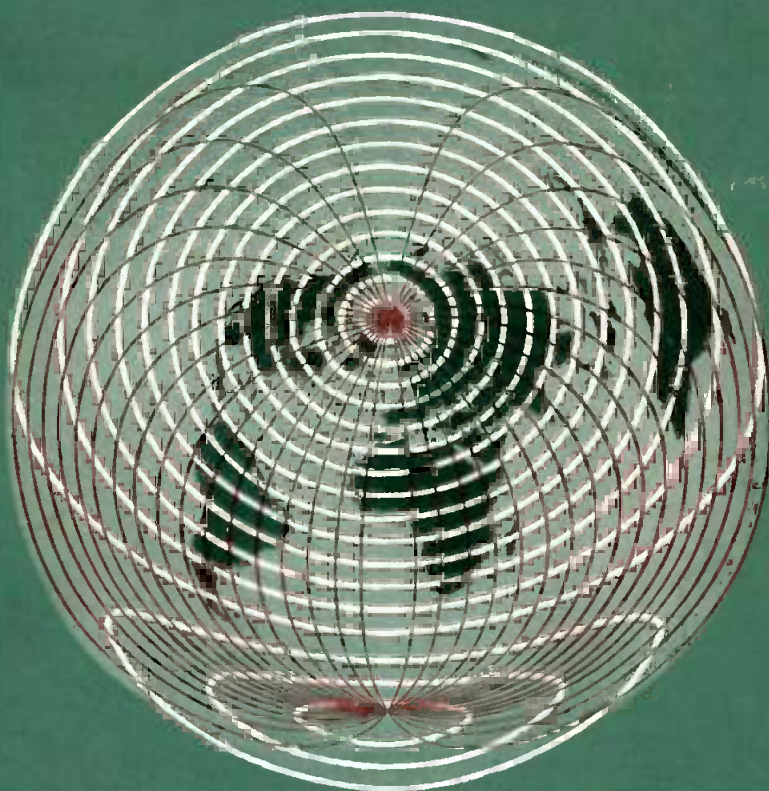


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Wireless World

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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

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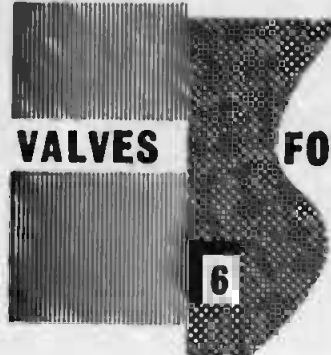
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FRAME GRID VALVES FOR TELEVISION



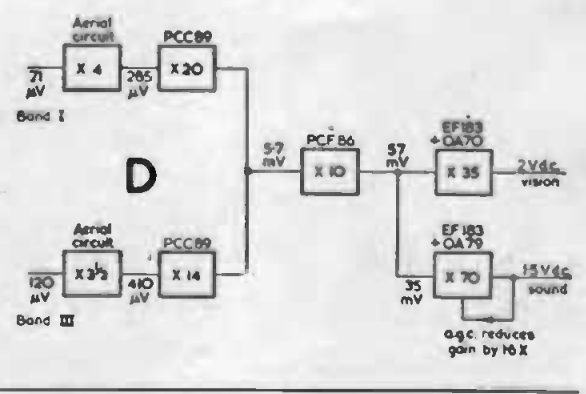
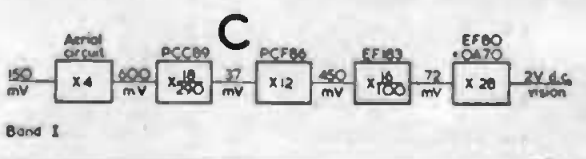
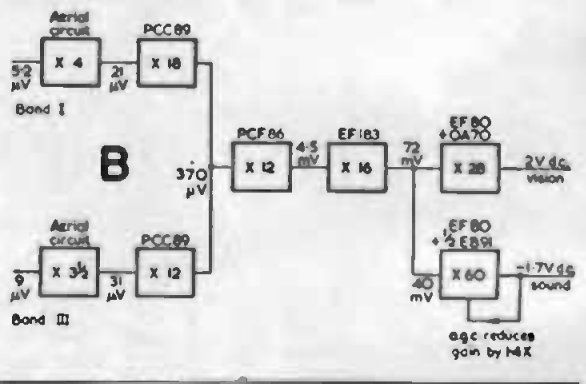
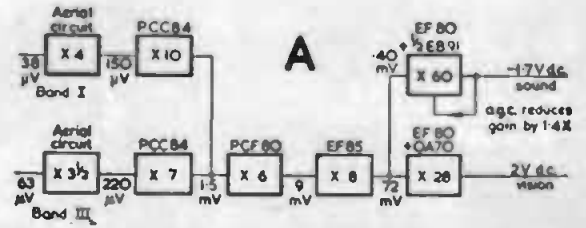
With a suitable valve line-up, receivers with two i.f. stages can be designed for various degrees of improved performance. Frame grid valves can be used throughout the tuner and i.f. stages, or some conventional valves can be retained, depending on the sensitivity required. Two classes of receiver satisfy 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 $20\mu\text{V}$ 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 $10\mu\text{V}$.

Signal levels in a conventional receiver are shown on line-up 'A'. The Band III sensitivity of $63\mu\text{V}$ falls short of the $10\mu\text{V}$ 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 $10\mu\text{V}$ 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.



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

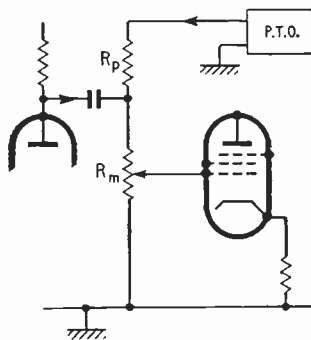


Fig. 1. E.J. Jasic method of providing a pilot tone with a level proportional to the recording gain control level.

acceptable to the tape system; for this would imply that the reproduction of pianissimo passages must occur at unity signal/noise ratio.

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

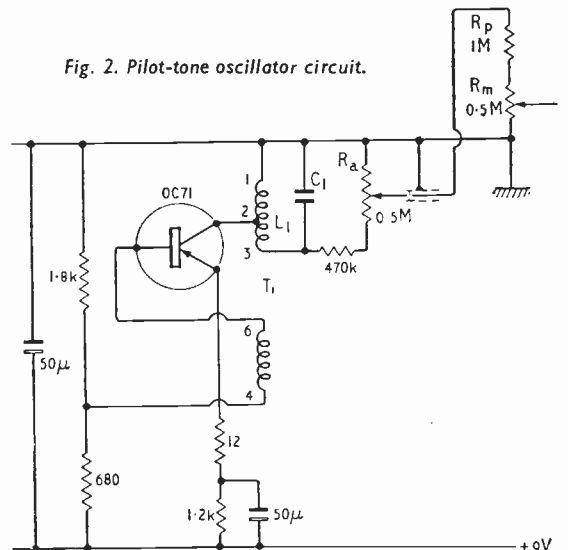


Fig. 2. Pilot-tone oscillator circuit.

Tape Recording

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 15 in per second with a normal R/P head, but will allow 7.5 in 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

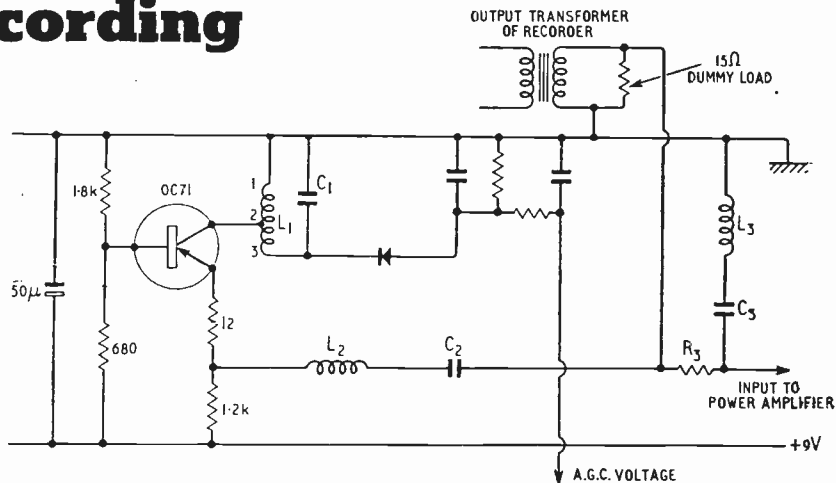


Fig. 3. Selective pilot-tone playback amplifier for providing an a.g.c. voltage to correct the play-back level.

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_n .

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	Distortion observable "
- 5.9	5	6	
- 6.8	10	12	
- 7.4	20	18	
- 7.8	40	24	
- 8.1	40	30	
- 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_n . 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,

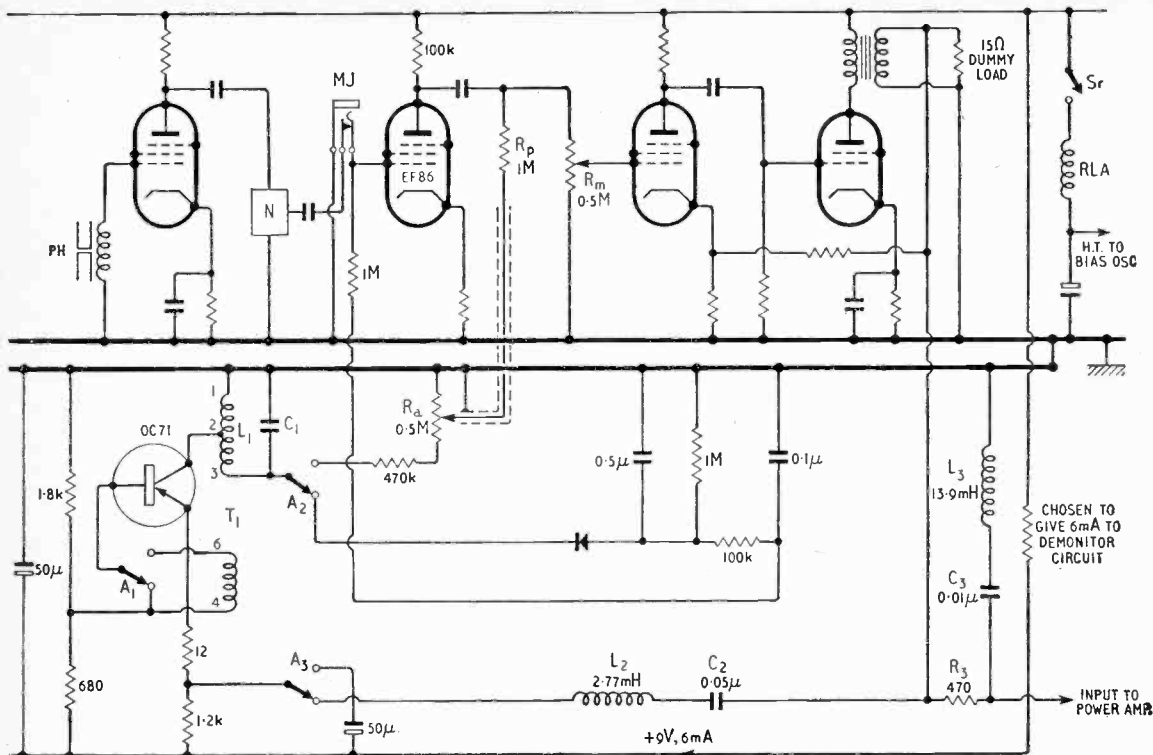


Fig. 4. Practical arrangement of pilot-tone oscillator and selective play-back amplifier and their connections to skeleton circuit of basic play-back amplifier.

KEY

- PH Play-back head
- N Frequency-correcting network
- MJ Microphone jack
- RLA Relay winding, 400Ω, 45 mA
- A₁, A₂, A₃ Relay change-over contacts, shown in un-energised condition (Play-back)
- S_r Switch on "Record" button (shown in Play-back condition)

- T₁ Pilot-tone oscillator transformer
Winding 1, 2, 3 0, 50, 280 turns total
1, 3 40 mH nominal (L₁)
4, 6 4 turns
(32 s.w.g. Lewmex wire on LA1 Ferroxcube core)
- C₁ 3470 pF nominal (to tune with L₁ for 13.5 kc/s)
- L₂ 2.77 mH (60 turns of 22 s.w.g. on LA7)
- C₂ 0.05μF nominal (to tune with L₂)
- L₃ 13.9 mH (165 turns of 28 s.w.g. on LA1)
- C₃ 0.01μF nominal (to tune with L₃)
- 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 16 2/3 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 incompatibilities 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 10⁶ and in the 4-29.7Mc/s band from 30 to 15 parts in 10⁶. 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

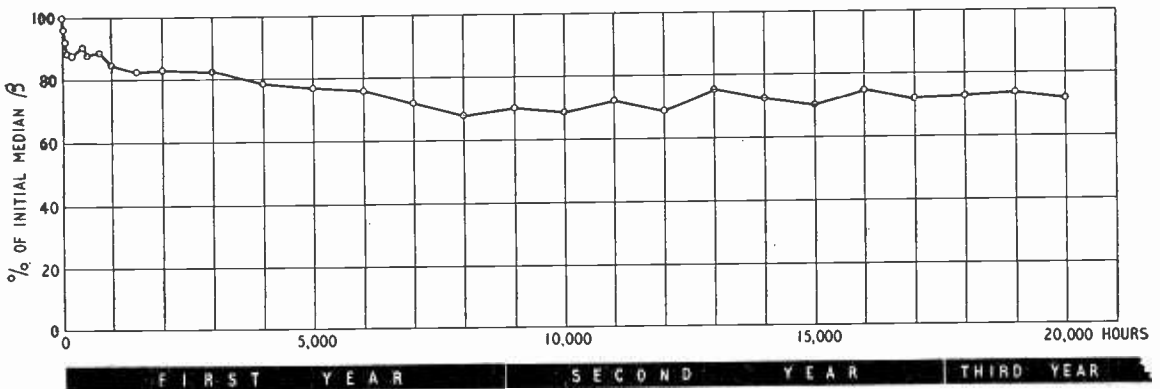


Fig. 1. Change during life of median value of β for a sample of fifteen GET103 transistors manufactured in May 1957. Junction temperature during electrical life test is approximately 65°C; while β is measured at 25°C.

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

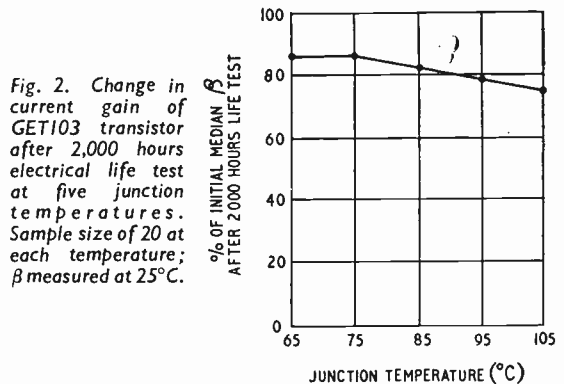


Fig. 2. Change in current gain of GET103 transistor after 2,000 hours electrical life test at five junction temperatures. Sample size of 20 at each temperature; β measured at 25°C.

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. transformer¹.

former 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 $1k\Omega$.

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 $i_{b,v3}$ 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

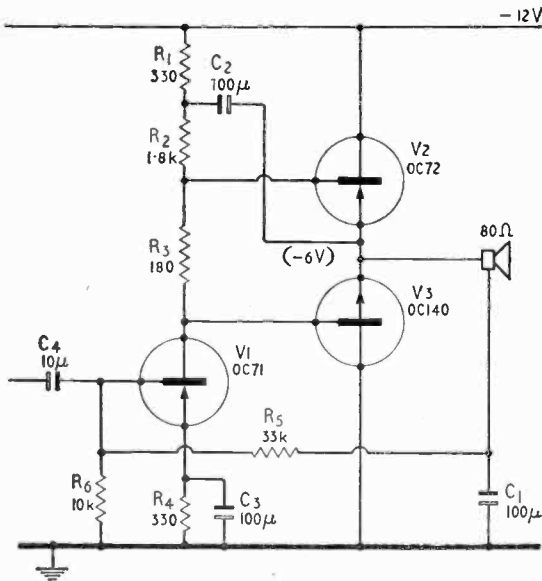


Fig. 1. Audio amplifier and 150-mW output stage for portable receiver using 12-volt two-terminal supply.

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 trans-

* Plessey Co. Ltd.

the reflected load $\beta v_2 R_L$, where β is the common-emitter current gain.

$$\therefore (R_2 + R_{in} + \beta v_2 R_L) \cdot i_{bv2} = 6 \text{ V} \dots (1)$$

i_{bv2} in turn will be equal to $1/\beta v_2$ times the peak load current,

$$\therefore i_{bv2} = (1/\beta v_2) \cdot \sqrt{(2 \times \text{peak power}/R_L)} \dots (2)$$

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

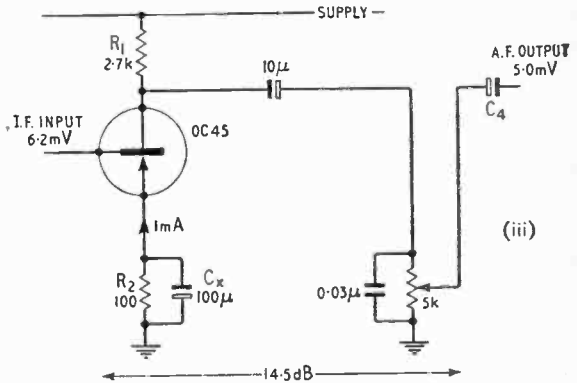
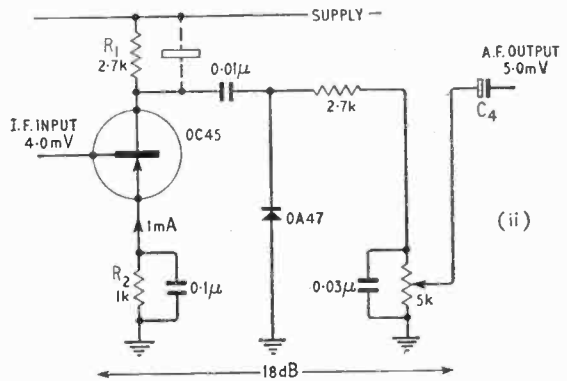
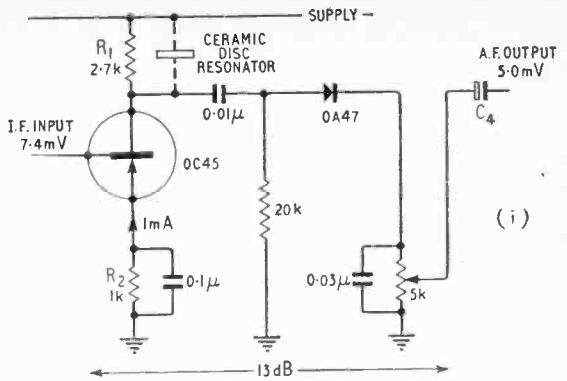


Fig. 3. Series (i)- and shunt (ii)- detector circuits and their final i.f. amplifiers compared with transistor-detector equivalent (iii). I.F. input (modulated 30% at 400c/s) shown produces 10mW a.f. output in 1-k Ω following load.

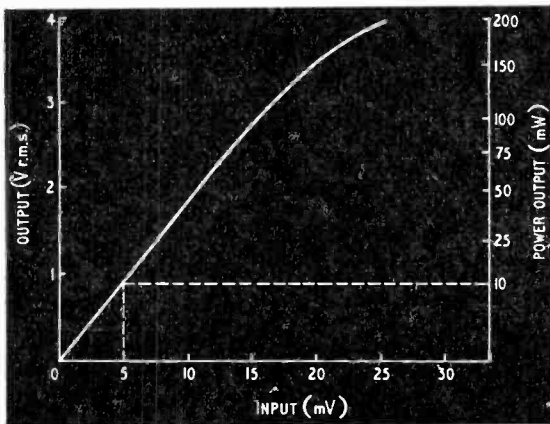
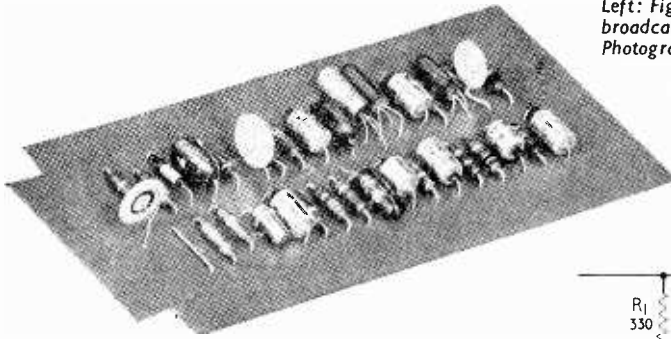


Fig. 2. Input/output characteristic of audio-frequency amplifier and power output stage shown in Fig. 1.

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 amplifier³. 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



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

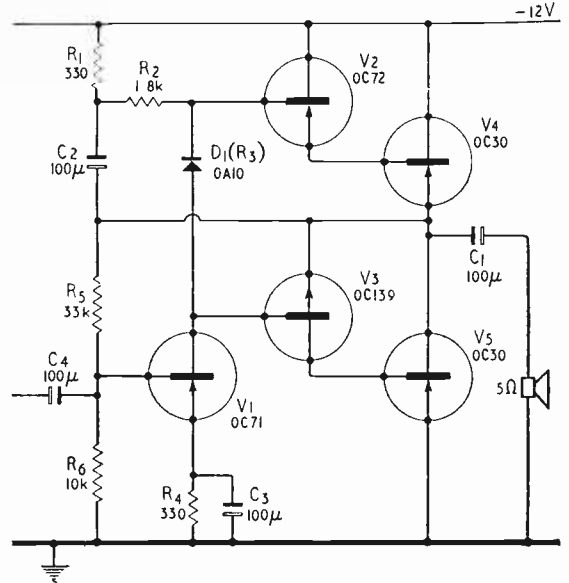
than that required for maximum β . R_2 is included to provide d.c. and thermal stability; the value chosen is such that when a signal is present it does not unduly disturb the operating conditions. The stage also produces amplified a.g.c. and the preceding i.f. stage can be so biased that an overload-protection diode is no longer necessary⁴. The emitter bypass capacitance C_X is shown as an electrolytic in Fig. 3(iii): $0.1\mu\text{F}$ 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. transformers¹.

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.

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.



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 $1\text{k}\Omega$, because of the emitter load.

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

$$i_{i,V2} = (1/50.30) \sqrt{(4/5)} = 0.6 \text{ mA},$$

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

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

A $1.8 \text{ k}\Omega$ 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 C₁ 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 R₁, thereby dispensing with R₁ and C₁, provided the feedback in Fig. 1, introduced by connecting R₅ to the emitters of V2 and V3 and the

d.c. through the loudspeaker can be tolerated and, secondly, R₄ and C₃ may be left out if a much lower value for R₆ 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

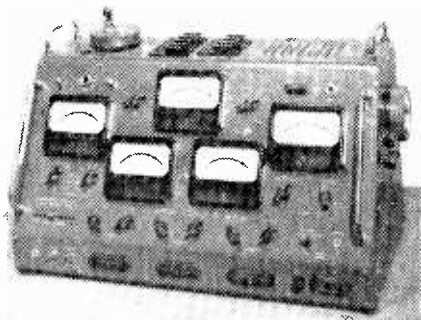
DESIGNED for laboratory investigations rather than the quick checking of valves in a servicing workshop, the main feature of the Metrix Type U-61B valve analyser is that valve-electrode potentials and currents may be indicated simultaneously and separately on five large-scale meters. Four, separate, 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.

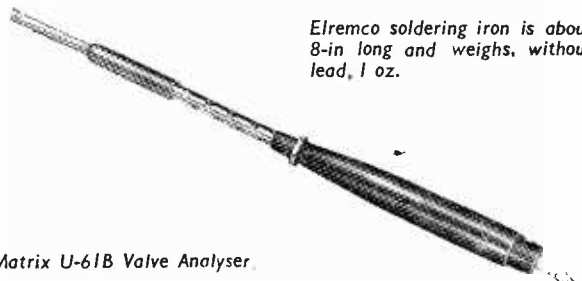
The Valve Analyser costs £275 and the Bridge £370: both are available from Metrix Instruments, Ltd., 59 Victoria Road, Surbiton, Surrey.

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 $\frac{1}{8}$ -in to $\frac{5}{8}$ -in and the bit and metal stem are electrically isolated from the element and its 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.



Left: Matrix U-61B Valve Analyser



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

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.

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.

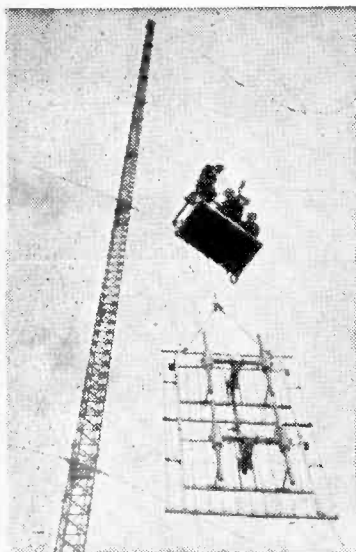
As in past years, free admission tickets will be available from the organizers (Audio Fairs, Ltd., 22 Orchard Street, London, W.1), exhibitors, audio dealers and *Wireless World*. As some of the tickets are for specific days, it would help if applicants stated their day of preference, and they are also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

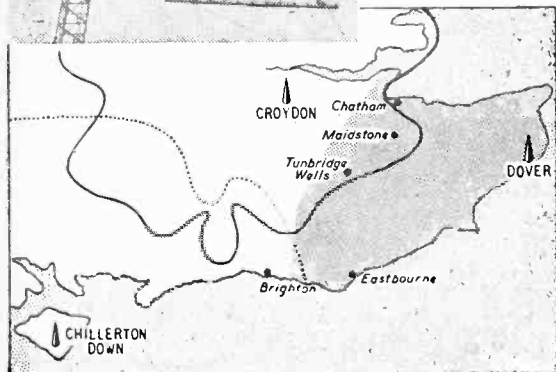
The Electronic Organ Constructors' Society, proposed in a letter from A. Le Boutillier in our September, 1959, issue, has now been formed. Its objects are to "encourage and assist amateurs in the construction of organs [electronic and pipe] and to provide opportunities for the exchange of ideas and technical 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.



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.



"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 Française 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.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.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



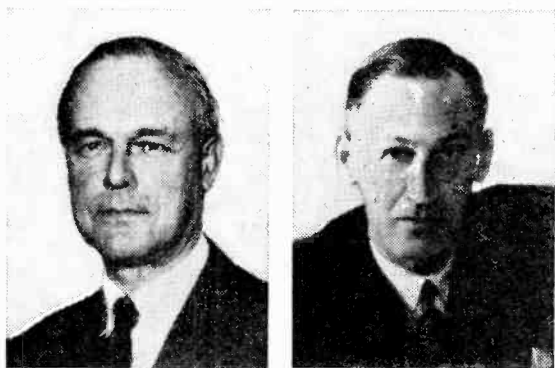
R. C. Parry

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 manager. He joined Metropolitan-Vickers radio department in 1928 and two years later transferred to Edison Swan's

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.



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. Plascott 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.

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 semiconductor devices, 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 thermo-junction 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 thermo-junction—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.

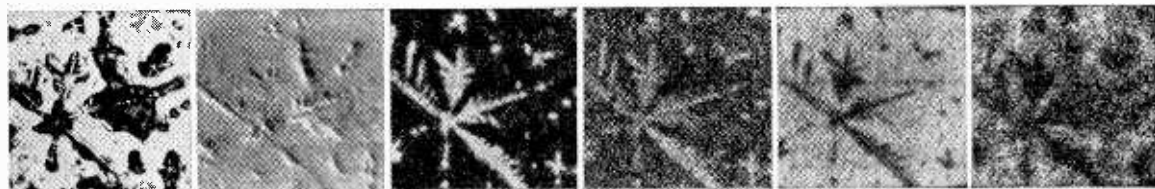
The magnetohydrodynamic method uses a jet of ionized gas to replace the moving conductors of a conventional generator and the power developed is “picked out” by electrodes placed in the gas flow. The practical application of this principle awaits the introduction of materials suitable for temperatures 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 chute (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.

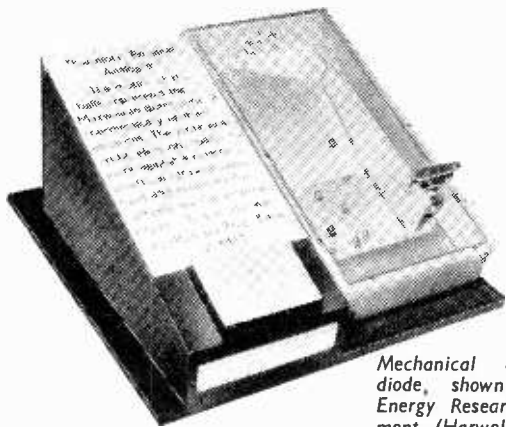
Radio Frequency Spectroscopy is employed for the routine analysis of free radicals (uncombined particles of the material)* in the Newport Instruments electron paramagnetic resonance spectrometer. As this instrument is designed for laboratory use it incorporates a large electromagnet and elaborate stabilization arrangements for the power supply to ensure a uniform (1 part in 10⁴), 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 10⁻⁶m.-diameter electron spot to scan a 0.5 × 10⁻³m. 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

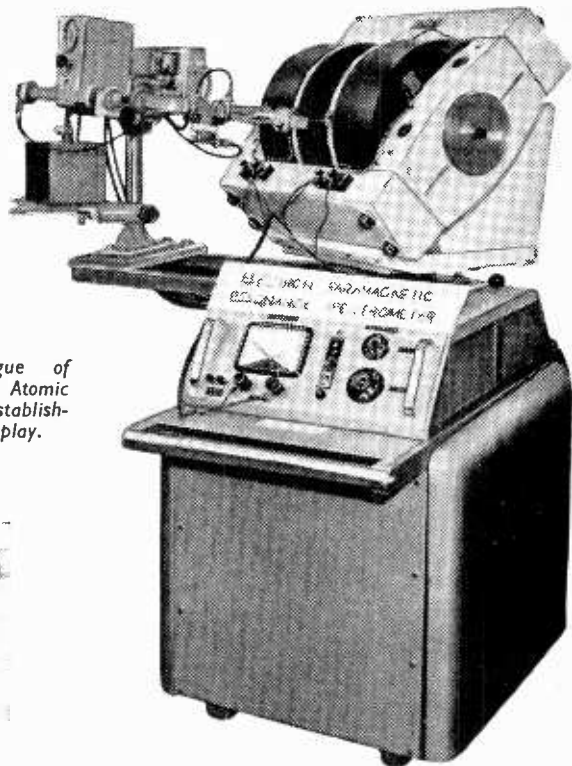
* For a fuller account of electron spin and nuclear magnetic resonances see *Wireless World*, p. 68, February, 1960.



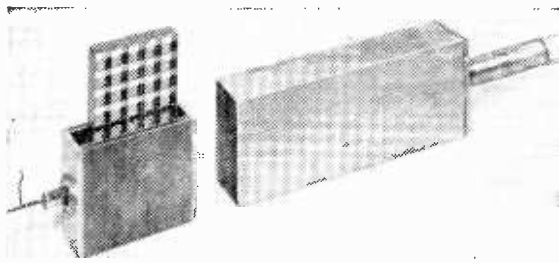
Images obtained with Cambridge Instruments Electron-probe X-ray Microanalyser during preliminary investigation of copper(70%)—nickel-tin-iron (10% each) alloy. L to R: optical, electron and X-ray(iron, nickel, copper, tin) images.



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



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



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

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.

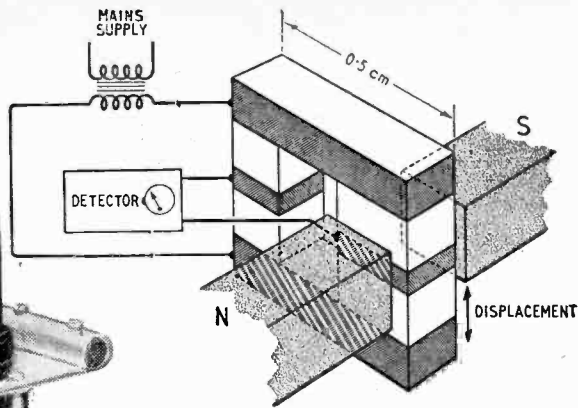
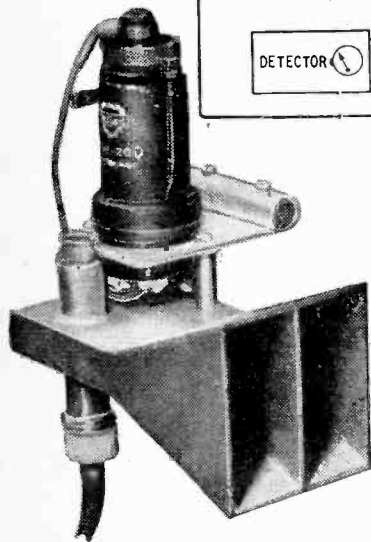


Diagram of the National Research Development Corporation magneto-resistive effect displacement meter. The soldered contacts are shown line-shaded and the direction of motion indicated by the arrows.

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.

to about 10^{-5} 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 magneto-resistive 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.

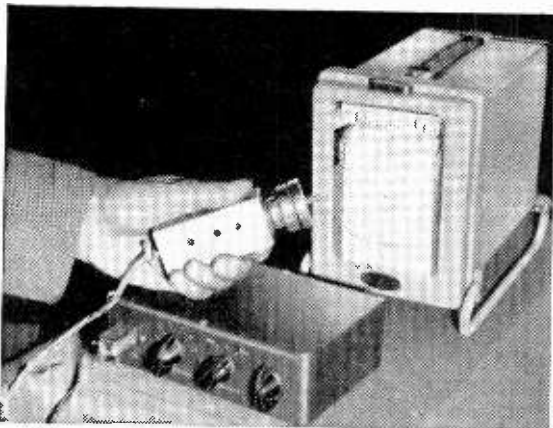
MEDICAL ELECTRONICS

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 gastrointestinal tract. A 400-kc/s transistor oscillator using a Gouriet circuit is modulated in frequency by the pressure transducer. This con-

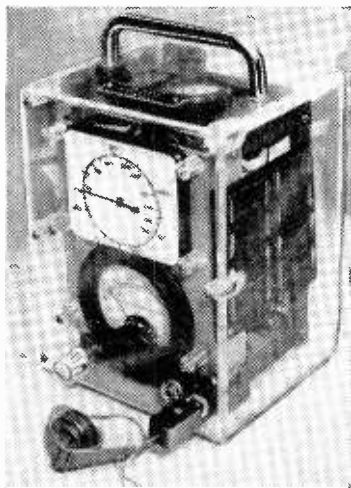
sists of a pot-cored inductor, forming the tuning inductance of the oscillator, with its magnetic circuit including a small ferrite disc which is attached to a flexible diaphragm. Pressure variations applied to the diaphragm therefore change the inductance and vary the frequency of the oscillator. The 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%.

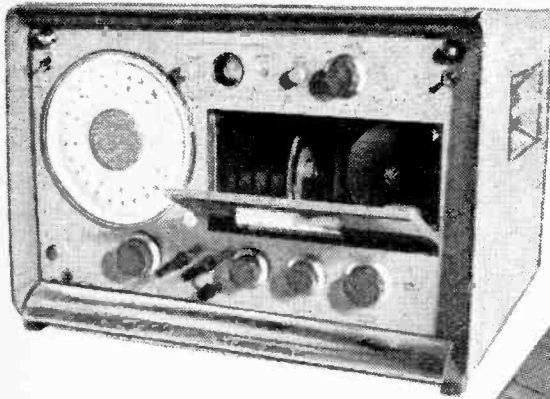
Another new transistor circuit shown by R.R.E. is the equivalent of a well-known valve circuit often used to provide very-low frequency oscillations. This circuit consists of a

phase inverter 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-inverter 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.

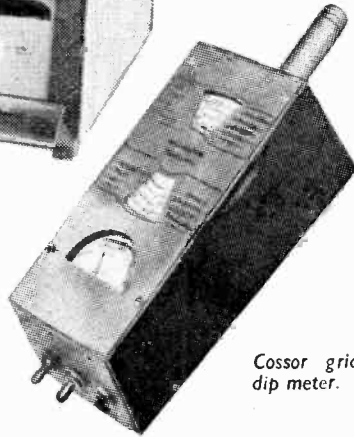
A transistor b.f.o. was also shown by R.R.E. Here a 100kc/s oscillator is switched between a load and output at a frequency variable between 80 and 100kc/s. This produces a b.f.o. in the output which is variable in frequency up to 20kc/s. Since all spurious frequencies produced by the switching are at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

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.

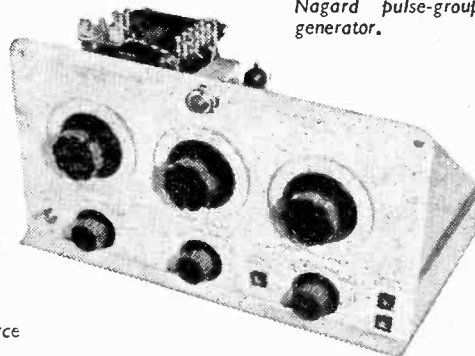
Frequency Meters—An often-used type of circuit first transforms the input to a square wave which is then used to pass a fixed charge every cycle into a capacitor. The charge current, being proportional to the input frequency and independent of the input waveform shape, thus gives a measure of the frequency. 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° .

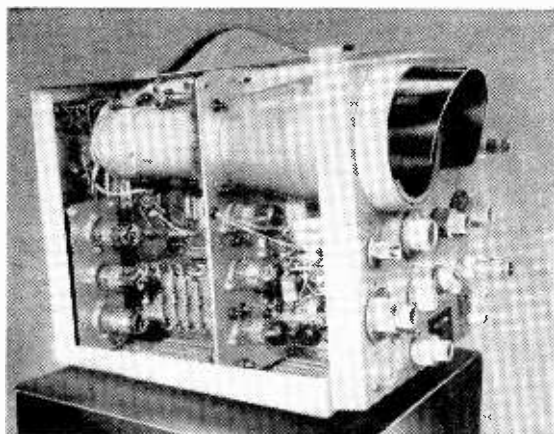
Incidentally, Ekco, for transistor converters, have adopted a simple method of obtaining three phases from two single-phase supplies. Known as a Scott transformer, it entails only the connection of one supply to the centre tap of the other. As long as the phase difference be-



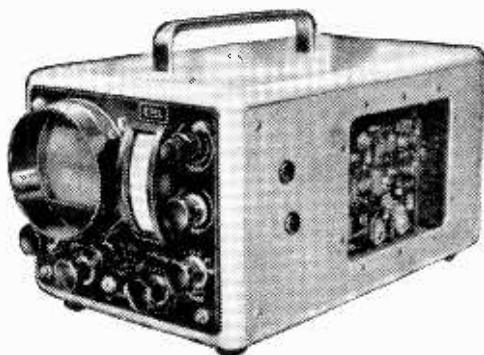
Dawe falling-ball noise source for acoustic calibration.



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. Milliammeter—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 persistence 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 $x=y=5\text{mA}$ 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 10^3 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 with-

out 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 5 μ sec duration, and a storage density of over 200 binary storage "cells" on a 3in \times 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.

COMMUNICATIONS

Hall-effect Modulator working at 5Mc/s was a feature on the A.E.I. (Mcrovick) 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.

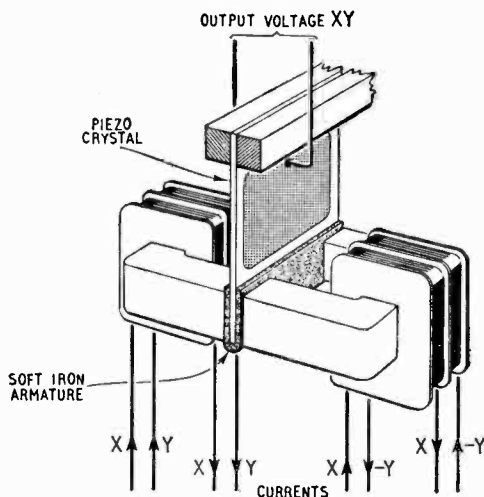
Fast-wave Electron-Beam Parametric Amplifiers.—Since in the wave of space-charge density modulation of an electron beam which travels faster than the beam itself, the fast-wave, the mean energy is greater than the d.c. energy of the beam, prospects are offered of absorbing the excess energy corresponding 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 input to

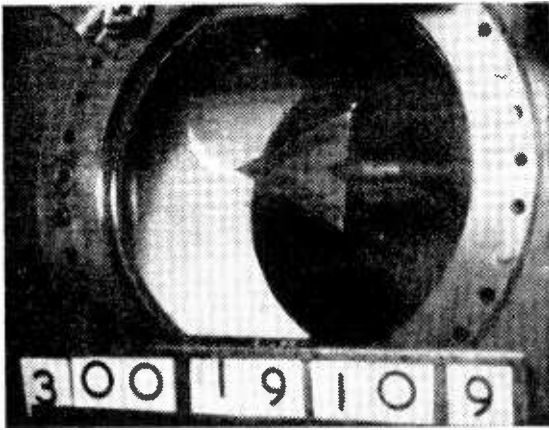
the output, and in which the spiral amplitude corresponds to the signal strength was shown by English Electric (Type N1036). This valve is similar to that described in "Technical Notebook" in our November 1958 issue (p. 555). It has the valuable property of amplifying in one direction only so that feedback 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 50 μ W. 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 30 μ A 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 side-band 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 side-band 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-



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



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 ($\frac{1}{16}$ 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

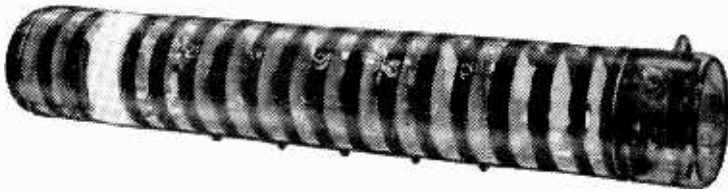
the reflected portion of the incident radiation not coupled out by the probe, has its plane of polarization at right angles to the coupling probe and is thus not coupled to this probe. Attached to the movable end of the absorbing strip in the same plane as this end is a flat tapered absorbing vane. This 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 wave-meter 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-

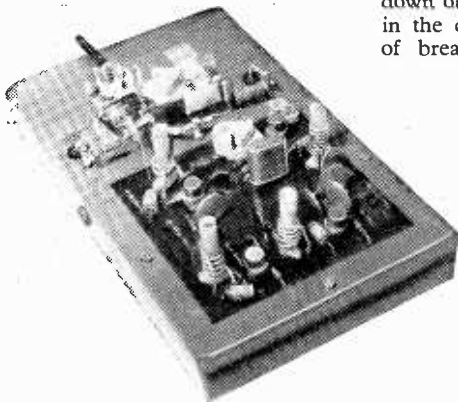


20th Century image-intensifier tube. Note ring accelerator electrodes on inside of glass envelope.

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 con-

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



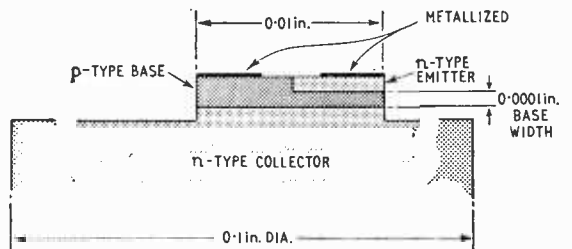
nection) represents the first essay of Ferranti's in the transistor field. It is an n-p-n type and the method of construction is shown in the diagram. A slice of the n-type silicon which subsequently forms the collector has a layer of p-type material diffused into it (providing the base), and then, by 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.

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 Tectron 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 $\pm 0.005\%$.

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

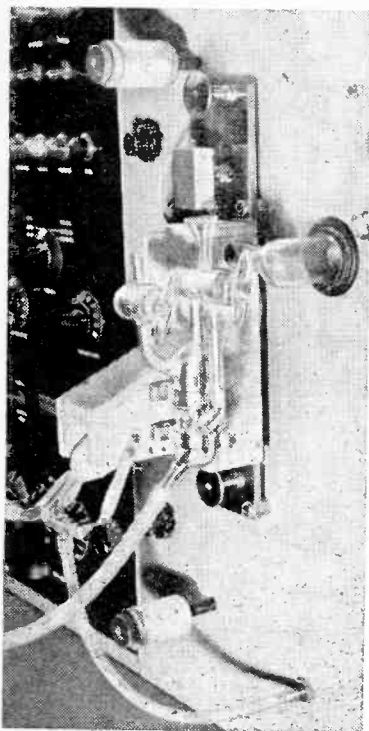


Cross-section of Ferranti h.f. transistor, showing "mesa," or plateau, form of construction.

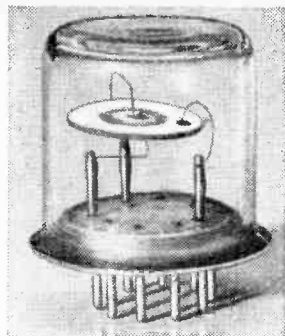
will give a visible spot on the display monitor.

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 1½ in diameter and 7 in 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.

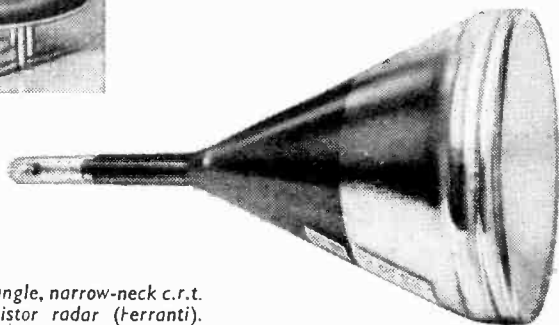
7-in Radar C.R. Tube developed primarily for transistor equipments was shown on the Ferranti stand. It has a narrow deflection angle of about 30° and a narrow diameter



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).

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 ICPI 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.

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 reson-

ance) 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_{g1} . 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

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

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

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

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_s , which is the drop across the cathode resistor due to both anode currents. Thus

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

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

$$e_{s1} = -R_1 i_1 \quad \dots \quad (4)$$

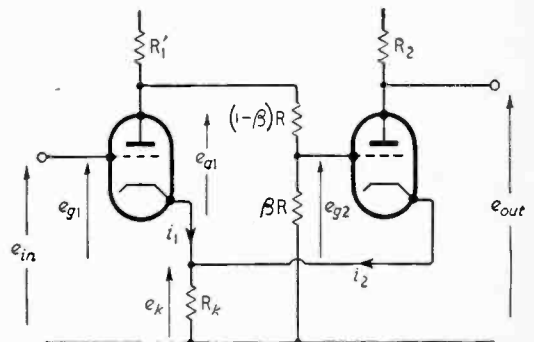
and this equation is shown by the new heavy branch in Fig. 2(d).

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

$$e_{g2} = \beta e_{s1} - e_k \quad \dots \quad (5)$$

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

$$i_2 = (\mu_2 e_{g2} - e_k) / (\rho + R_2)$$

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

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

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

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_{a1} 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 rearranged in Fig. 3(d) and the point e_{a1} is dropped altogether.

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

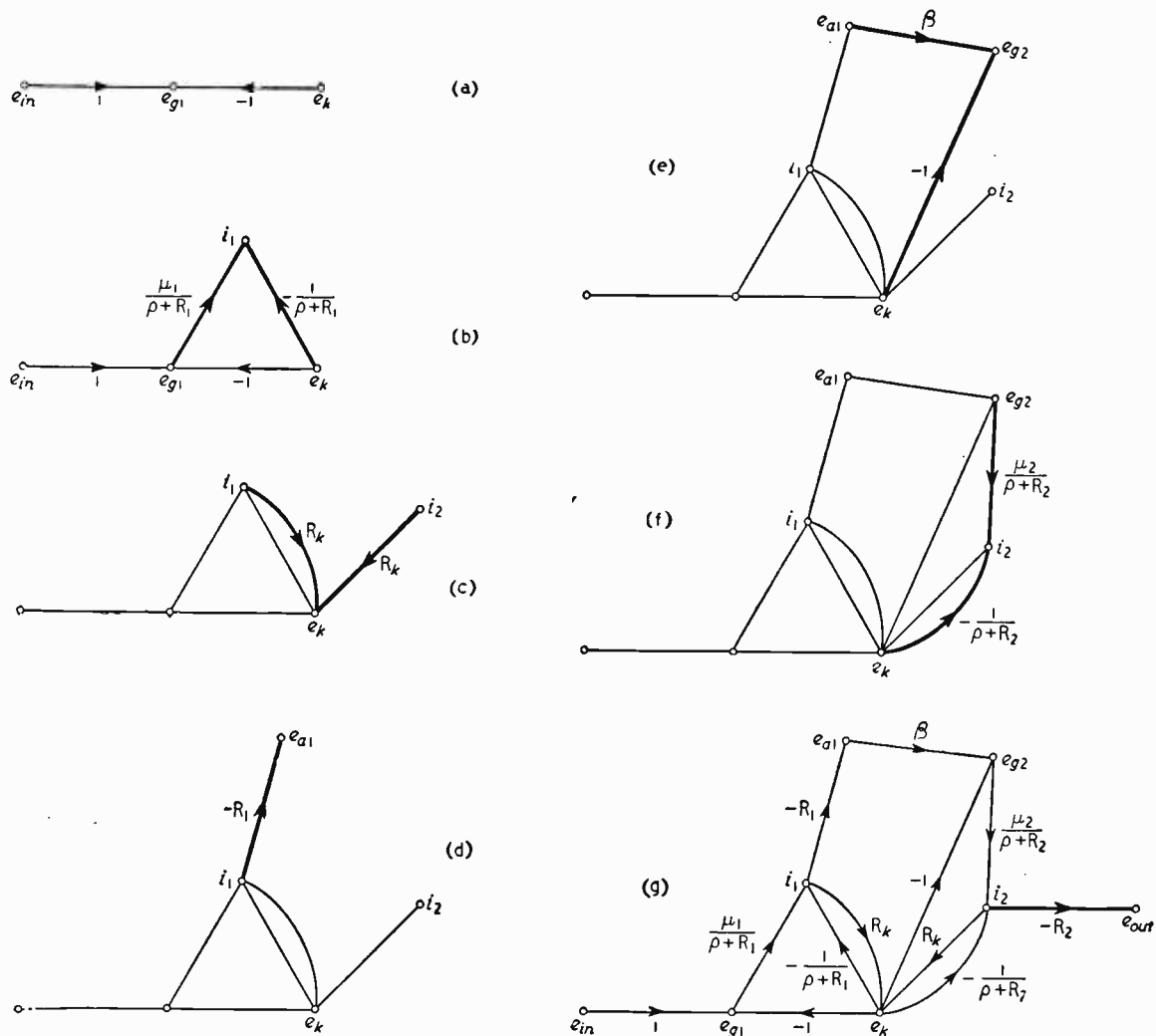


Fig. 2. Signal-flow diagram for the circuit of Fig. 1 obtained step by step. Heavy lines indicate the additions corresponding to successive equations.

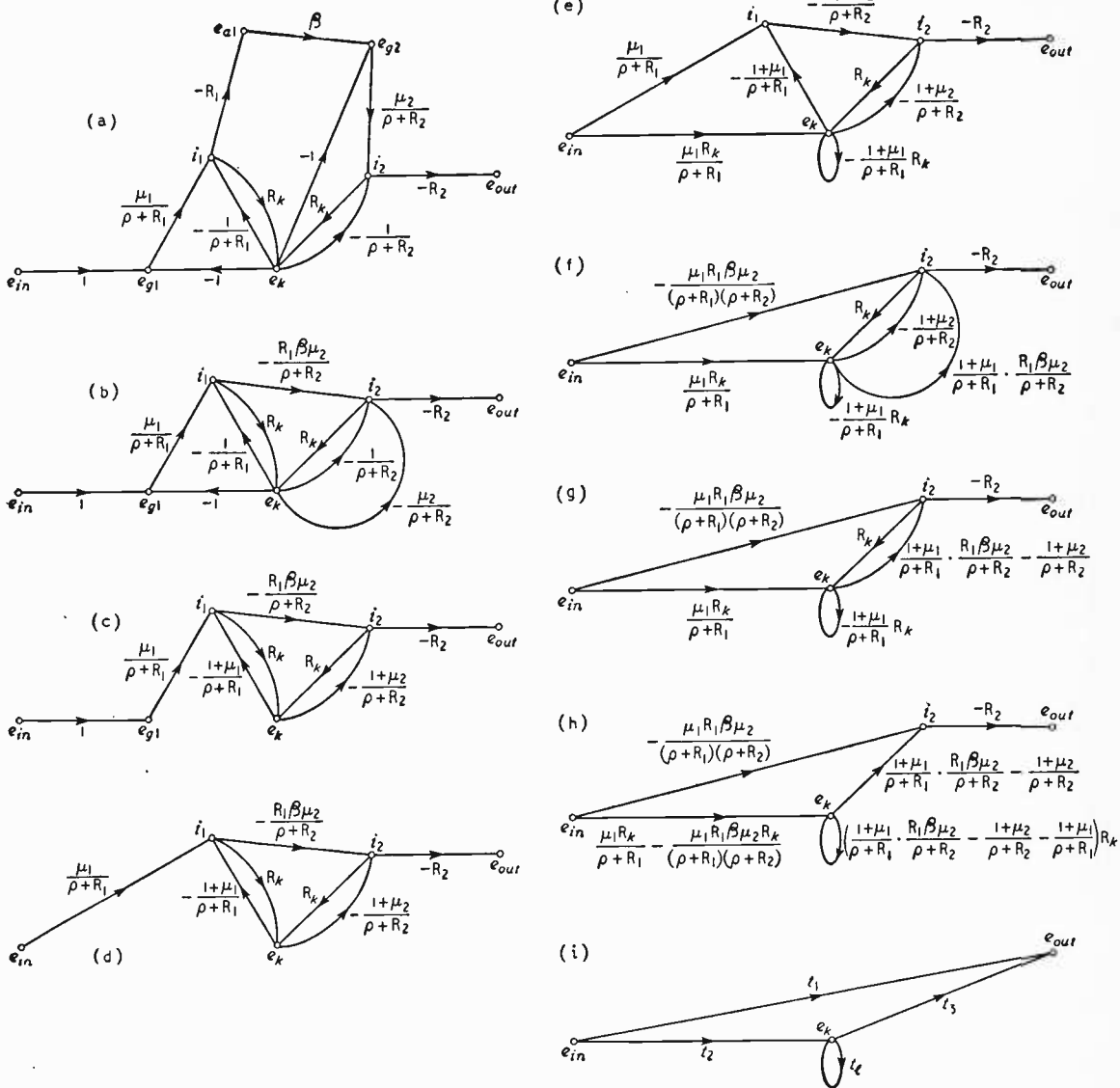


Fig. 3. Stages in the reduction of the signal-flow diagram for the circuit of Fig. 1.

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 $\mu_1, \mu_2, \rho, R_1, R_2$. 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. Warfedale 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.

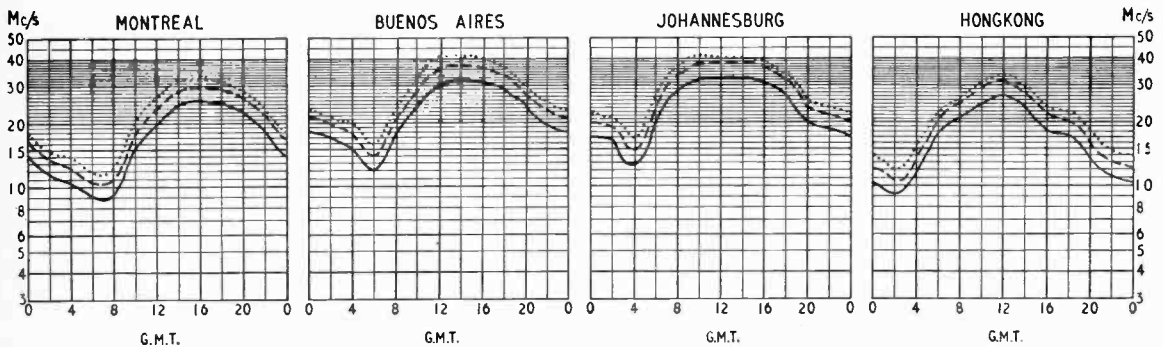
The Practical Hi-Fi Handbook, by Gordon J. King, Assoc. Brit.I.R.E. Introduction to high-quality sound reproducing equipment written with the needs of the service technician in mind. Pp. 224; Figs. 158. Price 25s. Odhams Press, Ltd., Long Acre, London, W.C.2.

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
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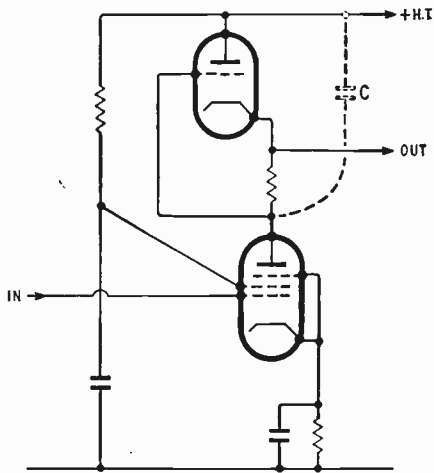
LETTERS TO THE EDITOR

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.

