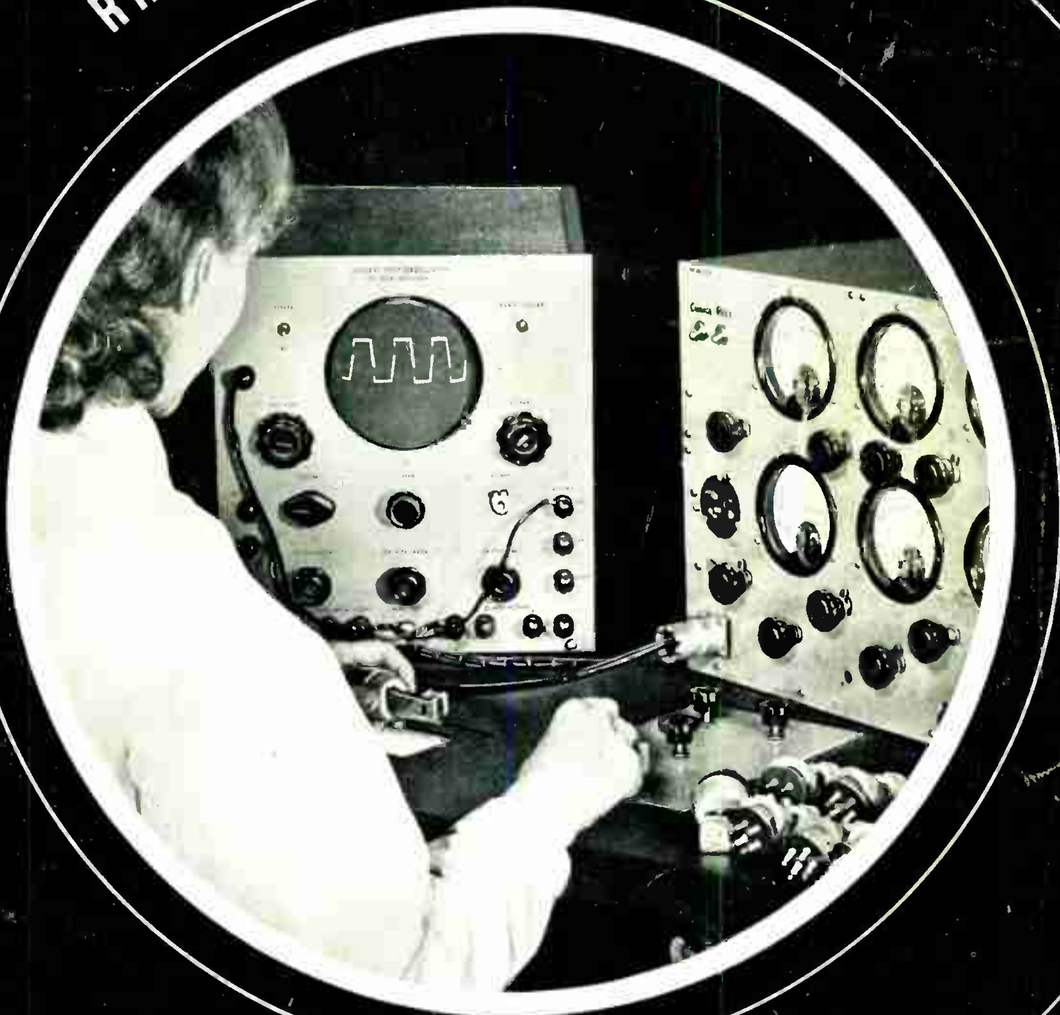
Wireless World

RADIO AND ELECTRONICS



JULY 1949

2/-

Vol. LV. No. 7

IN THIS ISSUE : TUNABLE TELEVISION RECEIVERS

The NAME helps you sell

The B I C C *All Wave* ANTI-INTERFERENCE AERIAL

BICC are world famous for their electrical and radio products. The Anti-Interference Aerial maintains this reputation.

What it does

It has been specially designed to alleviate interference caused by radiation from electrically-operated transport, vehicle ignition systems, electrical appliances using commutator motors, lighting systems, etc. A high signal level is obtained and this ensures better listening on all broadcast wave-lengths, giving maximum choice of programmes against a quiet background.

What it is

A 60-ft. polythene-protected dipole complete with insulators and matching transformer, 80-ft. coaxial screened downlead with polythene plug moulded to each end, and a receiver transformer. All the necessary components for the Aerial are included in the complete kit.

Write for Publication No. 221S giving further information.

Obtainable only from recognised dealers. **£6 . 18 . 0**

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BRITISH INSULATED CALLENDER'S CABLES LIMITED
NORFOLK HOUSE, NORFOLK STREET, LONDON, W.C.2

Fine Limits of Accuracy

VALVE CHARACTERISTIC METER

A comprehensive instrument built into one compact and convenient case, which will test any standard receiving or small power transmitting valve on any of its normal characteristics under conditions corresponding to any desired set of D.C. electrode voltages. A patented method enables A.C. voltages of suitable magnitude to be used throughout the Tester, thus eliminating the costly regulation problems associated with D.C. testing methods.

A specially developed polarised relay protects the instrument against misuse or incorrect adjustment. This relay also affords a high measure of protection to the valve under test. Successive settings of the Main Selector Switch enable the following to be determined :—

Complete Valve Characteristics including Ia/Vg, Ia/Va, Is/Vg, Is/Va, Amplification Factor, Anode A.C. Resistance, 4 ranges of Mutual Conductance covering mA/V figures up to 25 mA/V at bias values up to −100V., together with "Good/Bad" comparison test on coloured scale against rated figures.

"Gas" test for indicating presence and magnitude of grid current, inter-electrode insulation hot and cold directly indicated in megohms, separate cathode-to-heater insulation with valve hot. Tests Rectifying and Signal Diode Valves under reservoir load conditions, and covers all the heater voltages up to 126 volts.

The AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD.
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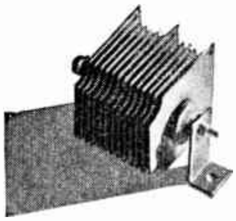
Avo Precision Electrical Testing Instruments

VC/3

H.T. AND E.H.T. RELIABILITY



Typical rectifier for use in A.C. or A.C./D.C. receivers.

Type 36EHT rectifier. Two such units only $2\frac{1}{2}''$ long by $\frac{7}{16}''$ dia. will give an output of 5.3kV.

"Westeht" E.H.T. supply unit. 5kV output from a 350-0-350 A.C. input.

Many WESTINGHOUSE RECTIFIERS HAVE OVER 21 YEARS' SERVICE TO THEIR CREDIT

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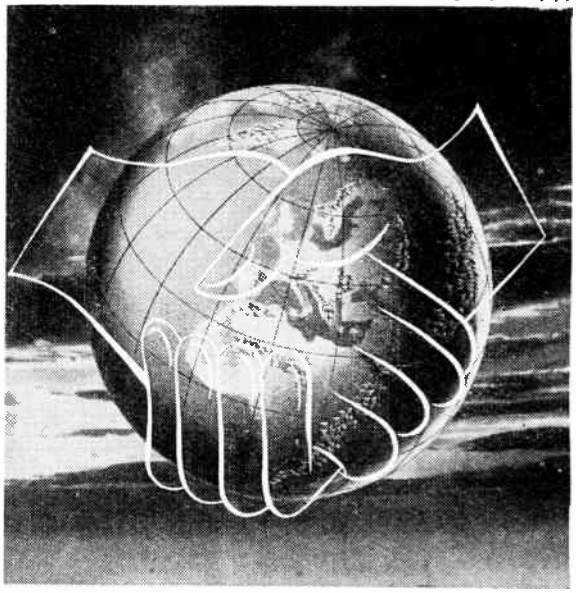

Plans for a neighbourly world

Marconi's first wireless messages did more than enable nation to speak to nation. They drew closer the world's boundaries, quickened the tempo of existence and turned distant acquaintances into next-door neighbours. Broadcasting has helped still further to increase our knowledge of our neighbours; wireless navigational aids and radar have brought greater safety and faster travel between Continents. And so Marconi's will continue to pioneer. Their engineers are busy today on developments which will make the world a closer community tomorrow.

Marconi

the greatest name in wireless

MARCONI'S WIRELESS TELEGRAPH COMPANY LTD., MARCONI HOUSE, CHELMSFORD, ESSEX.

DAILY DEMONSTRATIONS

of the "BARKER 148A" mounted in the "RD" BASS REFLEX CABINET in conjunction with the "RD" JUNIOR or "WILLIAMSON" AMPLIFIERS.

Full details forwarded on request.

ROGERS DEVELOPMENTS CO.,
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AN ATTEMPT TO REALISE AN IDEAL

In the High Quality World, let us commend Patience, Perseverence, and Good Temper above all; but also Skill and Intelligence.

The ultimate performance of a speaker unit—especially if it is a very good one—depends as much on the intelligence of the user as on the skill of the designer.

If you are a true quality enthusiast, perseveringly pursuing an Ideal, then we know we can help you.

To readers in the North West, we demonstrate the 148A and discuss its best possible use.

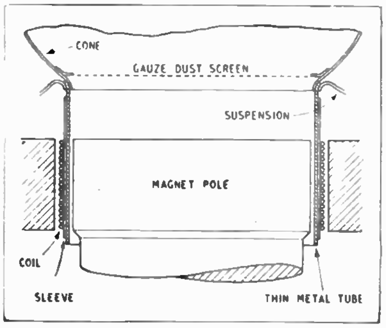
J. H. BRIERLEY (Gramophones and Recordings) **LTD.,**
46 Tithebarn Street, Liverpool, 2

MR. A.C. BARKER'S 148A

In December 1947 we were complimented by the Wireless World on some features of the Barker 148. These were: the excellent balance at comparatively low levels; the homogeneity of high frequency response; low frequency response sensibly uniform down to 40 c/s with no major bass resonance.

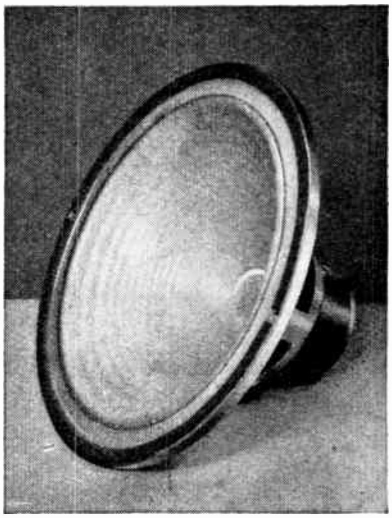
Of the new 148a, with its better magnet and new cone treatment, owners and critics have remarked: the attack and transient response give the impression of contrast expansion; so wide a range of frequencies with apparent evenness of output produces an aural naturalness which has to be heard to be appreciated; it is the best baffle loaded speaker we have ever heard.

We ourselves believe it to be the most NATURAL, satisfyingly truthful and pleasant to live with sound reproducer made anywhere.



The unique constructional features, patented in many countries and exclusive to BARKER, contribute to this performance. First is the DUAL DRIVE shown on the left, and second the cone LOGARITHMIC CORRUGATIONS.

These produce a very smooth highly damped acoustic generator of exceptionally wide frequency range and remarkable clarity. They are described fully in a new leaflet obtainable at the specialists who join us in this announcement, or



from your usual dealer, or from our monomark address
BCM/AADU, LONDON, W.C.1
The 148a is being sent to many countries overseas.
EXPORT ENQUIRIES INVITED

MOST NATURAL SOUND REPRODUCER

See our Advt. on page 10

ALWAYS THINK OF
GOODSELL LTD.
FOR STANDARD AND SPECIAL
HIGH FIDELITY AMPLIFIERS

WEBB'S RADIO invite you to hear the "Barker 148A" in our demonstration room, from radio or the Brierley pick-up. You will doubtless endorse our opinion that this is an outstanding loud-speaker.

(Webb's hire-purchase facilities available on all equipment.)

Stockists for: BARKER, MORDAUNT, VOIGT, LEAK, CHARLES, BRIERLEY, AND ALL "HI-FI" EQUIPMENT.

