. at 250 volts.

! HOME CONSTRUCTORS !

YOU CAN BUILD THIS TUNING UNIT FOR ONLY £10.10.0
(Plus 5/- carr. and ins.)
Please send S.A.E. for fully descriptive leaflet, or the Assembly Manual is available for 1/6

STERN'S 12 VOLT CAR RADIO *incorporating . . .* PRINTED CIRCUIT and POWER TRANSISTOR



A versatile design covering both LONG and MEDIUM WAVEBANDS, incorporating Transistor Output thus having very low battery consumption. Is operated direct off 12 volt car battery.
We offer it on the UNIT ASSEMBLY BASIS . . . consisting of . . .
THREE SEPARATE FULLY WIRED, ALIGNED AND TESTED UNITS ALL FOR £15.0.0
Only 12 solder joints are required to finish the complete receiver. Send 1/6 for manual containing complete data.

CAR BATTERY CHARGER A COMPLETE KIT OF PARTS FOR ONLY .. £2.19.6

Will charge 6 or 12 volt batteries at max. 2½ amps. The design incorporates Reliant Resistor and Fuse and we supply complete with Metal Box container. EASY-TO-FOLLOW ASSEMBLY INSTRUCTIONS ARE INCLUDED.

SPECIAL CASH ONLY BARGAIN

A bulk purchase enables us to offer this very useful INTERCOM SET or BABY ALARM *For only* **£5.5.0**

Consists of MASTER UNIT (illustrated) and one EXTENSION, providing 2-way TALK-LISTEN facility. Complete in polished wood cases, size of each only 7¾ x 4¾ x 6in. high.

! ! RADIOGRAM CHASSIS ! !

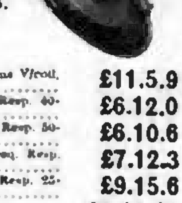
ARMSTRONG MODEL A F 208 .... £23.2.0
Complete AM/FM chassis producing 3 watts. Separate Bass and Treble controls.
ARMSTRONG "STEREO TWELVE" £37.16.0
The most complete A.M./F.M. unit yet produced. For Stereo, giving 6 watts high fidelity push-pull output on each channel, 12 watts for Monaural
ARMSTRONG "JUBILEE" £29.8.0
An AM/FM chassis with nine valves and with push-pull output stage providing 6 watts.
ARMSTRONG AM/FM "STEREO 44" £28.7.0
Provision is made for Stereo and Monaural playback from pick-up or tape. Outputs provided for Stereo or Monaural tape recording.

RADIO TUNING UNITS

The JASON "MERCURY" Switched F.M. TUNER. PRICE ASSEMBLED AND TESTED £13.10.0
Complete Kit of Parts £9 19 6.
DULCI Model FMT/2 .... £19.17.6
A complete self-powered FM Tuner incorporating automatic frequency control.
ARMSTRONG "S.T.3." AM/FM Tuning Units £27.6.0
A self-powered high fidelity tuner covering full VHF, medium and long wavebands with automatic frequency control on VHF.
DULCI "H4/T" AM/FM Tuning Units £25.15.2
A 4-waveband self-powered high fidelity tuner covering the VHF/FM transmissions plus the long, medium and short wavebands.
NEW HIRE PURCHASE TERMS are available on all above. Illustrated leaflets available—send S.A.E. (Carr. and Ins. 5/- extra.)

Hi-Fi LOUDSPEAKERS

WE HAVE IN STOCK THE COMPLETE RANGE BY GOODMANS - WHARFEDALE - W.B.



And will be pleased to send you Illustrated and Priced Leaflets.

Recommended Types are:

GOODMANS "AXIOM 300." The best 12in. Seller. 15 ohms V/coil, Freq. Resp. 30 c/s., 16,000 c/s £11.5.9
GOODMANS "AXIETTE" 8-inch. 3 or 15 ohms. Freq. Resp. 40-15,000 c/s £6.12.0
W.B. "STENTORIAN" H.F.816, 8in., 3 or 15 ohms. Freq. Resp. 50-15,000 c/s £6.10.6
W.B. "STENTORIAN" H.F.1016, 10in., 3 or 15 ohms. Freq. Resp. 30-15,000 c/s £7.12.3
W.B. "STENTORIAN" H.F.1214, 12in., 15 ohms. Freq. Resp. 25-14,000 c/s £9.15.6
WHARFEDALE "SUPER 8 FS/AL" 8in. 3 or 15 ohms £6.19.11
WHARFEDALE "GOLDEN FSB." 10in. 3 or 15 ohms Voice Coil £7.13.3
WHARFEDALE "W12/FS." 12in., 15 ohms. Voice Coil £10.5.0
WHARFEDALE "SUPER 12/FS/AL." 12in., 16 ohms Voice Coil .. £17.10.0

LOUDSPEAKER ENCLOSURES—TWEETER UNITS CROSSOVER UNITS *are also available.*

SPECIAL CASH ONLY OFFER !!

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY £8.7.6 (plus 7/6 carr. and ins.). The Amplifier consists of a 2-stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey colour Rexine—WE ALSO SUPPLY SEPARATELY:—

(a) The 2-stage (plus Rectifier) AMPLIFIER £4 2 6
(b) The PORTABLE CARRYING CASE £3 17 6
(c) 12in. P.M. SPEAKER 18 9
(Carriage and Insurance 4/- extra)

STERN RADIO LTD. DEPT. W. 109 FLEET ST., LONDON, E.C.4
Telephone FLEET STREET 5812/3/4

CLYNE RADIO LTD.

162, HOLLOWAY ROAD, LONDON, N.7
NORth 6295/6/7
ALSO AT:—18, TOTTENHAM COURT ROAD, LONDON, W.1.
MUSeum 5929/0095
99 CHEAPSIDE, E.C.2. MON 6860
All post orders and correspondence to 162, HOLLOWAY RD., LONDON, N.7.

Open: Tottenham Court Rd., and Cheapside: 9 a.m. to 6 p.m. Mon. to Fri., Sat. 1 p.m. Holloway Road: 9 a.m. to 6 p.m. daily. Thurs. 1 p.m., Sat. 5.30 p.m.

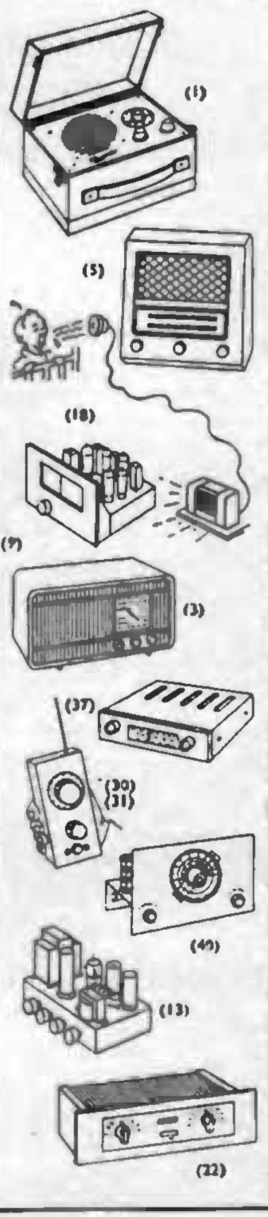
If not stated, please add postage on orders under £1. Cash with order or C.O.D. (charges extra).

Our Advantageous H.P. and Credit Sale Terms are available on any single item over £5. Your enquiries invited. Please print your name and address!!

TO BUILD YOURSELF

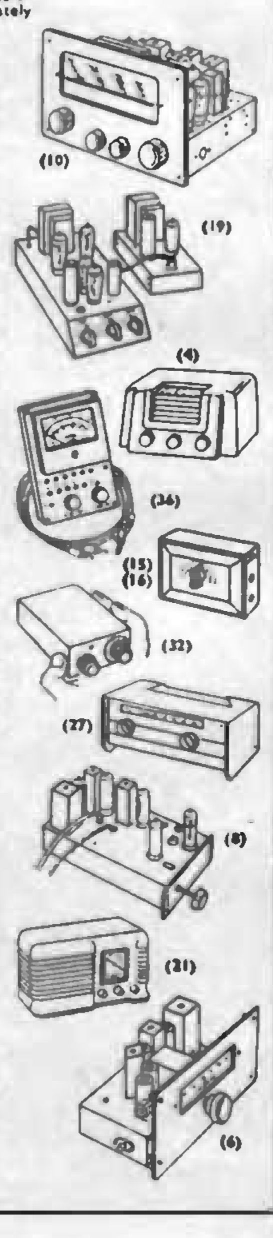
ALL PARTS AVAILABLE SEPARATELY

WE ARE THE EXPERTS IN THIS FIELD AND CARRY THE MOST COMPREHENSIVE STOCKS IN THE COUNTRY.



	All required components at special inclusive price	P. & P.	Instruction Book and itemised price list available separately
(1) New Look "RAMBLER" all dry s'het portable...	£7 7 0	2/6	1/6
(2) "RAMBLER" Mains Unit (suitable for most portables)	£2 7 6	1/6	9d.
(3) "ECONOMY FOUR" T.R.F. Mains Receiver	£5 10 0	2/6	1/6
(4) "FAMILY FOUR" (our new T.R.F. Receiver)	£3 19 6	2/6	1/6
(5) "SUPERIOR FOUR" (four valve mains receiver)...	£5 15 0	2/6	1/6
(6) Standard JASON F.M. Tuner	£6 15 0	2/6	2/-
(7) Fringe area JASON F.M. Tuner	£7 15 0	2/6	2/-
(8) JASON "MERCURY" Switch tuned F.M. feeder	£9 19 6	2/6	2/-
(9) OSRAM 912 Printed circuit F.M. Tuner	£8 8 0	2/6	2/6
(10) JASON "ARGONAUT" AM/FM Chassis	£15 5 0	2/6	2/-
(11) JASON "ARGONAUT" AM/FM Tuner	£13 19 6	3/6	2/-
(12) F.M. Power pack (suitable for most tuners)	£1 17 6	1/6	1/-
(13) R.C. 3/4 watt amplifier (with Bass, Middle, and Treble controls)	£4 5 0	2/6	1/-
(14) 2-amp. Battery Charger	£1 16 6	2/6	3d.
(15) R.C. Transistor/Crystal Receiver ('phones extra)...	£1 1 0	1/3	3d.
(16) R.C. Super Transistor/Crystal Rec. (ditto)	£1 7 6	1/3	3d.
(17) R.E.P. 1-valve Battery Receiver	£2 2 0	2/-	9d.
(18) "CRY-BABY" ALARM (Baby Alarm)	£3 12 6	2/6	1/-
(19) MULLARD 510 Amplifier (printed circuit) Ultra Linear version	£9 9 0	3/6	1/6
(20) TELETRON "TRANSIDYNE" Transistor Portable	£11 19 6	2/6	1/-
(21) "DE-LUXE" Printed Circuit Superhet	£7 19 6	3/6	1/6
(22) JASON J.T.V. 2 Tuner	£13 19 6	3/6	2/6
(23) RADIO JACK	19 6	1/6	6d.
(24) MULLARD TYPE "C" Tape pre-amp.	£12 9 6	3/6	2/6
(25) JASON J.3-3 Stereo pre-amp.	£15 17 0	2/6	2/6
(26) JASON J.4-4 Stereo pre-amp.	£22 14 0	2/6	3/-
(27) NEW JASON F.M. TUNER with built-in power supplies and cabinet	£8 19 6	3/6	2/6
(28) NEW JASON FRINGE AREA F.M. TUNER as above	£10 19 6	3/6	2/6
(29) PULLIN Series 90 TEST METER	£5 19 6	2/6	1/6
(30) R.C. Super Personal Portable, 1-valve (phone extra)	£1 15 0	2/6	2/-
(31) R.C. Super Personal Portable, 2-valve (phone extra)	£2 1 0	2/6	2/-
(32) R.C. TRANSETTE 2-Transistor Personal Portable	£3 9 6	2/-	2/-
(33) JASON EVEREST 6-Transistor 2-wave Portable	£13 19 9	3/6	3/6
(34) JASON EVEREST 7-Transistor 2-wave Portable	£15 18 9	3/6	3/6
(35) CLYNE Cathode Ray Oscilloscope	£12 19 6	5/-	10/-
(36) Compact Multi-Range Test Meter	£2 19 6	1/6	1/6
(37) CAR RADIO. Printed circuit. 5-valve Superhet	£12 19 6	3/6	3/6
(38) JASON Audio Generator AG10	£14 5 0	3/6	2/-
(39) JASON Oscilloscope OG10	£22 10 0	5/-	3/6
(40) Super SHORT WAVE RADIO, 1 valve	£1 15 0	2/-	2/-

Instruction Books which contain full description, easy-to-follow practical wiring diagrams, theoretical diagrams, itemised price lists, etc., are free of charge with all parcels but may be purchased separately as shown above.



NEW! NEW! THE "WAVEMASTER" 7-TRANSISTOR LUXURY PORTABLE

To build yourself! Medium and Long Waves—Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10in. x 6½in. x 4½in. at base tapering to 4in. at top. Very attractive two-tone Vynide covered cabinet with cream and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. Weight complete with long-life 7½ volt battery—4½ lb. Mazda transistors throughout. High-Flux 7in. x 4in. Elliptical Speaker, slow motion tuning, co-axial socket at rear for direct connection to Car Radio Aerial. Improved reception by use of seven-section plated telescopic aerial disappearing into Cabinet when closed, 34in. above Cabinet when fully extended. Construction simplified by bakelite chassis board with the following components already mounted:—Tuning Condenser—I.F. Transformers (3). Oscillator Coil, Trimmer Bank, Output Transformer, Interstage Transformer, Ferrite Rod Aerial, Brackets and Earth Bar. SPECIAL INCLUSIVE PRICE for all required components, full assembly instructions—nothing more to buy—is £10/19/6 plus 3/6 P. & P.
Alignment service available. Full assembly instructions and individually priced parts list, all of which are available separately 2/6 post free.

VISIT OUR FULLY EQUIPPED
HI-FI SHOWROOM
AT TOTTENHAM COURT ROAD FOR DEMONSTRATIONS OF THE LATEST
HI-FIDELITY EQUIPMENT
BY ALL LEADING MANUFACTURERS

We stock equipment of Quality by all leading makers: i.e., Leak, Quad, Armstrong, Dulci, Ferrograph, Reflectograph, Vortexion, Linear, Wharfedale, Grundig, Goodmans, W.B., Rogers, Garrard, Lenco, B.T.H., Pamphonic, Simon, Brenell, Collaro, etc., etc.

A full range of high quality cabinets to suit all purposes is on show, i.e., "RECORD HOUSING," "W.B." etc., Enquire about our interesting part-exchange scheme for personal callers.

SUPER MAGNETIC RECORDING TAPE SPECIAL !!!
Trade enquiries invited
First delivery Famous American Ferrodynamics Acetate Base High Quality Recording Tape. An enthusiast's "must." Brand new (NOT SUB-STANDARD), 7in. 1,200ft. on plastic spool, 25/-; 7in. 1,800 ft. on plastic spool, 35/-. Professional quality "MYLAR" Du Pont 7in. 1800ft. 44/-, 7in. 2400ft. 60/-, 5in. 1200ft. 37/6. P. free.

NEW BRANCH !!
CITY BRANCH NOW OPEN AT
99, CHEAPSIDE,
LONDON, E.C.2.
Telephone: MONarch 6860

Situated midway between Bank and St. Paul's Stations and no more than one minute from either. Monday to Friday 9 a.m.-6 p.m. Saturday 1 p.m.

STILL LEADING THE FIELD!

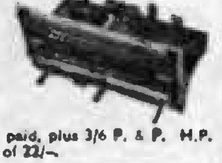
CLYNE CATHODE RAY OSCILLOSCOPE for Home Construction

The latest addition to our comprehensive stocks of quality equipment for the constructor. This is an exceptionally sound and robust instrument of the most versatile type, that will be a boon to the seriously minded amateur, serviceman or constructor. Specifications: 8-Range Time Base, switched from 20 c/s. to 160 Kc/s. Y-Plate Amplifier has a sensitivity of 50 mV, and frequency response of 20 c/s to 600 Kc/s with a gain of 150. A calibrating voltage of 6.3 v. 50 c/s. is provided. Employs ECR30 2½in. Cathode Ray Tube and 4 valves; 2/ECF80, 1/EF91, 1/6X5. Controls: X-shift, Y-shift, Focus, Width, Brilliance, ON/OFF, Time Base Frequency (Fine), Time Base Frequency (Coarse). Sync. Selector, Sync. Amplitude, Y-input Selector, X-input Selector, Amplifier Gain. Operates from 200/250 v. A.C. Mains. All required components for the construction of this wonderful instrument, including comprehensive assembly instructions, available at a SPECIAL INCLUSIVE PRICE OF ONLY £12/19/6, plus 5/- carriage and packing.

A.M. GRAM CHASSIS SPECIAL! (By famous manufacturer). This special offer chassis is being offered for a limited period only and represents the best possible value for money. Spec.: 3 wavebands, Long, Medium and Short, 5 miniature valves—6C7, 6F15, 6LD20, N108, U107. Attractive vertical glass dial (13in. x 3½in.) in red, green and gold on black background. Two-speed dial drive. Full range tone control. Output approx. 4 watts to match 3 ohm speaker. For A.C. mains 110/250 v. Overall size 13in. x 6½in. x 6½in. high. WHILST STOCKS LAST. £7/19/6 ONLY, plus 7/6 P. & P.

SPECIAL PURCHASE A.C./D.C. CHASSIS MANUFACTURER'S SURPLUS

Owing to favourable purchase we can offer strictly limited quantity of these handsome chassis. A.C./D.C. 200/250 v. for Medium and Long Wave plus gram position. Incorporates own frame aerial. Valve line up: U107, N108, DH107, W107 and X109. Overall chassis size 12 x 5½ x 7½in. high. Attractive bronze dial with gold and cream lettering. Dial size 11½ x 4½in. Scale length 7½in. Logging scale provided. Price £7/19/6 only, tax paid, plus 3/6 P. & P. H.P. terms £4 deposit, plus four monthly payments of 22/-.



ADVANCE ANNOUNCEMENT ! TWO NEW COMPETITIVELY PRICED TAPE RECORDER KITS NOW READY !

Both 3 watts output, printed circuit construction, valve line-up EF86, EL84, ECC83, EZ80 and EM84 recording indicator. Latest 8"x4" High Flux Speaker. Complete with Tape and empty Spool, and Acos 39-1 stick mike with stand. Attractive two-tone Cabinet. Supplied with latest COLLARO Studio 3-speed deck. Total price 25 guineas. Supplied with B.S.R. single-speed deck, total 20 guineas.
N.B. These are Kits, amplifier supplied unassembled. Full assembly instructions are included. Please add 7/6 for packing and carriage. All parts available separately. Full details on application.

RECORD PLAYERS

Full range of changers, single players, transcription units at usual competitive prices. Interesting H.P. facilities.

E.M.I. 4-SPEED STEREO SINGLE RECORD UNIT. Complete with Stereo Head and Sapphire Styli. Brand New and Fully G'teed. ONLY £6/19/6 plus 3/6 P. & P. whilst stocks last.

GARRARD RC.121D MK. II STEREO MONAURAL 4-SPEED AUTO-CHANGER. Complete with GC8 plug-in Crystal Head and Sapphire Styli for monaural records. Finished in cream. Brand new, fully guaranteed. Limited stocks. ONLY £11/0/6, plus 5/- P. & P. NOTE: Garrard L.P. Stereo plug-in head for above available as optional extra for £2/0/1 inc. P.T. Terms available.

B.S.R. UA8 MONARCH. 4-speed Mixer Autochanger complete with turnover crystal insert and Sapphire Styli. Few only, now at £6/19/6, plus 3/6 P. & P. Brand new and fully guaranteed.

THE LATEST COLLARO "CONQUEST" 4-speed autochanger in cream with Studio "O" insert. Brand new, fully guaranteed. £7/19/6, plus P. & P. 3/6.

COLLARO "CONQUEST" STEREO/MONAURAL. Latest type—full guarantee. Brand new. £8/19/6, plus 3/6 P. & P.

DECCA PORTABLE AMPLIFIER. As supplied in famous DECCAMATIC III. Complete with small cream knobs. Full range tone and volume controls. Employs ECL82 valve. Size 3 x 3½ x 8½in. Only 59/6, plus 2/6 P. & P.

SPECIAL CELESTION 8 x 6in. elliptical high flux loudspeaker 30/-, plus 1/- P. & P. to fit.

VERY ATTRACTIVE PORTABLE CABINET in two-tone rexine covering for accommodating the above items and ancillary equipment. 75/-, plus 5/- P. & P.

Note. If the above three items are purchased together they will be supplied at the special inclusive price of £7/2/6, plus 6/6 P. & P.

LATEST COLLARO STUDIO TAPE TRANSCRIPTOR. 3 motors, 3-speed: 1⅞, 3¾, 7½ i.p.s., takes 7in. spools. Push-button controls. £15/15/-, plus 5/- P. & P. Usual H.P. facilities.

LATEST B.S.R. "MONARDECK." Single speed Tape Deck. Takes 5¾in. Spools—3¾ i.p.s. At £9/19/6 only, plus 5/- P. & P.

A COMPACT TEST METER FOR HOME CONSTRUCTION. This is a very sensitive multi-range test meter (500 microamp basic movement) covering the following ranges: A.C./D.C. voltage: 0-10 v., 0-50 v. and 0-500 v. Current: D.C. 0-10 mA., 0-50 mA. and 0-500 mA. Resistance (on internal battery) 2K.ohm to 100K.ohm. Housed in a smart grey stove enamelled case measuring 3¾in. x 7in. x 1¾in. overall. Brand new best quality components and High Stability resistors are used throughout, resulting in a thoroughly reliable, accurate instrument.
NOTE: Meter is supplied with calibrated scale fitted, and all components, including shunt, are prepared for immediate soldering into position. Comprehensive assembly instructions with practical and theoretical diagrams are supplied together with all necessary components at a SPECIAL INCLUSIVE PRICE OF ONLY 59/6, plus 1/6 P. & P. The instruction envelope is available separately if required at 1/6 post free.

PRECISION TEST METER (To build yourself)
Nineteen ranges D.C./A.C. Current and resistance. Designed and produced for use by the famous Pullin Company. All necessary components at Special Inclusive Price of only £5/19/6, plus 2/6 P. & P. Illustrated leaflet with full description available on request.

CABY UNIVERSAL TEST METERS
These pocket-size multi-range test meters are of excellent quality and cover all the most useful ranges (A.C. Volts D.C. Volts, resistance and current). Supplied complete with test prods, instruction book and batteries. Model A.10 (2,000 ohms per volt) £4/17/6
Model B.20 (10,000 ohms per volt) £6/10/-
Plus P. & P. 3/6 on each.
Fully detailed and illustrated leaflet available on request.

ALFA POCKET TESTMETER
A most versatile test meter covering 15 ranges. 3,333 o.p.v. basic movement. Ohms ranges: 0-20K. 0-2 Meg. Volts: A.C. and D.C. 6 v., 12 v., 60 v., 300 v., 1,200 v. Current: D.C. 300 microamps, 30 mA., 300 mA. Size only 3½in. x 5in. x 1¾in., overall. Supplied complete with instructions and test prods. ONLY £5/19/6, plus 2/6 P. & P.

CLYNE RADIO LTD.
162 Holloway Road, London, N.7.
99 Cheapside, London, E.C.2.
18 Tottenham Court Road, London, W.1

SEE OVER FOR MORE BARGAINS →

METERS. We carry large stocks of Meters from 25 microamps to 1,500 v. A few of the most popular types are: 25 microamps 2½in. Flush Round, 65/-; 100 microamps 2½in. Flush Round Moving Coil at 45/-; 500 microamps 2in. Flush Round Moving Coil at 18/6; 1 mA. 2in. Flush Square Moving Coil "Elliott" 1954 manf., 25/-; 50 mA. 2in. Flush Square Moving Coil 8/6; 1 mA. 2½in. Flush Round 35/-. Send stamp for complete list. We shall be pleased to quote for special meters to your own specification.

SPEAKER BARGAINS

Goodmans 8in. x 2½in., 3 ohms. 24/- plus 1/6 P. & P. 10in. Elac High Flux 3 ohm, 39/6 plus 2/6 P. & P. 8in. Celestion High Flux 3 ohm, 32/6 plus 2/- P. & P. 4in. Plessey Tweeter, 15/- plus 1/6 P. & P. R. & A. Type 9120, Mk. II, 12in., 10–12 watts, 3 ohm, 12,000 gauss, 55/- plus 3/6 P. & P. R. & A. Type 8120, Mk. II, 12in., 10–12 watts, 3 ohm, 10,000 gauss, 39/6 plus 3/6 P. & P. 12in. Bakers Selhurst, 15 ohms, 15 watts, 30–14,000 c.p.s., £4/10/- plus 3/6 P. & P. All the above brand new and fully guaranteed.

Special! Special! Latest E.M.I. full frequency speaker. Size 13½in. x 8½in., 3 ohm speech coil. Double cone. Unrepeatable at 39/6 each only. Plus 3/6 P. & P.

AERIAL TUNING UNIT

ZA0841. This well made ex-W.D unit contains a host of useful components including: 1 mA. 2in. flush round M/C meter, 1 mA. Westinghouse full-wave meter rectifier, 3-pole 5-way heavy-duty silver plated wavechange switch. 3in. dia. silver plated rotary tuning indicator, 350 pF tuning condenser with insulated coupler and 3½in. calibrated dial (0–180 deg.). etc., etc. Contained in strong metal carrying case 9in. x 9in. x 8in. with hinged lid. ONLY 27/6 plus 5/- C. & P.

No. 38 AFV WALKIE-TALKIE A wonderful offer. This famous transreceiver unit, with relay operated SEND/RECEIVE switch, covering 7.4–9 Mc/s band, range approx. 5 miles. Good condition. ONLY 22/6 plus 2/6 P. & P. per unit (less accessories). Quantity Export inquiries welcomed.

"ROLEX" SPECIAL HEAVY DUTY MAINS/BATTERY AMPLIFIER. Very smart unit housed in grey crackle finish case with chrome and cream fittings. For use on A.C. mains 200/250 v. or 6 v. D.C. battery. Valve line-up: 6SK7, 6SN7, 6SL7, 2-6V6, 6X5 and 629C vibrator, 20 watts output to match 4, 8, 16, 250 and 500 ohm speaker systems. Ideal for P.A. work, etc. Size: 13½in. x 8½in. x 7½in. Mike and gram inputs with separate gain controls, tone control. Brand new, fully guaranteed. ONLY £15/15/-, plus 7/6 P. & P.

DLR5 BALANCED ARMATURE HEADPHONES. Complete with headband and leads. 7/6 pair, plus 1/6 P. & P.

HIGH IMPEDANCE LIGHTWEIGHT HEADPHONES. Brand new imported type 4,000 ohms. Complete with leads, 15/- plus 1/6 P. & P.

AMPLIVOX HEADSET SPECIAL (not surplus). As used in up-to-date ships, aircraft, etc. Excellent quality super lightweight low impedance magnetic headphones complete with button microphone attached and plastic ear moulds. Absolutely brand new. 45/- pair. Plus 1/6 P. & P.

EVERSHED AND VIGNOLES BRIDGE MEGGERS. Series 2, 250 v. Perfect and complete with leather carrying case. FEW ONLY at £19/19/-, plus 7/6 P. & P.

EXTRA SPECIAL OFFER!!

A small three-valve **PORTABLE RECORD-PLAYER AMPLIFIER** mounted on baffle 12 x 7in., with High Flux 6½in. Loudspeaker. Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready to use. £5/12/6 plus 3/6 P. & P.

NEW STYLE CABINET finished in two-tone Leatherette. Will accommodate above Amplifier and Baffle without modification, also most types of Ancillary Equipment. Overall size 18 x 13½ x 8½in. Fitted with carrying handle, £3/9/6 plus 5/- P. & P.

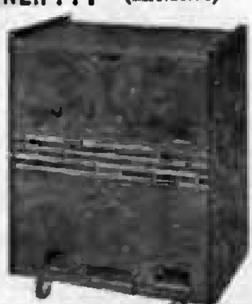
NOTE. If both items purchased together they will be supplied at a special inclusive price of £8/7/6 plus 6/6 P. & P.

CABINET SPECIAL!!! JUST ARRIVED!!

Leading manufacturers' special tape equipment cabinet—multi purpose. Will house all your portable tape or record playing equipment, speaker up to 8in. or 10in. x 6in. Size 18in. x 16in. x 14in. Dark green rexine covered, chrome carrying handles and fitted detachable lid with lockable clips. (Keys supplied.) Brand new in original packing. PRICE ONLY 75/- plus 5/- part packing and carriage. (Limited quantity.) A truly professional job!