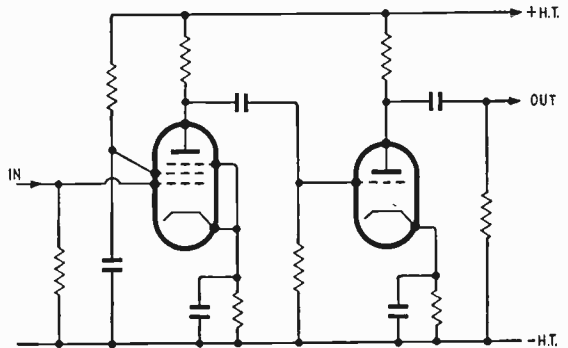
The single stray capacitance can be an important factor if this circuit is used as the amplifying stage in a feedback amplifier, as it restricts the phase shift to 90°, which ensures stability in such circuits.

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.

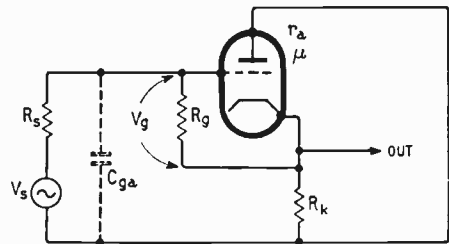
Moreover, some of Mr. Bailey's statements do not



(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_s 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 $r_a (R_s + R_k) / [r_a + R_s + R_k (1 + \mu)]$, 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 100k Ω), 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 straight-forward 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 appro-

prate 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,
University of Manchester.

Manchester, 13.

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 franking 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.

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

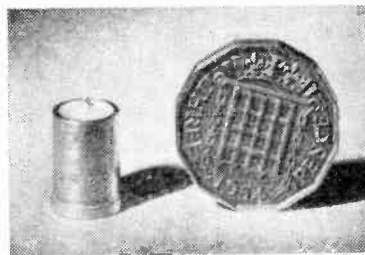
Technical Notebook

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 1 μ sec in duration. Speed of reading has not been stated precisely but is presumably of the order of 10⁸ 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

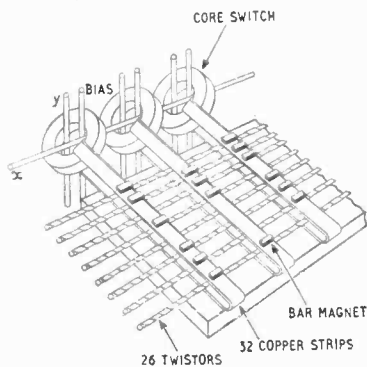
smaller energy differences can be obtained between nuclear spin quantum levels. It is proposed to induce transitions between suitable nuclear spin quantum levels by means of electron spin transitions.

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 0.5m μ H. 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 \times damping factor \times efficiency \times maximum possible grid circuit resistance \div (input voltage \times harmonic distortion \times 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

II.—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.

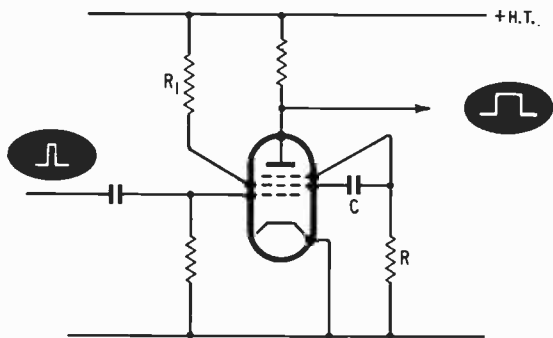


Fig. 1

(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

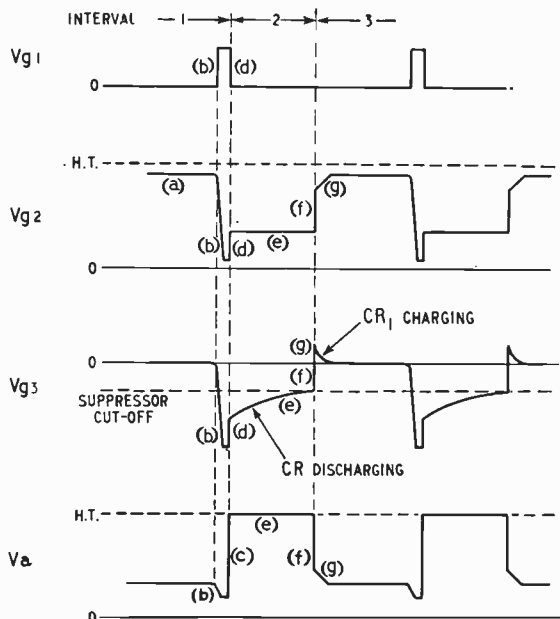


Fig. 2

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,

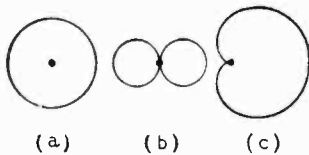


Fig. 1. Polar diagrams showing the directivity of (a) an ordinary vertical aerial, (b) a loop aerial, and (c) the well-known direction-finding aerial in which (a) is added to (b)—one loop of (b) being negative.

which is what one wants to know when setting up a transmitter for maximum efficiency or when measuring v.h.f. impedances.

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.

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

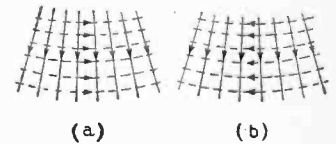


Fig. 2. The continuous lines represent the electric field, and the broken lines the magnetic field, together making an electromagnetic wave travelling at right angles to them, (a) towards you, and (b) away from you.

* 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."?

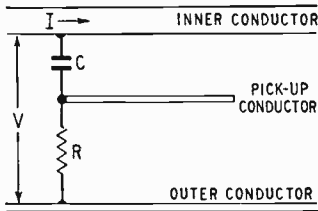


Fig. 3. The basic principle of a reflectometer is the coupling of a pick-up conductor to both electric and magnetic fields in such a way that the two effects cancel out for either direct or reflected wave as desired.

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.f.s 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

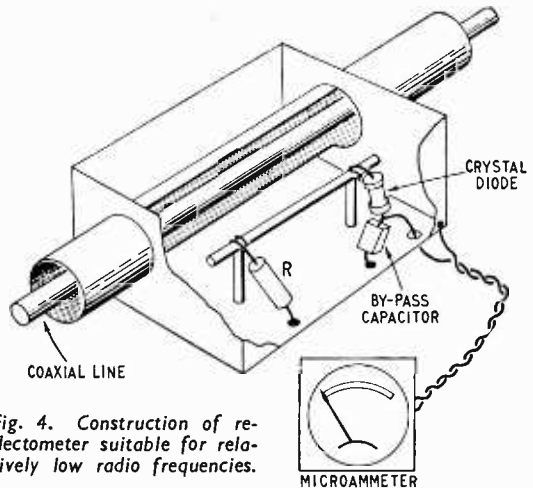


Fig. 4. Construction of reflectometer suitable for relatively low radio frequencies.

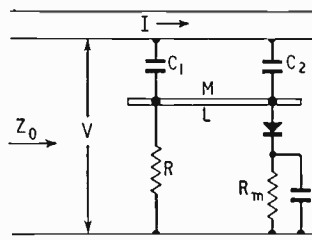


Fig. 5. Approximate equivalent circuit diagram of the Fig. 4 type of reflectometer.

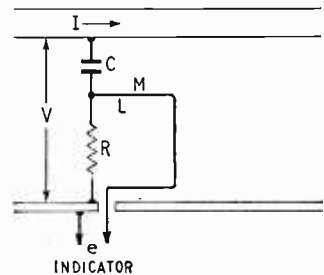


Fig. 6. Circuit diagram of loop type of reflectometer.

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

$$M \approx RCZ_0$$

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 ;

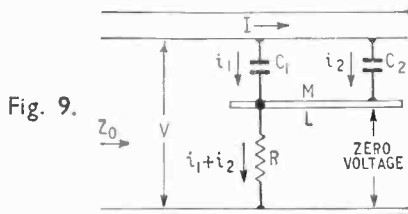


Fig. 9.

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

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

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

$$(i_1 + i_2)R + i_2j\omega L - Ij\omega M = 0 \quad \dots \quad (3)$$

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

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

$$\frac{M}{Z_0} = R(C_1 + C_2 - C_1\omega^2 LC_2) + j\omega(C_2 L - C_1 R \frac{M}{Z_0}) \quad \dots \quad (5)$$

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

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

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

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

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

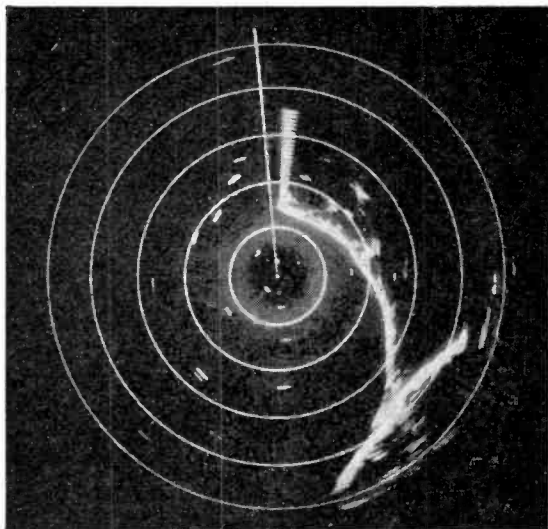
$$\frac{M}{Z_0} \approx RC$$

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 25 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.f.s, 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.

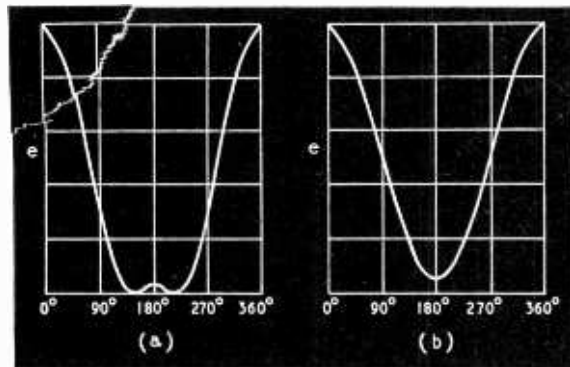
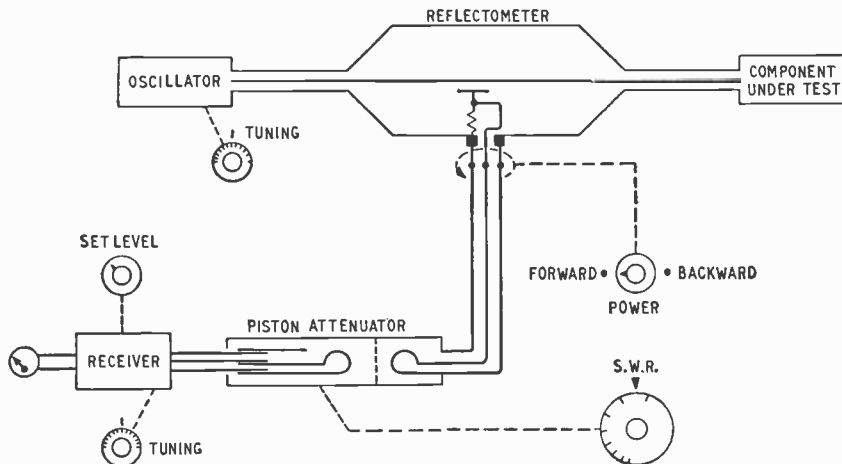


Fig. 7. Variation of response as the loop in Fig. 6 is rotated through one whole turn, with the magnetic coupling (a) too tight, (b) too loose, compared with the electric.

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 elsewhere⁷.

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 $60 - 52 = 8\text{Mc/s}$ 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, $60 - 2.825 = 57.175\text{Mc/s}$ 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.

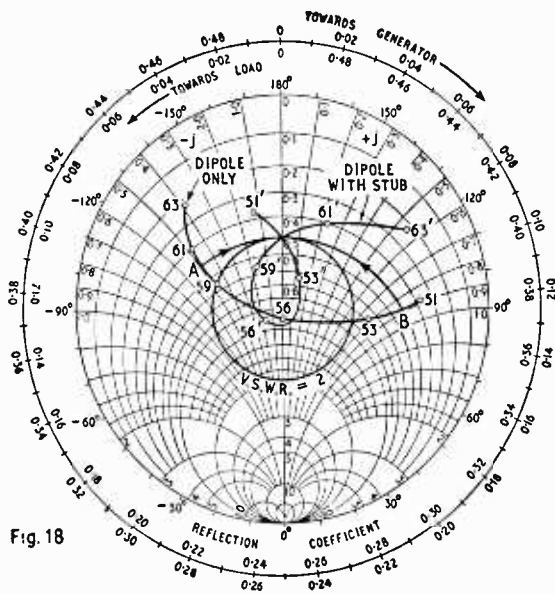


Fig. 18

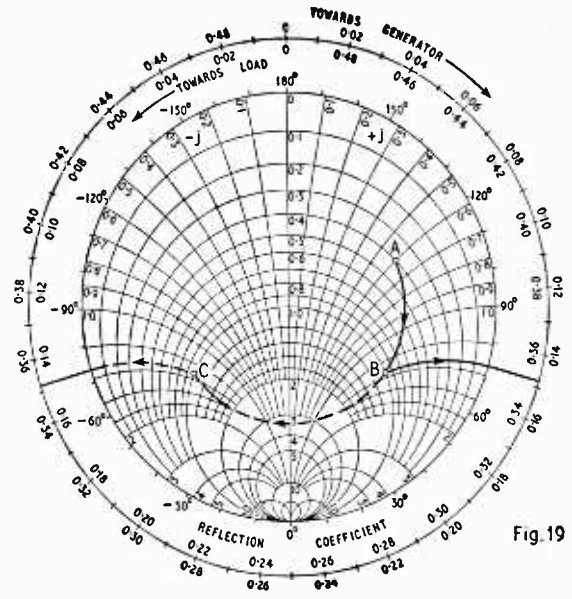


Fig. 19

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 $\frac{1}{2}$ -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 $\frac{1}{4}$ or $\frac{3}{4}$ 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 $\frac{1}{4}$ (or $\frac{3}{4}$) 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 $\frac{1}{4}$ (or $\frac{3}{4}$) 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 $\frac{1}{8}$ wavelength would lead to field distortion and would effectively place the two stubs in parallel; (b) the use of spacings between $\frac{1}{8}$ and $\frac{3}{8}$ wavelength would increase the area on the chart representing loads which could not be matched. At $\frac{1}{4}$ -wavelength spacing, loads within the circle of unity conductance could not be matched. A spacing of $\frac{3}{8}$ wavelength may be used where $\frac{1}{8}$ wavelength is mechanically inconvenient. Wider spacings than $\frac{3}{8}$ wavelength would offer no electrical advantage; a spacing of $\frac{1}{2}$ 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 $\frac{3}{8}$ 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 $\frac{3}{8}$ -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 $3\lambda/8$.

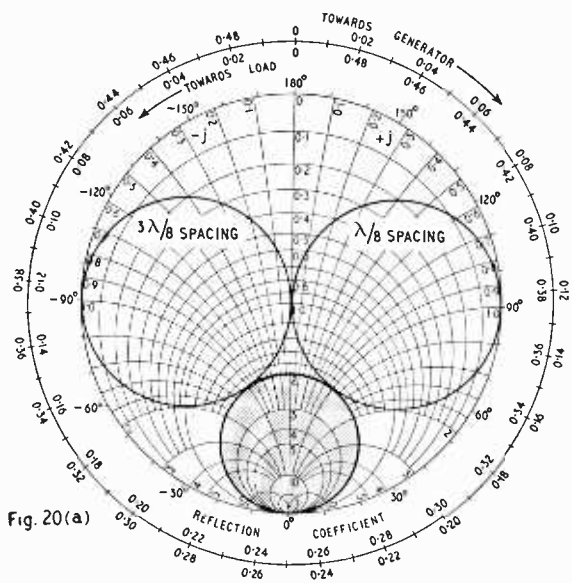


Fig. 20(a)

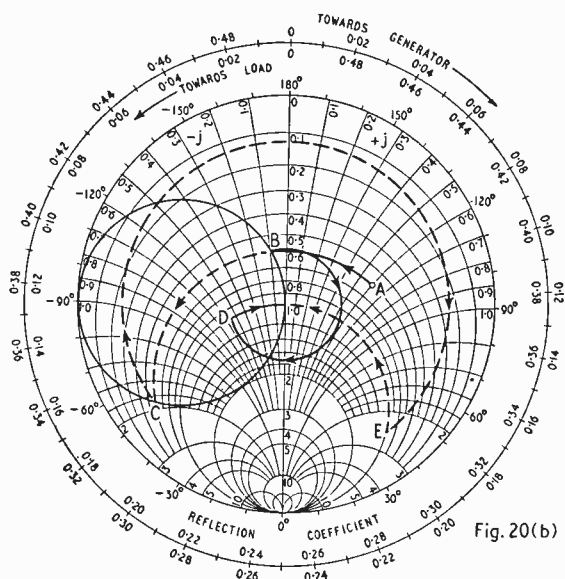


Fig. 20(b)

$1 - B/Q + jB$, where B is the required susceptance. For example, if $Q = 10$, this line will pass through the points $1 + j0, 0.9 + j1, 0.8 + j2 \dots 0 + j10$; 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 $0.51Z_0$ 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

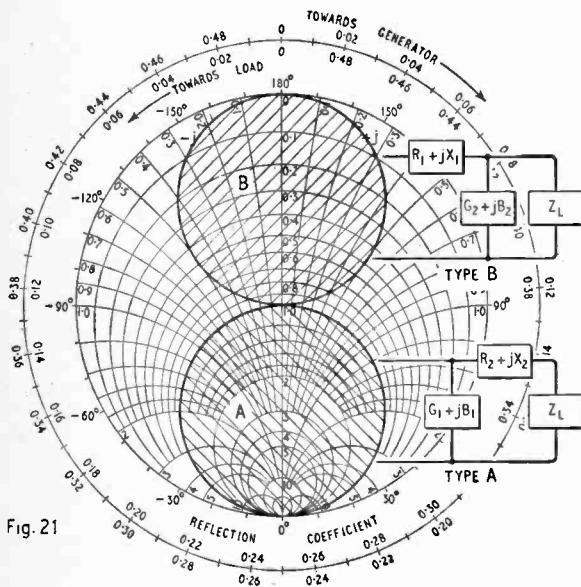


Fig. 21

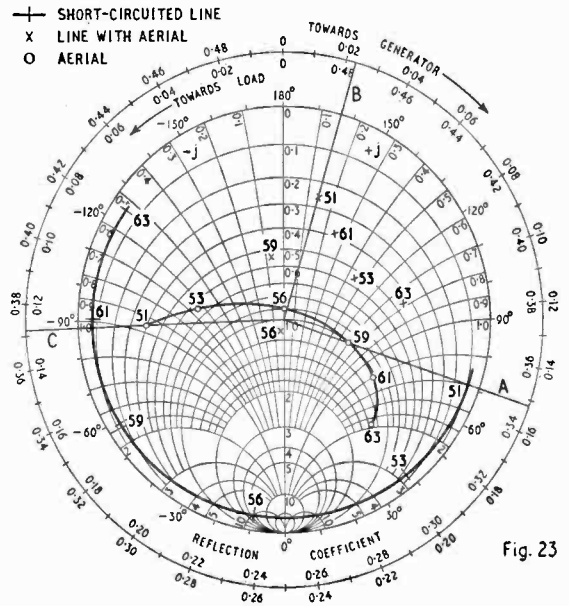


Fig. 23

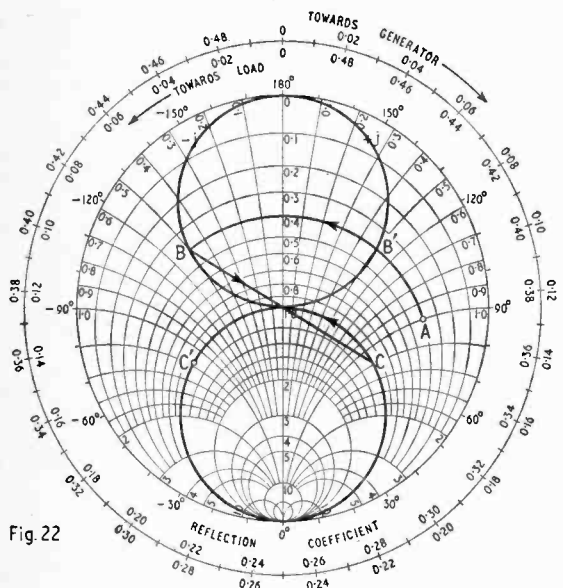


Fig. 22

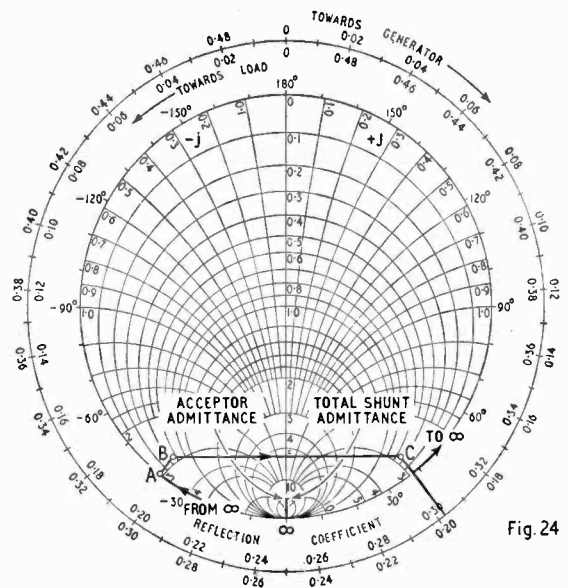


Fig. 24

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 $1.25Y_0$ 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 Strafford⁹ 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

- ϵ = 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
= $FL\sqrt{\epsilon}/300 = FL/300v$.
- v = Velocity factor of line = $1/\sqrt{\epsilon}$.
- Y = Load admittance.
- Y_0 = Line admittance.
- y = Normalized load admittance, = Y/Y_0 .
- Z = Load impedance.
- Z_0 = Line impedance.
- z = Normalized load impedance, = Z/Z_0 .

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.

† 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:—

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

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 dB_a 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:—

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

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.

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

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

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

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 Electrofil 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 Igranite 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.—Sundee 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 re-viewing 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 photo-voltaic cells for instrumentation and control applications” by Dr. V. Magee and Dr. A. A. Shephard 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. Powell 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.

BARNESLEY

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 Elm-bank 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. 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 photo-voltaic 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 Ruth-erford College of Technology.

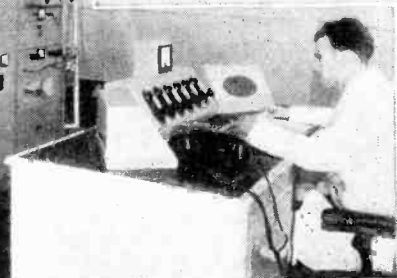
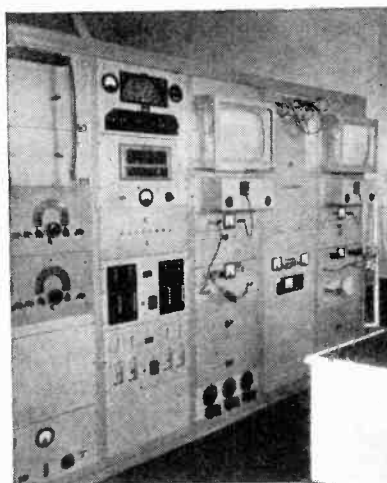
SHEFFIELD

21st. Institution of Production Engineers.—"Electronic control mechanism" by O. S. Puckle at 6.45 at the Devon-shire 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 Col-lege 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 aeri-als and a Band II aerial sur-mound a corner reflector array for Band III. Until the opening of the Dover station I.T.A. trans-missions were received from London by means of a microwave link (the paraboloid can be seen on the out-ripping) from another recep-tion site at Thanet, 20 miles away. The control room is housed in the mill.



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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 liness. 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 Ärztliche 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 com-



"WIRELESS WORLD" PUBLICATIONS

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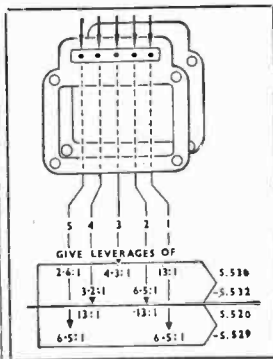
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plete write-off, another has lost one half of its director and the opposite half of its reflector; the third is pretty badly buckled. That sort of thing is, I suppose, only to be expected, for some of the gusts have been terrific—strong enough to make 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 aerals 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

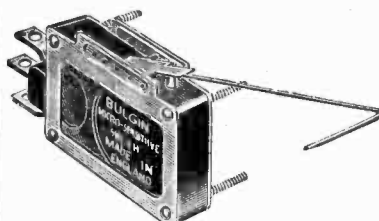
WHEN the fitting out of the recently launched Orient Line's s.s. *Oriana* is completed a bit later in the year she will be the most fully equipped passenger ship in the world from the television point of view. Her Marconi installation will enable her to receive programmes on Band I and III from transmitters 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?

WIRELESS WORLD, MARCH 1960

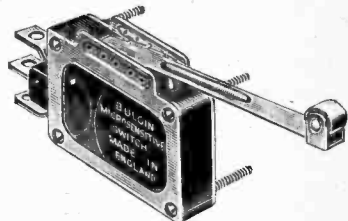


"M" TYPE MICRO SWITCHES

To increase the utility of the large range of "M" Micro Switches (full technical details page 97 of *Bulgin Catalogue*) we offer six different Operator Attachments. Each operator is complete with a pair of side brackets, and four 8-B.A. bolts and nuts, for the sandwiching assembly and fixing. Each operator-lever can be pivoted in its brackets, in up to 5 different ways; providing over 750 possible combinations! Side brackets are of brass and barrelled-nickel-plated; Operators-levers are nickel-silver blades. The rollers and wire extensions are as tabled. Patented by BULGIN in the U.K. and U.S.A. All the devices on this page are essential when operating movement is by wiping or smearing motion—as with Cams or Slides, and not by direct button movement. **NOTE:** Wipe, or slide-deflexion to be away from Lever-anchorage or pivoting.

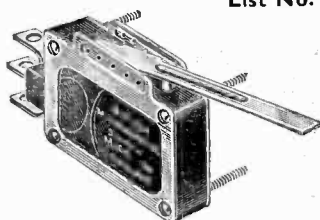


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List No. XXX/L/R-G to L/R-P

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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 tele-archics 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 hen-pecked 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.

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 prophesied 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.).

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.



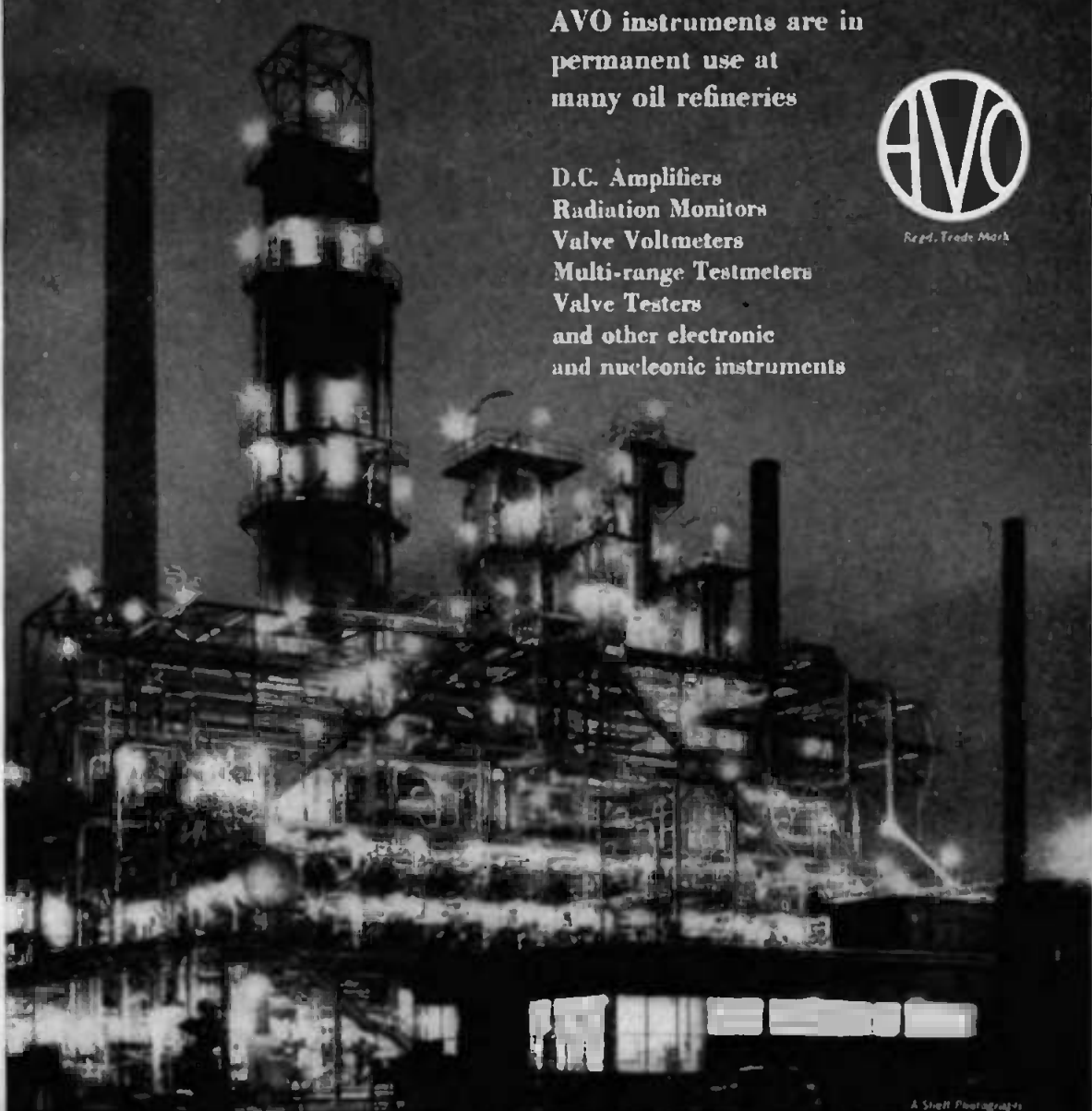
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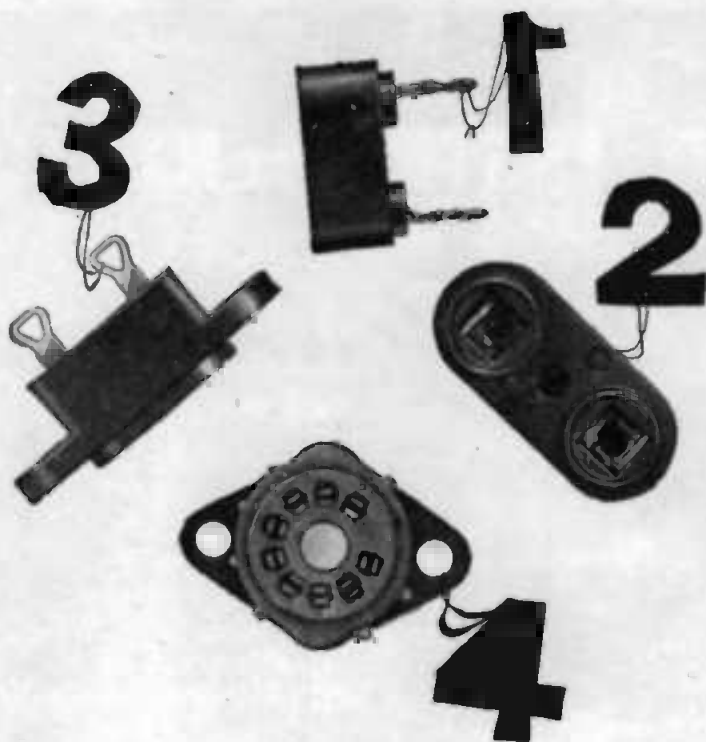


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CAC 17/26

Backward Wave Oscillators

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

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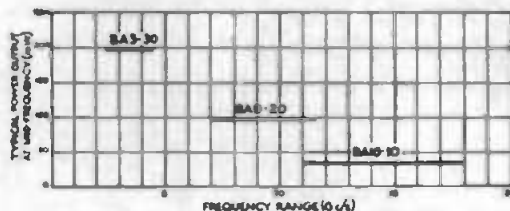


BA16-10 demounted from electromagnet focusing system

Abridged data

Type No.	Frequency Range (Mc/s)	Power Output over Frequency Range (mW)	Delay Structure Voltage Range (V)	Sensitivity at 90Mc 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

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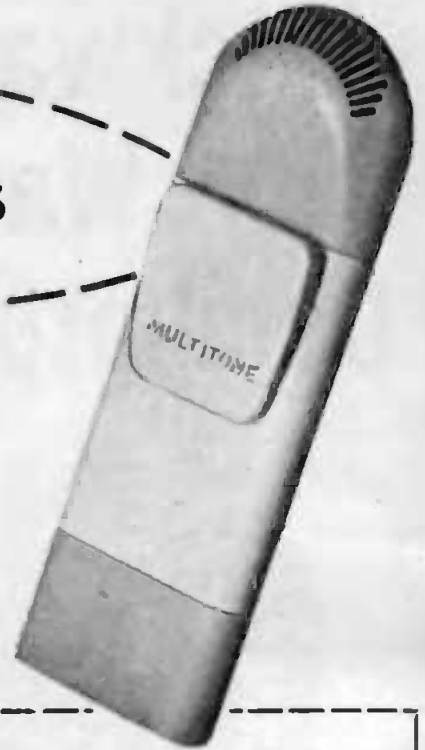
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THE MULTITONE

personal call

system of staff location

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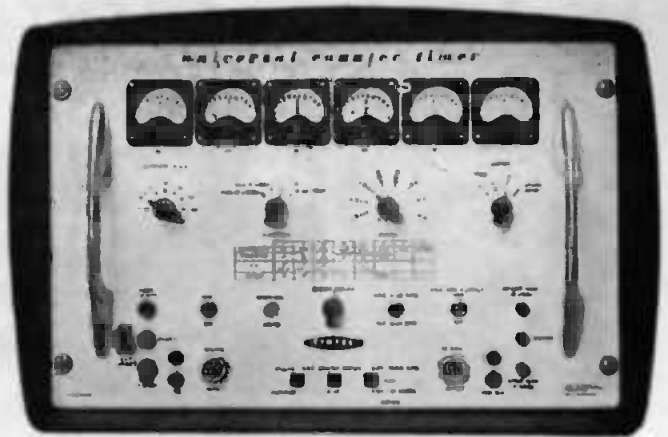
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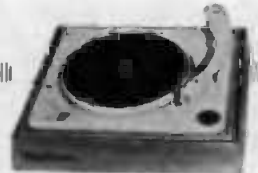


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V-7A	Valve Voltmeter Kit	RA-1U	Transcription Record Player
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These four Cossor Oscillographs, each designed for an important range of applications, offer first-class performance backed by rigid adherence to published specifications.

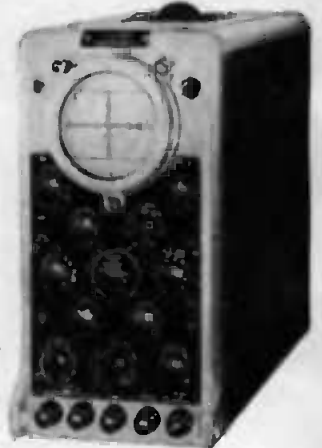


MODEL 1065 PULSE OSCILLOGRAPH

Tube: single-beam, P.D.A.
Bandwidth: d.c. to 15 Mc/s (-50%).
Sensitivity: 250 mV/cm.
Overshoot: less than 3%.
Time-base: triggered or repetitive over range 40 cm/sec to 5 cm/usec.
X Amplifier: gain 5, continuously variable.
Time-base delay: 2 ranges, continuously variable.
Calibration: voltage and time, by calibrated shifts
Probe: 1.5 M Ω , 12 pF

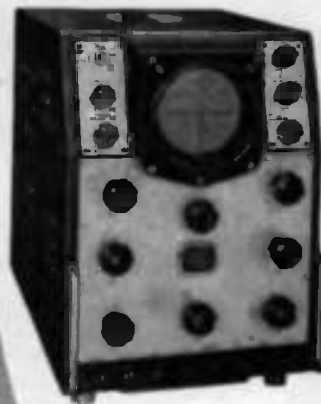
MODEL 1058 FOR THE TV & RADIO ENGINEER

Tube: single-beam
Bandwidth: d.c. to 6 Mc/s (-50%).
Sensitivity: 250 mV/cm.
Time-Base: triggered or repetitive, over range 30 cm/sec to 1.5 cm/usec. Special facilities for triggering from TV line or Frame pulses on I.V.D.A.P. composite video waveform.
X Amplifier: gain 5, continuously variable.
Calibration: time and voltage calibration facilities.



MODEL 1049 INDUSTRIAL DOUBLE-BEAM OSCILLOGRAPH

Y Amplifier: A1: d.c. to 200 kc/s (-30%) at gain 900; A2: d.c. to 400 kc/s (-30%) at gain 30.
Time-Base: repetitive or triggered in 18 ranges, down to 7.5 sec/sweep.
Intensity modulation: three modes including beam bright-up.
Calibration: time and voltage, by calibrated shift (X and Y1) and multiplier (Y2).



MODEL 1035 MK III GENERAL PURPOSE DOUBLE-BEAM OSCILLOGRAPH

Y Amplifiers: A1: 5 c/s to 5 Mc/s (-30%), Maximum gain 3,000; A2: 5 c/s to 250 kc/s (-30%) at gain 30, with trace inversion facility.
Time-base: repetitive or triggered in 9 sweep ranges from 100 nsec to 10 usec.
Time-base delay and pulse bright-up facilities.
X Amplifier: gain 5, continuously variable.
Calibration: voltage and time, by calibrated shifts.

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Transistorized Power Units

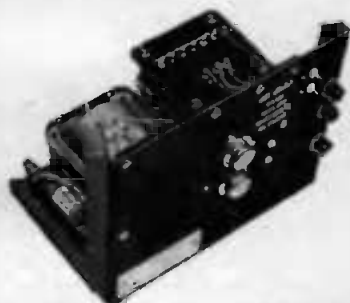


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MODEL 1328 LABORATORY POWER UNIT

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.



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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.

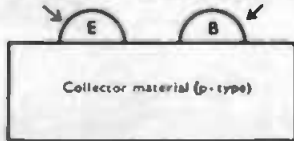
So far as the normal p-n-p germanium alloy transistor is concerned, the OC44 with its average frequency cut-off of 15 Mc/s probably represents the upper limit of frequency attainable in quantity production. A major factor limiting the high frequency performance is the transit time of the minority carriers 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.

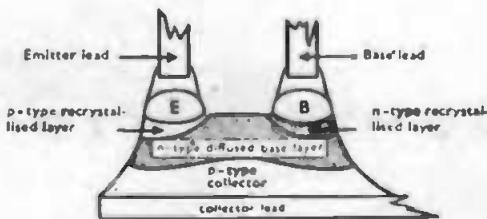
The new technique in practice

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.

Pellet with both p- and n-type impurities to form emitter and base
 Pellet with n-type impurities only to form ohmic contact with n-layer (base) which is made to extend from junction



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

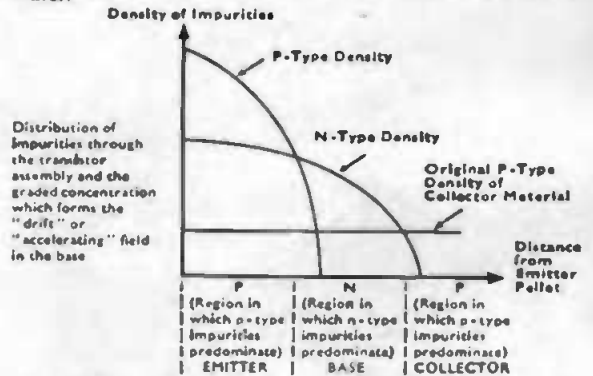


Simplified transistor assembly after alloying and etching (NOT TO SCALE)

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.



Distribution of impurities through the transistor assembly and the graded concentration which forms the "drift" or "accelerating" field in the base

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

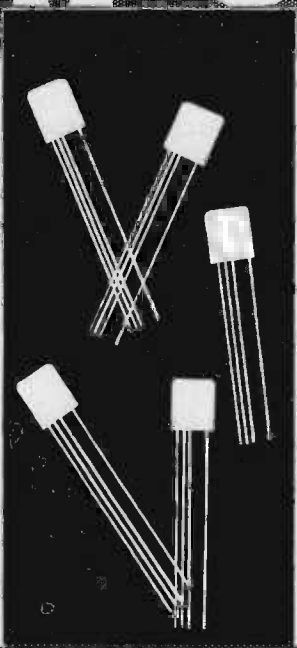
Abridged Data

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_t min. 40 Mc/s
- f_t 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



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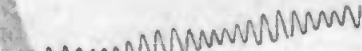
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TYPE S.G.63A FM/AM SIGNAL GENERATOR

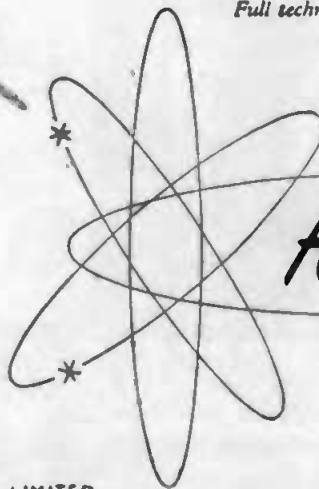
Here, within this one modestly priced instrument, are the essential facilities and the essential accuracy demanded for servicing radio and television receivers on bands I, II and III. The S.G.63A provides:

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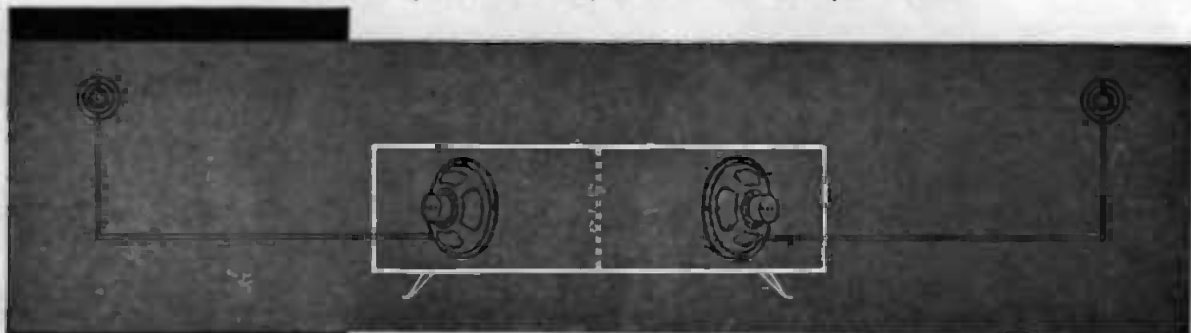
MODEL G44/1300

FULL WIDTH STEREOPHONIC

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The complete answer to the demand for a reasonably priced high quality speaker system for the reproduction of stereophonic recordings in the home.

Utilising two very small pressure type direct radiator units for the higher frequencies and two 12in. reproducers for the lower, the equipment covers a response which is substantially level from 35-15,000 c/s. with true stereophonic effect.



The price for two HF.1300 and two G.44 units, complete with enclosure details is:—

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LOW-NOTE REPRODUCER G-44

This new 12in. Loudspeaker has been designed specially to work in conjunction with the HF.1300. A skilfully balanced voice coil and cone assembly with correct cone edge termination result in a level and clean low frequency response.

COMPLETE SYSTEM

The system uses only one enclosure, 15in. high x 42in. wide x 18in. deep, having a central dividing partition with one G.44 unit mounted at each end. The enclosure should then be positioned near the centre and against one wall so that the speakers are facing outwards and are about 2ft. 6in. from the floor.

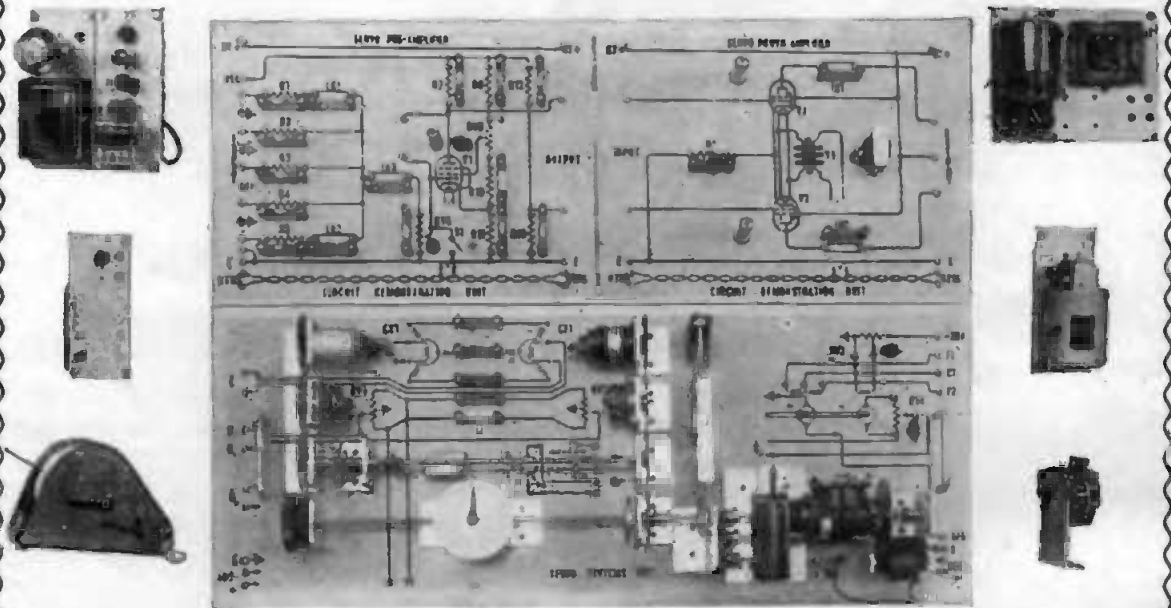
The two HF.1300 units should then be placed near the corners of the room, one on each side of the enclosure and approximately 4 feet above the floor. The width of sound will very nearly correspond to the distance between these two units. No elaborate cross-over networks are required and the system is completed by a 12 Mfd. capacitor in series with each high note unit.

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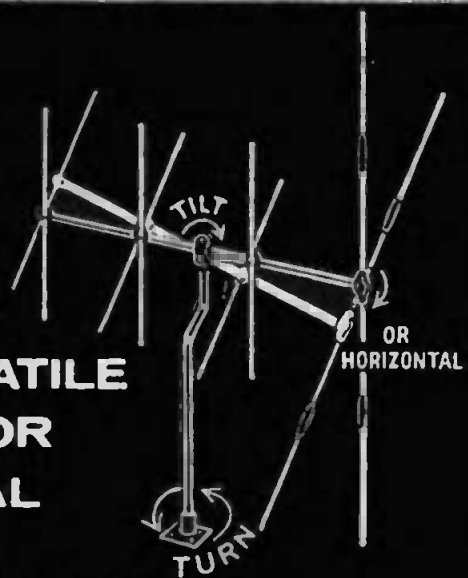
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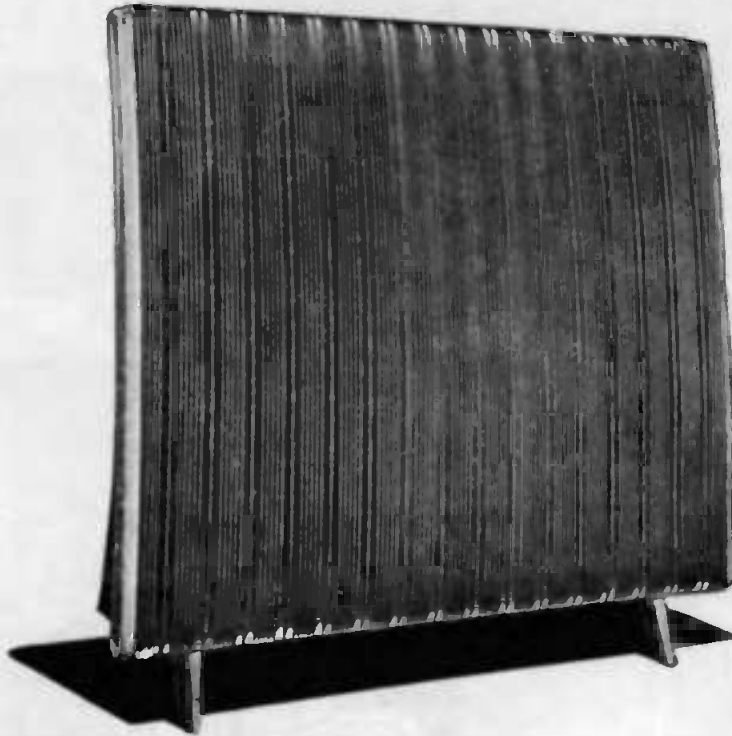
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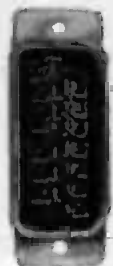
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5 1/2"	950	45	1 7 6	1200	1 4 0	1 15 0	7"	2400	2 8	4 0 0
7"	1200	1 4 0	1 15 0	1800	1 36	2 10 0	SUPERGRADE			
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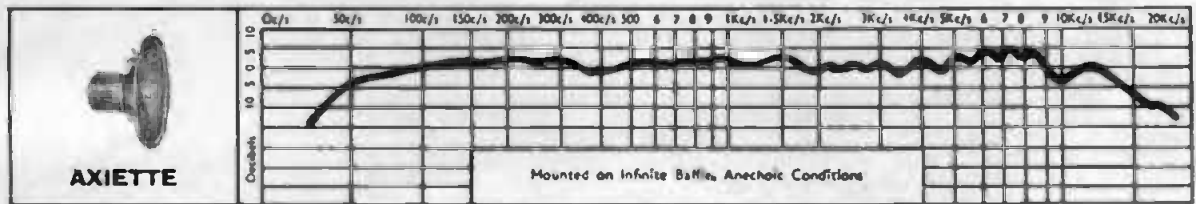
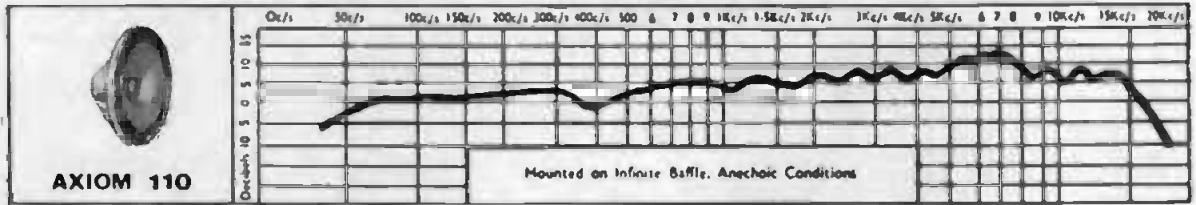
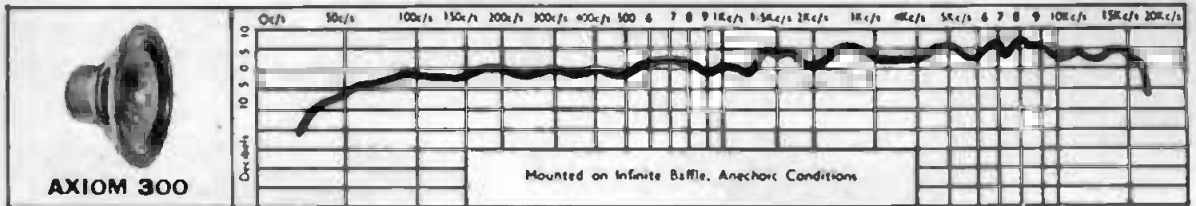
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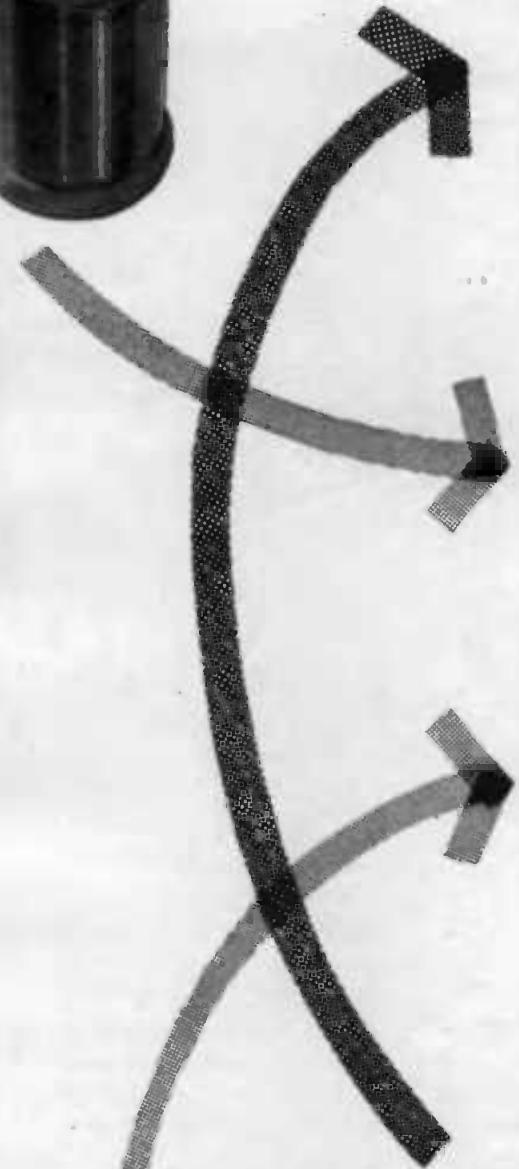
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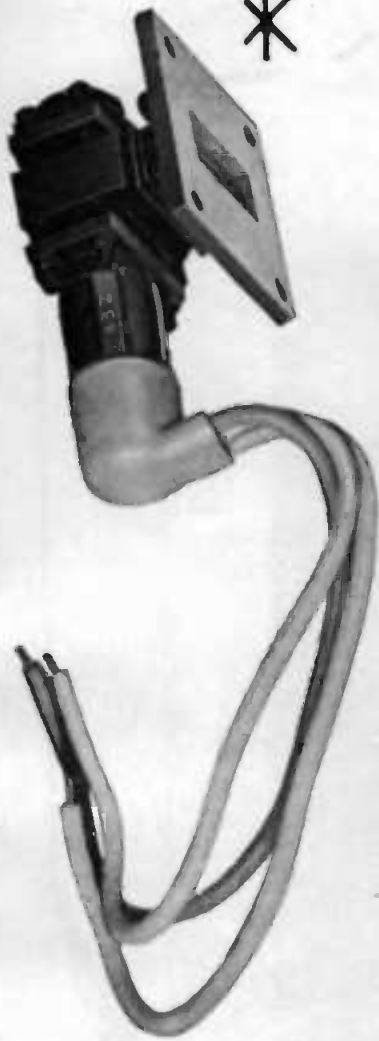
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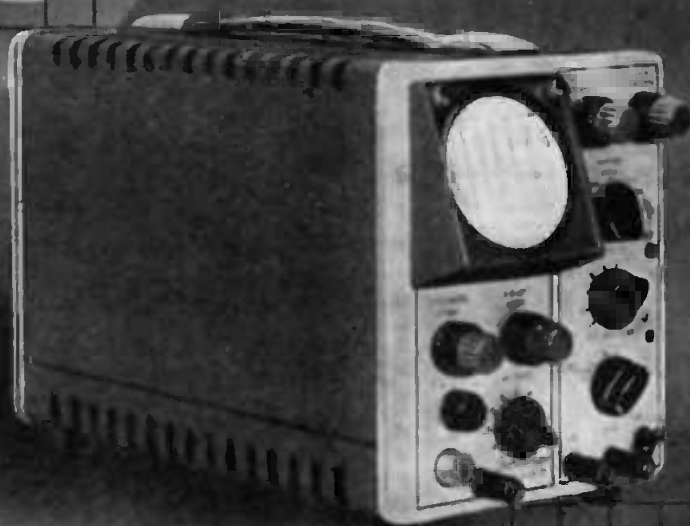
Frequency measurement up to 1Mc/s
- for less than £300
and time measurement into the bargain!

Other models available from £245

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Electronics

**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 (8½ in. x 6½ in. x 13 in.) and has a performance and specification unequalled by many much larger instruments.