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SMALL OSCILLOSCOPE AND WOBBULATOR

Specially designed for Service Engineers

Oscilloscope Type 1/B

Time-base: 10—350,000 c/s.
X.Plates: Direct or Amplified.
Y.Plates: Direct or Amplified.
Miniature Valves and $1\frac{1}{2}$" **diameter C.R.T.**
Dimensions: Height $7\frac{3}{4}$" Width $5\frac{1}{2}$" Depth 11"

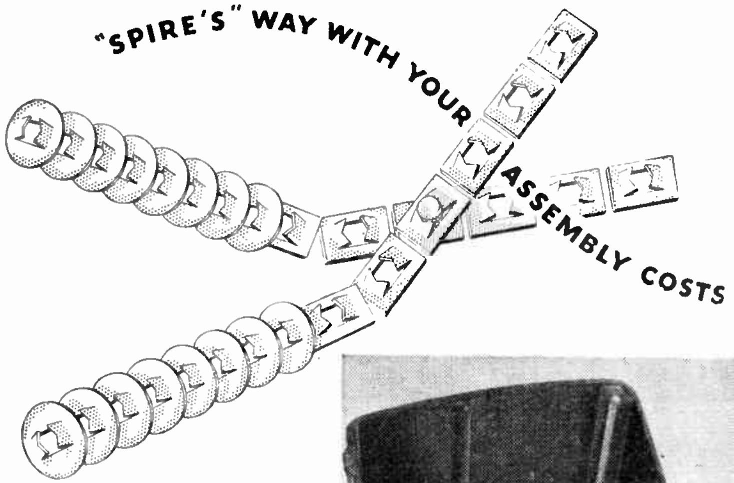
Wobbulator Type 1/B

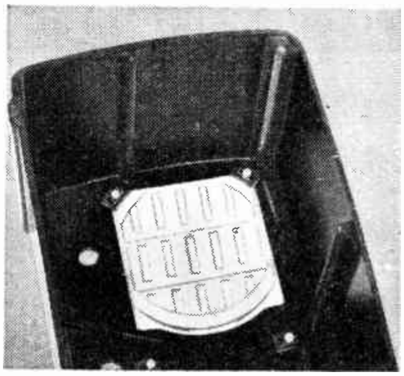
Separate Power Supply: 200-250V. 50 c/s.
Output Voltage: 4V. R.M.S.
Nominal Frequency: 1.2 Mc/s.
Frequency Deviation: 0 to $\pm$40 Kc/s.
Dimensions: Height $2\frac{3}{4}$" Width $5\frac{1}{2}$" Depth 11"

The two units clip together and are priced at

ONLY **£20**

ERSKINE LABORATORIES LTD—SCALBY, SCARBOROUGH, YORKS.





The mounting of this loudspeaker grille is achieved by the use of "Push-On" Type Spire Fixes on integral unthreaded moulded studs. Inserts eliminated; moulding costs reduced; assembly is REALLY FAST.

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Keeping assembly cost DOWN (and at the same time keeping assemblies safely together) can be a major production headache. Spire Speed Nuts answer that requirement. And many others as well. Acting on its own double-spring locking device, each Spire nut is speedier to put on, holds tighter when it's home. Awkward fixings and blind assemblies are tackled with equal ease by Spire. Sometimes threaded members can be eliminated altogether. Will you write for more information on Spire Speed Nuts -- the fastest thing in fastenings?

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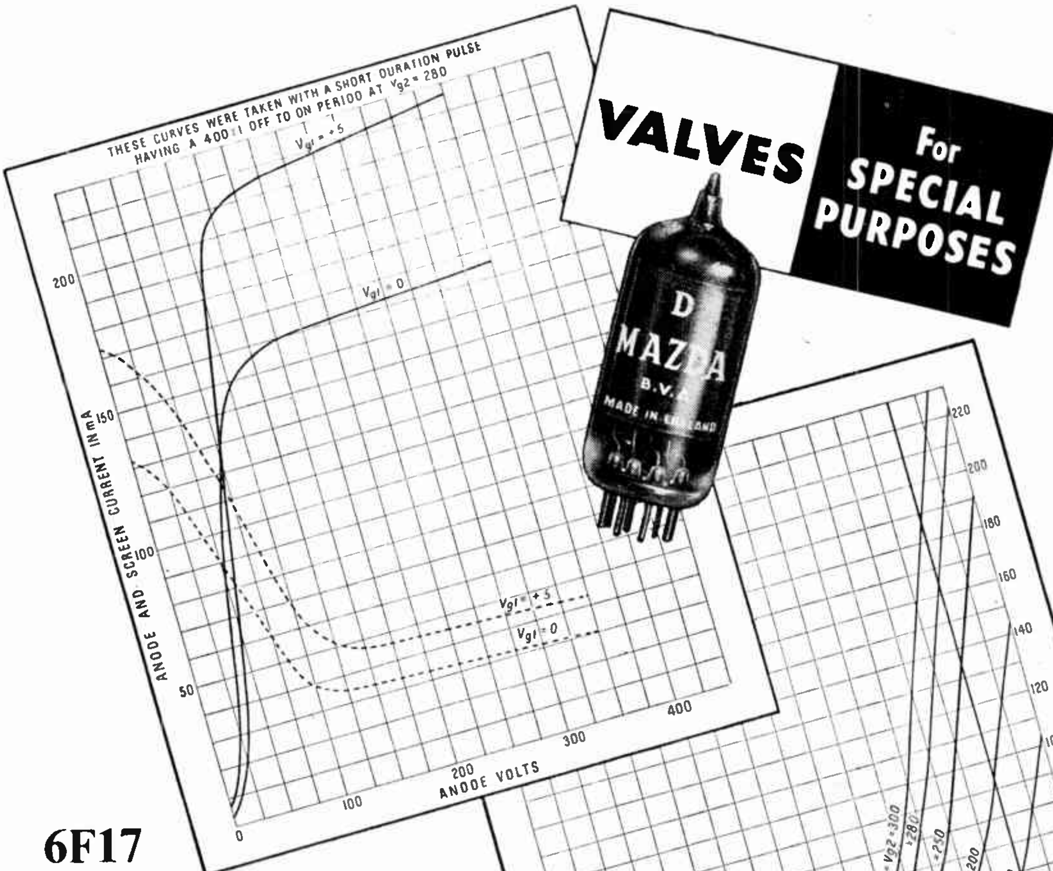

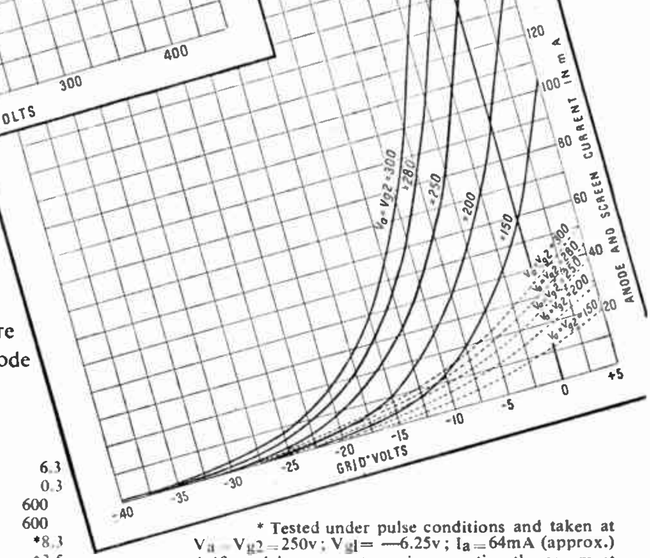

6F17

MINIATURE PULSE AND R.F. BEAM TETRODE

The Mazda 6F17 is an indirectly heated miniature pulse and R.F. Beam Tetrode having an anode dissipation of 3.5 watts.

RATING

Heater Voltage (volts)	V_h	6.3
Heater Current (amps)	I_h	0.3
Maximum Anode Voltage (volts)	V_a(max)	600
Maximum Screen Voltage (volts)	V_{g2}(max)	600
Mutual Conductance (mA/V)	gm	*8.3
Maximum Anode Dissipation (watts)	Pa	‡3.5
Maximum Screen Dissipation (watts)	Pg2	0.7

* Tested under pulse conditions and taken at $V_a = V_{g2} = 250$v; $V_{g1} = -6.25$v; $I_a = 64$mA (approx.)
‡ If used in a can at maximum rating the can must be matt black both internally and externally.

Further details given on application to the Radio Division.

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MAZDA
RADIO VALVES AND TELEVISION TUBES

THE EDISON SWAN ELECTRIC CO. LTD., 155 CHARING CROSS ROAD, LONDON, W.C.2
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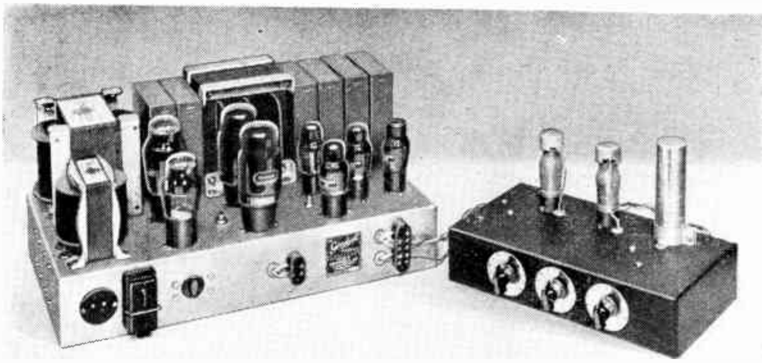

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IS OUR P.X. 25
Price **£30·10·0**

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15 WATT HI-FIDELITY AMPLIFIERS

are unsurpassed in performance

AS DESCRIBED BY T. D. N. WILLIAMSON IN "*Wireless World*," MAY, 1947

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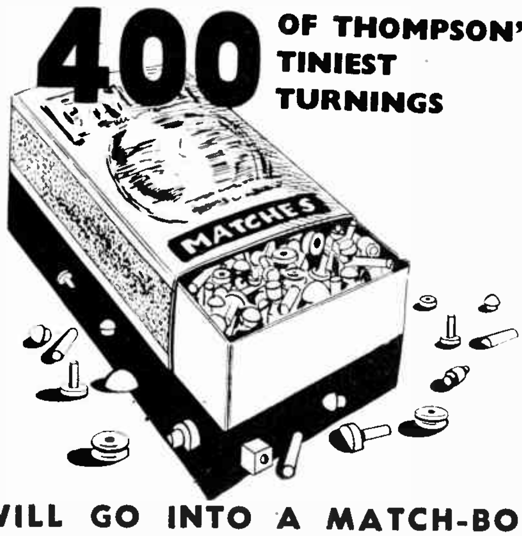
Easy Terms from LONDON RADIO SUPPLY CO. Balcombe, Sussex



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WILL GO INTO A MATCH-BOX

and every single one is DEAD ACCURATE in size

That's how Thompson's work. Whether you require large or small turnings *in wood*, Thompson's will make them exactly to your specification.

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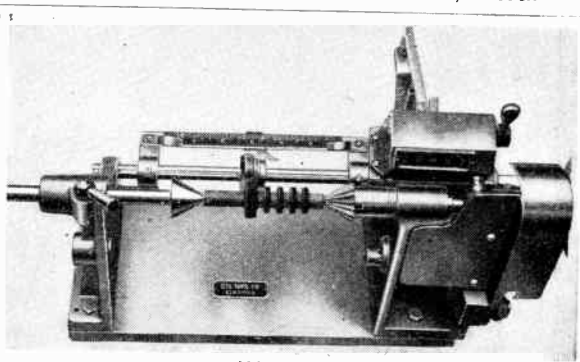
'Phone : Crosshills 2312-3 (2 lines) *'Grams :* Turnwood, Crosshills



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AUTOMATIC COIL WINDING MACHINES

AND HAND WINDING MACHINES

Machines supplied complete with stand motor and Two-speed Friction Clutch

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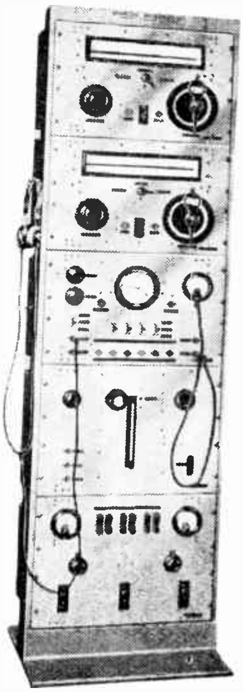

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MEASURING

EQUIPMENT

Type TME I

Years ago, the frequency measuring equipments made by Marconi's were for their own use — because nowhere else could sufficiently accurate instruments be obtained. The present equipment therefore, Type TME 1, boasts a long and distinguished pedigree and, like its predecessors, is precision-built to an exacting specification. Anywhere in the world it can be rapidly installed and its rated stability of 1 part in 10^6 maintained indefinitely. In price too, it commends itself as the ideal laboratory standard. Please ask for further details. Type TME 1 Frequency Measuring Equipment is available for early delivery.

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Northern Office: 30 Albion Street, Hull. Western Office: 10 Portview Road, Avonmouth. Southern Office & Showrooms: 109 Eaton Square, London, S.W.1. Midland Office: 19 The Parade, Leamington Spa.