RETURN OF A WINNER!!! (Exclusive)

We have been fortunate in obtaining a further limited supply of this fine and popular cabinet. Instantly recognised as being of leading High Quality manufacturer's stock, this trolley-type cabinet is finished in polished dark walnut. Can easily be adapted to accommodate tape recorder, amplifier, radiogram, etc., etc. External measurements: 24½in. x 16in. x 29in. The whole is mounted upon "easy run" castors. Subject to being unsold, £5/19/6. Plus 15/- C. & P.

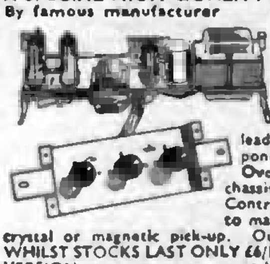


ALLAN DOUGLAS ELECTRONIC ORGAN

Readers will no doubt be pleased to know that our working model of this amazing organ for home construction, may now be heard and seen, at our Hi-Fi Showroom in Tottenham Court Road, W.1. For the benefit of constructors all components, keyboards, chokes, etc., are available ready made. Full constructional details are available in book form at 15/- plus 1/6 p. and p. We shall be happy to forward a complete price list on receipt of a stamp. Please address all organ enquiries for the attension of Mr. L. Roche.

A SPECIAL HIGH QUALITY PUSH-PULL AMPLIFIER

By famous manufacturer



Limited stocks only of this really wonderful quality amplifier employing 4 valves: 2-EL84, ECC83, EZ80. Separate Bass and Treble Controls mounted with Volume control upon loose panel with flying leads. Excellent quality components employed throughout. Overall dimensions: (Main chassis) 12½in. x 4in. x 5in. high. Control panels 6in. x 2½in. Input to match standard high impedance crystal or magnetic pick-up. Output approx. 8 watts max. WHILST STOCKS LAST ONLY £6/19/6, plus 3/6 P. & P. STEREO VERSION—same appearance and valve line-up, only £7/9/6 plus P. & P.

—TRANSISTORS!!!—

SURPLUS—P.N.P.

RED SPOT (Audio/Experimental Application) .... 5/- ea.

WHITE SPOT, R.F. up to 2.5 Mc/s .... 7/6 ea.

STANDARD—

BRIMAR

TS8 .... 18/6 ea.

MULLARD

OC16 Power 3 watt .... 54/- ea.
OC44 .... 18/6 ea.
OC45 R.F. up to 6 Mc/s .... 16/6 ea.
OC70 .... 10/- ea.
OC71 .... 10/- ea.
OC72 .... 14/6 ea.
OC/72 matched pair .... 27/- pr.
OC73 .... 12/6 ea.
OC77 .... 18/6 ea.

NEWMARKET

V6/2R R.F. up to 4 Mc/s .... 19/6 ea.
V6/4R R.F. 4–8 Mc/s .... 23/- ea.
V6/8R R.F. up to 8 Mc/s .... 26/- ea.

Audio

V10/15A .... 12/- ea.
V15/10P (Power) .... 15/- ea.

MAZDA

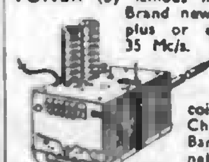
XA104 R.F. up to 6 Mc/s .... 18/- ea.
XA103 R.F. up to 4 Mc/s .... 15/- ea.
XB104 Audio up to 1 Mc/s .... 10/- ea.

Attractive discounts for bulk purchases. The above is a selection only. Let us have your enquiries.

(ALL POST FREE)

★ BARGAIN CORNER ★

12 CHANNEL T.V. TURRET TUNER (by famous manufacturer). Brand new, NOT surplus or ex-equipment, 35 Mc/s. I.F. PCC 84 and PCF 80 valves. Complete with coils; Band I Channels 1 to 5. Band III Channels 8 to 11. In manufacturer's original carton. Fully guaranteed at only 39/6 plus 2/6 P. & P.



ACOS MIC 39-1. Crystal stick microphone with stand. List price 5 gns. Our price 39/6 plus 1/6 P. & P.

MIC40. General purpose crystal microphone with desk stand. Our price 25/- only plus 1/6 P. & P.

DEAF AID TYPE EARPIECES. Standard magnetic type complete with lead and plug. As new. ONLY 12/6 plus 1/- P. & P.

ANOTHER PORTABLE CABINET BARGAIN! Ex leading manufacturer's battery portable attache type case. Attractive two-tone grey rexine finish. Size closed 13½in. x 9½in. x 3½in. Complete with fittings and handle. Including Medium and Long Wave frame aerial which fits in lid. Limited quantity only at bargain price of 19/6 plus 2/- P. & P. Brand new.

TRANSFORMER SPECIAL. Supplied quality half shrouded drop thro' Mains Transformer. Input 200/250 v. Output 350–0–350 v. 80 mA.: 6.3 v. 3 amps. 5 v. 2 amps. Ex-equipment but guaranteed O.K. ONLY 9/6 plus 1/- P. & P.

8in. **LOUDSPEAKER.** Ex-equip. as new. Less transformer. 3 ohm speech/coil. In attractive cloth covered cabinet. Ideal for extension speaker. 22/6 plus 1/6 P. & P. Speaker only, less cabinet at 13/6 plus 1/6 P. & P.

BARGAIN! REPLACEMENT PICK-UP INSERTS. All brand new and fully guaranteed. Complete with Sapphire Styli. **FONOFLUID** 21/- each. B.S.R. TC8 (less bracket) 15/- each. B.S.R. Hi-G with bracket, 18/- each. B.S.R. Hi-G (less bracket), 15/- each. E. V. **POWER POINT** in Garrard plug-in shell, 18/6 each. **GARRARD GC2** 16/- each. E. V. **CARTRIDGE** only 11/6 each. All plus 9d. P. & P.

VALVES. We have perhaps the most up-to-date valve stocks in the trade. New imported valve types fully guaranteed and P.T. paid and all the usual surplus types at special prices. We also carry a comprehensive stock of all B.V.A. types at current list prices. Send stamp for NEW list now available. Note: Certain American special purpose types can be supplied. Enquiries invited.

RE-GUNNED CATHODE RAY TUBES. (As new.) Guaranteed 12 months. 12in., 14in., and 15in., £5/10/-; 17in., £6; 21in., £7/19/6; plus 10/- c. and p.

CLYNE RADIO LTD.

162 Holloway Road, London, N.7
99 Cheapside, London, E.C.2
18 Tottenham Court Road, London, W.1.

ALSO SEE PAGES 136 & 137

MOBILE RADIO TELEPHONES

MODEL HP II

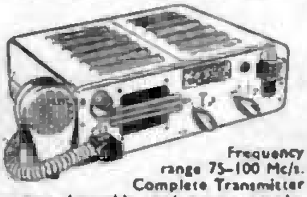
Technical Specification:

TRANSMITTER

R.F. power output: 5 watts.
Frequency stability: 3 parts in 10^6 per degree centigrade.
Carrier noise level: 52dB below 30 per cent. depth of modulation.
Spurious omissions: 2nd harmonic attenuated 54dB, all others at 70dB.
Modulator output: 4.5 watts.
Modulation capability: 90 per cent.
Modulator response: Flat to within 1dB from 150—3000 c/s.
Public address: Audio output 4.5 watts.

PANEL CONTROLS

Aerial socket, pilot lamp, extension speaker, selector switch, volume control.



Frequency range 75—100 Mc/s. Complete Transmitter Receiver Assembly, and power supply, measuring only 8½in. x 8in. x 4in. Weight 14¼ lb.

Each set comprises one V.H.F. Trans/Receiver, one 12v. power supply and one hand microphone.

Original cost over £100; supplied in used condition but in working order at

ONLY **£18** PER SET

plus 30s. 0d. carriage.

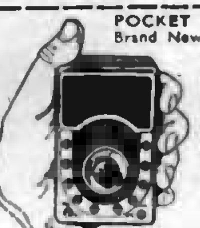
Specification (contd.):

RECEIVER

Sensitivity: Less than 1 microvolt.
Frequency stability: 2 parts in 10^6 per degree centigrade.
Selectivity:—6dB at ± 25 kc/s.
—30dB at ± 50 kc/s
—50dB at ± 65 kc/s off tune
Signal to noise ratio: 12dB or better for 1μv input. A.F. Output: 1 watt.
Speaker Impedance: 3 ohms.

POWER PACK

Power input: 12 v.
H.T. Output: 300 volts at 105 mA. for Transmitter. 250 volts at 54 mA. for Receiver.
L.T. Output: 6.3v. at 1.6 amps.; 6.3v. at 2.6 amps.



POCKET MULTI - METER Brand New. 2,500 o.p.v. Multi range. 6/30/120/300/1,200 v. A.C., ditto D.C. 0-1k., 0-1 meg-ohm; 400 micro-A., 12 m.A., 300 m.A.; −00 to +65 db, 5 ranges. 3 x 4¾ x 1½in. Large clear dial. Leads supplied. (List price £6/19/6). OUR PRICE £4/7/6. P. & P. 2/6.

SIGNAL GENERATOR. 100 kc/s.-100 Mc/s. and 100 Mc/s.-200 Mc/s. Internal Mod. 400 c.p.s. to a depth of 30%, modulated or unmodulated R.F. output continuously variable 100 milli-volts. C.W. and mod. switch, variable A.F. output. Magic eye. Metal case 10 x 6¼ x 5½in. A.C.200/250 v. Brand new. Only £6/19/6. Carr. 5/–.

T.C.S. RECEIVER

1.5 to 12 Mc/s. 7-valve superhet, built like a dream. 12SK7-RF, 12SA7 Mixer, 12A6 Oscillator, 12Q7 Detector, AVC - BFO - 1st AF, 12SK7-I.F.'s. The 12A6 final puts 1.4 watts into 500 ohms with an input modulated only 30%. Panel controls: R.F. Gain, A.F. Gain, C.W. Pitch, band-switch, mod.-C.W. switch, power switch, ground and aerial posts, M.O. or crystal frequency switch, speaker jack, card holder to log 30 stations, hand vernier tuning knob turning a large etched calibrated plate behind hair lined window, anti-backlash gears used. Used condition. £8/10/-, carriage 15/–.

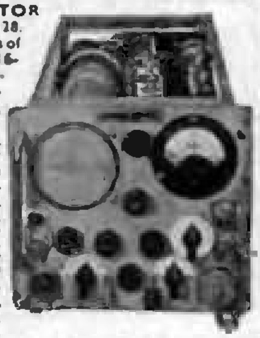
T.C.S. TRANSMITTER available at £9/10/-, carriage 15/–. Note.—If both items purchased together, £17. Carriage 25/–.

D.M. 34. America's finest little dynamotor offering 12 v. in with 220 v. out at 80 mA. With suppression and smoothing mounting base. Size 4¼ x 2¾ x 2¾in. Original packing. ONLY 35/– P. & P. 3/6.

WIRELESS SET No. 19 Mk. II

This famous Transmitter-Receiver incorporates "A" Set—TX/RX covering 2-8 Mc/s. (37.5-150 metres). "B" Set—VHF TX/RX covering 230-240 Mc/s. (1.2-1.3 metres) and intercom. amplifier. Complete with 15 valves, 500 micro-amp. check and tuning meter, circuits, and instruction book (American manufacture). In used condition, 65/–. Carr. 10/–.

MONITOR TYPE 28.



Consists of VCR138A-SP61, 1-5U4, 1-VU120, 3-EA50, 1 mA. meter scaled 100-0-100v. Incorporates Y shift, X shift in μ/sec., Focus, sync., Bias. Input to X plates switched x20. x5 and direct, requires only suitable power pack for use as oscilloscope. 70/–, carr. 10/–.

ALIGNMENT ANALYSER Type MC12

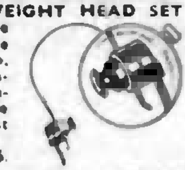
A.C. MAINS 200/250 volts. Provides:—"WOBBULATOR" (SWEPT FREQUENCY) OPERATION, for FM/TV alignment linear frequency sweep up to 12 Mc/s. From 400 kc/s.—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided, 0–60 pf. and 0–120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned cct. I.F. transformer, etc., to be rapidly determined. ONLY £6/19/6. P. & P. 5/–.

HI-FI CO - AXIAL SPEAKERS. BRAND NEW—U.S.A. MADE. 12in. Co-axial Speaker. The woofer uses 6.8 oz. Alinco 5 magnet. Has 3in. tweeter and an electronic crossover network to separate the speaker functions. Frequency response: 40-17,000 cycles. Output 12 watts, impedance 8 ohms. ONLY 120/–. 8in., 2½in. tweeter, 10 watts, etc., 90/–. P. & P. 4/– on each.

BRAND NEW VARIABLE TRANSFORMERS.

Input 230 volts. Output 0-260 volts. 5 amps. Brand new, only £9. Carr. 12/6.

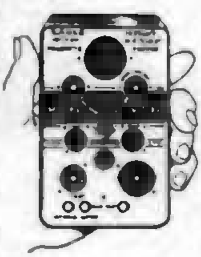
AMERICAN LIGHTWEIGHT HEAD SET



These H.S.30 phones are the smallest used by the U.S. Air Force. 250Ω imp. using soft rubber miniature ear moulds for maximum music and voice reproduction of the finest quality.
ONLY 15/–. P. & P. 2/6.

VERDIK HI-FI AMPLIFIER. 10-watt push-pull ultra-linear feedback. Beautifully styled in green stove enamel. Provision for tuner, bass and treble. 5-position selector for radio, tpae, mike, tape, L.P. and std. records. List price 20 gns. OUR PRICE £14/19/6. P. & P. 7/6.

INSTANT VALVE FILAMENT TESTER MODEL VT-41

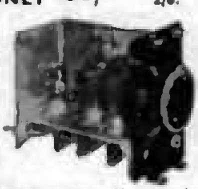


Pocket-size battery operated
GIVES INSTANT CHECK OF:

- All Radio Valves.*
- All T.V. Valves.*
- All T.V. Radio Fuses.
- Circuit Continuity.
- All Pilot Lamps.
- Has built-in miniature 7- and 9-pin valve straighteners and battery test.

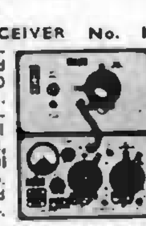
*International Octal, B.8, B.9, B7 Battery and Mains types.
Beautifully styled—precision made. Supplied complete. Fully guaranteed. ONLY **30/-** P. & P. 2/6.

CONVERT TO V.H.F.



Within minutes you can extend the frequency of your receiver to cover V.H.F. by using our brand new V.H.F. Convertors. R.F.26 covers 50-65 Mc/s. vernier calibrated tuning, 20/–. R.F.25 covers 40-50 Mc/s., switched tuning, 8/6. Circuits supplied. P. & P. 3/6 on each.

PORTABLE TRANS/RECEIVER No. 18



A self-contained Trans/Receiver for Telephone and C.W. Range approx. 10 miles. Frequency 6-9 Mc/s. (50-33.3 metres). Valve line-up: 3 ARP-12, 1 AR-8, 1 ATP4. Complete with aerial, H.T. and L.T. meter and all accessories. Weight 20lb. Size 8 x 10 x 17in. Brand New only 80/–. Carr. 10/–.

Relda Radio Ltd

Callers: 87 TOTTENHAM COURT ROAD, LONDON, W.1.
Mail orders: (DEPT. W.) 32a COPTIC ST., LONDON, W.C.1. MUS. 9607
WOT! You don't own a Relda catalogue! It's terrific and fully illus. Only 1/3

R.S.C. HI-FI TAPE RECORDER KIT

Build a high quality recorder in the £70 class for only

25½ GNS. Carr. 17/6.

OR DEPOSIT 3 GNS. and 12 monthly payments of 45/9. Cash price if settled in 3 months.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR. THE LINEAR LT45X HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7 x 4in. LOUDSPEAKER. Reel of Best Quality TAPE. Spare Tape Spool, a Portable Cabinet, size approx. 16 x 13 x 9in., finished in veneered walnut or two-tone rexine, and connection diagram for wiring amplifier to transcriptor.

FEATURES INCLUDE

★ 3 SPEEDS. ★ FREQUENCY RESPONSE 50-12,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZATION FOR EACH SPEED. ★ OUTPUT 4 WATTS. ★ MAGIC EYE RECORDING LEVEL INDICATOR. ★ 3 MOTORS. Fast rewind. ★ TAPE MEASURING AND CALIBRATING DEVICE. ★ TAKES FULL 7in. DIAMETER REELS OF TAPE. ★ NEGLIGIBLE HUM. ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.

Full descriptive leaflet supplied on receipt of S.A.E.

HI-FI 10 WATT AMPLIFIERS

BRAND NEW BUT IN SLIGHTLY SOILED CONDITION

£5-19-9 Carr. 7/6

A REMARKABLE OPPORTUNITY

Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs, for mike and gram. Separate bass and treble controls. High sensitivity. Output for 15 ohm loudspeaker. Guaranteed, tested, and in perfect working order.

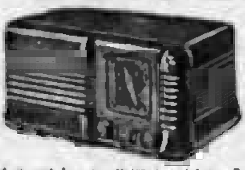
VALVES! Full range at really competitive prices. All [illegible]

REPANCO CONSTRUCTIONAL ENVELOPES AND COMPONENTS ALWAYS IN STOCK

All parts for: One Transistor Receiver 25/-; Two Transistor Receiver 42/-; 3 Dee 3 Transistor Receiver £3 19/6; Mini 7 Seven Transistor Pocket Portable Receiver £9 19/6; Major 7 Seven Transistor Portable Receiver 15 gns. Only Mullard, Ediswan, or Brimar Transistors supplied for Mini 7 and Major 7 Receivers.

Constructional Envelopes. 3 Dee 9d., Mini 3 Pocket Portable 1/3, Mini 7 1/6, Major 1/6.

THE SKY FOUR T.R.F. RECEIVER



A design of a 3 valve 200-250 v. A.C. mains L. and M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, SP61, 6P6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-Point wiring diagram, instructions and parts list 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram 39/9 or ready for use 46/9.

Type BM2. Size 8 x 5½ x 2½in. Supplies 120 v. 90 v. and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp., fully smoothed. THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND H.T. 2 v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions. 49/9 or ready for use 59/6.

PHILIPS CONCENTRIC (Dual Cone) P.M. SPEAKERS

10 in. Diameter. 3-5 ohms. 99/9.

SPECIAL OFFER OF BEST QUALITY RECORDING TAPE.

P.V.C. based. On plastic spools. By leading manufacturers. Brand new. 3in. 150ft. 5/11, 5in. 600ft. 15/11, 7in. L.P. 1,700ft. 35/-, 3in. 225ft. L.P. 7/9, 5in. 850ft. L.P. 22/6. EMPTY PLASTIC SPOOLS. 3in. 2/9, 5in. 2/11, 7in. 3/9.

R.S.C. PORTABLE TAPE RECORDER

19 GNS. Carr. 10/6

★ Single speed 3¾in. per sec.
★ Recording level indicator.
★ Fast rewind.
★ Twin Track.
★ Takes 5¾in. tape spool. ★ Output 3 watts. ★ Inputs for mike and gram. ★ Complete with tape spool, reel of tape, and microphone. For 200-250 v. A.C. mains.

ACOS HI-FI CRYSTAL 'MIKES'

33-1 hand or Desk type

35/9 (Listed 60/-)

39-1 Stick type

39/6 (Listed 5 Gns.)

Limited number.

R.S.C. TRANSFORMERS

FULLY GUARANTEED

INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS
Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a.	17/6
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t. 5 v. 3 a.	49/9

TOP SHROUDED DROP-THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9
250-0-250 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 130 mA., 6.3 v. 4 a. c.t., 6.3 v. 1 a. suitable for Mullard 510 Amplifier	29/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9

ELIMINATOR TRANSFORMERS
Primaries 200-250 v. 50 c/s.

120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 4-0-4 v. 250 mA.	9/11

FILAMENT TRANSFORMERS
Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a.	5/9	12 v. 1 a.	7/9
6.3 v. 2 a.	7/6	6.3 v. 3 a.	8/11
0-4-6.3 v. 2 a.	7/9	6.3 v. 6 a.	17/6

OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 for 3S4, etc.	3/9
Small Pentode 5,000Ω to 3Ω	3/9
Standard Pentode 5,000Ω to 3Ω	5/9
Standard Pentode 8,000Ω to 3Ω	5/9
Push-pull 8 watts 6V6 to 3 ohms	8/9
Push-pull 8 watts EL84 to 15 ohms	8/9
Push-pull 10-12 watts 6V6 to 3Ω or 15Ω	16/9
Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15Ω	17/9
Push-pull EL84 to 3 or 15 ohms	17/9
Push-pull Ultra Linear for Mullard 510	27/9
Push-pull 15-18 watts, sectionally wound 6L6, KT66, etc., or 3 or 15 ohms	23/9
Push-pull 20 watt high-quality sectionally wound 6L6, KT66, etc., to 3 or 15Ω	47/9

SMOOTHING CHOKES

250 mA., 5 H., 100Ω	11/9	80 mA., 10 H., 350Ω	5/6
150 mA., 7-10H., 250Ω	11/9	60 mA., 10 H., 400Ω	4/11
100 mA., 10 H., 200Ω	8/9	1 amp. 0.3Ω L.T. type	6/6

PARMEKO MAINS TRANSFORMERS
Fully Shrouded.

450-0-450 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9
500-0-500 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a.	31/9

EXTENSION SPEAKERS

Limited number in handsome walnut veneered cabinets. 2-3 ohms speech coils, 6½in. 23/9. 8in. 35/9. 10in. 56/9.

DRY SHAVERS. Brand new in carrying case. Operation from 3 U2 batteries, fitted in case. Just the thing for travel. Only 59/6 (approx. half price).

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode Fichanger is used. Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 300 mV. input depending on Ae. location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-4-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.

GARRARD BATTERY OPERATED RECORD PLAYING UNITS. Complete with Pick-up to take 45 r.p.m. records. Used by leading manufacturers in Transistorised Record Players. Require 6 v. battery. Only £3/19/6. Carr. 3/6.

PORTABLE CABINET

Two Tone Rexine with all cut outs to take above unit, amplifier and speaker. 29/6.

B.S.R. MONARCH AUTO-CHANGERS

Type UA8 4 speed. T/O Pick-up with sapphire stylus, £7/19/6. Carr. 4/6.

Collaro AC4/564 4-speed single players with hi-fi turnover crystal pick-up head £6/12/6. Carr. 4/6.

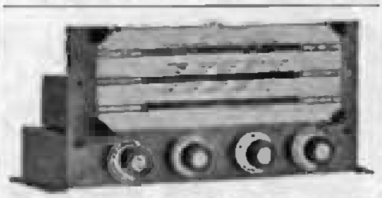
R.S.C. A12 STEREO AMPLIFIER KIT

£3-19-6 Carr. and packing 7/6.

A complete kit of parts to construct a good quality 3 + 3 watt (total 6 watts) stereo amplifier providing really life-like reproduction. Suitable for use with all stereo pick-up heads at present available. Ganged volume and tone controls. Preset balance control. Outputs for matched 2-3 ohm speakers. For 200-250 v. A.C. mains. Astonishing value.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS

HF1012, 10 watts 15 ohms (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/10/9. Please state whether 3 ohm or 15 ohm required.



AM FM RADIOGRAM CHASSIS, HIGH QUALITY. PUSH-PULL. 6-8 WATT OUTPUT. Current manufacture. 12 months guarantee. For 200-250 v. mains. Covers L. and M. wavebands plus F.M. Includes 8 latest type miniature B.V.A. valves. Only 22 gns. plus 7/6 carr. Or deposit £2/12/- and 9 monthly payments of £2 12/-.

E.M.I. 4-speed Single Players with hi-fi T/O crystal pick-up head for Stereo and Monaural. £6/19/9. Carr. 3/6.

GARRARD 4-SPEED AUTO-CHANGERS

Type RC/130H. Limited number at £10/19/6 (approx. half price). Carr. 5/6. Brand new.

A.M./F.M. RADIOGRAM CHASSIS

A 6 valve unit by a leading manufacturer. Covers L. and M. wavebands plus V.H.F./F.M. Excellent quality output. High sensitivity. Built in Ferrite aerial. For 200-250 v. A.C. mains. 12 months guarantee. Only **13½** GNS. Carr. 10/-.

Or deposit 45/- and 12 monthly payments of 22/6.

A beautifully designed and finished walnut veneered table cabinet made to suit the chassis can be supplied for only 32/9.

30 WATT AMPLIFIER R.S.C. A.10 ULTRA LINEAR

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolts minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., etc., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT. Price in kit form with easy-to-follow wiring diagrams

ONLY **11 Gns.** Or Factory built with 12 months' guarantee £13/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9 and 12 monthly payments of 24/9.

Carr. 10/-.
Cover as illustrated 18/9 extra.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE. Frequency response ± 3 D.B. 30-20,000 c/cs. Tone Controls ± 12 D.B. at 50 c/cs. + 12 D.B. to − 6 D.B. at 12,000 c/cs., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 x 9 x 9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN/GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.

LINEAR "DIATONIC" 10 WATT HIGH FIDELITY AMPLIFIER. A compact attractively finished unit. 12 gns. Cash. Send S.A.E. for leaflet. H.P. Terms. Dep. 22/3 and twelve monthly payments of 22/3.

LINEAR LI/10 10 WATT HIGH FIDELITY AMPLIFIER, with 3 position equalisation switch. 13 Gns.

LINEAR L6/5 HIGH QUALITY STEREO AMPLIFIER. Total output 10 watts. Handsome Perspex Facia Plate. All controls ganged. Only 12 Gns.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. Bass and Treble controls. For A.C. mains input of 200-250 v, 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves. Size only 6 x 5 x 5½in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5/19/6** Or Deposit 22/- and 5 monthly payments of 22/-. Send S.A.E. for leaflet.

GL3A MINIATURE 3 WATT GRAM AMPLIFIER
For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11½ x 2½ x 2½in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only 59/6.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER. Spec. exactly as A5 below with exception of output wattage. Complete kit of parts, diagrams and instructions £3/15/-, carr. 3/6.

R.S.C. A5 6-8 WATT HIGH GAIN AMPLIFIER
A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 60 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 25 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only £4/15/- or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

P.M. SPEAKERS. 2-3 ohm 7½in. Perdio 21/9. 8in. Goodmans 17/9. 7 x 4in. R.A. Elliptical 18/9. 6½in. Rola 18/9. 8in. Rola 19/9. 8in. Goodmans 25/9. 8 x 5in. Elac with high flux magnet 25/9. 10in. R.A. 28/9. 10 x 6in. Elliptical Goodmans 29/9. 12in. R.A. 29/11. 12in. R.A. 3 or 15 ohms. 10 watts, 12,000 lines, 59/6.

TWEETERS. 4in. Plessey, 3 ohms, 18/9. R.A. 15 ohm 25/9.

COLLARO CONQUEST 4-SPEED AUTO-CHANGERS. With studio pick-up with turnover head. BRAND NEW. Cartoned latest model. For 200-250 v. A.C. mains. £7/19/6. Carr. 4/6.

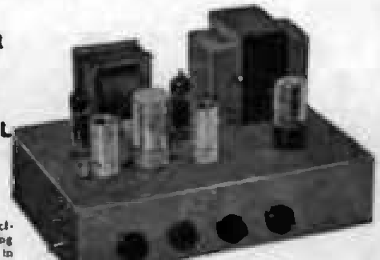
ACOS Crystal Microphone Inserts. Brand new. Only 5/11 ea. Ex. Equip. 4/11 ea.

ACOS HGP59 Hi-Fi Crystal Cartridges. (Turnover type, with sapphire stylus). Standard replacement for Garrard and Collaro. Only 19/9. B.S.R. Ful-6 19/9. Garrard GC9 19/9.

COSSOR V.H.F. F.M. RADIO RECEIVER KITS. Brand New Boxed with valves, printed circuit and 10 x 6in. Speaker. For 200-250 v. A.C. mains. Pre-aligned I.F.T.s. Normal price 15 Gns. Our price £8/19/6.

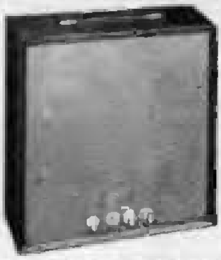
HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH PULL
ULTRA LINEAR
OUTPUT
"BUILT-IN"
TONE CONTROL
PRE-AMP
STAGES



Two input sockets with associated controls allow mixing of "mike" and gram. as in A10. High sensitivity. Includes 6 valves, ECC83, ECC83, EL84, EL84, 6Y2. High Quality sectionally wound output transformer specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut." Frequency response ± 3 D.B. 30-30,000 c/cs. Six negative feedback loops. Hum level 60 D.B. down. ONLY 23 millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For STANDARD or LONG PLAYING RECORDS. For MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.0 a. For supply of a RADIO FEEDER UNIT. Size approx. 12-9-7in. For A.C. mains 200-250 v. 50 c/cs. Output for 3 and 15 ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 45/- extra). Only **8 Gns.** Carr. 10/-. If required louvred metal cover with 2 carrying handles can be supplied for 18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 18/9, and 12 monthly payments of 18/9. Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones, etc. with cash and credit terms.