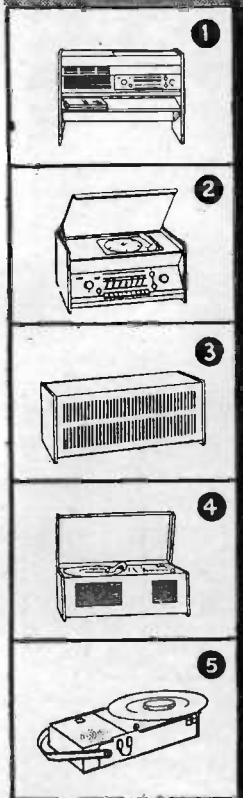
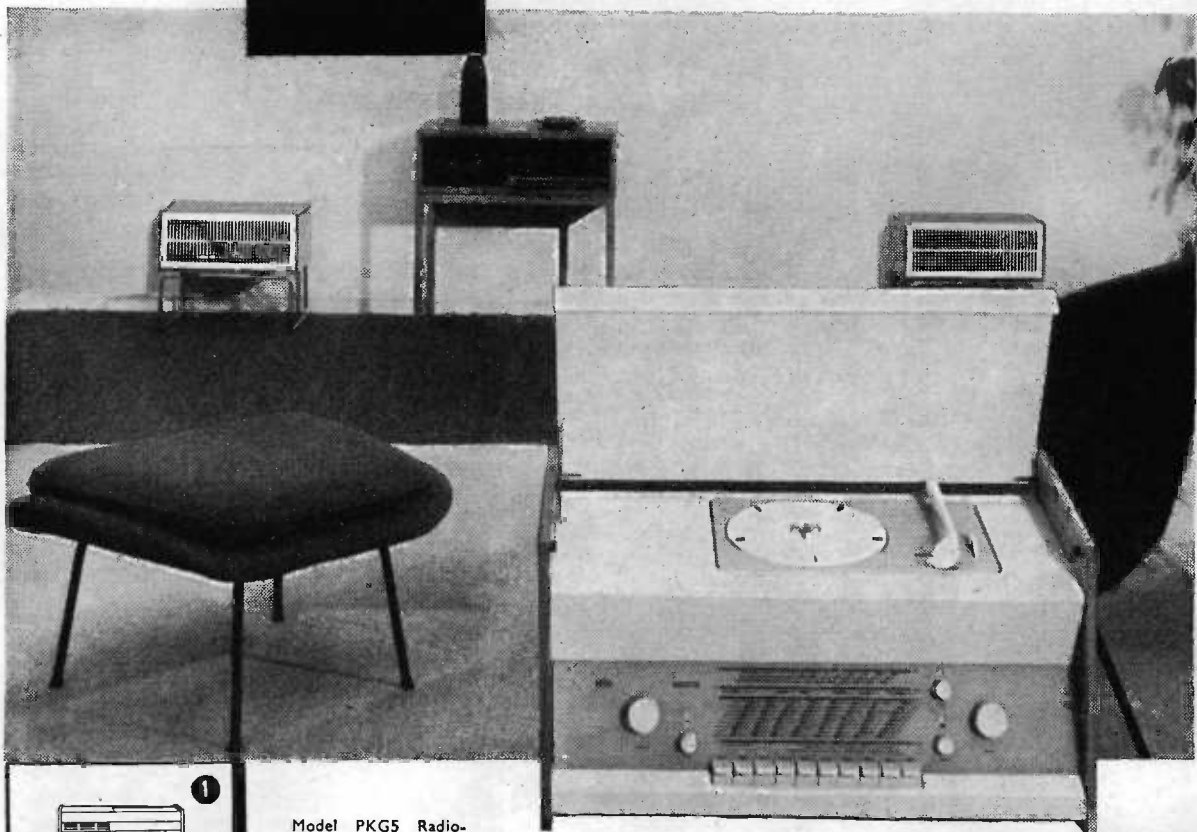
The D.C. coupled amplifier (-3db at 6 Mc/s), voltage calibration, wide-range calibrated time base (5 sec. to 1µ sec. per cm.) and a precision flat-faced C.R. Tube are only a few of the features that put the S31 far ahead of any other portable scope.

TELEQUIPMENT LTD

313 Chase Road - Southgate - London N.14 - Tel. 444 1106



contemporary radios and radiograms



1 Model PKG5 Radiogram, in natural sycamore

2 Model Atelier I, in sycamore and white

3 Loudspeaker LI, matching Atelier I

4 Model SK5 Table Radiogram, in sycamore and white with plastic lid

5 Model TPI Transistorised Battery Portable Radiogram

Model Atelier I, Table radiogram, with two LI Loudspeakers for monophonic or stereophonic reproduction of radio and record.

STYLED in beauty to delight your eyes and ears.

Providing the most critical listener with concert-hall mono or stereophonic reproduction of radio and record in the comfort of his own home, in cabinets of undating charm and beauty . . . a range of moderately priced radio receivers and radiograms that will satisfy the taste of the most fastidious, in keeping with modern furnishing trends.

Available from leading Departmental Stores and Radio Dealers
Sole Concessionaires for United Kingdom

WINTER TRADING CO. LTD.
95/99 Ladbroke Grove, London, W.11.
Telephone: Park 1341 (10 lines)



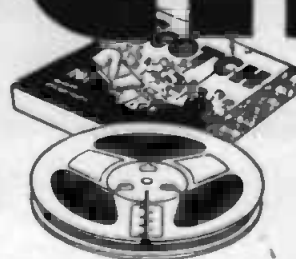
*Those who know
insist on . . .*

TRADE MARK

SCOTCH

BRAND

recording tape



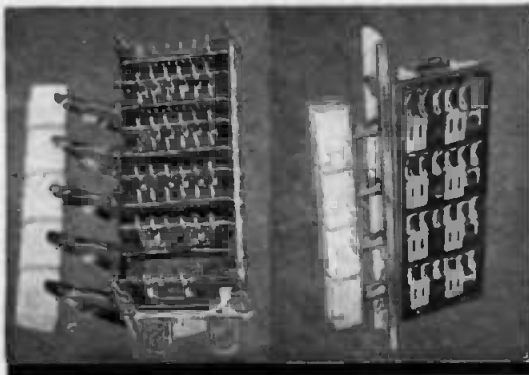
WORLD'S LARGEST SALES OF MAGNETIC TAPE



PUSH BUTTON & PIANO KEY SWITCHES

A whole range of PB and PK switches is provided by Plessey to meet the contemporary requirement in TV, radio and audio equipment design. And whether you plan to employ the one or the other, you will find a suitable Plessey switch with the shape of key or button you prefer—in the colour of your choice.

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MINIATURE PIANO KEY SWITCHES

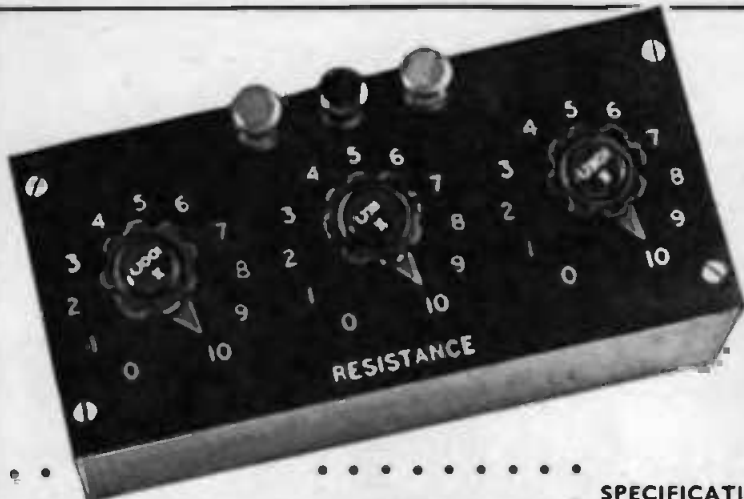
Among the many universally employed ranges of Plessey switches is featured a miniature piano key series, available with either standard or printed circuit contacts.

* May we suggest that you talk to a Plessey Technical Representative about your switch requirements.

THE PLESSEY COMPANY LIMITED
New Lane · Havant · Hants
Telephone: Havant 1701

Plessey

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



Winston DECADE RESISTOR BOXES

The practical application of imaginative thinking, based on tested principles, has produced, in Winston Electronic Equipment, a range of instruments that matches the rapid advance of industrial methods.

Sub-Contract

Full sub-contract facilities for the development and manufacture of Electronic Equipment and Sheet Metal Work. Coil Winding Facilities. A.I.D. and A.R.B. Approved.

SPECIFICATIONS:

- Range 100 ohms to 111,000 ohms.
- Zero Resistance 0.006 ohms.
- Accuracy $\pm 1\%$
- Maximum Current 10's decade 100 mA.
100's decade 35 mA.
1000's decade 10 mA.
- Terminals Screw type.
- Mounting Metal case and panel.
- Finish Blue hammertone case. Black and silver photoetched panel.

PRICE £13.13.0



L BAND SIGNAL GENERATOR

Frequency Range 800-2100 Mc/s in one band; single-dial control directly calibrated to $\pm 1\%$.
Frequency Stability warm-up drift $< .2\%$; ambient drift $\approx .003\%$ 1°C.



X-BAND SPECTRUM ANALYSER

Frequency coverage 8,600/10,000 Mc/s.
Absolute Frequency Measurement ± 1 Mc/s.
Relative Frequency Measurement ± 250 Kc/s.
Sensitivity minus 85 db relative to 1 mW at the input.

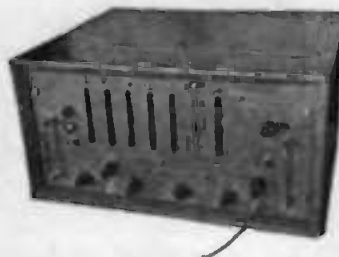
TEMPERATURE CONTROLLER

The Winston/United Steel Temperature Controller provides accurate control of temperatures over any required period and its stability is such that it will hold a furnace at a preset temperature (for example) of 1000°C to within plus or minus 1°C.



BECKMAN BERKELEY Frequency and timing instruments.

Frequency range of 1 Mc or 10 Mc/s with extension facilities to 110 Mc/s, 220 Mc/s, 1000 Mc/s and 15,000 Mc/s.



Write for full particulars of facilities available and catalogue of Instruments and Electronics, to:—

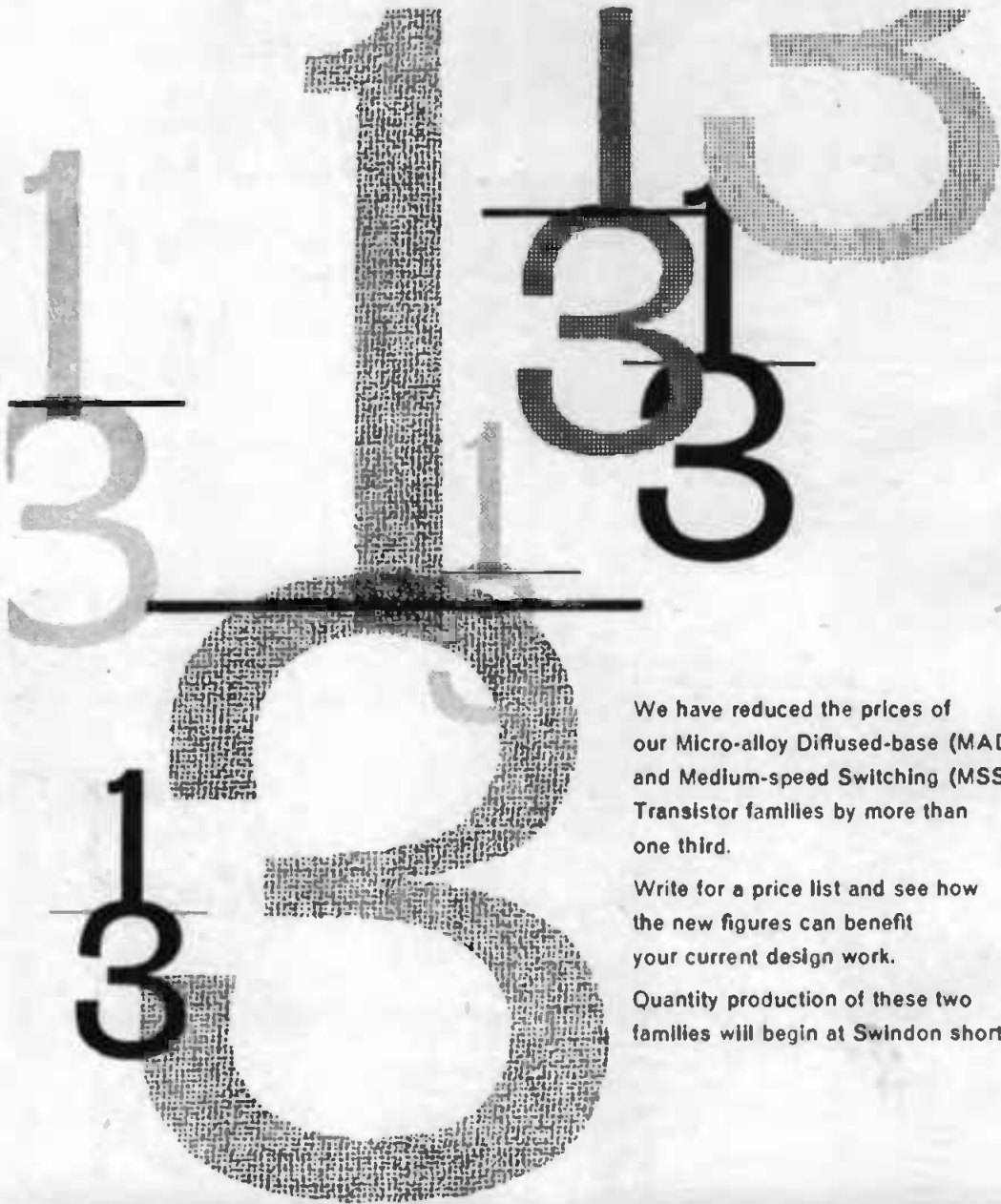
IN ADDITION TO THE ITEMS FEATURED THE WINSTON RANGE OF ELECTRONIC EQUIPMENT INCLUDES:—

- Semi Decade Oscillator
- Capacitor Boxes
- "L" Band Spectrum Analyser
- "S" Band Spectrum Analyser
- Valve Voltmeter
- Transistor Curve Tracer

- Transient Oscillograph
- Hellpots
- Dials
- Shockley Diodes
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- Sheet Metal Work
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WINSTON ELECTRONICS LIMITED

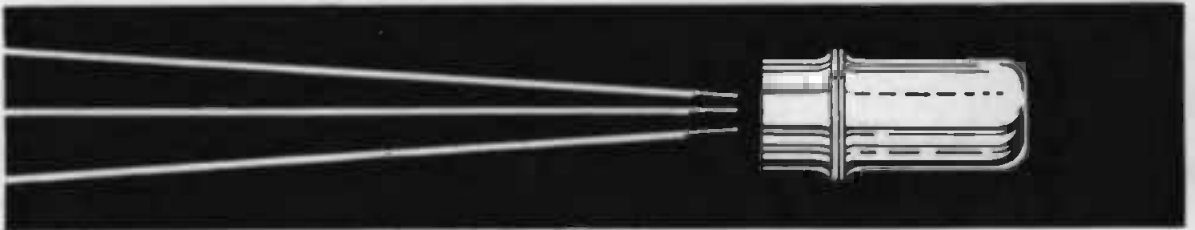
INSTRUMENTS — COMPONENTS — PRODUCTION FACILITIES
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Telegrams: Winston, Shepperton



We have reduced the prices of our Micro-alloy Diffused-base (MADT) and Medium-speed Switching (MSS) Transistor families by more than one third.

Write for a price list and see how the new figures can benefit your current design work.

Quantity production of these two families will begin at Swindon shortly.



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Telephone: Swindon 6421



Vacuum Oven

- Made In Stainless Steel highly polished ★
- Single or double ended opening ★
- Heated externally or Internally with Infra-red radiation, depending on requirement ★
- Multi-Cam Timer for automatic setting of sequence operations Press Button Starter ★
- Vacuum to 10^{-4} m.m. with required pumping speeds ★
- Internal dimensions as required ★

.....

DOUBLE ENDED STAINLESS STEEL VACUUM OVENS

.....

- Made throughout in polished stainless steel.
- Single action door openings.
- Rectangular with shelf spacings to suit.
- Double ended controls.
- Electrical interlocking of air inlet and isolation valve.
- Outer cover hermetically sealed.
- Temperature range 0° - 300° C or equivalent F.
- Temperature controls:
Normal $\pm 7\frac{1}{2}^{\circ}$ C.
Special $\pm 1^{\circ}$ C.
- Internal spacing 7 x 8 x 18in. (can be altered to special requirements).
- Vacuum range:
To 10^{-4} mm.
- Respective vacuum gauges incorporated.
- Automatic air inlet valve on backing pump.
- Visual Indicators and fuses on all switches.
- Flanged for fitting into dry box.

We design and manufacture Ovens to customers' special requirements. Should you have any problems in this field, our Technical Department is always willing to help you solve them.

Vacuum Ovens with temperatures of up to 600° C are also manufactured by us on similar lines but with Sectional Heating and Water Cooled Ends.

Glove Boxes supplied with ovens as required.

OVEN: Vac. Range 10^{-4}
Temp. Control $\pm 7\frac{1}{2}^{\circ}$



ABOVE OVEN: Vac. Range .02 mm.
Temp. Control $\pm 1^{\circ}$

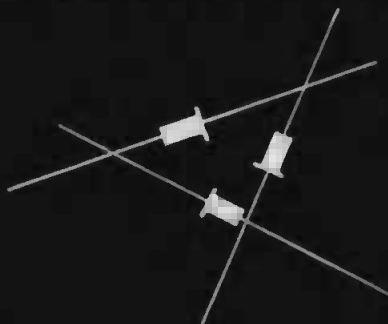


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Phone: MITcham 8211 (3 lines)

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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

SIMET

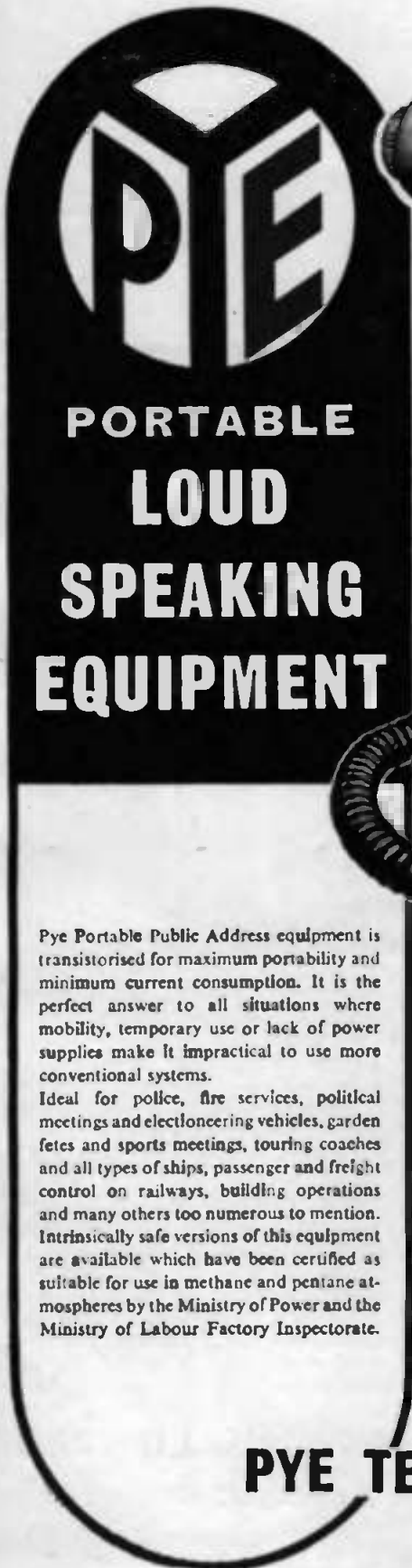
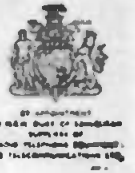
"G" Series Rectifiers,
which is the range from which
these Type Approved devices
have been developed,
offer high temperature operation
—250mA, at 150°C up to 600 P.I.V.
—and high voltage operation
up to 1000 P.I.V.
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CV 7029	600v	6G8
CV 7028	400v	4G8
CV 7027	200v	2G8
CV 7026	100v	1G8

Plessey

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**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 3¼" 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

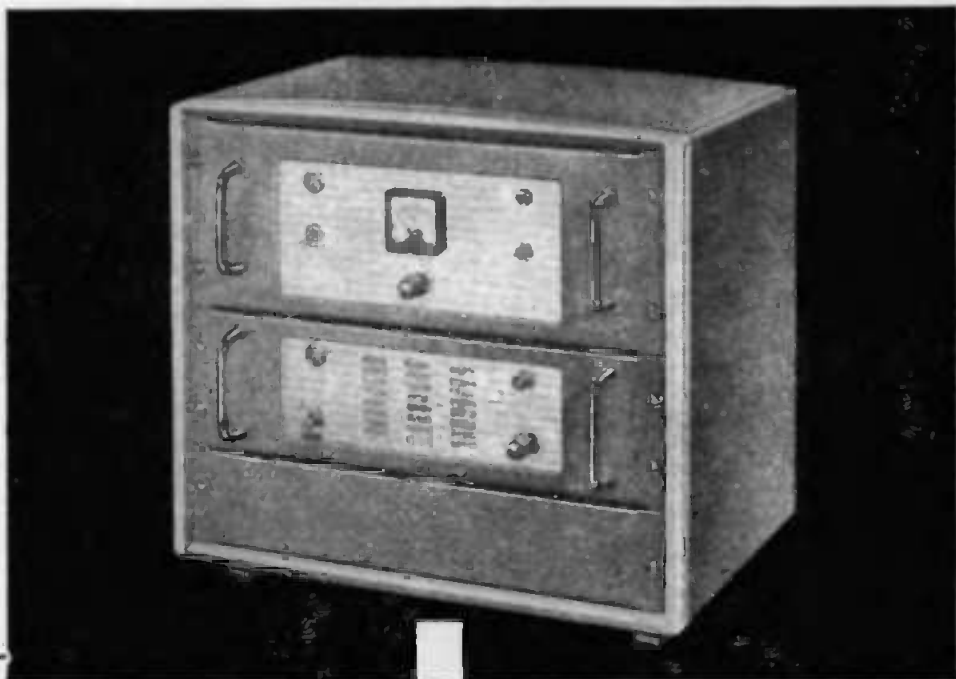


PANORAMA

FEATURING PYE TELECOMMUNICATIONS EQUIPMENT



BY APPOINTMENT
TO H.M. DUKE OF EDINBURGH
SUPPLIER OF
RADIO TELEPHONE EQUIPMENT
PYE TELECOMMUNICATIONS LTD.



Ranger '450' Radiotelephone Fixed Station

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.

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.

PYE TELECOMMUNICATIONS LIMITED

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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



MICROWAVE LINKS

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 TDUs

A specialised oscilloscope, having a linear timebase of good short term stability and long term accuracy, for examination of the d.g. 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.

A new Grommet development

THE DOUBLE SEALING EMPIRE RUBBER GROMMET

infinitely accommodating in use:
considerably reduces range of sizes
because the same grommet can be used with
several plate thicknesses or cable sizes



This newly developed self-conforming grommet, because it is immediately self-locking against the elements, is the solution to many of an engineer's sealing problems.

Any one size will not only accommodate itself to a variety of mounting plate thicknesses, but (designed for cable or control rod) will take these in a variety

of sizes and be weather-, water- and dust-proof at a variety of angles to the cable or rod.

Because of its capacity to conform to many varying requirements, it enables a workshop stock range of grommets to be reduced to perhaps one tenth of that at present maintained.

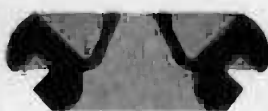
THE NEW BLIND GROMMET



FREE

Note how when sprung into position the grommet provides a perfect double seal by its own permanent pressures. The angled groove also creates a tight pressure hold on the metal plate.

THE NEW DESIGNED GROMMET

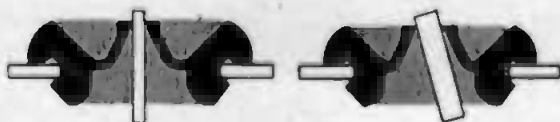


FREE



FITTED

In the cable grommet variety the same double pressure seal is created, allied to tight seal on various diameters of cable. This new grommet gives sound sealing at all vital points.



A useful feature of this cable grommet is that by reason of the designed taper of the cable entry and the flexibility of the web, a considerable angle of cable entry and a variety of cable size are possible. This avoids necessity for special grommets with angled bores.



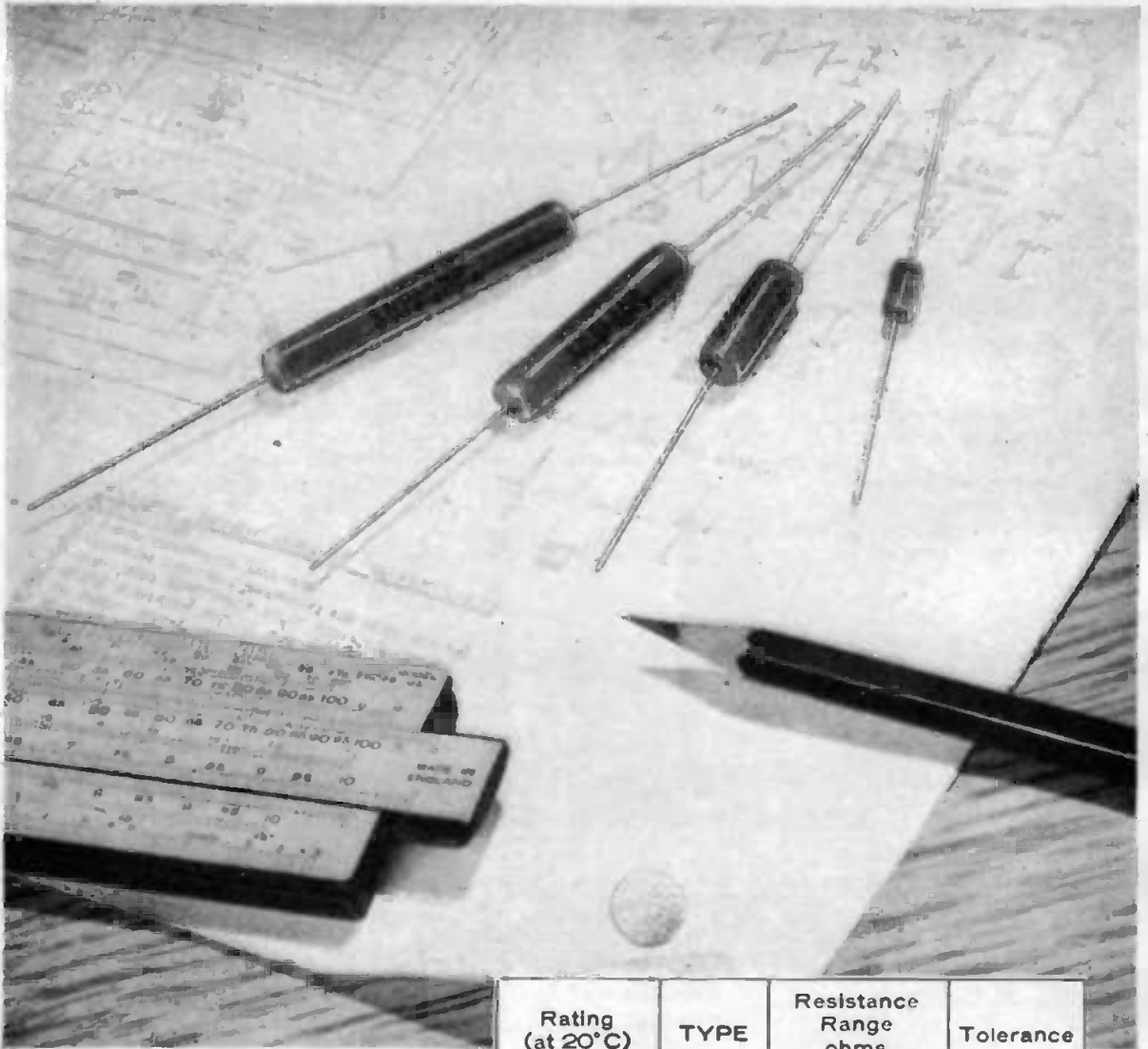
In the conventional grommet, only one thickness of plate and only one size of cable can be accommodated. No effective seal is afforded by the parallel groove.

Now being produced in a range of sizes
THESE GROMMETS WILL SOLVE
YOUR SEALING PROBLEMS



ENQUIRE
for catalogue section
and detailed particulars.

PAINTON Miniature Vitreous Wirewound Resistors



Rating (at 20°C) Watts	TYPE	Resistance Range ohms		Tolerance
		Min	Max.	
4	MV1A	1	9.9	10%
		10	6,800	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

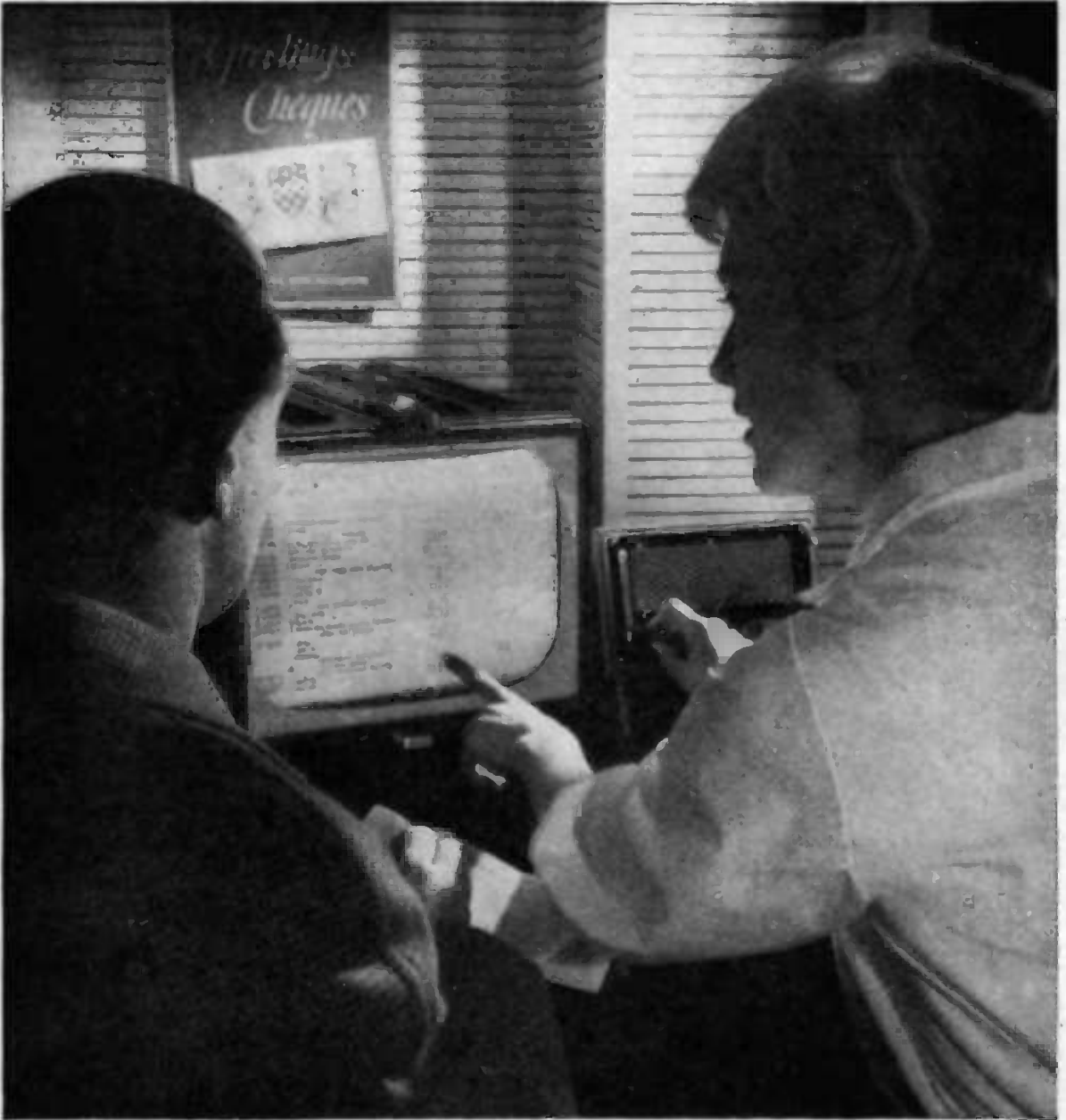
- ★ Fully Type Approved to RCS 111
- ★ Top Quality ★ Quick Delivery
- ★ Competitive Prices



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Tel: 34251 (10 Lines) Telegrams: 'Cell Northampton'.

Always specify Painton Wirewounds



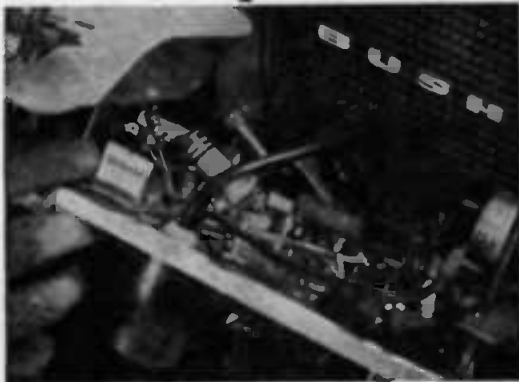
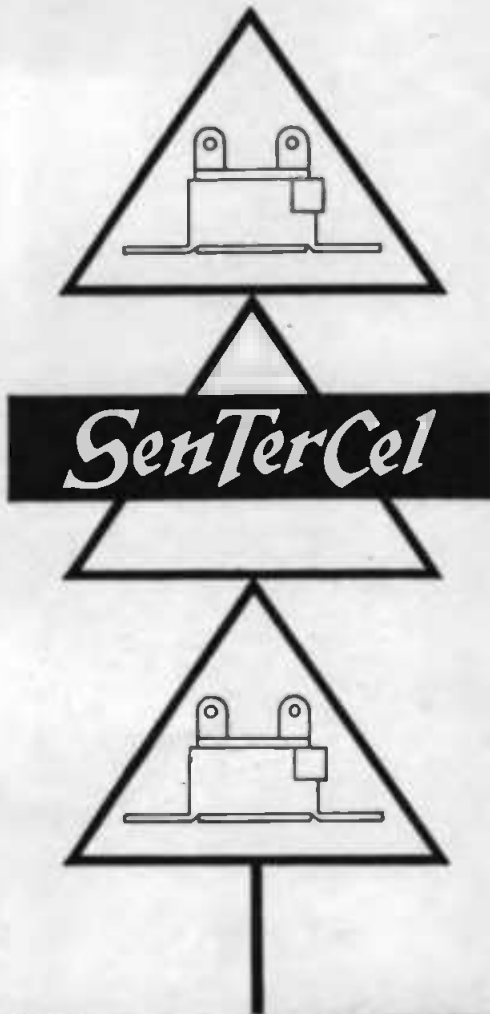
Westminster Bank uses Pye Television



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 Atomic 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.

CONTACT COOLED RECTIFIERS



SenTerCel Contact Cooled Rectifiers have been selected by Bush for H.T. supply circuits in their domestic radio receivers. These belong to a comprehensive range of rectifiers which offer important reductions in size, weight and cost over the conventional metal rectifiers. In addition greater facility in chassis layout is permitted since they can be mounted at any angle. A table of ratings is shown below

aid BUSH reliability

Push-Pull and Bridge Connections · Half-Wave and Voltage-Doubler Connections

Qty.	Type	Circuit	Maximum Input Volts (r.m.s.)	Max. Output Current mA (mean)	Typical D.C. Output Voltage			
					16 mfd. Resv. Cap. Half Load	32 mfd. Resv. Cap. Full Load	60 mfd. Resv. Cap. Half Load	60 mfd. Resv. Cap. Full Load
1	C2H	Half-Wave	125	60	135	115	135	120
1	C3H	" "	125	120	120	85	130	120
1	C2D	" "	250	60	275	245	280	255
1	C3D	" "	250	120	275	245	290	275
1	C7D	Volt-Doubler	125	60	275	245	290	265
1	C3D	" "	125	120	260	205	290	265

Qty.	Type	Circuit	Maximum Input Volts (r.m.s.)	Max. Output Current mA (mean)	Typical D.C. Output Voltage			
					16 mfd. Resv. Cap. Half Load	32 mfd. Resv. Cap. Full Load	60 mfd. Resv. Cap. Half Load	60 mfd. Resv. Cap. Full Load
1	C2V	Push-Pull	125-0-125	120	140	120	140	130
2	C7D	" "	250-0-250	120	775	250	200	255
1	C1V	" "	125-0-125	240	130	115	140	130
2	C3D	" "	250-0-250	240	280	250	290	260
1	C3D	Bridge	250	120	275	250	280	255
2	C3D	" "	250	240	280	250	280	260

Send for leaflet MF/102



Standard Telephones and Cables Limited

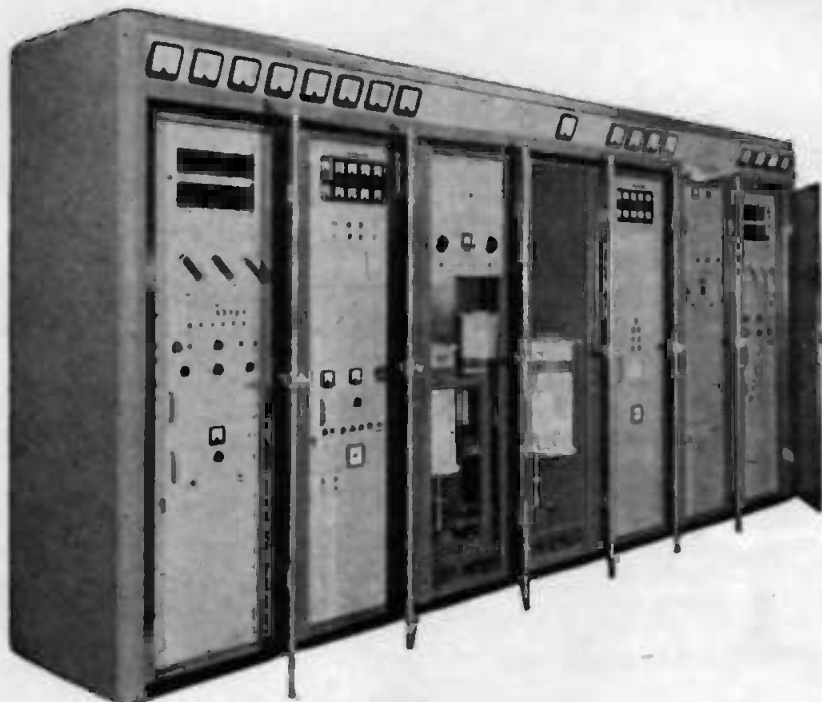
Registered Office: Connaught House, Aldwych, London, W.C.2

RECTIFIER DIVISION: EDINBURGH WAY · HARLOW · ESSEX



Medium Power TV Transmitter for Band III

The 5kW vision transmitter, sound transmitter and combining unit are contained in an assembly of cubicles with built-in air cooling system. This complete operational unit measures 15' 1" overall. The combining unit incorporates a bridge type diplexer and vestigial sideband filter and provides the necessary monitoring facilities with a single coaxial output.



Features:

- ★ Modern styling and latest technical design.
- ★ Includes power supplies, integral cooling and comprehensive control system.
- ★ Simplified circuitry and use of tuning suitable for two transmitters operating in parallel.
- ★ Fully protected against overload and provided with optional resetting safety devices for the protection of equipment.
- ★ Comprehensive monitoring and metering facilities.
- ★ Ease of maintenance.
- ★ Frequency stability suitable for receivers operating on inter-carrier system.
- ★ Easy to install.
- ★ Economical to operate both in power requirement and in valve replacement costs.
- ★ Mechanical Interlock system is employed for personnel protection.
- ★ Can be supplied for British, American, C.C.I.R. and O.I.R. standards.

For full technical details please write to

PYE LIMITED · SALES DEPARTMENT · TELEVISION TRANSMISSION DIVISION · CAMBRIDGE

The new concept of electronic equipment manufacture

A new philosophy:

Made for everyday use

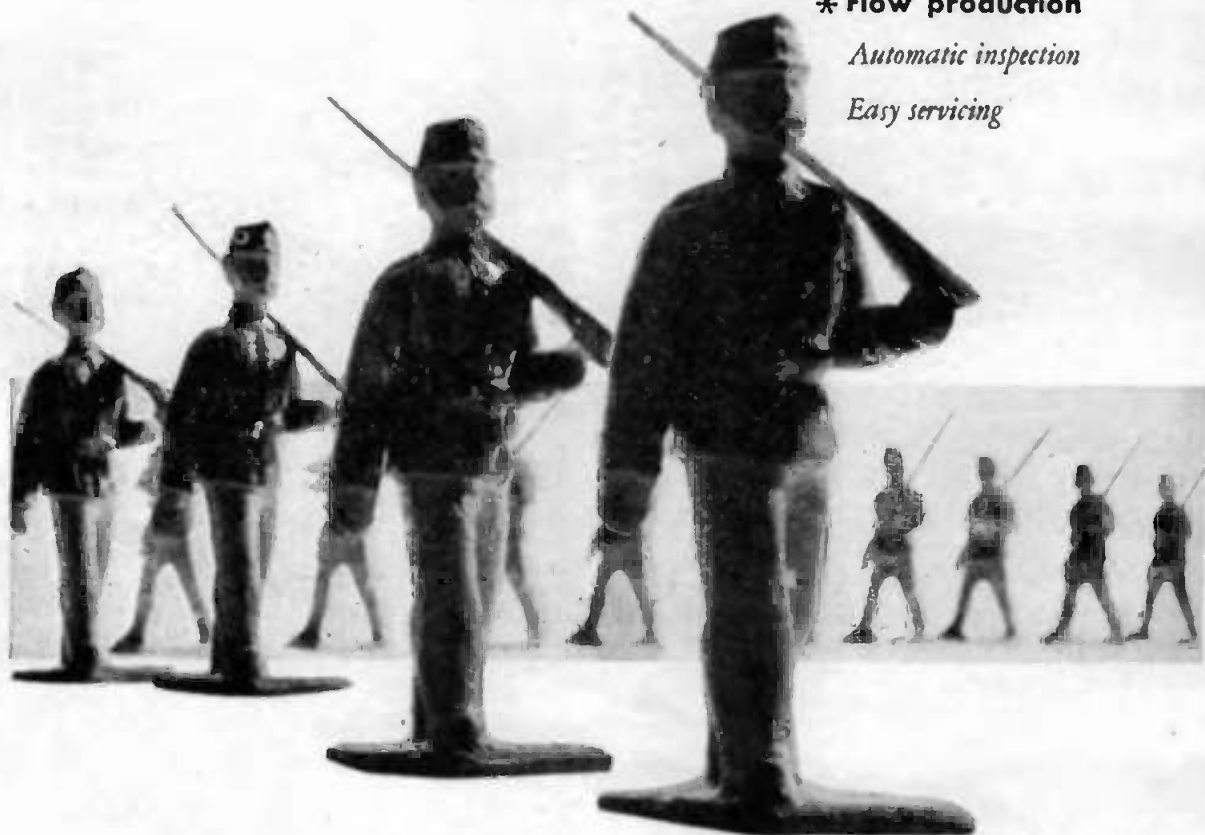
Wide range available

Modern techniques

*** Flow production**

Automatic inspection

Easy servicing



* Uniformity and excellence in quality and performance are the end results of automatic production as applied to the manufacture of the new Philips electronic tools for industry.

Each one of these tools is as dependable, as robust, as simple in every day factory or laboratory use as are its fellows.

And because of automatic production, prices are remarkably low and users are assured of the long term availability of standard components throughout the world.

Dependable **PHILIPS** tools 
for the electronic industry

Sold and serviced by Philips Organizations all over the world

Overseas enquiries please, to the manufacturers,
N.V. Philips, Eindhoven, the Netherlands.

Sole Distributors in the U.K.: Research & Control Instruments Ltd.,
207 King's Cross Road, London W.C.1

DC-Microvoltmeter GM 6020

Measuring ranges:

A in 11 steps from 100 μ V up to 10 V full scale deflection

B in 11 steps from 10 mV up to 1000 V full scale deflection.

Input impedance:

in range A: 1 M Ω (\pm 1.5%) // 15 - 20 pF

in range B: 100 M Ω (\pm 1.5%) // 10 pF

Overall accuracy: 3% \pm 5 μ V

Deflection of pointer: always positive;

polarity is indicated by 2 lamps

Main supply: 110 ... 245 V; 50 ... 100 c/s

5" scale with mirror reading



The price - a pleasant surprise



★ MODEL 4HF

fit **Garrard** for Good....



MODEL 301. The Connoisseur's Transcription Motor and used by the B.B.C. and broadcasting stations throughout the world. Wow and flutter have been reduced to the minimum and all three speeds are adjustable. Can be supplied with turntable stroboscopically marked.



MODEL TA. Mk. 1E. A single Record Player particularly suitable for the home constructor. It is mounted on a rectangular unit plate. Voltage range 100/130 and 200/250 A.C. only. A model for battery operation is also available.



MODEL TPA.12. Transcription Pick-up Arm designed for monaural and stereophonic record reproduction. It is an instrument of the highest quality with its modern styling finished in Ivory, Chrome and Red. Fitted with M.P.M.4 Plug-in moulding which accepts most cartridges, it is the companion to the Model 301 Transcription Motor.

Garrard equipment is the perfect product of combined design and engineering achievement. Each unit, while conscious of changing modern moods, bears all the dignity of Garrard experience. Beautiful equipment made to give pleasure always.

★ **MODEL 4HF.** A high quality single Record Player elegantly styled and carefully designed to provide maximum reliability with fidelity of reproduction. Fitted with TPA.12 Pick-up Arm which allows records up to 16in. to be played.



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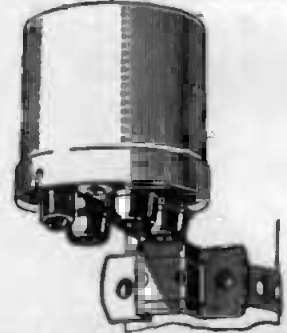
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TYPE 1



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Output current range	0 to 1 amp	Rating	continuous
Voltage regulation (no load to full load)	approx. 7%	Efficiency at full load	36%
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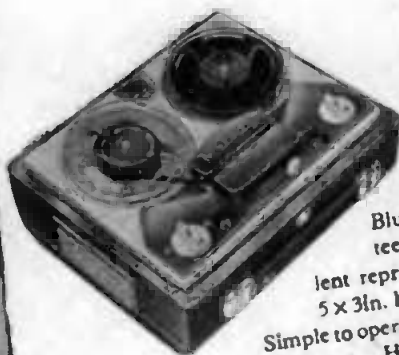
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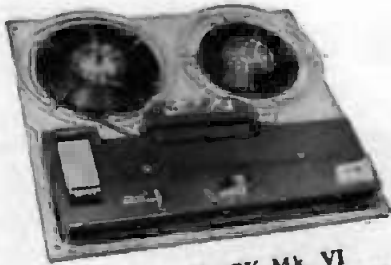
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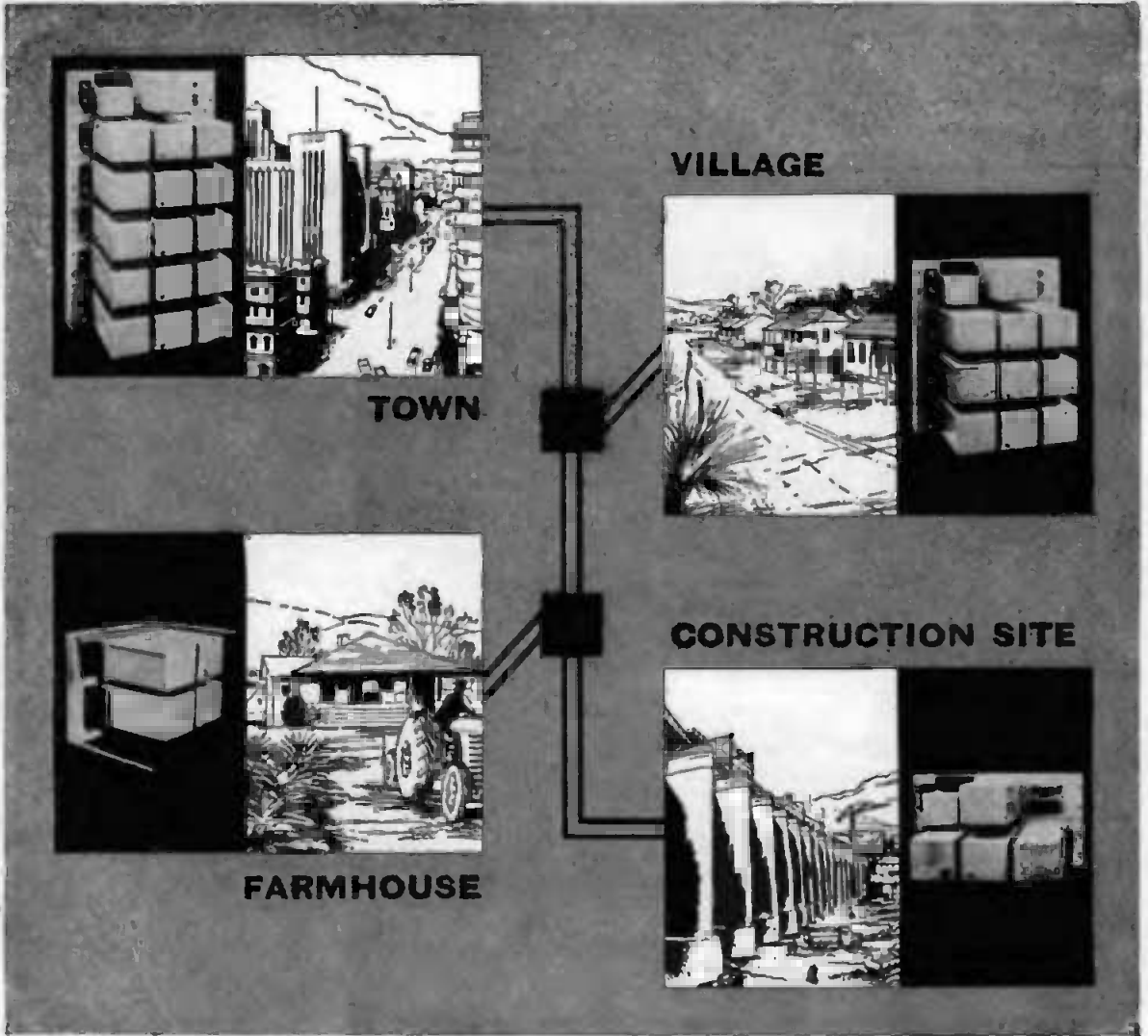
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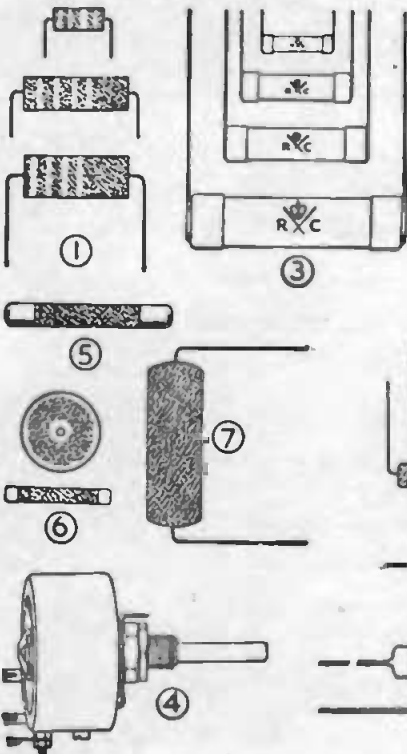
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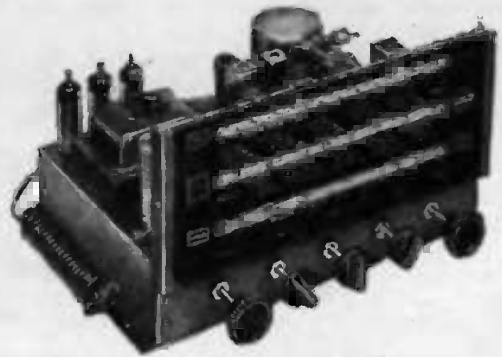
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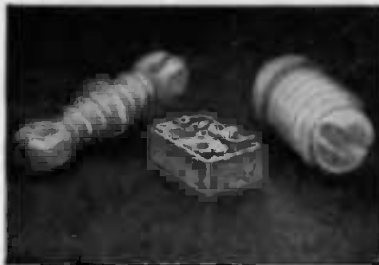
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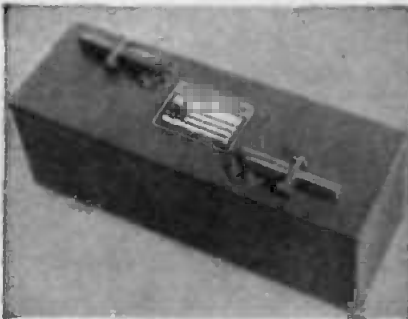
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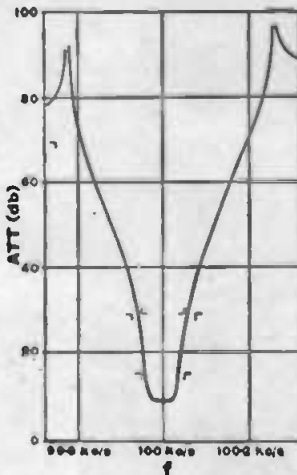
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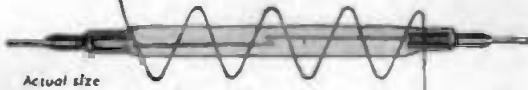
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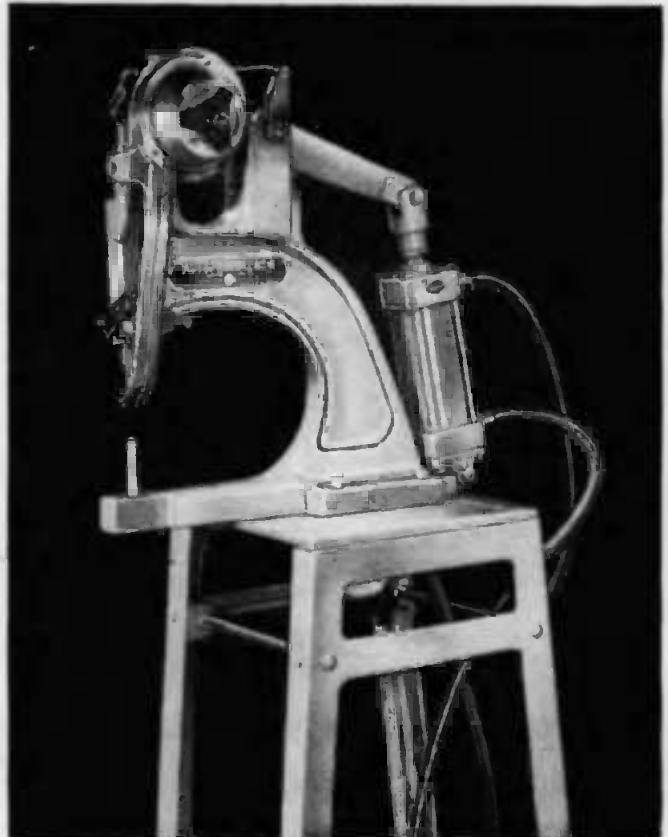
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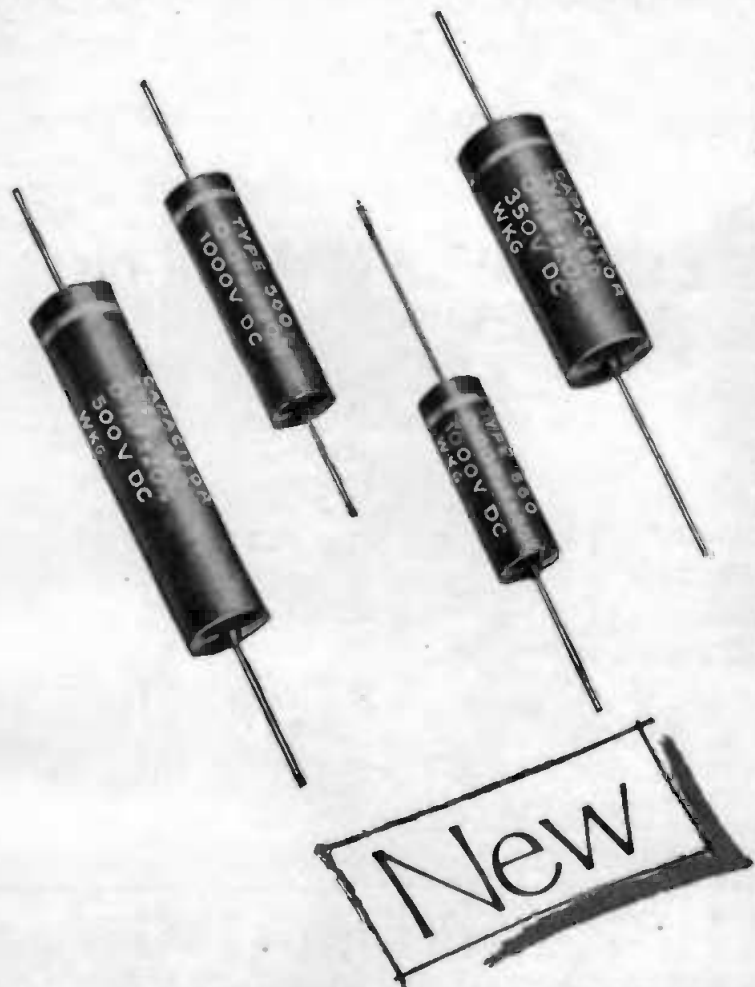
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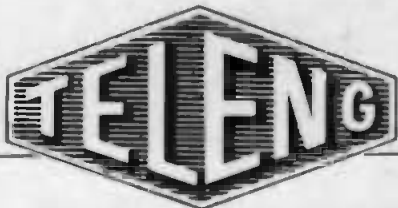
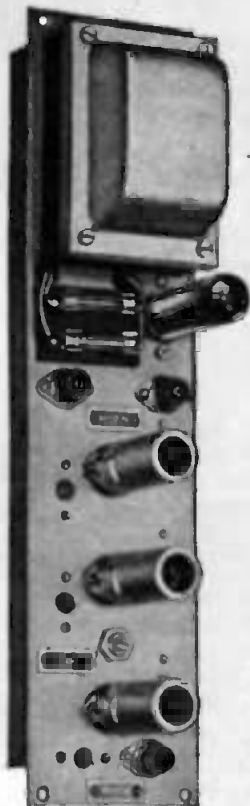
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0.002	1,000	2,500	250	$\frac{1}{2}$	1
0.005	1,000	2,500	250	$\frac{1}{2}$	1
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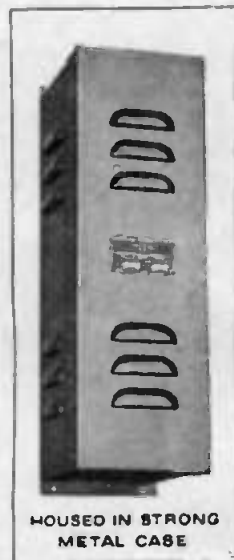
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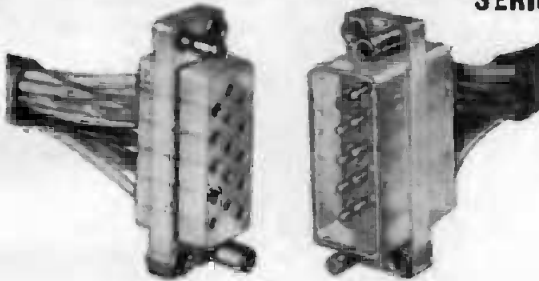
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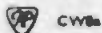
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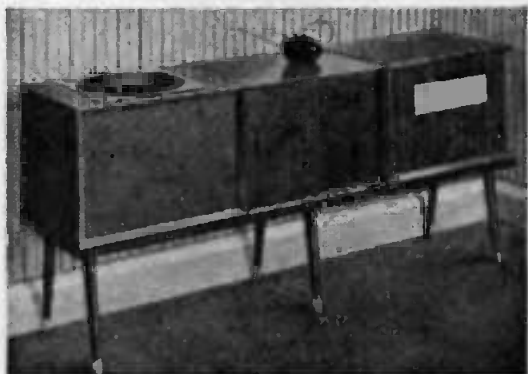


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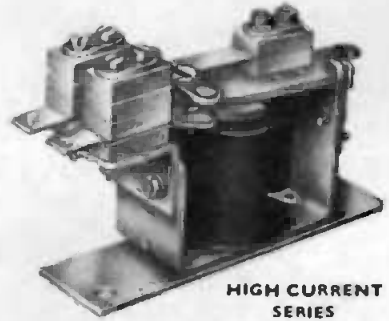
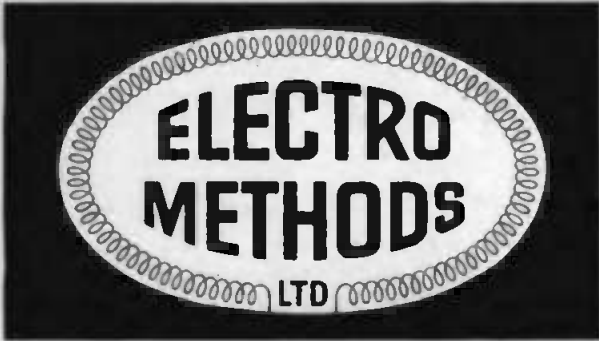
The **GRAM UNIT** (right) will house all turntables (transcription or autochange) or all tape decks. Motor board measures 19 × 14½ in. It will take most amplifiers and maybe a radio tuner too, if mounted on the side. Price: £5/19/6.