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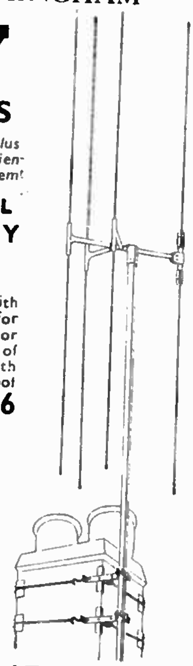
IN LONDON OR BIRMINGHAM

WOLSEY

TELEVISION AERIALS



From Single Dipole to the Triple Reflector model illustrated, every WOLSEY Tele. Aerial is the most efficient of its type. Many years specialisation is behind them!

THE FIRST AND MOST SUCCESSFUL
TRIPLE REFLECTOR ARRAY

giving increased gain for fringe areas and greatly reduced interference in town areas.

WOLSEY TR/MI. Half Wavelength Dipole with three Reflectors spaced at ⅛th wavelength for London, ¼ wavelength for Birmingham. Reflector elements positioned in a parabola. Constructed of steel tubing, Cadmium plated. Duralumin Rods with Polythene V.H.F. insulators and P.V.C. waterproof bushes. Weight only 5½lbs. As illustrated. (pole and lashings extra). List Price. **£6**

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Baker 12in. Energised Loudspeaker........ £2 10 0

(The above to callers only)

A list giving other single items, and details of the many components available will be forwarded on request.

NEW HIGH FIDELITY LOUDSPEAKERS AND CABINETS.

Goodmans "Axiom 22," high flux version of the "Axiom 12" £12 13 0

Goodmans R22/1206, high flux bass loud-speaker. Resonance 55 cps.................... £11 0 0

Bass Reflex Cabinet for the "R22" and "Axiom 22." Very solidly constructed and finished in figured Walnut. Carriage 10s. £16 16 0

"RD Junior" corner reflex cabinet for the Wharfedale W10.CS. Compact and attractive design giving good bass response down to 35 cps. Carriage 10s. £12 10 0

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Your designs

LET US BRING THEM TO

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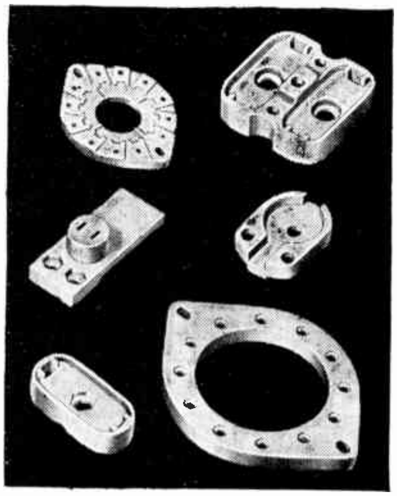

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A High Permittivity Material. For the construction of Condensers of the smallest possible dimensions.

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Supplied to ADA by R.C.A., ADA electron valves are designed to satisfy completely the requirements of radio receivers, service, amateur and laboratory equipment. Sturdily constructed and thoroughly tested, every ADA valve is guaranteed to give long, trouble-free use.

The ADA trademark is your assurance of dependable performance and durability.

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UNIT CONSTRUCTION in one case provides alternative time bases or amplifiers and improvements at minimum cost. Adequate power supply for all requirements in separate easily portable case.

TYPE 103

STANDARD UNITS include:— D.C. AMPLIFIER of high sensitivity — less than 1 mV. per. cm. with linear response 0-2.5 Mc/s. TIME BASE with calibrated velocity from 10 c/s to 1 Mc/s, automatic synchronisation and free from effects of mains variations.

OSCILLOGRAPH & OSCILLOMETER

INPUT SIGNAL VOLTAGES measurable by directly calibrated Y shift control, independently of amplifier gain.

THE ONLY PORTABLE instrument combining all the above for the purposes of enabling you to

SEE WHAT YOU MEASURE—MEASURE WHAT YOU SEE AT HIGH OR LOW FREQUENCIES AND D.C.

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complete in transit case as illustrated.

12/6d. CARRIAGE FREE

These equipments were in working order before being stored in the open, but their general condition has now deteriorated.

SIZE
15½" × 19" × 10½" high

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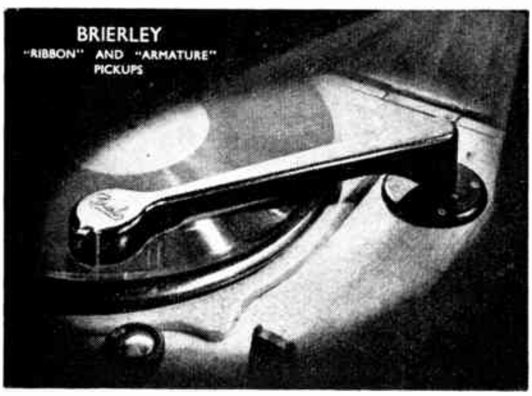
Ribbon, type JB/P/R/2

Microarmature, type JB/P/A/1



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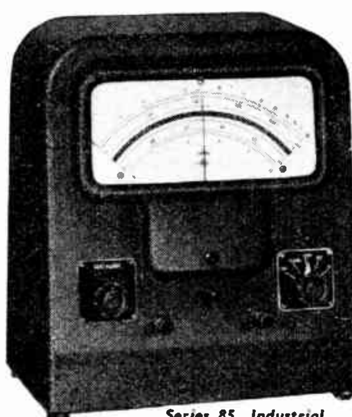

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A Linear Scale Bridge-type Ohmmeter, with press key, designed for routine production testing of all resistive components. For battery or A.C. mains operation. (A.C. mains operated instruments are compensated for voltage variations up to — 15%.) Designed and constructed to withstand severe industrial use. Available as single or multi-range.

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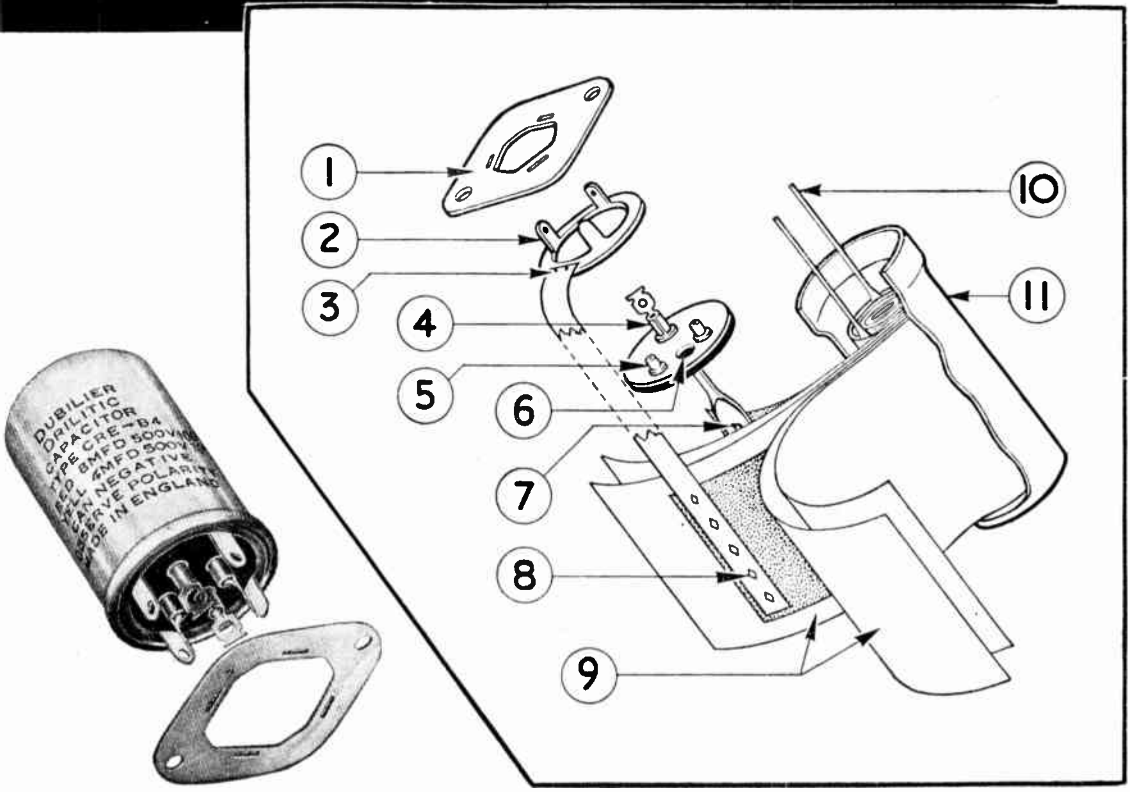
DUBILIER "DRILITIC" CAPACITORS have all the essential features

CONDENSER CO (1925) LTD.



C.T.E. and C.R.E. Ear Mounting "Drilitic" Capacitors.

For the time being these capacitors are only available to manufacturers of radio and electronic equipment.

By the application of special manufacturing techniques we are producing "Drilitic" Capacitors to a high level of engineering efficiency. The equivalent series resistance and leakage current have been reduced, breakdown voltage and life expectancy have been increased and both the audio and radio frequency impedances, together with the temperature characteristics have been improved. In addition to these finer electrical characteristics "Drilitic" Capacitors are extremely small in physical size. To obtain the maximum advantage from the small size, Ear Mounting "Drilitic" Capacitors are now available to provide a more rapid and efficient means of fixing. They are obtainable in single and multiple capacitor forms and in a wide range of capacitances and voltages. High ripple current "Drilitic" Capacitors for television and electronic apparatus, and high temperature "Drilitic" Capacitors for equipment with high ambient temperature or for tropical operation are also available.

We shall be pleased to forward full details of these latest engineering developments together with the eleven points of special interest, upon application.

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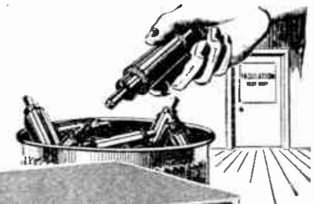
'Phone : Acorn 2241 (5 lines) 'Grams : Hilvoltcon, Phone London. Cables : Hilvoltcon, London. Marconi International Code

D28A

RUINED
by the tests which should have saved them



but this would have saved them

High Voltage Testing of insulated components has hitherto meant, in many instances, complete destruction of units below standard. Furthermore, such tests have involved appreciably long periods of time.

This Airmec non-destructive high voltage insulation tester will give immediate indication of weakness in insulation before breakdown voltage is reached. It will indicate the maximum safe voltage at which insulation can be worked and will show whether or not ionisation is present within the insulation. The instrument is self-contained, portable, low in cost, and safe to operate. It may be used by unskilled personnel and is many times faster in use than other test equipment. Voltages up to 5kV are available.

For testing radio and electrical components, motor and transformer windings, insulated wire and cables, and determining deterioration of insulation after storage.

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Manufacturers of all types of Industrial Electronic Equipment and Test Gear

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TYPE "K."

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IMPEDANCE 52 Ohms at 1,000 c.p.s.

SENSITIVITY, 1.2 x 10^{-12} Watts at 1kc. = .0002 Dyne/cm^2

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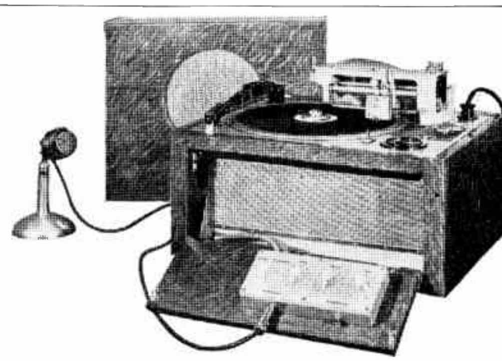

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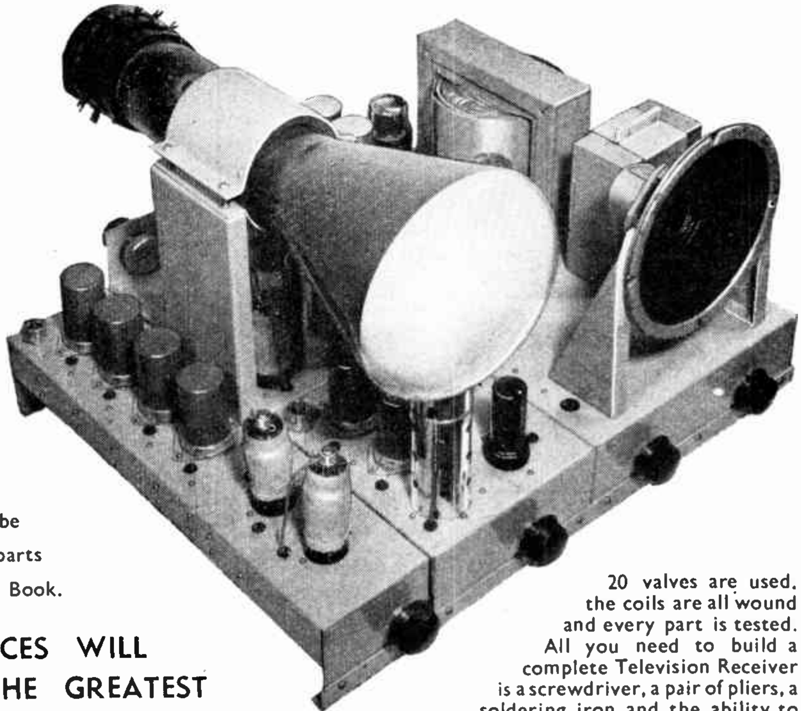