R.S.C. PORTABLE GUITAR AMPLIFIERS



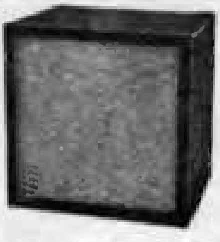
JUNIOR 5 WATT. High Quality Output. Separate Bass and Treble "cut" and "boost" controls. Sensitivity 15 mv. High Flux 8in. Lspeaker. Input sockets for Radio/Tape or Gram Pick-up and Mike/Instrument Pick-up. Handsome strongly made cabinet (size approx. 14 x 14 x 7in.). Finished in satin walnut and fitted carrying handle.
£8/19/6 Carr. 7/6. Or Deposit £1 and nine monthly payments £1.
Send S.A.E. for leaflet.

SENIOR 10 WATTS. High Fidelity Push-Pull output. Separate Bass and Treble "cut" and "boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two Loudspeakers are incorporated, a 12in. P.M. for Bass notes, and a 7 x 4in. elliptical for Treble. Cabinet is well made and finished satin walnut. Size approx. 18 x 18 x 8in. 15 Gns. Plus 10/- carr. H.P. TERMS. DEPOSIT 26/9. and 12 monthly payments 26/9. Both models for 200-250 v. A.C. mains.

STAAR GALAXY 4-SPEED MIXER AUTO-CHANGERS. Brand New, cartoned. Turnover sapphire styli. Many exclusive features. Unique design motor virtually free from rumble. For 200-250 v. A.C. mains. Limited number tested and guaranteed £5/19/6. Carr. 4/6

PORTABLE CABINETS

For Record Players or Tape Recorders. Rexine covered. Wide selection of attractive designs and colour combinations.
PRICES FROM **15/9**



12in. 10 WATT HIGH QUALITY LOUDSPEAKER IN POLISHED WALNUT FINISHED CABINET

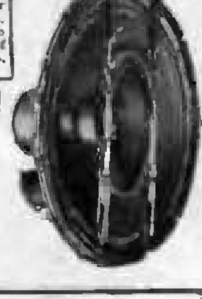
Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Unit £4/19/6. Carr. 5/-.
Terms Deposit 11/- and 9 monthly payments of 11/-.
12in. 20 WATT 16,000 line Lspeakers 15 ohms. In Cabinet finished as above. Size 18 x 18 x 8in. £7/19/6 or Deposit 13/10 and 12 monthly payments 13/10.

PORTABLE CABINETS. Attractive design. Two-tone rexine covered. Will take Collaro, B.S.R. Garrard or Staar Auto-Changer, amplifier and 7in. x 4in. or 8in. speaker. Slightly soiled. Only 49/6.

ACOS HIGH FIDELITY PICK-UPS. GP54 with HGP59/37 Cartridge. Turnover sapphire stylii, cream finish. Limited number at approx. half-price. Only 29/11.

SPECIAL OFFER

Above cabinet Staar Changer, Gram amplifier, and 8in. or 8in x 4in. speaker £9/19/6. Carr. 10/-. Or with Collaro Conquest changer in lieu of Staar, 12 Gns. Carr. 10/-.



PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only £5/17/6. Or Deposit 10/6 and 12 monthly payments of 10/6.

R.S.C. (LEEDS) LTD. MANCHESTER, LEEDS & BRADFORD

Open to callers at the following branches :—
5-7 County (Mecca) Arcade, Leeds, 1.
54-56 Morley Street, (above Alhambra), Bradford.
8-10 Brown Street, (Market, St.) Manchester, 2.

TERMS: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage stated. Trade supplied. Post orders to Mail Order Dept., 29-31 Moorfield Road, Leeds, 12.

Special Offer !

. . . to 'Wireless World' readers

50 only Philips Hi-Fi Speakers

10" Dual Concentric Models, as currently fitted, in quality receivers.

Only 2 gns. each plus 2/6 p. & p.

DON'T BE DISAPPOINTED !

Orders executed in strict rotation.

New additions to GOODMANS speaker range

Latest release of two 10" units

AXIOM 110 - £5.

AXIOM 112 - £8 10s.

also the new Triaxiette Super 8" Unit, £13 10s.

The well known 8" Axiette (£6 12s.) and the 12" Audiom 60 (£9 12s.) as recommended for two speaker systems, are still available, ex stock.

RECORD PLAYER BARGAINS—Latest 4-speed models

NEW RELEASE by E.M.I.—4-speed Single Player Unit fitted with latest stereo and monaural Xtal cartridge and dual sapphire styli. Auto stop and start. A fidelity unit and bargain buy at only £6/19/6.

SINGLE PLAYERS. B.S.R. (TU9) 90/-; COLLARO (4/544), 6 gns.; GARRARD (4SP) £7/10/-. Carr. and Ins. 3/6.

AUTOCHANGERS. B.S.R. (UA8), £8 19/6. COLLARO £7/19/6. GARRARD (RC121/4D Mk. II) plug-in head, stereo adapted. 10 gns. Stereo head £2 extra.

RECORD PLAYER CABINETS

Contemporary styled, rexine covered cabinet in two-tone fawn and brown, or mottled red with white polka dot. Size 18½ x 13½ x ht. 8½in., fitted with all accessories, including baffle board and anodised metal fret. Space available for all modern amplifiers and autochangers, etc. Uncut record player mounting board 14 x 13in. supplied.

Cabinet Price £3.3.0. Carr. and Ins. 3/6.

2-VALVE 2-WATT AMPLIFIER

Twin stage ECL82 with vol. and neg. feedback. Tone controls A.C. 200/250 v. with double-wound Mains trans. Complete with knobs, etc., ready wired to fit above cabinet.

£2.17.6 P. & P. 1/-

6-in. Speaker and matching trans. 22/- P. & P. 1/6.

TRANSISTOR 'ONE-WATT' AMPLIFIER

6 v. Battery operated

Latest Push-Pull, 4 Transistor circuit giving full 1 watt Output into standard 3 ohm speaker. Good sensitivity and improved freq. response. Neg. feedback. Var. Tone and Volume Controls. Chassis Size 6¾in. x 3½in. x 1½in. Current consumption 10 mA quiescent—250 mA at 1 watt.

2 matched GEC GET15 Transistors .... 42/- pr.
2 GEC GET3 Transistors .... 21/- pr.
Driver Trans. 8/6
Output Trans. (to 3 ohms) 10/6

Complete Kit of Parts incl. circuit etc., less speaker, ONLY **99/6** P. & P. 2/6.

Circuit and instruction booklet 1/6 post free

NOW! The TOURIST Portable

4 valve, Med. & L.W., flyweight battery Radio. Size only 8in. x 6½in. x 4in. Weight 3½lb. with battery:— P. & P.

Complete receiver component kit 57/6 1/6
Set 4 miniature valves (96 series) 35/- 9d.
5in. Speaker & O/put Trans. 21/- 1/6
Cabinet, Dial and Knobs, etc. ...22/6 2/-

Latest superhet circuitry delayed AVC and A.F. Neg. feedback.

Complete kit—BARGAIN—only £6.10.0, post free

Terrific performance—
Remarkable size—
Staggering Value

Send for Booklet NOW! 1/6 post free

NEW BOXED VALVES ALL GUARANTEED

1R5/1T4	7/6	EABC80	[illegible]	EZ81	7/6
1S5	7/6	ECC84	10/6	MU14	9/6
3S4/3V4	8/-	ECF80	11/6	PCC84	10/6
5Z4	9/6	ECH42	10/6	PCF80	10/6
6K7	5/6	ECL80	10/6	PCL83	12/6
6K8	8/6	EF80	[illegible]	PL81	12/6
6Q7	8/6	EF86	12/6	PL82	9/6
6V6	7/6	EF91	[illegible]	PL83	11/6
DAF96	9/-	EL41	10/6	PY80	7/6
DF96	9/-	EL84	9/6	PY81	9/6
DK96	9/-	EY51	10/-	PY82	7/6
DL96	9/-	EY86	10/-	U25	12/6

SPECIAL PRICE PER SET

1R5, 1T4, 1S5, or 3S4 or 3V4, 27/6.
DK96, DF96, DAF96, DL96, 35/-.
6K8, 6K7, 6Q7, 6V6, 5Z4 or 6X5, [illegible]

COAX 80 OHM CABLE.

Stand. ¼in. diam. Low Loss Semi-Air Spaced Aerial.

Special Reduced Prices

20 yds. 12/6, p. & p. 1/6; 40 yds. 32/6 p. & p. 3/-; 60 yds. 22/6, p. & p. 2/6; All other lengths 9d. per yard.

Coax Plugs 1/-, Sockets 1/-, Couplers 1/3, Cable End Sockets 1/6. Outlet Boxes 4/6.

JASON FM TUNER UNITS (87-105 Mc/s)

Designer-approved kits of parts for these quality and highly popular tuners available as follows.

STANDARD MODEL (FMT)—as previously extensively advertised. COMPLETE KIT, 5 gns., post free. Set of 4 spec. valves, 30/-, post free.

LATEST MODEL (FMT2)—attractively presented shelf mounting unit to enclosed Metal Cabinet with Built-in Power Supply. COMPLETE KIT, £7, p. & p. 2/6. Set of 5 spec. valves, 39/6.

NEW JASON COMPREHENSIVE F.M. HANDBOOK, 2/6 post free. 48hr. Alignment Service. 7/6, p. & p. 2/6.

MULLARD "3-3" AMPLIFIER

Quality built to Mullard's specification, with special sectionalised O/P Trans.

Complete kit with front panel only £6 19/6. P. & P. 3/6.

2 WAVEBAND CAR RADIO KIT

12 v. operation Med. & Long Waves

Modern development of the famous Brimar Hybrid vibratorless car radio circuit. Five latest type Brimar low voltage valves and power transistor. R.F. stage and permeability pre-aligned Cyldon Tuner Unit provide extremely good sensitivity and signal/noise ratio. Printed circuit for easy construction and 7 x 4in. elliptical speaker for fidelity output. Self-contained robust metal cabinet 8 x 7 x 2½in. with attractive calibrated dial. Speaker and power transistor stage mounted separately approx. 8 x 6 x 3in.

Recommended Buy *Complete Kit* *Bargain Price* **£12.19.6**

Instruction booklet and parts list available 3/6 post free. P. & P. 3/6.

C.R.T. Heater Isolation Transformers

New improved types—mains prim. 200/250 v. tapped

All Isolation Transformers now supplied with alternative no boost, plus 25% and plus 50% boost taps at no extra charge.

2V 2A type ....12/6 (P. & P. 1/6)
6.3V .6A type ..12/6 (P. & P. 1/6)
10.5V .3A type ..12/6 (P. & P. 1/6)
13V .3A type ..12/6 (P. & P. 1/6)

Small size and tag terminated for easy fitting. Other voltages available.

RE-GUNNED TV TUBES NEW REDUCED PRICES

. . . and now 12 months guarantee!

All tubes rebuilt with new heater, cathode and gun assembly—reconditioned virtually as new.

12in. £6, 14in. £7, 17in. £8.10.0, etc.

10/- part exchange allowance on old tube

Carr. and ins. 10/-. Comprehensive stocks—quick delivery.

CONDENSERS—Silver Mica. All pref. values, 2 pf. to 1,000 pf., 6d. each. Ditto ceramics 9d. each. Tubulars 450 v. T.C.C. etc., .001 mfd.-.01 and .1/350 v., 9d. each. .02-.1/500 v. 1/- each. .25 Hunts 1/6. .5 T.C.C. 1/9. .001 6 kv. 5/6. .001 20 kv. 9/6.

RESISTORS—FULL RANGE 10 ohms—10 megohms 20% ¼ w. and ½ w., 3d., 1 w., 5d. (Midget type modern rating). 1 w., 6d. 2 w., 9d. 10% Hi-Stab ¼ w., 5d., ½ w., 7d. 5% ½ w., 9d. 1% HI-STAB ½ w., 1/6 (10-100 ohms 2/-).

PRE-SET W/W POTS. T/V Type, 25 ohms—50 K ohms, 3/-. 50K—2 Meg. (Carbon 3/-).

SPEAKER FRET—Expanded Bronze anodised metal 8 x 8in., 2/3; 12 x 8in., 3/-; 12 x 12in., 4/6; 12 x 16in., 6/-; 24 x 12in., 9/-; 36 x 12in., 13/6, etc., etc.

TYGAN FRET (Contemporary patt.), 12 x 12in., 2/-; 12 x 18in., 3/-; 12 x 24in., 4/-, etc.

LOUDSPEAKERS—P.M. 3 ohms, 2½in. Elac, 17/6. 3½in. Goodmans 18/6; 5in. Rola, 17/6. 6in. Elac 18/6; 7 x 4in. Goodmans Elliptical 18/6; 8in. Rola, 20/-; 10in. R. and A., 25/-; 10in. W.B.-HF1012, 99/9. 12in. Plessey 15 ohms with 6/4in. Tweeter and Cross Over Filter, 97/6.

Electrolytics All Types New Stock

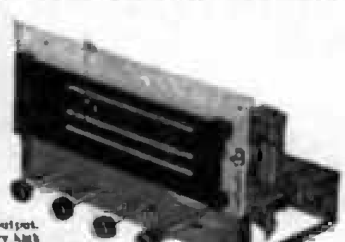
TUBULAR		CAN TYPES	
25/25 v., 50/12 v.	1/9	8+8/450 v.	4/6
50/50 v., 100/25 v.	2/-	32+32/275 v.	4/6
8/450 v.	2/3	50+50/350 v.	[illegible]
16+16/450 v.	5/6	60+250/275 v.	12/6
32+32/450 v.	6/6	100+200/275 v.	12/6

Comprehensive range in stock

VOLUME CONTROLS—10K—2 Megohms. ALL LONG SPINDLES. MOOCANITE MIDGET TYPE, 1½in. diam. Guar. 1 yr. LOG or LIN Ratios less Sw. 3/-. D.P. Sw. 4/6. Twin gang controls ¼ Meg., ½ Meg., 1 Meg. less Sw., each 8/9.

7 VALVE AM/FM RADIOGRAM CHASSIS

Valve Line-up: ECC85, ECH81, EF89, EABC80, EL84, EM81, EX80.



Three Waveband and Switched Gram positions. Med. 200-500 m., Long 1,000-2,000 m., VHF/FM 88-96 Mc/s. Philip's Continental Tuning insert with permeability tuning on FM and combined AM/FM IF transformers. 460 Kc/s and 10.7 Mc/s. Dust core tuning all coils. Latest circuitry including AVC and Neg. Feedback. Three watt output. Sensitivity and reproduction of a very high standard. Chassis size 13½ x 6¾in. Height 7½in. Edge illuminated glass dial 11½ x 3½in. Vertical pointer. Horizontal station names. Gold on brown background. A.C. 200/250 v. operation.

Aligned and tested ready for use **£13.10.0** *Carr. & Ins. 5/-*

Complete with 4 Knobs—walnut or ivory to choice.

Three ohm P.M. speaker only required. Recommended quality speakers

8in. Goodmans special cone 21/6
10in. Rola (Heavy Duty) 30/-

Post & Pkg. 1/6

We are sorry to cause our customers disappointment, but existing orders have already exhausted present stocks of the above. A new replacement chassis, virtually identical, will be available from early February, price unchanged.

ONLY A FEW ITEMS ARE LISTED FROM OUR COMPREHENSIVE STOCK. WRITE NOW FOR FULL BARGAIN LISTS, 3d.

Terms: C.W.O. or C.O.D. post and packing up to ½lb. 7d.; 1lb. 1/1; 3lb. 1/6; 5lb. 2/-; 10lb. 2/9.

TRS RADIO COMPONENT SPECIALISTS

70 BRIGSTOCK RD., THORNTON HEATH, SURREY

Established 1946. Tel: THO 2188 Hours: 9 a.m.—6 p.m. 1 p.m. Wednesday

HARVERSON T.R.F. EASY FOUR KIT

All parts and point to point wiring diagram.

OUR PRICE **£4.12.6**

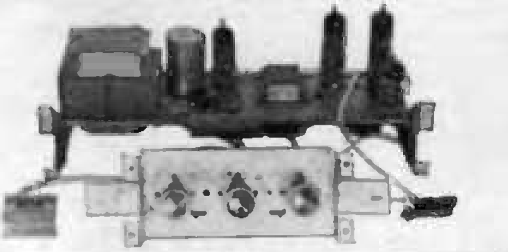
Plus P. & P.

We have made a fortunate purchase of a small quantity of Taylor Meters. There are assorted types—Nos. 90, 90a, 70a and 75a. These are secondhand meters, but are mechanically perfect and fully guaranteed. We regret that we cannot supply leads, or meter No. to your order.

Get them while they last at **£6.6.0**

Also a few Signal Generators 65A or B at **£8.10.0**

8 WATT Push Pull MONAURAL AMPLIFIER



By well-known manufacturer—employing four Mullard valves: ECC.83, 2 EL.84 and EZ.80. Bass, treble and volume on remote panel. Elegant knobs. OUR PRICE—Plus P. & P. **£6.19.6**

12-CHANNEL TURRET TUNERS

By Clydon: 35 MC/IF, PCC.84 and PCF.80. Band 1–1–5. Band 3–8–11. BRAND NEW Plus P. & P. **39/6**

SWITCHES ROTARY

Size 1 1/16in. dia., 2in. spindles.

PRICE 2/11 ea.

1 pole 10 way.
1 pole 12 way.
2 pole 2 way.
2 pole 3 way.
2 pole 4 way.
2 pole 5 way.
2 pole 6 way.
3 pole 3 way.
3 pole 4 way.
4 pole 3 way.

STEREO and MONAURAL CARTRIDGES

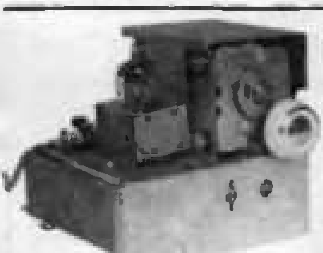
All makes and types in stock. Write for our bargain list.

A few only as this month's bargain offer. Product of a well known manufacturer Don't miss this wonderful offer.

OUR PRICE **£9.15.0**

Plus P. & P.

6" × 4" 3 ohm Plessey Speaker. **12/-** Plus P. & P.



F.M. TUNER HEAD

(as illustrated) uses ECC.83, less valve **14/6**

Plus P. & P.

Valve 7/-. Plus P. & P.

Regret no Circuit

SPEAKERS—We can supply a complete range of speakers at keen prices—send for our list. THIS MONTH'S SNIP—R.A. Type 9120 Mk. II, 12in., 10-12 watts. PRICE Plus P. & P. **55/-**

SPRAGUE—·! Condensers—350 v. D.C. at per 12/- for 100. Plus P. & P. " DON'T MISS THIS."

GARRARD Large Record Spindle—Type LRS.2 for use on changers RC.110 and 111. Also for R.C. Mk. II and R.C. 121 Mk. II. New and boxed. 8/6 each. Both automatic.

VOLUME CONTROLS

All values: 5 K/ohms—2 meg.

No switch 3/-
D.P. switch 4/9

WODEN P.P.O.P. TRANSFORMERS

20 watt, 4,500 ohm load.

A BARGAIN at 27/6. Plus P. & P.

AMAZING SCOOP

Cossor 10" Tubes 108K. Brand New, boxed and guaranteed. Manufacturer's Surplus.

21/- each

Plus P. & P. 12/6

NEW ELECTROLYTICS. FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	64/350 v.	5/6	8/500 v.	3/-
2/450 v.	2/3	100/25 v.	2/-	16/500 v.	4/-
4/450 v.	2/3	250/25 v.	1/-	32/350 v.	4/-
8/450 v.	2/3	500/12 v.	3/-	100/270 v.	5/6
8/500 v.	2/9	8+8/450 v.	4/6	2.500/3 v.	4/-
16/450 v.	3/6	8+8/500 v.	5/-	6.000/6 v.	5/-
16/500 v.	4/-	8+16/450 v.	5/-	8+16/500 v.	7/-
32/450 v.	5/6	8+16/500 v.	5/6	32+32/450 v.	6/6
25/25 v.	1/9	16+16/450 v.	5/6	50+50/350 v.	7/-
50/25 v.	2/-	16+16/500 v.	5/-	64+120/350 v.	11/6
50/50 v.	2/-	32+32/350 v.	4/6	100+200/275 v.	12/6

12 ASSORTED POTS. Wire wound and carbon. Switched and unswitched. All useful sizes at 21/- dozen. Plus P. & P.

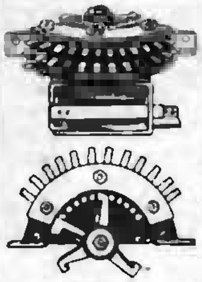
TAYLOR WINDSOR 240A PATTERN GENERATOR. Not New, but perfect, £8/10/- each. Plus P. & P.

WIRE. Twin padded, grey, with maroon tracer Mains lead — usually 10d. per yd. — Our Price 25/- per 100 yd. coil.

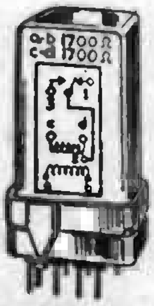
THIS MONTH'S OFFER: Small generator or motor, 12 v., with reduction gear. Has dozens of applications. Ideal for the model maker. Don't miss this. 12/6 each. Plus P. & P.

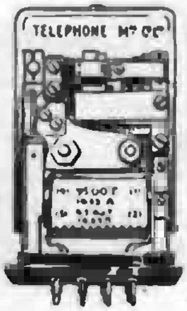
HARVERSON SURPLUS CO. LTD.

48 BEDDINGTON LANE
CROYDON, SURREY
THOrnton Heath 2577



MINIATURE UNISELECTOR SWITCH. Two banks of ten plus home contacts one bank continuous of normal. 30 ohms coil for 24 volt operation. Brand new, manufacturer's packing. Price 22/6 each. P. & P. 2/6. As illustrated.





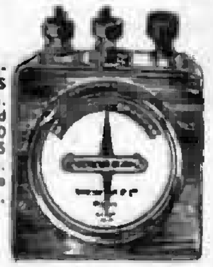
SIEMENS H.S. RELAY. Very latest type, sealed. H96E. 1,700 ohms plus 1,700 ohms, single C.O. contacts. Brand new with fixing clip. In maker's cartons. Price 16/6 each, plus 1/- P. & P.

NEW CARPENTER'S TYPE POLARISED RELAYS. 2 x 9,500 turns at 1,685 ohms. Price 22/6 each. P. & P. 1/-.

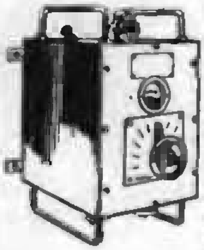
BRAND NEW SOUND POWER OPERATED EX ADMIRALTY HEAD AND BREAST SETS. Two such sets connected up will provide perfect intercomm., no batteries required. Will operate up to ½ mile. Original manufacturer's boxes. Price 17/6 each, plus P. & P. 2/-; or 32/6 per pair. P. & P. 3/-.

AUTO TRANSFORMER

Air cooled, very conservatively rated at 3 kVA., will handle 6 kVA. Tapped 220/230/240/250 volt, 12 amp. 105/110/115/120 volt, 28.5 amp. Brand new. Each one shrouded in a metal case and packed in original manufacturer's wooden case. Price £15. Carr. £1. Nett weight over 2 cwt.



NEW GALVANOMETERS Solid brass, 3in. dial, in polished wooden case. 70 degree scale, 35 mA either side. 100 ohm coil. Price 12/6 each. P. & P. 1/6.



L.T. TRANSFORMER. Input 230 V. Output 50 V. 50 amp. Adjustable by regulator switch on primary. Steel case with mains switch. Will take 100% overload. Weight 150 lb. Wound at 800 amps. per sq. inch. Brand new. Price £15. Carr. £1.

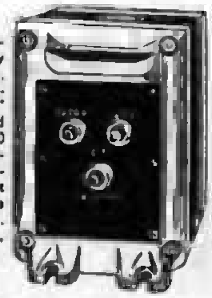


PLATE TRANSFORMER of very best U.S.A. make, brand new, original manufacturers' cases. Input tapped at 190/210/230/250 v. Output 2250-0-2250, centre tapped 400 mA. Nett weight 76 lb., size 13 in. x 9in. x 6½in. Price £6/10/- each, plus carr. 10/-.

MINIATURE MOVING COIL DIFFERENTIAL RELAY. Two coils 350 ohms each. Operating current minimum 140 microamp, nominal 400 microamp, maximum 8 milliamp. One pole two way, or, centre stable. Two way contact current 100 mA. at 50 V. A.C. or D.C. Size 1½ x ¾ x ¾in. Price 22/6 each.

HIGH SPEED RELAY. Siemens, two bobbins, 1,000 ohms each. New, 10/6 each. P. & P. 1/-.

SOLENOID OPERATED MAGNETIC RELAY. Type S. SCW/3942 with 4 make, 4 break 25 Amp. contact D.C. coil resistance 160 ohms, 24 v. operation. Housed in metal screening can 2⅝in. x 1in. x 1⅞in. Brand new. 7/6 each. P. & P. 6d.

U.S.A. 27-volt 4-pole CHANGE-OVER RELAYS. Brand new and boxed, 5/6 each. P. & P. 6d.

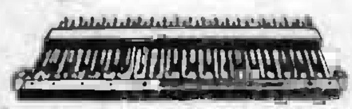
ROTARY RELAY, 12 volt. Heavy duty change-over contacts and one low current for external circuit, plus one break set. Price 7/6. P. & P. 1/6.

A VERY SUPERIOR BRAND NEW RELAY IDEAL FOR MODEL WORK. 7,000 ohms coil. Will pull in at 750 microamp and out at 450 microamp. Change-over, platinum contacts. Vacuum sealed, will therefore not be affected by oil, moisture or water and never needs adjusting. Weight 2½ oz. Price 18/6. P. & P. 1/-.

MINIATURE TYPE SEALED SLAVE RELAY. 700 ohms coil. Will work on 12 v. D.C. Single pole change-over contact. Weight 2 oz. Ex. new equipment. Price 9/6. P. & P. 1/-.

MUIRHEAD PRECISION, 4 bank, 1 pole 24 position Stud Switch. Heavy duty contacts. Brand new. Original boxes. Price 17/6 each. P. & P. 1/-.

CERAMIC PRECISION SWITCH. 2 pole, 6 way, 4 banks. New in manufacturer's boxes. Price 10/6. each. P. & P. 1/6.



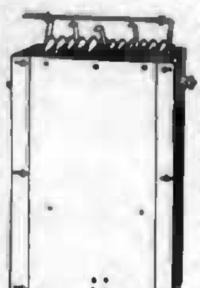
20 WAY STRIP containing standard Post Office telephone Jack Sockets, overall size 11 x 3½ x ⅞in. New. Price 15/- each. P. & P. 1/6. **10 WAY STRIP** standard Post Office telephone Jack Sockets, spacing allowing Igranic Jack Plugs. New. Price 10/-. P. & P. 1/6.

LATEST MOST MODERN TYPE OF EX W.D. MINIATURE HEADPHONES As illustrated. Brand new, low impedance. Price 10/6 plus P. & P. 1/6.

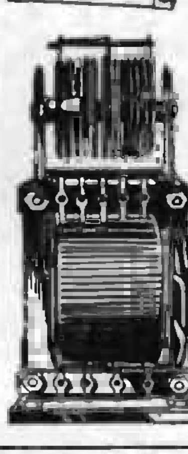
NEW MOVING COIL HEADSETS. Complete with Tannoy carbon hand microphone, with plug suitable for No. 19 set. Price 12/6 each, plus P. & P. 2/-.

AUTO TRANSFORMERS. Step up, step down, 110-200-220-240 v. Fully shrouded. New. 300 watt type £2/2/- each. P. & P. 2/6. 500 watt type £3/3/- each. P. & P. 3/9. 1,000 watt type £4/4/- each. P. & P. 6/6. Also 60 watts 19/6 each. Plug P. & P. 2/-.

MARCHING COMPASS Mk. 1. Brand new ex W.D. Price 14/6. P. & P. 1/-.



BRAND NEW SELENIUM FULL WAVE BRIDGE TYPE RECTIFIERS, in manufacturer's original packing. D.C. output 36 v. 10 amp., made up of 12 x 110 mm. dia. plates. These fitted in cooling funnel (removable). Size 11½in. x 8in. x 4⅞in. Price 45/-. P. & P. 3/3.



TWELVE PLATE F.W. BRIDGE CONNECTED RECTIFIER mounted on 200/250 volt A.C. input transformer. Output 36/40 volt D.C. at 1.2 amps. New, perfect. Price 16/6. P. & P. 3/6.