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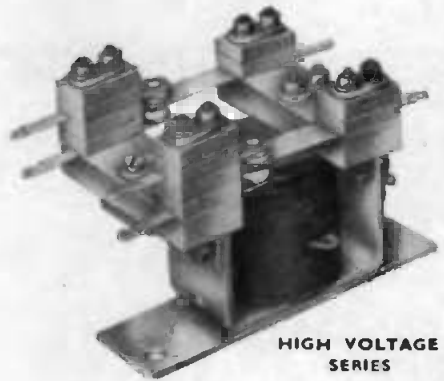
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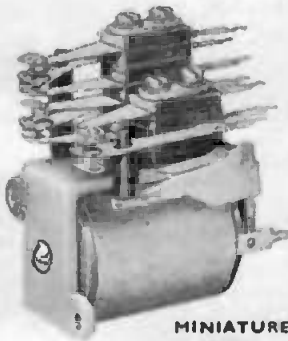
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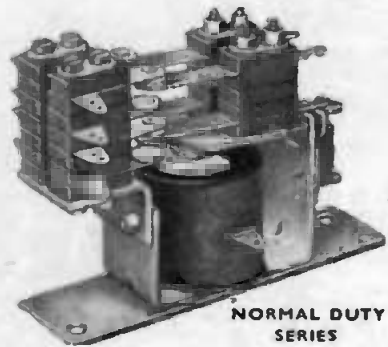
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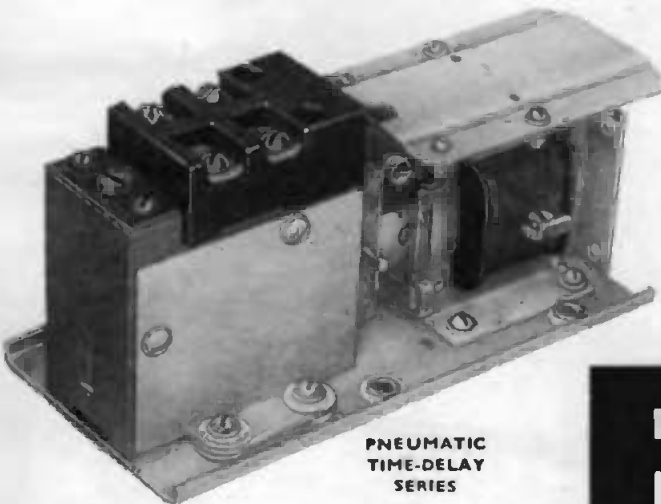
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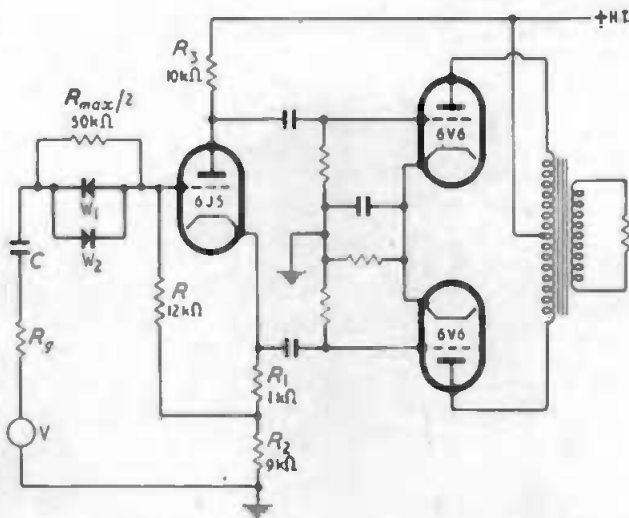
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ARTICLES IN THE FEBRUARY ISSUE INCLUDE:

TRANSIENT STORAGE OSCILLOSCOPE

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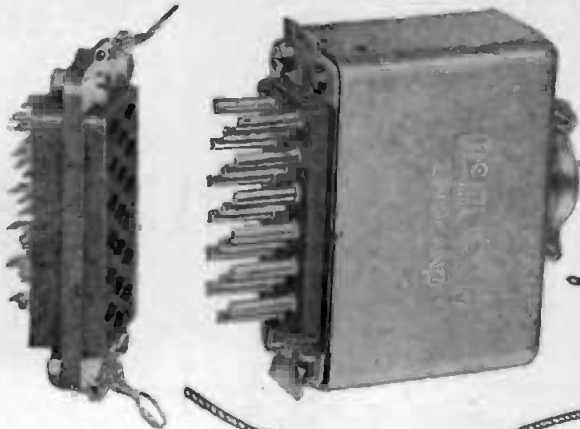
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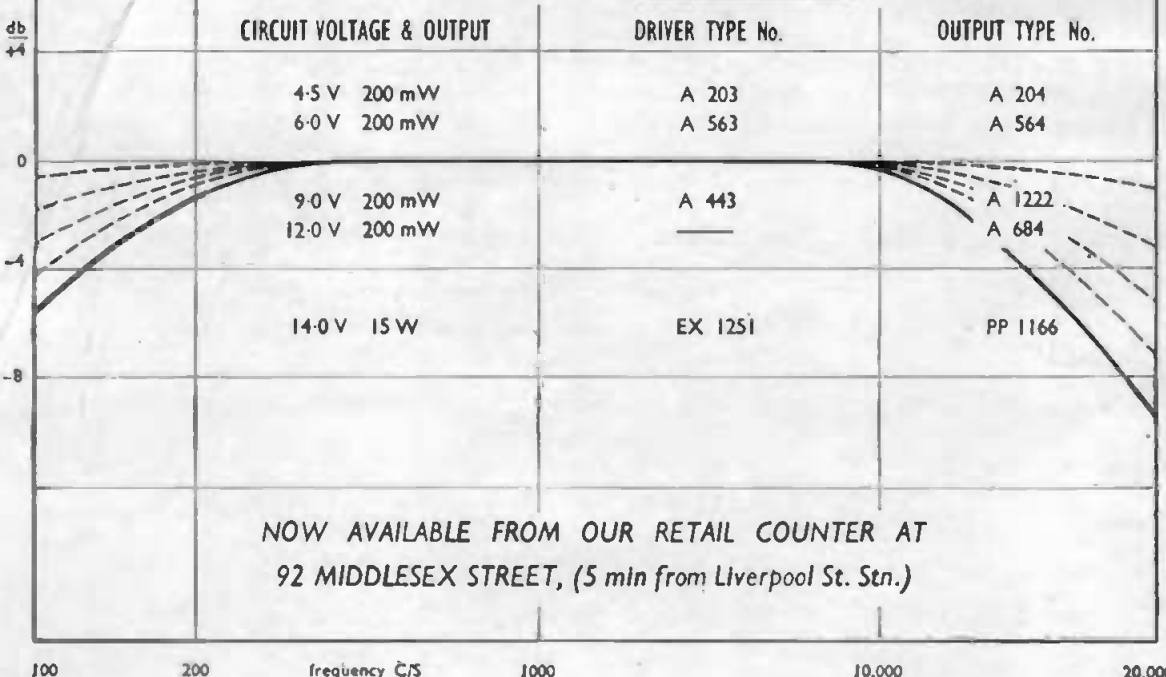
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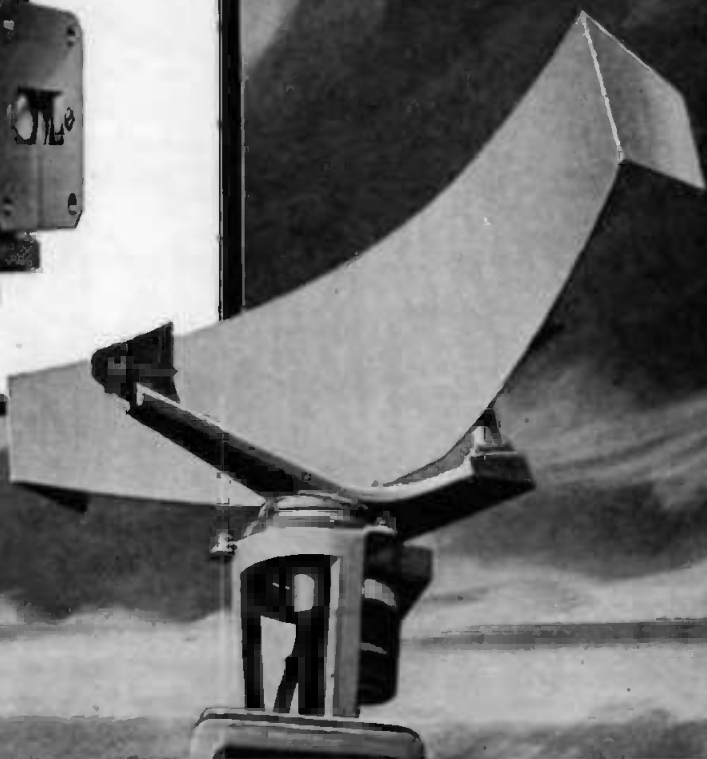
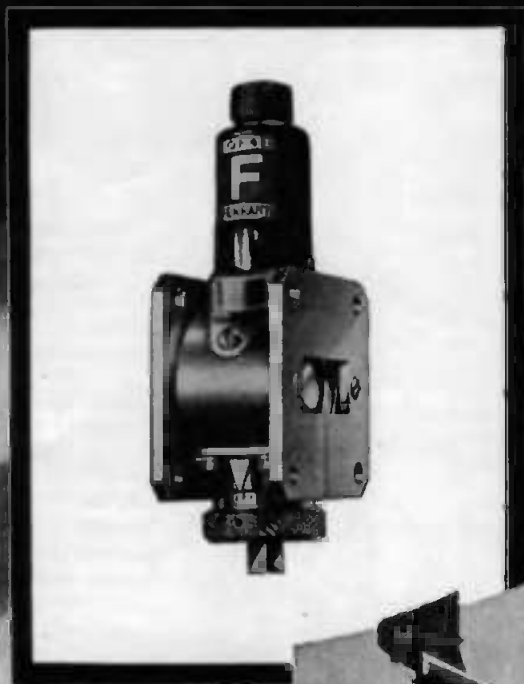


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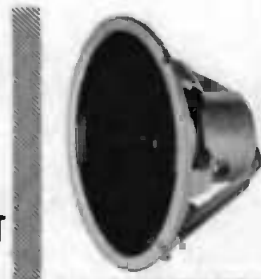
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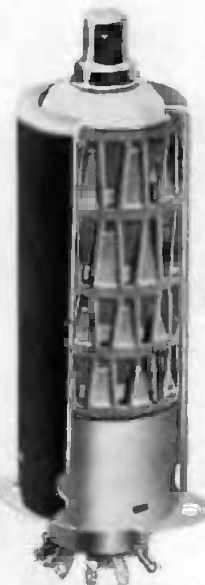
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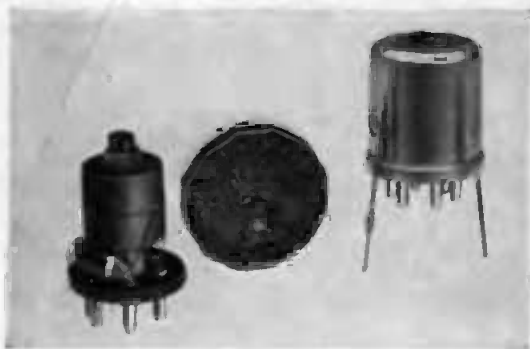
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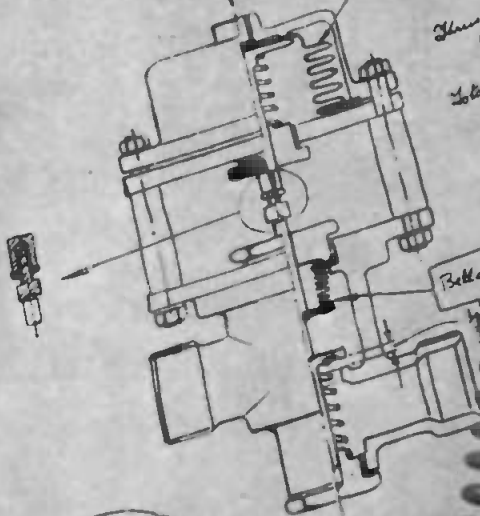
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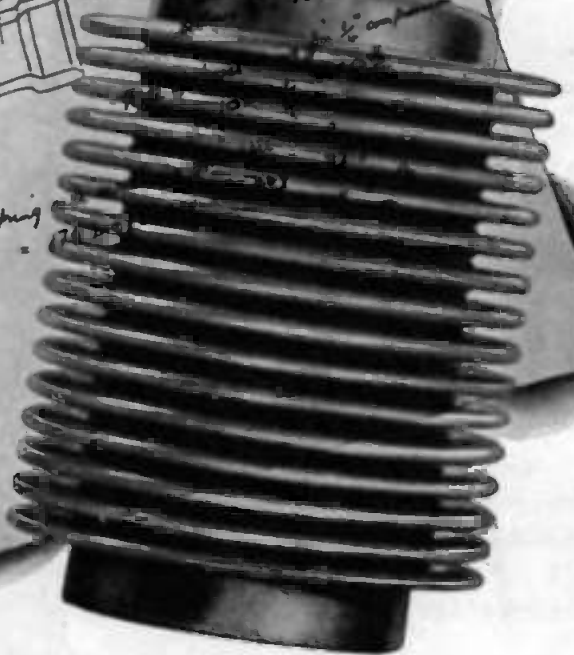


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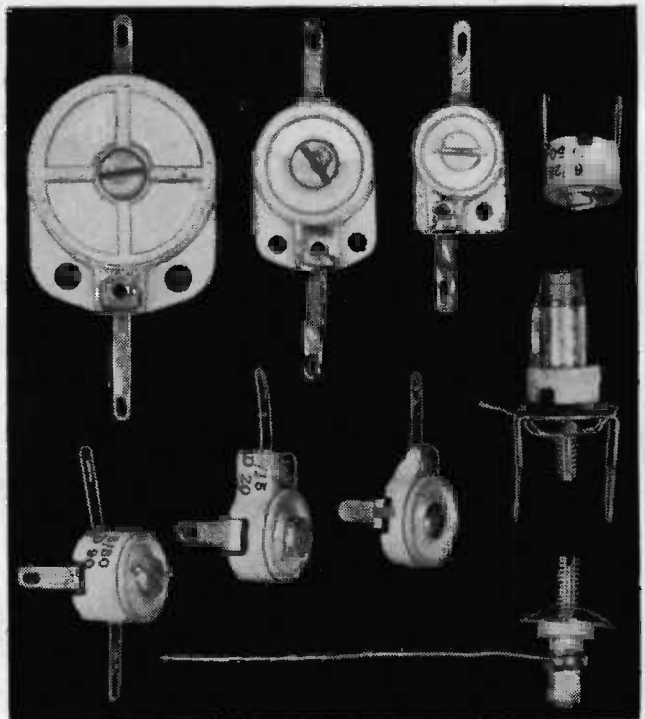
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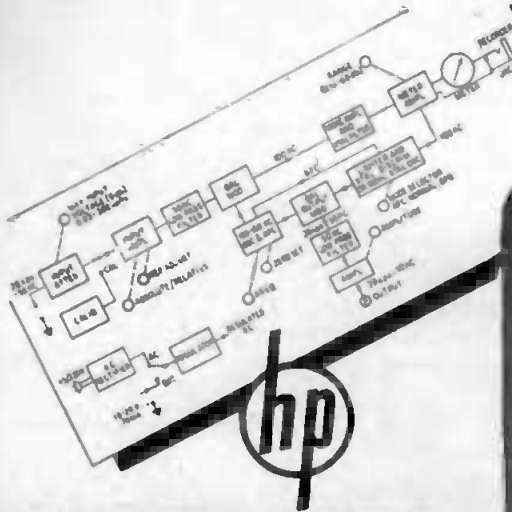
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Frequency Calibration: Linear graduation 1 division per 10 cycles. Accuracy $\pm (1\% \times 5)$ c/s.

Voltage Range: 3 μ v 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: $\pm 5\%$ of full scale value.

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 ± 25 cycle bw—at least 50 db down.
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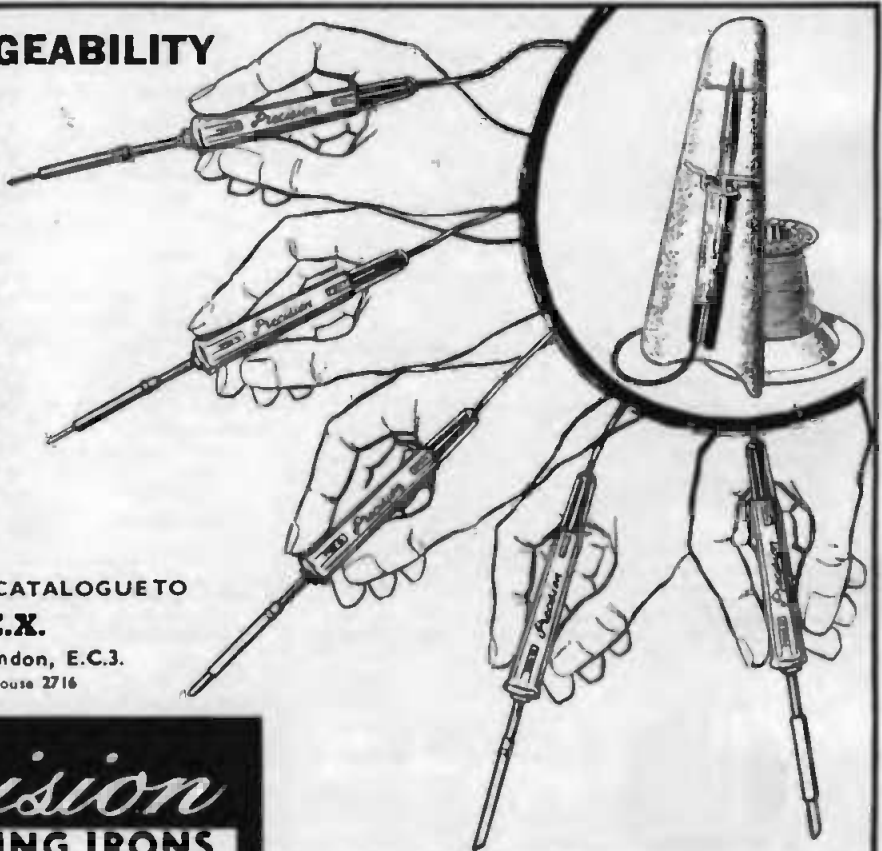
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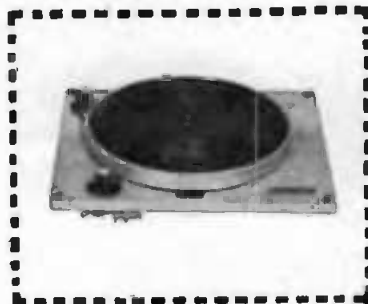
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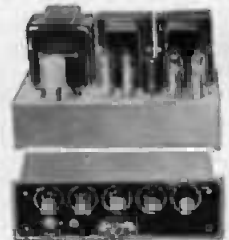
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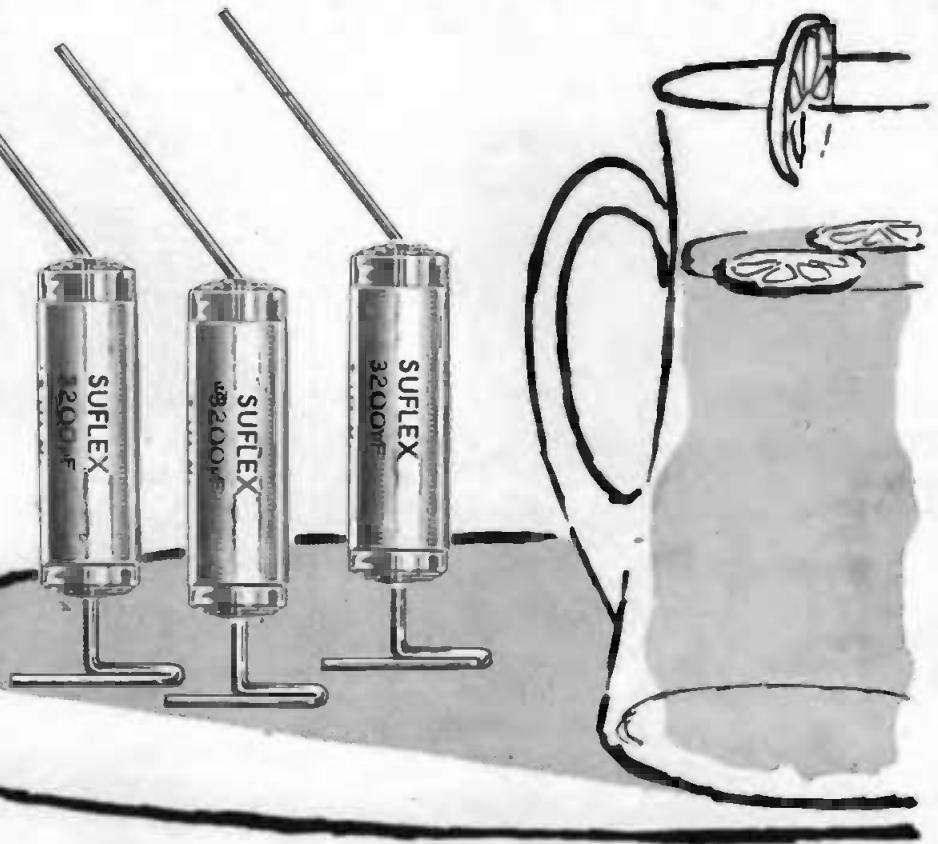


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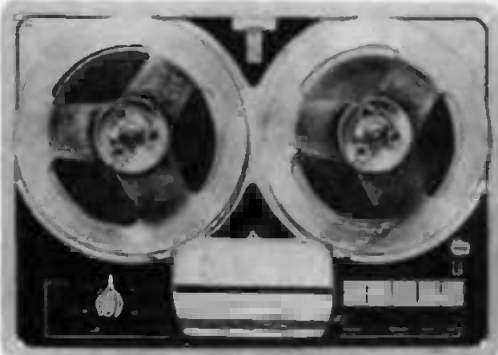
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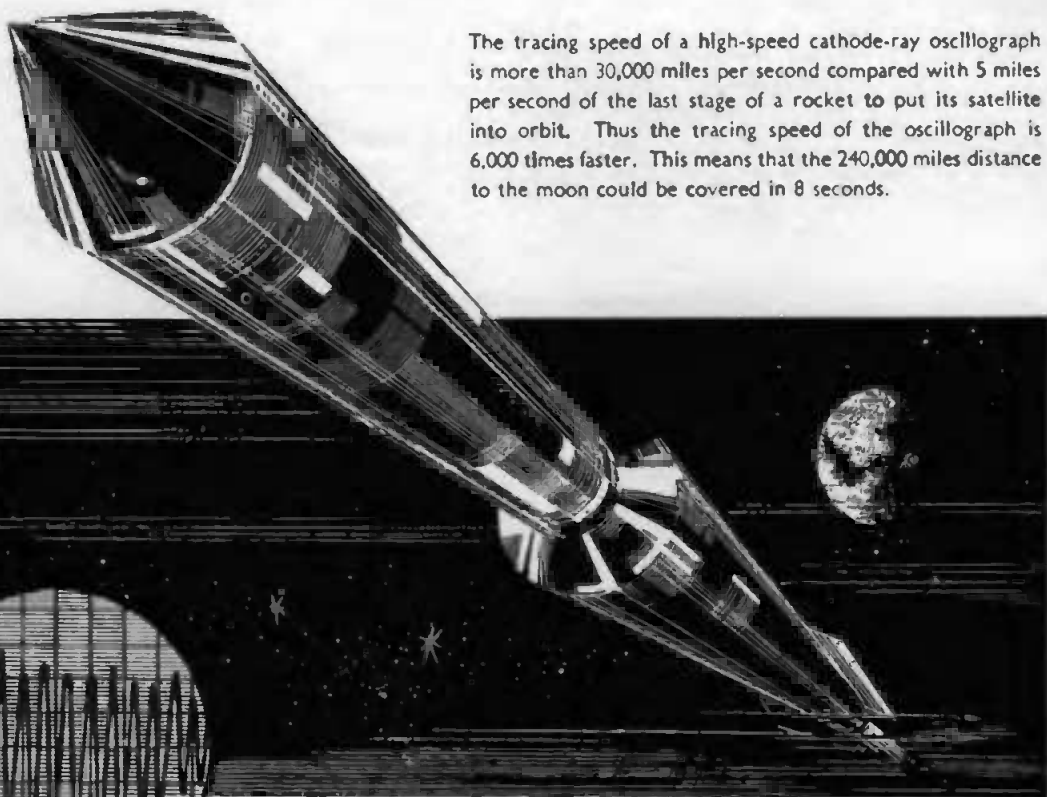
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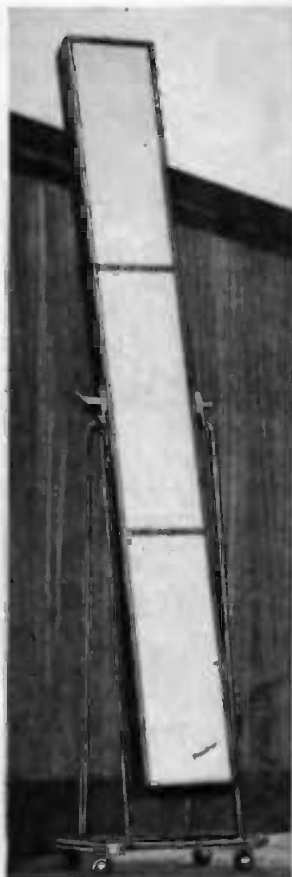
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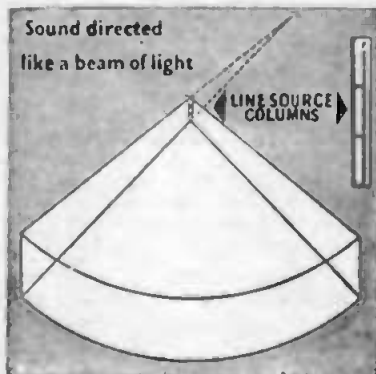
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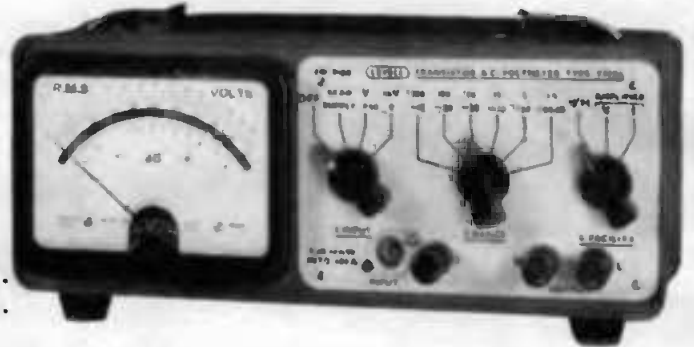
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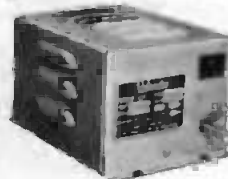
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ABRIDGED DATA — Typical operation

TUBE	ICPI Monitor	3AFPI General Purpose	3AZPI Double Gun*	4EPI General Purpose	4LPI Split Beam	5BKPI Helical P.D.A.	5BUPI General Purpose	5BVPI High Writing Speed	5BVPIA High Writing Speed	5SCLPI High Sensitivity
V ₂₁(kV)	0.5	1.0	1.5	2.0	1.5	1.4	2.0	4.0	1.5	1.5
V ₂₃(kV)	0.5	1.0	1.5	2.0	1.5	1.8	2.0	4.0	4.0	1.5
V ₂₄(kV)	—	—	—	4.0	3.0	4.0	4.0	8.0	8.0	15
V ₂₅(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.....

.....

.....

ICPI 5BKPI
 3AFPI 5BUPI
 3AZPI 5BVPI
 4EPI 5BVPIA
 4LPI 5SCLPI



Electronic Tubes Limited
 Kingsmead Works · High Wycombe · Bucks
 Telephone: High Wycombe 2020

Arcoelectric

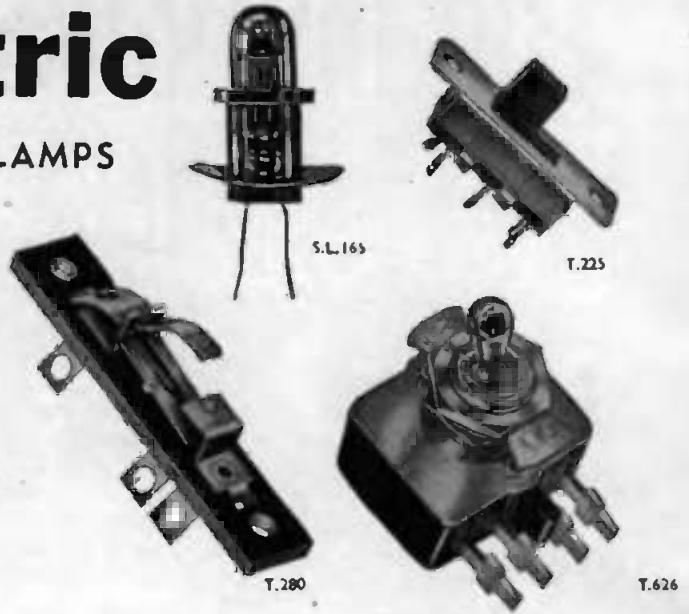
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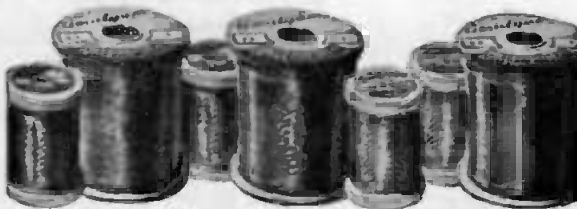
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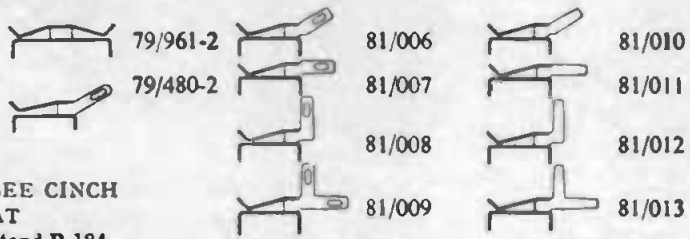
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SPECIFICATION

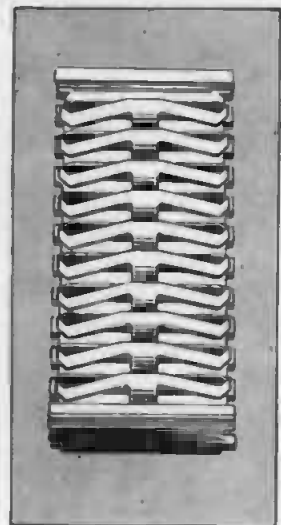
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Current rating: 5 Amps at 500 V.D.C. wkg.
Voltage proof: 2 K.V/D.C.
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Contacts: Phosphor Bronze, finished Gold plate on Silver, Silver or E.T.
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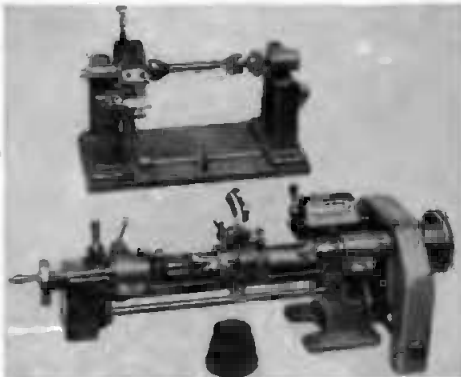
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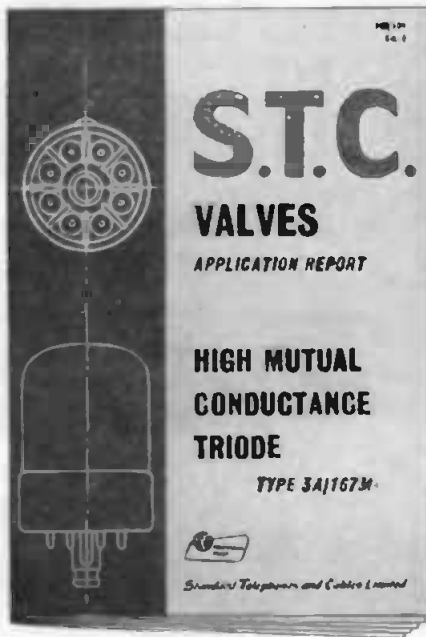
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Accuracy	0.1% of full scale reading on any range.
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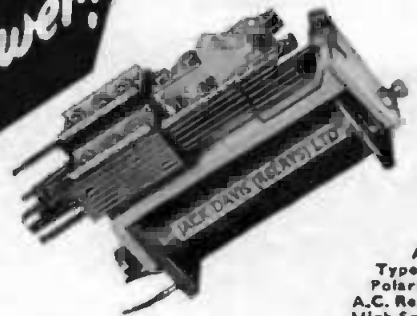
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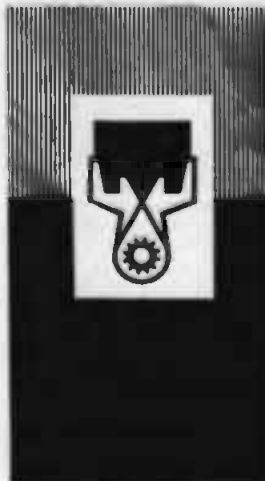
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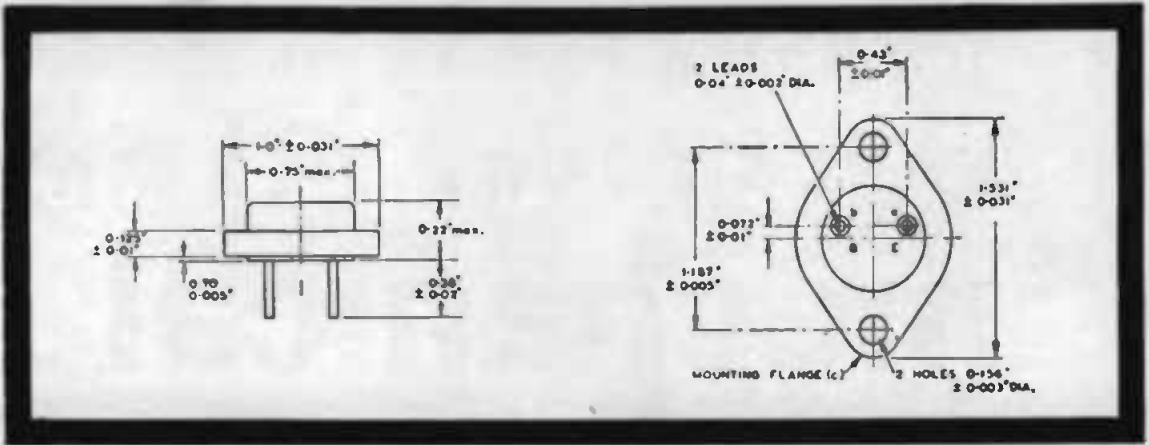
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Maximum Ratings (Absolute Values)	XC155	XC156	
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Peak collector to emitter voltage, base open circuit (volts).....	-50	-65	
Peak collector to emitter voltage, base and emitter joined or with an external base/emitter circuit resistance less than 40 ohms (volts).....	-65	-80	
Peak emitter to base voltage (volts).....	-60	-60	
Peak collector current (amps).....	-10	-10	
D.C. Collector current (amps).....	-5	-5	
Collector dissipation (mounting flange temperature 85°C) (watts).....	10	10	
Switching Characteristics (Common Emitter) (Typical production spreads)			
D.C. Current gain ($V_{ce} = -1.5V, I_c = -4A$).....	minimum	20	20
	average	26	26
	maximum	50	50
D.C. Collector to emitter saturation voltage ($I_c = -4A, d.c. I_b = -400 mA$) (volts).....	average	-0.4	-0.4
	maximum	-0.8	-0.8

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MARCH 1960

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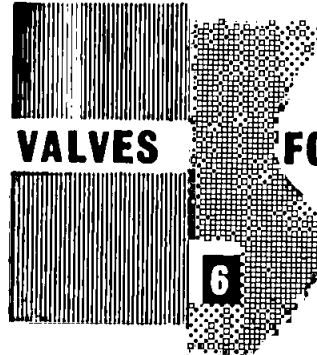
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FRAME GRID VALVES FOR TELEVISION



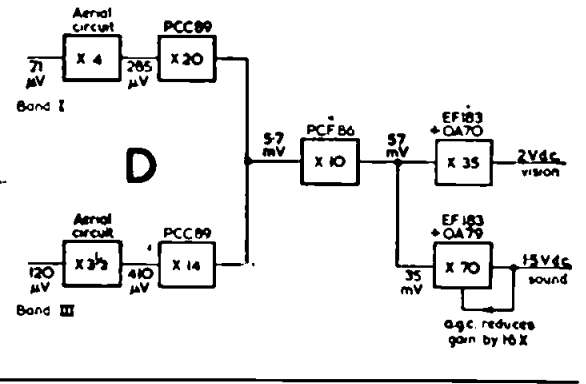
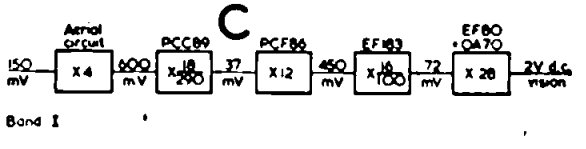
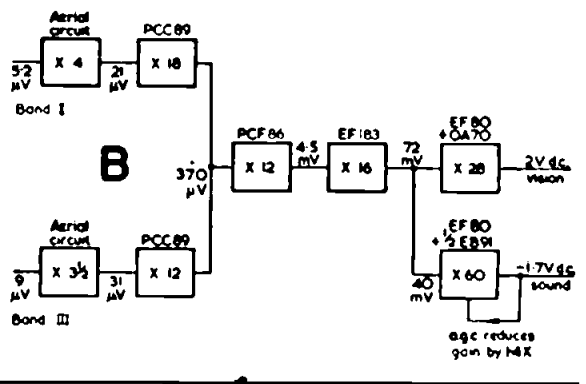
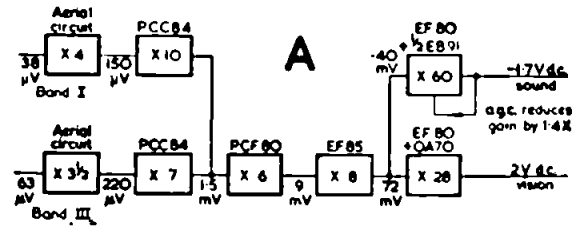
With a suitable valve line-up, receivers with two i.f. stages can be designed for various degrees of improved performance. Frame grid valves can be used throughout the tuner and i.f. stages, or some conventional valves can be retained, depending on the sensitivity required. Two classes of receiver satisfy 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 $20\mu\text{V}$ 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 $10\mu\text{V}$.

Signal levels in a conventional receiver are shown on line-up 'A'. The Band III sensitivity of $63\mu\text{V}$ falls short of the $10\mu\text{V}$ 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 $10\mu\text{V}$ 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.





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The proved reliability of the Brimar 'T' range of valves has been "built-in" as the result of experience gained from a programme of examination and testing. One of these tests is illustrated. Valves are placed in a rotor inside a chamber which is later evacuated. The rotor is then accelerated at high speed to simulate the effects experienced by super high speed aircraft flying at high altitudes. The information derived from this and other tests on valves for special applications is used to improve manufacturing techniques on commercial types: which makes Brimar the obvious choice when the demand is for a *reliable* valve.

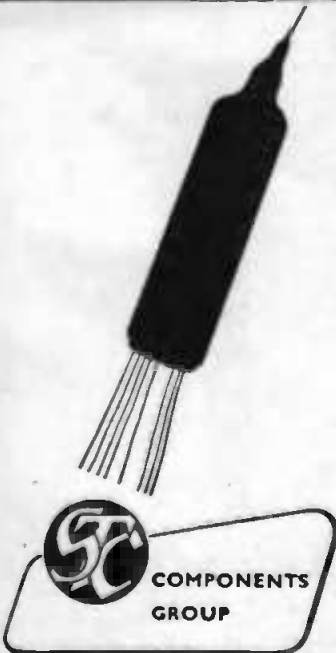
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"BELLING-LEE" NOTES

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.

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Voltage proofs: 1,400 V. d.c.

Cable Size:
Outside dia. 0.16 in.
Max. dia. over outer conductor $\frac{1}{8}$ 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
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Aspects of design

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).

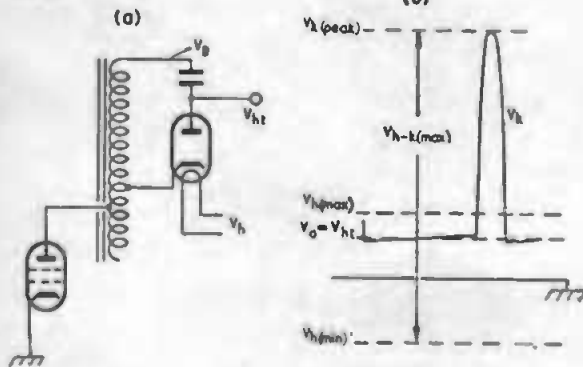
If the diode is connected to a separate winding the working conditions are different. The diode cathode is connected to the boosted HT potential and during the flyback interval the diode anode receives a high voltage negative pulse. During the scanning stroke the diode anode is at or near boosted HT 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
Max Anode Current (peak)	(mA)	600
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.

FIG. 1



20 EFFICIENCY DIODES FOR TV LINE OUTPUT STAGES

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.

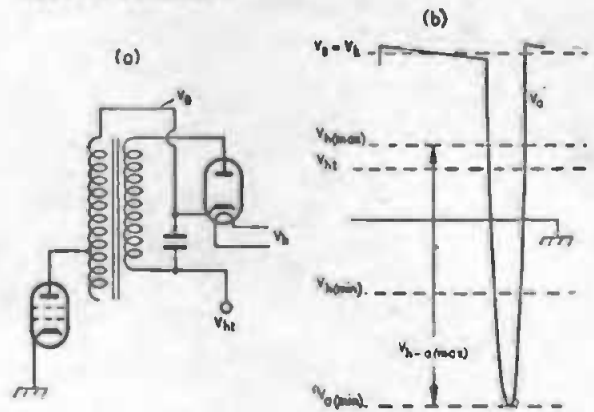
Next consider the voltage ratings. A Maximum Peak Inverse Voltage of 5.0 kV is quoted. This is a Design Centre Rating and refers to Maximum Peak Voltage between anode and cathode in the reverse direction. An Absolute Maximum figure is also given for this rating. This must not be exceeded even under the 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.



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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_b	0.1
Heater Voltage (volts)	V_b	26

Tentative Ratings and Characteristics MAXIMUM DESIGN CENTRE RATINGS

Anode Dissipation (either section) (watts)	$P_{a(max)}$	2.5
Total Anode Dissipation (watts)	$P_{(a+g)} max$	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)	$C_{g-b, h, s}$	3.0
Grid to Anode (each section)	C_{g-a}	1.5
Anode to Cathode, Heater and Shield (each section)	$C_{a-b, h, s}$	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

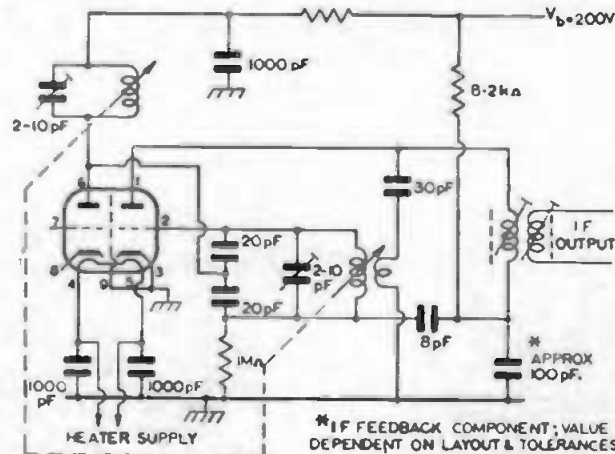
Supply Voltage (volts)	V_b	170	170
Anode Load (k Ω)	$R_{a'}$	1.5	1.3
Anode Voltage (volts)	$V_{a'}$	155	160
Anode Current (mA)	$I_{a'}$	8.7	6
Grid Bias Voltage (volts)	V_g	-1.4	-2
Mutual Conductance (mA/V)	g_m	6	4.7
Valve Anode Resistance ($\partial v_a / \partial i_a$) (k Ω)	$r_{a'}$	8.4	10.5
Equivalent Grid Noise Resistance (Ω)	R_{eq}	500	650

TYPICAL OPERATION AS SELF OSCILLATING MIXER

Supply Voltage (volts)	V_b	170	200
Anode Load (k Ω)	$R_{a'}$	4.7	8.2
Grid to Cathode Resistance* (M Ω)	$R_{g-a'}$	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 ($\partial v_a / \partial i_a$) (k Ω)	$r_{a'}$	16	15

* IF feedback voltage tends to stabilise oscillator performance and permits this relatively high grid leak.

Typical Circuit of 10L14 as Self-Oscillating Mixer

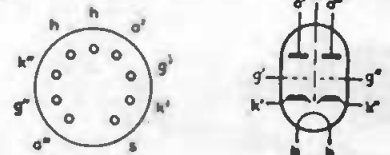


* IF FEEDBACK COMPONENT; VALUE DEPENDENT ON LAYOUT & TOLERANCES.



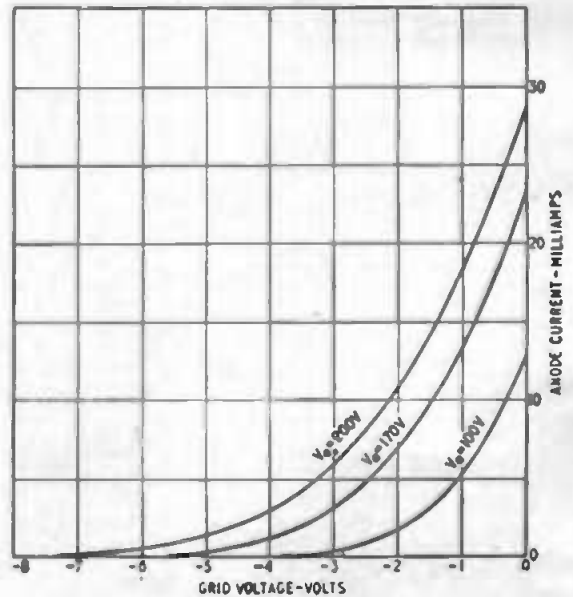
Note: It is recommended that the triode on pins 6, 7 and 8 should be used as the RF amplifier and that on pins 1, 2 and 3 as the self oscillating mixer.

BASE
B9A (NOVAL)



MAXIMUM DIMENSIONS (mm)
Overall Length 56
Seated Height 49
Diameter 22.2

Characteristic curves of Ediswan Mazda Valve Type 10L14 (each section)



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Temperature compensating range

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Working voltage: 500 V d.c. Diameter: 0.2 in. to 0.5 in. Thickness: 0.1 in. to 0.25 in.

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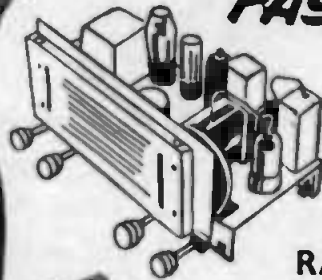
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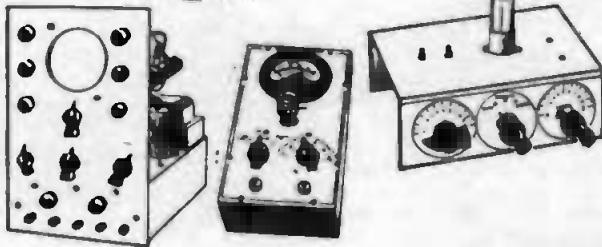
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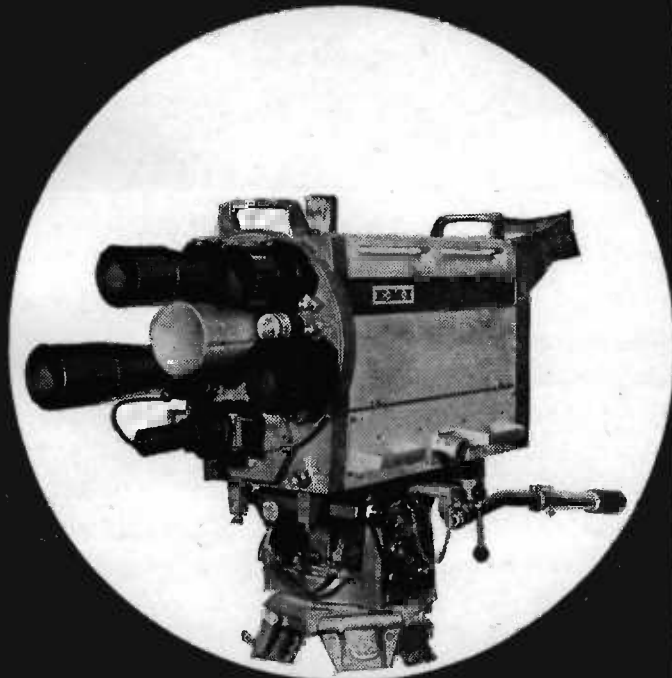
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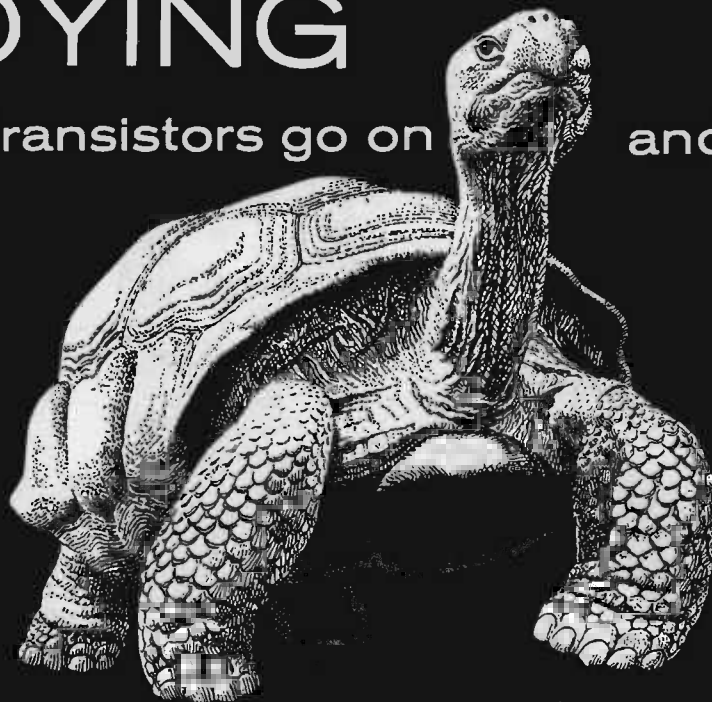
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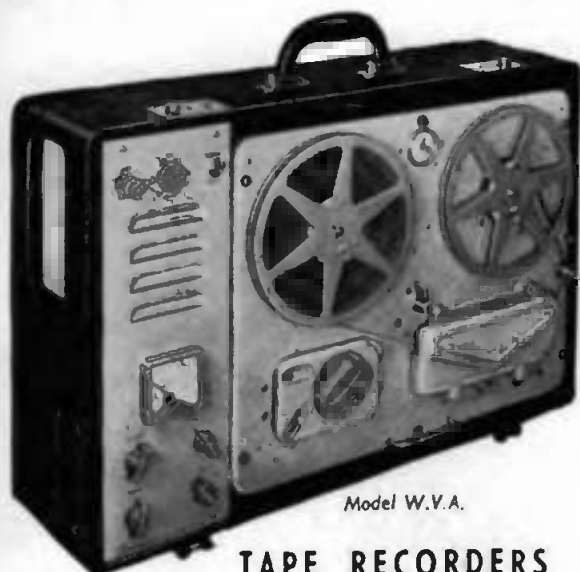
GET103 Failure Rate is only 0.06% in 1,000 hours!