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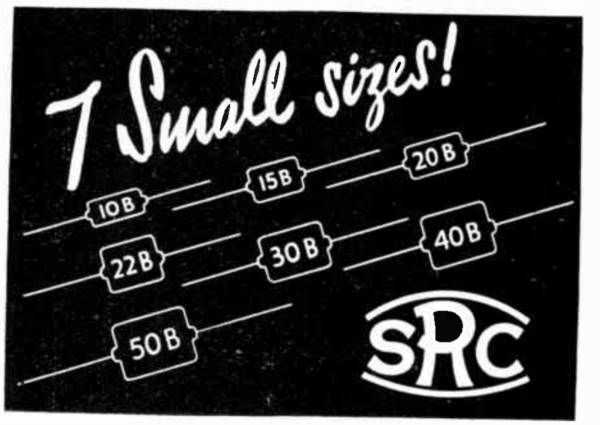

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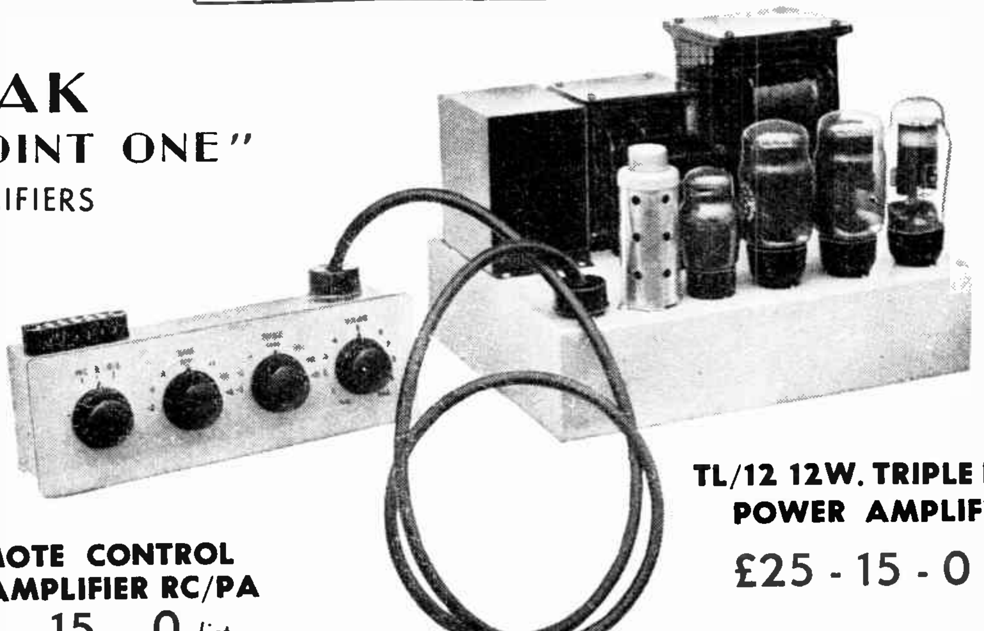

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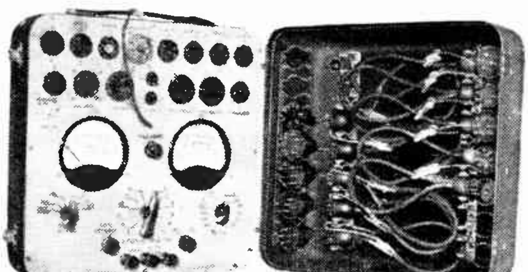

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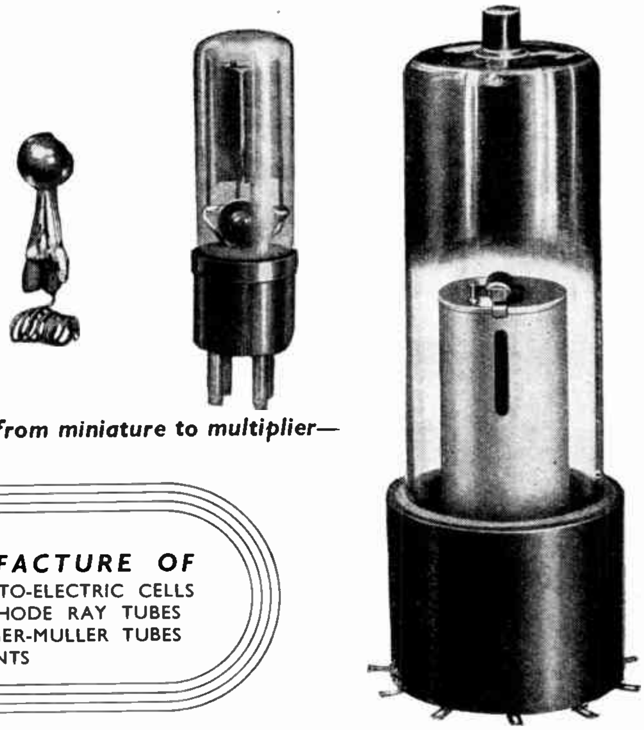

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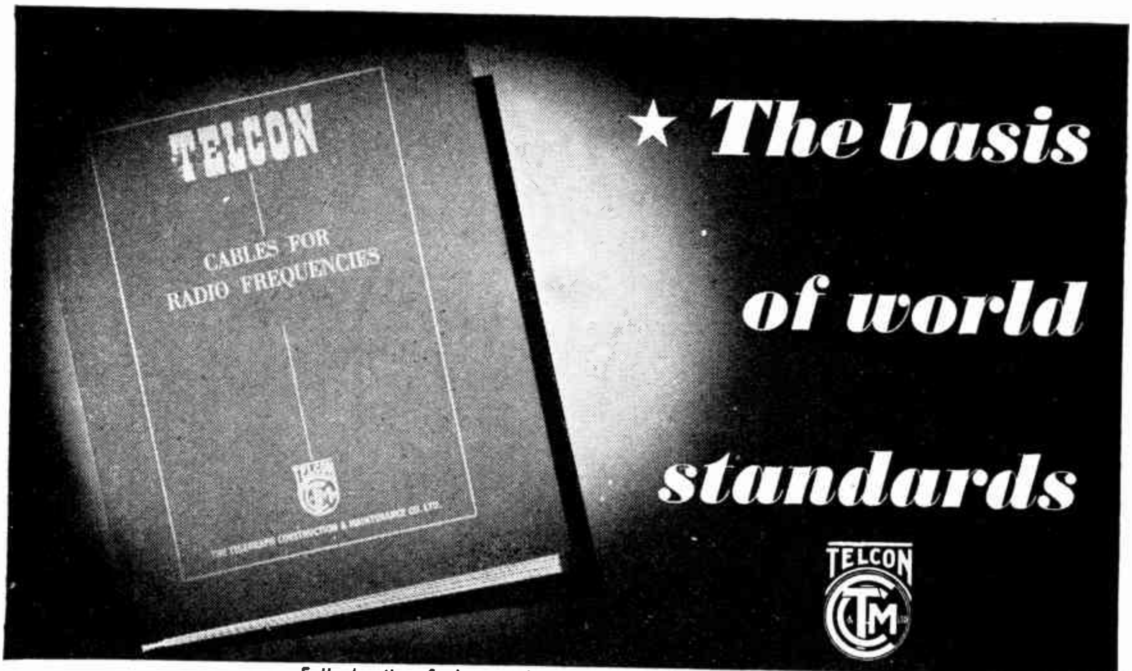

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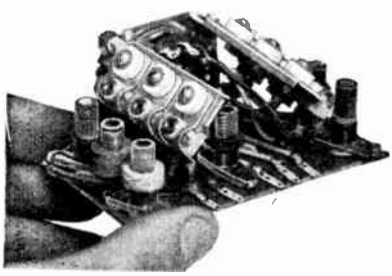

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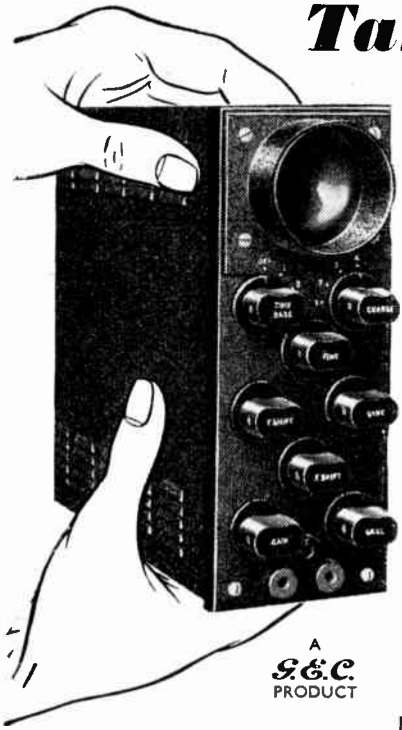

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12 in.	Double Sided	6/6d.
	* Single Sided	5/3d.
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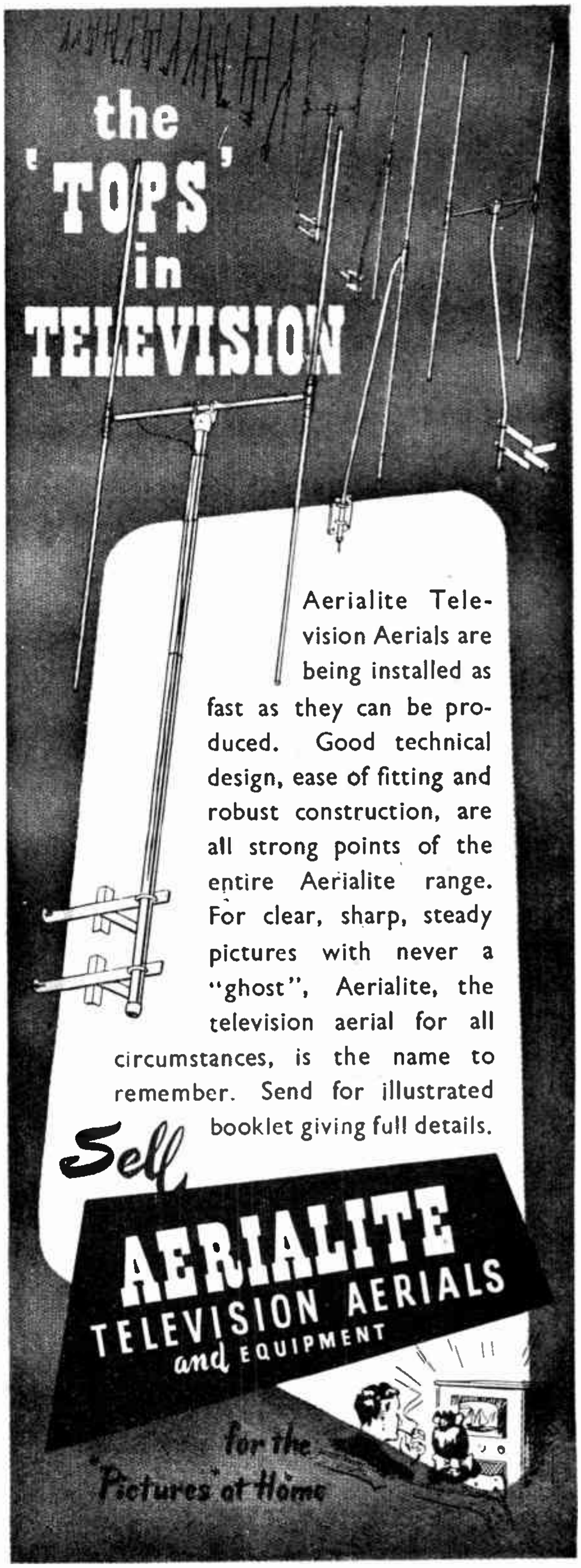

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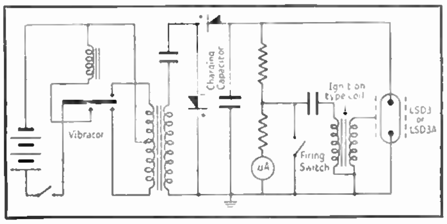
Some data is given here, and if you would like full details, including recently published articles on flash circuits, please write to the address below.