SPRINGLOADED FUSED TEST PRODS, complete with wire leads and spade terminals. Price 4/6 per pair. P. & P. 1/-.

MUIRHEAD VERNIER DRIVE. Scaled 0-180 degrees, ratio 31/1, dia. 3in., as fitted to R.F.26 units. Complete with lampholder. In manufacturer's original packing. New. 8/6 each. P. & P. 1/6.

WE ARE EXPERTS AT OVERSEAS PACKING & SHIPPING!

SERVICE TRADING Co.

PERSONAL CALLERS ONLY: **9 Little Newport Street, London, W.C.2.** *Tel: GER 0576*

ALL MAIL ORDERS: *(Early Closing Thursday).*

47-49 High Street, Kingston-on-Thames

Telephone: KINgston 4585

REDUCED TO 59/6

RP2

or 4/1 Initial Payment balance at 2/11 for 19 weeks.

A beautifully styled cabinet. Made by famous manufacturers. Grey polka dot cloth, with clipped lid and carrying handle. Size 16 × 14¼ × 8½in. Uses a B.S.R. Monarch UA8 Player and 6½in. round or 8 × 5in. elliptical speaker. Post, packing and insurance 4/6.

69/6 CASH

RP3

or on weekly terms

A delightful looking cabinet in two tone leatherette. Size 14¼ × 17½ × 8½in. Will take B.S.R. Monarch 4 speed auto changer and 6.1/3in. round speaker. Post, packing and insurance 4/6. Or on Credit Terms

Initial payment 4/7 plus cost and ins. and 19 weekly payments of 3/5.

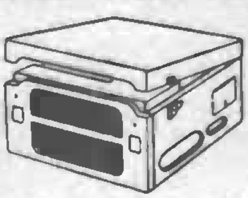
U.A.8. B.S.R. MONARCH 4-SPEED AUTOCHANGER

£6.19.6 or Terms

U.A.12. LATEST B.S.R. MONARCH 4-SPEED MIXER £8/9/6.
COLLARO CONQUEST 4-SPEED AUTOCHANGER £6/19/6.
COLLARO CONQUEST STEREO AUTOCHANGER 11 gns.
P. & P. on all the above 5/6.

COLLARO CONQUEST STEREO AUTOCHANGER 11 Gns.
4-speed autochanger with turnover cartridge for Stereo L.P. and Standard. Carr. & Ins. 5/6 or Initial Payment 11/1 plus Post & Ins. and 19 weekly payments of 9/11.

TAPE RECORDER CABINETS 19/6



Suitable for the Truvox Tape Recording Deck. Less front cast speaker panel. Size 13¾ × 15 × 8½in. deep. Detachable lid with compartment for spare tape. Covered in green washable plastic material. P. & P. 4/6.

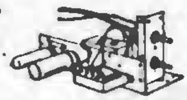
B.S.R. FUL-FI Crystal Turnover Cartridges 18/6.
Brand new. Including sapphire needles for L.P. and Standard, giving fullest range and finest tone obtainable for any player. Can be fitted to all standard pickup arms. P. & P. 9d.

AMPLIFIERS

12 Months' Guarantee

ALL PORTABLE AMPLIFIER Mk. D.1.

59/6



Brand new. Latest design with printed circuit. Dimensions 7 × 2½ × 5in. A.C. only. Mains isolated 2-3 watts output. Incorporating EL84 as high gain output valve. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

AMPLIFIER Mk. D.2 79/6
Printed circuit. Latest design. Dimensions 7 × 2½ × 5in. A.C. only. Mains isolated. 3-4 watts output. Incorporating the latest ECL82 triode pentode output valve giving higher undistorted output. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

AMPLIFIER Mk. D.3 89/6
De luxe model. Printed circuit. Latest design. Dimensions 7 × 2½ × 5in. A.C. only. Mains isolated. 3-4 watts output. Incorporating the latest ECL82 triode pentode output valve giving higher undistorted output. Volume, treble and bass control. Knobs 3/6 extra. P. & P. 3/6.

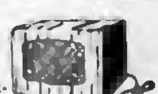
AMPLIFIER Mk. D.5 39/6
Simple circuit employing ECL80 triode pentode output valve giving 2-3 watts output. A.C. only. Mains isolated. Single control for volume and on/off switch with knob. P. & P. 3/6.

3 TRANSISTOR AMPLIFIER 79/6
9 volts. 1 control. P. & P. 3/6.

R.P.I. CABINET 59/6

Takes B.S.R. TU9 4-speed single player, 7 × 4 in. elliptical speaker, most of the modern portable amplifiers. Attractive speaker grille and recessed control panel. Dimensions 14¼ × 14¼ × 6¾, weight 13½lbs. Carriage and insurance 4/6.

EXTENSION SPEAKERS 19/9



Polished oak cabinet of attractive appearance. Fitted with 8in. P.M. speaker W.B. or Goodmans of the highest quality. Standard matching to any receiver (2-5 ohms). Switch and flex included. Ins. carr. 3/9.

PL10 CABINET

39/6

Size 14¼ × 12½ × 6in. Takes B.S.R. T.U.9 4-speed record player unit. 8 × 5in. elliptical speaker. Single control amplifier. Carr. and ins. 4/6.

8in. P.M. SPEAKER 8/9

With O.P. transformer fitted	10/-
Postage 2/6.	
7 × 4in. Elliptical Speakers	18/6
9¼ × 4¼ Elliptical Speakers	22/6
Postage 2/9.	

TAPE RECORDER CABINET 99/6
Superbly styled modern tape recorder cabinet. Two-tone green rexine and vinyl grey. Dimensions 19¼ × 15 × 9¼in. deep. Detachable lid. Recess compartment for microphone extension plugs. Carr. and Ins. 5/6.

A LARGE SELECTION ASSORTED TYPES AND SIZES PLAYER CABINETS from 19/6
All rexine covered in modern two-tone colours. Your enquiries invited. Please let us have your requirements.

LATEST LINE JUST IN—

REGRET NO ILLUSTRATION YET!

Stereophonic Cabinet with Extension Speaker Cabinet. Well-known manufacture show model. Two-tone colours. Size 18 × 14 × 8½in. high. Suitable for a B.S.R. Stereophonic Autochanger. Two 7 × 4in. speakers. Four-hole control panel for any suitable stereophonic amplifier.

CASH PRICE 99/6 or initial payment 6/1 plus Ins. & Carr. and 19 weekly payments of 4/11. Carr. & Ins. 5/6.

SMALL TAPE RECORDER CABINETS 29/9
Suitable for conversion to single record player cabinet. Dimensions: 13 × 10¼ × 7in. deep. In two-tone cloth covered. Carrying handle and lock with key. Carr. & Ins. 4/6.

MODERN 17" T.V. CHASSIS 24 Gns. COMPLETE & WORKING or Terms

15/3 Initial Payment. Balance at 14/3 for 35 weeks.
or 29/6 Initial Payment. Balance at 25/6 for 19 weeks.
Ins., Carr. 25/-. (Must be paid with Init. Payment.)

Latest chassis including 17in. tube. Permanent magnet speaker, 13-channel turret tuner (any two selected channels fitted). Other channels supplied on request at 7/6 each. 13 valves. Chassis and valves guaranteed for three months. C.R.T. for 12 months full guarantee. Sound I.F. 10.5 Mc/s. Vision 16 Mc/s. A.C. only.
Ready and working to fit into your own cabinet. Carr. and ins. 25/-.
As above with 14in. tube, complete and working, £10/10/-.

DUKE & CO. 621/3 ROMFORD RD., MANOR PARK E.12 ILF. 6001/3
HOURS 9-6. OPEN ALL DAY SATURDAY. THURSDAY 9-1 p.m.

Premier RADIO CO

23 TOTTENHAM COURT RD., LONDON, W.1. Tel.: MUSeum 3451/2

★ VISIT OUR NEW BRANCH AT **309 EDGWARE RD., W.2.** TEL.: PADdington 6963

The 'Carol'

TR/1 TAPE RECORDER

INCORPORATING THE NEW B.S.R. TAPE DECK. A Quality Tape Recorder at a price that YOU can afford.

The operation of this Recorder is simplicity itself and the quality in both reproduction and finish, leaves nothing to be desired, the cost being well below present-day prices.

STAR FEATURES:
Deck Controls. Record/Playback Switch and rewind switch with interlocking device to prevent accidental erasure.
Speed. Single 3¾in. per sec.
Playing Time. 5¾in. Standard Tape 1½ hrs. L.P. Tape 2 hrs. 8 mins.
Inputs. Sockets for Microphone, Radio, Gram., etc., with extension Speaker Socket.
PRICE, including Tape and Spare Spool
Amplifier Controls. On/off Tone and Volume Controls.
Power Output. 2½ watts.
Valve Line-up. ECC83, ECL82, EZ80.
Overall Size. 13½ x 12 x 8in.
Weight. 20 lb.
Microphone. Acos crystal with stand incorporated and fitted with screened lead and jack plug.

Only 19 Gns. plus 18/- P. & P.

H.P. TERMS: £2 deposit and 12 monthly repayments at £1/12/11.

THE "Petite" PORTABLE

MAY BE BUILT FOR **£7-7-0**

plus 3/- post & Pkg.
Batteries extra.
H.T. 10/- (Type B126) or equivalent.
LT 1/6 (Type AD 35) or equivalent.
★ High Q frame aerials.
★ High sensitivity on both wavebands.
★ Medium and long wave superhet circuit.
★ Instruction book 1/6.
★ Size only 8in. x 8in. x 4½in.
★ Weight including batteries 5¾lb. ★ 4 valves of the economy type.

WHY NOT CONVERT YOUR BATTERY PORTABLE TO MAINS OPERATION WITH THE COSSOR MU2 BATTERY ELIMINATOR. SUITABLE FOR PREMIER "PETITE"

This Eliminator is completely assembled and supplied with 6ft. of Mains Lead and Turpedo-type of On/off Switch. It is housed in 2 Metal Containers approximately the same size as the AD35 and B126 Batteries, and suitable for such Receivers as the Cossor 543, 551 and 552 or Receivers operating on 1.4 volt L.T. and 90 volt H.T. for use on 200-250 v. A.C. mains. Size: L.T. unit 3in. x 2½in. x 1½in., H.T. Unit 4in. x 2½in. x 2in. Original Price 3 Gns. OUR PRICE for a limited period only, 37/6 plus 2/- P. & P.

RECORDING TAPE

By well-known manufacturers, Brand New, boxed and fully guaranteed.

1,800ft. on 7in. spool	32/6
1,200ft. on 7in. spool	21/-
1,200ft. on 5¾in. spool	22/6

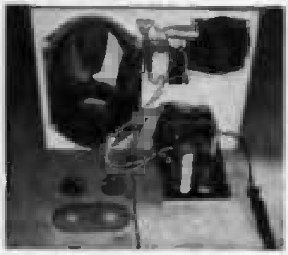
Postage and packing 1/- per spool.

Unrepeatable Bargains ! ! !

THE FAMOUS COSSOR 3 WATT AUDIO AMPLIFIER KIT 562K

ORIGINAL PRICE £9/15/-

OUR PRICE **£5.19.6** P. & P. 2/6



This Kit assembled will provide a compact versatile Amplifier which incorporates the most up-to-date pre-assembled printed circuit and is suitable for operation from Radio, Microphone or Gramophone. The circuit design includes negative feedback, valve line-up 6V6, 6BQ5, EF86. Two Loudspeakers are used, i.e., 10 x 6in. Elliptical and 4in. Treble, ensuring high quality output, suitable for use on 200/250 v. A.C. mains. All items are supplied, including Loudspeakers, Knobs and Escutcheon, with full assembly instructions and in makers' original carton.

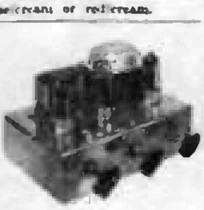
THE COSSOR MODEL 554 Battery Operated Transistor RECORD PLAYER

This Portable Record Player incorporates the latest Garrard BA1 Turntable and Pickup and also a fully transistorised Amplifier, it is completely Battery operated, using two 4½ volt AD28 Batteries. The output from the high quality 7 x 4in. Elliptical Speaker is astounding, suitable for 7in. 45 r.p.m. Records and fitted with a speed adjusting control. The complete Unit is housed in an attractive rexine covered Cabinet with carrying handle and clips, overall dimensions being 11 x 8¾ x 5in., available in two-tone, blue/cream or red/cream.

PRICE **£8.19.6** 4/- P. & P.
Batteries Extra at 3/3 each.

THE "MID-FI"

A NEW DESIGN 4½ WATT AMPLIFIER KIT MAY BE BUILT FOR 95/-
Plus 3/- P. & P.



A new circuit for the home constructor requiring a good-quality medium-powered Amplifier for reproduction of Records of F.M. Broadcasts. Technical Specifications: separate bass and treble controls. Valve line-up EF86, EL84, EZ80. Voltage adjustment for A.C. mains from 200/250 volt 3 or 15 ohms impedance. Negative feedback. Size 7 x 5 x 2in., overall height 5in. Silver-hammered finished Chassis.

RCA VICE-PRESIDENT 8-10 WATTS PUSH-PULL AMPLIFIER

A compact versatile Amplifier complete with plug-in Power Pack, valve line-up HY90, 2 × 19AQ5 and 12AX7, separate bass and treble control, suitable for Speakers of 15 ohms impedance and two 3-ohm tappings for Tweeters. For use on A.C. mains, tappings 110-150 and 210-250 can also be supplied with Power Pack suitable for AC/DC mains. PRICE COMPLETE WITH ESCUTCHEON AND KNOBS, £6/19/6. 3/6 p. & p.

RCA PRESIDENT 10-WATT PUSH-PULL AMPLIFIER

A well-designed compact Amplifier with 10 watts push-pull output; specifications: valve line-up 6BR7, 12AX7, 2-BW4 and Metal Rectifier. Separate Power Pack and separate Control Panel incorporating Volume On/Off, Bass and Treble Controls, suitable for Speakers of 15 ohms impedance with separate tappings for two 3-ohm Tweeters, for use on A.C. mains 110-150 and 200-240. PRICE COMPLETE WITH ESCUTCHEON AND KNOBS £7/19/6. 3/4 p. & p.

AMERICAN RECORDING TAPE

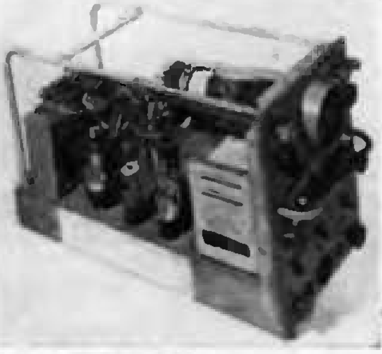
Manufactured by Ferrodynammics, brand new and fully guaranteed.

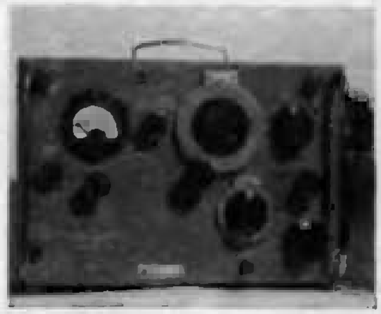
1,200ft. on 7in. spool	25/-
1,800ft. on 7in. spool	35/-
600ft. on 5in. spool	14/6

Postage and packing 1/- per spool.

PROOPS Walk-around Store

and MAIL ORDER SERVICE





SCOPE UNIT T.S. 74. . . . . . **£4.10.** *delivered free.*
A basic 'scope with brilliance and focus controls on front panel which also contains X-plate terminals, gain control and two-speed timebase switch. Immediately behind the panel is a separate screened compartment that houses two VR65 and a VR92 (tunable input receiver—convert to input amplifier) and a signal generator (3xVR65 and VR135) modulated at two frequencies over its 155 to 255 mc/s range. Substantial EHT and HT power pack (VU120 and 5Z4G) at rear, plenty of free room, four high-voltage pre-set pots, two full length tag boards, 12 valves plus VCR139A.

W.1191A WAVEMETER . . **£4.10.** *plus 15/- carriage.*
Four valve crystal controlled heterodyne frequency meter covering 100 kc/s to 20 mc/s in 8 switched bands with variable RF oscillator zero beat against crystal to give an audio output into high or low impedance phones. Designed to work as a signal generator with CW or modulated output through variable attenuator and incorporating also a second crystal oscillator that can be switched in to convert the unit to a fixed spot frequency receiver or transmitter at the wavelength of any spare crystal between 100 kc/s and 20 mc/s.
Precision two speed dial, calibrated book with crystal check points in lid of neat metal case. Designed for 2 v. and 40-60 v. supply.
Circuit diagram supplied. Additional technical information 10/- extra by order only. *Used, but in good order.*

●●●●●●●●●●●●●●●●●●●●●●●●●●●

ETCH-YOUR-OWN PRINTED CIRCUIT KITS 21/- post free

Each contains over 60 sq. in. of laminated board and sufficient chemicals to make dozens of printed circuits, plus comprehensive instruction book giving advice and examples on translating theoretical circuits into layouts ready for etching. High-quality materials—completely safe to handle—carefully prepared to ensure fine definition and uniform results without laboratory control.

●●●●●●●●●●●●●●●●●●●●●●●●●●●

Brand New, Individually Tested, Fully Guaranteed

LOW-VOLTAGE, HALOGEN-QUENCHED, GEIGER-MUELLER TUBES 25/- post free

Working voltage 400-450. Highly sensitive. Effective length 11.8 cm. Background count 90/minute. Response 30,000 counts/minute. 80-volt plateau. Standard British 4-pin base, stainless iron electrode.
Ideal for basic experimentation and instructional demonstration.
Circuits of simple all transistor and conventional valve counter circuits supplied on request with each tube.

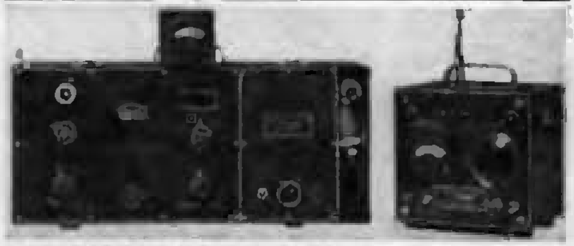
3-INCH CIRCULAR SCALE MILLIAMETER

American panel mounting "Radio Altitude" meter with modern (coil round magnet) movement giving beautifully steady deflection to reading on large dial boldy marked 1 to 4 with sub-divisions in tenths. Supplied with suppressed zero which requires 6.5 mA. for full scale deflection (0 – 1.5 mA.) but pointer is easily re-set to zero by moving conventional hair spring adjuster behind dial, when 5 mA. gives f.s.d. Rear housing incorporates on/off switch (operated by rotating small knob on front face) and 5-pin plug, two pins direct to meter and two to switch. Not new. 12/6, *post free.*

SIGNAL GENERATOR 52A . . **£10** *plus 10/- carriage.*
As illustrated, mains operated 7 valve precision generator covering 5 to 50 mc/s in 4 turret-tuned accurately calibrated bands with RF voltage set and monitored by 50 microamp meter in valve voltmeter circuit. Optional CW or internal modulation at 400 c/s to 30%, or variable depth external amplitude or pulse modulation down to 1 microsecond as required. 1 microvolt to 100 mV output through 5 step and microvolt calibrated vernier attenuator (accuracy ± 3 db) into 70 or 100 ohm dummy antenna on 3 foot cable.
BRAND NEW with calibration charts and handbook.

SIGNAL GENERATOR. 600-1200 Mc/s
Test Set 281, Ref. 10SB/6152. Operates from 230 volt 50 cycle mains. In case 14in. × 14in. × 12in. Fitted 11in. dia. parabolic aerial and Perspex radome. 2.CV.90 (Mazda Osram E.1368). Oscillator in precision cavity. Modulator and 6X3 rectifier.
Suitable for 23 centimetres and latest B.B.C. television 654 mc/s. band. Direct dial reading wide band.
BRAND NEW. **£20** *carriage paid*

SIGNAL GENERATOR AND WAVEMETER
Type W.1649. Frequency of signal generator: 140 to 240 mc/s. Accuracy ± 0.5 mc/s. Frequency of heterodyne wavemeter: 155 to 255 mc/s Accuracy ± 0.2 mc/s. Containing VR.135 and 4-VR.91. 5 meg. crystal. Retractable aerial. Power requirements: 6.3 v. and 120 v. Unit housed in copper lined wooden case. Size: 15½in. × 13in. × 14½in. In good used condition. £2/10/- *plus 10/- packing and carr.*



1-30-A SIGNAL GENERATOR 100-156 Mc/s
Modern, portable, battery operated, 5 valve Signal Generator with alternative crystal or master oscillator, either optionally modulated by 1,000 c/s Hartley oscillator. Large directly calibrated dial with precision slow motion drive. Five step and variable attenuator. Supplied with matching black crackle carrying case for 6 and 135 volt batteries with 10ft. supply cable, and metal cased 1 mA. test meter for checking crystal resonance, etc. Brand new. £2/17/6 *plus 7/6 packing and carriage.*

1-95-A FIELD STRENGTH METER 100-156 Mc/s
Self-contained, tunable-input, valve-voltmeter with telescopic aerial and battery-fed diode rectifier and pentode amplifier for measuring field strength, presence of modulation, and approximate frequency of transmitter. Compensating circuit for state of 1½ and 45 volt batteries. In attractive black crackle case. Brand new.
£4/2/6 *plus 5/- packing and carriage.*

TEST KIT 25
Set of 3 cm. Waveguides, coupling unit, tubular feeder, adaptor unit and waveguide connectors with 30ft. of U.S.A./British terminated co-axial cable and potted 230-110 volt step-down transformer. Brand new.
£7/10/- *carriage paid.*

T.S.184/AP. 70cm. WAVEMETER
Tuning stops adjustable to any 30 mc/s Band within 400-470 mc/s coverage. 6J6 Detector. 24-page instructions covering use as signal generator with 6 and 30 volt battery. BRAND NEW in light steel carrying case.
£2/10/- *plus 7/6 packing and carriage.*

PROOPS BROTHERS LTD
52 TOTTENHAM COURT ROAD, LONDON, W.1
Head Office and mail order enquiries: Dept. W.

Shop hours: 9 a.m. to 6 p.m. Thurs. 9 a.m. to 1 p.m.
OPEN ALL DAY SATURDAY
Phone: LANgham 0141

25,000 OHMS PER VOLT TESTMETER

Made by TRIPLETT of America. Size 7½ x 6¼ x 6½in., and incorporates a unique tilting bakelite container size 5¼ x 3½in., which has two meters, a 25,000 ohms per volt moving coil for D.C. measurements, and a first grade moving iron for A.C. Reads Resistance up to 40 Megohms, A.C. & D.C. volts to 1,000, D.C. current to 250 mA., and also has 0-50 Microamps range. Facilities for measuring Condenser Capacity, etc., and Audio Output. Completely portable, with protective face cover. Complete with leads, batteries, and instructions. Fully reconditioned. ONLY £10/10/- (post, etc., 3/6).

UNIVERSAL AVOMETER 34 RANGE MODEL D

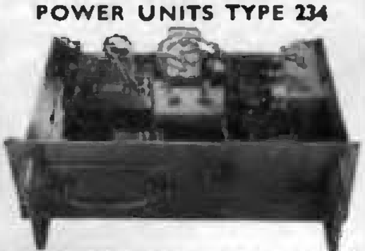
Ex-Air Ministry, but thoroughly reconditioned and checked. Supplied with internal batteries and instructions. Covers ranges as follows:

D.C. VOLTS	A.C. VOLTS	D.C. Current	A.C. Current
150 mV.	7.5 v.	15 mA.	75 mA.
300 mV.	15 v.	30 mA.	150 mA.
1.5 v.	75 v.	150 mA.	750 mA.
3 v.	150 v.	300 mA.	1.5 amp.
15 v.	300 v.	1.5 amp.	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	
300 v.	1,500 v.	30 amp.	Resistance
750 v.			1,000 Ω
1,500 v.			10,000 Ω

ONLY £8/19/6 (Postage, etc., 3/6).

CANADIAN MOVING COIL PHONES. Low-resistance fitted noise-excluding chamois ear muffs, and leather covered head-band. Lead terminates to jack plug. BRAND NEW. ONLY 19/6 (Post 1/6).

POWER UNITS TYPE 234



Primary 200/250 v. 50 cycles. Outputs of 250 v. 100 mA., and 6.3 v. 4 amps. Fitted double smoothing. For normal rack mounting (or bench use) having grey front panel size 19in. x 7in. BRAND NEW, ONLY 59/6 (carriage, etc., 7/6).

CRYSTAL CALIBRATOR No. 10

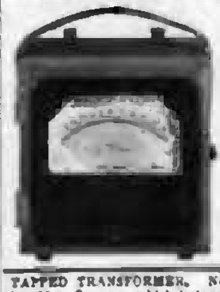
A superb Crystal Controlled Wavemeter just released by the Ministry of Supply. Has directly calibrated dial for nominal coverage of 1.5-10.0 Mc/s. but may actually be used from 500 kc/s. up to 30 Mc/s. Complete with 500 kc/s. Crystal, 2 valves type 1T4, 1 or 1R5 and 1 of CV286 (Neon Stabiliser), and Instruction Book. Size 7in. x 7½in. x 4in., weight 5lb. Used but in first class condition. ONLY £2/19/6. Ca... 3/6.

12 VOLTS AMERICAN DYNAMOTOR. Delivers 220 volts at 100 mills. Size 5½ x 3½in. diameter. Ideal for running Radio and Electric Shaver, etc., from car battery. ONLY 32/6.

EHT TRANSFORMERS. 6.6 kV. (Rect.) with 2 v. 1 a., 79/6. 7 kV. (Rect.) with 2 v. 1a., 89/6. 2.5 kV. (Rect.) with 2-0-2 v. 1.1 a., 2-0-2 v. 2 a. (for VCR 97 tube, etc.), 47/6 (postage 2/- per trans.).

6 v. VIBRATOR PACKS. Output approx. 130 v. at 30 mA., fully filtered and smoothed. Complete, ONLY 12/6. (Post 2/6.)

HIGH FREQUENCY A.C. VOLTMETER



A First Grade Moving Iron Instrument with 6in. Mirror Scale, reading up to 150 volts A.C. at 400 and 1,200-2,400 cycles. In substantial Oak case with removable lid, overall size 8½in. x 8½in. x 5½in. Recently made for the Air Ministry, by Everett Edgcumbe, and in perfect order. Brand New & Unused. ONLY £7/10/-. Can also be supplied for 50 cycles, use either 0-150 or 0-300 volts.

TAPPED TRANSFORMER. Normal primary, delivering 30 v. 2 amps., which is tapped to obtain 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v. ONLY 90/-. (Post 7/6.)

HETERODYNE FREQUENCY METERS TYPE LM14

Frequency range 125-20,000 kc/s. in 2 bands. This is the United States Navy model of the well-known BC.221 Frequency Meter, but have many additional features which increase their usefulness. Voltage stabilisation circuits and Crystal control ensure extreme accuracy, and in addition they are fitted with an Internal Modulation switch to allow use as a Signal Generator. Size only 8½in. x 8in. x 6½in. Full information on request.

RCA 8in. P.M. SPEAKER

In heavy black crackled metal case, designed for use with AR 88 Receiver, or any set with 3 Ohms Output. BRAND NEW IN MAKERS' CARTONS ONLY 45/- (Post 2/6).

AR88 LF RECEIVERS

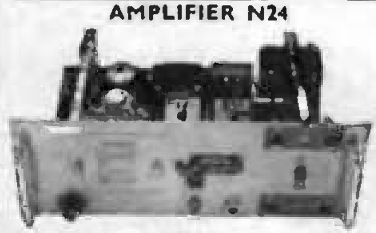
Reconditioned as new, and in perfect order. Frequency coverage 75-150 kc/s. and 1.5-30 Mc/s. ONLY £50 (carriage 25/-).

OSCILLOSCOPE No. 11

Made by A. C. Cossor. Incorporates Hard Valve Time Base with speeds of 1-8-40 milliseconds, but simply converted to produce 3 cycles per second to 30 kc/s. Controls include Fine and Coarse Gain, Brightness, Focus, X and Y shifts. Has Power Pack for nominal 115 v. and 230 v. A.C., with adequate fuse protection. Employs 2½in. tube type ACR10. Grey and black engraved front panel, size 19in. x 7in. For standard rack use if required, depth of unit being 12in. In steel transit case as illustrated. Complete with leads and suggested modification data. BRAND NEW, ONLY £12/10/- (carriage 15/-).

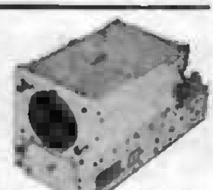
CARRYING CASES, solid leather. BRAND NEW. Internal dimensions 5½in. H. x 8½in. W. x 4½in. D. Fitted lock and key, and shoulder strap. Ideal for Test Instrument, Camera and accessories, etc. ONLY 35/- (postage 2/-).