5,000 GET103 transistors—random samples from regular production—have been submitted to electrical life test. Up to the end of 1959 only three catastrophic (inoperative) failures had occurred, indicating a failure rate of 0.06% per 1,000 hours. Some of these tests continue to run indefinitely, and we are thus building up life information for periods of many thousands of hours. Transistors can also show changes in electrical characteristics during life: gain and leakage currents are the parameters most likely to change, but the precise operating conditions determine the extent of the changes. Our life tests show that after an initial "settling-down" period, the subsequent rate of change in the characteristics of G.E.C. transistors is extremely small, indicating that they will continue functioning satisfactorily for tens of thousands of hours.

G.E.C.

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Tel: Stepping Hill 3811 or for London Area ring Temple Bar 8000, Ext. 10.



Model W.V.A.

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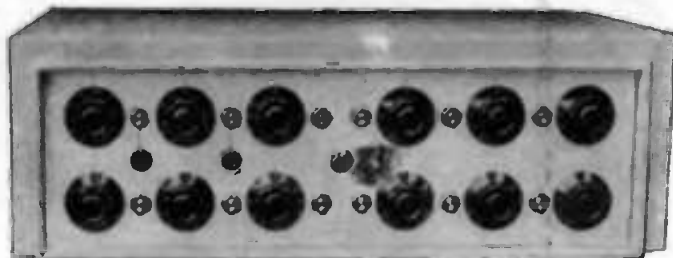
Gives 30 watts continuous signal and 50 watts peak Audio. With voice coil feedback distortion is under 0.1% and when arranged for tertiary feedback and 100 volt line it is under 0.15%. The hum and noise is better than -85 dB referred to 30 watt.

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

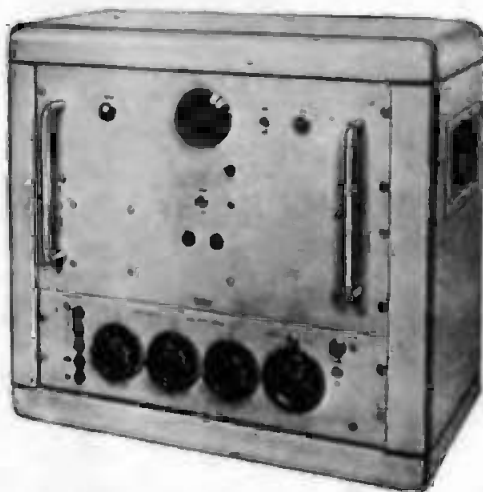
This is similar to the 4-channel, but is fitted with 12 hermetically sealed controls, 12 balanced line microphone transformers potted in mu-metal boxes, and a mains transformer also potted in mu-metal. All components which can affect noise are tested and selected before insertion. It is supplied in standard steel case or 7in. rack panel.



Vortexion

quality equipment

120/200 WATT AMPLIFIER



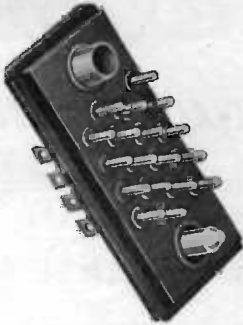
Will deliver 120 watts continuous signal and over 200 watts peak Audio. It is completely stable with any type of load and may be used to drive motors or other devices to over 120 watts at frequencies from 20,000 down to 30 cps in standard form or other frequencies to order. The distortion is less than 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.

Full details and prices of the above on request

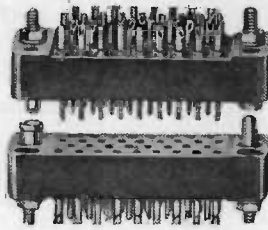
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Telephones: LIBerty 2814 and 6242-3

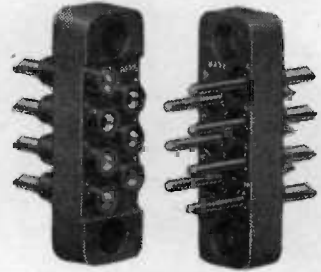
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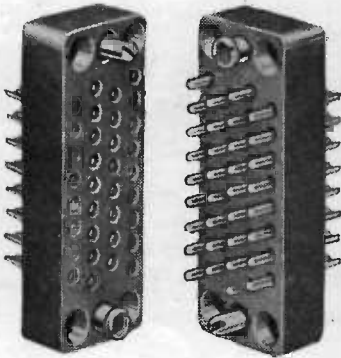
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POWER SERIES



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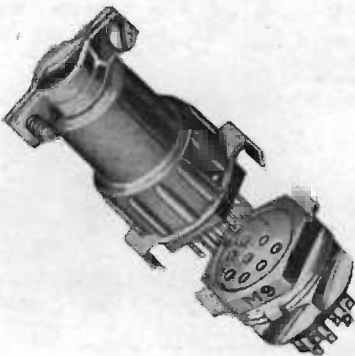


Electrical Connectors

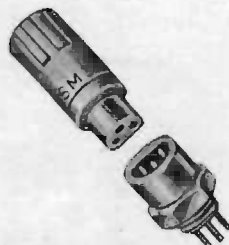
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- * Gold-plated Contacts



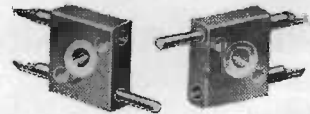
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Extract from Test Report by J. C. G. Gilbert reprinted from the Music Trades Review, also reprinted in our advertisement in the October issue of this magazine. The full two-page Test Report and an illustrated brochure on the amplifiers will be sent you on request.

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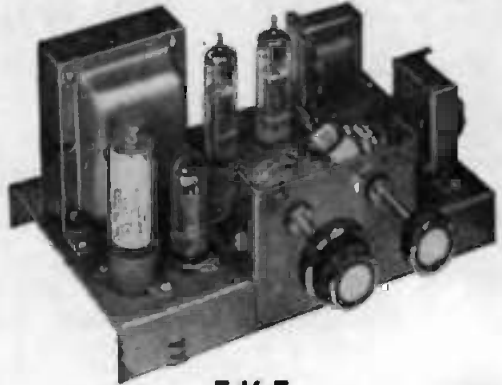
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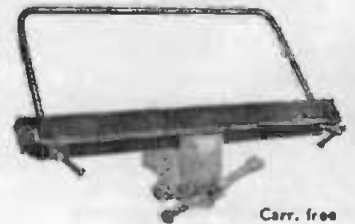
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W.D. Circuit Details

Diagrams and other information extracted from official manuals. All 1/6 per copy. 12 for 15/-.

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|---------------------|---------------------|
| A-1134 | R-100 |
| B-1345 | MRO Receiver |
| DC-317 | K89, A KCB |
| R-103A | R1114/A |
| DC-342 | EA-1B |
| EA-1B | A R80D |
| R-204 | AN/APA-1 |
| R-1155 | 79 |
| R-1124A | 74 |
| R-1124A/E-1481 | E.T.18 |
| R-1147 | CAY-46-AAM |
| R-1224A | PA DAK |
| R-1042 | A.R.B-3 |
| I-1255 | Indicator 40A |
| B.C.1204-A/B | Indicator A.R.B.3 |
| B-433-A (or 4B) | Indicator 42 |
| B-434-A (or 4B) | Indicator 6K |
| B-433-S-A (or 4B) | R.P. unit 24 |
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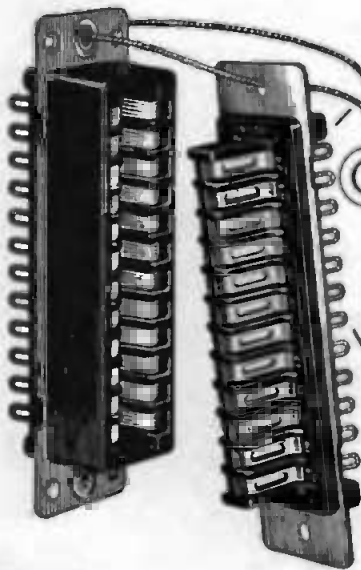
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024	6/-	4A75	6/6	6N7	6/-	12A17	6/-	35L6T	6/6	DAF95	6/-	8C93	12/6	8P93	12/6	KT41	22/6	PK86	7/6	U33	9/6	UL46	8/6
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1A7OT11	6/6	4A95	12/6	6P28	20/6	12A27	7/6	35Z3	10/6	DD45	15/-	8C932	16/6	8K93	6/6	KT43	18/-	PK88	7/6	U35	9/6	UL48	8/6
108	12/6	6A00	6/6	6Q70	6/-	12A29	12/6	35Z4	6/6	DD70	15/-	8C933	16/6	8L93	12/6	KT43	7/-	PK89	7/6	U36	9/6	UL49	8/6
1D6	9/-	6A05	7/6	6B70	10/-	12A37	6/-	35Z5OT	6/-	DD81	6/-	8C934	24/6	8L94	10/-	KT44	18/-	PK90	12/6	U37	9/6	UL50	8/6
1D8	10/6	6A08	7/6	6B70T	8/6	12A38	6/-	48	12/6	DD82	6/-	8C935	24/6	8L95	10/6	KT45	18/-	PK91	12/6	U38	9/6	UL51	8/6
1H8OT	11/-	6B04	20/6	6B70T	8/6	12A39	10/-	48	12/6	DD83	6/-	8C936	24/6	8L96	10/6	KT46	18/-	PK92	12/6	U39	9/6	UL52	8/6
1L4	6/-	6B10	6/-	6B70T	6/6	12B17	11/6	6CD60	6/6	DD83	6/-	8C937	24/6	8L97	10/6	KT47	18/-	PK93	12/6	U40	9/6	UL53	8/6
1LD8	6/-	6B20	7/6	6B70T	6/6	12B70T	10/6	6L40T	6/6	DD87	6/6	8C938	24/6	8L98	10/6	KT48	18/-	PK94	12/6	U41	9/6	UL54	8/6
1LN8	6/-	6B24	15/-	6U4T	12/6	12B70T	10/6	6L40T	6/6	DD87	6/6	8C939	24/6	8L99	10/6	KT49	18/-	PK95	12/6	U42	9/6	UL55	8/6
1NSOT	11/-	6B27	22/6	6U30	7/6	12B70T	6/6	35KU	19/11	DK40	8/6	8C940	24/6	8L100	10/6	KT50	18/-	PK96	12/6	U43	9/6	UL56	8/6
1B5	7/6	6B30	10/6	6V60	7/6	12B80T	6/6	75	6/6	DK81	7/6	8C941	24/6	8L101	10/6	KT51	18/-	PK97	12/6	U44	9/6	UL57	8/6
1B4	9/-	6B37	7/6	6V60T	6/6	12B80T	6/6	75	6/6	DK82	10/6	8C942	24/6	8L102	10/6	KT52	18/-	PK98	12/6	U45	9/6	UL58	8/6
1B5	7/6	6B38	7/6	6X4	6/6	12B87	6/6	80	6/6	DK94	6/-	8C943	24/6	8L103	10/6	KT53	18/-	PK99	12/6	U46	9/6	UL59	8/6
1B7	9/-	6B40	7/6	6X4	6/6	12B87	6/6	80	6/6	DK94	6/-	8C944	24/6	8L104	10/6	KT54	18/-	PK100	12/6	U47	9/6	UL60	8/6
1T4	6/-	6C4	7/6	6X8OT	6/6	12B87	6/6	81	15/6	DL44	15/-	8C945	24/6	8L105	10/6	KT55	18/-	PK101	12/6	U48	9/6	UL61	8/6
1U4	10/6	6C40	6/6	6X91.3	10/6	12B97	10/6	81	15/6	DL44	15/-	8C946	24/6	8L106	10/6	KT56	18/-	PK102	12/6	U49	9/6	UL62	8/6
1U6	10/6	6C40A	20/6	7D4	21/6	1487	27/10	8A5	10/-	DL82	7/6	8C947	24/6	8L107	10/6	KT57	18/-	PK103	12/6	U50	9/6	UL63	8/6
1X3	10/6	6C48	15/6	7B7	6/6	15A95	10/6	160B3	10/6	DL84	7/6	8C948	24/6	8L108	10/6	KT58	18/-	PK104	12/6	U51	9/6	UL64	8/6
1A4	7/6	6B5	12/6	7D2	6/6	15B09	10/6	445T	33/6	DL86	6/-	8C949	24/6	8L109	10/6	KT59	18/-	PK105	12/6	U52	9/6	UL65	8/6
1A8	10/6	4P1	20/6	7C8	6/6	20D1	12/6	180RTA33.8	DL810	10/6	12/11	8C950	24/6	8L110	10/6	KT60	18/-	PK106	12/6	U53	9/6	UL66	8/6
1B7	10/6	4P60	7/6	7HT	6/6	20D1	24/6	607	7/6	DM70	7/6	8C951	24/6	8L111	10/6	KT61	18/-	PK107	12/6	U54	9/6	UL67	8/6
1D6	9/-	6P12	6/6	7B7	10/6	20L1	26/6	4033L	18/6	EA30	6/6	8C952	24/6	8L112	10/6	KT62	18/-	PK108	12/6	U55	9/6	UL68	8/6
1Q4	7/6	6P13	11/6	7Y4	6/6	20P1	26/6	4033L	18/6	EA30	6/6	8C953	24/6	8L113	10/6	KT63	18/-	PK109	12/6	U56	9/6	UL69	8/6
1Q8OT	7/6	6P22	10/6	8D2	6/6	20P1	23/6	ACHPAN	7/6	EAD30	6/6	8C954	24/6	8L114	10/6	KT64	18/-	PK110	12/6	U57	9/6	UL70	8/6
1B4	7/6	6P23	7/6	9H94	12/6	20P1	22/6	ATP4	6/-	KAC81	7/6	8C955	24/6	8L115	10/6	KT65	18/-	PK111	12/6	U58	9/6	UL71	8/6
1V4	7/6	6P5	6/6	10C1	12/6	25A43	11/6	AZ51	10/6	KAP13	6/6	8C956	24/6	8L116	10/6	KT66	18/-	PK112	12/6	U59	9/6	UL72	8/6
6B40Y	17/6	6H0T	1/6	10C1	20/6	25L40T10	11/6	AZ11	13/11	KB11	2/6	8C957	24/6	8L117	10/6	KT67	18/-	PK113	12/6	U60	9/6	UL73	8/6
6U40	6/6	6H0	6/6	10P1	17/6	25L40	6/6	K36	24/6	KB11	6/6	8C958	24/6	8L118	10/6	KT68	18/-	PK114	12/6	U61	9/6	UL74	8/6
6Y40	11/6	6H6	6/6	10P3	10/6	26Z3	10/6	H143	7/6	EBP1	5/6	8C959	24/6	8L119	10/6	KT69	18/-	PK115	12/6	U62	9/6	UL75	8/6
6Y30	6/6	6H70	6/6	10L20	6/6	25Z50	10/6	CHL51	22/6	EBG33	7/6	8C960	24/6	8L120	10/6	KT70	18/-	PK116	12/6	U63	9/6	UL76	8/6
8Z3	12/6	6H0T	6/6	10L11	6/6	27U	10/6	CHL52	22/6	EBG41	6/6	8C961	24/6	8L121	10/6	KT71	18/-	PK117	12/6	U64	9/6	UL77	8/6
8Z40	10/6	6H70	6/6	10L13	6/6	2817	10/6	CHL53	10/6	EBG51	3/6	8C962	24/6	8L122	10/6	KT72	18/-	PK118	12/6	U65	9/6	UL78	8/6
6A8	10/6	6K00	6/6	10F13	15/6	30C1	6/6	CV63	10/6	EBP90	10/6	8C963	24/6	8L123	10/6	KT73	18/-	PK119	12/6	U66	9/6	UL79	8/6
6A8A	10/6	6K23	10/11	10F14	10/6	30F8	7/6	CV1	10/6	EBP93	10/6	8C964	24/6	8L124	10/6	KT74	18/-	PK120	12/6	U67	9/6	UL80	8/6
6A7	6/6	6L1	22/6	12A4	6/6	30PL1	10/6	CV31	10/6	EBP99	3/6	8C965	24/6	8L125	10/6	KT75	18/-	PK121	12/6	U68	9/6	UL81	8/6
6A09	6/6	6L60	6/6	12A4M	12/6	30L1	6/6	D1	3/6	EHL21	23/6	8C966	24/6	8L126	10/6	KT76	18/-	PK122	12/6	U69	9/6	UL82	8/6
6A8A	6/6	6L70T	10/6	12A15	17/6	30T12	6/6	D15	10/6	EHL21	23/6	8C967	24/6	8L127	10/6	KT77	18/-	PK123	12/6	U70	9/6	UL83	8/6
6A1A	6/6	6L10	12/6	12A15	13/11	30T10	6/6	D43	17/6	EB92	5/6	8C968	24/6	8L128	10/6	KT78	18/-	PK124	12/6	U71	9/6	UL84	8/6

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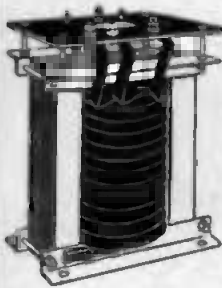
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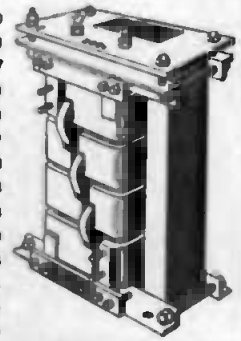
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5 V 300 A	£20
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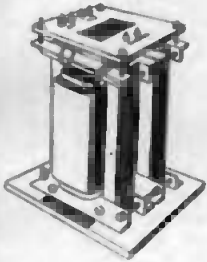
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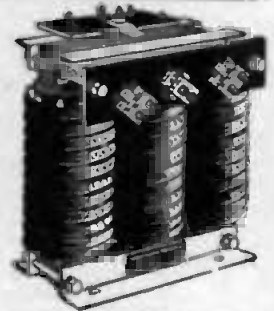
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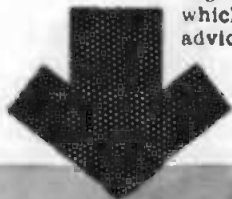
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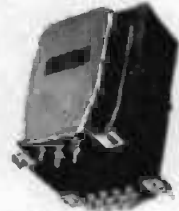
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3A4	0/0	6P27	0/0	30P4	10/0	EB231	0/0	RA20	0/0	U20	0/0
2Q4	7/6	90T0	9/9	30L12	0/0	EB279	0/0	HL1DD	0/0	U33	0/0
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6B9G	2/6	708	7/6	826	0/0	EB298	10/0	PC080	10/0	U2CH1	0/0
6BA5	0/0	787	7/6	865	4/6	EB299	0/0	PC080	7/6	U2CL2	11/0
6BE6	0/0	827	0/0	CB131	2/6	EB300	0/0	PC092	0/0	U2CL3	11/0
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6C6	0/0	10P9	10/6	DAP91	0/0	EB305	7/6	PEN48	7/6	U2F95	14/0
6C8	0/0	10L13	0/0	DAP93	0/0	EB306	11/6	PER46	0/0	U2V99	7/6
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6D4	0/0	12A76	7/6	DP92	0/0	EB309	4/6	PL36	14/0	U2L46	0/0
6P1	0/0	12A77	0/0	DB77	7/6	EB310	4/6	PL81	10/6	U2L46	0/0
6P6G	0/0	12A17	0/0	DK29	10/6	EB311	0/0	PL82	7/6	U2M20	0/0
6P13	0/0	12AX7	7/6	DK91	4/6	EB312	11/6	PL43	0/0	U2U4	10/0
6P14	0/0	12J30T	2/0	DK92	0/0	EB313	11/6	PL44	11/-	U2U7	0/0
6P15	0/0	13K70T	0/0	DK96	2/6	EB314	11/6	PTB1	0/0	U2Y11	10/0
6H8	0/0	12K80T	0/0	DL33	0/0	EB315	0/0	PV22	11/-	U2Y41	0/0
6J50	0/0	12Q70T	0/0	DL34	11/6	EB316	0/0	PY60	7/6	U2Y83	0/0
6J50T	0/0	12R47	0/0	DL91	0/0	EB317	0/0	PY61	7/6	U2Y80	0/0
6J6	0/0	12S70T	0/0	DL98	0/0	EB318	4/6	PY92	7/6	X43	11/-
6J70	0/0	14P7	14/0	DL94	7/6	EB319	0/0	PY93	0/0	X46	11/-
6J70T	7/6	18B00	10/0	DL96	0/0	EB320	0/0	PZ39	10/-	X78	14/0
6K6GT	0/0	3BD1	0/0	EA46	0/0	EB321	0/0	K19	10/0	X79	14/0
6K70	0/0	30L1	0/0	EAC90	7/6	EB322	0/0	K241	0/0	Y63	0/0
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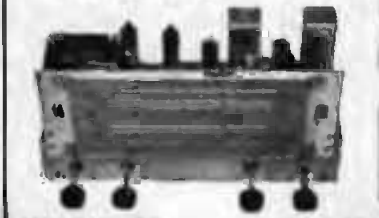
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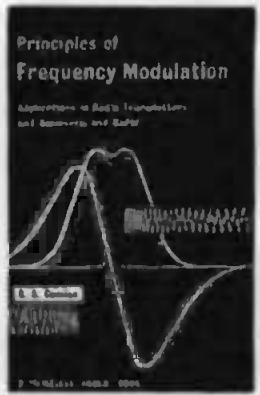
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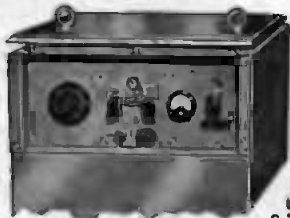
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ROTARY CONVERTERS. 12 v. D.C. input. 230 volts A.C. 150 watts, 50 cycles output. Housed in wooden case and fitted with voltage control slider resistance, switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition, individually tested, **£9/19/6** each. P. & P. 10/-.

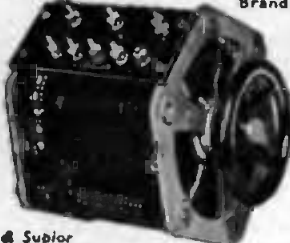
BRILLIANT CONDITION EX-GOVT WAVEMETERS

Type 4373 Tropicalised. Ref. 107/54d. Continuously variable via slow motion drive. 150 to 250 mc/s. Clearly graduated dial for at-a-glance readings. (INCORPORATING) 1 mA meter, with 6.3V/80A valve. Supplied complete with spare valve and co-axial lead. **ONLY £3-19-6** Carr 10/-



VARIAC TRANSFORMERS

Brand New



4 Superior OUTPUT (2KVA) Completely Variable 0 to 270 volts. 9 amps. INPUT 230 Volts, 50/60~ A SHROUDED FULLY VARIABLE TRANSFORMER FOR BENCH OR PANEL MOUNTING. SIZE—Approximately 8½ inches Cube. WEIGHT—Approximately 30 lb. PRICE: RIDICULOUS, **ONLY £15.0.0** Plus 12/6 carr., supplied and boxed new.

CONSTANT VOLTAGE TRANSFORMERS FERRANTI 7½-KVA MOVING COIL. Stabilised output voltage in the range 200-250 v. Plug-board tappings. The selected output voltage is constant with ±1% at all loads 0 to 30/37½ amps when the supply voltage is varying over the range +8% to -12%.
● Frequency compensated 45-55 and 50-66 c/s.
● Excellent output waveform.
● Can be used as a variable transformer.
● Used. Complete with spare and instruction book at a fraction of the normal cost, only **£65.**
● A.C. Mains Stabiliser.



AUTO TRANSFORMERS

3 KVA Air Cooled (100% under-rated) GUARANTEED 230/250 tapped, 12 amps. 0 KVA 105/120 tapped, 28.5 amps. Made by well-known manufacturer and housed in strong metal case. Weight: 2 cwt. Brand new, in original maker's case. PRICE **£15.0.0** Carr. 25/-

U.S.A. R-9A7E-4 Radio Receivers

First class for comparison, originally designed for R.D.P. Valve: 1-6B7GT 4-6B7GT, 1-6A7 OT, 1-VR100-5B, 1-5U4G, 1-6X6-OT, 1-6B17GT, 3-6B4G, 2-67919-2, 1-6B7GT. Chassis size 20 x 9 x 11in. Weight 26lb. Brand new. Components valve (transformers, condensers, resistors, etc.) for exceeds this remarkable low price. Buy now. Only 150 sets available. **85/-** P. & P. 12/6



ONE MILLION YARDS!! SCREENED WIRE FLEX

For Immediate Delivery—priced for mass cost. Specifications: Class braided 14/204in. Covered 074 p.v.c. Tinned Copper Screened. American colours. Applications: Microphone leads pick-up leads etc. BRAND NEW—ON MAKER'S REELS. Minimum Order: 250 yds REEL 55/- (8d. per yd.). P. & P. 8/- TEN REELS £25 Carr. Paid.



TRUVOX LOUD HAILERS

COMPLETE WITH POWER MICROPHONE



For public address from cars, boats, etc., similar to Police Type ex-H.M. Forces. Simply connect to a 6/12-volt. car battery and use. Amazingly powerful. Why pay £2 a day hire charge for amplifiers. Buy this complete unit. **only £7.14.6**

by return. TWIN SPEAKER UNIT COMPLETE **£10/14/6.**

EX-GOVT. PUBLIC ADDRESS SYSTEM Complete with amplifier unit, 4 speakers, microphone, headphones and all spares packed in wooden cases. 6 or 12 volt D.C. handling capacity 8 watts. Ideal for cars, boats, factories, etc. **£15.15.0** Carr. 30/-

AERIAL MASTS

IMPROVED TYPE 50 MK II 36 ft. HIGH

Kit comprises—4 2½in. dia Tubular Steel Sections of 6ft length, top-section and base. Pick-up, Guys and Fittings. YOU can purchase this normally expensive MAST for a fraction of its cost. Please add £1 for (returnable) wooden carrying case. The MAST is particularly suitable to take service for T.E., F.M. and T.V. (especially COMMERCIAL) and has many other uses. Extra 6ft. sections can be supplied at 27/6 per section. **£8.10.0** only Carr. 15/6

U.S.A. Type 45ft. TELECOM. AERIAL MAST. (7 sections, 6ft. 8in. x 2½in. guys, etc.). This entirely complete set in carrying case 12½ Gns. Carr. 17/6. Or 2 sets for £25. Carr. extra. British Manufacture only. ARMY TYPE 32ft. MASTS similar to above but 10 in. screw-sections, suitable for permanent lightweight installation. Kit in canvas bag. **£5/10/-**. Carriage 12/6.

VERY SPECIAL OFFER—EXPORT ONLY

Just released by the Ministry of Supply. "80" SETS. Manufactured by E. K. Cole, Walkie Talkie and A.F.V.—3,000 available. "22" SETS ALSO—500 only. TELEPRINTERS—120 Creed 78 for immediate disposal. Enquiries are invited for Bulk supply at reducing low prices.

MICRO SWITCHES

BURGESS BRAND NEW MINISTRY RELEASE (NO. 4 BR. METAL BODY UNIVERSAL CONTACT) A.M. Ed. 60 6000 Compare this remarkable almost half-price offer. **78/-** per Doz. (min. quantity) **£25** per 100



THE IRONGATE (M.O.) CO.

2/4 IRONGATE WHARF ROAD, PRAED STREET, LONDON, W.2

Dept. (WW5)

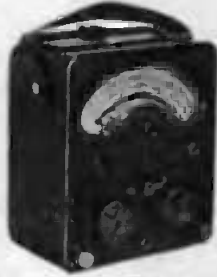
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G.W. SMITH & CO. (RADIO) LIMITED

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



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	10K, 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, un-filled, 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. Bin, 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, £8/10/- 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 new, 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. 2 1/2 in.	69 6
25 microamp D.C. M/C. post. rd. 2 1/2 in.	59 6
500 microamp D.C. M/C. flush rd. 2 1/2 in.	79 6
50 microamp D.C. M/C. post. rd. 2 1/2 in.	49 6
100 microamp D.C. M/C. flush rd. 2 1/2 in.	62 6
500, 1,000 microamp D.C. M/C. post. rd. 2 1/2 in.	19 6
1 milliamper D.C. M/C. flush rd. 2 1/2 in.	92 6
1 milliamper D.C. M/C. flush rd. 2 1/2 in.	26 6
1 milliamper D.C. M/C. flush rd. 2 1/2 in.	50 6
1 milliamper D.C. M/C. flush rd. 2 1/2 in.	69 6
200 milliamper D.C. M/C. flush rd. 2 1/2 in.	9 6
30 amp D.C. M/C. flush rd. 2 1/2 in.	4 6
15 volt D.C. M/C. flush rd. 2 1/2 in.	10 6
150 volt D.C. M/C. flush rd. 2 1/2 in.	32 6
300 volt A.C. M/C. flush rd. 2 1/2 in.	95 6
300 volt A.C. M/C. flush rd. 2 1/2 in.	25 6
300 volt A.C. M/C. flush rd. 2 1/2 in.	25 6

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 VOLT-METERS. 5 ranges A.C. and D.C. I.S. 5, 15, 50 and 150 volts. Operation 200/250 volts A.C. Supplied brand new complete with internal HF probe. £19/10/- 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 mid.; 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/-.

FURZELL 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 "O" 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 LT. 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, 6.3 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

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





UNREPEATABLE OFFER
 DUE TO LARGE PURCHASE
 FROM GOVERNMENT
COSSOR 339
 DOUBLE BEAM
 OSCILLOSCOPES
 PERFECT WORKING CONDITION
ONLY £15 EACH
 Carriage 10/- extra.

**PORTABLE PRECISION
 VOLTIMETERS**

Brand new and boxed instruments by famous manufacturer. Housed in polished teak case. Moving iron movement reading A.C. or D.C. volts on 2 ranges. 0-160 v. and 0-320 v. Bin. mirror scale. Accuracy within 2%. Supplied at a fraction of original cost. Only £5/19/6 each. P/P. 3/6.



MARCONI TYPE TF-340 OUTPUT POWER METERS. Meter calibration 50 MW/17DB F.S.D. Meter multipliers. 0.1-10-100 Impedance values. 25-30-40-50-60-80-100-125-150-200 ohms. Impedance multipliers. 0.1-1-10-100. Perfect condition. £9/19/6 each. 7/6 carriage.

CRYSTAL CALIBRATORS NO. 10. Range 500 Kc/s. to 30 Mc/s. Compact size 7 x 7 1/2 x 4 in. Utilise 2-IT4, 1R5 and CV286 valves and 500 Kc/s crystal. Supplied in perfect condition with instructional handbook. 59/6 each. P/P. 3/6.

12 VOLT ROTARY CONVERTERS. Input 12 volt D.C. Output 230 volt A.C. 150 watts, 50 cycles. Housed in wooden case and fitted with voltage control slider resistance switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition fully tested. £9/19/6 each P/P 10/-

SURPLUS HEADPHONES. R.C.A. chamois padded, moving coil, fitted jack plug, 19/6 pr. P/P. 1/6. AMERICAN HS.30 super light weight, 50 ohms. 15/- pr. P/P. 1/6. 4,000 ohms light duty, 12/6. P/P. 1/6.

MARCONI TF848 UNIVERSAL IMPEDANCE BRIDGES. Ranges 1p-100 mfd. 1uh-1h. 1Ω-10 megohm, 200-250 v. A.C. Perfect as new £45 each.

MARCONI TF410c VIDEO OSCILLATORS. Ranges 20 c/s.-30,000 c/s., 30 Kc/s.-5 Mc/s. Variable attenuator 200/250 v. A.C. £35/0/0.

DON MK. V FIELD TELEPHONES. Ideal for all inter-communication. Buzzer calling. Supplied fully tested complete with batteries and instructions. 39/6 each. P/P. 3/6 each.

PARMEKO TRANSFORMER. Input 230 volts Output 350/0/350 volts 150 m/a. 6.3 volts 3.5 amp 5 volts 4 amp. New, boxed. 32/6 each. P/P. 2/6.

AVO POWER PACKS. 230 volts input. Output 675 volts, 6 m/a and 1.5 volts 250 m/a. Fully smoothed. New boxed 19/6 each. P/P. 2/6.

PARMEKO TABLE TOP TRANSFORMERS. Input 230 volts. Output 620/550/375/0/375/550/620 volts 250 m/a. Also 2-5 volt 3 amp. windings. Size 6 1/2 x 6 1/2 x 5 1/2 in. New, boxed at 45/- each. P/P. 5/6.

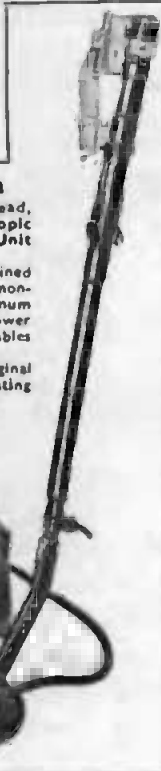
PHOTO VOLTAGE AMPLIFIERS. These special instruments incorporate a 1 microamp mirror galvanometer and a double selenium photo-electric cell. Housed in aluminium case complete with 12 volt lamp and housing. Brand new. £9/19/6 each. P/P. 7/6.

FIELD TELEPHONES TYPE L. Generator bell ringing, light and very portable. Supplied complete with batteries. Fully tested. As new, 59/6 each P/P 3/-.

24 VOLT ROTARY CONVERTERS. Input 24 volt D.C. Output 230 volts A.C. 50 cycles, 100 watts. Housed in metal case with inlet/outlet plugs. Brand new. 92/6 each. P/P. 7/6.

POST OFFICE JUMPER LEADS. 4ft., fitted with two str. jack plugs, 3/- each. P/P. 9d. Standard jack sockets 9d. each.

VORTEXION PORTABLE AMPLIFIERS Operation from 200/250 volts A.C. or 12 volts D.C. Separate inputs for microphone or gram. Push-pull 10 watt; output matched to 7.5 Ω, 250 or 500 ohms. Incorporate volume control and full switch tone control. Not brand new but good working order, 10 guineas each. P/P. 6/-.



MARCONI TF-517 SIGNAL GENERATORS. 10-18 Mc/s., 33-58 Mc/s.; 150-300 Mc/s. 200/250 volts operation, 65/- each for callers only.

MINE DETECTORS No 4a
 Complete equipment comprises Search Head, Amplifier Headset, Control Box, Telescopic Rods for Search Head, Search Head Test Unit and Test Depth Measure and Heaversack. Operation is from a standard 60 v./1.5 v. combined dry battery. The unit will detect ferrous or non-ferrous metals to a depth of 24in. giving maximum signal but can be used at greater depths giving lower output. Ideal for tracing underground pipes or cables and any hidden metallic objects. Complete equipment supplied brand new in original transit cases complete with circuit and operating instructions.

6 VOLT VIBRATOR PACKS. Output 120 volts 30 m/a. Fully smoothed. New, boxed 12/6 each. P/P. 2/-.

SOUND POWERED TELEPHONE HANDSETS. No batteries required to use. Ideal for inter-com. New boxed 15/- each. P/P. 1/6.

BATTERY CHARGING OR MODEL RECTIFIERS AND TRANSFORMERS. Rectifiers. All full wave and bridged, 12/18 volt 1.5 amp., 4/3; 12/18 volt 2.5 amp. 6/9; 12/18 volt 4 amp. 9/9; 12/18 volt 6 amp. 18/6; 24/30 volt 1 amp. 12/6; 24/30 volt 4 amp. 22/6; 24/30 volt 15 amp. 62/6. Transformers. All primaries tapped 200/250 volts. 3.5, 9 or 17 volt 1 amp. 9/9; 3.5, 9 or 17 volt 2 amp. 14/3; 3.5 9 or 17 volt 4 amp. 16/6; 9 or 17 volt 6 amp. 26/-; 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volt 2 amp. 18/6. Please add postage.

POTTED TRANSFORMER. Primary 230 volts. Secondary 350/310/0/310/350 volts. 220 m/a. 6.3 volts 13 amp., 5 volts 3 amps. 49/6 each. P/P. 3/6.

EDDYSTONE MAINS POWER PACKS. 200/250 volts input. Output 175 volts 60 m/a. and 12 volts 2.5 amp. Double choke and condenser smoothed, 524 rectifier. Supplied new and unused only 22/6 each. P/P. 3/6.

HOOVER ROTARY TRANSFORMERS. Miniature type, 12 volt D.C. input. Output 310 volts 30 m/a. New boxed 12/6 each. P/P. 1/3.

ROTARY TRANSFORMERS. Two models either 6 or 12 volt input D.C. Output 250 volts 80 m/a. 22/6 each. P/P. 2/6.

SPECIAL OFFER OF P.V.C. RECORDING TAPE. Brand new, boxed on 7in. universal spools 600ft. std., 12/-; 1,200ft. std. 19/6; 1,800ft. long play, 30/- P/P. 1/-

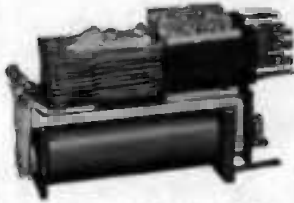
PRICE
99/6 EACH
 Carriage 10/6.



BRAND NEW R.C.A. EXTENSION LOUDSPEAKERS
 Bin., 3 ohm Quality Speaker mounted in attractive black crackle case to match AR88 Receivers, etc.
 45/- each. P/P. 3/6.

DEPENDABLE RADIO SUPPLIES LTD.

12a TOTTENHAM STREET, LONDON, W.1.
(2 minutes Goodge Street Station Opp. Heals in Tottenham Court Road)
Phone LANgham 7391/2. Hours of Business 9-6.
Callers welcome. Terms: Cash with order or C.O.D.



POST OFFICE RELAYS TYPE 3,000

BUILT UP TO YOUR REQUIREMENTS
Type 600 also available

COMPONENT PARTS ALL PLATED

- | | | |
|-----------------------|---------------------------------|--|
| Yokes, 2/- each. | Top Plates, 3d. each. | Fixing Screws (with insulators), 2d. each. |
| Armatures, 9d. each. | Bottom Plates, 3d. each. | Buffer Blocks, 6d. |
| Adjustable, 1/3 each. | Armatures adjustable, 4d. each. | Screws each. |
| Spindles, 1/- each. | | |

BUILD UPS CONTACTS

- | | | | |
|--------|--------|----------|----------------|
| | Silver | Platinum | |
| 1. C/O | 1/3 | 4/- | Up to 100 Ohms |
| 2. C/O | 2/6 | 8/- | " " 500 " |
| 3. C/O | 3/6 | 12/- | " " 1,000 " |
| 4. C/O | 4/6 | 16/- | " " 5,000 " |
| 6. C/O | 6/6 | 24/- | " " 10,000 " |
| 8. C/O | 8/6 | 32/- | " " 20,000 " |
| | | | " " 40,000 " |
| | | | " " 80,000 " |
- Other build ups to order; all types of relays built to your specification.

COIL VALUES

- | | | |
|------|--------|------|
| | Single | Twin |
| 3/- | 4/- | 5/- |
| 6/- | 7/- | 8/6 |
| 14/- | 17/6 | 20/- |
| 28/- | | |
- *Slugged coils extra.

SIEMENS HIGH SPEED C/O RELAYS

- | | | | |
|--------------------------|-----|------------------------------|------|
| 250 + 250 ohm Twin Coils | 6/6 | 1,000 + 1,000 ohm Twin Coils | 10/6 |
| 850 + 850 " | 8/6 | 1,700 + 1,700 " | 17/6 |

G.E.C. MINIATURE SEALED RELAYS

No.	Ohms.	Build Ups	Voltage	Price
Z.530002	180	4C	12	£1 2 6
Z.530005	2	2C	1.3	12 6
Z.530006	40	2C	6	15 0
Z.530008	670	2C	24	19 6
Z.530010	40	2C 2K	6	17 6
Z.530011	180	2C 2K	12	£1 2 6
Z.530014	2	1C	1.3	10 6
Z.530015	40	1C	6	12 6
Z.530016	180	1C	12	19 6
Z.530018	2,500	1C	48	£1 2 6
Z.530019	2	2C 2K	1.3	14 6
Z.530020	2	4C	1.3	14 6
Z.530022	2	M.B.	1.3	12 6
Z.530023	2	2B 2M	1.3	12 6
Z.530024	40	2M	6	12 6
Z.530025	40	M.B.	6	12 6
Z.530027	180	2M	12	17 6
Z.530028	180	M.B.	12	17 6
Z.530031	670	M.B.	24	17 6

S.T.C. MINIATURE SEALED RELAY

- | | | | | |
|--------|-----|----|----|------|
| 4184GD | 700 | 2C | 24 | 19 6 |
|--------|-----|----|----|------|
- 1/6 Post & Packing on all relays. Send for lists



ROTARY TRANSFORMERS

Delivery on stock. Quotations on application.

M.T. 31
Input 11.5 v.
Output 250 v. at 125 mA.

M.T. 32
Input 11.5 v.
Output 490 v. at 65 mA.

AS SUPPLIED TO GOVERNMENT DEPARTMENTS AND LEADING MANUFACTURERS. NEW AND BOXED.

ROTARY TRANSFORMERS

Made by DELCO
TYPE 1 27/4 P. & P. 3/6.
TYPE 2 37/4 P. & P. 3/6.
Type 1. Dual voltage 12 or 24 v., input 265 v., 120 mA. output; 500 v., 26 mA. output.
Type 2. 12 v. input 275 v. 110 mA. output; 500 v., 50 mA. output.
Both types dual output.
MADE IN U.S.A.



OTHER DYNAMOTORS IN STOCK, SEND FOR LIST

F.C.C. "CATHODRAY" VISCOSOL TYPES. 1 mfd., 2 kv. wkg. 7/6 each. 0.25µF. 4 kv. wkg. 6/- each. 0.05µF. 8 kv. wkg. 7/6 each. 0.1µF. 8 kv. wkg. 8/6 each. 0.05µF. 5 kv. wkg. 6/6 each. 0.1µF. 7 kv. wkg. 7/6 each. 0.5µF. 2.5 kv. wkg. 6/6 each. 0.25µF. 2.5 kv. wkg. 6/- each. 0.0025µF. 6 kv. wkg. 5/- each. 0.0025µF. 8 kv. wkg. 4/6 each. 0.006µF. 5 kv. wkg. 5/- each. 0.0025µF. 3 kv. wkg. 4/- each. 0.05µF. 2.5 kv. wkg. 4/6 each. 0.075µF. 2.5 kv. wkg. 4/- each. 0.05µF. 2.5 kv. wkg. 4/- each. 0.05µF. 3 kv. wkg. 4/6 each. All the above are taking stock and mounting.

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35FT. AERIALS. Heavily galvanized steel tubes, four 5ft., 2in. dia. steel tubes fit into the base (these are then pegged to the ground). Max four sections, as advertised Jan. issue. £12/10/-, carr. 2/-.

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RF DRIVER UNIT. Freq. 100-150 mc/s., valves 2. 430A/C/2; 2. CV107B; 1. CV105K; 0-100 mA. meter 3 1/2 in. scale, 3 slow motion drives and C.O. section, fits any 19in. rack. Brand new in maker's case. No charge for case or packing. Price £3 each. post 10/-.

VALVES. 6KT7, 2-6; 6AR5, 2-6; 6YR54, 1/-; 6LA6/20, 15/-; CV73, 2-6; CV121, 12/6; 6X5, 10/-; CV25, 15/-; V8110, 3/- each. All valves are new boxed.

AMERICAN L.T. TRANSFORMERS. Potted type, finished in black crackle and very conservatively rated. (1) 230 v. input, 3 x 6 v. C.T., at 3 amps each and 4 v. at 2a. output, 18/6 each. (2) 230 v. input, 2 x 6.3 v. C.T., and 3 a., and 6.3 v. at 3 a. output, 17/6 each. (3) 230 v. input, 2 x 6.3 v. at 3 a., and 4.5 v. C.T., at 3 a. output, 17/6 each. (4) 230 v. input, 25 v. at 2 a., and 3 v. at 1 a., 12/6 each. (5) 230 v. input, 3 x 6.3 v. at 3 a. C.T., 1. 6.3 v., 3 a. 22/6 each. (All these transformers are new and boxed, please include postage 2/6 each.)

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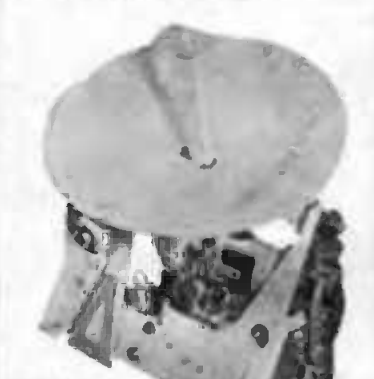


Manufacturers at this current. The charger is fitted with 20 amp. fuses on the D.C. output, 10 amp. fuses on the A.C. input. 2 1/2 in. 0-20 M.C. D.C. ammeter. On/off full charge/trickle charge switch. Heavy duty output terminals and mains neon indicator lamp. Behind control panel are mounted full charge ballast and trickle charge resistances.

These units are designed to charge all 24 volt lead-acid battery combinations. That is two 12 volt or four 6 volt batteries in series at a 20 amp. max. rate. Can also be used for trickle charging 24 volt batteries at 125, 350 and 700 m.a.; are ideal for the electronic industry, research laboratories, schools, etc., as a general purpose L.T. supply unit.

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All ratings Tropical and in perfect condition. No. 1. Pri. 200-240 v. Sec. 12 v., 40 a., completely enclosed in metal case. 52/6 Carr. 4/- No. 2. Pri. 230 v. Sec. tapped 4-6-11 v., 200 a., £11/10/- Carr. 7/6. No. 3. Pri. 200-250 v. Sec. 50 v., 30 a., £6/10/- Carr. 7/6. No. 4. Pri. 200-240 v. Sec. 50 v., 20 a., £4/10/- Carr. 7/6. No. 5. Pri. 200-250 v. Sec. tapped 28-29-30-31 v., 21 a., £4/17/6. Carr. 7/6. No. 6. Pri. 100-250 v. Sec. two separate windings, tapped 15-16-17 v., 4 a., 35/- Carr. 4/- No. 7. Pri. 220-240 v. Sec. three separate windings. 6.5 v., 50 a., 6 v. C.T. 15 a., 6 v. C.T. 2.5 a., £4/19/6. Carr. 7/6. No. 8. Pri. 220-240 v. Sec. 6.3 v., 15 a., 25/- P.P. 3/6. No. 9. Pri. 220-240 v. Sec. four separate windings, 5 v. C.T. 4 a., 5 v. C.T. 4 a., 5 v. C.T. 4 a., 4 v. 4 a., Potted Type. 32/6. P.P. 3/6. No. 10. Pri. 220-240 v. Sec. three separate windings. 6.3 v. C.T. 4 a., 6.3 v. C.T. 4 a., 6.3 v. 4 a., Potted Type. 29/6. P.P. 3/6. No. 11. Pri. 115-230 v. Sec. 5 v., 15 a., 15 kv. Insulation, 37/6. Carr. 5/-, No. 12. Pri. 220-240 v. Sec. 45 v., 2 a., 17/6. P.P. 3/6. No. 13. Pri. 200-240 v. Sec. tapped 9-15 v., 4 a., 22/6. P.P. 3/6. No. 14. Pri. 220-240 v. Sec. tapped 10-17-18 v., 10 a., 52/6. Carr. 4/-.

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All components available separately. Send for descriptive leaflet and prices.

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2-WATT POWER STAGE
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All Speaker Sizes Blocked.

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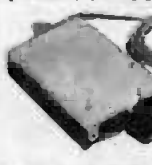
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- ★ 5-stage Reflex Circuit
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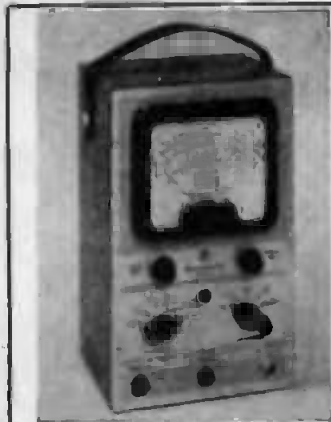
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Sub-units	Type	With valves	Less valves	P.P.
TRANSMITTER	81	60/-	25/-	2/6
RECEIVER	114	25/-	7/6	2/6
IF Amplifier	476	32/6	12/6	2/6
Modulator	105	20/-	—	2/6
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CRYSTAL CONTROLLED OSCILLATORS; 10 Kc/s., 100 Kc/s. and 1 Mc/s. ON/OFF MODULATOR. With handbook. Unused. ONLY 79/6. P.P. 2/6.



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From 6 Kc/s-47 Mc/s. FT243, FT241, 10X3 and 57G. All types for all purposes. Send for free list.



CATHODE-RAY TUBES (IDEAL FOR 'SCOPES)

2AP1	2in.	25/-
VCR139A	2 1/2in.	35/-
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Screens for VCR97 P.P. 2/- any type. ALL GUARANTEED FREE LIST and Data on request.

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. LT 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/-

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0-15 v.	2 1/2in.	M.I. (A.C.) F.R.	8/6
0-40 v.	2in.	M.C. (DC) F.S.	7/6
0-150 v.	2 1/2in.	M.C. (DC) F.R.	12/6
0-200 v.	2in.	M.C. (DC) F.R.	12/6
0-600 v.	2 1/2in.	M.C. (DC) F.R.	12/6
0-300 v.	5in.	M.I. (AC) P.	50/-
0-15 kv.	2 1/2in.	M.C. (DC) P.	15/-
0-2 1/2 kv.	2in.	M.C. (DC) P.	15/-
0-500 UA	3 1/2in.	M.C. (DC) F.R.	59/6
0-400 UA	3in.	M.C. (DC) F.R.	59/6
2 1/2-0-2 1/2 mA	2 1/2in.	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	2 1/2in.	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	2 1/2in.	T.C. (RF) P.	10/-
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4-channel Xtal controlled. 100 to 120 mc/s. New condition. £6/10/-, p.p. 10/6.

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AC/DC volts. 0-500 volts. D.C. mA. 0-500 mA. RESISTANCE 0-20 K.

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£25 - 0 - 0 p.p. 10/- INCLUDING OPERATING INSTRUCTIONS

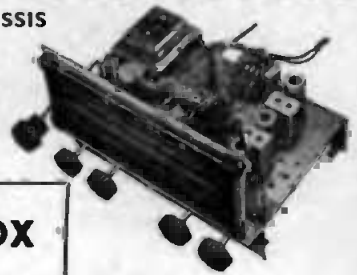
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HENRY'S RADIO LTD. 5, HARROW ROAD, PADDINGTON, W.2 (AT JUNCTION OF EDGWARE RD. AND HARROW RD.) PAD 1008/9

LASKY'S RADIO

7-VALVE AM/FM RADIOGRAM CHASSIS

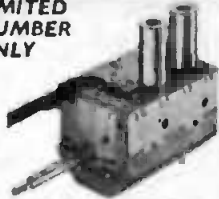
Famous make. For 200-250 v. A.C. Output 4 watts matched to 3 ohm speaker. 7 valves: ECC85, ECH81, 1 F39, EABC80, EL84, E280, EM81, magic eye tuning indicator. Covers medium, long and FM bands. Length 12in., height 7 1/2in. front to back 8 1/2in. Limited number only.



LISTED AT 22 GNS
LASKY'S PRICE
£16.19.6

Carr. and Insur. 12/6
Available on H.P. terms.
Brochure on request.

LIMITED NUMBER ONLY



12-CHANNEL TURRET TUNERS

New purchase offered at still lower price. I.F. 33.38 mc/s. Complete with PCC84 and PCF80 valves and 8 sets of Coils for 5 Band 1 channels and 8, 9, 10 Band III. New and unused. Value over 7/.

LASKY'S PRICE **39/6**
Post free.

The "FIREBALL" TURRET TUNER covering Channels 1-5 Band I, and 6-13 Band III. Uses PCC84 and PCF80 valves. A cascade Turret Tuner of unique design, compact and lightweight.

LASKY'S PRICE **£5.19.6**
complete with valves, Post 2/-



ACOS CRYSTAL STICK MIKE, type MIC.39/1, complete with cable. Listed at 45/5/-.

LASKY'S PRICE **39/6**
Post free.
Desk Stand 2/6 extra.

ACOS type 33/1. Crystal hand or table Mike, 20/6. Post 1/6.

RIBBON MIKE on table stand. Famous make, high impedance.

LASKY'S PRICE **£6.19.6**
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SPECIAL OFFER RECORDING TAPE

Famous make, P.V.C. base on latest type plastic spools. Brand new, perfect, boxed and guaranteed.

1,800ft. on 7in. spool 32/6
1,200ft. on 7in. spool 21/-
1,200ft. on 5 1/2in. spool 22/6
850ft. on 5 1/2in. spool 18/6
SCOTCH PLASTIC TAPE 1,200ft. on 7in. spool 25/-

GEVAERT L.P. PLASTIC
1,700ft. on 7in. spool 35/-
850ft. on 5 1/2in. spool 18/6
210ft. on 3in. spool 4/6

Post: 1 spool, 1/6
Orders over 60/- post free.
All other makes of tape in stock. Long Play, Double Play, and the American "MYLAR."

TRANSCRIPTION TURNTABLES

COLLARO 4-sp. type 4T200 with Studio transcription pick-up. LIST (19/10/-).

LASKY'S PRICE **£16.19.6**
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In carrying case, 25/- extra.
GARRARD 301 £22 7 3
GARRARD 301 (Strobe) £23 18 4
GARRARD 4HF (Stereo) £10 4 8

GARRARD 4HF (G.C.8) £18 8 8

LENCO GL.54, stereo, bloodred diamond £23 17 0
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MAESTROVOX 10-12 watt HIGH FIDELITY AMPLIFIER AND PRE-AMPLIFIER

LIST 22 GNS.

LASKY'S PRICE **£12.19.6**

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Built to latest Mullard circuit and complete with Mullard valves: two EL84 p.p., two EF86, one ECC83 and EZ81 rectifier. Main Amplifier chassis size 7 1/2in. x 10in., maximum height 5in., gold hammer finish. Separate Pre-Amplifier in polished wood case, walnut veneered, with smart maple and gold escutcheon, size 10 1/2in. x 3 1/2in. x 4in. Brand new and unused.

8-VALVE 5-WAVE AM/FM CHASSIS BY LEADING MANUFACTURER

New and unused. Limited number only. Valve line-up: ECC85, ECH81, EF80, EABC80, ECC83 p.p. output, two EL84, EZ81 rectifier. Power pack and amplifier mounted on separate chassis. Covers long, medium, 2 short and VHF/FM bands. Pick-up and extension speaker sockets. Large edge-lit glass dial. Flywheel tuning. For 200-250 v. AC/DC mains.

LASKY'S PRICE **£17.19.6** CARR. 5/-

Available on Hire Purchase terms

TEST METERS

Full range of the latest test gear by Avo, Taylor, Pullin. Example:

THE NEW TAYLOR METER. Model 127A. Pocket size, high sensitivity, inexpensive. 20,000 ohms per volt. Large easy-to-read scale. Tests up to 20 megohms with internal batteries. 21 ranges, volts, amps, and ohms. Dimensions: 5 1/2 x 3 1/2 x 1 1/2in. £10. Post free. Available on h.p. terms.

TAPE RECORDER BARGAINS

The HARTING HM.5. A 2-speed superbly-made high quality Tape Recorder of Continental manufacture. List 25 Gns.

LASKY'S PRICE **59 gns.**
Complete with Mike and Tape. Carr. and Insur. 25/- Further details on request.

Few only left. "LIGHT" TAPE RECORDER (foreign) 2-sp. 3 1/2 x 7 1/2, with inputs for mike and tuner. In blue/grey carrying case. For 200/250 v. A.C.

LASKY'S PRICE **21 gns.**
Including Tape, Crystal Hand Mike and Radio Jack.
Carr. & Insur., 12/6.

UNIVERSAL SOUND MIXER 3 channels. For use with all tape recorders and audio amplifiers. Size 4 1/2 x 3 1/2 x 3 1/2in.

LASKY'S PRICE **35/-**
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HIGH FIDELITY TAPE RECORDER HEADS

Leading make, new and unused upper or lower track RECORD/PLAY-BACK, high impedance. Double wound and will reproduce up to 12,000 c.p.s. at 7 1/2 i.p.s. Azimuth adjustments. Output 5 millivolts at 1 Kc. at 7 1/2 i.p.s. ERASE, low impedance.

LASKY'S PRICE **39/6** Post 1/3
Worth double. Please specify upper or lower track.

"INSTANT" BULK TAPE ERASER

and Head Demagnetiser. Erases a complete reel of magnetic tape in few seconds. **27/6** Post free.

PLASTIC TAPE SPOOLS

3in. 5in. 5 1/2in. 7in. 8 1/2in.
2/6 3/6 3/6 3/6 5/6
7in. Metal Spools, 1/6 each.
Post extra.

TAPE DECK OFFERS!



Latest B.S.R. "MONARDECK," SINGLE-SPEED. 3 1/2 i.p.s., takes 5 1/2in. spools. Simple controls.

LASKY'S PRICE **£9.19.6**
Tape extra. Carr. & Insur., 12/6.



Latest COLLARO STUDIO TAPE TRANSCRIBER. 3 motors 3-speed, 1 1/2, 3 1/2, 7 1/2 i.p.s. takes 7in. spools. Push-button controls.