PRINCIPAL CHARACTERISTICS OF LSD3

Max. Energy of Discharge	100 joules
Operating Voltage	2,000-2,700V
Trigger Voltage	3,000-3,500V
Approx. Flash Duration	150 micro-secs
Peak Light Output	40 mega-lumens
Integrated Light Output	4,000 lumen-secs
Base	4-pin U.X.
Light Quality	Closely resembling daylight

Basic circuit for portable battery-operated flash equipment



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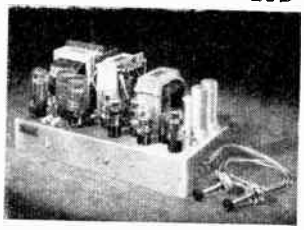

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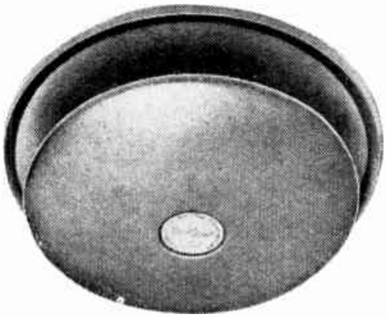

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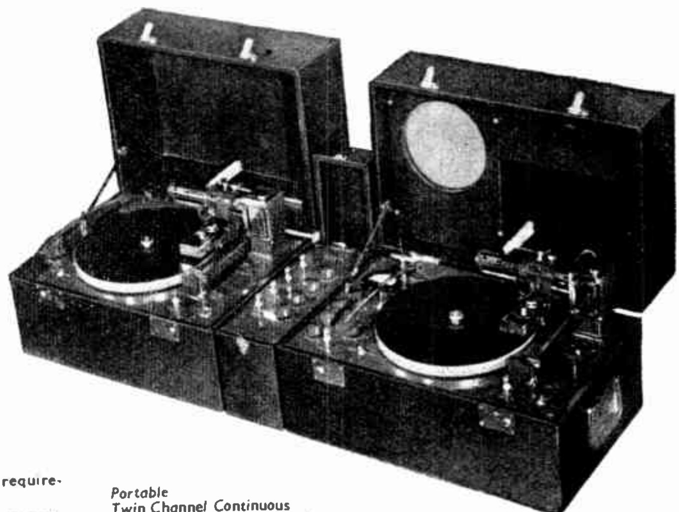

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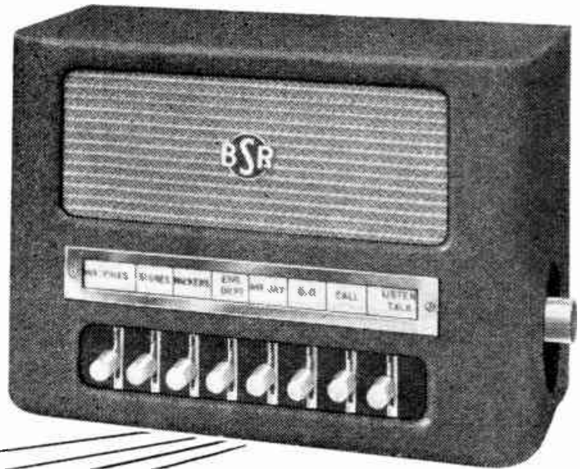

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Wireless World

RADIO AND ELECTRONICS

JULY 1949

39th YEAR OF PUBLICATION

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c

Valves and their applications

The DL93 as a Power Amplifier at V.H.F.

In the rapidly expanding field of low power V.H.F communications for Business Radio and similar purposes, the designer often has difficulty in obtaining satisfactory transmitting valves for his equipment, since the choice of valves suitable for many such applications is severely limited in this country. In particular there still exist few directly-heated miniature types capable of an efficient performance when used as power amplifiers in battery-operated V.H.F. 'walkie-talkie' transceivers.

At the lower V.H.F. frequencies the designer's requirements for an efficient directly-heated power amplifier are

	SERIES	PARALLEL
Vf	2.8	1.4 V (D.C.)
If	0.1	0.2 A
V_a max.	150 V	
Vg_2 max.	135 V	
Vg_1 max.	–30 V	
I_a max.	20 mA	
Ig_1 max.	0.25 mA	
Ik max.	25 mA	
p_a max.	2.0 W	
pg_2 max.	0.9 W	

The above limiting values are for intermittent operation as an R.F. power amplifier.

TABLE 1

met by the DL93. This valve is a miniature pentode on a B7G pressed glass base, and has a low filament consumption. A table of maximum ratings is shown in Table 1.

In the 60-80 Mc/s Business Radio band the valve has a very satisfactory performance. When operated as a conventional Class C amplifier at 80 Mc/s, and driven by another DL93, the valve has a power output of approximately 1.5 watts and an anode efficiency approaching 55%. Figure 1 shows a suitable circuit for use at this frequency.

The circuit contains no unconventional features, and is simple to adjust. Moreover the layout of the components is not critical, although all leads should be kept short. An efficient screen between the grid and anode circuits should be provided. The grid anode capacitance of the DL93 is low and consequently neutralisation is not essential; a neutralised circuit is somewhat easier to adjust, however, and in this case the neutrodyne (Hazeltine) circuit is recommended.

In semi-portable equipment the existing Business Radio regulations allow the DL93 to be operated at its maximum ratings. In "walkie-talkie" transceivers a maximum of 1 watt input to the final stage is permissible, and an anode potential of 90 volts is therefore adequate. Two 45-volt hearing aid layer batteries may be used to provide the H.T. supply.

Since quartz crystals with a natural resonant frequency as high as 80 Mc/s are not yet generally available, frequency stabilisation entails the use of a master oscillator of comparatively low frequency (15 Mc/s for example) followed by a multiplier chain. Since it is of major importance to minimise the power consumption of the multiplier stages, hearing aid subminiatures such as the DL72 may be used with advantage. The final power amplifier may then be operated from another DL93 as driver. Alternatively, if a reduced power output can be tolerated, the amplifier stage may profitably be driven directly by the final multiplier.

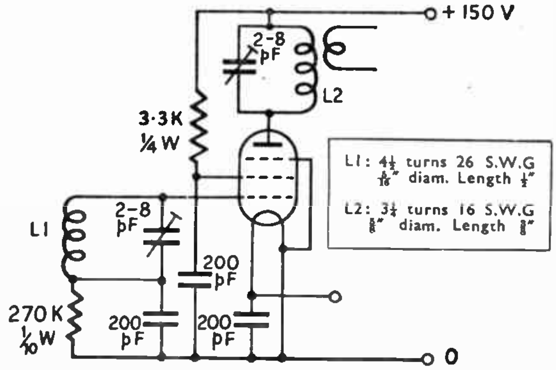


FIGURE 1

The variation in performance of the DL93 with frequency may be summarised as follows. At frequencies below 100 Mc/s the efficiency and output remain virtually constant, the required drive decreasing with the frequency. It is noteworthy that at frequencies of the order of 5 Mc/s the drive required for full output is unusually low (1.2mW approximately). Thus at these lower frequencies the valve is capable of its optimum performance when driven by a DL72 buffer stage. Above 100 Mc/s the performance deteriorates; the valve will nevertheless give a satisfactory performance in the 144-146 Mc/s amateur band.

The efficiency of the DL93 when used in the 156-184 Mc/s Business Radio band is of the order of 15% to 25%. Details of Mullard miniatures and subminiatures suitable for operation in this and in the 460-470 Mc/s bands will be published in later articles.

Mullard

Reprints of this report from the Mullard Laboratories, together with additional circuit notes, can be obtained free of charge from the address below.

VOL. LV. NO. 7

Wireless World

RADIO AND ELECTRONICS

JULY 1949

MONTHLY COMMENTARY:

International Television Argument

WRITING on the possibilities of rivalry between American, British and Dutch firms in international markets for television equipment, our U.S. contemporary, *Electronics* (May, 1949, issue), says, editorially:

"The crux of the matter is the standards to be adopted. Should they follow American or British practice? Evidently, the adoption of one or the other might give a preferred position in the market. So far as studio and transmitting equipment is concerned, it is not difficult to meet the customers' desires regarding standards without major increase in cost. But receivers are different; if foreign standards depart too widely from those used by the manufacturer in his domestic product, the cost of exported sets may rise substantially, possibly enough to price them out of the market."

That is a fair statement of the position. Any competent designer and manufacturer, whether American or European, can provide foreign customers with transmitting equipment for working to any reasonable standards that they may fancy. With receivers, on the other hand, standards are commercially much more important and we enter the realms of Big Business. The country whose standards are adopted by others will have a ready-made export market for its domestic production.

IT is less easy to agree with the substance, and still less with the implications, of the paragraph that follows. It reads:

"We feel strongly that whatever standards are adopted in foreign lands, they should not restrict the utility of the service. Further, at the risk of starting an international argument, we venture to remark that two important aspects of the British standards are restrictive. One is the use of a 2.5-Mc/s video band, as compared with the 4.0-Mc/s standard in the U.S.A. The choice of a narrow bandwidth must inevitably restrict the detail of the images provided to foreign customers. The second is the 25-per-second picture transmission rate, adopted in Britain to conform with the 50-c/s power supply frequency. This limits the brightness of flicker-free images to a value substantially lower than that possible with the 30-per-second American rate."

It is implied here that the ratio of bandwidths is a measure of relative picture quality between the British and American systems. Of course, it is fundamental—even platitudinous—that the information content of any form of radio communication is determined by bandwidth. May we say, then, if the American 4-Mc/s bandwidth is good, the French 10-Mc/s system must be potentially better and a hypothetical 20 Mc/s better still? And where are we to stop? It is hardly practical engineering to argue along these lines, so long as the availability of communication channels is limited and economy must be considered.

IN any case, the comparison made by *Electronics* is factually incorrect. First, the British system employs 2.75 Mc/s—not 2.5 as stated. Secondly, the ratio of bandwidths can only be taken as an indication of relative picture quality if the frame frequency is the same. If the Americans used a 25-frame rate, they would need only a 3.3-Mc/s bandwidth for their present picture quality. The relative quality of British and American pictures is in the ratio 3.3 : 2.75 and not 4 : 2.5 as implied by *Electronics*.

As to the alleged reduction of flicker resulting from the 30-per-second American picture rate, are we seriously asked to believe that it was chosen for that reason? Surely, with the American 60-c/s supply frequency there was no other practicable choice. The use of a frame frequency differing from the mains frequency calls for much more extensive smoothing of receiver h.t. supplies and so increases receiver cost.

With the notable exception of the American continent the world's electrical supply systems are predominantly 50 c/s; for this reason the lower picture rate will generally be preferred. Any advantage in freedom from flicker offered by the higher rate is largely academic.

TELEVISION STATION SELECTION

A Look to the Future

By W. T. COCKING, M.I.E.E.

UP to the present British television receivers have been designed for the reception of one station only—the vision and sound channels of Alexandra Palace. When the Birmingham station opens there will be two stations in operation and, according to the present plan,[1] there will eventually be five.

Since all stations are intended to transmit the same programme each receiver will need to receive only one of the stations except perhaps, in certain fringe areas mid-way between two of them. Even here one station will, in general, afford a better signal than the other and so it is necessary only for the receiver to be able to receive this better one.

Even under the new plan, therefore, it will not be necessary for any individual receiver to be suitable for more than a single station. However, there are certain obvious difficulties in manufacturing only single-station receivers; if this course is continued, each maker will eventually have to produce five different models. This alone will increase production costs and, in addition, he will have to regulate the relative quantities made very nicely.

Then viewers do occasionally move their homes, and those changing from the service area of one station to that of another will not expect their receivers to become obsolete.

It is, therefore, likely that the receiver of the future will have to be suitable for any of the five stations. There are many possible ways of doing this and it is interesting to consider their relative merits.

In the first place it is clearly unnecessary for the means of station selection to be operable by the user. If such a control were provided he would use it only on those rare occasions when he moves to a different service area. There is no objection to such a control if it proves the most economical way of arranging the selection, of course, but it is not a necessary control. All the user requirements can be met by providing a form of station selector which can be adjusted by any competent technician.

One method, which is already being applied, is to build the set so that the signal-frequency circuits, and the oscillator if the receiver is a superheterodyne, form an accessible and replaceable sub-unit. One such sub-unit can be made for each channel and station selection effected by changing sub-units.

The method is obviously better suited to the superheterodyne than the straight set, for this requires only two or three tuning circuits, whereas the latter needs ten to fifteen. The disadvantage of the method is that it is still necessary to manufacture different units for different areas and to arrange for their production in the proper quantities to meet the demand. Also the manufacturer must be able still to supply the alternative sub-units for many years so that the viewer who moves to another area can be provided for.