AMPLIFIER N24



Utilises 4 valves, 1 each 5Z4G, 6V6G, 6J7G, 6J5G and high quality components such as "C" Core Transformers and Block Paper Smoothing Condensers. A.C. Mains Pack for nominal 110/230 volts. Provision for 600 ohms or High Impedance Input. Output to 600 ohm Line. For normal use only requires changing Output Transformer. Output approximately 4 watts. Designed for Standard Rack Mounting, having grey front panel size 19in. x 7in. All connections to rear panel, front having "On/Off" Switch. Gain Control, Indicator Light. Fuses and Valves Inspection Panel. BRAND NEW IN MAKER'S PACKING. ONLY £4/9/6 (carriage 10/6).

"Q FIVER" COMMAND RECEIVER.



The famous American BC 453 covering 190-550 kc/s. I.F.s being 85 kc/s. Complete with all 6 valves and circuit. Size 11 x 5½ x 5in. BRAND NEW IN MAKER'S CARTONS. ONLY 89/6 (Post 3/6).

TCS RECEIVERS

The renowned American set designed by Collins for static or mobile use. Coverage 1.5-12.0 Mc/s. in 3 bands. Complete with all 7 valves. Power required 12 v. L.T. and 725 v. H.T. Size 21in. x 13in. x 11in., in black crackled case. IN NEW CONDITION, ONLY £10/10/- (carriage 15/-).

10,000 OHMS PER VOLT TESTMETER

This latest Cahy model is a handy pocket sized tester 5½in. x 3½in. x 2½in. Reads low D.C. voltages at 10,000 ohms per volt, up to 1,000 v. A.C. and D.C. at 4,000 o.p.v. Resistance to 20 megs., D.C. current to 250 milliamps, and also Decibels. Complete with Test Leads, Batteries, and Instruction Book. ONLY £6/10/-.

MAINS ISOLATING TRANSFORMER. Manufactured by Vortexion. Fully shrouded. Will provide true 1:1 Ratio from nominal 230 v. Primary. Rated at 100 watts. BRAND NEW. ONLY 22/6 post 2/6.

Cash with order please, and print name and address clearly

PLEASE ADD POSTAGE OR CARRIAGE COSTS ON *ALL* ITEMS

HARRIS ELECTRONICS (LONDON) LTD.

Radio Corner, 138 Gray's Inn Road, London, W.C.1. Phone: TERMINUS 7937

Open until 1 p.m. Saturdays. We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross

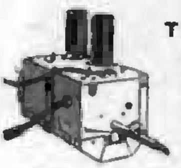
SOUTH SUPPLIES

(ELECTRICAL) LTD.

95 OLD KENT ROAD, LONDON, S.E.1.

Tel.: BERmondsey 5810

CASH WITH ORDER



12 - CHANNEL TURRET TUNER

BRAND NEW. Fitted with coils 1 to 5 and 8 to 9. 34/38 Mc/s. Complete with P.C.F. 80 and P.C.C. 84 Valves.

Manufacturer's price £7/7/0.

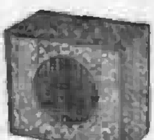
OUR PRICE **£1.17.6** Plus P. & P. 3/6.

ELECTRIC CLOCK, AUTO COOKER TIMER & TIME SWITCH

BRAND NEW. Modernise and add pounds to the value of your electric cooker. Ideal for automatic cooking, or any heat or current control. Complete with handsome electric clock. 200/250V. 30 Amp. Full fitting instructions.

OUR PRICE **£3.17.6**

Plus 2/6 P. & P.



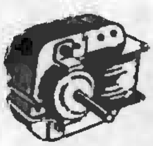
8" LOUDSPEAKER IN CABINET

Beautifully finished in Leather cloth.

ONLY **22/6**

Plus 2/6 P. & P.

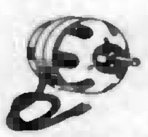
FAN or PROJECTOR MOTOR



220/250 V. BRAND NEW

22/6

Plus 2/6 P. & P.

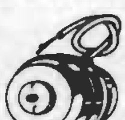


ENCLOSED MAINS FAN MOTOR

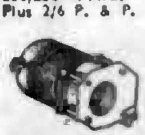
200/250 V. A.C. BRAND NEW. **22/6**

Plus 2/6 P. & P.

B.T.H. FAN MOTOR



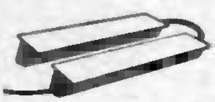
200/250 V. A.C. Plus 2/6 P. & P. **32/6**



ELECTRIC BLOWER

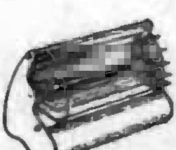
12 or 24 V. Ideal for Car heaters. Plus 2/6 P. & P. **17/6**

TANK IMMERSION HEATER



Complete with separate Thermostat. 200/250 V. Famous make. Ideal Frost prevention. Photo developing trays etc. List £3/0/0.

TO CLEAR **22/6** Plus 2/6 P. & P.



1 KW. ELECTRIC FIRE

Chrome reflector. Fully enclosed back. Made to sell at £2/5/–. BRAND NEW.

OUR PRICE **19/6** Plus 3/– P. & P.

MARCH HARES VIA DUODE SOUND REALLY NATURAL

Two of our favourite records are those of Alice and her friends.

When we hear them via **DUODE** they come to life so much that we can picture the immortal scenes in the room, with Mock Turtle's heavy breathing and March Hare lightly scuttering around.

DUODE SOUND is so natural and clear that it is the one really satisfying, long term investment for anyone with first-class gear, and good ears.

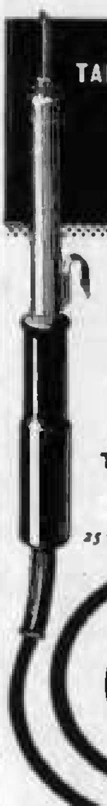
And remember that any **DUODE** made since 1946 can be brought right up to date at moderate cost.

Write NOW for details—

DUODE Ltd.

24 Dingwall Rd., Croydon, Surrey.

TAKE THE PROBLEMS OUT OF SOLDERING



HENLEY SOLON

TRADE MARK

FOR 25 YEARS THE BEST *ELECTRIC* SOLDERING IRON

25 watt Instrument Model (Illustrated)

RELIABLE
SPEEDY
LONG-LASTING

Leaflets on request from:

AEI

CABLE DIVISION
Associated Electrical Industries Ltd.
Distribution Equipment Sales Dept.
59-62 High Holborn
London · W.C.1
Phone: CHAncery 2441-9

LEWIS have the CABINET for YOU

EXTENSIVE RANGE OF CABINETS FROM £4-7-6

THE GROSVENOR
Price £19.19.0

This elegant cabinet is available in veneered figured walnut and polished to a high gloss in a medium shade. Gold embellishments are an attractive feature of the design. 9in. black legs are normally fitted. A three sliding door system reveals ample storage room and space for equipment.

THE BUREAU
Walnut £16.16.0

This popular bureau cabinet is veneered with the finest selected Walnut and beautifully polished in a medium shade. Designed to accommodate almost any of the many units we have available and to give generous storage compartments.

TWO NEW LEWIS CATALOGUES:—

FREE!

The Cabinet Catalogue

The Equipment Comparator Catalogue

(Designed to assist your choice of cabinet and equipment).

Please send me details of your two new catalogues

Name ....

Address ....

....

BLOCK CAPITALS PLEASE WW30

LEWIS radio

120 GREEN LANES, PALMERS GREEN, LONDON, N.13 (Near the Cock Tavern).

Telephone: BOWes Park 1155/6

GEE (Bros.) RADIO LTD.

15, LITTLE NEWPORT STREET, LONDON, W.C.2. *GER. 6794/1453*

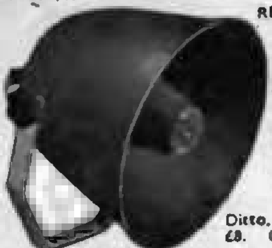
ADJOINING LEICESTER SQUARE TUBE STATION—Open 9-6 Weekdays, 9-1 Sat.

VORTEXION PORTABLE AMPLIFIER A first class amplifier for 200/250v. A.C. or 12v. D.C. operation, 10 watt push-pull output matched to 7.5, 15, 250 or 500 ohms. Incorporates inputs for mike and gram, volume control and bass and treble control. Good working order. **ONLY £9/19/6.** Carr. 10/6.

OLDHAM MINERS' LANTERN (all steel). 9½in. tall, 3¾in. dia. Complete with bulb and rechargeable accumulator. Ideal Inspection lamp for garages, outhouses, etc. 19/11. Post 2/6.

TELESCOPIC AERIAL MAST. 20ft., 4 sections of 5ft. each. Independently locking at any height. Tapering from 2in. to ⅞in. (less accessories). 50/-, carr. 5/-.

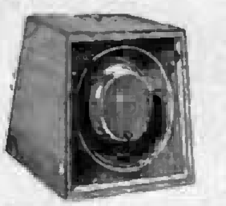
AERIAL MAST (Army type). 32ft. high. Lightweight kit comprising 10 steel screw-in sections (approx. 1in. dia.). Complete with guys, insulators, pegs, etc. All in canvas carrying bag. Only £4. Carr. 7/6.



RE-ENTRANT LOUD HAILERS (Ex-Govt.) Heavy duty 20 watts all-metal 15 ohms. Diameter 15in., length 15in. (approx.) good condition. £6/10/-. Carr. 10/-. Ditto. Brand new, £8. Carr. 10/-.

HEAVY DUTY—ALL STEEL TRIPOD STANDS. Adjustable every 6in. to approx. 9ft. 6in. when fully extended. (Folds up to only 4ft. 6in. for storage). Suitable for outdoor speakers, public address systems, floodlighting, etc., etc. (as illus Dec.). OUR PRICE £3/10/-. Carr. 5/-.

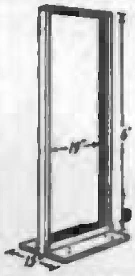
VITAVOX PRESSURE UNITS TYPE N Heavy duty. Special quality. 20 watts P.M. Brand new, 80/-. Ditto but in good order, 40/-. Carr. 5/- on each.



TRUVOX/TANNOY LOUD-HAILERS With 180 ohm line transformer and condenser. Impedance 7½ ohms, handling capacity 8 watts. Complete in slope-front wooden case. In good condition 18/6. P. & P. 3/6. Brand new 25/-. P. & P. 3/6.

PRECISION SERIES 834-S (U.S.A.). Multi range tester for A.C./D.C. volts, ohms and milliamps. Basic movement 400 microamps. Housed in wooden box with carrying strap. Overall size 7½ x 7 x 5in. Complete with test prods, batteries, etc. Ready to use. £4/19/6. Post 2/6.

ACCUMULATORS 12 v. 25 A.H. New and unused. Housed in strong wooden case for extra protection, 45/-. Carr. 7/6. 2 v. 100 A.H. 75 actual. Ex Govt. New and unused. Complete with carrying handle. Size 6½ x 6½ x 3¾in., 15/- each. Carr. 3/6. 3 sent for 50/-, or 6 for £5, carr. paid. Ditto 16 A.H., 5/-. P. & P. 2/-; 6 for 24/-. P. & P. 10/-. Ditto 14 A.H., less handle, 5/-. P. & P. 2/-; 6 for 24/-. P. & P. 10/-



G.P.O. RACKS

19in. Heavy duty, all steel. Standard drilling.

5ft. 6in. angle uprights. £3/10/-. Carr. 15/-.

6ft. channel uprights (as illustrated) £5. Carr. 15/-.

7ft. channel uprights. £6. Carr. 15/-.

19in. x 14in. PANEL SHELF in 14 s.w.g. steel. Suitable for above racks. 15/-. P. & P. 5/-.

ROTARY CONVERTER. 24 v. D.C. to 230 v. A.C. 50 cycles. 150 watts. Brand new and unused. £8/10/-. Carr. 7/6. Ditto, 100 watts, £6/9/6. Carr. 7/6.

ROTARY CONVERTER. Ex-Govt. 12 v. D.C. input, 230 v. A.C. output, 50 cycles at 135 watts. Complete in carrying case with lid. Voltage control, sliding resistance, mains switch and 0–300 v. A.C. flush meter. In good condition, £10. Carr. 10/-.

Motor only, without case, etc. Brand new and unused £8/10/-. Carr. 5/-.

VARIABLE VOLTAGE TRANSFORMER. (BERCO Regulator) Pri. 440 v. 50 cycles, sec. 0–440 v. at 6.5 amps. or can be connected for 230 v. to give 0–230 v. at 12 amps. Brand new and unused £18/10/-. Carr. 10/-.

6 kV/A. AUTO-TRANSFORMER. 230/110 v. 50 cycles (fully tapped primary and secondary). Capable of 25% over actual rating. Brand new and unused. £18. Carr. 20/-. Also 3 kV/A as above, £12/10/-. Carr. 20/-.

20 kV/A AUTO-TRANSFORMER. 230/115 v. 50–60 cycles, by Jefferies Transformer Co., U.S.A. Perfect condition. £20. Carr. £1.

CONSTANT VOLTAGE TRANSFORMER. 190–260 v. primary, sec. 115 v. at 1½kV/A (listed at 2 kV/A). Brand new and unused. £25 or £45 per pair. Carr. 10/- each.

A.C.-D.C. RECTIFIER POWER SUPPLY UNITS

110/230 v. A.C. 50 cycles input, 100/110 v. D.C. output max. 2½ amp. Brand new and unused, £4/10/-. Carr. 7/6.

230 v. A.C. 50 cycles input, 200/220 v. D.C. output at 3/4 amps. approx. Good condition, £10. Carr. 10/-.

200/250 v. A.C. 50 cycles input, secondary 24 v. at 26 amps. D.C. Capable of 25% over actual rating. Brand new and unused. £12/10/-. Carr. 20/-.

200/250 v. pri., 110 v. sec. at 4 amps. max. Brand new and unused. £8/10/-. Carr. 10/-.

AIRBORNE TRANSMITTER RECEIVER. TYPE 1986. A mobile 10-channel crystal controlled V.H.F. Tx/Rx, covering 124.5/156 Mc/s. I.F. band width 23 kc/s. Complete (less external attachments) in metal case, with all valves and 24 v. rotary power unit. Used, but in first-class condition. ONLY £8/10/-. Carr. paid. Also, complete with control box and all necessary connecting leads, £12, carr. paid.

AIRCRAFT RADIO RECEIVER. (By R.C.A.) Freq. 195 Kc/s to 9050 Kc/s. (33-1500 metres) continuous. For 28v. D.C. input with built-in dynamotor. This 6 valve receiver with 2 R.F. stages and 2 I.F. stages with B.F.O. and C.W. is in our opinion one of the finest sets so far released by the Air Ministry. £7.10.0. Carr. 5/-.

TELEPHONE SETS (TELE "F"). Housed in bakelite cases, complete with built-in ringing generators and batteries. Ideal between two or more positions up to practically any distance. Tested before despatched. ONLY 70/-. P. & P. 3/6. 2 sent for £6/10/-. Carr. paid.

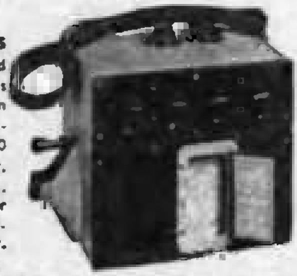
TELEPHONE CABLE. Twin one-mile drums (Don 8), £5. Carr. 20/-. Single one-mile drums (Don 3), 50/-. Carr. 7/6.

TELEPHONE DIALS. Standard (G.P.O.) Pattern, 0–9. Brand new. 30/-. P. & P. 1/-.

C.M.G. 25 PHOTO CELLS (OSRAM). Brand new, 15/-. P. & P. 1/-.

EVERSHED 12 PEN TIME RECORDER. Portable 12-channel instrument for simultaneous recording of 11 events with time marks provided by the 12th pen. Recording is in the form of "on/off" pulses. Speed 2in. per sec. Price unused (less pens), £10. Carr. 10/-.

BRAND NEW CRYSTAL CALIBRATOR No. 10. (Battery powered 1.4 v. valves.) Complete with full working instructions, circuit diagram, carrying haversack, connecting lead and spare valves. Frequency range: 1.5 to 10 Mc/s. (Nominal) but can actually be used up to 30 Mc/s. Weight 5lb. Size 7in. x 7½in. x 4in. A miniature B.C.221 in every respect. A must for every laboratory, etc. ONLY £4/19/6. P. & P. 2/6.



BRIDGE MEGGERS Evershed and Vignoles Series 2 in perfect condition. 250 v. £22, carr. paid. Leather case available at 20/- extra.

CATHODE RAY TUBES. 2¾in. Type VCR139A 25/-; 3in. Type 3BP1 30/-; 5in. Type 5FP7 35/-; 5in. Type 5CP1 35/-; 6in. Type VCR97 25/-. All post free.

EVERSHED AND VIGNOLES MEGGER CIRCUIT TESTER (low reading ohm meter). 2 ranges, 0–3, 0–30 ohms. The perfect meter for continuity and polarity testing, complete with test leads and ready to use. Brand new. Only £4/17/6. P. & P. 3/-.

MULLARD BRIDGE Type GM. 4140/1. Mains operated from 100–250 v. A.C. Will test resistances from 0.1 ohm to 10 megohms and condensers from 10pf. to 10mfd. Good condition and complete with instruction booklet. £6/19/6. P. & P. 2/6.

MARCONI SIGNAL GENERATOR. TYPE TF517-F/1. Covering 10–18 Mc/s. 33–58 Mc/s. 150–300 Mc/s. In very good condition. Complete with full technical data and instructions. Unrepeatable at only £12/10/-. Carr. 20/-.

ALSO MARCONI SIGNAL GENERATOR. TYPE TF390G for 200–250 v. A.C. mains input. Frequency range 4–16 Mc/s. and 32–100 Mc/s. Indirect calibration. Output 1 µV to 100 M/V. 400 c/s internal modulation. In good order. Only £12/10/-. Carr. 20/-.

MARCONI VALVE VOLTMETERS TF.428 B/1. 5 ranges A.C. and D.C. 1.5, 5, 15, 50 and 150 v. A.C. mains operation 200/250 v. Supplied in good working order. £14. P. & P. 7/6.

AVO VALVE DATA MANUAL. Containing a host of information on hundreds of valves including civilian equivalents of many service types. 21/-. Post free.

COVENTRY RADIO LTD.

189/191 Dunstable Road, LUTON.
Audio & Component Specialists Est. 1926

If you are unable to visit us at Luton, send for a copy of our

HI-FI CATALOGUE

of 300 items 70 pages.
Price 1/- plus 6d. postage.

Also available now

"THE GRUNDIG BOOK"

12/6 plus 1/- postage.
If you own a tape recorder of any make you will find this book an essential for successful recording.

LUTON'S HI-FI CENTRE

Telephone Luton 7388/9

P. A. MARRIOTT & CO., LTD.

Specialists in the manufacture of Magnetic Recording Heads.

SUNLEIGH WORKS, SUNLEIGH ROAD, ALPERTON, WEMBLEY, MIDDX. WEM 7493

METERS

WE CAN SUPPLY WITHIN 7-14 DAYS

a complete range of moving coil—moving iron—electrostatic—thermocouple—also multirange meters—meggers—pyrometers and laboratory test instruments, etc.

All to B.S.89

Instruments tested and standardised on our premises, and replacements supplied from our stock.

REPAIRS

Delivered 7-14 days

Our skilled craftsmen carry out repairs or convert any types and makes of single and multirange meters.

Where desired repairs are accepted on contract.

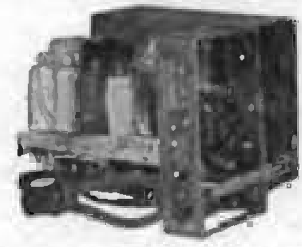
THE V.Z. ELECTRICAL SERVICE
NOTE NEW ADDRESS:
311 EDGWARE ROAD, W2.

SOUTHERN RADIO'S SPECIAL BARGAINS

TRANSMITTER - RECEIVER

TYPE 38 MK II

* WALKIE-TALKIE *



Complete in Metal Carrying Case. 9in. × 6½in. × 4in. Weight 6lb. Frequency 7.3 to 9 Mc/s. Five valves, £1/2/6. Post paid.

These TX-Rs are in NEW CONDITION, but owing to demand they are not tested by us and carry no guarantee, but should prove SERVICEABLE.

ATTACHMENTS for Type "38" Trans-receivers. ALL BRAND NEW. Headphones 15/6; Throat Microphones 4/6; Junction Boxes 2/6; Aerials, No. 1 2/6; No. 2 5/-; Webbing 4/-; Haversacks 5/-; Valves—A.R.P. 12 4/6; A.T.P.4 3/6; Set of FIVE VALVES 19/- the set.

SPECIAL OFFER No. 2:
"38," as above, complete with set of external attachments, 42/6, post paid.

SPECIAL OFFER No. 3:
Transmitter-Receiver "38" Mk. II. Brand new with complete set of external attachments including Webbing, Haversacks and Valves. 57/6 post paid. Fully guaranteed.

CONDENSERS. 100 assorted Mica; Tubular, etc., 15/-. NEW.

CONTACTOR TIME SWITCHES. 2 impulses per sec., in case. 11/6.

REMOTE CONTACTOR. For use with above. 7/6.

LUFBRA HOLE CUTTERS. Adjustable ¾in. to 3½in. For Metal, Plastics, etc., 7/-.

MAGNETS. Strong Bar type, 2 × ⅜in., 1/6 each.

MORSE TAPPERS. Midget type 2/9; Standard, 3/6; Heavy type on base, 5/6. ALL BRAND NEW.

MORSE PRACTICE SET. TAPPER with **BUZZER** on base. Complete with battery, 12/6. BRAND NEW.

PACKARD-BELL AMPLIFIERS. Complete. BRAND NEW, with valves, relay, etc., etc., 17/6 each.

QUARTZ CRYSTALS. Types F.T.241 and F.T.243. 2-pin, ½in. spacing. Frequencies between 5,675 kc/s. and 8,650 kc/s. (F.T.243), 20 Mc/s. and 38.8 Mc/s. (F.T. 241, 54th Harmonic), 4/- each. ALL BRAND NEW. TWELVE ASSORTED CRYSTALS, 45/-. Holders for both types, 1/- each. Customers ordering 12 crystals can be supplied with lists of frequencies available for their choice.

RECORDING BLANKS. Brand new. "Emidisc." Ready for cutting. 13in, 6/- each or 15 complete in metal case £4.

RESISTANCES. 100 assorted useful values. New wire end 12/6. NEW.

SPECIAL OFFER. 12 ASSORTED METERS. Slightly damaged. Mainly broken cases (perfect movements). Including 3 BRAND NEW Aircraft Instruments. 12 for 45/-.

STAR IDENTIFIERS. Type 1 A-N Covers both Hemispheres, 5/6.

T1154 TRANSMITTERS. Complete in transit case. New condition, £2/5/-.

TEST METERS D.C. PORTABLE 0-5,000 ohms 0-6mA 0-1.5v and 3 v. In case 3½in. × 3½in. × 2½in. Voltage range can easily be extended by addition of resistances to suit individual requirements. Brand new, 12/6.

ATTACHMENTS for "18" Transreceivers. ALL BRAND NEW. Headphones 15/6; Hand Microphone 12/6; Aerials 5/-; Set of 6 Valves 30/-.

TRANSPARENT MAP CASES. Plastic 14in. × 10½in. Ideal for Maps, Display, etc., 5/6.

Post or carr. extra. Full list Radio Books, etc., 3d.

SOUTHERN RADIO SUPPLY, LTD.
11, LITTLE NEWPORT STREET,
LONDON, W.C.2. GERrard 6653

LONDON CENTRAL RADIO STORES

TIME SWITCHES, VENNER. 8-day clockwork. 230v. 1a. Thoroughly reconditioned and guaranteed. £2/10 - including post and packing.

EX-NAVAL SOUND POWERED TELEPHONES with Hand Generator calling, and neon Indicator in steel-clad case size approximately 9in. × 7½in. × 7in., 50/-.

SOUND POWERED BREAST MIKE AND HEAD-SET. No Batteries needed. 25/-.

CARBON TELEPHONE HANDSETS. New. 12/6.

SOUND POWERED INSERTS. Suitable for Transistor Sets. New, 3/9.

CENTRE ZERO mA. METER. 1-0-1. Suitable for tuning indicator or galvo. Resistance 75 ohm. Panel mounting overall dimensions 3in. 25/- new and boxed.

AVO UNIVERSAL TEST METERS. Reconditioned as new. In perfect working order. Model 40 £10/10/-. Model 7 £9/9/-.

3½in. **P.M. SPEAKER** 3Ω in grey metal cabinet complete with volume control. Very sensitive. Approx. measurements 5½ × 4½ × 2½in. Approx. weight 2½lb., 25/-.

HIGH-SPEED ELECTRO-MAGNETIC COUNTERS. Ex Govt. 0-9,999, 25/50 v. D.C. Size 4 × 1 × 1in. Single coil 2,300Ω or single coil 500Ω, 18/6.

VENNER TIME SWITCHES, for switching on/off lighting and power. Reconditioned as new. In iron-clad cases, 10 amp., 75/-; 15 amp., 85/-; 20 amp., £3/5/-.

TELEPHONE DIALS. 0-9. Suitable for inter-office and factory installations. With fixing mount, fitted with connecting tags, 21/-.

3-OHM P.M. SPEAKERS. In good working order, 10in., 27/6; 8in. 9/6; 6in. 9/6; 5in. 11/6.

ELECTRICITY SLOT METERS (1/- in slot) for A.C. mains. Fixed tariff to your requirements. Suitable for hotels, etc. 10 A., 84/-; 15 A., 94/-; 20 A., 104/-. Other amperages available. Reconditioned as new.

QUARTERLY ELECTRIC CHECK METERS. Reconditioned as new. 10 A., 42/6; 15 A., 52/6; 20 A., 57/6. Other amperages available.

BALANCED ARMATURE HEADPHONES. Suitable for crystal sets. 12/6.

LIGHT WEIGHT HEADPHONES. Low resistance 300 ohm each earpiece. 12/6.

MOVING COIL HAND MIKE. Type 7. 7/6.

All prices include carriage

23 LISLE ST. (GER. 2969) LONDON, W.C.2
Closed Thursday 1 p.m. Open all day Saturday

POST PAID—CUT PRICE TOOLS

AUTOMATIC PUSH DRILLS, with 8 wood bits, 1/16in. to 11/64in., 13/6. **WHIT. OPEN END SPANNERS,** drop forged and plated, set 6, 1/16in. to ⅜in., 11/6. **POCKET NEON TESTER,** with retractable screwdriver, 5/-.

5in. **SIDE CUTTERS,** 5/-. 5in. **PLATED ROUND NOSE TAPERED PLIERS,** 5/-. 7in. **FLAT NOSE BOX JOINT TAPERED PLIERS,** 8/6. 7½in. **COMBINATION PLIERS,** 6/-.

H.S. TWIST DRILLS. Set 7, 1/16in. to ¼in., 3/6. Full size in wallet, 6/-.

12 v. D.C. MAGNETIC SWITCH. Cuts out on 2 amp. overload or dead short. 13/6. P.P.

NEW AND BOXED BSR MONARCH UA8 4-SPEED RECORD AUTO CHANGERS. 200/250 v. A.C. £6/19/6. Carriage 5/-.

OUR FAMOUS TRANSFORMERS. Input 200/250. Output tapped 3 to 30 v., 2 a. or tapped 5, 11, 17 v. 5 a. Each 24/6. P.P.

F.W. METAL RECTIFIERS. 12/0 volt, 1 a. 7/6; 3 a., 13/-; 4 a., 17/6; 6 a., 27/6; P.P.

TOGGLE SWITCHES DPDT 3/-.

MICRO SWITCHES Make and Break 5/6.

MAINS TRANSFORMER AND RECTIFIER giving 12 v. 1 a. D.C Output 19/6. P.P.

NICKEL NIFE BATTERIES. 1.2 volt, 2.5 amp. Size 3 × 2½ × 1in. Practically everlasting. 6/- or 3 for 16/- P.P. 4 for 21/-.

ARMY MORSE KEYS. 3/-. P.P.

COSSOR 3 WATT AMPLIFIER KIT with two Speakers. Listed at £9/15/-. Price £6/2/-. P.P.

All items new and guaranteed

RELAYS. We hold large stocks. Any contact combination and operating coil voltage supplied from 3/-. 6 v. Relays 4 make 6/-. 2 for 11/6. 3 for 16/-. 4 for 21/-. P.P.

KEY SWITCHES from 3/-.

Lists sent on request. *Post orders only to*

THE
RADIO & ELECTRICAL MART
29 STATION APPROACH, SUDBURY TOWN, WEMBLEY, MIDDX.