LASKY'S PRICE **£15.15.0**
Tape extra. Carr. & Insur., 12/6.

LATEST MOTEK K.10 DECK, push-button controls, 3 motors, 3 speeds, rev. counter. Free response better than 40 to 12,000 c.p.s. at 7 1/2 i.p.s. 2-tone grey. Few only left.

LASKY'S PRICE **£13.19.6**
Carr. & Ins., 12/6.
Suitable Case 39/6

TAPE RECORDER AMPLIFIER for use with Collaro Studio Transcriber. Size 1 1/2 x 5 x 3in. Uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mike/gram/radio inputs, ext. i.a. jack, superimposing switch. £12/10/6. Complete with matching knobs (Gold/Black). Post 3/6.

MAINS MOTORS, shaded pole. Ideal for fans, tape recorders, etc. For A.C. mains, 19/6. Post 1/6.

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 7 1/2 x 3 1/2 in. max. height 4 1/2 in. 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 25/19/6
LT45 Tape Deck Amplifier 12 Gns.
L50 50 watt Amplifier 10 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, EF80 and EZ81, **£6.19.6** Post free.
All components available separately.



BARGAINS IN 4-SPEED MIXER AUTO-CHANGERS

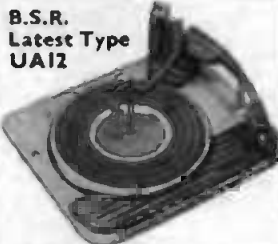


B.S.R. 4-spd. mixer Auto-Change type UA8, complete with latest B.S.R. "ful-6" Carr. & 1kg. 5/- **£6.19.6**

Identical, wired for Stereo and with Stereo cartridge, £7/10/6.



COLLARO, incorporating auto and manual control. Complete with Studio crystal p.u. and sapphire stylus. LIST £13/17/6. **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 mono-stereo and Stereo heads £12/10/0
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All the above Auto-Change are new and unused in maker's cartons.

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Auto start and stop, complete with pick-up and crystal cartridge.
COLLARO 4/564, £6/0/6, Post 5/-
GARRARD 4SP., £6/9/6, Post 5/-

GARRARD TA Mark II, wired for stereo, plug-in head. £8/0/6. 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 MGP.89 or MGP.37 turnover crystal cartridge with L.P. and standard styl. List 30/7. **LASKY'S PRICE 18/-** Post free.

BUILD A BATTERY TRANSISTOR RECORD PLAYER at the amazing low price of only **£5/19/6** plus 5/- post.

- ★ Push pull 500 milliwatts output.
- ★ Smart carrying case, 11 x 8 1/2 x 5 in.
- ★ Garrard Turntable and P.U. type BA1, (45 r.p.m.).
- ★ 4 Transistor Amplifier on Printed Circuit (ready built).
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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 3-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 U14 batteries. **25/10** Post free.
EARPHONES. High imp., 14/6. Low imp., 7/6. Post 1/6.

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ROUND			
3 1/2 in.	4 in.	5 in.	6 1/2 in.
17/6	19/6	14/6	14/-
ELLIPTICAL			
7 x 4	9 x 6	10 x 2 1/2	10 x 6
15/6	27/6	27/6	28/-

Post Extra.

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GRUNDIG, ELIZABETHAN, BRENNEL, 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.

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LASKY'S HIGHLY EFFICIENT EASY-TO-BUILD SETS : TUNERS : AMPLIFIERS

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.P. amplifiers (1.5 to 3 Mc/s). Double spot—yellow and red. Each **7/6**

Type T81. Suitable for all audio applications. Each **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/-.

EDSWAN MAZDA TRANSISTORS. The very latest types. XB103 10/-; XB103 10/-; XC101 12/6; XA101 15/-; XA102 17/6.

SPECIAL OFFER. Set of 7 Edswan Transistors: XA101, XA102, 2 XB103, XB104, 2 matched XC101. Price 70/6.

CRYSTAL DIODES. General Purpose GRX10, each 1/-; Per doz. 9/6. All other types in stock.

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All types in stock. Example:—**V18 10P**. Ideal for output stage of car radio, will give approx. 8 watts operating from 12 v. Each 11/- post free. Suitable Output Transformer for above, correct ratio, matched to 3 ohms, 0/6. Post 1/-. Driver Transformer, 0/6. Post 1/6.

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. 1/4th watt, most values available. Each 3/4d., 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 UF80, UABC80, UL84, UY85. Complete Kit, listed at 18 gns. **LASKY'S PRICE £8.19.6** Post 2/6.

Circuit Diagram and Building Instructions, 1/6 each, post free.

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 3 1/2in. x 3 1/2in. **£5/12/6** Post 3/6

4-TRANSISTOR AUDIO AMPLIFIER, Mk. II, 200/250 milliwatts, with 2 OC72 and 2 yellow/green. Size 6 1/2 x 2 x 1 1/2in. **£3/10/6** Post 3/6

4-VALVE ALL-DRY SUPERHET PORTABLE. Medium and long wave. Mains/battery £8/10/6. 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, 8 1/2 x 4 1/2 x 5in. **£4/19/6** Post 5/-

LASKY'S F.M. TUNER. Printed Circuit version of the G.E.C. 012 "F.M. Plus," using 5 valves. **£7/10/6** Post Free

COMPLETE PARCEL



LASKY'S CAR RADIO

CAN BE BUILT ABSOLUTELY COMPLETE

FOR £12.19.6

- ★ Small size. Will fit any car
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- ★ 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.P. 470 K/c.s. Medium waveband. Printed circuit. Uses 4 transistors and 1 diode, 2 1/2in. speaker, Ferrite slab aerial, etc., in leatherette case 6 x 3 1/2 x 1 1/2in. 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.

G.R. TUBE BARGAINS

NEW, UNUSED AND TAX FREE



10in. Metal Cone. Famous make. Type T901/B. 0.3 v. 3 amp. heater, ion trap. 12-14 Kv. E.H.T.

LASKY'S PRICE £8.9.6 Carr. and Insur. 2/6.

FERRANTI 9in. type T9B 4 v. heater. Triode, octal base, standard deflection LIST 2 GNS. **LASKY'S PRICE 50/-** Carr. & Insur. 12/6.

FERRANTI 12in. types T12/4 and T12/4A. LIST 41S. **LASKY'S PRICE 84/-** Carr. & Insur. 12/6.

FERRANTI 17in. type TR17/10. 6.3 v. 3 amp. heater. Broad new and efficient. **LASKY'S PRICE £7.19.6** Carr. & Insur. 12/6.

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17 in. 90 degree G.R. TUBES Seconds but in perfect working order and guaranteed. Price on request.

RE-QUINUED G.R. TUBES GUARANTEED FOR 12 MONTHS

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17in. rect.	£8 19	6	21/-
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Mullard, Brimar, G.E.C., Mazda, Concor, E.M.I., Philips, Pinnacle, Telefunken, etc. Send for our New List of manufacturers' surplus, ex-Govt. and imported Valves at lowest prices.

5-millamp **METER RECTIFIERS**. Special offer of limited number at only **8/6** Post 1/6.

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Leading makes, including **ARMSTRONG, DULCO, EMPRESS**, etc. A.M. chassis (1,2,3,4) from 7 GNS. A.M./P.M. chassis from 14 GNS. A.M./P.M. STEREO from 22 GNS.



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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 pre-amplifier (described below) with which an unaltered 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 PARMKO MAIN TRANSFORMER (which has extra Power available to drive Radio Tuner) and the choice of the latest Ultra-Linear PARMKO or the PARTHIDON Output Transformer. Price: COMPLETE KIT (Parmko Output Trans) **£10.00**



ABOVE: INDUCTOR-PORATING PARTHIDON OUTPUT TRANSFORMER £10/- extra.

Alternatively we supply ASSEMBLED AND TESTED **£11.10.0**

MULLARD'S PRE-AMPLIFIER TONE CONTROL UNIT

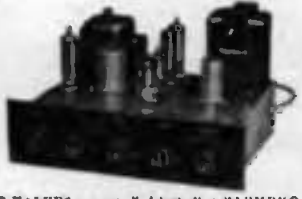
Employing two 6F90 valves, and designed to operate with the Mullard 3-3 and 5-10 MAIN AMPLIFIERS, but also perfectly suitable for other makes. Our kit is strictly to MULLARD SPECIFICATION and incorporates: ● Equalisation for the latest R.L.A. characteristics. ● Input for Crystal Pick-ups, and variable 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 **£6.6.0**



Alternatively we supply ASSEMBLED AND TESTED **£8.0.0** (Carriage and Insurance 3/- extra.)

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 PARMKO MAIN TRANSFORMER and choice of the latest PARMKO or PARTHIDON ULTRA Linear Output Transformer. Adequate power available to drive Radio Tuner. Price: COMPLETE KIT, Parmko Transformer **£13.10.0**



Alternatively we supply ASSEMBLED AND TESTED **£13.10.0** (Plus Purchase (Assembled Amp. only). Deposit £2 14/-, 12 months at 10% ABOVE incorporating PARTHIDON OUTPUT TRANSFORMER £10/- extra.

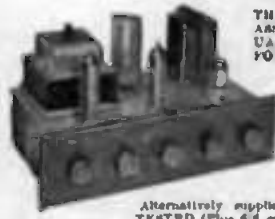
SPECIAL PRICE REDUCTIONS

- (a) 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. TERM: Deposit £3 10/- and 12 months of £2/7/6.
- (c) 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. TERM: Deposit £5 and 12 months of £2/10/8.
- (e) The COMPLETE KIT OF PARTS to build one "5-10" Main Amplifier (Parmko Transformer) and the Dual Channel Pre-Amplifier Control Unit **£21.10.0**
- (h) One "5-10" Amplifier (Parmko Transformer) and the Dual Channel Pre-Amplifier both Assembled and Tested **£25.0.0** H.P. TERM: Deposit £5 and 12 months of £2/10/8.
- (i) COMPLETE KIT OF PARTS to build Two "5-10" Main Amplifiers (Incorporating Parmko Output Transformer) and the Dual Channel Pre-Amplifier Control Unit **£31.0.0**
- (j) Two "5-10" Amplifiers (Parmko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested **£36.0.0** H.P. TERM: Deposit £7/6/- and 12 months of £2 12/-.

Carriage and insurance 7/6 extra. Prices quoted are subject to £1 6/- extra for Partible Trans.

THE COMPLETE ASSEMBLY MANUAL AVAILABLE FOR 1/6.

COMPLETE MULLARD 3-3



A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES. Price for COMPLETE KIT **£7.10.0** OF PARTS (Plus 6/6 carriage and insurance.) Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 6/6 carriage and insurance.) **£8.19.6** H.P. TERM: Deposit £2 and 8 monthly payments of £1.

Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMKO OUTPUT TRANSFORMER. We also include switches and 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 STEREO PHONIC or MONAURAL operation. Price: COMPLETE KIT OF PARTS **£10.0.0** Alternatively ASSEMBLED AND TESTED **£11.15.0** H.P. TERM: Deposit £2 7/-, 12 months at 17%.



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

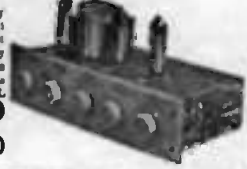
This model incorporates two 2-Valve Pre-Amplifiers interlinked above combined into a single Unit enabling it to be used for both STEREO PHONIC or MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifier requiring an input of 250 mV.



Price: COMPLETE KIT OF PARTS **£12.10.0** Alternatively ASSEMBLED AND TESTED **£15.0.0** H.P. TERM: Deposit £3 and 12 months of £1/2/-.

COMPLETE STEREO AMPLIFIER

A thoroughly recommended design that very effectively meets the many requests for a low priced but good quality DUAL CHANNEL STEREO PHONIC AMPLIFIER. Price: COMPLETE KIT OF PARTS **£8.10.0** Alternatively ASSEMBLED AND TESTED **£10.10.0** Two Mullard 6BL7 Triode Pentode Valves are incorporated in the design, they form a "CLASS A" single ended output stage in each channel. The input sensitivity is 200 mV/ohm, therefore when used with our BESTEREO Crystal Pick-ups or Radio Tuning Units, an output of 3 Watts per channel is achieved, or similarly when switched to MONAURAL Pick-up position a combined output of 6 Watts is produced.



Please consult S.A.B. 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.

THE "ADD-A-DECK"

Incorporating the NEW B.S.R. "MONARDECK" and MATCHED PREAMPLIFIER **£17.17.0** Deposit £3 12/-, 12 months of £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 3 1/2 in./sec. speed. It uses Sin. Tape Spools, thus providing up to 1 1/2 hours' playing time on L.P. Tapes or 1 hour on the standard 6 in. 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.



!! HOME CONSTRUCTORS !! A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS Designed by the W.B. STENTONIAN COMPANY for "Hi-Fi" Loudspeaker systems or to accommodate high quality equipment. The specially designed Base Keflex Cabinets containing the very powerful "Bostorian" 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 STENTONIAN LOUDSPEAKERS. Please contact S.A.B.

STERN RADIO LTD. DEPT. W. 109 FLEET ST. LONDON, E.C.4 Telephone: FLEET STREET 5812/14

Each Model incorporates the highly successful HF/TRJ 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.



Stern's "fidelity" TAPE RECORDERS

BEFORE YOU BUY—YOU SHOULD HEAR THESE RECORDERS—THEY ARE COMPARABLE TO THE MUCH HIGHER PRICED MODELS

- MODEL CR2/S. Incorporates the New COLLARD "STUDIO" TWIN TRACK 3-speed Deck. H.P. Terms Deposit £8/4/- and 12 months of £3/0/2. **£41.0.0**
- MODEL CR2/T. Incorporates the very popular 3-speed COLLARD MR. IV "TRANSCRIBTOR" Deck, which has both upper and lower tape tracks. H.P. Terms Deposit £9/10/- and 12 months of £3/12/7. **£49.10.0**
- MODEL TR2/EL. VI. Incorporates the New TRUYOX MR. VI TWIN TRACK 2-speed Tape Deck. H.P. Terms Deposit £9/10/- and 12 months of £3/12/7. **£49.10.0**

!! RECORD PLAYERS !!

The LATEST MODELS are in Stock. Many at REDUCED PRICES!!! Send S.A.E. for ILLUSTRATED LEAFLET

- B.S.R. MONARCH UAS 4-spd. Mixer Autochanger with Crystal Pick-up. **£6.19.6**
- Th. COLLARD "CONQUEST" 4-spd. Autochanger, Studio "O" Pick-up. **£7.10.0**
- The latest COLLARD "CONTINENTAL" 4-speed MIXER Autochanger Studio "U" Pick-up. **£8.10.0**



- The NEW COLLARD model RPS1, 2-speed Single Record Player, Studio Cartridge. **£9.18.9**
- The COLLARD model 4 3/4 1-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 ROLEX 4 4-speed Autochanger fitted with latest Crystal Pick-up..... **£10. 0. 0**
- The latest GARRARD TRANSCRIPTION ROTOM "301" with Neobac magnetically shielded turntable..... **£23.18.4**
- The new GARRARD Model 4HP High Quality Single Record Player fitted with the latest T.P.A. 12 Pick-up arm and G.C.E. Crystal Cartridge GARRARD Model TA/RE. II Single Record Player fitted with high output Crystal Pick-up, detachable head..... **£18. 7. 6**
- CRYSTAL PURCHASE TERMS available on all units £8 10/6 and over. Carriage and insurance on each above 5/- extra.

STERN'S MK. II "fidelity" F.M. TUNING UNIT

(Plus 5/- carr. and ins.)
HI-RE PURCHASE Deposit **PRICE £14.5.0**
 £2 17/- and 12 months at £1/0/11. Incorporates the latest MULLARD PERMEABILITY TUNING HEAD and the corresponding MULLARD VALVE LINE UP comprising EC835, 3 type EP35 (or EP39), RM84, Tuning Indicator, plus 2 type O.A. 79 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 **£15.0.0**
 ALL FOR
 Only 18 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. 21 amps. The design incorporates Reheat 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 7 1/4 x 4 1/2 x 4 1/2 in. high.

!! RADIOGRAM CHASSIS !!

- ARMSTRONG MODEL A F205. (Complete AM/FM chassis producing 3 watts. Separate Bass and Treble controls). **£23.2.0**
- ARMSTRONG "STEREO TWELVE". The most complete A.M./F.M. unit yet produced. For Stereo, giving 5 watts high fidelity push-pull output on each channel. 12 watts for Monaural. **£37.16.0**
- ARMSTRONG "JUBILEE". An AM/FM chassis with nine valves and with push-pull output stage providing 5 watts. **£29.8.0**
- ARMSTRONG AM/FM "STEREO 46". Provides a basis for Stereo and Monaural playback from pick-up or tape. Outputs provided for Stereo or Monaural tape recording. **£28.7.0**
- The JASON "MERCURY" Sintered P.M. TUNER. PRICE ASSEMBLED AND TESTED. **£13.10.0**
- DULCET Model FRT75. A complete self-powered P.M. Tuner incorporating automatic frequency control. **£19.17.6**
- ARMSTRONG "S.T.3." AM/FM Tuning Units. A self-powered high fidelity tuner covering full V.H.F. medium and long wavebands with automatic frequency control on V.H.F. **£27.6.0**
- DULCET "BAY" AM/FM Tuning Units. A 1-waveband self-powered high fidelity tuner covering the V.H.F./P.M. transmission plus the long, medium and short wavebands. NEW HI-RE PURCHASE TERMS are available on all above. Illustrated leaflet available—send S.A.E. (Carr. and Ins. 3/- extra). **£25.15.2**

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. driver. 15 ohms Voice 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. 8in. 3 or 15 ohms. Freq. Resp. 50-15,000 c/s. **£6.10.6**
 - W.B. "STENTORIAN" H.F. 10in. 3 or 15 ohms. Freq. Resp. 20-15,000 c/s. **£7.12.3**
 - W.B. "STENTORIAN" H.F. 12in. 15 ohms. Freq. Resp. 25-14,000 c/s. **£9.15.6**
 - WHARFEDALE "SUPER 3 P/AL" 8in. 3 or 15 ohms. **£6.19.11**
 - WHARFEDALE "GOLDEN FIB." 10in. 3 or 15 ohms Voice Coil **£7.13.3**
 - WHARFEDALE "WIS/PS" 12in. 15 ohms. Voice Coil. **£10.5.0**
 - WHARFEDALE "SUPER 18/P/AL" 12in. 15 ohms Voice Coil. LOUDSPEAKER ENCLOSURES—TWEETER UNITS CROSPOVER UNITS **£17.10.0**
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. Recline—WE ALSO SUPPLY SEPARATELY—

- (a) The 2-stage (plus Rectifier) AMPLIFIER **£3 2 6**
- (b) The PORTABLE CARRYING CASE **£3 17 6** (Carriage and insurance 4/- extra)
- (c) 12in. P.M. SPEAKER **18 0**



Stern's "fidelity" TAPE EQUIPMENT

THE FINEST RANGE OF TAPE EQUIPMENT FOR THE HOME CONSTRUCTOR

A SELECTION OF HIGH FIDELITY PORTABLE TAPE PRE-AMPLIFIERS

Adds "HI-FI" Tape Recording to your existing Audio Installation.

IN ALL MODELS WE INCORPORATE THE

TYPE "C" PRE-AMPLIFIER

- (a) The new "COLLARO" STUDIO 3 speed Deck. Deposit: £7/6/-, 12 months £2/13/6 **£36.10.0**
- (b) The COLLARO Mk. IV "Transcriptor" 3 Speed Deck. Deposit: £8/6/-, 12 months £3/0/11 **£41.10.0**
- (c) The new TRUVOX Mk. VI Tape Deck. Deposit: £8/14/-, 12 months £3/3/10 **£43.10.0**
- (d) The BRENNEL Mk. V 3 Speed Deck. Deposit: £10/6/-, 12 months £3/15/7 **£51.10.0**
- (e) The WEARITE MODEL 4A Tape Deck. Deposit: £12/4/-, 12 months £4/9/5 **£61.0.0**



STERN'S MULLARD TYPE "C" TAPE PRE-AMPLIFIER—ERASE UNIT

INCORPORATING THE NEW FERROXCUBE POT CORE PUSH-PULL OSCILLATOR and 3 SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR.



PRICES . . . INCLUDING SEPARATE SMALL POWER SUPPLY UNIT COMPLETE KIT **£14.0.0** ASSEMBLED AND TESTED **£17.0.0**

Deposit £3/8/- and 12 months of £1/4/11. Assembled unit only. ALSO AVAILABLE EXCLUDING POWER SUPPLY UNIT FOR **£11.15.0** and **£14.10.0** respectively. (Carr. and Ins. 5/- extra)

Send S.A.E. for leaflet or 2/6 for Complete Assembly Manual. WHEN ORDERING PLEASE STATE MAKE OF TAPE DECK TO BE USED We present this "HI-FI" Pre-amplifier strictly to Mullard's specification etc., incorporating ONLY NEW HIGH GRADE COMPONENTS and the SPECIFIED NEW MULLARD VALVES. It comprises a COMPLETELY SELF-CONTAINED UNIT, all components and valves being contained in a well ventilated Box—Chassis neatly finished in Hammered gold with a very attractively engraved PERSPEX FRONT PANEL.

FOR PERMANENT HIGH QUALITY INSTALLATIONS

WE ALSO OFFER (excluding Case) the following

- (a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PRE-AMPLIFIER and Power Unit Assembled and Tested **£32.10.0**
H.P. Terms: Deposit £6/10/- and 12 months at £2/7/8.
- (b) As above but TYPE "C" PRE-AMPLIFIER supplied as complete Kit of Parts **£29.0.0**
- (c) The COLLARO Mk. IV TAPE DECK and the MULLARD Type "C" Pre-amplifier and Power Unit assembled, tested **£35.0.0**
H.P. Deposit £7 and 12 months £2/11/4.
- (d) As in (a) above but the Type "C" supplied as COMPLETE KIT OF PARTS **£32.0.0**
- (e) The TRUVOX Mk. VI TAPE DECK and the assembled Type "C" Pre-amplifier and Power Unit **£40.0.0**
H.P. Deposit £8 and 12 months £2/18/8.
- (f) As above but the Type "C" supplied as complete KIT OF PARTS **£36.10.0**
- (g) The BRENNEL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and POWER UNIT **£46.0.0**
- (h) As above, but the Type "C" supplied as complete KIT OF PARTS **£43.0.0**
- (i) The WEARITE 4A DECK with Type "C" assembled and tested **£56.0.0**
H.P. Deposit £11/4/- and 12 months £4/2/1.
(Carriage and Insurance on above quotes 10/- extra)

STERN RADIO LTD.
DEPT. W 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

YOU CAN BUILD A COMPLETE HIGH QUALITY TAPE RECORDER for **£36.0.0**



H.P. TERMS . . . Deposit £7/4/-, 12 months £2/12/10.

FOR THIS WE SUPPLY:— COMPLETE KIT OF PARTS TO BUILD THE HF/TR3 TAPE AMPLIFIER.

THE NEW COLLARO "STUDIO" TAPE DECK. PORTABLE CARRYING CASE (as illustrated) ROLA/CELESTION 10in. x 6in. P.M. LOUDSPEAKER. ACOS CRYSTAL MICROPHONE 1200ft. SPOOL E.M.I. TAPE.

Alternatively for those who prefer another type of TAPE DECK we will supply precisely as above—but IN PLACE OF THE COLLARO "STUDIO" DECK—WE INCLUDE:—

- (a) The Mk. IV COLLARO "TRANSCRIPTOR" DECK... **£39.15.0**
H.P. TERMS . . . Deposit £8, 12 monthly payments of £2/18/2 (£1 extra if we are required to wire up the Transcriptor Switch Banks).
- (b) The new TRUVOX Mk. VI DECK **£45.0.0**
H.P. TERMS: Deposit £9, 12 months of £3/6/- (Carr. and ins. on all above is 12/6 extra).

For constructors with their own Cabinet—WE OFFER:—

- (a) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK **£28.0.0**
- (b) As above but HF/TR3 ASSEMBLED and TESTED **£31.10.0**
H.P. TERMS: Deposit £6/6/-, 12 months of £2/6/2.
- (c) COMPLETE KIT to build the HF/TR3 together with the Mk. IV COLLARO "TRANSCRIPTOR" DECK (£1 extra if we are required to wire up Deck Banks) **£30.15.0**
- (d) As above but HF/TR3 ASSEMBLED and TESTED **£34.10.0**
(£1 extra if we are to wire up Deck Switch Banks)
- (e) COMPLETE KIT to build the HF/TR3 together with the NEW TRUVOX Mk. VI TAPE DECK **£36.0.0**
- (f) As above but HF/TR3 ASSEMBLED and TESTED **£39.10.0**
H.P. Terms: Deposit £7/18/-, 12 months of £2/17/11.
- (g) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENNEL Mk. V TAPE DECK **£41.10.0**
- (h) As above but HF/TR3 ASSEMBLED and TESTED **£45.0.0**
H.P. Terms: Deposit £9, 12 months of £3/6/-.
- (i) THE ASSEMBLED and TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer, etc. **£55.0.0**
H.P. TERMS: Deposit £11, 12 months of £4/0/8
(Carriage and Insurance on each above is 10/- extra.)

Attractive PORTABLE CASE is available to accommodate the TRUVOX or COLLARO TAPE DECKS and we offer it together with ROLA/CELESTION 10 x 6in. LOUDSPEAKER—ACOS CRYSTAL MICROPHONE—and 1200ft. SPOOL E.M.I. TAPE—ALL FOR **£9.0.0** (Carriage and Insurance 5/- extra.)

WE HAVE THE NEW 2-SPEED TWIN TRACK

TRUVOX Mk. VI Tape Deck in stock **£26.5.0** Deposit **£5.15.0** 12 months **£2/18/6**

It incorporates PRECISION REV. COUNTER and PAUSE CONTROL and fully maintains the general high standard of all Truvox equipment. The very popular COLLARO Tape Decks and the BRENNEL Mk. V Decks are also available.

THE MODEL HF/TR3 TAPE AMPLIFIER

Incorporating 3-SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR. PRICE FOR COMPLETE KIT OF PARTS **£12/15/-** FULLY ASSEMBLED AND TESTED **£16/10/-** HIRE PURCHASE: Deposit **£3/6.0** and 12 months at **£2/4.0**. A very high quality amplifier based on the very successful Type "A" design completed in the MULLARD LABORATORIES. ONLY NEW HIGH-GRADE COMPONENTS are incorporated including MULLARD VALVES and a GILSON OUTPUT TRANSFORMER . . . other features are: Magic Eye Recording Head Indicator—Effective Tone Control—Monitoring and Extension Speaker Socket—has own Power Supply and can be used as independent amplifier for direct reproduction of Gram Records or from Radio Tuner. (Small size 11 x 7 x 4in.—Truvox—Collaro—or Brenell—please specify which. Send S.A.E. for leaflet or 2/6 for Assembly Manual.)



PLEASE ENCLOSE S.A.E. WITH ALL CORRESPONDENCE

CLYNE RADIO LTD.



162, HOLLOWAY ROAD, LONDON, N.7

ALSO AT:—18, TOTTENHAM COURT ROAD, LONDON, W.1.

99 CHEAPSIDE, E.C.2. MON 6860

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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.

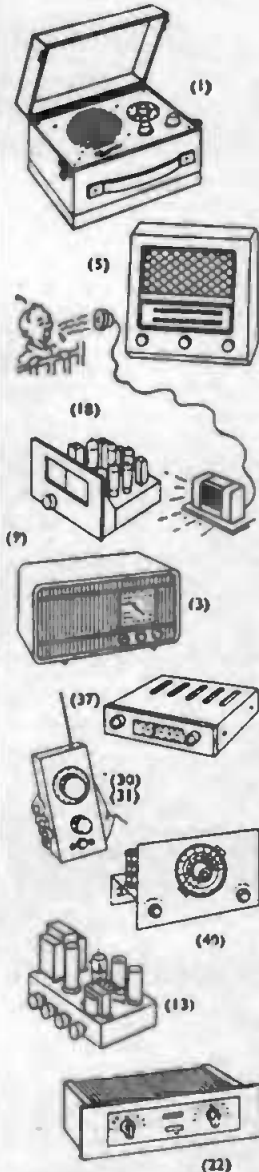
If not stated, please add postage on orders under £1. Cash with order or C.O.D. (charges extra).

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.

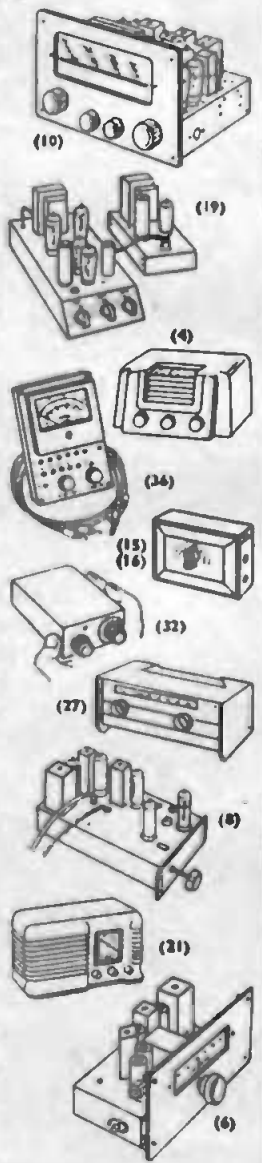
All required components at special inclusive price	P. & P.	Instruction Book and itemised price list available separately
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- | | | | |
|---|----------|-----|------|
| (1) New Look "RAMBLER" all dry s'het portable... | £7 7 0 | 2/6 | 1/6 |
| (2) "RAMBLER" 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) P.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 S10 Amplifier (printed circuit) Ultra Linear version | £9 9 0 | 3/6 | 1/6 |
| (20) TELETRON "TRANSIOYNE" 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.Y. 2 Tuner | £13 19 6 | 3/6 | 2/6 |
| (23) RADIO JACK | £9 6 1/6 | 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 supply 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 | £23 10 0 | 5/- | 3/6 |
| (40) Super SHORT WAVE RADIO, 1 valve | £1 15 0 | 2/- | 2/- |

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 6 1/2in. x 4 1/2in. at base tapering to 4in. at top. Very attractive two-tone Vynilide covered cabinet with cream and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. Weight complete with long-life 7 1/2 volt battery—4 1/2 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, Vortaxon,
Linear, Wharfedale, Grundig, Goodmans, W.B., Rogers, Garrard, Lenco,
B.T.H., Pamphonic, Simon, Bronell, 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 Ferrrodynamics 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. 1,800ft. 44/-; 7in. 2,400ft. 60/-; 5in. 1,200ft. 37/6. P. free.



**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 6MB4 recording indicator. Latest 8"x4" High Flux Speaker. Complets with Tape and empty Spool, and Aco 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.

**LATEST COLLARO STUDIO
TAPE TRANSCRIBER.** 3 motors, 3-speed: 18, 24, 7 1/2 i.p.s., takes 7in. spools. Push-button controls. £15/15/-, plus 5/- P. & P. Usual H.P. facilities.
LATEST B.S.R. "MONAR-DECK." Single speed Tape Deck. Takes 5 1/2in. Spools—3 1/2 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 3 1/2in. x 7in. x 1 1/2in. 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) £4/19/-
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 3 1/2in. x 5in. x 1 1/2in. overall. Supplied complete with instructions and test prods. ONLY £5/19/6, plus 2/6 P. & P.

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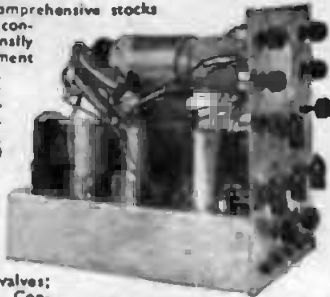
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Situated midway between Bank and St. Paul's Stations and no more than one minute from either. Monday to Friday 9 a.m. - 6 p.m. Saturday 1 p.m.

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: B-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 2 1/2in. 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. Specs.: 3 wavebands, Long, Medium and Short, 5 miniature valves—6C7, 6F15, 6LD20, N108, U107. Attractive vertical glass dial (1 1/2in. x 3 1/2in.) 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 1 1/2in. x 6 1/2in. high. **WHILST STOCKS LAST, £7/19/4 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 serial. Valve line up: U107, N108, DH107, W107 and X109. Overall chassis size 12 x 5 1/2 x 7 1/2in. high. Attractive bronze dial with gold and cream lettering. Dial size 1 1/2 x 4 1/2in. Scale length 7 1/2in. 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/-.



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 Styl. Brand New and Fully Guaranteed. ONLY £6/19/6 plus 3/6 P. & P. whilst stocks last.

GARRARD RC.1210MK.II STEREO MONAURAL 4-SPEED AUTO-CHANGER. Complete with GCB plug-in Crystal Head and Sapphire Styl. 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. UAS MONARCH. 4-speed Mixer Autochanger complete with turnover crystal insert and Sapphire Styl. 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 3 1/2 x 8 1/2in. 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 resin covering for accommodating the above items and ancillary equipment. 7 1/2in., plus 5/- P. & P.

Note. If the above three items are purchased together they will be supplied at the special inclusive price of £72/6, plus 6/6 P. & P.

CLYNE RADIO LTD.



162 Mollway Road, London, N.7.
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18 Tottenham Court Road, London, W.1

SEE OVER 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 2 1/2in. Flush Round. 65/-; 100 microamps 2 1/2in. 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. 2 1/2in. 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 2 1/2in., 3 ohms. 24/- plus 1/6 P. & P. 10in. Etac High Flux 3 ohm. 39/6 plus 2/6 P. & P. 6in. 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. 64/10/- plus 3/6 P. & P. All the above brand new and fully guaranteed.

Special! Special! Latest E.M.I. full frequency speaker. Size 13 1/2in. x 8 1/2in., 3 ohm speech coil. Double cone. Unrepeatable at 39/6 each only. Plus 3/6 P. & P.

AERIAL TUNING UNIT

ZA0041. This well made ex-V.D unit contains a host of useful components including: 1 mA. 2in. flush round M/C meter, 1 mA. Wasting-house full-wave meter rectifier, 5-pole 5-way heavy-duty silver plated wavechange switch, 3in. dia. silver plated rotary tuning indicator, 350 pF tuning condenser with insulated coupler and 3 1/2in. 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. 18 AFV WALKIE-TALKIE A wonderful offer. This famous transmitter-receiver 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: 13 1/2in. x 8 1/2in. x 7 1/2in. Mike and gram inputs with separate gain controls, tone control. Brand new, fully guaranteed. **ONLY 61/15/-, plus 7/6 P. & P.**

DLRS BALANCED ARMATURE HEADPHONES. Complete with headband and leads, 7/6 pair, plus 1/6 P. & P.

HIGH IMPEDANCE LIGHT-WEIGHT 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 619/19/-, plus 7/6 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 19in., 65/10/-; 17in., 66; 21in., 67/19/6; plus 10/- e. and p.

EXTRA SPECIAL OFFER!!

A small three-valve **PORTABLE RECORD-PLAYER AMPLIFIER** mounted on baffle 12 x 7in., with High Flux 6 1/2in. 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. 65/12/6 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 13 1/2 x 8 1/2in. Fitted with carrying handle. 63/9/6 plus 5/- P. & P.

NOTE. If both items purchased together they will be supplied at a special inclusive price of 68/7/6 plus 4/6 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!

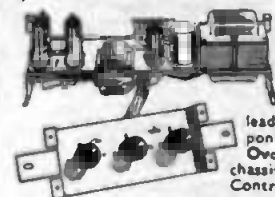
RETURN OF A WINNER!!! (Exclusive)

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: 24 1/2in. x 16in. x 29in. The whole is mounted upon "easy run" castors. Subjects to being unsold. 56/19/6. 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 attention 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) 12 1/2in. x 4in. x 5 1/2in. high. Control panels 6in. x 2 1/2in. Input to match standard high impedance crystal or magnetic pick-up. Output approx. 8 watts max. **WHILST STOCKS LAST ONLY 66/19/6, plus 3/6 P. & P. STEREO VERSION—same appearance and valve line-up, only 67/9/6 plus P. & P.**

— TRANSISTOR !!! —

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 5/- ea.
OC44 18/6 ea.
OC45 R.F. up to 6 Mc/s 18/6 ea.
OC70 10/- ea.
OC71 10/- ea.
OC72 14/6 ea.
OC72 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 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.

ACOSMIC 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 attaché type case. Attractive two-tone grey rexine finish. Size closed 13 1/2in. x 9 1/2in. x 3 1/2in. 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 three 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 Stylus. **FONOFLUID 21/- each.** B.S.R. TCG (less bracket) 15/- each. B.S.R. Hi-G with bracket, 10/- each. B.S.R. Hi-G (less bracket), 15/- each. **E. V. POWER POINT** in Garrard plug-in shell, 10/6 each. **GARRARD GC2 16/- each.** **E. V. CARTRIDGE** only 11/6 each. All plus 9d. P. & P.

CLYNE RADIO LTD.

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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 10⁶ 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.

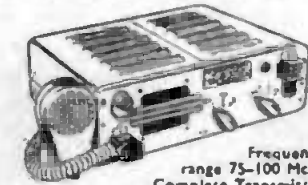
Specification (contd.):

RECEIVER

Sensitivity: Less than 1 microvolt.
 Frequency stability: 2 parts in 10⁶ 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 μ v 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.



Frequency range 75-100 Mc/s.
 Complete Transmitter Receiver Assembly, and power supply, measuring only 8 1/2 in. x 8 in. x 4 in. Weight 14 1/2 lb.

Each set comprises one V.M.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. Od. carriage.

POCKET MULTI-METER

Brand New. 2,500 o.p.v. Multi range. 4/30/120/300/1,200 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 4 1/2 x 1 1/2 in. 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 cps. 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 6 1/2 x 5 1/2 in. 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: A.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 4 1/2 x 2 1/2 x 2 1/2 in. Original packing. ONLY 35/-, P. & P. 3/6.

MONITOR TYPE 18

Consists of VCRI386-SP61, I-SU4, I-VU120, J-EASO. 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/-.

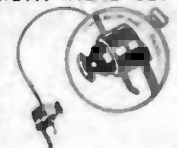


ALIGNMENT ANALYSER Type MC12

A.C. MAINS 200/250 volts. Provides—"WOBBULATOR" (SWEEP 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 ckt. I.F. transformer, etc., to be rapidly determined. ONLY £6/19/6. P. & P. 5/-.

AMERICAN LIGHTWEIGHT HEAD SET

These H.5.30 phones are the smallest used by the U.S. Air Force. 250 Ω imp. using soft rubber miniature ear moulds for maximum music and finest reproduction of the voice quality. ONLY 15/- P. & P. 2/6.

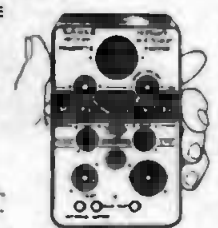


VERDIK HI-FI AMPLIFIER. 10-watt push-pull ultra-linear feedback. Beautifully styled in green stove enamel. Provision for tuner, bass and treble. S-position selector for radio, tape, L.P. and std. records. List price 20 gns. OUR PRICE £14/19/6. P. & P. 7/6.

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.M.F.

Within minutes you can extend the frequency of your receiver to cover V.M.F. by using our brand new V.M.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/-.



BRAND NEW VARIABLE TRANSFORMERS.

Input 230 volts. Output 0-260 volts, 5 amps. Brand new, only 69. Carr. 12/6.



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/-.



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

25 1/2 ^{0/8 Carr.} ^{17/6.}

OR DEPOSIT 3 ONS. and 12 monthly payments of 45/9. Cash price is added to 3 months.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTION. THE LINEAR TASK HIGH QUALITY TAPE AMPLIFIER. A HIGH FLOW T.Y. etc. LOUDSPEAKER. Steel of Best Quality TAPE. Spare Tape Spool, a Portable Cabinet, size approx. 16 x 12 x 4 in., finished in veneered walnut or two-tone resin, and connection diagram for wiring amplifier to transcription.

FEATURES INCLUDE

- ★ 8 SPEEDS. ★ FREQUENCY RESPONSE 30-11,000 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 7 1/2" 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 BUY 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 16 ohm loudspeaker. Guaranteed, tested, and in perfect working order.

VALVES! Full range at really competitive prices. All guaranteed.

REPAIRO CONSTRUCTIONAL ENVELOPES AND COMPONENTS ALWAYS IN STOCK

All parts for: One Transistor Receiver 25/-; Two Transistor Receiver 42/-; 3 Dec 3 Transistor Receiver 43 10/6; Mini 7 Seven Transistor Pocket Portable Receiver 49 10/6; Major 7 Seven Transistor Portable Receiver 15 gns. Only Mullard, Philips, or Britvar Transistors supplied for Mini 7 and Major 7 Receivers.

Constructional Envelopes. 3 Dec 04, 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 electronic rectifier. For inclusion in cabinet illustrated or walnut veneered type. 16 empura valves 6K7, 6PM1, 6X5 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 1/6. This receiver can be built for a maximum of 24/10/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-Point wiring diagram, instructions and parts list 1/6. This receiver can be built for a maximum of 24/10/6 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 4 1/2 x 4 1/2 x 2 1/2 in. 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 32/9 or ready for use 46/9.

Type BM2. Size 8 1/2 x 7 1/2 in. Supplies 120 v. 00 v. and 60 v. 40 mA. and 3 v. 0.4 a. to 1 amp. fully enclosed. 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. 42/9 or ready for use 58/6.



PHILIPS CONCENTRIC (Dual Cone) P.M. SPEAKERS

10 in. Diameter. 3.5 ohms. 200.

SPECIAL OFFER OF BEST QUALITY RECORDING TAPE. P.V.C. based. On plastic spools. By leading manufacturers. Brand new. 3in. 150ft., 5/11, 3in. 600ft. 18/11, 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

- ★ Single speed 3 1/2 in. per sec.
- ★ Recording level indicator.
- ★ Fast rewind.
- ★ Twin Track.
- ★ Takes 5 1/2 in. 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.

19 ^{Carr.} ^{10/6} ^{GNS.}

AGOS HI-FI CRYSTAL 'MIKES'

- 33-1 hand or Desk type
- 35/9 (Listed 60/-)
- 30-1 Stick type
- 39/6 (Listed 50 Gns.) Limited number.

R.S.C. TRANSFORMERS FULLY GUARANTEED

INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS

Primary 200-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

230-0-250 v. 80 mA. 6.3 v. 2 a. 5 v. 2 a.	17/6
240-0-240 v. 80 mA. 6.3 v. 2 a. 5 v. 3 a.	25/0
300-0-300 v. 100 mA. 6.3 v. 4 a. 5 v. 3 a.	25/0
330-0-330 v. 100 mA. 6.3 v. 4 a. 5 v. 3 a.	25/0
350-0-350 v. 100 mA. 6.3 v. 4 a. 5 v. 3 a.	25/0
423-0-423 v. 200 mA. 6.3 v. 4 a. 5 v. 3 a.	33/9

TOP SHROUDED DROP-THROUGH TYPE

240-0-240 v. 70 mA. 6.3 v. 2 a. 5 v. 2 a.	15/0
330-0-330 v. 80 mA. 6.3 v. 2 a. 5 v. 2 a.	18/0
230-0-250 v. 100 mA. 6.3 v. 4 a. 5 v. 3 a.	23/0
300-0-300 v. 100 mA. 6.3 v. 4 a. 5 v. 3 a.	23/0
300-0-300 v. 130 mA. 6.3 v. 4 a. 5 v. 3 a.	23/0
350-0-350 v. 100 mA. 6.3 v. 4 a. 5 v. 3 a.	23/0
350-0-350 v. 150 mA. 6.3 v. 4 a. 5 v. 3 a.	23/0



EXTENSION SPEAKERS

Limited number in hand - some walnut veneered cabinets. 2-3 ohms speech coils. 6 1/2 in. 23/9. 8 in. 35/9. 10 in. 56/9.

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 x 3 watt (total 6 watt) 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. Attractively valued.

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. 8/10/6. Please state whether 3 ohm or 15 ohm required.



AM FM RADIOGRAM CHASSIS. HIGH QUALITY. PUSH-PULL. 6-3 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 22/12/- and 9 monthly payments of 22/12/-.

Z.E.L. 1-speed Single Players with hi-fi TriO crystal pick-up head for Stereo and Monaural. 23/10/9 Carr. 5/6.

GARRARD 4-SPEED AUTO-CHANGERS

Type RC1700H. Limited number at 210/10/6 (approx. half price). Carr. 5/6. Brand new.

DRY SHAVERS. Brand new in carrying case. Operation from 3 U2 batteries, fitted in case. Just the thing for travel. Only 58/6 (approx. half price).

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit especially suitable for use with any of our Amplifiers. A Trade Heatside Fitchner is used. Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. directing is avoided. The W. Ch. Sw. incorporates Gram-position. Controls are Tuning W. Ch. and Vol. Output will read most Amplifiers requiring 500 mV. Input depending on A.C. location. Only 250 v. 13 mA. H.T. and L.T. of 4.5 v. 1 amp. required from amplifier. Size of unit approx. 9-4 in high. Send S.A.E. for illustrative leaflet. Total building cost is 21/10/-. 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 42/10/6 Carr. 3/6.

PORTABLE CABINET

Two Tone - Excite with all cut-ups to take above unit, amplifier and speaker. 29/6.

B.S.R. MONARCH AUTO-CHANGERS

Type HA4 4 speed T.O. Pick-up with ampure stylus. 27/10/6 Carr. 5/6.
Model AC1054 4-speed single player with hi-fi turnover crystal pick-up head 26/12/6. Carr. 4/6.

ELIMINATOR TRANSFORMERS
Primary 200-250 v. 50 c/s.
130 v. 40 mA. 5-0-5 v. 1 a.
80 v. 15 mA. 5-0-5 v. 250 mA.

FILAMENT TRANSFORMERS
Primary 200-250 v. 60 c/s.
6.3 v. 1.8 a.
7.4-0-7.4 v. 2 a.
7.9 v. 6 a.

OUTPUT TRANSFORMERS
Midge Battery Pentode 6A1 for 35A, etc.
4-watt Pentode 5,000 Q to 4Q
Standard Pentode 3,000 Q to 5Q
Standard Pentode 8,000 Q to 2Q
Push-pull 8 watts 6V6 to 3 ohms
Push-pull 8 watts EL84 to 15 ohms
Push-pull 10-12 watts 6V6 to 8Q or 15Q
Push-pull 10-12 watts to match 6V6 to 3-5-8 or 16Q
Push-pull 8184 to 3 or 15 ohms
Push-pull Ultra Linear for Mullard 610
Push-pull 18-18 watts, sectionally wound 6L6, KT66, etc. or 8 or 15 ohms
Push-pull 20 watt high-quality sectionally wound. 6LA, KT66, etc. to 3 or 15Q

RECTIFYING CHOKES
250 mA., 5 H., 100Q 11/9 40 mA., 10 H., 350Q 5/6
150 mA., 7.10H, 250Q 11/9 500 mA., 10 H., 400Q 4/11
100 mA., 10 H., 900Q 8/9 1 amp. 0.5Q 1 T. type 6/6

PARALLEL MAINS TRANSFORMERS
Fully shrouded.
450-0-450 v. 130 mA. 6.3 v. 4 a. 5 v. 3 a.
500-0-500 v. 130 mA. 6.3 v. 4 a. 5 v. 3 a.

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 13 1/2 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. 6P6S, 6X4S, 6AR5, 6X4, 6Z5A. Tone Control, Pre-Amp. stages are incorporated. Fidelity is extremely high. Only 12 millivolts minimum input is required for full output. THIS ENSURES THE STABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.



Separate Bass and Treble give both "hi" 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., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH FUSE IS INCLUDED FOR SUPPLY OF 300 v., 20 mA. and 0.5 v. 1.5 A. FOR A RADIO FEEDER UNIT. Price in kit form with easy-to-follow wiring diagrams. Or Factory built with 12 month guarantee £12/10/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 2/6 and 12 monthly payments of 2/6.

ONLY 11 Gns.

Cart. 10/-

Cover as illustrated 18/9 extra.

Type 807 output valve 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. 20-20,000 c/c. Tone Control ± 12 D.B. at 50 c/c. ± 12 D.B. to ± 6 D.B. at 12,000 c/c. Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 x 9 x 9 in. approx. Power consumption 150 watts. For A.C. mains input of 200-250 v., 50 c/c. 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 best 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. 2/3 and twelve monthly payments of 2/3.

LINEAR L/10 10 WATT HIGH FIDELITY AMPLIFIER, with 3 position equalization switch. 13 Gns.

LINEAR LWS HIGH QUALITY STEREO AMPLIFIER. Total output 10 watts. Hand-wired Percepsac Mini Plate. All controls ganged. Only 12 Gns.

LINEAR LAS 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/c. Output for 3/3 ohm speaker. Three miniature Mullard valves. Size only 6 x 6 x 6 1/2 in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5/19/6** Or Deposit 2/- and 5 monthly payments of 22/-, Send S.A.E. for leaflet.

OLSA MINIATURE 3 WATT GRAM AMPLIFIER

For 200-250 v., 50 a.p.s. A.C. mains. Overall size only 11 1/2 x 7 1/2 in. Fitted Val. and Tone Control with mains switch. Designed for use with any kind of single player or record changing unit. Output for 3-ohm speaker. Guaranteed 12 months. Only 59/6.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER. Spec. exactly as A3 below with exception of output voltage. Complete kit of parts, diagrams and instructions 23/15/-, cart. 3/6.

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 80 millivolts input is required for full output so that it is suitable for use with the latest high-impedance 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 equalization. Hum-level is negligible being 71 D.B. down. 12 D.B. of negative feedback is used. H.P. of 300 v., 20 mA. and I.T. of 0.5 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/c. Output for 3-ohm speaker. Chassis is pot silver. Kit is complete in every detail and includes fully punched chassis (with components) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value of only **£4/15/-** or assembled ready for use 25/- extra, plus 3/6 cartage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.



F.M. SPEAKERS: 3-3 ohm 7 1/2 in. Parto 2/0. 6 in. Goodmans 17/0. 7 x 4 in. K.A. Kipp-Ural 10/0. 6 1/2 in. Rola 18/0. 8 in. Rola 19/0. 8 in. Goodmans 25/0. 8 x 4 in. Kite with high cut magnet 25/0. 10 in. H.A. 22/0. 10 x 8 in. Kipp-Ural Goodmans 29/0. 12 in. H.A. 29/1. 12 in. H.A. 3 or 15 ohms. 10 watts, 12,000 Hms. 59/6.

TWEETERS: 4 in. Plessey, 3 ohms. 18/0. R.A. 18 ohm 25/0.
COLLARO CONQUEST 4-SPEED AUTO-CHANGERS. With studio pick-up with turnover head. **BRAND NEW** Cartridge latest model. For 200-250 v., A.C. mains. 67/19/6. Cart. 1/-.

ACOS Crystal Microphone Inserts. Brand new. Only 5/11 ea. **EX. Equip 4/11 ea.**
ACOS HOPAS H.P. Crystal Cartridges. Turnover type, with capillary stylus. (Standard) replacement for Garrard and Collaro. Only 19/0. **R.S.C. Part 4 19/0.** Garrard GC5 19/6.

COLOUR V.H.F. F.M. RADIO RECEIVER KITS. Brand New Razed with valves, pre-set circuit and 10 x 6 in. Speaker. For 200-250 v., A.C. mains. Pre-aligned I.P.T.A. Normal price 13 Gns. Our price **£21/0/6.**

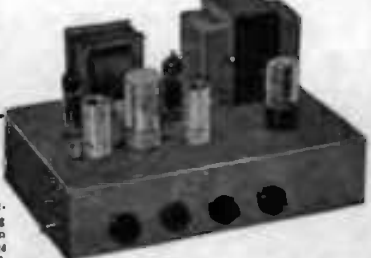
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Open to callers at the following branches —
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8-10 Brown Street, (Market, St.) Manchester, 2.

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.**

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 5 valves. 6X4S, 6X4, 6AR5, 6Z5A. High quality sectionally wound output transformer specially designed for Ultra Linear operation, and with individual controls for Bass and Treble - "Hi" and "Cut." Frequency response ± 3 D.B. 20-20,000 c/c. 81 negative feedback loop. Hum level 60 D.B. down. ONLY 22 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 PLATING RECORDS. For MUSICAL INSTRUMENTS such as STRING BASS, GUITAR, etc. OUTPUT SOCKET with plug provides 300 v., 30 mA. and 0.5 v., 1.5 A. For supply of a RADIO FEEDER UNIT. Size approx. 12 x 7 in. For A.C. mains 200-250 v., 50 c/c. Output for 3 and 15 ohm speakers. Kit is complete to last out. Chassis is fully punched. Full instructions and point-to-point wiring **8 Gns.** Cart. diagrams supplied. Or factory built 45/- extra. Only 10/- if required in metal cover with 3 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 Chassis, 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 10 mv. High Flux Beam. Input socket for Radio/Tape or Gram Pick-up and 1/4" Instrument Pick-up. Handmade strong metal cabinet (size approx. 14 x 18 x 1 1/2 in.) finished in satin walnut and fitted carrying handle. **£8/19/6** Cart. 7/6. Or Deposit 2/1 and nine monthly payments 2/1. Send S.A.E. for leaflet.



SENIOR 10 WATTS. High Fidelity Push-Pull output. Separate Bass and Treble "cut" and "boost" controls. Tone separately controlled high gain input so that two instruments such as Guitar and String Bass can be used at the same time. Two Loud-speakers are incorporated, a 7 1/2" P.M. for Bass notes, and a 7 x 4 in. elliptical for Treble. Cabinet is well made and finished satin 15 Gns. This 10-w. r.m. H.P. **TERMS. DEPOSIT 26/9.** and 12 monthly payments 26/9. Both models for 200-250 v. A.C. mains.

STAR GALAXY 4-SPEED MIXER AUTO-CHANGERS. Brand New, carious. Turnover supplies 4/5. 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.** Cart. 4/6

PORTABLE CABINETS

For Record Players or Tape Recorders. Recline covered. Wide selection of attractive designs and colour combinations. **15/9**
PRICES FROM



18 in. 10 WATT HIGH QUALITY LOUDSPEAKER IN POLISHED WALNUT FINISHED CABINET

Gain 12,000 Hms. Speech coil 3 ohms or 15 ohms. Only **£4/19/6.** Cart. 6/-.
Terms Deposit 1/1/- and 8 monthly payments of 1/1/-.
18 in. 20 WATT 18,000 Hms Loudspeaker 15 ohms. In Cabinet finished as above. Size 18 x 10 1/2 in. **£7/19/6** or Deposit 12/10 and 12 monthly payments 12/10.

PORTABLE CABINETS. Attractive design. Two-tone ramp covered. With tab-Clifford. R.R. Garrard or Rola Auto-Changer. amplifier and 7 in. x 4 in. or 6 in. speaker.

ACOS HIGH FIDELITY PICK-UPS. GP33 with HOP5037 Cartridge. Turnover cap-type styl. cream finish. Limited number at approx. half-price. Only 29/11. Rights only. Only 49/6.

SPECIAL OFFER

Above cabinet Mixer Changer. Gram amplifier and 6 in. or 6 1/2 x 4 in. speaker **£9/19/6.** Cart. 10/- Or with Collaro Conquest changer in lieu of Starr. 12 Gns. Cart. 10/-.



PLESSEY DUAL CONCENTRIC 12 in. F.M. SPEAKERS

(13 ohms), consisting of a high quality 12 in. speaker of orthodox design supporting a small elliptical speaker of ready wired with choke and condensers to act as tweeter. This high fidelity is highly recommended for use with our All or any smaller amplifier. Rating 10 watts. Gain 12,000 Hms. Price only **£5/17/6.** Or Deposit 10/6 and 12 monthly payments of 10/6.

R.S.C. MANCHESTER (LEEDS) LTD.,

For addresses and terms see page 141

ELECTRIC BELLS. Dia. diameter. 4.5 v. to 12 v. Battery or Mains operation. Only 4/8.

SELENIUM RECTIFIERS

We can quote special prices for quantities of 10 to 10,000 of most types. Special types made to order.

L.T. Types	H.T. Types H.W.
2 1/2 v. 1 a. b. w. 2/0	150 v. 40 mA. 2/0
6 1/2 v. 1 a. b. w. 2/0	250 v. 80 mA. 2/11
Following F.W. (Bridge)	250 v. 60 mA. 4/11
6 1/2 v. 1 a. 3/11	350 v. 80 mA. 6/11
6 1/2 v. 2 a. 6/11	260 v. 250 mA. 12/0
4 1/2 v. 2 a. 0/0	Contact Cooled
4 1/2 v. 4 a. 12/3	250 v. 80 mA. 6/11
6 1/2 v. 4 a. 14/0	260 v. 75 mA. 6/11
6 1/2 v. 6 a. 15/0	F.W. (Bridge).
6 1/2 v. 10 a. 25/0	
6 1/2 v. 15 a. 35/0	

JACK PLUGS. Standard type complete with diff. screened lead. 1/11 each.