Trimming Range

From the manufacturing point of view it is much better if all sets can be alike in their components and if the differences can be merely ones of adjustment. At first sight, this seems easy, for it would appear to be necessary only to increase the range of the trimmers so that the set could be tuned to any station in the band. It should not be impossible to make inductances adjustable over a sufficient range for this. Allowing for stagger tuning, a frequency ratio of 1.6:1 is needed and this means an inductance ratio of 2.56:1. By using a very thin-walled former a simple metal or dust-iron slug should provide adequate coverage and there is always the possibility of increasing it by using a composite slug. A slug partly of metal and partly of dust-iron will reduce inductance when the one end is inserted and increase it when the other comes inside the coil, thus increasing the total variation obtainable.

A receiver designed on these lines could be tuned to any station in the band by a competent technician equipped with the proper apparatus. However, there is rather more in changing frequency than just re-trimming circuits. In the sound channel, changes in the Q of the coils with frequency may seriously affect the performance and, in particular, the amount of sound-channel rejection obtained. Towards the high-frequency end of the band an increase of Q is desirable to maintain the sound-channel rejection. With slug tuning, however, the Q is likely to decrease very considerably at this end of the band.

Then the input resistance of a valve decreases with frequency. It is approximately inversely proportional to the square of frequency. This may or may not be serious, for there is a possibility of devising a correcting network to mitigate this natural tendency. If this proves to be impracticable, however, then there is no doubt at all that the changing input resistance will very seriously affect the performance and call for circuit changes for different frequencies. Couplings are another factor which may need alteration. There is the aerial feeder to first-grid coupling circuit for one, there are the sound-channel rejector-circuit couplings for a second and there are the band-pass type couplings, if they are used, for a third.

It is clear, therefore, that the design of a straight set embodying ten to fifteen tuned circuits is by no means a simple matter. The superheterodyne scores heavily in this respect, for the bandwidth, sound-channel rejection and gain are obtained chiefly at the fixed intermediate frequency. Only the signal- and oscillator-frequency circuits need alteration for a different station,

[1] Wireless World, May 1949, p. 175.

and a considerable variation in their performance over the band is tolerable.

The superheterodyne, however, has it own troubles. It is well-known that even when only the reception of one station is being considered it is necessary to choose the intermediate frequency very carefully if the picture is to be free from a pattern produced by harmonics of the intermediate frequency being fed back from the output to the input. With an intermediate frequency of the usual order of magnitude,—5-13 Mc/s—it is impossible to avoid this effect on all stations simply by selecting the frequency and it is necessary to employ very thorough screening and filtering to prevent the feedback. This is quite expensive.

There are, in addition, the possibilities of interference by signals operating in the i.f. band and on the second channel and it is necessary to take precautions against local-oscillator radiation. The attainment of adequate frequency stability in the oscillator is another difficulty which confronts the designer.

All these superheterodyne disadvantages are found in the ordinary broadcast receiver and in spite of them it has become almost universal. There are two reasons for this, one of which does not apply at all in the present-day television case and the other of which applies only partially. The first is the need in a broadcast set on the short-wave bands for a degree of selectivity which it is not possible to obtain at signal frequency. This would seem to apply to television only if frequencies higher than those now envisaged were adopted. The second reason lies in the few circuits which need be varied for tuning in a superheterodyne as compared with a straight set of similar performance.

This is the real merit of the superheterodyne for television but it does not apply with quite the same force as in a broadcast set because the station selector need not be a user control. It is not necessary to have ganged circuits operated by a panel control.

The superheterodyne could be made freer from its liability to special forms of interference if its intermediate frequency were made considerably higher than is now customary. If the intermediate frequency were lower than the lowest frequency of the signal band and higher than one-half of the highest frequency of the band, then i.f. harmonic interference would be impossible. The lowest signal frequency is 41.5 Mc/s, the highest 66.75 Mc/s. Therefore, from this point of view the intermediate frequency should be less than 41.5 Mc/s and greater than 33.375 Mc/s.

By choosing a frequency in the band 33.375-41.5 Mc/s, therefore, one drawback of the superheterodyne can be eliminated. It is quite a satisfactory frequency from the point of view of obtaining bandwidth, sound-channel rejection and gain, for all these can be secured adequately at the higher frequency of 45 Mc/s, as is evidenced by all the satisfactory straight sets now produced.

Since such an intermediate frequency is nearer the signal frequency than is at present usual the liability to the direct pick-up of signals on that frequency is increased. As a partial offset to this, signals on the higher frequency are usually rather weaker. Nevertheless, more care in the avoidance of this type of interference must be taken.

The liability to second-channel interference is reduced because of the higher frequency and its elimination should not prove very difficult.

The problem of the oscillator may well be serious. If the oscillator frequency is higher than the signal frequency, the main trouble will be that of obtaining adequate frequency stability. Thus, suppose an intermediate frequency of 35 Mc/s is chosen, then the oscillator must cover from $45+35=80$ Mc/s to $66.75+35=101.75$ Mc/s. These frequencies are rather high for obtaining stability cheaply.

If the oscillator frequency is made lower than the signal frequency there is considerable danger of harmonics of the oscillator causing interference. This is shown by the diagram of Fig. 1 which indicates signal frequencies on one scale and intermediate frequencies on the other. The television channels are marked and the shaded areas represent interference bands, the order of the oscillator harmonic involved being marked in them.

If 35 Mc/s were chosen interference would be experienced from the third oscillator harmonic when receiving Channel 2. For instance, the vision carrier for Channel 2 is to be 51.75 Mc/s. The oscillator would be $51.75-35=16.75$ Mc/s and its third harmonic 50.25 Mc/s. This would beat with 51.75 Mc/s to give a difference frequency of 1.5 Mc/s which would produce a most noticeable pattern on the picture.

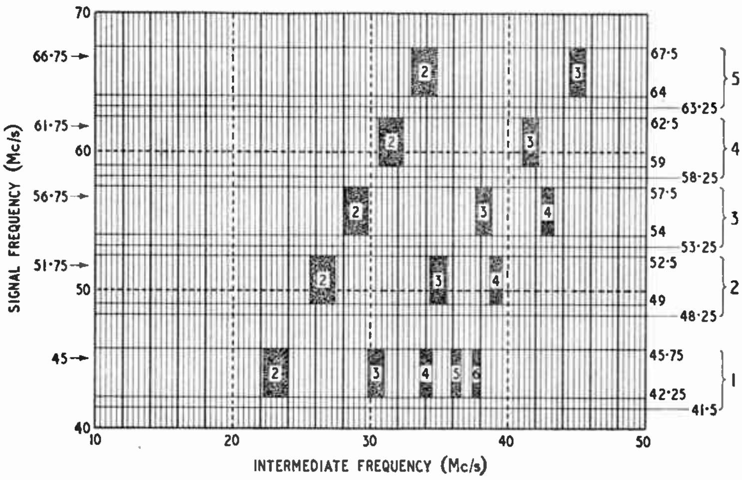


Fig. 1. This diagram shows intermediate frequencies with which interference will be found from oscillator harmonics when the oscillator is lower in frequency than the signal : the numbers in the shaded interference areas indicate the order of harmonic involved.

Television Station Selection—

Examination of Fig. 1 shows that there is only one possible intermediate frequency for the avoidance of this effect on all channels. This frequency is 37 Mc/s. A vertical line at 37 Mc/s on the diagram does not cross any shaded area.

With this frequency the oscillator must cover 45 − 37 = 8 Mc/s to 66.75 − 37 = 29.75 Mc/s which is a wide range to cover in a single sweep. The relatively low frequency of the oscillator, however, greatly eases the problem of securing adequate frequency stability.

We cannot, however, yet say that this frequency will be satisfactory, for all the possible forms of interference have not been examined. Since the oscillator frequency is lower than the intermediate frequency it is necessary to make sure that none of its harmonics falls in the intermediate frequency band. This can be taken as 37 − 2.75 = 34.25 Mc/s to 37 + 0.75 = 37.75 Mc/s with a sound channel at 37 − 3.5 = 33.5 Mc/s.

For Channel 1, the oscillator will be at 45 − 37 = 8 Mc/s and its harmonics will be 16, 24, 32, 48 Mc/s. The third harmonic just misses the i.f. band.

For Channel 2, the oscillator will be at 51.75 − 37 = 14.75 Mc/s and its harmonics will be 29.5, 44.25 Mc/s. Again, they miss the i.f. band.

For Channel 3, the oscillator will be at 56.75 − 37 = 19.75 Mc/s and its harmonics will be 39.5, 59.25 Mc/s.

For Channel 4, the oscillator will be at 61.75 − 37 = 24.75 Mc/s and the second harmonic will be 49.5 Mc/s.

For Channel 5, the oscillator will be at 66.75 − 37 = 29.75 Mc/s and the second harmonic will be 59.5 Mc/s.

The frequency is then satisfactory in this respect.

There is next the possibility of interference from a station which is spaced from an oscillator harmonic by the intermediate frequency. It is similar in nature to ordinary second-channel interference but involves an harmonic instead of the fundamental of the oscillator. The possible interference frequencies, including the genuine second · channel frequencies, are listed in the table.

If these frequencies are compared with the signal bands it will be seen that with one exception none falls within the band of the station being received. The responses are, therefore, in principle capable of being eliminated by signal-frequency selectivity. The exception is in Channel 4. The fourth harmonic of the oscillator when it is set for reception of Channel 4 is 99 Mc/s. The intermediate frequency will, therefore, be produced by a signal on 99 − 37 = 62 Mc/s and this is within the Channel 4 band of 59–62.5 Mc/s.

TABLE.

Channel	1	2	3	4	5
Frequencies (Mc/s).					
$37 - f_0$	29	22.25	17.25	12.25	7.25
$2f_0 \pm 37$	53 & 21	66.5 & 7.5	76.5 & 2.5	86.5 & 12.5	96.5 & 22.5
$3f_0 \pm 37$	61 & 13	81.25 & 7.25	96.25 & 22.5	101.25 & 37.25	126.25 & 52.25
$4f_0 \pm 37$	69 & 5	96 & 22	116 & 42	136 & 62	156 & 82
$5f_0 \pm 37$	77 & 3	110.75 & 36.75	135.75 & 61.75	160.75 & 86.75	185.75 & 117.75

It is, therefore, probable that this scheme may fail on this channel, which is the Birmingham one. It is possible that this could be evaded by changing the intermediate frequency very slightly, but there is not much scope for this without merely transferring the interference from one channel to another. Thus a shift to 37.5 Mc/s would be impracticable because the sixth harmonic of the oscillator would fall in Channel 1.

Oscillator Frequency

From the interference point of view it seems much safer to have the oscillator higher in frequency than the signal. Frequency stability is then the difficulty and it is rather hard to estimate the requirement until the Birmingham station has been in operation and some experience of the single-sideband transmission has been gained. The requirements for the sound channel can easily be estimated and those for the single-sideband reception of a double-sideband transmission are known. It is to be expected that the conditions in the reception of a single-sideband transmission will not be very different, but they may not be quite the same.

Placing the oscillator higher than the signal in frequency is advantageous from nearly every point of view save that of the oscillator drift. In what follows it will be assumed that it is so placed.

The intermediate frequency is no longer critical and a frequency of about 35 Mc/s is suitable, so far as vision is concerned. The sound intermediate frequency now comes above the vision at 38.5 Mc/s, however, and there is here one possible cause of trouble for it is also 3 Mc/s away from the sound channel of Channel 1. The 3-Mc/s beat between the two may thus find its way into the vision channel by modulating the vision carrier in the frequency changer. It would be wiser to choose a frequency not less than 4 Mc/s below Channel 1. This would make the sound intermediate frequency 37.5 Mc/s and the vision 34 Mc/s.

True second-channel interference on vision could then arise only from stations in the band 113—134.75 Mc/s plus a small extension to cover the i.f. amplifier bandwidth. On sound it could come from the band 116.5—138.25 Mc/s.

If the bandwidth of the signal-frequency circuits is about 3.5 Mc/s, the second-channel frequency is about ten times the bandwidth away, or twenty times the half-bandwidth. A single resonant circuit which is down 1 db only at the edges of its band is therefore down 14 db at the second-channel frequency.

It is difficult to estimate how much attenuation is needed at signal frequency. The second-channel band is an aircraft communication band and so considerable field strengths from nearby aircraft and ground stations may be experienced. As a minimum an interfering signal should be 30 db below the television signal at the frequency-changer input.

In a television receiver designed for limit range the interfering field strength might well be 40 db greater than that of the television signal and then the receiver should give 70-db discrimination. On the other hand, in areas of strong signals the interfering signal might never be more than 20 db below the television signal and only 10-db discrimination in the receiver would suffice.

Sensitivity

As very large numbers of receivers are used in areas of high field strength, where neither a maximum of gain nor the highest second-channel rejection are needed, it is clearly uneconomic to provide all receivers with them. The right course is surely to design the receiver to suit conditions in the major part of the service area, and to have a pre-amplifier which increases both gain and second-channel rejection for long-range reception.