NORTHERN ELECTRIC CO.—CANADA

OFFERS

PROFESSIONAL TECHNICAL POSITIONS

having JOB SECURITY

The Company, established in 1895 and the leader in the Communications field in Canada, has recruited technical personnel in the United Kingdom for more than seven years. In over 20 years no engineer or scientist has been laid off owing to recessions. Our continuing expansion now has created additional vacancies for professionally qualified engineers and scientists in the following fields:—

TRANSISTOR DESIGN AND PRODUCTION
Experience desired on development, design, or production of alloyed and diffused semiconductor devices.

TEST SET DESIGN
Experience required in design and development of test sets for complete range of telecommunication equipment or high voltage power cables.

INSTRUMENTATION AND ELECTRONIC MEASUREMENT
Experience required in these fields and/or pulse and microwave circuitry, transistor and diode parameter measurements, etc.

DESIGN AND DEVELOPMENT OF TELECOMMUNICATIONS SYSTEMS
Experience required in communications engineering, including carrier multiplex, data transmission, radio systems, etc.

PRODUCTION AND MANUFACTURING ENGINEERING
Professional engineers required experienced in determination of facilities and methods such as used in mass production of telecommunications apparatus and equipment.

Above positions are in Montreal and various centres in Ontario. Interviews will be held in convenient centres in Great Britain during late March. Transportation allowance for successful applicants. All inquiries treated in confidence and acknowledged. Give full details of qualifications, experience, etc., in first letter to:

Dept. N.E.C., National Employment Service,—Canada, 61 Green Street, LONDON, W.1.

ARE YOU A SKILLED AND EXPERIENCED ELECTRONICS TECHNICIAN?

HAVE YOU BEEN A WIRELESS OR RADAR FITTER IN THE ARMED FORCES?

DO YOU HAVE GOOD TECHNICAL QUALIFICATIONS BUT LACK INDUSTRIAL EXPERIENCE?

If you can answer "YES" to at least one of these questions then we should like to hear from you.

We need new test and calibration engineers to help us increase the output of our very wide range of telecommunications measuring instruments.

The work requires the understanding of the most modern and varied circuit techniques and embraces all frequencies up to 10,000 Mc/s.

The posts are permanent and pensionable and will prove attractive to men who believe strongly that there is a real career for them in production.

Call and talk it over if you live close to us at St. Albans. Alternatively, write to Dept. C.P.S., Marconi House, 336/7, Strand, London, W.C.2., giving full details of your education and experience and quoting reference W.W.2970J.

MARCONI INSTRUMENTS LIMITED
LONGACRES, HATFIELD ROAD, ST. ALBANS

PYE

TELEVISION RECEIVERS

A

TECHNICAL AUTHOR

is required to compile maintenance manuals and other literature for the Pye range of television receivers.

Applications are invited from engineers with an up-to-date knowledge of T/V receiver techniques and circuitry and the ability to express themselves in clear, concise English.

Applications quoting "T.A." should be addressed to the

Chief Engineer,
Pye Ltd., Cambridge.

Plessey

DOMESTIC EQUIPMENT DIVISION

TELEVISION DESIGN ENGINEERS

The planned expansion of this Division has created important vacancies for Senior Development Engineers who are experienced in receiver design techniques.

Applications are invited from competent and ambitious engineers who really understand the problems involved in the design of modern television receivers for large-scale production. The development programme is varied and interesting with opportunities for foreign travel in connection with export 625-line projects.

Vacancies also exist for Radio Development Engineers (including car radio) and for draughtsmen in the Styling Department and Drawing Office.

In all these positions ability will be recognised, leading to promotion to positions of higher responsibility.
High commencing salaries are envisaged.

Reply in confidence to: The Personnel Manager,

THE PLESSEY COMPANY LIMITED, ILFORD, ESSEX.

Saturday morning interviews can be arranged in Central London for convenience.

An opportunity for versatile young Electronic Engineers.

AUSTIN MOTOR COMPANY LTD., LONGBRIDGE,

Require:—

ELECTRICAL/ELECTRONIC MAINTENANCE ENGINEERS for ELECTRONIC DATA PROCESSING EQUIPMENT. Both Valve and Transistor technique as well as Magnetic Drums and Cores are involved with a variety of input and output equipment.

Men aged between 22 and 30 preferably possessing H.N.C. in Electronic or Electrical Engineering including Electronics or similar qualifications are invited to apply.

The positions are permanent, working conditions are good and prospects excellent. Five day week and opportunity given to join the Company's Pension & Life Assurance Scheme.

Applications, stating age, qualifications and experience in electronic applications to:

Chief Electronics Engineer,
Austin Motor Company, Ltd.,
Longbridge, BIRMINGHAM, 31.

ULTRA

ULTRA RADIO AND TELEVISION LIMITED

Stonefield Way, South Ruislip, Middlesex.

An important expansion in Television Research and Development is planned for 1960. The Company's modern laboratories at Ruislip are to be extended and new and varied projects in all fields of Television Receiver Design will be undertaken. This increased activity has created a number of additional permanent posts.

SENIOR TELEVISION ENGINEERS having considerable experience of Television Receiver Design are needed to provide the foundation for the expansion. Their theoretical knowledge should be equivalent to Degree standard, preferably including transistor theory.

These posts should attract men already in the £1,000—£1,500 Salary bracket.

TELEVISION ENGINEERS interested in Receiver Design, having either academic qualifications or adequate experience in this field, are needed to support the Senior Engineers and complete the working team. Excellent opportunities will arise, in the expanding Development activity, for future promotion.

Salaries will be according to experience up to £1,000.

SENIOR TEST EQUIPMENT ENGINEERS are required to design the special purpose test equipment demanded by the Television Receiver Designers, both for Development and Production use. The problems are varied and cover all types of electronic circuit from D.C. to U.H.F. Since new demands constantly arise, the Senior Test Equipment Engineers need to be versatile men with considerable experience and sound academic training.

Salaries will vary with experience and qualifications within the range of £1,000—£1,500.

TEST EQUIPMENT ENGINEERS not yet in the Senior category are needed to balance the Department. They will assist in the development of Special purpose test equipment, and will have ample opportunity for increasing their experience.

Salaries will be in accordance with experience up to £1,000.

SENIOR DESIGNER DRAUGHTSMEN with experience of television receivers, or similar mass-produced equipment, are required to deal with the increasing volume of mechanical design caused by the all-round expansion.

The projects to be undertaken will include some of the most up-to-date developments in the industry and require experienced and responsible men.

Senior Designer Draughtsmen are also required for Special Purpose Machinery used in television production.

Salaries will vary according to experience from £900 to £1,200.

THE TELEVISION LABORATORY is modern and newly equipped with up-to-date instruments. It provides all the necessary facilities for scientific work and is situated in a pleasant residential area.

The Company provides a Free Life Assurance and Contributory Pension Scheme.

Applications, with details of training, qualifications and experience to:—The Technical Manager, at the above address.

WANTED
TELECOMMUNICATIONS ENGINEERS and TECHNICIANS

American communications organization operating in Libya needs experienced personnel for operation and maintenance of 2,000 Mc/s. microwave and 1,000 Mc/s. Troposcatter radio systems including voice and teletype carrier equipment.

Qualifications :

Engineers: Minimum of HNC or City and Guilds final examination.

Technicians: Minimum of Intermediate City and Guilds or equivalent.

Applicants must have minimum of three years' experience in operation and maintenance of similar systems and possess the personality and ability to work in isolated locations.

Detailed particulars will be furnished to qualified applicants. Send résumé to:

HYCON-PAGE
Attn: Mr. Edson
Box 666
Tripoli, Libya

UNITED COMPONENTS LTD.

Design and Manufacturing Organisation

for

R.G.D. - REGENTONE - ARGOSY

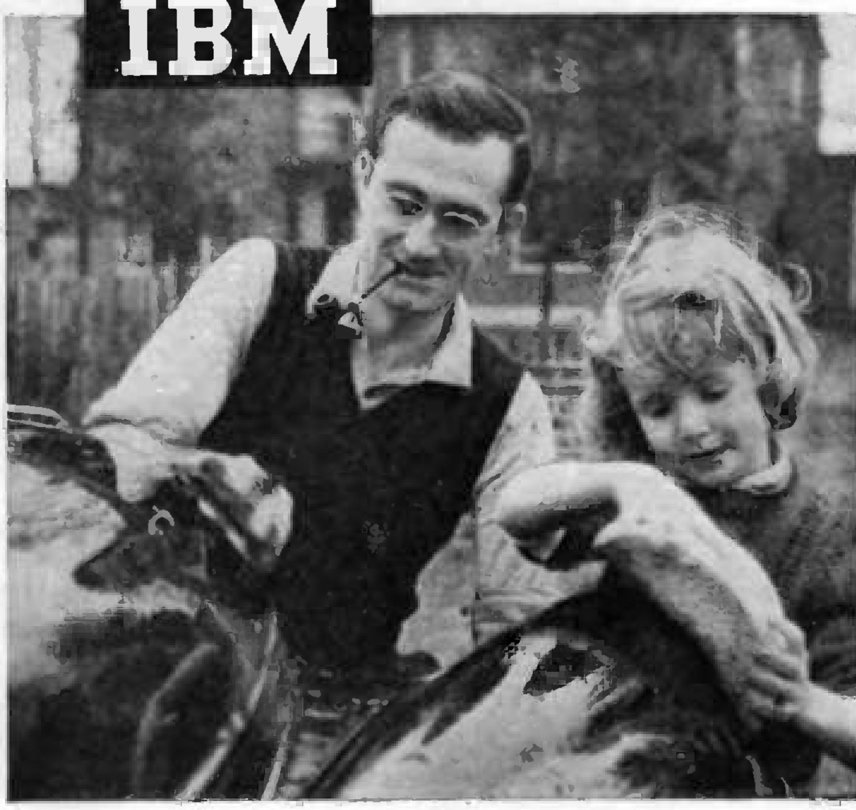
Invite applications from Electronics Engineers for Senior and Junior positions in expanding design teams engaged on the following work:

- Television Receiver Design.
- Radio Receiver Design.
- Transistor Applications for Radio and T.V. Receivers.
- Test Equipment Engineering.
- Instrument Standardising.
- Component Testing.
- Technical Clerk.

These appointments offer unrivalled scope for personal advancement. Excellent working conditions with every facility required for top quality work. Salaries are excellent, normal working hours short and a pension and life insurance scheme is operated by the company. All applications will be regarded as strictly confidential.

Write to: **Technical Director,**
United Components Ltd.,
Eastern Avenue West, Romford, Essex.

I'm a Customer Engineer with IBM



and I *enjoy* it. Plenty of variety. I install and look after data processing equipment—electro mechanical and electronic, including computers—in all sorts of interesting places: banks, factories, offices, government departments and research laboratories. I joined IBM three years ago at the age of 23, and after thorough training I'm already making £950 a year. You've heard of IBM of course. They're the world's largest manufacturer of data processing equipment and one of the fastest expanding companies in Britain today.

There are Customer Engineering jobs with IBM in most parts of the country. If you think you have suitable experience—R.A.F. radar or Royal Signals, a National or City and Guilds certificate, for example—so get in touch with **W. M. R. Jeffreys at 101 Wigmore Street, London, W.1. WEL**beck 6600. Please quote reference Q1.

BRITISH BROADCASTING CORPORATION

Engineering Division

Electrical Engineers being corporate or graduate members of the Institution of Electrical Engineers or of the British Institution of Radio Engineers or who hold a U.K. University degree in Electrical Engineering, a Higher National Diploma in Electrical Engineering or the City and Guilds' Full Technological Certificate in Telecommunications Engineering (Course No. 50) are required for shift keeping, operational and maintenance duties at transmitting stations in the British Isles. Citizens of the U.K. up to 30 years of age are eligible for these appointments. Salary on appointment £890 rising by annual increments to a maximum of £1,185 p.a. Good prospects of promotion to more senior posts. Further particulars and application forms from:—

Engineering Recruitment Officer, Broadcasting House, London, W.1.

Please quote reference **EX.60.6** W.W.

EARN what you're really worth!

You've got ability—everyone has. But are you making the most use of it—to earn what you're really worth? If not, let ICS training develop your ability and help you to a better job, with more security!

Take the right course now . . .

Advertising & Salesmanship
General Advertising
Sales Management
Exams.: Joint Inter., A.A. and I.P.A. Finals, I.S.M.A., U.C.T.A.

Architecture and Building
Clerk of Works
Building Construction
Exams.: R.I.B.A. (Inter.) R.I.C.S., I.Q.S., Inter., Final & Dip. in Working Up, L.I.O.B.

Art
Commercial Illustrating.
Oils and Water-Colours.

Commercial Training
Bookkeeping
Computer Programming
Office Training Bookk'ping
Exams.: I.C.W.A., C.I.S., C.C.S., A.C.C.A., Inst. Bk-keepers.

Draughtsmanship (State Branch)
Drawing Office Practice
Mechanical Drawing
Maths. & Machine Drawing

Farming and Horticulture
Pig and Poultry Keeping
Flower and Veg. Growing.
Smallholding
Exam.: R.H.S. General
Fire Engineering
Instn. of Fire Engnrs.

General Education
Good English
Exams.: G.C.E. Subjects at Ordinary or Advanced Level

Management.
Industrial Mangmt., Office Mangmt. Personnel Mangmt.
Exams.: Br. Inst. of Mangmt. Inter., Final and Cert. in Foremanship

Mechanical Engineering
Wide range of subjects incl. Workshop Practice, Diesel Engines, Refrigeration & Welding. Engineering Maths., Production Eng.
Exams.: I.Mech.E., Soc. of Engrs., Cert. in Foremanship

Motor Engineering
Motor Mechanics
Running and Maintenance
Photography
The Amateur Photographer
Exam.: P.D.A.

Radio, T.V. and Electronic Engineering
Basic Electronics
Radio Engineering
Indust. Electronics & T.V.
Radio Servicing
T.V. Servicing and Eng.
Practical Radio (with kits)
Electricians
Exams.: Brit.I.R.E., Soc. of Engrs., C. & G. Certs. for Telecom Technicians, Radio Amateurs, Radio Servicing (RTEB)

Writing for Profit
Short Story Writing
Journalism

And Many Other Courses

. . . and fill in this coupon

INTERNATIONAL CORRESPONDENCE SCHOOLS, (Dept. 222Q), Intertext House, Parkgate Rd., London, S.W.11.

Please send FREE book on ....

Name .... Age ....

Address ....

....

Occupation 3.60

MARCONI INSTRUMENTS, ST. ALBANS

require

TECHNICAL WRITERS

This Company has immediate vacancies in its Technical Literature (Telecommunications) Section. Applicants should have electrical engineering qualifications and/or experience in the design or development of electronic equipment. The duties are varied and interesting and the posts provide permanent and pensionable positions in a well-established Company.

Please write giving full details of experience and qualifications to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2, quoting reference WW 2970L.

TELEVISION RECEIVER TESTER for SPAIN

Pye Associated Spanish Company have a vacancy for a senior television set tester in Madrid. Accommodation arranged; production bonus; interesting position in a growing industry. Only persons seriously interested in settling in Spain should apply in writing to Mr. L. W. Jones, Works Director, Radio Works, St. Andrew's Road, Cambridge.

BRADFORD INSTITUTE OF TECHNOLOGY

Principal: B. G. Edwards, Ph.D., B.Sc., F.R.I.C.

Applications are invited for the post of

TECHNICIAN in the ELECTRICAL ENGINEERING LABORATORIES

The principal duties of the person appointed will be the maintenance and repair of apparatus, setting up of laboratory experiments and lecture demonstrations and the testing of instruments. A knowledge of electronics would be an advantage.

Applicants should preferably possess a Final Certificate of the City and Guilds of London Institute in appropriate subjects or an Ordinary National Certificate or other suitable qualifications or experience.

Salary scale: £465 to £650 per annum, with efficiency bars at £525 and £590. Commencing salary according to qualifications and experience.

Further particulars and forms of application may be obtained from the Registrar, Bradford Institute of Technology, Bradford 7.

W. H. LEATHEM,
Clerk to the Governors.

AN EXPANDING COMPANY

engaged in the manufacture and development of a wide range of thermionic devices wishes to engage the services of FOUR QUALIFIED

ELECTRICAL ENGINEERS or PHYSICISTS

who have had some relevant experience in the design, development, or manufacturing of valves.

Applications will be treated in confidence and selected applicants will be interviewed by arrangement.

Salary will be assessed within the range £1,500—£2,000.

Details of experience, qualifications, age and present salary etc., to

Box WW 1023 L.P.E. Romano House, 399/401, Strand, London, W.C.2.

Ferranti

AIRCRAFT EQUIPMENT LABORATORIES
BRACKNELL
(Berks)

Immediate vacancies exist for:—

(i) **TRANSISTOR CIRCUIT DEVELOPMENT ENGINEERS**
(ii) **INSTRUMENT DEVELOPMENT ENGINEERS**

The appointments offer:—

★ Interesting work on new projects
★ Ideal working conditions in well-equipped laboratories one hour's journey from London
★ Excellent salaries commensurate with qualifications and experience
★ Housing assistance for suitable candidates
★ Pension and Dependants' Assurance Benefits

Brief details of qualifications and experience should be sent to:—
FERRANTI LTD., WESTWICK, BAGSHOT ROAD, BRACKNELL, BERKS., marked for the attention of **Mr. T. J. Lunt,** and quoting reference AEB.

INTERVIEWS CAN BE ARRANGED FOR SATURDAY MORNING

SKILLED MEN!

USE YOUR KNOWLEDGE IN A WORTHWHILE JOB

VACANCIES FOR
LINEMEN
DRIVERS
DISPATCH RIDERS
DRAUGHTSMEN
DRIVER ELECTRICIANS
RADIO MECHANICS
TECHNICAL STOREMEN
TELEGRAPH MECHANICS
OPERATORS
in
THE ROYAL SIGNALS

Up to £25 tax-free Bonus plus first-rate wages for two weeks of your time

Are you in a skilled trade? Then you can probably add a tidy sum to your income by joining the Army Emergency Reserve. For one thing, you get pay and allowances at full Regular Army rates whilst in camp. And the more your skill's worth in civilian work, the higher your Army rank and pay. Better still, you also get £9-£25 bonus tax-free.

For this you just spend 14 days a year at a camp, working on your own speciality. And money's not the only profit you get from that. You get a grand refresher course, giving you a lot of new ideas, and putting you right in touch with the latest Army developments. And you get a welcome break from the usual routine, with sports, games and a great social life. For the place is full of people with the same interests as yourself. Don't miss this chance! Send off the coupon now to: Col. W. B. Rowett, H.Q., A.E.R., R. Sigs., Blacon Camp, Chester. Tel: 21144.

POST THIS OFF RIGHT AWAY!

Please send me—without obligation—the illustrated booklet telling all about the Army Emergency Reserve.

NAME ....

ADDRESS ....

....

TRADE ....

(WD/ABB)

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

INSTRUMENT MECHANICS

Interesting careers are offered at Dounreay to fully time served Instrument Mechanics, Instrument Makers and Electricians.

Instrument Makers should have experience in the maintenance of air operated instruments for process control. Electricians should have maintenance experience of one of the following: temperature recording instruments; relays and instrument control circuits; or electronic instruments, radar or television.

Rate of pay is £12/12/- for a 44-hour 5-day week.

Working conditions and promotion prospects are good and there are opportunities for study.

Married men living beyond daily travelling distances will be eligible for housing. A lodging allowance is payable to eligible married employees while waiting for housing.

Applications, quoting reference L.19 to:

Assistant Personnel Manager,
Dounreay Experimental Reactor Establishment,
Thurso, Caithness, Scotland.

DIGITAL COMPUTERS

Electronic Engineers or Physicists of graduate standard required for technical supervision of "National-Elliott 405" Digital Computer Installations in London, Midlands and North.

Experience in Digital Computer techniques, although an advantage, is not essential as training will be provided. The main requirements for any applicant will be an analytical mind.

Good salaries will be paid to suitable applicants, and there are opportunities for rapid promotion.

Please apply in writing to the Personnel Manager,

The National Cash Register Company, Ltd., 206-216 Marylebone Road, London, N.W.1.

COMMERCIAL MANAGER

required for leading ELECTRONIC COMPANY specialising in AUDIO and ASSOCIATED EQUIPMENT. TECHNICAL knowledge in this field preferable. This is a top line post with great scope, offering first class opportunity to a man with a successful sales career in this industry.

Apply Box No. 7061 c/o "Wireless World."

IMPERIAL CHEMICAL INDUSTRIES LIMITED, NOBEL DIVISION,

requires an

ELECTRONIC TECHNICIAN

for work in the Research and Development Department at Stevenston, Ayrshire. The post will involve responsibility for the design of electronic equipment with particular reference to specialised instruments. Applicants should preferably be of H.N.C. standard and should have had full-time experience in electronics—for example on radar or gunnery duties in the Services. There is no rigid age limit for this appointment.

Should it be necessary for the selected candidate to move his home to the Stevenston area, assistance in the removal and purchase of a house may be obtained from the Company, details of which will be explained at the interview.

The Company also operates a contributory Pension Scheme and an Employees' Profit-Sharing Scheme.

Salary will be commensurate with age and experience.

Applications should be made in writing to the Division Staff Manager, 460, Sauchiehall Street, Glasgow, C.2.

BRITISH RELAY WIRELESS LTD.

have vacancies in the London Area for:

1. Experienced ENGINEERS with sound knowledge of the servicing of television and audio equipment to be responsible for the maintenance of television relay stations. Technical qualifications to C. & G. Final Certificate or equivalent.
2. ENGINEER to carry out the planning and estimating of wiring projects in all types of buildings. Applicants should have a sound knowledge of the wiring techniques associated with modern buildings and be able to co-operate with architects and contractors throughout all stages of the work. Experience of Television and audio distribution systems would be an advantage.

Apply in writing giving details of experience, qualifications and present salary to:—

London Area Engineer
BRITISH RELAY WIRELESS LTD.
9/13 Camberwell Rd., S.E.5.

TECHNICAL WRITER RADIO AND TELEVISION

A Technical Writer is required for the preparation of Service Manuals for radio and television receivers. Applicants must have up-to-date knowledge of good servicing practice and be able to write effectively and well. Previous experience as a writer is desirable but not essential and the salary for the post will be assessed according to ability and qualifications. Applications including details of age and experience should be sent to the

Personnel Manager (R.23)
Murphy Radio Limited,
Welwyn Garden City, Herts.

RADAR, WIRELESS and INSTRUMENT FITTER CIVILIAN INSTRUCTORS

(Male) required by Air Ministry in the provinces. Appointments unestablished, but good prospects of becoming pensionable. Trade training, practical experience and ability to teach are essential. Pay £727 at age 26 rising to £900.

Apply to:
Air Ministry, C.E.4c (CIV), London, W.C.2.

MARCONI INSTRUMENTS LIMITED

ST. ALBANS, HERTS.

have vacancies for

SENIOR DRAUGHTSMEN with experience in electronics.

also

DETAIL DRAUGHTSMEN with experience in electronics or otherwise.

Excellent opportunity for experienced men to widen experience with well established and continually expanding company, offering long term progressive employment and good working conditions.

Please write giving full details of experience and qualifications to Dept. C.P.S., Marconi House, 336/337, Strand, London, W.C.2. quoting reference WW2070K

T/V ENGINEERS

Required by Multiple Company. All Districts. Top Wages and Commissions. These are permanent and Pensionable Posts. Preferably able to drive, although not essential.

CALL or PHONE NOW!

J. & F. STONE LIGHTING & RADIO LIMITED
Edgware Road, The Hyde, Hendon, N.W.9.
Tel. No.: COLINDALE 7062

OR

J. & F. STONE LIGHTING & RADIO LIMITED
82, Rye Lane, Peckham, S.E.15.
Tel. No.: NEW CROSS 2134

Z. & I. AERO SERVICES LTD.

14 South Wharf Road, London, W.2

Telephone: AMBassador 0151/2 Cables: ZAERO, LONDON

A.R.B Approved Stockists

RETAIL BRANCH: 85 TOTTENHAM COURT ROAD, LONDON, W.1

AN/AMT-11 RADIO SONDE TRANSMITTERS

Complete transmitter designed to transmit signals in the range of 395-405 mc/s. range audio modulated at 10 to 200 c/s, modulation frequency depending on the magnitude measured. Measurements range: pressure 1,060 to 8 millibars; Relative Humidity 15 to 90%; Temperature −90 to +50°C. Equipment includes barometric switch and measuring device, humidity and temperature measuring elements, aerial and pressure calibration chart. Transmitter Circuit consists of Double Triode 3A5 with one half acting as modulating oscillator, the other as a buffer, and UHF Triode 5703.

PRICE, brand new without batteries £2 10 0
Manual 17 6
One manual supplied free per each six transmitters.
Packing and postage 6 6
Battery required: 120 VHT and 7.5V L.T. Weight, without battery: approx. 13 ozs.

STANDARD WAVEMETER No. 2

Laboratory Standard Wavemeter covering a range 0.5 kc/s. to 10 mc/s. on fundamentals and up to 300 mc/s. in harmonics. Generation of any frequency from 0.5 kc/s. to 10 mc/s. with accuracy of 1 in $10^6 \pm 10$ c/s.; Generation of any kc/s. from 2 kc/s. to 10 mc/s. with accuracy of 10^6. Output signal amplitude 0.2 to 0.3V. Decade tuning. Mains operation. PRICE £280 0 0
Packing and carriage £5 10 0

UNIVERSAL IMPEDANCE BRIDGE

(Test Set Type 373)

General Purpose Impedance Bridge for 115/230 v. A.C. operation. Measurements ranges: 0.1 to 100,000,000 ohms, 1 pF to 1,000mF; 0.1μH. to 100H. Accuracy 1 to 2% (centre of the range) for resistance and capacitance and 10% average for inductance. Operating frequency 1,000 c/s. except higher capacitance ranges where measurements are made at mains frequency. Direct leakage current reading up to 5mA. Polarising voltage from 0 to 300 volts for reforming electrolytic capacitors. Neon tuning indicator and headsets for balancing.
PRICE, unused and guaranteed .... £30 p.p. £1.

TF 562B/1 MARCONI OSCILLATOR DETECTOR UNIT

Frequency Range 100 kc/s. to 20 mc/s. in six bands. Oscillator output: .3 to 1V; Detector sensitivity at least 10μV at low frequency end, tailing off to 200μV at high frequency end. The Unit consists of separate Oscillator and Detector Units mounted in common cabinet. RF output modulated at 1,000 c/s; Headphone balancing (null indication).
PRICE, fully overhauled and guaranteed £75 0 0
Packing and carriage £1 0 0

MARCONI TF-144G SIGNAL GENERATOR

Frequency Range 85 kc/s. to 25 mc/s.; Output 1μV. to 1 volt; 200-250 v. A.C. mains power supply or battery operation. Complete with mains lead and output lead with Dummy Aerial.
PRICE £85 0 0
Packing and carriage £1 0 0

COMPLETE 3-CM BAND TEST EQUIPMENT

Equipment consists of: TS-13 Signal Generator covering a band of 9305 to 9443 mc/s. and providing pulsed triggered, pulse self-synchronous, CW and FM output of at least 60μW average; TS-12 Standing Wave Detector and Set of Waveguides and Adaptors (All U.S. Standard flanges). Details and prices on application.

MARCONI TF-987/1 NOISE GENERATOR

Directly calibrated noise generator for use with receivers in the range from 1 to 200 mc/s. Direct calibration in noise factor values. Accuracy ±0.5db. Output Impedance 70Ω. Power Supplies 200/250V A.C.
PRICE £25 0 0
Packing and carriage 15 0

INSULATION TESTERS

EVERSHED SERIES 1 MEGGER INSULATION TESTERS. 500 volts, 40 megohms, secondhand, fully overhauled and guaranteed £25 0 0
Packing and carriage 15 0
EVERSHED SERIES 2 BRIDGE MEGGERS, 500 volts, 100 megohms, with built-in four decade resistance box and ratio arms of .01-.10-1.0-10-100; Selector for Bridge, Megohms and Varley measurements. Unused and fully guaranteed £65 0 0
Packing and carriage £1 0 0
EVERSHED SERIES 2 MEGGER INSULATION TESTERS, 1,000 volts, 200 megohms in leather cases, brand new £45 0 0
Packing and carriage 15 0
500 volts, 100 megohms in leather case, secondhand. Fully overhauled £17 10 0
Packing and carriage 15 0
EVERSHED SERIES 3 MEGGERS (Wee Meggers).
500 volts, in leather case £13 10 0
250 volts, in leather case £11 10 0
Packing and postage 15 0

COMMUNICATION RECEIVERS

ALL AVAILABLE ON H.P. OR CREDIT TERMS. Completely overhauled to "as new" performance and fully guaranteed for six months.