FUNCTION TRANSISTORS. R.P. Type, 12/6. Audio type, 6/0. Power type Golep V18 10P 5 watts, 17/6. OCT1, 10/-. OCT2 17/-. X B109 10/-. X B104 10/-. X A101 0/4 17/6. and many other types.

VIBRATORS. Oak and Wearite, synchronous 7-pin, 2 v. 7/0, 6 v. 2/6. 12 v. 4-pin non-synchronous 7/0.

2 v. 16 A.H. EX. GOVT. ACCUMULATORS. New Board. Only 2/6 each, 3 for 12/-. plus 2/6 carr.

EX. GOVT. MADE TRANSFORMERS

All 250-550 v. 50 c/s input.
Fr. 0-110-200-230-250 v. 275-0-275 v. 100 mA., 6.3 v.
250 v. 60 mA., 6.3 v. 2 a. 10/11
250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., 8 v. 2 a. 11/0
300-0-300 v. 60 mA., 6.3 v. 2 a. 11/0
265-0-265 v. 180 mA., 6.3 v. 2 a., 5 v. 2 a., 8 v. 2 a. 12/11
350-0-350 v. 100 mA., 6.3 v. 2 a., 5 v. 2 a. 12/11
0-24-24-24 v. 15 amp. A.C. conservative Govt. rating (marked with D.G. rating after rectification) 60/0. Carr. 18/-.
6-10-20-26 v. 24 a. (Govt. rating) 70/0. Carr. 18/-.
AUTO 300 watts 0-215-230-235-230-215-340 v. 20/0
Carr. 7/6. 50 watts, 0-110/120-230/230 v. 8/11

ARDENTE DEAF AID EARPIECES with lead and plug. Brand New. Only 15/6.

POWER PACK KITS. Only 18/11. Fully smoothed H.T. output of 250 v. 40 mA. and L.T. supply of 6.3 v. 1.5 amp. Consisting of Double Wound Mains Transformer 230/260 v. 50 a.p.a. A.C. primary, Selenium Rectifier, Smoothing Choke, Double Electrolytic Condensers, Aluminium Chassis, and Circuit.

SPECIAL OFFER, Brand New Ex-Govt. 24 v. 15 amp. F.W. Bridge Selenium Rectifiers. Only 29/9 ea.

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EX. GOVT. SMOOTHING CHOKES
200 mA., 3-5 H., 90 ohms Ferrisite 2/0; 100 mA., 6 H., 100 ohms 2/11; 150 mA., 10 H., 80 ohms 2/0; 80 mA., 20 H., 100 ohms 5/0; 120 mA., 12 H., 100 ohms 5/0; 50 mA., 50 H., 1,000 ohms 6/0; 100 mA., 10 H., 100 ohms 6/0; 80 mA., 8-10 H., 250 ohms 2/11.

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BATTERY CHARGING EQUIPMENT

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6/12 v. variable charge rate up to 6 amps. Consisting of Mains Trans., F.W. (Bridge) Selenium Rectifier, 0.7 amp. meter, multi-position switch with knob, fuses, fuseholders, panels, plug and circuit. Only 59/6 Post 4/6.

ASSEMBLED CHARGERS

6 v. 1 a. 10/0
6 v. 2 a. 20/0
6/12 v. 1 a. 20/0
6/12 v. 2 a. 38/0
6/12 v. 4 a. 66/0
Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. & pkg. 3/6.

CHARGER TRANSFORMERS

200-230-250 v. 50 c/s.
0-9-15 v. 1 a. 12/0
0-9-15 v. 2 a. 18/0
0-9-15 v. 3 a. 18/0
0-9-15 v. 5 a. 19/0
0-9-15 v. 6 a. 23/0

BATTERY CHARGER KITS

Consisting of Mains Transformer F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/9 extra.
6 v. or 12 v. 1 amp. 24/0
As above, with ammeter. 30/0
6 v. 2 amps. 28/0
6 v. or 12 v. 2 amps. 31/6
6 v. or 12 v. 2 amps. 42/0 (inclusive of ammeter)
6 v. or 12 v. 4 amps. 63/0
6 v. or 12 v. 4 amps. with variable charge rate selector and ammeter 69/0

CHARGER AMMETERS

0-1.5 amp., 0-3 amp., 0-4 amp., 0-7 amp., 0-25 amp., 0-60 amp. 8/6

ASSEMBLED CHARGER

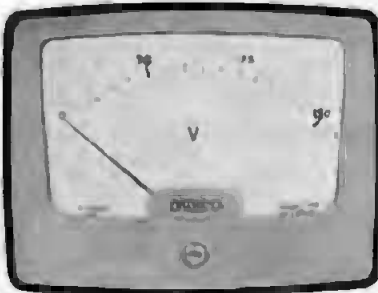
6 v. or 12 v. 2 amps. Plated Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only Carr. 3/9. **49/9**
As above, but for 3 amp. charging. Only 69/0. Carr. 2/9

All for A.C. Mains 200-250 v. 50 c/s. Guaranteed 12 months. **ASSEMBLED 6 v. or 12 v. 4 amps.**



Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 5/-
Output Deposit 13/3 and 5 monthly payments of 13/3.
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The 6 amp. model only, is slightly store soiled and is being offered at well below usual price.

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ELLIOTT now make four spring differential coil D.C. meters?

As with every other item and component of Elliott instrumentation systems these instruments are designed and built with one aim: absolute functional efficiency.

Model No.	Barrel dia.	Case size	Scale length
2705	2 1/2 in.	4 1/2 in. x 3 1/2 in.	3.40 in.
3705	3 1/2 in.	5 1/2 in. x 4 1/2 in.	4.20 in.

	First Coil	Second Coil	Both coils 50 Volts D.C. Self-contained. Tag boards and resistance boxes extend ranges to 1000 Volts.
Minimum F.S.D.	50 mic/A 1 Volt D.C.	100 mic/A 1 Volt D.C.	
Maximum F.S.D.	65 mA	65 mA	

If you use instruments you must know about Elliotts Instruments for Prototype equipment 14 days delivery
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BENSON'S BETTER BARGAINS

POWER UNITS. Input A.C. 115/250 v. Outputs: D.C. 330 v., 100 mA. and 6.3 v. A.C. twice. Potted trans. and LF choke; new (post 3/6). 30/- Input 230 v. A.C. Outputs: D.C. 350 v., 80 mA., A.C. 6.3 v. Valves: 907, EA60, EF60, 524G, 25/-
MONITOR 56, comprising Indicator 248 and Power Unit 675. Valves VCR133a, 3/EF50, 2/ECC83, 5/EF55, EF37A, 6V6, 3SEAS0 and 2/SU4G, VU120A. Two units each 12 x 0 x 18 in., black finish. Panel controls: Brill, Focus, T.B. Expansion, "Y" shift, "X" shift (two). T.B. 10/20K secs. A.C./D.C. switch. "Y" amp. multiplier/divider. Sig. input, trig., and Y2 input. Voltmeter centre-zero, 5/20/100. "X, Y and G" on "jumpers" at rear. 230 v. A.C. input, with 18-way Cable and mains cable. Cathode probe unit extra. 17/6, 2/10s. (Rail 20/-).
RELAYS (Contactors), two heavy-make contacts: 12 v. or 24 v. either 3/6. **INDICATORS.** Type 101, with VCR530 (6 pin, Blue, magnetic. Octal base), and 2/EB91, 2/EP91, 2/R10, new cond., 30/- (post 7/-). Type 1 with VCRX263, 2/EF52, 5/6J0, 1/6V6, 1/EY51, 2/EB91, 3/EP91, RF EHT Generator and 28 mc/s. xtal. 45/- (Rail 7/6). Type 97 with VCR517, 10 valves, 30/- (Rail 7/6).
HEADPHONES, CLR. 7/6. CR109 Noise Limiter assemblies, with valve, 3/6.
NEW M.C. METERS. 3 1/2 in. round flush, 50µA, 70/-; 100µA, 66/-; 1 mA., 55/-; 2 mA. (rectified), 44/-; 2 1/2 in., 1 mA., 22/6; 2 in. 200 mA., 300 mA., each 8/6. 2 1/2 in. 20 v. A.C., 8/6; 2 in. 40 v., 8/6; 300 v. A.C. 2 1/2 in., 10/-.
VIBRATORS, Mallory G634C 12 v. 4-pin, 7/6; 6 v. 5-pin reversible, 7/6. R11558, good condition, tested, with handbook, 27/10/- (Rail 10/-). SCR522 Modulation or Driver Trans., either 7/6. **DRIVES:** slow motion Admiralty 200:1 ratio, scaled 0-100, 5/8. R1155 6.0M. "N" type, new, 10/6. **VIBRAPAK,** 6 v. D.C. to 250 v. 60 mA., smoothed case, 22/6. 12 v. to 250 v. 60 mA., 21/- (p. 3/6). **DYNAMOTORS** (post 3/6): 12 v. to 250 v. 60 mA., and 6.3 v. 2.5 A., 11/6; 6 v. to 250 v. 60 mA., 11/6. Potentiometers, miniature wirewound, 60, 100Ω, 600Ω, 1k and 2k, each 1/6. **CHOKES.** LF 10H 200 mA., 8/6; 0H 100 mA., 6/6; Potted 10H 100 mA., 7/6; "C" 5H 400 mA., 10/6. **SWITCHES,** toggle U.S.A., DPDT, 1/6. **METAL RECTIFIERS,** 240 v. 100 mA., 4/-; 240 v. 30 mA., 3/6; 600 v. 30 mA., 5/6; 240 v. 80 mA., 5/6; 1,000 v. 30 mA., 7/6. **McE. Inserts,** G.P.O. carbon, 2/6, bal. armature type, 2/6. **CONTROLS** Camera Type 35; a timing device with 24 v. miniature motor; new (post 3/6). **10/6. TRANSFORMERS,** input 230 v. Output 6.3 v., 1.5 A., 6/6; 3 A., 8/6; 1 A., and 3 A., 8/6; 325 v. 20 mA. and 6.3 v., 1 A., 8/6. Multiratio output (40 mA.), 6/6. "C" Core Input 230 v. Outputs: 285/315v., 150 mA., & 700/850 v., 480 mA., half-wave; (Rail 7/6). 30/- Input 110/230 v. Outputs: 315-0-315 v., 60 mA (plus), 6.3 v., 1.8 A., & 5 v., 2A. 25/- (p. 3/6).

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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
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 Triaxlette Super 8" Unit, £13 10s.
The well known 8" Axlette (£6 12s.) and the 12" Audiom 40
(£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 Etal cartridge and dual speed stylus. Auto stop and start. A fidelity unit
and bargain buy at only £6/10/6.

SINGLE PLAYERS. HMK (TUR) 90/-; COLLARO (4/24) 8 gns.; GARRARD 487
£7/10/-. Carr. and Ins. 3/6.

AUTOCHANGERS. HMK (UAR) £8 10/6. COLLARO £7/10/6. GARRARD (RC12) £9
5/6. All plug-in head, stereo and mono. 10 gns. Stereo head £7 extra.

RECORD PLAYER CABINETS
Contemporary styled, rubber covered
cabinet in two-tone tan and brown, or
optional red with white puffs dot. Size
18 1/2 x 18 1/2 x 8 1/2 in., fitted with all
accessories, including letter board and
acoustic metal feet. Spare available for all
modern amplifiers and autochangers,
etc. Universal record player mounting board
14 x 12 in. supplied.
Cabinet Price £3.3.0. Carr. and Ins. 3/6.

Table with columns: NEW BORED VALVES, ALL GUARANTEED. Lists various valve types like 1BA174, 1B5, etc.

SPECIAL PRICE PER SET
1B5, 1T5, 1N5, or 1R4 or 2V4, 27/6
DK96, DP96, DA96, D124, 38/6
8K8, BK7 607 474, 524 or XA, 38/6

2.17.6 P. & P. 1/-
6-in. speaker and matching trans. £2/-
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
speakers. Good sensitivity and improved
freq. response. Neg. feedback. Var. Tone
and Volume Control. Chassis size 6 1/2 in x
3 1/2 in x 1 1/2 in. Current consumption 10 mA
quiescent—250 mA at 1 watt.
2 matched GEC GGT18 Transistors 42/- pr.
2 GEC OKT3 Transistors 21/- pr.
Driver Trans. 8/0
Output Trans. (to 3 ohms) 10/6
Complete kit of Parts, tools, circuit etc., free
specimen, ONLY 99/6 P. & P. 2/4.
Circuit and instruction booklet 1/6 post free.

NOW! The TOURIST Portable

4 valves, Med. & L.W., lightweight battery
Radio. Size only 8 1/2 x 8 1/2 in. x 4 in. Weight
3 1/2 lb. with battery. P. & P.
Complete receiver component kit 57/6 1/6
Set of miniature valves (88 units) 35/- 9d.
5in. Speaker & Output Trans. 21/- 1/6
Cabinet, Dial and Knobs, etc. 22/- 3/4
Latest superb circuitry delayed AVC and
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Complete kit—BARGAIN—only
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Terrific performance—
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2 WAVEBAND CAR RADIO KIT

Modern development of
the famous Britvox Hybrid
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Britvox low voltage valves
and power transistor, B.P.
stage and permanent
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Unit provide extremely
good sensitivity and signal-to-noise ratio. Printed circuit for easy construction and
7 x 4 in. elliptical speaker for fidelity output. Shell contained in metal cabinet
8 x 7 x 2 1/2 in. with attractive calibrated dial. Speaker and power transistor stage
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Recommended
Buy Complete Kit Bargain Price £12.19.6
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Isolation Transformers

New improved types—mains
prim. 200/250 v. tapped
All Isolation Transformers now sup-
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25% and plus 50% boost taps at an
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2V 2A type 12/6 (P. & P. 1/6)
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Small size and low terminal for
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RE-GUNNED TV TUBES
NEW REDUCED PRICES

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All tubes rebuilt with
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reconditioned virtually
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12in. £6, 14in. £7, 17in.
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CONDENSERS—50v. Min. All post
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etc. 101 mkt.-01 and 1,500 v. 9d. each
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T.C.C. 1 1/2 001 6 kv. 5/6. 001 10 kv. 9/6

RESISTORS—FULL RANGE: 10 ohms—
10 megohms 10% 1 v. and 1 v. 2d. 1 v. 5d.
(50Watt type modern rating). 1 v. 5d. 2 v.
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ohms 2/-).

FREE-SET W.W. POST. TV Type. 25 ohms—
50 K ohms. 3/- 30K—3 Meg. (Carbon 3/-)

SPEAKER FRET—Reconditioned Bronze an-
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12 x 12in. 4/6; 12 x 16in. 5/-; 24 x 12in.
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TYOAN FEET (Contemporary pat.) 12 x
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LOUDSPEAKERS—P.M. 3 ohms 2 1/2 in.
Kinc. 17/6. 5in. 24in. Goodmans 18/6. 5in.
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K. and A. 25/-; 10in. V.L. HP1015 99/6
12in. Fluoray 15 ohms with 6 1/2 in. Tweeter
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VOLUME CONTROLS—16K—1 Megohm.
ALL LONG SPINDLE MOOGANITE
MIDGET TYPE. 1 1/2 in. diam. 5mm. 1 yr.
LOG or LIN Ratio low 5/-; D.E.
Hv. 4/6. Twin gang controls 1 Meg. 4 Meg.
1 Meg. low Hv. each 5/6.

COAX 80 OHM CABLE.

Manufactured from Low Loss Semi-Air
Special Aerial.
Special Reduced Prices
30 yds. 12/6. 6 x 1/4. 60 yds. 20/6
P. & P. 3/- 60 yds. 22/6. P. & P. 3/6.
All other lengths 8d. per yard.
Coax Plug 1/-. Socket 1/6. Couplers
1/6. Cable and Socket 1/6. Outlet
Boxes 4/6.

JASON FM TUNER UNITS

(97-105 Mc/s)
Designer-approved line of parts for their
quality and highly popular tuners available
to follow.

STANDARD MODEL (FMT)—as previously
described extensively advertised. COM-
PLETE KIT, 5 gns. post free. Set of
4 spec. valves, 30/-, post free.

LATEST MODEL (FMTD)—attractively
presented shell mounting unit to enclose
Metal Cabinet with built-in Power Supply.
COMPLETE KIT, 6/6. P. & P. 2/4.
Set of 5 spec. valves, 35/6.

NEW JASON COMPREHENSIVE F.M.
HANDBOOK, 2/6 post free. 48p. Align-
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MULLARD '13"
AMPLIFIER

Quality built to Mullard's specifica-
tion with special methanized C.P.
Trans.
Complete kit with front panel only
£8/10/6. P. & P. 3/4.

7 VALVE AM/FM RADIOGRAM CHASSIS

Valve Line-up: ECC85,
ECH81, EF89, EA8C80
EL84, EM81, EX80.

Three Waveband and Switched
Gram positions. Med. 200-
500 m. Long 1,000-2,000 m.
V.H.F. FM 80-90 Mc/s. PH80.
Continental Tuning insert
with perpendicular tuning on
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IP transformer. 600 Kc/s
and 10.7 Mc/s. Dust core
tuning all coils. Latest
circuitry including AVC and
Neg. Feedback. Three unit output.
Headily and reproduction of a very high
standard. Chassis size 12 1/2 x 6 1/2 in. Height 7 1/2 in. Edg.
(Plasticated glass die) 1 1/2 x 3 1/2 in. 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—valves not necessary to choose.
Three chan. P.M. speaker only required. Recommended quality speakers.
(See Goodmans special com. 21/6
10in. Kite (Heavy Duty) 30/-
Post & Pkg. 1/6



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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 4lb. 7d.;
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The world famous E.M.I. Angel Transcription P.U.

SPECIFICATION
Physical
 Length 15½ inches (40.22 cms.)
 Height 2½ inches (6.41 cms.)
 Width 7½ inches (19.05 cms.)
 Centre of base to stylus tip 12 inches (30.72 cms.). Approx. overall.
Stylus
 A diamond stylus is fitted to the 33½ 45 r.p.m. head supplied.
Head Impedance
 1 ohm. (measured at 1,000 c.p.s.)
Frequency Response
 For a constant recorded velocity the frequency response is sensibly level within the following limits, with micro-groove stylus, 20-14,000 c.p.s. With standard stylus 20-20,000 c.p.s.
Distortion
 Measured at 400 c.p.s., the total harmonic distortion is less than 5% for a recording level of 0.20 db referred to 1 cm. sec. r.m.s. transverse velocity.
Sensitivity
 50 mV at secondary of transformer provided from a recording level of 0.19db referred to 1 cm. sec. r.m.s. velocity.
Weight at Stylus Point
 Variable from 2-10 grammes as required.



★ (MODEL 17A)

A PICKUP FOR THE CONNOISSEUR ORIGINALLY PRICED AT £17/10/- WE CAN OFFER THE LAST REMAINING FEW AT

£5.10.0

PLUS P. & P. 5/-

★ WITH DIAMOND STYLUS



500 MICROAMMETER

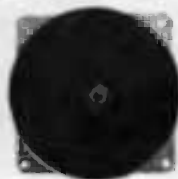
A 4½" Panel mounting 500 Microammeter marked in ohms and ideal for building into a multi-range meter.

PRICE **£2.10.0**
 Plus P. & P. 3/6.

PLESSEY TWEETER

This well-known Plessey 3 ohm Tweeter at our amazing price of . . .

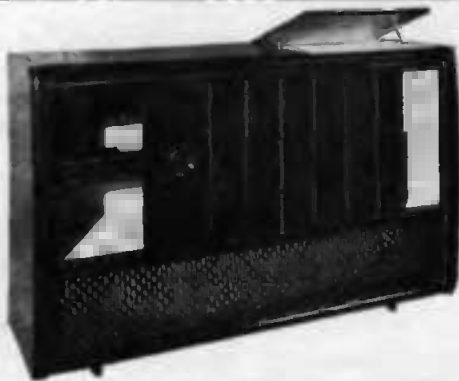
10'6 TAX PAID
 Plus P. & P. 1/6.



This cabinet as used by a world famous manufacturer. Cost nearly £30 to make. Will accommodate any type of equipment. Can also be used as a cocktail cabinet. Money refunded if not completely satisfied.

Legs for above if desired at £1 per set.

Dimensions—Length 51½", Height 32½", Depth 17½" without legs—Legs 6".



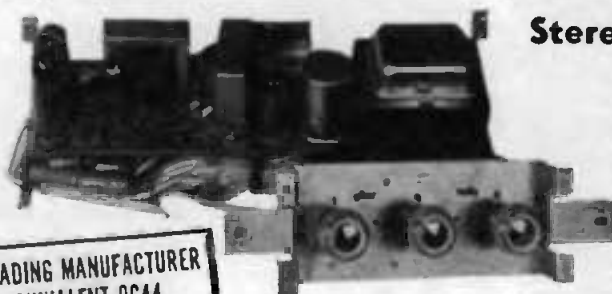
The cream of the Cabinet World

OUR PRICE **£18.10.0**

Plus P. & P. 12/6. Scotland & N. Ireland 25/-

Valve line-up

ECC83, EL84 x EL84, EZ80. Mullard Valves. Bass-Treble-Balance and volume on remote control panel. Fitted with elegant control knobs. Should not be missed.



Stereo Amplifier

This Stereo amplifier as illustrated. Made by a leading manufacturer, it is a robust precision-built job, which we offer at the amazing price of . . .

£7.9.6 Plus P. & P. 3/6.

STOP PRESS TRANSISTOR BY LEADING MANUFACTURER FIRST GRADE EQUIVALENT-OC44 11/6 EACH-60/- FOR 6



**HARVERSON
T.R.F. EASY
FOUR KIT**

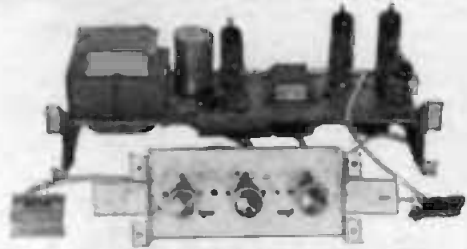
All parts and point to point wiring diagram.
OUR PRICE
£4.12.6
Plus P. & P.

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 **£8.10.0**
65A or B at

**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 MCIF, PCC.84 and PCF.80. Band 1-1.5. Band 3-8-11.
BRAND NEW
Plus P. & P. **39/6**

**SWITCHES
ROTARY**

Size 1 1/2 in. dia., 2 in. 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.

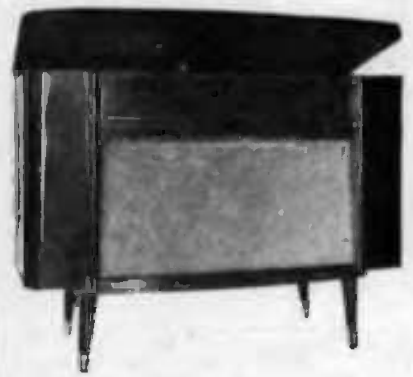
**STEREO and
MONAURAL
CARTRIDGES**

All makes and types in stock. Write for our bargain list.

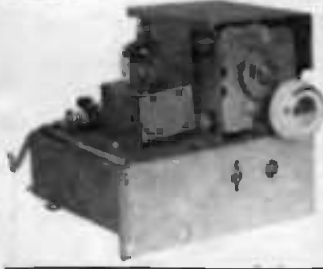
A few only as this month's bargain offer. Product of a well known manufacturer. Don't miss this wonderful offer.

OUR PRICE
£9.15.0

Plus P. & P.



6" x 4"
John 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 2/6. Plus P. & P.

AMAZING SCOOP
Cosmor 10" Tubes
100K. 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/-
16/45 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. -oil.

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.

SPECIAL OFFER. LIMITED QUANTITY.

GENERAL PURPOSE CATHODE RAY OSCILLOSCOPE

The famous model 160-B C.R. Scope, manufactured by R.C.A. of U.S.A. Best general purpose instrument of its kind, complete with 6in. cathode ray tube. Unused, guaranteed perfect. For operation on 110 v. A.C. Price £12/10/- Carr. 10/-
Step-down transformer to enable the above to operate on 230 v. Price 19/6.

FRESHLY IMPORTED MINIATURE CONTACT COOLED RECTIFIERS

Half-Wave Type

Max. A.C. in. 125 v. D.C. Out. 80 mA... 4/-
Max. A.C. in. 250 v. D.C. Out. 50 mA... 7/-
Max. A.C. in. 250 v. D.C. Out. 85 mA... 8/6

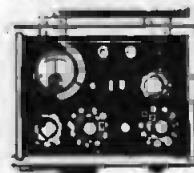
Television Type

Max. A.C. in. 250 v. D.C. Out. 300 mA 18/6
Full-Wave Bridge Connected
Max. A.C. in. 250 v. D.C. Out. 75 mA... 9/6
Max. A.C. in. 250 v. D.C. Out. 150 mA. 15/-



MAINS POWER SUPPLY UNITS, potted and sealed transformer and choke by famous maker. Mounted on metal chassis 6 1/2 x 7 1/2 in., complete with 5Z4 rectifier valve and full smoothing. Input tapped 220-230-240 volts.

Output: 300 V. D.C. at 100 mA.
6.3 V. A.C. at 4.5 amp.
6.3 V. A.C. at 2 amp.
Rectifier supply 5 V. A.C. at 3 amp. Very conservatively rated. Price 42/6 plus P. & P. 6/6.



WHEATSTONE BRIDGE UNIT.

4 stud switches 0-10, 0-100 ohms, galvanometer centre zero, F.S.D. 2.5 mA. In oak carrying case 16 x 7 1/2 x 6 in., 40/- each. P. & P. 3/6.



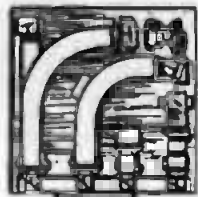
CABY MULTI-RANGE TEST METER. Freshly Imported.

Guaranteed Model A-10. A.C./D.C. Voltages, sensitivity 2,000 ohms per volt. Ranges: 10, 50, 250, 500, 1,000 v. Resistance: 10K ohm and 1 meg-ohm D.C. Current: 0.5 mA., 25 mA., 250 mA. Decibel range. Accuracy: 2 to 3%. Price 64/17/6.

P. & P. 1/6. Ask for leaflet fully illustrating and describing this and other models.

FRESHLY MANUFACTURED TRANSFORMERS. Ideal for model makers. Input tapped 200/250 volt. Output multi-tapped from 3 to 30 volts at 2 amperes. Price 19/6.

P. & P. 2/-



WAVE GUIDE

3 cm. mounted on a carrying board consisting of: (1) directional coupler, (2) 90 degree bend, (3) co-ax to wave guide adaptor type N. (4) British to W.916. (5) Co-ax to wave guide adaptor circular flange. (6) Circular to American adaptor. Complete in carrying case with coaxial cable. Price 60/- Carr. 10/-

Circular to American adaptor. Complete in carrying case with coaxial cable. Price 60/- Carr. 10/-

AERIAL AS ILLUSTRATED. Ideal for Car. Overall length 33in., khaki, with flexible shaft which enables the aerial to be fixed firmly in any position. Price 8/6, plus P. & P. 1/6.

NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohm, 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

W. W. RHEOSTAT. New. 3.5K, 25 watts. Price 7/6. P. & P. 1/6.

W. W. RHEOSTAT. New. 5K, 25 watts. Price 7/6. P. & P. 1/6.

SLIDER RESISTANCE. 44 ohm, 1 1/2 amp. Price 18/6. P. & P. 2/-

EX P.O. MAGNETIC COUNTER 3 ohms type for 4 1/2 volt D.C. operation. Price 6/6 each. P. & P. 1/-

AS ABOVE 500 ohm for 24/36 volt D.C. operation. Price 6/6 each. P. & P. 1/-

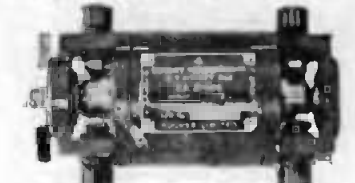
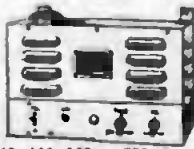


DESK TELEPHONE HANDSETS. Brand new (perfect) complete with two-way calling system (buzzer), internal battery. All ready for simple two-way connection. Price £3/5/- each, or £6/5/- the pair. P. & P. 3/6 each unit.

TRIPLE RANGE VOLTMETER. 0-5

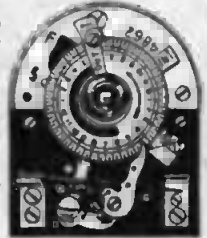
25-250 v. D.C. M/C 3 1/2 in. meter 3 1/2 in. scale, mounted in bakelite carrying case 7 1/2 in. x 4 1/2 in. x 3 in. complete with handle and test leads, 27/6 each. P. & P. 2/-

12 v. D.C. AMP-LIFIER. as new, for operation on 12 v. car battery, 10 watts undistorted output, with 6L6 valves in push-pull. Mike/Gram. input, capped output 7 1/2, 15, 62, 100, 250 or 500 ohms £12/10/- each. Carr. 15/-



MIDGET ROARY TRANSFORMERS. 2 1/2 in. dia. x 4 1/2 in. Input 11.5 volt. Output 310/365 volts at 30 mA. Brand new. 12/6 each. P. & P. 1/6.

VENNER 8-day clockwork Time Switch. Contacts 1 amp. 230 volt. 24 hour phase, 1 hour divisions, allows setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 1/6.



JACK PLUGS. Very latest type (201). Screw on bakelite covers in red or black. 2 contacts. Price 2/- each, post free. Dozen lots 21/- 3-contact type same price.

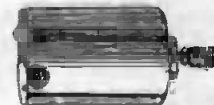
MERCURY SWITCH, 10 amp. contacts. Single pole. New. Price 3/6. P. & P. 6d.

METERS GUARANTEED PERFECT

Charging Types	
2 1/2 amp. D.C. M.I. 2 1/2 in. fl. rnd.	7/6
5 amp. D.C. M.I. 2 1/2 in. fl. rnd.	11/6
7 1/2 amp. D.C. M.I. 3 1/2 in. proj. rnd.	12/6
9 amp. D.C. Hot Wire W.R. 2 1/2 in. fl. rnd. 6/6	
Voltmeters	
12 v. D.C. M.C. 2 1/2 in. proj. rnd.	8/6
20 v. D.C. M.C. 2 in. fl. sq.	9/6
25 v. D.C. M.C. 2 in. fl. rnd.	7/6
30 v. M.I. 3 in. proj. rnd.	10/6
40 v. M.C. 2 in. fl. sq.	9/6
150 v. D.C. M.C. fl. rnd. 2 1/2 in.	10/6
250 v. A.C. rectified moving coil linear scale 3 1/2 in. fl. rnd.	35/-
300 v. A.C. M.I. 2 1/2 in. fl. rnd.	22/-
400 v. A.C. M.I. 4 1/2 in. fl. rnd.	35/-
Milliammeters	
1 mA. M.C. 2 1/2 in. fl. rnd.	25/-
2 mA. M.C. 2 1/2 in. fl. rnd.	14/6
5 mA. M.C. 2 in. round.	12/6
10 mA. M.C. 3 1/2 in. fl. rnd.	30/-
30 mA. M.C. 2 1/2 in. fl. rnd.	9/6
500 mA. M.C. 2 1/2 in. fl. rnd.	9/6
Microamp	
50 microamp, scaled 0-100, M.C. 2 1/2 in. rnd. fl.	42/6
200 microamp, M.C. 2 1/2 in. rnd. fl. (calibrated 0-50)	29/6
50 microA. 2 1/2 in. square, sidestitching 3 scales	35/-
500 microA. M.C. 2 in. rnd.	16/6

Postage on all meters 1/- each.

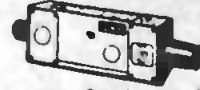
NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR 9 ampere in unspillable plastic cases. Comprises 6 x 2 v. separate cells connected by terminal strips, 6 x 5 1/2 x 4 1/2 in. over terminals. Price 19/-, plus P. & P. 2/6. Wooden carrying case for same with lid and strap price 3/6.

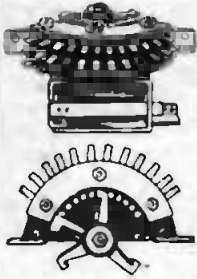


MINIATURE P.M. MOTOR. 12/24 volt, reversible. 1 1/2 in. dia. New. Price 9/6 each. P. & P. 1/-

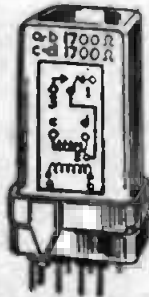
AIRCRAFT CINE CAMERA G45B Mk. III

Fully modified, fitted with 1/3.5 triple anastigmatic lens, takes 25ft. of 16 mm. film, fitted with 24 v. motor. 16 exposures per sec. Brand new, original packing, 64/10/- each. P. & P. paid.

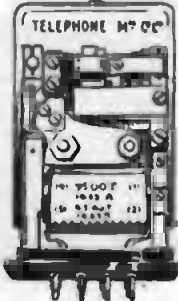




MINIATURE UNISELECTOR SWITCH. Two banks of ten plus home contacts one bank continuous of normal. 30 ohms coil for 24 volt operation. Brand new, manufacturer's packing. Price 22/6 each. P. & P. 2/6. As illustrated.



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. 1/6.

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 1 1/2 x 1 1/2 x 1/2 in. Price 22/6 each.

HIGH SPEED RELAY. Siemens, two bobbins, 1,000 ohms each. New, 10/6 each. P. & P. 1/6.

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 2 1/2 in. x 1 in. x 1 1/2 in. 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 2 1/2 oz. Price 18/6. P. & P. 1/6.

MINIATURE TYPE SEALED SLAVE RELAY. 700 ohms coil. Will work on 12 v. D.C. Single pole change-over contact. Weight 2 oz. Ext. new equipment. Price 9/6. P. & P. 1/6.



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 1/2 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.



MUIRHEAD PRECISION, 4 bank, 1 pole 24 position Stud Switch. Heavy duty contacts. Brand new. Original boxes. Price 17/6 each. P. & P. 1/6.

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 3 1/2 x 1/2 in. New. Price 15/- each. P. & P. 1/6.
10 WAY STRIP standard Post Office telephone Jack Sockets, spacing allowing Igranac 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.

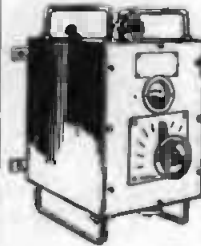
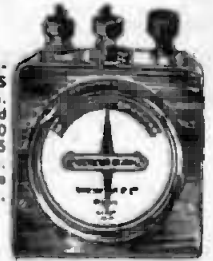


NEW MOVING COIL HEAD-SETS. Complete with Tannoy carbon hand microphone, with plug suitable for No. 19 set. Price 12/6 each, plus P. & P. 2/-.

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/-.

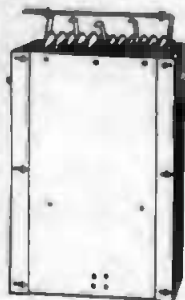
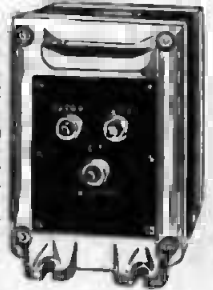
MARCHING COMPASS Mk. 1. Brand new ex W.D. Price 14/6. P. & P. 1/6.

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.



LT. 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.

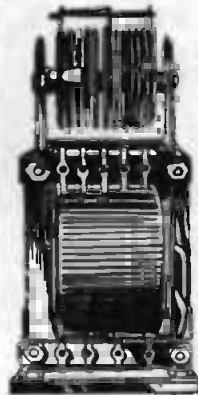
PLATE TRANSFORMER of very best U.S.A. make, brand new, original manufacturer's cases. Input tapped at 190/210/230/250 v. Output 2250-0-2250, centre tapped 400 mA. Nett weight 76 lb., size 13 in. x 9 in. x 4 1/2 in. Price £6/10/- each, plus carr. 10/-.



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 13 1/2 in. x 8 in. x 4 1/2 in. 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 amp. 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. 1/6.



MUIRHEAD VERNIER DRIVE. Scaled 0-180 degrees, ratio 3/1, 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! PERSONAL CALLERS ONLY: 9 Little Newport Street, London, W.C.2. Tel: GER 0576
SERVICE TRADING Co. ALL MAIL ORDERS: (Early Closing Thursday), 47-49 High Street, Kingston-on-Thames Telephone: KINGSTON 4585

CALLING ALL TELEVISION AND RADIO DO-IT-YOURSELF EXPERTS - THE NEXT 2 PAGES ARE FOR YOU!

A CHASSIS IS FOR SPARES 9/6 ALL THIS FOR ONLY

56 Resist., incl. 7 variable. Controls. Condensers, incl. electrolytics. Coils. 7 I.F. and R.F. trans., 14 valve holders. 0 B7G, 6 B5G, 3 octal, 4 trans., mains. O-PP-Line-Frame. Chokes 250 mA. Metal rec., 300 volt 250 mA. Fuse panel, scanning coils, focus magnet. Plugs, sockets, switch, chassis, screws, tag strips, etc. I.F. strip in separate power pack can be used without dismantling. Chassis has been used but were working when stored. Seven pages of circuits and instructions showing position of each component. Carriage 10/6.

SOUND/VISION AND I.F. STRIP 2/9

Salvaged. Complete sound and vision strip. Eight-valve holders. Less valves. I.F.'s 16-10 Mc/s. Size 8 1/2 x 4 1/2 in. Drawings free with order. P. & P. 2/6.

SOUND/VISION AND I.F. STRIP 7/9

Plessey. I.F.'s 10.5 Mc/s. vision. Eight valve holders. Less valves. Size 8 1/2 x 5 x 4 1/2 in. Circuit incl. The tuner unit plugs directly into this chassis. P. & P. 2/6.

TIMEBASE 2/9

Containing scanning coils, line transformer, etc. Less valves. Drawings free with order. P. & P. 2/6.

R.F. E.H.T. COIL 7/9

7-10 KV.R.F. Frequency approx. 22 Kc/s. Uses 6V8 or P61 as osc. Suitable for Ultra model V600, 700 and many other sets or replacing E.H.T. mains transformers. Ideal when using a larger tube. Size 4 1/2 x 2 in. dia. Base 4 x 4 in. Circuit drawings available with order. P. & P. 2/6.

REPLACEMENT RE-BUILT T.V. TUBES



CASH PRICE £8.10.0

OR Yours for 8/6 initial payment (plus Carr. & Ins.) and 19 weekly payments of 8/6.

12 months full guarantee

All sizes except 10in. Completely rebuilt gun assembly, new cathode, heaters, etc., giving the high standard required for long picture life, quality and value. Carr. and Ins. 15/6.

EXPRESS DESPATCH SERVICE

Please phone to confirm tube in stock. Send Telegraph Money Order. Tube despatched passenger train same day. This service only available with remittance by a Telegraph Money Order and cash sales—not terms.

AERIALS

B.B.C. indoor type. Folded dipole with 12ft. co-ax cable fitted. Post 1/9.

COMBINED T.V. AERIAL 35/6

Loft type. Single dipole B.B.C. with 3 elements. I.T.A. Swivel bracket for universal fixing. Ins., carr. 3/-. Or initial payment of 2/3 plus ins. and carr. and 19 weekly payments of 1/9.

CO-AX CABLE 6d. YARD

Cut to any length. Good quality at a very cheap price. Allow 1/6 postage on 20 yards 45/- per 100 yards. Post and packing 3/6.

FOCUS MAGNETS 9/9

Brand new. 38 mm., incorporating picture shift control. P. & P. 1/3.

FOCUS MAGNETS 12/6

38 mm. Brand new. Post and packing 1/3.

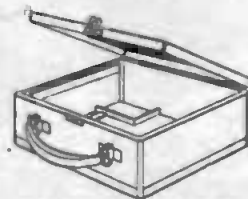
T.V. MASKS 2/9

Gold plastic for 15in. tubes. Post 1/3.

INSULATING TAPE 1/6

Finest quality. 75ft. x 1/2 in. in sealed metal container. Postage 6d.

STURDY CASE 12/6



8 1/2 x 7 1/2 x 3 1/2 in. deep. Covered in burgundy and grey washable rexine. Strong clasp, hinges and handle. Ideal for portable radio chassis or transistor set. Can be adapted as a

record carrying case to hold 18 7in. long playing records. P. & P. 2/6.

NO DEPOSIT-INTEREST FREE-20 or 36 WEEKS TO PAY! SEND FOR A FREE CATALOGUE—FULL DETAILS ON GOODS AND EASY PAYMENTS

TRANSFORMERS

MAINS TRANSFORMERS 7/9

Primary 200-250. Secondary 300-0-300. 6 v. at 3.3 amps. Post and packing 2/9.

350 0-350 v. at 250 mA. 12/9

6.3 volt at 4 amp., 6.34 volt at 4 amp., 4 volt at 3 amp., 22 volt at .3 amp., 4 volt centre tapped at 1.5 amp. Primary 200-250 volt, 50 cycles. P. & P. 3/9.

MAINS AUTO 0-205-225-245 v. at 300 mA. 8/9

Isolated windings of 6.3 v. at 2-6 amp., 6.3 volt at 3-6 amp., 2 v. at 1-4 amp. P. & P. 3/9.

350 0-350 v. at 250 mA. 12/9

6.3 volt at 5 amp., 4 volt at 4 amp., 4 volt at 7 amp., 4 volt centre tapped at 1 amp. Primary 200-250 volt, 50 cycles. P. & P. 3/9.

FRAME OUTPUT TRANSFORMERS 1/9

500 ohms primary. 18 ohms secondary. P. & P. 1/6.

HEATER TRANSFORMERS 3/9

2-1 ratio. Auto trans., 2 v. to 4 v., 3 watts. P. & P. 1/9.

HEATER TRANSFORMER 12/9

12 volt at 1/2 amp. 0-200-250 primary. P. & P. 1/9.

EY 51 ISOLATION TRANSFORMERS 7KV 5/9

1-1 ratio. Isolation trans. for 6.3 v. tube. P. & P. 1/9.

O.P. TRANSFORMERS 1/3

Standard size. 2-5 ohms. Post and packing 1/-. 20 for 51. P. & P. 5/6.

SMOOTHING CHOKE 250 mA 5/9

2nd 40 ohms. D.C. Res. New. P. & P. 1/6.

AUTO TRANSFORMERS, NEW, 8/9

4-5 v. at 2 amps. P. & P. 2/9.

MAINS TRANSFORMERS, NEW, 11/6

Type 672 primary. 210/250 v. Sec. 6.3 at 2 amp. Centre tapped 5 v. at 2 amp. P. & P. 2/6.

SOLO SOLDERING TOOL, 12/6

110 v., 6 v. or 12 v. (special adaptor for 200/250 v., 10/- extra). Automatic solder feed including a 20ft. reel of Erskin 60/40 solder and spare parts. It is a tool for electronic soldering or car wiring. Revolutionary in design. Instantly ready for use and cannot burn. In light metal case with full instructions for use. Post 3/6.



BAKELITE CABINETS, 5/9

Brand new. Colour brown. Attractive design. Size 12 x 7 x 5 1/2 in. Ideal for small receivers, converters, etc. P. & P. 3/9.



2 GANG CONDENSER 3/6

Brand new. Standard size. 2-5 ohms 0006. P. & P. 1/-.

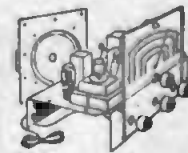
BUGIN 2-PIN FLEX CONNECTORS, 1/- pair

(Flat type). Post 6d.

MORE OF OUR ITEMS ON THE NEXT PAGE!

CHASSIS 1/-

6 or 8 valve, latest type midjet valve design for A.M. or F.N. Brand new. Cadmium plated. Size 12 1/2 x 7 1/2 x 2 1/2. P. & P. 1/9.



SUPER CHASSIS 79/6

Five-valve superbet chassis including 8in. P.M. speaker and valves. Four control knobs (tone, volume, tuning, w/change, switch). Four wavebands with position for gram. P.U. and extension speaker. A.C. Ins., carr. 5/6.



HOME RADIO 79/6

A.C./D.C. Universal mains. Five valve octal superbet. 3 waveband receiver can be adapted to gram. P.U. In attractive wooden cabinet. 9 1/2 x 18 1/2 x 11 1/2 in. Ins., carr. 4/6.

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.

REDUCED TO 59/6

or 4/1 Initial Payment balance at 2/11 for 10 weeks.

A beautifully styled cabinet. Made by famous manufacturers. Grey polka dot cloth, with clipped lid and carrying handle. Size 16x14 1/2 x 8 1/2 in. Uses a B.S.R. Monarch UA8 Player and 8 1/2 in. round or 8 x 5 in. elliptical speaker. Post, packing and insurance 4/6.



AMPLIFIERS

12 Months' Guarantee
ALL PORTABLE AMPLIFIER Mk. D.1. 59/6



Brand new. Latest design with printed circuit. Dimensions 7x2 1/2 x 6 in. 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 7x2 1/2 x 6 in. 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

The luxe model. Printed circuit. Latest design. Dimensions 7x2 1/2 x 6 in. 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.

69/6 CASH

or on weekly terms

A delightful looking cabinet in two tone leatherette. Size 14 1/2 x 17 1/2 x 8 1/2 in. Will take B.S.R. Monarch 4 speed auto changer and 6.1/3 in. round speaker. Post, packing and insurance 4/6. Or on Credit Terms



Initial payment 4/7 plus cost and ins. and 10 weekly payments of 3/6.

U.A.8. B.S.R. MONARCH 4-SPEED AUTOCHANGER

£6.19.6

or Terms



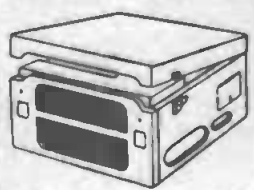
U.A.12. LATEST B.S.R. MONARCH 4-SPEED MIXER 25/9/6.
COLLARO CONQUEST 4-SPEED AUTOCHANGER 26/9/6.
COLLARO CONQUEST STEREO AUTOCHANGER 11 Gns.
P. & P. on all the above 5/6.

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 10 weekly payments of 9/11.

TAPE RECORDER CABINETS 19/6

Suitable for the Truvox Tape Recording Deck. Less front cast speaker panel. Size 13 1/2 x 15 x 8 1/2 in. deep. Detachable lid with compartment for spare tape. Covered in green washable plastic material. P. & P. 4/6.



B.S.R. FUL-PI 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.

PL10 CABINET

39/6

Size 14 1/2 x 12 1/2 x 6 in. Takes B.S.R. T.U.9 4-speed record player unit. 8 x 3 in. 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 x 4 in. Elliptical Speakers..... 19/6
9 1/2 x 4 1/2 Elliptical Speakers..... 22/6
Postage 2/6.

TAPE RECORDER CABINET 99/6

Superbly styled modern tape recorder cabinet. Two-tone green resin and vinyl grey. Dimensions 19 1/2 x 15 x 9 1/2 in. deep. Detachable lid. Recess compartment for microphone extension plug. Carr. and ins. 5/6.

A LARGE SELECTION ASSORTED TYPES AND SIZES PLAYER CABINETS from 19/6

All resin covered in modern two-tone colours. Your enquiries invited. Please let us have your requirements.

R.P.I. CABINET 59/6

Takes B.S.R. TU9 4-speed single player, 7 x 4 in. elliptical speaker, most of the modern portable amplifiers. Attractive speaker grille and recessed control panel. Dimensions 14 1/2 x 14 1/2 x 8 1/2, weight 13 1/2 lbs. Carr. and insurance 4/6.



EXTENSION SPEAKERS 19/9

Polished oak cabinet of attractive appearance. Fitted with 8 in. 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.



LATEST LINE JUST IN -

REGRET NO ILLUSTRATION YET!

Stereophonic Cabinet with Extension Speaker Cabinet. Well-known manufacture show model. Two-tone colours. Size 18 x 14 x 8 1/2 in. high. Suitable for a B.S.R. Stereophonic Autochanger. Two 7 x 4 in. speakers. Four-hole control panel for any suitable stereophonic amplifier.
CASH PRICE 99/6 or initial payment 6/1 plus Ins. & Carr. and 10 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 x 10 1/2 x 7 in. 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 17 in. 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. Vidcon 16 Mc/s. A.C. only. Ready and working to fit into your own cabinet. Carr. and ins. 25/-. As above with 14 in. tube, complete and working, £19/10/-.

SCOPE FOR A BARGAIN

DOUBLE-BEAM OSCILLOSCOPE TYPE 13A



Made for the Ministry by leading manufacturers (e.g., Erskine & Hartley Electromotives) this fine instrument is suitable for the examination of waveforms from two cycles to ten megacycles. It is extremely well designed and incorporates such desirable features of construction as potted "C" core transformers and paper smoothing capacitors for complete reliability. No electrolytic condensers are used.

TIME BASE 2 e.p.s. to 750 Kc/s.
Y PLATE AMPS. 5 Mc/s. bandwidth (3 dB).
CAL. MARKERS 1μ sec. and 10μ sec.
SIZE AND WEIGHT 13in. x 10in. x 22in. 58lb.
EXTERNAL PROBE For RF measurements
POWER SUPPLIES Internal (AC mains)

All instruments are in first-class condition and are carefully checked and tested before despatch. Mains connector, test leads, probe and circuit diagram are neatly contained in the detachable front cover.

£25 Carr. 30/-

UNIVERSAL IMPEDANCE BRIDGE TF373

An excellent bridge of earlier design having an almost identical specification to the TF365. These we offer are in very good electrical and mechanical condition and are in perfect working order. £35 carriage paid.

FERRANTI TESTMETER TYPE Q

Volts 0 to 30, 150, 600 A.C./D.C. with additional 0.3 v. D.C. and 0-15 v. A.C. ranges; milliamps 0 to 7.5, 20, 150 and 750 D.C.; amps 0-25 K. Accuracy 1000 1st grade. 500 ohms per volt. With leads, probe, battery and instructions. In velvet lined 4x7x3in. case. Brand new condition, perfect working order 52/6. Post 2/6

MARCONI B.F.O. TF602A

Frequency range 10 e.p.s. to 12,000 e.p.s. Operation is from A.C. mains. Output indication by magic eye (incorporates 9) cycles check. A reasonably compact instrument useful for general audio testing. Fair condition, tested and working perfectly. 88/19/6. Carriage 10/6.

CHARLES BRITAIN (RADIO) LTD.

it's NEW— it's miniature



CHANNEL TYPE 40 TRANSISTORISED SIGNAL GENERATOR

NET PRICE **£5.15.0** POST PAID

BATTERY 2/6 EXTRA • CASH WITH ORDER OR C.O.D.

- ★ TRADE AND EXPORT ENQUIRIES INVITED ★
- ★ Small enough to fit in your pocket—only 4½" x 3½".
- ★ Frequencies up to 20 Mc/s on fundamentals.
- ★ R.F. and audio outputs, attenuated.
- ★ Full standard specification.
- ★ Light weight—low consumption.

Write for descriptive leaflet or order today from—

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 STOCKISTS OF CARR FASTENER COMPONENTS

ALL POPULAR TYPES OF

Cinch COMPONENTS SUPPLIED FROM STOCK

TRANSISTORS. A.F. 7/6 each. R.F. 15/- each.
 TRANSISTOR CONDENSERS. Miniature Electrolytic Capacitors. 32 mfd. 3 v., 25 mfd. 25 v., 25 mfd. 6 v., 16 mfd. 12 v., 8 mfd. 6 v., 5 mfd. 12 v., 2.5 mfd. 25 v., 1.6 mfd. 6 v., 1 mfd. 12 v. All these types of condensers are 2/6 each. SPECIAL DISCOUNTS FOR QUANTITIES.

THREE ASTOUNDING TV TUBE OFFERS

- All brand new in famous makers' cartons
 - (1) 17in. rectangular aluminized 6.3 HTRS 3A current; max. anode voltage 16kV. Usual price £17/5/- OUR PRICE £9/10/6. Grating and carr. 15/-.
 - (2) Ferranti T12/44 and T12/54G 12 in. magnetic white fluorescence; 4 v. heater; max. anode 10 kV. As used in many TV receivers. Original price £17/5/-. Our price £4/19/6. Grating and carr. 12/6.
 - (3) Ferranti 9in. Tube round white fluorescence, 5 v. heater, max. anode voltage 7 kV. Our price £2/19/6. Grating and carr. 11/6.
- JONES PLUGS AND SOCKETS. 6 pin 2/6 pair; 6 pin 3/6 pair; 8 pin 4/6 per pair; 12 pin 4/6 per pair. If cover required send 1/6 extra per cover.

- WANDER PLUGS. Red and black doz. 2/-
- PHILIPS TRIMMER TOOLS 1/- each doz. 10/6
- 4-WAY PUSH-BUTTON UNITS 2/6 each. Knobs for same, 3d. each.
- POINTER KNOBS. Small black with white line, 7/6 per doz. Small white with black line 8/- per doz. Both types fin. spindle. Large price reductions for 1,000 lots and over.

CASH WITH ORDER OR C.O.D. ALL ORDERS DEPT. W.1. ALL ORDERS FOR LESS THAN £2 ADD POSTAGE.

We invite your enquiries for items not listed. Trade Counter open 9 to 6 Monday to Friday. Also 9 to 1 Saturday. Callers welcomed.

Large stocks of all types of resistors, condensers, valveholders always available ex stock. Manufacturers' enquiries welcome.



AVOMETER MODEL D.
£8.19.6 (P. & P. 3/6)

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 Amps.
15 V.	300 V.	1.5 Amps.	7.5 Amps.
20 V.	500 V.	2 Amps.	10 Amps.
150 V.	750 V.	15 Amps.	
200 V.	1.5 KV.	30 Amps.	
750 V.			Resistance
1.5 KV.			0-1000 ohms.
			±10% K ohms.

Thoroughly overhauled. Complete with batteries and instructions. An extremely robust meter at a very reasonable price.

CRYSTAL CALIBRATOR No. 10.
A crystal controlled heterodyne wave-meter covering 500 Kc/s. to 10 Mc/s. (Harmonics up to 30 Mc/s.) Requires 15 mA. and 12 v. 0.3 A. D.C. but can be easily modified for 120 v. and 1.4 v. working. Size 7x7x4in. First class condition, complete with valves, crystal, instruction manual and circuit. ONLY 5/9/6. Post 3/6.

CHOKES. Parmako 5 M., 200 m/amps., 6/6. MRO chokes, 17 M., 80 m/amps., 7/6. AR-88 chokes, 15 M., 90 m/amps., 8/6. Parmako 8 M., 100 m/amps., 7/6. Postage any type, 1/6.

G'SER (BC-453)
This Command Receiver covers 190-550 Kc/s. (-F.F. 85 Kc/s.) and is ideal for double superhet conversion, etc. Supplied BRAND NEW in original cartons, with all 6 valves and CIRCUIT. 8/9/6. Post 3/6.

SELENIUM BRIDGE RECTIFIERS. Fanned cooled, A.C. input 45 v. RMS. D.C. output 30 v. 10 amps. BRAND NEW. Boxed, 4/5/6. Post 3/6.

HEAVY DUTY LT. TRANSFORMERS. (Gresham.) Latest type potted, oil filled. Pri. 230 v. 50 c/s. Sec. 0-70-75-80 v. 4 amps. Size 3 1/2 x 4 1/2 x 6 1/2 in. high. Wt. 19 lb. BRAND NEW. 42/6. carr. 5/6. Gardner's Transformer. Tapped mains input. Secondary 12 volts RMS (C.T.). 30 amps. Housed in sheet metal case 9 1/2 x 8 1/2 x 6 1/2 in. high. BRAND NEW. 72/6. carr. 7/6.

4-VOLT VIBRATOR PACKS. MRO type, 180 v. D.C., 65 m/amps. BRAND NEW. 29/6. post 3/6. Type PU2, 200 v. D.C., 100 m/amps., with OZ4 rectifier. BRAND NEW 25/- Post FREE.

ADMIRALTY HT TRANSFORMERS Pri 230 v. 50 c/s. Secs. 620-550-375-0-375-550-620 v. (620 and 550 v. 200 m/amps., 375 v. 250 m/amps.), p.u.s two 5 v. 3 Amp. rectifier windings. Total rating 278 VA. Upright mtg. Wt. 25 lb. Made 1953. BRAND NEW. Original boxes. 45/- Carr. 5/-.

INSTRUMENT TRANSFORMERS. 230 v. A.C. input. Outputs 0-65-130-195 v. 85 m/amps., 6.3 v. 5 amps., 6.3 v. 0.3 amps. Shrouded. Size 3 1/2 x 3 1/2 x 3 1/2 in. high. 15/- post FREE.

ARB8D MAINS TRANSFORMERS. Input 110-240 v. Output 345-0-345 v. 125 mA/amps., 6.4 v., 4.5 amps., 5 v. 2 amps. 4 1/2 x 4 1/2 x 5 1/2 in. high. Wt. 12 lb. Potted. Tag ends. RCA BRAND NEW. Boxed, 29/6. post 3/6.

MARCONI CR100

Completely overhauled. In perfect working order. LOOK LIKE NEW. £21.
Later model with Noise Limiter, £25.
Carr. Engl and Wales 30/-. Send S.A.E. for full details.

RCA AR-88 SPEAKERS

A high quality 3 ohm unit fitted into heavy gauge black crackled steel cabinet, size 10 1/2 x 11 1/2 x 6 in. Fitted with rubber feet and 6ft. lead. Ideal for extension speaker, CR100, etc. In original cartons. BRAND NEW. 45/-. Post 3/6.