Suppose, as a basis for discussion, that the basic receiver takes the form of a superheterodyne without a signal-frequency amplifier. The minimum useful signal at the input of the mixer will be of the order of 1 mV. This is a very approximate figure which might well be halved by careful design; it also depends upon how much noise is considered tolerable on the picture. Such a receiver with 30-db second-channel discrimination would be satisfactory over a very large part of the service area.

The simplest form of signal-frequency circuit would be a single resonant and damped circuit which would provide something like 14 db attenuation against second-channel interference. The remaining 16 db or so might be obtainable from the aerial, which is normally a resonant structure. However, it is very doubtful if it could be relied upon for this, especially in the case of the higher-frequency channels. For Channel 5, for instance, the aerial would be resonant at about 65 Mc/s in its half-wave mode. The second-channel band is 134-137.5 Mc/s and is quite close to 130 Mc/s at which frequency the aerial is again resonant on a full-wave mode.

It is therefore unwise to reckon on much selectivity from the aerial. Even if the aerial itself were usefully selective, it would probably be impracticable to make full use of it, for it would hardly be possible to keep the feeder properly terminated over the full band of frequencies involved. In the second-channel region, therefore, it is probable that the feeder itself would pick-up interference.

It is, therefore, good practice to include adequate second-channel rejection in the receiver itself and, in general, this will require the provision of two tuned circuits. There is, however, another possibility. Since the whole second-channel band lies outside the television band it is theoretically possible to secure the second-channel discrimination by means of a band-stop filter,* which might be inserted between the feeder and the input circuit of the receiver.

If this proved economically possible a further step could be taken. The bandwidth of the input circuit itself could be made very wide to cover the whole television band—26 Mc/s—and the station selection accomplished by varying only the oscillator. This would be a form of single-span tuning.[2]

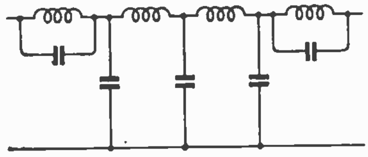


Fig. 2. A three-stage low-pass filter which includes two *m*-derived half-sections, the use of which is suggested as a simple way of preventing second-channel interference and oscillator radiation.

Increasing the first-circuit bandwidth nearly 7.5 times would result in a considerable loss of sensitivity. The signal/noise ratio would also deteriorate at least as much. It would probably become considerably poorer because of inter-modulation effects in the frequency-changer.

In practice, therefore, it would probably be better to retain signal-frequency tuning supplemented as necessary by fixed-tuned band-rejection filters.

* Or a low-pass filter, see later.
[2] *Wireless World*, March 23, 1934, p. 196.

Oscillator Radiation

One other factor must be considered: oscillator radiation. This can be very serious on these high frequencies, especially if a signal-frequency amplifier is not used. In the case considered with the vision intermediate frequency at 34 Mc/s, the oscillator operates at one of five frequencies in the band 79 Mc/s to 100.75 Mc/s.

At high-frequencies control-grid injection usually works best in the frequency-changer and the oscillator may provide about 2 V on the grid of the valve. Since the first circuit impedance may be 2 kΩ, this is very roughly a power of the order of 2 mW. A single tuned circuit may reduce this by 8-9 db and the feeder will introduce 1-2 db loss.

The oscillator power fed to the aerial may thus be as much as 200 μW. The signal power collected by the aerial may be only 0.05 μW. The radiated field strength in the immediate vicinity of the aerial may thus be 20 times as great as the field of the television signal.

In the example taken it will not interfere with other television receivers, but it may do with other services, including f.m. broadcasting. It must be very seriously considered, therefore, and the use of a band-stop filter in the aerial circuit is one way of preventing it.

This matter of using fixed filters to reduce interference and radiation is simpler than it may at first appear. Separate band-stop filters for the second-channel and oscillator bands are not necessary; a single low-pass filter can be used instead. If such a filter is given a cut-off frequency of, say, 70 Mc/s it will have little effect in the television band, but give some 12-16 db attenuation per section in the second-channel band. In the oscillator band such a simple filter is less good and may introduce no more than 5 db attenuation per section. It could, however, be greatly increased by using one or two *m*-derived sections (this is nothing but filter terminology for one or two tuned rejector circuits!).

Television Station Selection—

The basic filter equations are $LC = 1/\pi^2 f^2$ and $L/C = R^2$ where R is the terminating resistance, in this case the feeder impedance of 70 Ω. From the two $C = 1/\pi f R = 65$ pF and $L = 1/\pi^2 f^2 C = 0.317\,\mu$H.

The basic form of a filter which should be suitable for the job is shown in Fig. 2. It comprises two prototype low-pass sections and one *m*-derived; the last is split into two half-sections, one at each end of the filter, since this improves the termination. Four coils and five capacitors are needed.

A filter of this sort looks as if it would be very cheap and easy to manufacture, but it is not safe to conclude that this is so without further investigation. It is not improbable that very close component tolerances would be needed, but it may be that normal tolerances could be used for some or all of the capacitors if the others, and in particular the coils, were adjustable in manufacture. The coils will need only four or five turns and might well be self-supporting and adjusted in production in the filter unit by squeezing the turns closer together or further apart.

In view of all this it looks as though the television set of the future might well take the following general form:—

1. Superheterodyne with 34-Mc/s intermediate frequency and local-oscillator frequency above the signal-frequency.

2. No signal-frequency amplification.

3. One signal-frequency circuit trimmable to any television channel.

4. From 1 and 2, only two trimmers for channel selection, both of which are easily adjustable with very little apparatus.

5. Low-pass filter unit for 70-Ω impedance with coaxial input and output connectors, for second-channel interference and oscillator-radiation elimination.

6. Separate one- or two-stage pre-amplifier, also with coaxial input and output sockets, for insertion between the low-pass filter and the receiver in order to increase the sensitivity, second-channel rejection, and signal/noise ratio in areas of low field strength. Such a unit could be trimmable to any station in the band with perhaps three or four trimmers; it might also need changes in the values of damping resistors.

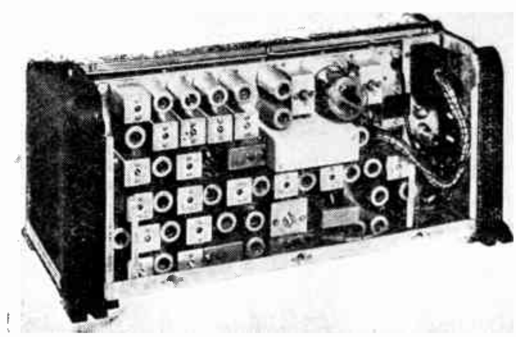
The writer feels that a scheme of this nature if carefully worked out might well prove to be the most satisfactory way of dealing with the problem of station selection. As he has pointed out there are other ways of solving it. It is probably impossible to decide the best way from theoretical considerations only and a good deal of experimental work will be needed. In particular, with the superheterodyne it is never safe to dogmatize for there are so many possibilities of interference with it that it is very easy to overlook one which becomes painfully evident when the set is tried.

In any case, television receiver design of the next few years will be especially interesting and there will doubtless be many different methods tried.

One final suggestion; the solution of the problem of oscillation stability might well be the use of an a.f.c. system operated by the sound signal.

DIVERSITY F.M. TRANSMISSION

New System With Synchronized Carriers



One of the G.E.C. f.m. mobile v.h.f. transmitter - receiver equipments used for the demonstration. It is entirely remote controlled.

FROM the data available it is still a debatable point whether amplitude or frequency modulation is the better for v.h.f. mobile communication services. A good case can be made for either, with some bias in one direction or the other according to the nature of the service required. In some quarters it has been said that when a wide coverage is needed, which may require several transmitters, the a.m. system with spaced carriers is the only satisfactory solution.

Hitherto this contention has not been challenged, but a recent demonstration arranged by the General Electric Company has shown that an f.m. system can be operated in a perfectly satisfactory way using three transmitters. These were arranged as a master station and two unattended satellites situated 10 and 17 miles respectively from the main station. The venue was London, the main transmitter being in Kingsway with one satellite at Mill Hill to the north and the other at Knockholt on the southern fringe of Greater London.

Unlike the majority of multi-station a.m. systems, the G.E.C. f.m. version operates on a single radio frequency for all operational messages to and from the mobile vehicles. Separate frequencies are, however, employed for the radio links between the main and satellite stations. The schematic diagram reproduced here gives the various frequencies employed for this particular system.

The use of a common frequency at the main and satellite stations necessitates very accurate synchronization of these transmitters and this is achieved by employing a single master oscillator at the main station, using an appropriate multiple of it for the " broadcast " transmitter there and another multiple, giving a somewhat higher frequency, which is radiated over link paths to the satellites. Here the frequency is converted to the actual multiple radiated from the main station's broadcast transmitter, and after suitable amplification, is radiated from the satellites' broadcast transmitters.

At no point in the chain is the actual multiple of the master oscillator lost, neither is the link signal, which carries the audio, demodulated.

From the schematic diagram it will be seen that this sytem is particularly economical in regard to the number of radio frequencies required. The common broadcast frequency employed on this occasion was 97.8 Mc/s, the outgoing control link was on 146.7 Mc/s and the incoming links on 154 and 155.4 Mc/s respectively. More will be said of these two later.

Thus this three-station f.m. scheme is operated with a total of four frequencies only. Some time ago we described a three-station a.m. system,[1] which might be said to be comparable in many respects, since it was operated in the same area, and for this no fewer than nine frequencies were employed.

It may be argued, of course, that the different method of modulation does not wholly account for this saving of channels and that an a.m. system could be operated also with synchronized transmitters. Be that as it may, the fact remains that the number of frequencies mentioned was employed at the time and a more recent two-station scheme,[2] also using a.m., absorbed six radio frequencies.

The main radio frequency is produced by a temperature-controlled crystal oscillator on approximately 1,527 kc/s, and this is multiplied 64 times to produce the broadcast frequency of 97.8 Mc/s at the main station.

A separate train of multipliers is used for the link transmitter and these raise the master frequency 96 times to 146.7 Mc/s. The ratio between broadcast and link frequencies is thus 2 to 3. Similar results can be obtained with other master oscillator frequencies, thus starting at 1,358 kc/s multiplations of 72 and 108 will yield virtually the same broadcast and link frequencies.

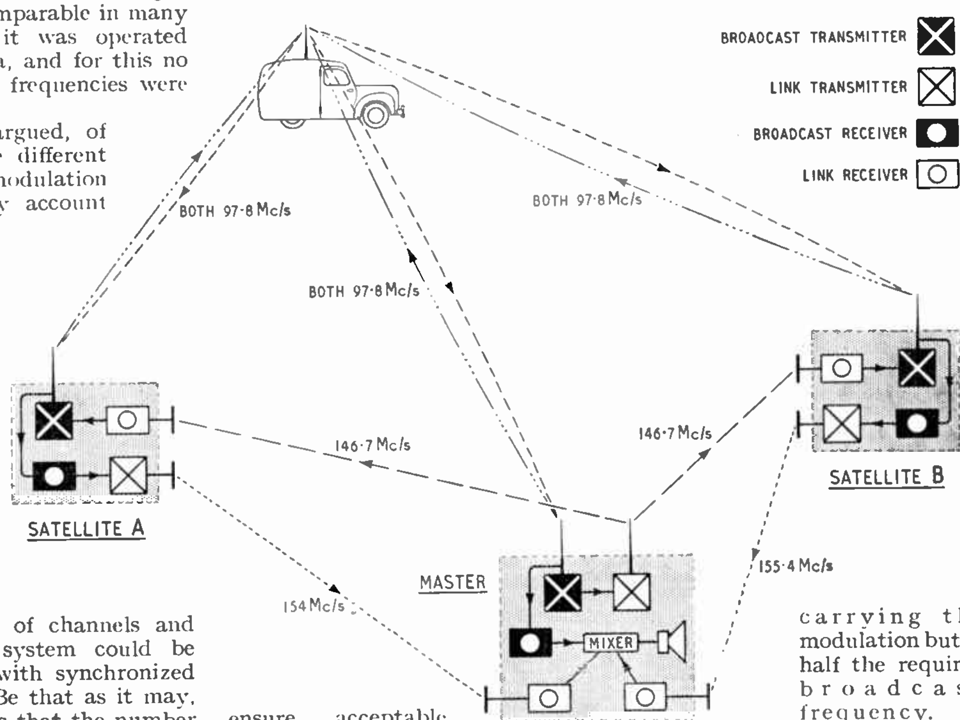
Modulation is applied separately to the broadcast and link channels at a very early stage, but in order to compensate for the distance between the main and satellite stations, a pre-determined delay is introduced into the channel going to the main station's broadcast transmitter.