RCA AR-88LF	£80 0 0
RCA AR-88D	£85 0 0
HALLICRAFTER S-27 (28-143 mc/s.)	£65 0 0
HALLICRAFTER S-36 (28-143 mc/s.)	£70 0 0
MARCONI CR-100, 60 kc/s-30 mc/s.	£42 0 0
BC-342, 1.5-18 mc/s.	£42 0 0

Please write for details.

UHF PORTABLE TRANSMITTER-RECEIVERS RT-159/URC-4

Pocket size Handie-Talkies, providing two-way voice or keyed communication in two crystal controlled frequencies, one in 125 mc/s. band and another in 260 mc/s. band. PRICE, complete with Mercury Battery.
Each £35 0 0
Packing and carriage 15 0

VARIACS

General Electric "Variac" or Superior Electric Co. "Powerstat" Variable Auto-transformers. Input 230V; Output from 0 to 270V. Max. Current 8 Amps. Rating 2 kVA. New and guaranteed £15 0 0
Packing and carriage 12 6

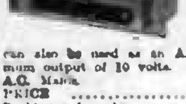
POWER UNITS TYPE 234

A.C. Mains Rack Mounted power unit providing an output of 160 to 270 volts H.T. and 6.3V A.C. at 4 amps. Brand new £2 19 6
Packing and carriage 10 0

5SP7 DOUBLE GUN ELECTROSTATIC CATHODE RAY TUBES

Screen coating gives blue-white short persistence and yellow long persistence trace. Average operating conditions: V(a3) 4,000 v., V(a2) 2,000 v., V(a1) 300-700 v. Cut-off voltage 45-75. Sensitivity 80-100 v. D.C. per inch on "Y" and 70-80 v. D.C. per inch for "X" axis. Heater 6.3 v. 0.6 A.
PRICE, new and guaranteed, ONLY £7 0 0
Postage and packing 2 6

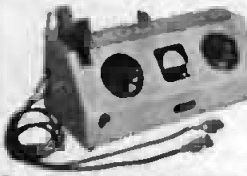
CATHODE FOLLOWER VALVE VOLTMETER



Voltage Range: 100 microvolts to 300 volts in six steps. Frequency Range 300 c/s. to 200 Kc/s. Noise level: 50 microvolts max. Accuracy: better than 3%. Input impedance 100 megohms 15 pF. The instrument can also be used as an A.C. Amplifier with a maximum output of 10 volts. Power supplies: 200-250 v. A.C. Mains.
PRICE £35 0 0
Packing and carriage £1 0 0

PLUGS, SOCKETS AND CONNECTORS

Large assortment of Cannon and Amphenol plugs and Sockets in AN, UG and U- series. PL-series American Plugs, etc. Please write for full price list.



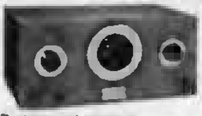
ARMATURE DROP TESTERS

(Ex A.M. Ref. 5G/549)

For testing Motor and Generator Armatures, max. dia. of commutator approx. 4in.; max. overall dia. 7in.; max. length approx. 15in. PRICE £5 10 0
Packing and carriage 15 0

AUDIO OSCILLATORS

HEWLETT PACKARD TYPE 200A R-C OSCILLATOR



Frequency Range 35 to 35,000 c/s. Output 1 watt into 500Ω. Distortion less than .5%. Power Supplies 115V A.C.
PRICE, new and guaranteed .. £28 0 0
Packing and carriage 15 0

B.S.R. LO-50 AUDIO OSCILLATOR

Frequency Range 0-16,000 c/s. Maximum output 0.5 Watts into 600Ω. Output Meter. Differential Dial Tuning. Power Supplies 230V A.C.
PRICE, fully overhauled and guaranteed £30 0 0
Packing and carriage £1 0 0

RECORDING MILLIAMMETERS

ELLIOTT SWITCHBOARD PATTERN SINGLE PEN RECORDER. Range 5 mA D.C. Chart width 6in. Chart drive: 230V A.C. at 3in. per minute.
PRICE £50 0 0
EVERSHED SINGLE PEN SWITCHBOARD PATTERN RECORDER. Range 2.5-0-2.5 mA. Centre Zero. Chart width 6in. Chart drive 230V A.C. at 3in. per minute.
PRICE £50 0 0
Please write for details of other recorders in stock.

MARCONI PRECISION HETERODYNE WAVEMETER TYPE TF-783

Range 3 to 15 mc/s. on fundamentals; extensible to at least 30 mc/s. by using harmonics. Accuracy better than 0.005%. Crystal reference oscillator giving check points every 20 and 200 kc/s. Mains operation.
PRICE, fully overhauled and guaranteed .. £55 0 0
Packing and carriage £1 0 0

TELEPHONE SWITCHBOARDS

BD-71 American 6-line Switchboard £12 10 0
BD-72 American 12-line Switchboard .. £22 10 0
Complete with Headphones and Chest set. Packing and carriage extra.

COSSOR MODEL 1049 Mk. III DOUBLE BEAM OSCILLOSCOPE

Fully overhauled and guaranteed £120 0 0
Also available: Cossor model 339, Erskine type 13, Dumont type 241 and Portable High Speed Oscilloscope Type TS-34. Please write for details.

MODULATOR UNITS TYPE BC-456E

Modulator Unit for use with Command Series Transmitters. This unit, designed for use with Carbon Microphones, contains the following valves: BFO-12J5GT, Speech Amplifier/Modulator—1625 and Voltage Regulator VR150-30.
PRICE, brand new without Dynamotor (DM33), complete with all plugs and circuit diagram .. £2 15 0
Packing and carriage 15 0

METERS

Checked and guaranteed

200μA DC MC 2in. Rd. Fl.	32/6
200μA DC MC 2½in. Rd. Fl. Weston mod. 301	35/-
200μA DC MC 2½in. Sq. Fl.	35/-
500-0-500μA DC MC Centre Zero 3½in. Rd. Fl., secondhand, calibrated 60-0-60 Yards per second	22/-
1mA DC MC 2in. Rd. Fl., mounted in 2½in. square steel box, fitted with test lead terminated with two-pin socket	20/-
5mA DC MC 2½in. Rd. Fl., calibrated 0-2 Amps	17/6
500-0-500mA DC MC 2½in. Rd. Fl. Weston model 820	18/-
2 Amps DC MC 2½in. Rd. Fl. Weston mod. 301	[illegible]
30-0-30V DC MC 2½in. Rd. Fl.	[illegible]
150V AC MI 2½in. Rd. Fl. Black Scale	20/-
300V AC MI 2½in. Rd. Fl.	20/-

Packing and carriage 2/6 to £. Please write for new stock and price list of meters.

We buy high quality British and U.S. Communication Receivers, Test Equipment etc.

For the First Time!
a GIANT new reference work

ENCYCLOPEDIC DICTIONARY OF ELECTRONICS AND NUCLEAR ENGINEERING

By Robert I. Sarbacher

You cannot hope to remain completely up to date without this inexhaustible compilation of modern terms and definitions, equipments, elements, components and systems. A quick-look-up and you know your answer, definitely and authoritatively. No wonder this alphabetical work, presented after twelve years' preparation, has established itself as the one essential book for all engineers, physicists and scientists. Price £8 net.

From all booksellers

PITMAN, Parker St., Kingsway, London, W.C.2

EASY PAYMENT PLAN

The Modern Book Co., 19-23 Praed St., London, W.2, has arranged a special instalment plan to cover payment of the book over one year. Write to them today for a special order form.

TELEPRINTERS, PERFORATORS, REPERFORATORS, TAPE READERS

Terminals and V.F. Telegraph multi-channel units; Testing Equipment Telephone Carriers and Repeaters; Signalling Rectifiers and Relays. Transformers, Transmit and Receive Filters; Repeating and Retardation Coils; Racks, Relay Bases, Uniselectors, Remote Control Transmitters, British, American and German Equipment.

BATEY & CO., GAIETY WORKS,
Akeman Street, Tring, Herts.
Tel.: TRING 2183 and 2310

PROVED

The finest method for cleaning records

Already over 200,000 enthusiastic users

THE "Dust Bug"
AUTOMATIC GRAMOPHONE RECORD CLEANER
PATENT No. 817,394

Price reduced to 17/6 (plus 6/10 purchase tax
from your local dealer or
CECIL E. WATTS LTD.
Consultant and Engineer (Sound Recording and Reproduction
Darby House, SUNBURY-on-THAMES, MIDDX

High Quality.....
Attractive Price......
Easy to Handle......

TRANSISTOR TAPE RECORDER

"MEMOTAPE"

Miniature in Size.
Precise in Mechanism.

Transistor :	3
Dimension :	7"(W) × 4¹/₄"(D) × 2¹/₄"(H)
Tape Transport :	1⁷/₈" & 3³/₄" per sec.
Recording Frequency :	250 c/s–3000 c/s
Recording :	Double track on 3 inch tape for total 120 min.
Source :	Built-in batteries Eveready 915 × 8 pcs
Accessories :	Moving coil microphone Earphone Speaker box with amplifier Pedal switch Carrying leather case

TOYO TRADING CO., LTD.

P. O. BOX
NO. 999 CENTRAL TOKYO JAPAN
NO. 2, 1-CHOME, HONGOKU-CHO, NIHONBASHI, CHUO-KU TOKYO
CABLE ADDRESS
"SHININGEAST" TOKYO JAPAN

Catalogue on Request

PORTLAND ELECTRONICS

TEST EQUIPMENT

CRYSTAL CALIBRATOR. FURZEHILL NO. 7, MK. I. Battery operated giving harmonics up to 30 mc/s. at 1 mc/s., 100 kc/s. or 10 kc/s. intervals. An extra stage serving as a modulator or detector enables both transmitters and receivers to be calibrated. Crystal frequency 1 mc/s., 6 valves. Supplied brand new in transit case with spare valves and accumulator. £3 17/6.

OUTPUT METER AF NO.1. A modern 5in. scale instrument covering 200μW to 6W f.s.d. in 11 ranges. Calibrated also in Decibels. Matching 11 impedances 2.5 to 20K ohms. Hammered enamel front panel from and sealed die cast case. As new now **£12/10/-** each.

PRECISION VOLT METERS. Elliott high grade 6in. moving coil, mirror scale voltmeters. F.s.d. 30 volts ±0.2%. In first class condition, complete with leather case and checked for accuracy before despatch. The resistance of each meter is individually marked and the range could easily be extended. **£7/5/-** each.

CONSTRUCTORS BARGAINS

POWER PACKS. Input 110-200-220-240 v. 50 c.p.s. or 12 v. D.C. **OUTPUTS** 200 v. 60 m/a. and 2,100 v. 80 m/a., one positive and one negative to earth. Unit is BRAND NEW and contains a wide assortment of useful power components including 4 8mf. 350 v. paper condensers, 2 chokes, 2 100 v. bridge rectifiers and 2 250 v. ½ wave metal rects. Also a 3-pole c/o heavy duty rotary switch with silver contacts, shock fuses, several small components and a potted double screened mains transformer as advertised previously at **12/6** (output from vibrator winding 24 v. C.T. 1 amps.) Less ballast lamps and vibrator but with full details of input and output connections, etc. A real snip at **27/6** each.

CONDENSERS. T.C.C. Tubular "Metalpack" 0.1 600 v. Brand new. **7/6** doz.

PRECISION POTENTIOMETERS. Colvern 50 k. 4in. cam corrected with centre tap. Only slightly used and exceptional value at **15/-** each. Ideal for bridges, etc.

MISC. NEW ITEMS. Valves EF91, 6C4 3/-; 4313C, 3/6; 3A4, 4/-; 6SN7, 5/-. C.R.T.s 3CP1, 20/-; 5FP7, 15/- each. Wearite I.F.T.s 465 kc/s., 6/6 pair. Heinemann circuit breakers, 2½ a., 5/6 each. W/W. pots, 50 ohm, 1/3; 5 k., 1/6; 50 k., 1/9; 100 k. log. carbon, 1/3. 230 v. A.C. solenoids with laminated armature, very powerful pull, ½in. stroke, 8/6 each.
All prices include post and packing. Terms C.W.O.

20 PORTLAND PLACE, STALYBRIDGE, CHESHIRE

METER REPAIRS

All makes of Single and Multi-range Instruments repaired and recalibrated.

★ *Prompt Service*
★ *All work guaranteed*
★ *Priority for urgent orders.*

Competitive prices for repairs to all types of instruments. Contracts a speciality.
New meters supplied from stock (2" to 6") and complete equipment manufactured to specification.
Call, write or phone for details to:

E.I.R. INSTRUMENTS LIMITED
329 Kilburn Lane, London, W.9 *Tel: LAD 4168*

TWO NEW ITEMS
AT WEBB'S RADIO

Famous USA **NATIONAL** Communications Receivers in stock
See page 74 this issue

The 'SME' Arm
Which so well solves most problems inherent in pick-up arm design.
Model "3009"
£25 . 0 . 0

WEBB'S RADIO
14 Soho Street, Oxford Street,
LONDON, W.1. *Telephone GERrard 2089*

Wireless World Classified Advertisements

Rate 9/- for 2 lines or less and 4/6 for every additional one or part thereof average lines 6 words. Box Numbers 2 words plus 1/-. (Address replies: Box 0000 c/o "Wireless World" Dorset House, Stamford St., London, S.E.1.). Trade Discount details available on application. Press Day April 1960 issue, Thursday, March 3rd, 1960. No responsibility accepted for errors.

WARNING

Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee! Many of these items will have been designed for special purposes making them unsuitable for civilian use, or many have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS & AMPLIFIERS

AM/FM stereo chassis, 6w output with 2 speakers; only £20.—Bel Sound Products, Marlborough Yard, N.19. [0182

RECEIVERS AND AMPLIFIERS SURPLUS AND SECONDHAND

HALLICRAFTER SX16 receiver, in good condition, selling domestic reasons, 11 spare valves; £25.—Box 7116. [8944

HRO Rx's, etc., AR88, CR100, BRT400 G209, S640, etc., etc., in stock.—R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0053

FOR sale! Two STC sound reinforcement amplifiers, voltage 200 to 250 A.C., input impedance 25 to 150 ohms, output impedance 650 or 160, output power 15 watts, both mounted in cabinet; £50 each o.n.o.—Director, Belgrade Theatre, Coventry. [8932

RECEIVERS AND AMPLIFIERS WANTED

WANTED, acoustical V.H.F. tuner unit.—Davies, Windsor House, Shrewsbury. [8954

LOUDSPEAKERS—SURPLUS AND SECONDHAND

HEAVY duty, re-entrant loudspeakers 15 ohm, with line trans. capable 20 watts output complete with mounting frame, brand new in original packing; £6/15 inc. carriage.—Pratt, "Daravec," Stock, Essex. Tel. Stock 326. [8958

NEW TEST EQUIPMENT

BRAND new signal generators, TS155C, 2,700 to 3,400mc/s; Heterodyne frequency meters, BC221, TS174, TS175A, 20kc/s to 1,000mc/s; receiver-indicators, APN9, PSM6; Simpson 260, multimeters.—Wright, 4A, Nepal Ave., Atherton, Manchester. [0019

TEST EQUIPMENT—SURPLUS AND SECONDHAND

COSSOR oscillograph 1035; £45 o.n.o.—7, Tatsfield Ave., Nazeing, Essex. Tel. Nazeing 3166. [8955

MEGGER insulation testers, unused, 500 volt, constant pressure, by Evershed & Vignoles; £30 each.—H. H. Bradford, Ltd., Ramsey, Harwich, Essex. [8692

UNUSED Parkinson Cowan D.C. check meters for disposal, frustrated export, available cheaply.—B.D.C., 591, Green Lanes, London, N.8. [8962

ELLIOTT portable laboratory, reflecting wattmeter, dynamometer type, .6% accuracy to .1 PF., max. 120 volts or 1 amp. 6 watts, recondition: £65.
CAMBRIDGE dynamometer, portable wattmeter, max. 300 volts or 1 amp. 75 watts; £15.
ONWOOD INSTRUMENT COMPANY, 43, Turret Grove, S.W.4. [8930

SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0056

AIRMEC Televet type 877 for sale, used only once, absolutely as new, no reasonable offer refused, also Taylor valve tester and Cossor D.B. Scope.—Radiovision Service, 57, High St., Hoddesdon, Herts. Tel. Hod. 3102. [8957

FOR sale, 50 Mullard high-speed automatic valve testers, each machine complete with 5 to 600 test cards in series and in metal cabinets; these machines are standard units and have come from a Government factory and were ordered for a discontinued Government job, some are new and some are slightly used; approx. cost from Mullard £120 each, can offer complete with cards and cabinets at £35 each; carriage and packing £3 extra.—Davidson Engineers (M/cr), Ltd., Irkdale St., Smedley Rd., Cheetham Hill, Manchester, 8. Tel. Collyhurst 1610. [8690

NEW COMPONENTS

CRYSTAL microphone inserts with exceptionally high output. (Cosmocord Mic 6.) Guaranteed newly made and boxed. 15/6 post free.—Radio-Aids, Ltd., Dept. W.29, Market Street, Watford, Herts. [0213

NEW COMPONENTS

AMAZING value: Philco Shortwave Car Radio converters, originally £10, to fit any existing car radio and add 6 extra wavebands, 16-19-25-31-49-metre bands, also standard broadcast, 6/12 volts, compact under dash mounting, chromium control panel with 6 press buttons, complete all fittings and instructions, easily fitted; 45/-, post free; each instrument brand new with Mullard valves.—Tomlins, 127, Brockley Rise, Forest Hill, S.E.23. [8878

COMPONENTS—SURPLUS AND SECOND-HAND

VALVES, new and used, from 1/6 each; all guaranteed, all types components cheap, radio, television books; lists free.—Hamilton Radio, 237 Sedlescombe Rd., N., Hastings. [0212

REMOVAL sale! Due to early demolition of existing premises we shall shortly be moving. Our stocks must be reduced! If possible call and select your bargain.
FOR our many postal customers we have put up special parcels, these consist of approx. £5 worth of new components for only 20/- + 3/- p.p. and consist of resistors, condensers, relays, volume controls, switches, coils, transformers, plugs and sockets and many other useful parts; you must not miss one of these bargain parcels 20/- plus 3/- post and packing.—Waltons Wireless Stores, 46, 47, 48 and 49, Stafford St., Wolverhampton.
NOTE. Our new address will be 15, Church St., Wolverhampton, Staffs. [0102

MAGSLIPS at low prices, fully guaranteed, 3 in Receiver No. 5 (AP 10461), 50v, 50c/s, unused, each in tin, 35/-, post 2/1; large stocks of these and other types.—P. B. Crawshay, 94, Pixmore Way, Letchworth, Herts. Tel 1851 [0087

BREAKING hundreds of TVs for spares, all makes; LOPTs from 25/-; scan coils from 17/6; valves from 3/6; tested; also large stocks of new TV components; send requirements for immediate quote and our new lists.—T.C.S., Ltd., 28, Brockley Cross, S.E.4. Tid. 5394. [0334

NEW GRAMOPHONE AND SOUND EQUIPMENT

TAPE recorders, Ferrograph, Vortexion, Brenell, Telefunken, Truvox, Reflectograph, and M.S.S.
TAPE decks; Wearite Brenell, Truvox, Bradmatic, Dulci-Harting, Amplifiers and tuners; Leak, Quad, R.C.A., Dynatron and Dulci; Microphones; Reslo, Lustraphone, Philips, Acos, Grampian, etc. All tape and accessories. Audio service department and recording studio.
HIRE purchase facilities available.
LAMBDA Record Company, Ltd., 95, Liverpool Rd., Liverpool, 23. Great Crosby 4012. [8404

CINE-VOX disc recording mechanisms for L.P. or standard operation from 30gns.—56gns.; also complete tape-disc or direct channels from 50gns.-112gns.
DEMONSTRATIONS can be arranged in London.—For full details write to K.T.S., Ltd., "Coplow," Park Rd., Braunton, N. Devon. Callers by appointment only. [0210

GLASGOW.—Recorders bought, sold, exchanged, cameras, etc., exchanged for recorders, or vice versa.—Victor Morris, 406, Argyle St., Glasgow, C.2. [0201

"EROICA" RECORDING STUDIOS (Est. 1949)—For the better class tape recorders for industry, research, music and private use; Ferrograph, Brenell, etc.; complete recording service; music for industry; tape/disc.—31, Peel St., Eccles, Manchester. Eccles 1624. Studio Director, Thurlow Smith, A.R.M.C.M. [0122

GRAMOPHONE AND SOUND EQUIPMENT—SURPLUS AND SECONDHAND

DULCI Harting tape deck, latest refinements, immaculate, £35.—Tel. Gra. 2351. [8961

DISC cutter M.S.S. complete, amplifier; £60. 4, Denmark St., London, W.C.2. Tem. 6769. [8947

SPECIAL purchase!—1,800ft Agfa-Wolfen L.P. tape on 7in spools, only 32/6; 1,200ft 7in Ferrotape, 26/6; p. & p. 1/6; send for complete list of tape bargains (including American Audio tape, BASF, etc.) and list of new and second-hand tape recorders.—E. C. G. Kingsley & Co., 132, Tottenham Court Rd., London, W.1. Eus. 6500. [0025

FOR SALE AND WANTED ADVERTISEMENT FORM TURN TO PAGE No. 189

TAPE RECORDING, ETC.

RENDEZVOUS RECORDS offer comprehensive 78/LP tape to disc recording facilities. —Leaflet from 19, Blackfriars St., Manchester, 3. [8829

TAPE to disc recording: Microgroove LP from 27/6. 78 r.p.m. from 11/-, also 45 r.p.m.; 48-hour service; s.a.e. for comprehensive leaflet to.—A. D. Marsh, "Deroy" Sound Service, Little Place, Moss Delph Lane, Aughton, Ormskirk, Lancs. Aughton Green 3102. [8931

TAPE/DISC/TAPE transfer editing, copying: if quality and durability matter (especially with LPs from your precious tapes), consult Britain's oldest transfer service; every new tape recorder is supplied with a 2-year service guarantee: latest American, Belgian, German tapes available at competitive rates.—Sound News Productions, 10, Clifford St., London, W.1. Reg. 2745. [0192

VALVES

VALVE cartons by return at keen prices; send 1/- for all samples and list.—J. & A., Boxmakers, 75a, Godwin St., Bradford 1. [0172

RECLAIMED valves, tested and perfect; huge stocks, modern and obsolete; all one price, 5/- plus 6d postage each; delivery by return. Lewis, 46, Woodford Ave., Gants Hill, Ilford, Essex. [8945

VALVES WANTED

NEW valves wanted, any quantity, best cash price by return.—Stan Willetts, 43, Spoon Lane, West Bromwich, Staffs. Tel. Wes. 2392. [8547

ALL types of valves British or American, transmitting and receiving; keenest cash prices paid. What have you to offer?—Write or call Lowe Bros., 9a, Diana Place, Euston Rd., N.W.1. Tel. Euston 1636-7. [8494

WANTED, EXCHANGE, ETC.

SNOOPERSCOPE(S) (infra-red telescope(s) wanted.—Write R. Sproull, 23, Parkhill Rd., London, N.W.3. [8924

A PROMPT cash offer for your surplus brand new valves, speakers, components, test instruments, etc.—R.H.S., 155, Swan Arcade, Bradford, 1. [0190

WANTED, all types of communications receivers and test equipment.—Details to R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley 4986. [0163

URGENTLY wanted, manuals or instruction books, data, etc., on American or British Army, Navy or Air Force radio and electrical equipment.—Harris, 93, Wardour St., W.1. Gerrard 2504. [6880

WANTED, good quality communication RYS tape recorders, test equipment, domestic radios, record players, amplifiers, valves, components, etc., estab. 18 years.—Call, send or phone Ger. 4638, Miller's Radio, 38a, Newport Court, Leicester Square, W.C.2. [6563

PROMPT cash for the purchase of surplus stocks of televisions, tape recorders, radios, amplifiers and domestic electrical appliances of every description, substantial funds available.—Spears, 14, Watling St., Shudehill, Manchester. Deansgate 7705 (3 lines). Bankers: Midland Bank, Ltd. [0216

REPAIRS AND SERVICE

BOULTON'S OF BRADFORD.

LOUDSPEAKER, pressure unit, and microphone repairs, D.C.R. cone assemblies and field coils in cartons, service and satisfaction guaranteed —D. C. Boulton, 134, Thornton Rd., Bradford, 1. Tel. 22838. [0171

MAINS transformers wound to any specification.

MOTOR rewinds and complete overhauls; first-class workmanship; fully guaranteed.

F.M. ELECTRIC Co., Ltd., Potters Bldgs., Warser Gate, Nottingham. Est. 1917. Tel. 54898. [0113

WE undertake the manufacture of transformers singly or in quantities to any specification; all work guaranteed for 12 months.

LADBROKE Rewind Service, Ltd., 820a, Harrow Rd., London, N.W.10. Tel. Ladbroke 0914.

TRANSFORMERS to any specification. Singles, rewinds, small or large batches; quick and efficient service, competitive prices, estimates by return of post from:

MESSRS. Newman & Son, 1, Grove Crescent, South Woodford, E.18. [0330

TRANSFORMERS.—Suppliers to B.B.C., I.T.A., and leading radio manufacturers, single or long runs, prompt delivery, home and export, rewinds to all makes.

FORREST (TRANSFORMERS), Ltd., Shirley, Solihull, Warwicks. Tel. Shi. 2483. [0128

SPEAKER repairs, cones fitted fields and clock coils wound, guaranteed satisfaction, prompt service.—L. S. Repair Services, Pluckley, Ashford, Kent. [0223

MISCELLANEOUS

METALWORK, all types cabinets, chassis, racks, etc., to your own specification, capacity available for small milling and capstan work up to 1in. bar.