MINIATURE 373 IF STRIPS. For FM tuner described in "Practical Wireless." Complete with 3 of EF91, 2 of EF92 and 1 of EB91. A fresh release enables us to offer these once again. BRAND NEW. Complete reprint of conversion instructions and circuit supplied free. 35/-. OR less valves, 12/6. Post, either, 2/6.

LOUD HAILER EQUIPMENT

IDEAL FOR CROWD CONTROL, FACTORIES, FETES, ETC. CONSISTS OF 4 SPEAKER UNITS AND CONTROL UNIT. COMPLETE WITH MICROPHONE, HEADPHONES AND SPARES. OPERATES FROM 12 VOLTS D.C. (OR 8 VOLTS D.C. WITH SLIGHTLY REDUCED OUTPUT, CONSUMING ONLY 3 AMPS. OUTPUT POWER 8 WATTS. ALL TESTED AND WORKING, BUT SLIGHTLY SOILED. A GENUINE BARBAIN. £419.6. CARRIAGE 28/6.

OUTPUT POWER METER TF340



Impedance from 2.5(Ω) to 20,000(Ω) in 40 steps. 100 w. to 5 watts. Four ranges 0-5 mW., 0-50 mW., 0-500 mW., and 0-5 watts. First class condition. Tested. £91/9/6. Carriage 7/6.

T.C.C. VISCONOL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71 deg C. CP152V. Size 3 x 1 1/2 x 5 1/2 in. high. BRAND NEW. Boxed. 8/6 each, post paid.

MINIATURE RELAYS (ALL BRAND NEW and BOXED)
G.E.C. sealed, wire ends, 670(Ω), 2 MFD makes, M1099..... 15/-
G.E.C. sealed, wire ends, 670(Ω), 4 c/overs, platinum, M1092 19/6
G.E.C. sealed, wire ends, 5,000(Ω), 2 c/overs, platinum, M1052..... 17/6
Siemens High Speed, 1K+1KΩ, 1 c/over..... 10/6

HRO SENIOR RECEIVERS



Complete with ALL NINE general coverage plug-in coils for 50 Kc/s. to 30 Mc/s. instruction booklet, and circuit, but less external power supply unit. Table models, as new condition, 21 GNS. Rack mounting, 18 GNS. Packing and carriage 22/- extra. Send S.A.E. for further details. HRO POWER PACKS. 115/230 v. A.C. mains input. Tested, and in good condition. Table or rack. 69/6. Post 4/-.

CHARLES BRITAIN (Radio) LTD.

11 UPPER SAINT MARTIN'S LANE LONDON, W.C.2 TEMple Bar OS45

One minute from Leicester Sq. Station. (Up Cranbourne St.) Shop Hours 9-6 p.m. (9-1 p.m. Thursday.) Open all day Saturday



SANGAMO-WESTON VOLTMETERS
S61. Dual range 0-5 and 0-100 v. D.C. FSD 1 m/a. 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads.

BRAND NEW. Boxed 27/6. Post 2/6.

ELECTROSTATIC METER. Dia. 6 1/2 in. reads 5-18.5 Kv. Manufactured 1953. Contained in wooden case 10x10x9in. high. £9/19/6. Post paid.

SANGAMO-WESTON ANALYSER E772. A useful multi-range meter. Thoroughly overhauled and in perfect working order. For full details see previous adverts. £7/10/-. Carr. 4/6.

AVO LC and R BRIDGES. Capacity 5 pfd to 50 mfd. Resistance 5 ohms to 50 megohms. Inductance can be measured against external standard. Balance is indicated on a meter, which can be used as a valve voltmeter from 0.1 to 15 v. Leakage test and Power Factor scale. For use on A.C. mains. Tested and guaranteed. £8/10/6. Post 3/6.

HICKOCK 1-177 VALVE TESTERS. Checks dynamic mutual conductance, shorts, emission, gas, and noise. For UX4, UX5, UX6, UX7, Octal, Local, 87G, and Acorn types. Portable, in wooden carrying case 15 1/2 x 8 x 5 1/2 in. Wt. 13 1/2 lb. BRAND NEW. Complete with instruction book and valve testing charts. For 117 v. A.C. 10 gne. Carr. 7/6. Matching auto. transformers for 230 v. A.C. 12/6.

MARCONI SIGNAL GENERATORS
85 Kc/s. to 25 Mc/s. A.C. mains operation. In fair condition and good working order. TF144F, £40. TF144G, £50.

RIISS RECEIVERS. With latest type super slow-motion drive. In good condition and perfect working order. Re-aligned and air tested. Model "B" 8/7/19/6. Model "L" (covers crawler and shipping bands) £12/19/6. Carr. (either) 10/6. Send S.A.E. for details of sets and power units, or 1/3 for illustrated booklet.

SCR522 TRANSMITTER/RECEIVERS. 100-150 Mc/s. Comprises BC624A rec., and BC625 trans. with valves, and in good condition. BC624A, less relay 19/6. With relay, 25/-. BC625 22/6. These two, on rack 47/6. Carr. 7/6.

MOVING COIL PHONES. Finest quality Canadian, with chamol ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. 19/6. Post 1/6.

VITAVOX PRESSURE UNITS TYPE M. 20 watts. P.M. Heavy duty. BRAND NEW, boxed. 89/6. Carr. 5/6.

RESISTORS

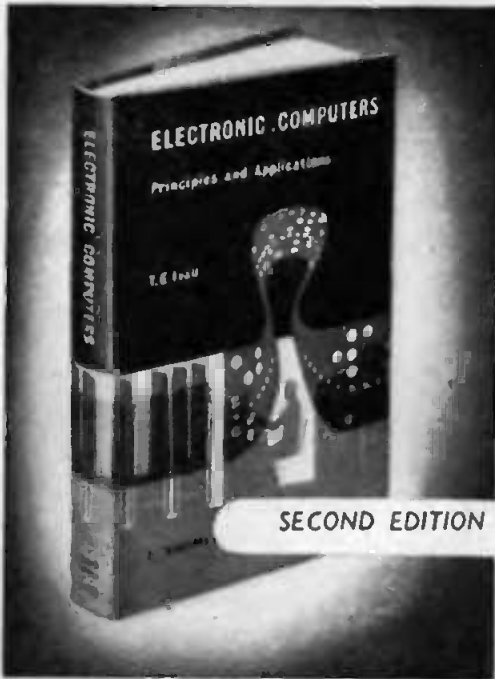
Morgan "T" (1 watt) and "R" (1 watt). Latest types, all BRAND NEW. 100 assorted, 10/- Post 1/-.

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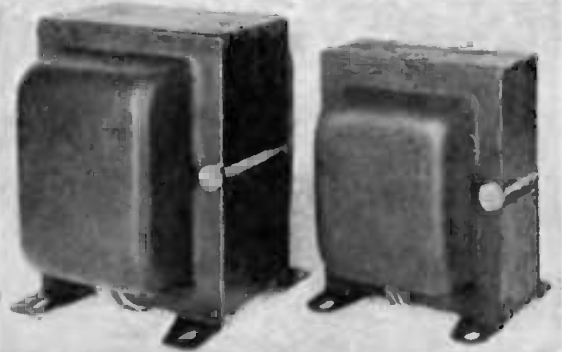
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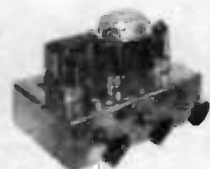
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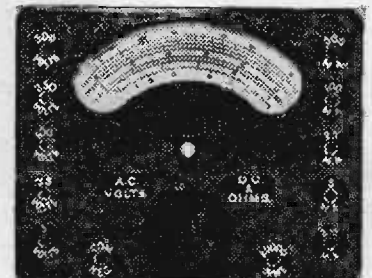
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SCR 522 TRANSMITTER (BC624) including all valves, 22/6. P. & P. 5/-.

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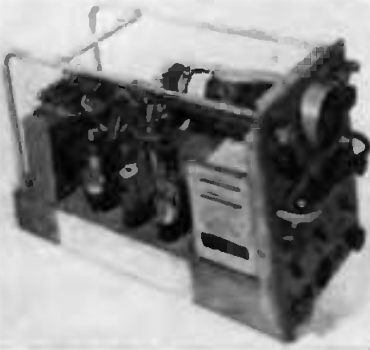
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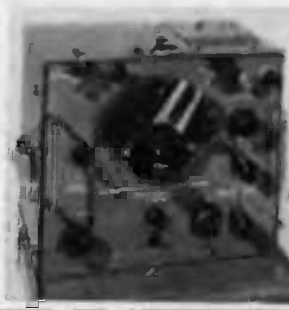
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 A basic scope with brilliance and focus controls on front panel which also contains X-plate terminals, gain control and two-speed timebase switch. Immediately behind the panel is a separate screened compartment that houses two VR65 and a VR92 (tunable 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.1181A 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.

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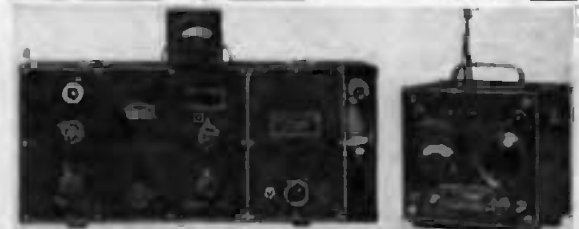
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 American panel mounting "Radio Altitude" meter with modern (coil round magnet) movement giving beautifully steady deflection to reading on large dial boldly marked 1 to 4 with sub-divisions in tenths. Supplied with suppressed zero which requires 6.5 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.



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 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 mcg. crystal. Retractable aerial. Power requirements: 6.3 v. and 120 v. Unit housed in copper lined wooden case. Size: 15 1/2 in. x 13 in. x 14 1/2 in. In good used condition. £2/10/- plus 10/- packing and carr.



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 Modern, portable, battery operated, 3 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.

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ECC163 9/6	EZ99 ... 7/6	UL153 ... 10/6	I L5S ... 3/6	6F1 ... 14/-	6X5G ... 7/-	12S7GT ... 10/6	382 ... 10/6
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ECC165 9/6	EZ99 ... 7/6	UL155 ... 10/6	I L5S ... 3/6	6F1 ... 14/-	6X5G ... 7/-	12S7GT ... 10/6	384 ... 10/6
ECC166 9/6	EZ99 ... 7/6	UL156 ... 10/6	I L5S ... 3/6	6F1 ... 14/-	6X5G ... 7/-	12S7GT ... 10/6	385 ... 10/6
ECC167 9/6	EZ99 ... 7/6	UL157 ... 10/6	I L5S ... 3/6	6F1 ... 14/-	6X5G ... 7/-	12S7GT ... 10/6	386 ... 10/6
ECC168 9/6	EZ99 ... 7/6	UL158 ... 10/6	I L5S ... 3/6	6F1 ... 14/-	6X5G ... 7/-	12S7GT ... 10/6	387 ... 10/6
ECC169 9/6	EZ99 ... 7/6	UL159 ... 10/6	I L5S ... 3/6	6F1 ... 14/-	6X5G ... 7/-	12S7GT ... 10/6	388 ... 10/6
ECC170 9/6	EZ99 ... 7/6	UL160 ... 10/6	I L				

Wilkinsons EST. 1921

METERS GUARANTEED

F.S.D.	Size	Type	Price
60 Microamps	2 1/2 in.	MC/FR	70/-
100 Microamps	3 1/4 in.	MC/FR	70/-
500 Microamps	2 in.	MC/FR	25/-
500 Microamps	2 1/2 in.	MC/FR	37/6
1 Milliamp	2 in.	MC/FS	27/6
1 Milliamp	2 1/2 in.	MC/FR	33/-
30 Millamps	3 1/4 in.	MC/FR	12/6
100 Millamps	2 1/2 in.	MC/FR	12/6
200 Millamps	2 1/2 in.	MC/FR	12/6
600 Millamps	3 1/4 in.	M1/FR	30/-
5 Amperes	2 in.	MC/FS	27/6
15 Amperes	2 in.	MC/FR	10/6
25 Amperes D.C.	2 in.	M1/FR	7/6
60-0-60 Amp.	2 in.	MC/FS	12/6
30-0-30 Amp.	2 in.	MC/FR	10/6
20 Volts	2 in.	MC/FS	10/6
50 Volts	2 1/2 in.	MC/FR	20/-
300 Volts	2 1/2 in.	M1/FR	25/-

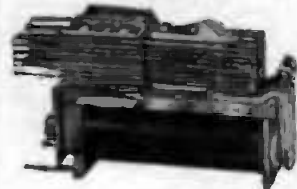


Postage on meters 1/6



CROSS POINTER METERS. 2 separate 100 microamp movements, 22/6. **MICROMMETER.** 250 P.S.D. 3 1/2 in. F.R. Sangano Mod. 537. Scales for valve voltmeter. Circuit available free. 85/-. Post 1/6.

RELAYS P.O. TYPE 3000



Build to your own specification
Keen Prices
Quick Delivery
Contacts up to 8-Changeover

MINIATURE RELAYS:

Siemens High Speed Sealed.	H06A	15/6	20	S.T.C. and G.E.C. Sealed.	4184GA	18/6
2.25Ω + 2.25Ω	H06C	10/6	700Ω	2 CO	418GD	18/6
145Ω + 145Ω	H06D	22/6	2500Ω	1 make	HD4186EE	22/6
600Ω + 600Ω	H06E	25/-	2700Ω	2 CO	4184GE	21/6
1700Ω + 1700Ω						
Siemens High Speed Open.						
100Ω + 100Ω	H85N	15/-	870Ω	4 CO	M1087	10/6
1000Ω + 1000Ω	H85A	17/6	2500Ω	1 CO	M1022	22/6
1700Ω + 1700Ω	H85L	17/6	5000Ω	2 CO	M1052	28/-

Comprehensive range available from stock.

SWITCHES. 1 hole fixing, 3 amp. 250 volt. 1/6 each, 12/- doz.

RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base, 4ft. 10in. in stock.



LOUDSPEAKERS.

P.M. ELAC 5IN. ROUND 18/6, POST 1/6. AXIOM 150 DUAL CONE 12IN. 15 WATTS 15 OHMS, FULLY DUSTPROOF, £7/10/6. POST 7/6. PYE 10IN. PORTABLE 3 OHMS 50/-, CARR. 7/6. 3IN. ROUND PLESSEY SPEAKER, SEALED TYPE WITH PROTECTIVE GRILLE 18/6, POST 1/6

JACK PLUGS. Cylindrical bakelite screw-on cover, 2 contact 2/6, post 6d.

SOCKETS. One hole fixing for above, 3/6, post 6d.



TELEPHONE PLUGS TYPE 201 with headphone cord, 3/- each, post 1/4. Large quantities available from stock.

TERMINAL BLOCKS. 2-way 4/- doz. or box of 50 for 15/-. 3-way 6/- doz., 50 for 22/6. Post 1/6.

VARIAC. Type 200 CUH. Infinitely variable 0—270 volts, 2.5 amps. Mounted in metal case with 0—250 voltmeter and 0—1 ammeter with its own input and output leads, complete unit, £12/10/6, carr. 7/6.

AVO TEST BRIDGES. 220/240 volt A.C. Measure capacities from 5 pf. to 50 mfd. and resistances from 5 ohms to 50 megohms. Valve voltmeter range 0.1 to 15 volts and condenser leakage test. BRAND NEW. Full working instructions supplied with instrument. £9/10/6. Post 3/-

OSCILLOSCOPE. Type 43. With 3 1/2 in. C.R.T. 138A. 4—617, 3—VR64, 624, VU120. Brand New with usual controls, power pack and leads. Suitable for 250 volts, £10/10/-. Carr. 12/6.

TEST KIT TYPE 25, which consists of set of 3 cm. wave guides and step-down transformer, etc., complete in carrying case, £7/10/-. carriage 15/-.

TEST SET TYPE 198. Oscillator unit and power pack 10SB/237 £38, carriage 20/-.

VARIAC TRANSFORMER. Input 250 volts. Output infinitely variable 0-250 volts and 0-270 volts. 9 amp., bench or panel mounting, £16, carr. 12/6.



TELEPHONES Easy to Fix

TELEPHONE SET TYPE "A" Ringing and speaking both ways on a 4-core cable. Very loud and clear over any distance. The handsets are as illustrated and the set is complete except wire. 4-core at 8d. per yard or 2-core at 3d. per yard extra. Price 75/- set, post 3/6.

SET B. Two headphones connected to breast microphones, with leads, plugs and fitted carrying cases. Join instruments together with two wires and 1 1/2 volt battery for a super intercom. 25/-, post 3/6.

SET "C" Similar to Set "A". Instead of P.O. Type handsets, two P.O. Desk Type Instruments are supplied with usual drawer in base. Complete ready for use. Price 150/-, post 7/-.

Set Type "D" Speaking only both ways on twin wire. The two handsets supplied are as illustrated with on/off switch built in handle. Supplied complete with battery and two 2-way terminal blocks. Price complete excepting wire 38/6, post 3/6. Twin flat PVC wire 3d. per yard. Twin flat PVC flexible 4d. per yard. Twin twisted silk flexible, 6d. per yard.

ROTARY CONVERTERS. Input 12 D.C. Output 230 A.C. 60 cy. 133 watts. In fitted case with variable resistance, 0/500 voltmeter. The ideal job for television where A.C. mains are not available. £10. Carr. 15/-.

BATTERIES. Portable Lead Acid type, 6 volts 125 ampere hours. In metal case 16in. x 18in. x 1 1/2 in. (Two will make an ideal power supply for our 18 volt Rotary Converter). Uncharged 88/10/- each, carriage 15/-. 24 volts 85 ampere, £15 each, carriage 15/-.

UNI-PIVOT GALVANOMETER by Cambridge Instruments, 50-0-50 microamps., dia. 4in. Knife pointer, mirror scale. Complete with leather carrying case. Ideal for laboratory use. £16, carriage 3/-.

SEMI-CONDUCTOR METAL RECTIFIERS
Charging Rectifiers. Full Wave Bridge.
12 Volts 1 Amp 8/6 each 24 Volts 1 Amp 13/- each
12 Volts 2 Amps 13/6 each 24 Volts 2 Amps 24/- each
12 Volts 3 Amps 18/6 each 24 Volts 3 Amps 28/- each
12 Volts 4 Amps 20/- each 24 Volts 4 Amps 36/- each

Discounts for quantities of above charging rectifiers.

MAINS TRANSFORMERS to suit above rectifiers.
12 Volts 1 Amp 12/6 each 12 Volts 4 Amps MT5 25/- each
12 Volts 2 Amps 24/- each CT109 12 Volts 4 Amps CT107 28/6 each
12 Volts 3.5 Amps 28/- each MT5B 24 Volts 3 Amps 28/- each

T.C.C. CONDENSERS. 0.1 Mfd., 31 kV. 75/- each, 1 Mfd. 10 kV. 48/- each, 10 Mfd. 10 kV. 150/- each.

RESISTORS EX STOCK IN QUANTITY WIRE WOUND, HIGH STABILITY CARBON ETC., BEST MAKES AT LOWEST PRICE.

MAGNETIC COUNTERS
Coating to 9999.
2-6 v. D.C., 18/- each, post 1/6
75—250 v. D.C. 15/- each, post 1/6

HIGH SPEED TYPE No. 100c. 36/-, post 1/6.
HIGH SPEED COUNTER with zero reset, 45/-, post 1/6.

VEEDER-ROOT MAGNETIC COUNTER. General purpose type with zero re-set. 800 counts per minute up to 999,999. 48 volt D.C. 85/-, post 2/6.
THERMOSTAT SATCHWELL. 1 1/2 in. stem 0/250 volt A.C./D.C. 15 amps A.C. 10 to 90 degrees cent. 25/-, post 2/6.
ROOM THERMOSTAT. Adjustable between 45 and 75 deg. Fahr., 250 v. 10 amp. A.C. Ideal for greenhouses, etc. 35/-, post 2/-.
SOLENOIDS. 12 volt D.C. with 3 1/2 in. lever. Ideal for remote control, model railways. 5/- ea., post 1/6. Unit of 26, 24/0/8. Cge. 15/-.

THIS MONTH'S SPECIAL OFFER. 60 amp. stydlok fuses complete with studs, nuts and washers, 2/6 each.

MULTI RANGE TESTMETER

20,000' ohms per VOLT
TAYLOR MODEL 127A.
HIGH SENSITIVITY
POCKET SIZE!

Performance equal to a high priced instrument.

20 Ranges
D.C. Current 50µA, 1mA, 10mA, 100mA, 1 Amp.
Volts D.C. 0.3, 2.5, 10, 25, 100, 250, 1,000V.
Volts A.C. 10, 25, 100, 250, 1,000.
3 Resistance Ranges from 0-20 megohms.
40µA Meter 3 1/2 in. arc. Accuracy D.C. 3%, A.C. 4%, Ohms 5%.
Dimensions 5 1/2 x 3 1/2 x 1 1/2 in. Price: £10.0.0 Post 2/6
Weight 14 oz.



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etc.

REPEATING THIS WONDERFUL OFFER BELOW MFRS. PRICE



10 WATT PUSH-PULL ULTRA LINEAR FEEDBACK



ORIGINAL MANUFACTURER'S PRICE 20 GNS.

LIMITED NUMBER ONLY AT

£14.19.6

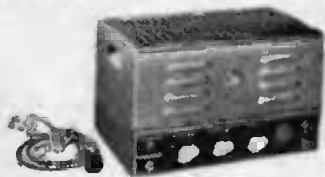
Complete Post & Pkg. 7/6 Fully guaranteed



AMPLIFIER AND PRE-AMPLIFIER

Beautifully finished in Grey-Green Stove Enamel. Provision for tuner, bass and treble, 5-position selector for radio, mic., tape, LP and std. records.

FOR THE ROVING BAND



BRAND NEW AND GUARANTEED. The Rolex mains and battery amplifier 230 v. A.C. and 12 v. car battery, 6 valve, 18 watt output, gram and mic. input. Fully encased, attractively finished. Valve line up: 1 6SK7, 1 6SN7, 1 6SW7, 2 6V6, 1 6X5 and 1 Mallory Vibrator. Ideal for small halls and home use. OUR PRICE 15 gns., plus 7/6 carr. & pkg. Can be supplied in 6 v. at same price.

A smaller 10 watt output version of the above, in 6v., 11 gns., plus 5/- carr. & pkg.

ANOTHER OF OUR AMAZING SCOOPS A Snip for the Constructor

Build this Costor Pocket 4 Transistor Superhet Receiver. Circuit description. 4 transistors (OC44, OC45, OC45, OC72), two OA70 diodes, two AGC systems, coverage 190-550 metres. Power output 30MW. Ferrite slab aerial, 2 1/2 in. moving coil speaker, printed circuit, attractive tuning control knob, leatherette case 6 in. x 3 1/2 in. x 1 1/2 in. All components including theoretical and point-to-point diagrams for easy construction. ONLY £7/19/6. Post & pkg. 2/6. All parts available separately. 9 v. PP4 battery 2/-. Maker's original price nearly £20.

SPECIAL OFFER

For the Hi-Fi enthusiast—Collaro 4-speed transcription motor and p/p using the new TX88 Studio cartridge. Brand new. List price £19/10/-. OUR PRICE £15/19/6. Crating and carr. 12/6. Easily wired for stereo to use Ronette stereo 6/0 cartridge.

THE LAST OF THIS OFFER

SLIGHTLY BOILED AT THE LOW PRICE 29/6

and 4/- post and packing.



Surplus to manufacturer's requirements, well made 2-tone colour portable player cabinets, will take non-auto player. Amplifier and 4 in. or 5 in. speaker. The above portable cabinet, B.S.R. T.U.9 and Acos pick-up, 4-speed player and 2-watt amplifier and 6 x 4 elliptical speaker making an ideal portable player, at the special price of £8/5/- plus 7/6 post and pkg.

BARGAINS IN PICK-UP CARTRIDGES

Brand new and complete with sapphire styl. B.S.R. T.C.8, less bracket, 15/- each. B.S.R. HI-G, 37/1/- with bracket, 17/6. Acos HI-G 59, with bracket, 17/6. Acos HI-G, with bracket, 17/6. Post and packing 9d. extra.

FOR THE CONSTRUCTOR

We can offer a limited number of RCA 10-12 watt amplifiers completely assembled. Just connect assembled amplifier chassis, control unit, power pack and attractive control panel together. Frequency response: 25-20,000 c.p.s., full 10 watt push/pull output, negative feedback, low hum level. Valve line up: 6BR7, 12AX7, 6BW6, 6BW6 and metal rectifier. Variable bass and treble controls and balanced loudness control which ensures true balance of sound from lowest bass to highest treble at both high and low listening levels. All this at the very low price of £7/19/6, plus post and pkg. 4/6.

HURRY! THE LAST OF THIS AMAZING OFFER. THE WORLD FAMOUS RCA ORTHOPHONIC AMPLIFIER

12-20 watt output. Distortions harmonic less than .1% at 10 watts/700 c.p.s. Noise Level: 85 D.B. below rated output. Frequency Response within 2 D.B., 20/2,500 c.p.s., within .5 D.B., 10/6,000 c.p.s. Feedback: 40 D.B. total. Output Impedance: 3.4 ohms, 7 ohms and 15 ohms. Spare Power: 295 v./45 M.A. and 6.3 v. 2.5 amps. for pre-amp. radio tuner and tape amp. A.C. Inputs 100/150 v. and 200/250 v. Valve Line-up: two EF86, two KT66 one GZ32. Dimensions: 16 1/2 x 8 x 7 1/2 in. Weight: 32lb.

PRE-AMP. Input: Mic., radio/tape high and low level, crystal magnetic p/p's. Tape and Record: output. Bass and Treble: lift and cut continuously variable. Mixing Facilitiless mic. input with radio and tape, low and high pass filter. Valve Line-up: one EF86, two ECC81. Dimensions: 12 1/2 x 6 1/2 x 3 1/2 in. Weight: 7lb. **THE COMPLETE EQUIPMENT AT 29 GNS. Carriage 15/-.**

HI-FIDELITY TAPE HEADS

Made by famous manufacturer. Brand new. Upper or lower track, record/play-back, high impedance giving up to 12,000 c.p.s. at 7 1/2 I.P.S. output 5 m/volts at 1 KC at 7 1/2 I.P.S. Erase heads low impedance. Only 39/6 per pair. Post 1/-. State upper or lower track.

THE NEW "INSTANT" BULK TAPE ERASER

Can erase a spool of magnetic tape in a few seconds. Demagnetises oxide deposits on tape heads. Only 27/6, post free.

SNIPS IN TAPE ACCESSORIES

Brand new E.M.I. 7 in. take-up spools in polythene bag, 3/9 each post free, 6 for 20/-. Brand new 5 in. Scotch Boy take-up spools 3/3 post free. 6 for 18/-.

KLENZATAPE, the new method for cleaning record and erase heads. 12/6. P. & P. 1/-.

METROTABS for identifying recorded passages on tape, 3/11 plus postage.

BRAND NEW AND GUARANTEED

7 in. reels of 1,200ft. P.V.C. base tape, 21/-, plus 1/6 post and pkg.
5 in. reels of 600ft. P.V.C. base tape, 14/6, plus 1/6 post and pkg.
4 in. reels of 300ft. P.V.C. base tape, 9/6, plus 1/- post and pkg.
7 in. reels of 1,800ft. LP. P.V.C. base tape, 32/6, plus 1/6 post and pkg.
5 1/2 in. reels of 1,200ft. P.V.C. base tape, 25/-, plus 1/6 post and pkg.
New E.M.I. 1 1/2 in. spools in polythene. The New American Audio Tape with plastic base. Also supplied in green or blue at no extra cost.

3 in. reel 150ft.....	6/-
4 in. reel 300ft.....	10/6
5 in. reel 600ft.....	18/-
7 in. reel 1,200ft.....	30/-
7 in. reel L.P. 1,800ft.....	35/-

Post and packing 1/6 per spool.

D.C. OSCILLOSCOPE



A.C. MAINS 200-250 VOLTS
SIMPLIFIED SERVICING
PROBLEMS WHEN USING
THE
'TEST-GRAB' SCOPE
3in. D.C. OSCILLOSCOPE

Engineered to precision standards, this high-grade instrument is made available at the lowest possible price, incorporating the essential features usually associated with luxury instruments. This "SCOPE" will appeal particularly to service Engineers and Amateurs. A high gain, extremely stable differential I-Ampmeter (30 mV/C.M.) provides simple sensitivity with A.C. or D.C. inputs. Especially suitable for measurement of transistor operating conditions where maintenance of D.C. levels is of paramount importance. Preheated X amplifier; fly-back suppression; Internal Time-base Scan Waveforms available for external use; pulse output available for checking T.V. Line O/P Transformers, etc.; Provision for external X 1/P and CRT. Brightness Modulation. Size 10in. high, 6 1/2in. wide, 9in. deep. Wgt. 11lb. £16/18/- plus P. & F. 7/6, or 30/- deposit, plus P. & F. 7/6 and 12 monthly payments of 2/6.

FULL 12 MONTHS' GUARANTEE INCLUDING VALVES AND TUBE

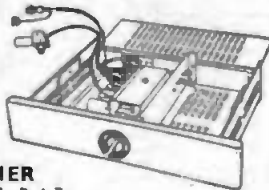
ALIGNMENT ANALYSER TYPE MC12

A.C. MAINS 200/250 volts. Frontier—"WOBULATOR" (SWEEP FREQUENCY) OPERATION, for FM/TV alignment linear frequency sweep up to 13 Mc/s. From 400 Kc/s.—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided 0—60 pf and 0—120 pf. SPECIAL FACILITY enable true resonant frequency of any tuned coil, I.F. transformer, etc., to be rapidly determined. Cash price £6/10/6 and 5/- P. & F. or H.P. terms 25/- deposit and 5/- P. & F. and 6 monthly payments of 2/1/6.



CHANNEL TUNER

Will tune to all Band I and Band III stations. BRAND NEW by famous manufacturer. Complete with M.C.C. 84 and P.C.F. 80 valves (in series). I.F. 16-19 or 33-38. Also can be modified as an aerial converter (instructions supplied). Complete with knobs.



22/6 Plus 2/6 P. & F.

HEATER TRANSFORMER

To suit the above, 250-250 v. 5/- Plus 1/6. P. & F.

B.S.R. MONARCH U88 with FUL-FI HEAD



4-speed plays 10 records 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Intermix 7in., 10in. and 12in. records of the same speed. Has manual play position, colour brown. Dimensions 13 1/2in. x 10 1/2in. Space required above baseboard 4 1/2in., below baseboard 2 1/2in. Fitted with Ful-Fi turnover crystal head. £6/10/6. Plus 5/- P. & F.

STEREO HEAD £7/10/6 Plus 5/- P. & F.

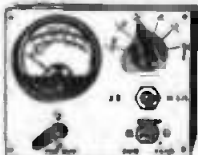
LINE E.H.T. TRANSFORMER

With built-in line and with control and winding for EY31. 14 KV. Beam coil, 80° deflection, on ferrite yokes. Frame O.P. transformer 600 pf. 10 KV. anastigmat condenser. Can be used for 14in., 17in. or 21in. tubes. Complete with circuit diagram.

29/6 Plus 4/- P. & F.

Focus Magnet suitable for the above (state tube). 10/-, 2/6. P. & F. 17in. PERSPEX MASK 8/6 Plus 2/6 P. & F.

AC/DC POCKET MULTI-METER KIT



Comprising 2in. moving coil meter scale calibrated to A.C./D.C. volts, ohms and milliamperes. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500; Milliamperes 0-10, 0-100. Ohms range 0-10,000. Front panel, range switch, wire-wound pot (for ohms zero setting), toggle switch, resistors and rectifier. Basic movement, h.a.s. In grey hammer finish case.

19/6 Plus 4/- P. & F. Built and tested 7/6 extra. Point-to-point wiring diagram 1/- free with kit.

SIGNAL GENERATOR



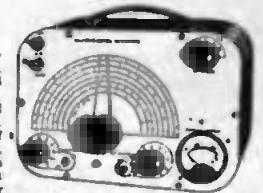
Covering 100 Kc/s—100 Mc/s on fundamentals and 100 Mc/s to 200 Mc/s on harmonics. Metal case 10in. x 6 1/2in. x 8 1/2in. grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F. output continuously variable 100 millivolts Q.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.

£6/19/6

SIGNAL GENERATOR

Coverage 120 Kc/s—230 Kc/s, 300 Kc/s—900 Kc/s, 900 Kc/s—2.75 Mc/s, 2.75 Mc/s—8.5 Mc/s, 8.5 Mc/s—28 Mc/s, 14 Mc/s—46 Mc/s, 34 Mc/s—84 Mc/s. Metal case 10in. x 6 1/2in. x 6 1/2in. Size of scale 6 1/2in. x 3 1/2in. 3 valves and rectifier. A.C. mains 200-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent. modulated or unmodulated R.F. Output continuously variable 100 millivolts C.W. and mod. switch variable 100 P.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%.

£4/19/6



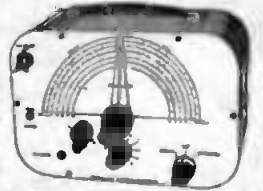
Or 25/- deposit and 4 monthly payments 2/1/6. P. & F. 5/- extra.

SIGNAL & PATTERN GENERATOR

£6/19/6

P. & F. 5/-

Or 25/- deposit, P. & F. 5/- and 6 monthly payments of 2/1/6. Coverage 7.5 Mc/s—210 Mc/s in five bands all on fundamentals, slow motion tuning scale, output, 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ±1%, A.C. mains 200-250 v.



F.M. TUNER UNIT

Permanently tuned by famous German Manufacturer. Coverage 88—100 Mc/s. Complete with EOC35. Size 4in. x 7in. x 2in.

25/- Plus P. & F. 1/6.

Circuit diagram free with unit.

10-7 Mc/s. I.F. and Discriminator Coil 4/- pair

2-TRANSISTOR POCKET RADIO

Uses Germanium diode, fully tuneable over medium and long waves. Size 3 1/2in. x 4 1/2in. x 1 1/2in. Complete set of components including case, 2 transistors and earpiece (two batteries). Point to point wiring diagram 1/6. (Free with kit).

19/6 Plus P. & F. 1/6.

PUSH-PULL OUTPUT STAGE

Inclusive of transistors with input and output transformers to match 3 ohm speech coil, suitable for use with the above kit. Complete kit of parts including transistors. Point to point wiring diagram 1/6. (Free with kit).

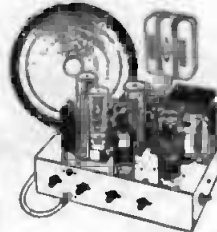
19/6 Plus P. & F. 1/6.

MAINS TRANSFORMERS

All with tapped primaries 200-250 volts. 0-100, 150, 200 v., 60 ma. 6.3 v. 3 amps. 10/8. 320-0-320 v. 75 ma. 6.3 v., 2.5 amp. 6 v., 2 amp., 10/6. 280-0-280, 20 ma. 6.3 v., 2 amp., 6.3 v., 1 amp., 10/6. Footage and packing on the above 2/-.

8 WATT PUSH-AMPLIFIER

COMPLETE WITH CRYSTAL MIKE AND 2in. LOUDSPEAKER



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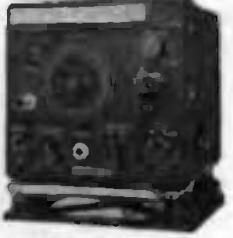
D.C. VOLTS	A.C. VOLTS	D.C. Current	A.C. Current
150 mV.	1.5 v.	10 mA.	75 mA.
300 mV.	3 v.	20 mA.	150 mA.
1.5 v.	7.5 v.	100 mA.	750 mA.
3 v.	15 v.	200 mA.	1.5 amp.
15 v.	75 v.	1 amp.	7.5 amp.
30 v.	150 v.	2 amp.	15 amp.
150 v.	750 v.	10 amp.	
300 v.	1,500 v.		Resistance
750 v.			1,000 Ω
1,500 v.			10,000 Ω

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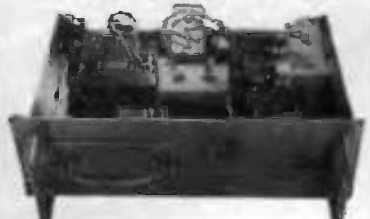
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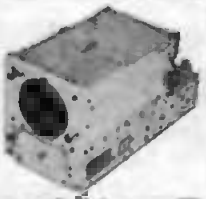
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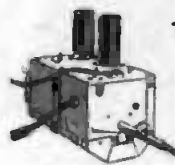
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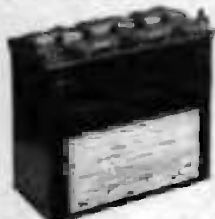
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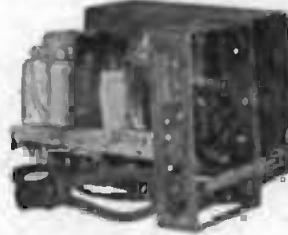
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1	275	1x11	W/B	1/6	84	350	1x3	O	2/6	12+20	275	1x2	F	1/6	100+200	250	11x4	C	2/6
2	275	1x11	W	1/6	75	12	1x11	C	10s.	18+16	160	1x11	T/B	1/6	100+200	275	11x4	O	5/6
4	180	1x11	T/B	1/6	80	450	1x3	W/B	2/6	18+18	275	1x2	F	2/6	100+250	275	11x4	O	5/6
4	180	1x11	W	1/6	100	13	1x11	W/B	1/6	18+18	380	1x2	C/B	2/6	100+300	275	11x4	O	5/6
6	25	1x11	W/B	1/6	100	23	1x11	T	1/6	20+10	450	1x2	C	2/6	100+400	275	11x4	O	5/6
6	250	1x11	W/B	1/6	100	25	1x11	T/B	1/6	20+20	275	1x2	F	2/6	150+30	350	11x4	O	5/6
8	180	1x11	T	10s.	100	25	1x11	W	1/6	20+20	450	1x3	W	3/6					
8	200	1x11	W	1/6	100	370	1x2	O	1/6	20+20	450	1x3	F	3/6					
8	250	1x11	W/B	1/6	109	278	1x3	C	1/6	24+24	330	1x2	O	1/6					
8	275	1x11	W	1/6	100	275	1x3	T/B	1/6	25+25	500	1x2	F	1/6					
8	450	1x2	F	1/6	100	350	1x3	PC	10s.	50+30	180	1x2	W/B	1/6					
10	780	1x4	O	8/6	150	25	1x11	W	1/6	32+22	180	1x2	C	1/6					
10	18	13/22	1x1	1/4	150	150	1x3	W/B	1/6	32+32	150	1x2	W/B	1/6					
10	18	1x11	T/B	1/6	200	6	1x1	M	1/6	32+32	150	1x3	F	10s.					
10	25	1x11	T/B	1/6	200	12	1x11	W	1/6	32+32	250	1x2	PC	1/6					
10	25	1x11	W	1/6	200	25	1x11	T	10s.	32+32	275	1x2	C	2/6					
10	25	1x11	W/B	1/6	200	33	1x11	C/B	10s.	32+32	275	1x2	F	1/6					
10	25	1x11	W	1/6	250	378	1x3	O	1/6	32+32	500	1x2	W/B	1/6					
10	25	1x11	W/B	1/6	250	6	1x3	C/B	10s.	32+32	330	1x2	W/B	3/6					
12	25	13/22	1x1	1/8	250	12	1x11	W	1/6	32+32	480	1x3	W/B	4/6					
12	150	1x11	T/B	1/6	250	23	1x11	T	1/6	40+20	180	1x2	F	10s.					
12	375	1x2	F	10s.	250	25	1x11	O	1/6	40+40	150	1x3	F	10s.					
16	250	1x2	F	1/6	250	40	1x11	T	1/6	40+40	275	1x2	PC	1/6					
20	250	1x2	F	1/6	250	180	1x3	F	1/6	40+40	300	1x2	PC	1/6					
20	4	1x11	W/B	1/6	400	6	1x2	P/R	8s.	40+40	430	1x3	W	2/6					
20	15	13/22	1x1	1/4	500	6	1x11	T	10s.	50+50	150	1x2	C	1/6					
20	150	1x1	T	10s.	500	8	1x3	O	8s.	50+50	280	1x3	F	1/6					
25	450	1x2	W/B	1/6	500	12	1x11	T	1/6	50+50	250	1x2	F	1/6					
25	12	13/22	1x1	1/8	500	12	1x11	W	1/6	50+50	275	1x2	F	1/6					
25	25	13/22	1x1	1/8	500	12	1x2	C	8s.	50+50	275	1x2	C	1/6					
25	25	1x11	W	1/6	500	25	1x3	C	1/6	50+50	275	1x3	PC	1/6					
25	50	1x11	T	1/6	5000	3	1x2	C	3/6	50+50	300	1x2	O	2/6					
25	30	1x11	W	1/6	6000	8	1x2	C/B	3/6	60+100	278	1x3	F	2/6					
32	275	1x2	F	1/6	6000	8	1x3	C/B	4/6	60+100	350	1x4	O	2/6					
40	180	1x3	W/B	6/6						60+200	278	1x4	O	2/6					
40	350	1x2	F	1/6						60+250	278	1x4	O	2/6					
50	6	13/22	1x1	1/4						80+300	278	1x4	O	2/6					
50	12	13/22	1x1	1/8						80+300	278	1x4	O	2/6					
50	18	1x11	W	1/6						100+65	250	1x3	F	2/6					
50	25	1x11	W	1/6						100+100	18	1x2	O	1/6					
50	50	1x11	T	1/6						100+100	25	1x2	F	1/6					
60	275	1x3	W	1/6						100+100	275	1x3	C	2/6					
60	350	1x2	T/B	2/6						100+100	300	1x3	F	3/6					
64	275	1x3	F	1/6						100+100	300	1x3	F	3/6					

TRIPLES Etc.

8+8+8	350	1x2	F	4/6
16+8+4	275	1x2	F	2/6
16+16+4	275	1x2	O	2/6
16+16+16	275	1x2	O	2/6
20+15+15	450	1x3	F/B	3/6
20+20+20	500	1x3	F	1/6
25+25+25	35	1x3	O/B	1/6
30+20+30	275	1x2	F	2/6
32+8+8	278	1x2	F	2/6
32+18+25	300/28	1x2	F	1/6
32+32+8	275	1x2	O	2/6
32+32+6	275	1x2	O	2/6
32+32+8	250	1x2	O	2/6
32+32+25	275/255	1x3	O	2/6
32+32+32	350	1x3	O	4/6
32+200+50	278	1x4	O	3/6
32+300+70	275	1x4	O	3/6
40+30+20	180	1x2	O	1/6
40+40+12	275	1x2	O	2/6
40+40+20	278	1x2	F	3/6
40+40+30	300	1x2	F	3/6
40+40+32	275	1x2	PC	2/6
40+80+20	450	1x3	F	2/6
50+24+24	275	1x3	F	2/6
50+50+6	275	1x3	F	3/6
50+50+10	180	1x2	O	1/6
50+50+30	350	1x3	F	2/6
60+30+30	278	1x4	O	3/6
100+40+40	450/50	1x4	F	4/6
100+100+50	300	1x3	F	4/6
100+100+200	278	1x4	O	4/6
100+250+250	275	2x4	O	5/6
100+400+18	275	1x4	O	4/6
100+400+32	278	1x4	O	4/6
200+250+250	275	1x4	O	6/6
40+20+10+10	350	1x2	O	3/6

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- (1) Radio and Television Development Engineers for work on Domestic Radio and Television Receivers.
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These are opportunities for progressive positions and with an expanding organisation. 40-hour 5-day week; Staff Canteen; Pension Scheme.

Please write, with details of previous experience and salary required to:—

The Personnel Manager,
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52-70 Tabernacle Street,
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coil designer

A vacancy exists with more than usually attractive future prospects for a senior designer of coils, transformers and network filters in the low frequency field to deal with varied and interesting requirements including transistorised active filters.

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to work in close liaison with the G.E.C. Research Laboratories on the development and production of magnetrons and Travelling Wave Tubes. Qualified engineers are invited to apply, quoting Ref. ME/2. Specialised training will be given where necessary.

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with at least O.N.C. Elec. or App. Physics are also invited to apply for more junior vacancies, which will offer good prospects of advancements as the group expands. Ref. TM/2.

Please write, quoting the appropriate reference to

Personnel Officer
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With practical experience in the design and development of one or more of the following:

- ★ Magnetic recording circuitry.
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At least one year's experience in Electronics is required.

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The posts offer much scope for originality and initiative in a small but rapidly expanding organisation.

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THE INDEPENDENT TELEVISION AUTHORITY has vacancies for ENGINEERS

for the operation and maintenance of television transmitters and ancillary equipment. The Authority is in a position to offer appointments with opportunities to suitably qualified young men who have either some experience in this field or who have had a good basic training in radio, radar or television. There would be opportunities for further training and all appointments are pensionable after the initial period of probation has been satisfactorily completed.

Service with the Authority may involve transfers to various locations in the United Kingdom, but preference for a particular area will always be considered.

Appointments will be made in the grades of Shift Engineer and Technical Assistant. Starting salary would be determined, to a certain extent, by qualifications and experience. Applications, giving details of age, academic qualifications and experience, quoting reference number E/12, should be addressed to the:

Personnel Officer,
Independent Television Authority,
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For details of the above, write to:
The Principal, P.11,
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34a Hereford Road, London, W.2



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:—

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Broadcasting House, London, W.1.

Please quote reference EX.60.6 W.W.

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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.

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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.

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Applications are invited for the post of
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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.

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Salary scale: £485 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. LEATHEN,
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AN EXPANDING COMPANY

engaged in the manufacture and development of a wide range of thermionic devices wishes to engage the services of **FOUR QUALIFIED**

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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.

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TRADE

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THE FIBRES DIVISION OF IMPERIAL CHEMICAL INDUSTRIES LIMITED

has vacancies at its Headquarters in Harrogate, Yorks. in the Instrument Section.

This Section of Research Department is concerned with the development and construction of prototype electronic instruments and research apparatus of partly mechanical and partly electronic components.

These vacancies fall into two categories requiring the following qualifications—

TECHNICAL OFFICERS

A degree or equivalent in Physics or Electronic Engineering.

ASSISTANT TECHNICAL OFFICERS

Higher National Certificate standard in Electronics.

In either case, a good knowledge of electronic principles and practice and of the physical problems involved in more important than engineering practice of final instrument making beyond the prototype stage.

Housing assistance, removal expenses and lodging allowances are available to enable married men to settle into the Harrogate district. Conditions include a five day week, canteen facilities, Staff Pension Fund and Employees Profit Sharing Scheme. Applications, giving brief details, to the

**STAFF OFFICER, FIBRES DIVISION,
IMPERIAL CHEMICAL INDUSTRIES LTD.,
HOOKSTONE ROAD, HARROGATE, YORKS.**



SALES ENGINEERING

Vacancies exist for technical assistants to senior sales engineers in the television, radio and audio fields. The positions give an unequalled opportunity for learning in an important activity at the centre of the business.

The products covered are picture tubes, receiving valves and semi-conductors; the customers are set-makers. The duties will be largely internal at first, but should broaden quickly depending on the individual. Written applications should be sent to the Personnel Officer,

Mullard Limited,
Mullard House,
Torrington Place,
LONDON, W.C.1.

NORTHERN ELECTRIC CO.— CANADA

OFFERS

JOB SECURITY AND OPPORTUNITY TO TELEPHONE ENGINEERS

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Our continuing expansion now has created additional vacancies for

EXPERIENCED TELEPHONE ENGINEERS

who can analyse customer requirements for particular installations and develop and prepare individual job manufacturing and installation specifications for manual and automatic switching equipment; transmission of short and long distance telephone, telegraph, radio, microwave and T.V. signals, etc.

Men qualified by experience and training for these equipment engineering positions will be interviewed in Great Britain during late March. Transportation allowance for successful applicants. Give full details in first letter to:

**DEPT. N.E.C., NATIONAL EMPLOYMENT SERVICE—CANADA,
61 Green Street, LONDON, W.1.**



PERSONAL CALL

Service Engineers required for the above system which includes Transmitters and transistorised receivers.

Training given to suitable applicants for positions in our test department and in the field.

Apply Personnel Department,
Multitone Electric Co. Ltd.
12-20 Underwood Street,
London, N.1. Telephone CLE 8022.

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INVITE APPLICATIONS FOR THESE POSTS**

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A sound technical and practical knowledge of broadcast receiver engineering and maintenance is required, together with administrative ability. Car radio experience desirable but not essential to person of right calibre.

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Experience of car radio application and maintenance desirable but not absolutely essential. This progressive appointment is in the Service Department.

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These appointments hold out very definite prospects of advancement for the right individuals.

Applications giving full details of career to date should be addressed to:

**THE STAFF MANAGER, S. SMITH & SONS (ENGLAND) LTD.,
CRICKLEWOOD, LONDON, N.W.2** quoting ref. SM243.

TELECOMMUNICATION ENGINEERS


Development Engineers, all grades, from minimum O.N.C. and C. and G. Telecom. and Radio or equivalent qualifications. Preferably with background of design and practical experience in H.F., V.H.F. amplifiers, filter and transistor techniques (£650-£1,250).

Tech. System Planning Engineers, Tech. Exps. of good general and technical educational level minimum O.N.C. and C. and G. Radio or equiva. To liaise with technical clients and lay out H.F. T.V. Relay or closed circuit systems. Previous experience advantageous but training given to persons with right background. Car drivers. Willing to travel (£750-£1,000).

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Remuneration, within range given, in line with character, ability and experience applicant can immediately bring to bear. All posts offer permanency and wide prospects in interesting and challenging field.

The above personnel are required immediately by TELENO LIMITED, Telecommunication Engineers of many years' standing, for their new works extension at Church Road, Harold Wood, Essex. (London-Liverpool St. 23 mins.) Write in first instance in complete confidence to Mr. J. R. Evans, Dept. PW.



I.C.T

Engineering Instructors

I.C.T have vacancies for men to instruct Computer Factory Test Personnel and Computer Service Engineers at their Engineering School, Letchworth, Herts.

Selected candidates will receive a detailed course of instruction in the applications of transistors to the Company's equipment. Full salary will be paid during training. These are permanent and pensionable appointments. Working conditions and amenities are excellent and there are good prospects of promotion.

Applicants should be engineers of H.N.C. standard who have had practical experience of transistors. Preference will be given to those with knowledge of pulse techniques. Some experience of teaching would be an advantage.

Write, giving brief particulars of education and experience, to the Manager, Personnel and Training Division (P.1.).

International Computers And Tabulators Limited

Gloucester House,
149 Park Lane, London, W.1

Please quote reference PT/EL on letter and envelope.

UNICAM INSTRUMENTS LIMITED

This Company specialises in the production of high quality optical instruments for use in spectrum analysis and has an international reputation as a leader in this field. At all stages of manufacture the best standards of workmanship are needed.

We have vacancies for men with electronic experience for testing. Radar and radio technicians with fault finding experience would be suitable.

If you have the kind of background which you think would fit you for this interesting work in a pleasant University City, please let us have full details of your qualifications and experience.

Write to:— The Works Manager,
Unicam Instruments Limited,
Arbury Works, Cambridge.
quoting reference ES.21.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY PRODUCTION GROUP INSTRUMENT MECHANICS

Windscale and Calder Works, and Chapelcross Works require experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitude analysers, counting circuits, television and industrial instruments used for the measurement of pressure, temperature and flow.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training Courses in Specialised Techniques are provided for successful applicants having suitable Instrumentation background.

Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions and promotion prospects are good.

Applications to:

Works Labour Manager, Windscale and Calder Works, Sellafield,
Seascale, Cumberland

or

Works Labour Manager, Chapelcross Works, Annan,
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Fly with the R.A.F. as an Air Signaller

There are immediate vacancies for fit young men to train as Air Signallers. They will carry out a wide range of skilled duties in the latest types of aircraft.

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Write for full details stating age and educational qualifications to:—

The Under-Secretary of State,

AIR MINISTRY (M.9) (WD 565), ADASTRAL HOUSE,
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UNITED KINGDOM ATOMIC ENERGY AUTHORITY

INSTRUMENT MECHANICS

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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.

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Assistant Personnel Manager,
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DIGITAL COMPUTERS

Electronic Engineers or Physicists of graduate standard required for technical supervision of "National-Model 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.,
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COMMERCIAL MANAGER

required for leading ELEC-TRONIC 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 Cumberwell 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,
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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. G.P.S., Marconi House, 336/337, Strand, London, W.C.2. quoting reference WW2070K

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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

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Tel. No.: COLINDALE 7063

OR

J. & F. STONE LIGHTING & RADIO LIMITED

82, Rye Lane, Puckham, B.E.15.

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Experiences in one or more of the following—
 (1) Maintenance of radio communication receivers.
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 (4) Fault finding in and maintenance of electronic apparatus.
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 Basic Pay £9/8 per week plus merit pay, assessed at interview and based on ability and experience as under—
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 Opportunities for permanent and pensionable posts. Five-day week, good working conditions, single accommodation available.
 Apply in writing to: Personnel Officer,
 C.O.H.C. (R&D),
 83, Clarence Street,
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2938, DPST (NO) DPST (NC), 160 G, 24V, 100 mA pull-in, 20 mA drop out (p.p. 1/6) 7/6
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Clare 223991344, SPDT, 12V, 130 G, 50 mA pull-in, 20 mA drop out (p.p. 1/6) 2/6
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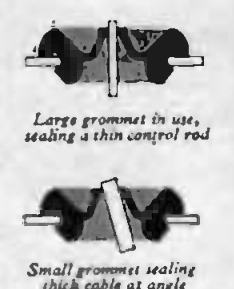
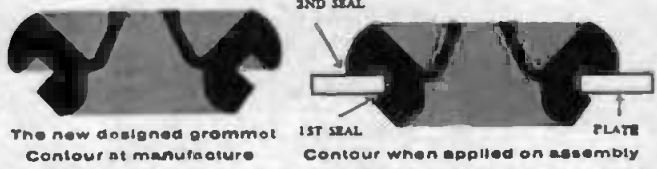
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PRICE, brand new without batteries £2 10 0
Manual 17 6
 One manual supplied free per each six transmitters.
Packing and postage 6 6
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Laboratory Standard Wavemeter covering a range 0.5 kc/s. to 10 mc/s. on fundamentals and up to 200 mc/s. in harmonics. Generation of any frequency from 0.5 kc/s. to 10 mc/s. with accuracy of 1 in 10⁵ to 10⁶ c/s.; Generations of any tone from 5 kc/s. to 10 mc/s. with accuracy of 1%. Output signal amplitude 0.2 to 0.3V. Decade tuning. Manual operation. **PRICE** £280 0 0
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Packing and carriage 41 0 0

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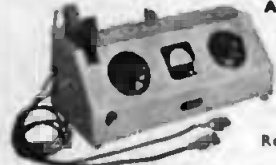
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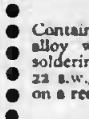
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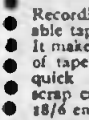
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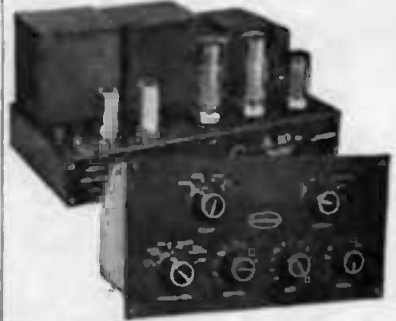
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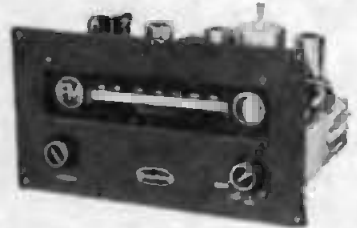
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TECHNICAL Assistant required for testing, installation and servicing work on X-ray fluorescence equipment; good knowledge of modern electronic techniques including pulse work would be an advantage; applicants should be prepared to travel in U.K. and abroad and hold current driving licence.—Please write, quoting reference D84 to Personnel Officer, Hiler & Watts, Ltd., 98, St. Pancras Way, N.W.1. [8952]

AIR Ministry requires examiners (technical class grade III) for aeronautical inspection services. 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. & O. 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.4s, London, W.C.1. or any Employment Exchange quoting City 85. [8956]

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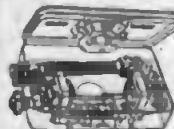
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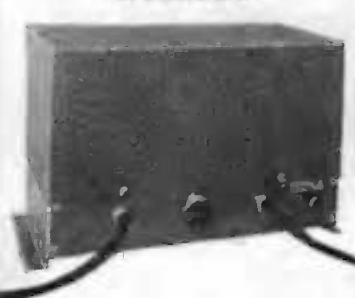
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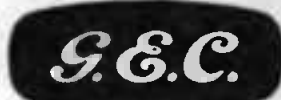
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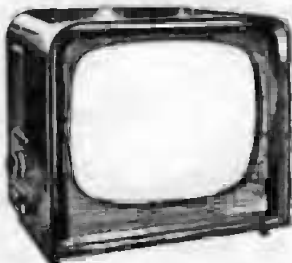
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