PHILPOTT'S METAL WORKS, Ltd., Chapman St., Loughborough. [0208

MISCELLANEOUS

AMMETERS, 6in dial, A.C. switchboard type, 1530, 50 amps approx., 700 individually crated, new, tropically packed, 45/- ea. or offer for lot; throat mikes, magnetic, 9,000 new inserts, 1/3 ea. or lot at 6d; landing lamp motors, 1,000 brand new, 24v, with geared movement, 17/6 ea. or lot at 10/-; most types of ex-Govt. optical equipment available in quantity; please state requirements.—H. W. English, 465, Rayleigh Rd., Hutton, Brentwood, Essex. [0628

AGENCIES WANTED

THE SENTINEL BURGLAR ALARM Co., Ltd., will be establishing an agency in the Manchester area for both the installation and maintenance of the wide range of burglar alarm equipment manufactured; established firms are invited to apply for particulars and only those firms that will be prepared to provide a day and night maintenance service will be considered.—For further details write The Sales Manager, Sentinel Burglar Alarm Co., Ltd., 15-17, The Broadway, London. E.15. [8920

CAPACITY AVAILABLE

ELECTRONICS engineers to the industry Production with 100% inspection. RADIO-AIDS, Ltd., 29, Market Street, Watford (25988), Herts [0214

ELECTRONIC tag boards, wiring and assembly prototypes and small runs.—Electro-Sound Systems, 3, Weybourne Rd., Weybourne, Farnham, Surrey. [8922

ELECTRONIC assembly, coil winding and machining; A.I.D. approved.—Bel Sound Products, Marlborough Yard, London, N.19. Tel. Arc. 5078. [0815

SITUATIONS VACANT

ENGINEERS: Career opportunities in U.S.A.
ENGINEERS with experience in radar, simulators, trainers or communication, are invited to submit their resumes for consideration. Company president will be in London in May to interview applicants. Please address: President, Transdyne Corp., 43, Albertson Ave., Albertson, New York, U.S.A. [8941

LOUIS NEWMARK Ltd., have the following vacancies at their development laboratories at New Addington, Croydon.
AN engineer or assistant engineer with H.N.C. or equivalent, and experience in the light electrical, electronics, electro-mechanical or or aircraft electrical fields to work on the development installation and flight test of automatic pilots for helicopters.
AN engineer or assistant engineer, with a degree or H.N.C. in light electrical or mechanical engineering and relevant experience, for design and development work on small mechanisms and electro-mechanical devices.
PENSION scheme. Apply in writing, giving full particulars to Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, Surrey. [0333

SALES Representative reqd., for industrial electronic firm situated in the West Riding of Yorkshire.—Apply Box 6900. [8934

PART-TIME electronic engineers for L.P. disc cutting, installation work, technical advising, wanted in London.—Box 6677. [0134

PART-TIME advertising and office manager required by London hi-fi dealers; age immaterial; experience important.—Box 6676. [0133

EXPERIENCED radio and television engineer required; good wages and position to man willing to live in the country.—Garlicks, Ltd., Northallerton, Yorks. [8925

JUNIOR sound engineer required for installing and maintenance of 16mm and 35mm cinema sound and projection equipment; full particulars and salary required.—Box 6892. [8933

TELEVISION bench and field engineers required at all times for vacancies in most parts of the British Isles; permanent positions with highest salaries plus bonus for suitable applicants, 5½-day week.—Box 1757. [0251

TANNOY PRODUCTS, Ltd., sound equipment designers and engineers, require prototype wiremen; good all-round knowledge and previous experience essential.—Apply Tannoy Products, Ltd., Norwood Rd., S.E.27. [8946

RADIO Servicing Dept. Manager required for Ceylon to take charge of about 20 local technicians. Young single man preferred. Good pay and allowances.—Write brief details previous experience: B. Rigold & Bergmann, Ltd., 54, Old Broad St., London, E.C.2. [8937

ELECTRONICS engineer required for work on aerial, amplifier and filter development; minimum qualifications H.N.C., age below 30.—Applications, stating age, qualifications, experience and giving some indication of salary expected, to the Secretary, Belling & Lee, Ltd., Great Cambridge Rd., Enfield, Middlesex. [8942

RADIO Technicians required by International Aeradio, Ltd., for overseas service. Permanent and pensionable posts. Normally tax-free, inclusive salary in local currency varying with location, and additional marriage and child differentials. U.K. leave, free air passages and insurance. Kit allowance. Qualified candidates to whom replies will be sent write to Personnel Officer, 40, Park St., W.1. [0262

SITUATIONS VACANT

ACCOMMODATION available in west country seaside town for additional radio, T/V service engineer; applicants with limited T.V. experience will be considered; permanent, progressive position; superannuation scheme.—Box 7079. [8960

GOLDEN opportunity for young man with sound knowledge of tape recorders and Hi-Fi to join new chain of specialised audio shops in London; must be first-class salesman; excellent scope; own staff notified.—Details in confidence to Box 6705. [8919

ROOTES, Ltd., Birmingham, require experienced radio service engineer with specialised knowledge of Radiomobile, Ekco, etc., to operate Mobile Radio Service; good pay and commission.—Write in first instance to Service Manager, Rootes, Ltd., 90, Charlotte St., Birmingham, 3. [8886

A REPRESENTATIVE is required by a rapidly expanding company in the electronics field; a technical background in electronics and electronic components will be necessary and the successful applicant will be a young man capable of negotiation at all levels; a car is provided.
APPLY, giving full details of age and experience, to The Managing Director, Messrs. Amos (Electronics), Ltd., Castle Mills, Buckingham, Bucks. [8927

DRAUGHTSMEN. Positive opportunities for advancement exist for keen Electronic Circuit and Mechanical Draughtsmen required to join team engaged on interesting Radar projects. Apply with brief details to: Personnel Officer, Decca Radar, Ltd., 2, Tolworth Rise, Surbiton, Surrey. [8936

TECHNICIAN research assistant required to work with small medical research group. Should have good electronic experience and be able to make up and assist develop research apparatus. Salary according to experience.—Applications and enquiries to Dr. Ellthorn, Royal Free Hospital, Lawn Rd., N.W.3. [8958

WIRELESS Technicians (all Home Office wireless depots in England and Wales, but not London): salaries £506 (age 21) to £715 (at age 28 or over) rising to £770; opportunities for establishment and promotion; good knowledge V.H.F. essential; ability to drive an asset. —Apply Director of Communications, Home Office, Whitehall, S.W.1. [8959

ELECTRONIC wiring assistant.—Applications are invited from men experienced in wiring electronic equipment, able to work from circuit diagrams and preferably used to prototype work; 5-day week, canteen, superannuation.—Please write, quoting Ref. D.75, to Personnel Officer, Hilger & Watts, Ltd., 98, St. Pancras Way, N.W.1. [8925

OVERSEAS Oil Exploration Company with world-wide seismic parties offers permanent career to electronic technicians. Work consists in maintaining and operating electronic recording equipment under field conditions. Live generally in camp. Qualification: H.N.C. or equivalent essential, with practical experience in electronics. Home leave every two years.—Box No. 5829. [0331

DRAUGHTSMEN.—E. K. Cole, Ltd., Southend-on-Sea, have vacancies in their development and engineering drawing office for draughtsmen with experience in design and production drawing of radio, T.V. and electronic apparatus, and for draughtsmen with experience of press tool design and tooling for automatic screw machines for posts in their tool design section.—Write Personnel Manager. [8928

TECHNICAL Assistant required for testing, installation and servicing work on X-ray fluorescence equipment; good knowledge of modern electronic techniques including pulse work would be an advantage; applicants should be prepared to travel in U.K. and abroad and hold current driving licence.—Please write, quoting reference D84 to Personnel Officer, Hilger & Watts, Ltd., 98, St. Pancras Way, N.W.1. [8952

AIR Ministry requires examiners (technical class grade III) for aeronautical inspection service. Vacancies exist mainly in the electrical and radio trades but a large number in most technical trades will arise during 1960. Quals.: full apprenticeship or equiv. training plus O.N.C. or O. & G. Inter. or Technicians Certificate or equiv. qual. Duties: Periodical inspection and testing of aircraft, accessories and components, M.T., radio, electrical, tools and ground equipment. At Henlow, radio division only, calibration of test equipments. Location: Vacancies are likely to arise at Carlisle, Heywood, Stafford, Hartlebury and Gloucester/Wiltshire area. Sealand and Henlow radio only. Opportunities will arise for serving a tour overseas. Some houses will be available shortly at Henlow. Appointments will be unestablished but are not expected to be of short duration and opportunities for permanent appointments are likely to arise. Salary on scale £620 to £850, staff age 28 and over will start at £727. Good prospects of promotion to Senior Examiner £800 to £1,005 and Chief Examiner £1,005 to £1,220.—Applications and further details from Air Ministry C.E.4a, London, W.C.1, or any Employment Exchange quoting City 85. [8956

SITUATIONS VACANT

TEST engineers.—Applications are invited from senior test engineers with previous industrial experience of testing radio communications, receivers and transmitters; successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details, to Personnel Officer, Redifon, Ltd., Broomhill Rd., S.W.18. [0252

CIRCUIT Designers and Circuit Laboratory Engineers required for design and testing of automatic telephone exchange systems and other similar projects. Candidates should have had previous experience of this work and preferably have at least an O.N.C. or an intermediate grouped C. & G. certificate. Knowledge of Crossbar Switching or totalizators would be an advantage. Good salary paid to selected applicants. Pension scheme after qualifying period.
WRITE giving full details of qualifications and experience to the Personnel Manager, Ericsson Telephones Limited, Beeston, Nottingham quoting Ref. DA 1 [0160

RADIO engineer required for work on aircraft and workshop overhauls. Aircraft maintenance engineer's licence an advantage. Good working conditions, generous holidays, staff superannuation and sick pay scheme. Commencing wage between £9/17/8 and £11/17/8 depending on experience, increasing with service to £13/4/8 for a 44-hour week of five days.—Application forms from Chief Clerk, The College of Aeronautics, Cranfield, Bletchley, Bucks. [8959

AN Assistant Technical Officer under 35 with a degree or similar qualification in physics or electrical engineering is required to join a small research team developing acoustics and ultrasonic techniques for studying fast chemical reactions; Laboratory Assistants with "A" levels in chemistry and/or physics are required for the same project.—Write with details to: Imperial Chemical Industries, Akers Research Laboratories, Personnel Services Section, Welwyn, Herts [8953

DEVELOPMENT Engineers are invited to apply for a position with a team working on new and long term navigation systems; applicants—preferably at degree or H.N.C. standard, between the ages of 28-38 should have experience at light electro-mech servo systems including transistorised synchro-systems; the company operates a superannuation and life assurance scheme and will pay an attractive salary for this post which is a staff appointment.—Please apply: The Personnel Officer, The Decca Navigator Company, Ltd., 247, Burlington Rd., New Malden, Surrey. [8940

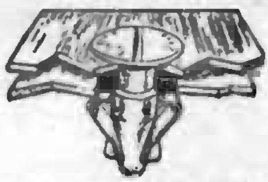
TELEVISION development.—Senior and junior vacancies exist in the Rediffusion organisation for engineers with experience of television receiver design. For the senior posts, wide experience would be accepted in lieu of academic qualifications. The work of the department is varied and covers the design of high-grade monitors and specialised wired television receivers, in addition to conventional receivers.—Apply, giving personal details, and salary required, to: Chief Development Engineer, Rediffusion Vision, Ltd., Fullers Way, Chessington, Surrey. [8921

ELECTRONICS engineers.—Ekco Electronics, Ltd., Southend-on-Sea, Essex, have vacancies for electronics engineers, based at Southend, for installation and service laboratory duties; work is in connection with industrial nucleonic systems, nucleonic counting equipment and general nucleonic instrumentation; permanent progressive posts in expanding organisation; requirements, good theoretical electronics background, preferably coupled with electronics fault-finding experience; salary commensurate with ability.—Please write, stating age, qualifications and experience, to Personnel Manager. [8929

MINISTRY of Aviation require electrical engineers (Assistant Signals Officers) for aviation telecommunications and electronic navigational aids. Min. age 23, 1st or 2nd Class degree in physics or engineering, or A.M.I.E.E. or A.F.R.Ae.S. (candidates with Parts I, II & III of A.M.I.E.E. or Parts I and II of A.F.R.Ae.S. or equiv., or of very high professional attainment without these quals. considered). Salary £690 (age 23) to £1,125 (age 34) max. £1,300. Slightly lower outside London and for women. Promotion prospects. Further details and forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D.554/9A [0026

(A) Experimental Officers (b) Assistant Experimental Officers; pensionable posts for men and women in mathematics, physics, meteorology, chemistry, metallurgy, biological sciences, engineering, miscellaneous (geology, library and technical information services); candidates must, on 31/12/60, be at least 26 and normally under 31 for (a), and at least 18 and normally under 28 for (b); qualifications should normally include H.S.C. or G.C.E., or equivalent, or H.N.C. or University degree; provisional admission if taking examinations in 1960; men's salary scale (London) (a) £1,005-£1,255; (b) £397/10 (at 18) to £710 (26 or over) rising to £880; promotion prospects; further education facilities.—Write Civil Service Commission, 17, North Audley St., London, W.1 for application form, quoting S/94-95/60. [8949

ODDIE FASTENERS



THE FASTENER WITH ENDLESS APPLICATIONS – SIMPLE – POSITIVE SELF-LOCKING. MADE IN A VARIETY OF TYPES AND SIZES. SPECIAL FASTENERS TO SUIT CUSTOMERS' REQUIREMENTS. WIDELY USED IN THE RADIO INDUSTRY.

Illustrated brochure and other information will gladly be sent on request.

DEPT. "W.W."

Oddie, Bradbury & Cull Ltd., Southampton

Tel.: 55883 Cables: Fasteners, Southampton

A.D

LOUDSPEAKER ENCLOSURES AND AMPLIFIER CONSOLE CABINETS

A. DAVIES & CO. (Cabinet Makers)

3 PARKHILL PLACE (off Parkhill Road), LONDON, N.W.3. GULLIVER 5775

Few minutes walk Belsize Park Underground

RACKS & PANELS

All types, open and enclosed, to G.P.O. or customer's specification.

SOUND SALES LTD.

Works & Laboratories:

West Street, Farnham, Surrey

Farnham 6461

OFFICIAL AVO REPAIR SERVICE

All repairs guaranteed 12 months. QUICK SERVICE. Our Staff is fully trained by AVO LTD. Final tests and calibration carried out on AVO test equipment. Repairs sealed with the AVO seal—the mark of Perfection.

FARNELL INSTRUMENTS LTD.

York Road, Wetherby

Telephone: Wetherby 2691/2

SITUATIONS VACANT

PATENT Examiners and Patent Officers; pensionable posts for men or women for work on the examination of patent applications; age at least 21 and under 29 (36 for examiners), with extension for regular forces service and Overseas Civil Service; qualifications: normally first or second class honours degree in physics, chemistry, engineering or mathematics, or equivalent attainment, or professional qualification, e.g., A.M.I.C.E., A.M.I.Mech.E., A.M.I.E.E., A.R.I.C.; London salary (men) £655-£1,460, 60; provision for starting pay above minimum; promotion prospects.—Write Civil Service Commission, 17, North Audley St., London, W.1, for application form, quoting S/128/60, and stating date of birth. [8948

SENIOR Scientific Officers (a): Scientific Officers (b); pensionable post for men or women in all major scientific fields, including physics, chemistry, biology, meteorology and mathematics; age limits: (a) at least 26 and under 32, (b) at least 21 and under 29; extension for regular forces service and Overseas Civil Service; qualifications: normally first or second class honours degree in science, mathematics or engineering, or equivalent attainment; additionally for (a), at least 3 years' relevant (e.g., post-graduate) experience; London salaries (men): (a) £1,233-£1,460, (b) £655-£1,150; provision for starting pay above minimum; promotion prospects.—Write Civil Service Commission, 17, North Audley St., London, W.1 for application form, quoting (a) S/53/60, (b) S/52/60. [8950

ASSISTANTS (Scientific); pensionable posts for men or women at least 17½ and normally under 26 on 1/1/60 with appropriate educational or technical qualifications (normally G.C.E. with passes at "O" or "A" level in 4 distinct subjects including English language and a scientific or mathematical subject, or O.N.C., or equivalent qualifications) and at least 2 years' experience in either: (i) engineering or physical sciences or (ii) chemistry, bio-chemistry or metallurgy, or (iii) biological sciences, or (iv) geology, meteorology, or skilled work in laboratory crafts such as glass-blowing; starting salary (men, London) from £347/10 (at 17½) to £550 (at 25 or over); Maximum (London) £715; promotion prospects; 5-day week generally.—Write Civil Service Commission, 17, North Audley St., London, W.1 for application form, quoting S/59/60. [8951

INSPECTORS of Police Grade II (Signals) required by Government of Nyasaland on probation, with prospects of permanent and pensionable employment, for one tour of 2 to 3 years in the first instance; commencing salary according to age and experience in scale £760 rising to £1,285 a year; uniform allowance of £18 a year in addition to an initial outfit grant of £50; free passages; liberal leave on full salary; candidates, preferably under 30 years of age and single, of good education and physique, not less than 5ft 7in in height, of normal vision without glasses, must have sound knowledge of H.F. and V.H.F. fixed and mobile simplex and duplex radio telephone systems and low-power petrol/electricity chargers and alternators; knowledge of morse and ability to instruct trainees on radio subjects an advantage.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2A/50901/WF. [8926

SITUATIONS WANTED

RADIO and radar technician, aged 26, single, with seven years experience, offers himself for a post in any country or colony.—Box 7081. [8943

TECHNICAL TRAINING

LEARN Radio and Electronics the New Practical Way! Very latest system of experimenting with and building radio apparatus—"as you learn"—Free brochure from Dept. W.W.10, Radiostructor, 46, Market Place, Reading, Berks. [0241

CITY & GUILDS (electrical, etc.) on "No Pass—No Fee" terms; over 95% successes. —For details of modern courses in all branches of electrical engineering, applied electronics, automation, etc., send for our 148-page Handbook—free and post free.—B.I.E.T. (Dept. 388A), 29, Wright's Lane, London, W.8. [0017

TUITION

FULL-TIME courses for P.M.G. Certificates, C.G.L.I., Telecommunications and Radar Maintenance Certificates.—Information from College of Technology, Hull. [0111

WIRELESS.—See the World as a radio officer in the Merchant Navy; short training period, low fees, scholarships, etc., available. boarding and day students; stamp for prospectus.—Wireless College Colwyn Bay. [0018

ALL Examinations easier to pass by I.C.S. home study methods. A.M.Brit.I.R.E., C & G. Telecoms, Radio and TV Servicing, etc.—Write for free Prospectus, International Correspondence Schools Ltd., Intertext House, Parkgate Rd. (Dept. 442A), London, S.W.11. [0033

"HOW and Why" of Radio and Electronics made easy by a new, no-maths, Practical Way. Postal instructions based on hosts of experiments and equipment building carried out at home. New Courses bring enjoyment as well as knowledge of this fascinating subject.—Free brochure from Dept. W.W.12 Radiostructor, 46, Market Place, Reading, Berks. [0240

COPPER WIRE

ENAMELLED, TINNED, LITZ, COTTON AND SILK COVERED

RESISTANCE WIRES

EUREKA-CONSTANTAN

Most Gauges Available

NICKEL-CHROME MANGANIN

SMALL ORDERS PROMPTLY DESPATCHED

B.A. SCREWS, NUTS, WASHERS, soldering tags, eyelets and rivets. EBONITE and BAKELITE PANELS.

TUFNOL ROD, PAXOLIN TYPE COIL FORMERS AND TUBES, ALL DIAMETERS

SEND STAMP FOR LIST *TRADE SUPPLIED*

POST RADIO SUPPLIES

33 Bourne Gardens, London, E.4

Phone: CLissold 4688

FERROGRAPH RECORDERS

Tandberg Stereo, Harting, etc.

Personal Recordings

Tape to Tape/Disc Service

GRIFFITHS HANSEN (Recordings) LTD.

24-25 Foley Street, London, W.1

Museum 2771

TRANSFORMERS

Since 1931 all types, single and 3-phs, 6w to 12 KVA, over 1,000,000 during the war, UL Output Transformers.

SOUND SALES LTD.

Works & Laboratories:

West Street, Farnham, Surrey

Farnham 6461

WORLD RADIO HANDBOOK 1960 15/6

by Hans Johansen. Postage 1/-.

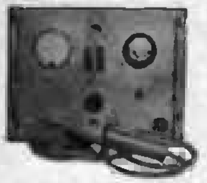
Amateur Radio Call Book 1960, by R.S.G.B. Postage 6d.	3/6
Stereo Handbook, by Briggs. Postage 1/-	10/6
The A.R.R.L. Radio Amateurs' Handbook 1960. Postage 1/3 ...	32/6
T.V. Engineers' Pocket Book, by Hawker. Postage 8d.	12/6
Mullard Circuits for Audio Amplifiers. Postage 10d.	8/6
Model Radio Control, by Safford. Postage 1/-	21/-
Oscilloscope Techniques, by Haas. Postage 1/-	23/-
All-in-One Tape Recorder Book, by Lloyd. Postage 10d.	12/6
The Oscilloscope Book, by Bradley. Postage 6d.	5/-
How to Get the Best Out of your Tape Recorder, by Guy. Postage 8d.	8/6
Beginners' Guide to Radio, by Camm. Postage 8d.	7/6

UNIVERSAL BOOK CO.

12 LITTLE NEWPORT STREET

LONDON, W.C.2 (adjoining Lisle Street)

5,000v. INSULATION TESTERS



5,000v Insulation Testers

Output voltage 0–5,000 v. A.C. or D.C. continuously variable from zero.
Output current 5 milliamp. max. for D.C. 10 milliamp. max. for A.C. Voltage indicator meter for both A.C. and D.C. Voltage reading drops to zero and Magic Eye closes.
Voltage indication by Magic Eye.
Power supply 200–250 A.C.
Dimensions 18 x 18 x 13in. Weight 30lb.

Made for flash testing and for the measurement of the breakdown voltage of electrical components and insulation. A spring-loaded switch is fitted in the test prod which keeps the 200/250 v. supply switched off. Original cost £75

Our price brand new in fitted transit case **£24**
LIMITED QUANTITY ONLY

Tape Recorder or Gram Unit cases size 16in. x 18½ in. x 14½in. Walnut 35/- each, carriage 5/-.

Electric Motors. 240 v. Ph. 1. 6/10 H.P. 960 R.P.M. £5/5/-. Post 10/-. 115 v. 1/6 H.P. 3,000 R.P.M. £3/10/-, post. 10/-.

Condensers. Electrolytic 32-32MF 350 v. wkg. 3/-, post 6d..

Rectifier Units. 240 v. A.C. in 100/120 v. D.C. out at 2.5A £9, post. 20/-.

Transformers. 210/250 v. in. 275-0-275 v. 50 mA. 6.3 CT. 3 A. out 17/6. 210/259 in. 300-0-300 v. 125MA 6.3 CT 2A. 6.3 CT. 2.5A 5 v. 2A. out 22/6. 220/240 v. in. 250-0-250 v. 250MA 4 v. 6.34A. 4 v. 6.3 v. 4 A. 4 v. 6.3 v. 8A. 4 v. 6.3 v. 3.5A 32/6. Postage 3/- in the £1 on all.

Pots 10K, 10k Wire, 2.5K 2m. 25K Lin and Log. .05/.25M 3/- each, post. 6d. Tygan Fret 2/- sq. ft.

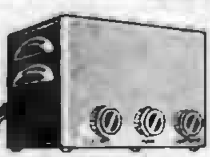
Transformers Step Down.
200/250 v. in 30 v. 100 watt out 17/6, post. 2/-.
200/250 v. in 110 v. 100 watt out 17/6, post. 2/-.
200/250 v. in 110 v. 3.04 amps. out £4/10/-, post. 5/-.

HARRINGAY SUPPLIES
345 HORNSEY ROAD, N.19 ARC 4107

BAND 3 T.V. CONVERTERS

LAST FEW HUNDRED AT THE LOW PRICE OF ONLY
63/- post paid

With 12 months' guarantee (B.V.A. valves, 3 months' guarantee). For all I.T.A. stations and all sets except Philips.
Fully wired, aligned and ready for use. With power pack, knobs, aerial switching, metal rectifier and 2 valves ECC81. Direct switching from B.B.C. to I.T.A. Fine tuning on front. No drift. State B.B.C.



With metal cabinet as illustrated. Stove enamel grey hammer finish.

Aerial Splitter, 8/- (p. & p. 1/-). Band III Aerials. Carr. Paid 3-element, 27/-; 5-element, 35/-; 9-element, 55/-. For mast clipping. Low-loss Co-axial, 8d. yard.

GLADSTONE RADIO
58A, HIGH ST., CAMBERLEY, SURREY

TUITION

T.V. and Radio—A.M.Brit.I.R.E., City and Guilds, R.T.E.B. Cert., etc., on "No Pass—No Fee" terms over 95% successes.—For details of exams. and home training courses (including practical apparatus) in all branches of radio, T.V. and electronics, write for 148-page Handbook—free—B.I.E.T. (Dept. 397A), 29, Wright's Lane, London, W.8. [0016

A.M.I.Mech.E., A.M.Brit.I.R.E., City & Guilds, G.C.E. etc., bring high pay and security; "No Pass—No Fee" terms; over 95% successes.—For details of exams. and courses in all branches of engineering, building, electronics, etc., write for 148-page Handbook—free.—B.I.E.T. (Dept. 387B), 29, Wright's Lane, London, W.8. [0118

LEARN-AS-YOU-BUILD course in basic radio, electronic and electrical theory with practical training building a 4-valve TRF and 5-valve superhet radio receiver; Signal Generator and high-quality Multitester.—Write for FREE book, International Correspondence Schools, Intertext House, Parkgate Road (Dept. 442), London, S.W.11. [0358

INCORPORATED Practical Radio Engineers home study courses of radio and T.V. engineering are recognised by the trade as outstanding and authoritative; moderate fees to a limited number of students only; syllabus of instructional text is free; the Practical Radio Engineer journal, sample only 2/-; 6,000 alignment peaks for superhets, 5/9; membership and entry conditions booklet 1/- all post free, from the Secretary, I.P.R.E., 20, Fairfield Rd., London, N.8. [0088

BOOKS, INSTRUCTIONS, ETC.

CATALOGUE No. 14 Government surplus and model radio control, over 500 illustrated items, 2/- (refunded on purchase), p.p. 6d. —Arthur Sallis Radio Control Ltd., 93 (C), North Rd., Brighton. [0195

BOOKS for C. and G. exams.; Telecom. Principles. A. and B. 9/6; Telecoms. (Principles), 1 and 2, 10/6; Maths. for Tels., 1, 7/-; Maths. for Tel., 2, 8/-; all post free.—Riddiford, 384, Tilehurst Rd., Reading, Berks. [8652

"RADIO Designer's Handbook." Editor, F. Langford-Smith, B.Sc., B.E., Senior Member I.R.E. (U.S.A.), A.M.I.E. (Aust.), a comprehensive reference book, the work of 10 authors and 23 collaborating engineers, containing a vast amount of data in a readily accessible form; the book is intended especially for those interested in the design and application of radio receivers or audio amplifiers. Television, radio transmission and industrial electronics have been excluded in order to limit the work to a reasonable size; 50/- net from all booksellers. By post 52/3 from Iliffe & Sons Ltd., Dorset House, Stamford St., S.E.1.

"WIRELESS Servicing Manual." By W. T. Cocking, M.I.E.E. This, the ninth edition of a standard work, which has come to be recognised as a reliable and comprehensive guide for amateur and professional alike, has been thoroughly revised and set in a larger and handier format. Essential testing apparatus is described and logical methods of deducing and remedying defects are explained. A completely new chapter on the servicing of frequency modulated V.H.F. receivers has been added: 17/6 from all booksellers. By post 18/8 from Iliffe & Sons Ltd., Dorset House, Stamford St., London, S.E.1.

"BASIC Mathematics for Radio and Electronics." By F. M. Colebrook, B.Sc., D.I.C.,A.C.G.I. Revised and enlarged by J. W. Head, M.A. (Cantab.). Presents in readable form a complete course in basic mathematics from engineering students of all kinds and leads on to the more advanced branches of mathematics of increasing importance to radio engineers. In this edition the chapter covering the application of mathematics to radio has been revised and enlarged, while new subjects covered include Stability, Linear Differential Equations, Elementary Statistics, Short Cuts to Numerical Calculations and an Introduction to Matrices. Will be invaluable to those requiring a refresher course as well as to those without previous knowledge of the subject. 17/6 net from leading booksellers. By post 18/6 from Iliffe & Sons Ltd., Dorset House, Stamford St., S.E.1.

"TELEVISION Engineering Principles and Practice, Vol. III, Waveform Generation." By S. W. Amos, B.Sc.(Hons.), A.M.I.E.E., and D. C. Birkinshaw, M.B.E., M.A., M.I.E.E. The third volume of a comprehensive work on the fundamentals of television theory and practice, written primarily for the instruction of BBC. engineering staff. This volume gives the application in television and sinusoidal, rectangular, sawtooth and parabolic waves and shows the mathematical relationship between them. The main body of the text is devoted to the fundamental principles of the circuits commonly used to generate such signals, the treatment being largely descriptive in nature and therefore less mathematical than that of the previous volume. The work is intended to provide a comprehensive survey of modern television principles and practice, 30/- net from leading booksellers. By post 31/- from Iliffe & Sons Ltd., Dorset House, Stamford St., London, S.E.1.

G.E.C.

TRANSISTOR AUDIO AMPLIFIERS

250 mW Class B push-pull using GET114 transistors, operating from a 6V supply. Class B single-ended push-pull (Transformerless) using GET114 transistors, operating from a 9V supply.

500 mW Class B push-pull using GET114 transistors operating from a 6V supply. Class B single-ended push-pull (transformerless) using GET114 transistors, operating from a 9V supply.

1 W Class B push-pull using GET114 transistors, operating from a 6V supply. Class B single-ended push-pull (transformerless) using GET114 transistors, operating from a 12V supply.

2 W Class B push-pull using GET116 transistors, operating from a 12V supply.

3 W Class B single-ended push-pull (transformerless) using GET115 transistors (mounted on 3"x3" fins) operating from a 12V supply.

These are a selection from the range of audio amplifier circuits using G.E.C. transistors. For details of any of these circuits or information on the wide range of G.E.C. transistors, please write to:

G.E.C. SEMICONDUCTOR DIVISION,
School Street, Hazel Grove,
STOCKPORT, CHESHIRE.

CLASSIFIED ADVERTISEMENTS

Use this Form for your Sales and Wants

To "Wireless World" Classified Advertisement Dept., Dorset House, Stamford Street, London, S.E.1

PLEASE INSERT THE ADVERTISEMENT INDICATED ON FORM BELOW

- RATE: 9/- for TWO LINES. 4/6 every Additional Line. Average six words per line.
- Name and address to be included in charge if used in advertisement.
- Box No. Allow two words, plus 1/-.
- Cheques, etc., payable to Iliffe & Sons Ltd., and crossed "& Co."
- Press Day, Thursday March 3rd for April, 1960 issue.

NAME ....

ADDRESS ....

....

			REMITTANCE VALUE............ENCLOSED		

Please write in block letters with ball pen or pencil.

NUMBER OF INSERTIONS ....

INDEX TO ADVERTISERS

Printed in Great Britain for the Publishers, Iliffe & Sons Ltd., Dorset House, Stamford St., London, S.E.1, by Cornwall Press Ltd., Paris Garden, London, S.E.1. Wireless World can be obtained abroad from the following: Australia and New Zealand: Gordon & Gotch, Ltd. India: A. H. Wheeler & Co. Canada: The Wm. Dawson Subscription Service, Ltd.; Gordon & Gotch, Ltd. South Africa: Central News Agency, Ltd., William Dawson & Sons (S.A.), Ltd. United States: Eastern News Co., 306 West 11th Street, New York 14.