The amount of delay needed to ensure acceptable fidelity seems by no means critical and this is proved both by aural tests and by examination of the waveforms of an 800-c/s tone on an oscilliscope, taken in a locality where the field strengths from the main station and one of the satellites was approximately equal.

From the oscillograms it appears that distortion is becoming apparent with four or less sections and also with eight or more sections, so it would appear that for this distance six is about the optimum. Each section introduces a delay equivalent to about 2.5 miles.

The r.f. output from the link transmitter is fed to a vertical dipole aerial giving omni-directional radiation. Variations of this are possible and the link transmitter could, if required feed two separate aerials beamed on their respective satellite stations.

At the satellite the master station's broadcast frequency, in this case 97.8 Mc/s, is extracted from the 146.7-Mc/s signal by first mixing with the 12th harmonic of a local oscillator, dividing the output by three, then mixing in the 4th harmonic of the local oscillator ; what emerges is a signal carrying the modulation but at half the required broadcast frequency. A doubler and power amplifier are all that are needed before the signal is radiated It should be noted that the link



Schematic diagram of the three-station f.m. diversity system of communication using synchronized transmitters, which has been evolved by the General Electric Company.

[1] Multi-carrier Communication System—*Wireless World*, February 1946, pp. 59–61.

[2] New Police Radio—*Wireless World*, December, 1947, pp. 457–459.

Diversity F.M. Transmission—
signal on the outgoing path has not been demodulated. This may appear to be a rather complicated process, but it ensures that the actual frequency radiated by the satellite is independent of the stability of the local oscillator.

As already explained the mobile vehicle talks back on the common broadcast frequency and its signals may be received at any or all of the fixed stations. When the signals are received at a satellite station they are demodulated and used to modulate a separate link transmitter for relaying to the main station.

The main station might conceivably be receiving the same message from a vehicle simultaneously on three different frequencies, (a) direct on the broadcast frequency, (b) via one of the satellites on its link frequency and (c) from the other satellite on still another frequency. The output from these three receivers are passed to a mixing unit where the one which has the best signal-to-noise ratio is selected and fed into the loudspeaker. This is, of course, quite automatic.

Several miles of London's busiest streets were covered in a radio-equipped vehicle during the course of a demonstration and at no period was the car ever out of touch. Signals were adequately loud and quite free from distortion during the whole time. From the immediate replies that were forthcoming it was evident that all outgoing messages were being received satisfactorily.

Some distortion was apparent when the delay network was removed from the main station's audio circuit, but this was much less than might have been expected and caused very little deterioration in intelligibility.

Finally, a brief description of the mobile equipment may not be out of place, although the transmitter-receivers used for the demonstration are not newly developed models.

The complete set measures 18 × 8 × 8in. and weighs 35lb. A double frequency changing superhet circuit is used for the receiver with the second i.f. on 455 kc/s. The first i.f. is dependent on the operating frequency, as this is adjusted to give the required input to the second mixer using the most suitable harmonic of the crystal-controlled oscillator. The i.f. bandwidth is approximately ±15 kc/s for 6db attenuation. Any single channel within the band 30 to 170 Mc/s can be employed, but the circuit would of course have to be pre-set as the equipment is remotely controlled. The audio output is about 1.25 watts.

The r.f. output from the transmitter varies somewhat according to the operating frequency, but at the worst it is not less than 10 watts and at the best 20, the larger amount being obtained at 100 Mc/s and below. The output valve is a new double tetrode, the TT15. The deviation is ±12.5 kc/s for the equivalent of 100 per cent. modulation, which also is the deviation used for the fixed stations.

Power to operate the set is supplied by a 12-volt battery—with optional 6-volt if required—and the consumption is 55 watts for the receiver alone, 95 watts on stand-by position with receiver on and transmitting valves alight and 175 watts on transmit.

The h.t. is supplied by two small motor generators, one for the receiver and another for the transmitter and filtered air for cooling is circulated through the set by fans on the motor generator.

Transmitter, receiver and power supplies are separate sub-assemblies easily removed for servicing. Miniature parts are used extensively and the whole of the equipment is fully tropicalized.

MANUFACTURERS' LITERATURE

Leaflet describing "Araldite" synthetic resin for surface and wire coating, etc., from Aero Research, Duxford, Cambridge.

Lists of components and kit sets for crystal receiver construction from the British Distributing Co., 66, High Street, London, N.8.

Illustrated leaflets describing the TV12 table television receiver and BA11 battery broadcast receiver from Bush Radio, Power Road, W.4.

Descriptive leaflet relating to the AC100 automatic record changing unit from Electrical and Musical Industries, Blyth Road, Hayes, Middlesex.

Complete catalogue of G.E.C. radio receivers for 1949-50, also catalogue of Pirelli-General electric wires and cables, from the General Electric Co., Magnet House, Kingsway, London, W.C.2.

Supplementary list of "Instanta" relays from Magnetic Controls, 48, Old Church Street, London, S.W.3.

List No. R449 of sliding resistances from M.R. Supplies, 68, New Oxford Street, London, W.C.1.

"Flux Facts" (Leaflet Ref. FF449) giving details of the properties of fluxes now available in cored wire solders made by Multicore Solders, Mellier House, Albemarle Street, London, W.1.

Technical specification of wide-range signal generators (Model 65B, 100 kc/s-46 Mc/s, and Model 65C, 100 kc/s-160 Mc/s) from Taylor Electrical Instruments, 419-424, Montrose Avenue, Slough, Bucks.

Illustrated leaflets of sound-amplifying equipment and commemorative brochure of testimonials relating to the 1948 Olympic Games from Philips Electrical, Century House, Shaftesbury Avenue, London, W.C.2.

Price list of amateur transmitting and receiving equipment from Radiocraft, Ltd., 25, Beardell Street, London, S.E.19.

DOMESTIC RECEIVERS

The new "49" series of receivers made by Pye, Cambridge, comprises a console (Model 49C), table radiogram (Model 49TG) and console radiogram (Model 49RG). The prices are £17 17s, £26 5s and £36 15s respectively, excluding tax. The basic circuit comprises a triode-hexode frequency changer, pentode-diode i.f. amplifier and detector, and a pentode output valve. New versions of the Baby "Q" all-dry battery portable and Model 19D receiver are also announced. The latter now incorporates the trawler waveband in place of the 13-metre band. Prices are £14 14s and £22 1s respectively, excluding tax.

Pye Model 49TG table-model radiogram.

TRANSITRON SYNC SEPARATOR

New One Valve Circuit

By H. V. VERSEY, Assoc. Brit. I.R.E.
(Engineering Division, British Broadcasting Corporation)

FOR good interlacing there are two major requirements which a sync-separator circuit must satisfy:
(1) the generation of a steep-fronted frame synchronizing pulse from one—preferably the first—of the sequence of broad pulses that form the frame synchronizing signal;
(2) the compl te elimination of line synchronizing pulses from the frame synchronizing circuits.

It is not easy to separate two pulses of similar amplitude and shape but of different durations such as the line- and frame-synchronizing pulses, whose durations are respectively 10 microseconds and 40 microseconds. Hitherto, very elaborate circuits with several valves, or incorporating costly delay lines, have been necessary for this purpose and consequently good interlacing has been achieved only at considerable cost. It was with economy in mind that the idea of using a transitron circuit, operating under specific bias conditions, first occurred to the author.*

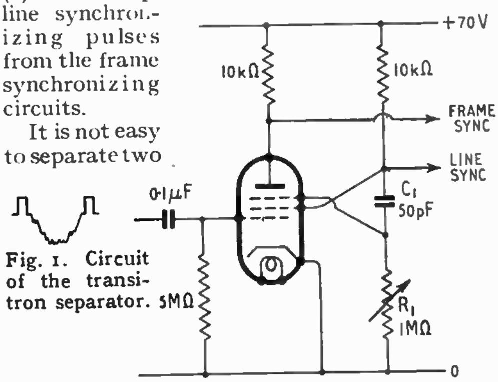


Fig. 1. Circuit of the transitron separator.

In the following description of the circuit and its behaviour it is assumed that the reader is conversant with the "flip-flop" action of the transitron. The "flip" occurs when the screen grid draws excessive current and drives the suppressor grid sufficiently negative to cut-off anode current. This is followed by the "flop," which occurs when the suppressor-grid potential has again risen to the point at which anode current starts to flow and the screen current is suddenly reduced.

The signal waveform, inverted so that the synchronizing pulses are positive, is d.c. restored at the control grid (see Fig. 1). The valve is cut off by black-level and picture signals, and conducts only during the synchronizing pulses, as is customary in most receivers. When a ten-microsecond positive-going line-synchronizing pulse appears on the control grid, the screen grid draws current and instantaneously drives the suppressor grid sufficiently negative to prevent the anode from drawing current. This action corresponds to the "flip" of the transitron cycle. The "flop" occurs when capacitor C_1, connected between the screen and suppressor grids, has recharged sufficiently to allow anode current, as well as screen current, to flow. The time constant $C_1 R_1$ is, however, so chosen that the line-synchronizing pulse finishes before the "flop" action can take place, and e valve consequently returns at the end of the line-synchronizing pulse to its original state with anode and screen currents cut off by the control-grid potential. Thus the anode remains at full h.t. potential throughout the whole period of the line-synchronizing pulse, and no pulse is produced there. A steep-fronted pulse of considerable amplitude is, however, produced at the screen grid and this pulse is used to switch the line timebase.

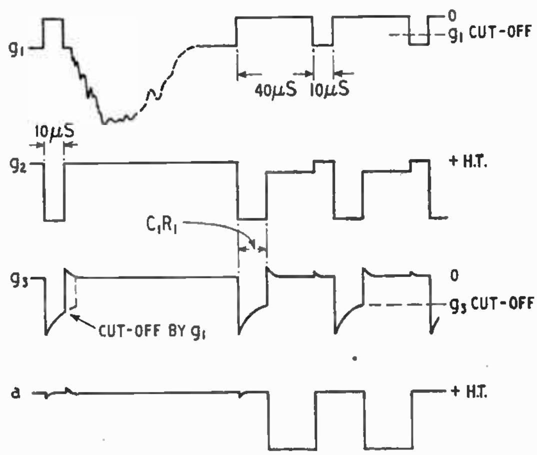


Fig. 2. The waveforms on the electrodes of the valve during line and frame pulse periods are shown here.

When the first frame-synchronizing pulse appears at the control grid, the "flip" action takes place as before, but this time the "flop" occurs before the 40-microsecond frame pulse has ended. This is contrived by making the time constant $C_1 R_1$ less than 40 microseconds. The result is that the circuit produces not only a negative-going pulse at the screen grid but also a steep-fronted negative-going pulse at the anode. This pulse at the anode is used to trigger the frame timebase. The waveforms at the various electrodes are shown in Fig. 2.

The time constant $C_1 R_1$ should be just over 10 microseconds. With a 50-pF capacitor for C_1 and a 1-MΩ variable resistor for R_1, a suitable value of R_1 can readily be found by observing the waveform at the anode and gradually increasing R_1 to a point just beyond that at which the line-synchronizing pulses vanish. In practice, the line-synchronizing pulses will not vanish completely at the anode, but for most purposes their amplitude is so small compared with that of the

* Patent Application 4280/49.

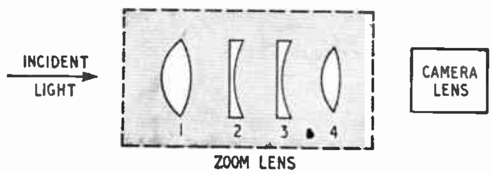
Transitron Sync Separator—
frame-synchronizing pulses that this does not matter. Where, however, the amplitude of the line-synchronizing pulses appearing at the anode is more than is desirable, the pulses can be removed by means of a suitably biased diode with a load resistor or by means of a low-pass filter.

ZOOM LENSES

Their Use in the Television Camera

By H. H. HOPKINS, *Ph.D., F.Inst.T.*

A RECENT innovation in television outside broadcasts has been the introduction of a zoom lens, which is an attachment for converting any ordinary fixed-focus camera lens into a lens of continously variable focal length. The new lens has been made by W. Watson and Sons, of Barnet, and was used for the first time at the televising of the Cup Final at Wembley this year.



General arrangement of the zoom lens.

The zoom lens is mounted on the front of the television camera and is operated by rotating an outer cylinder which imparts axial movements to the two inner component lenses, 2 and 3, by means of cam slots, the outer components, 1 and 4, remaining stationary. If suitable movements are given to 2 and 3, the final image remains in focus on the photo-cathode of the television camera, and the focal length of the combined optical system varies. The result is that the size of details in the picture is altered, creating the illusion that the camera is moving towards or away from the scene. The zoom lens at present being used for television enables the image of any detail in the scene to be varied over a range of 4 : 1 in area, and it will work in conjunction with any camera lens having a front diameter not greater than 2 in and covering an angle of field that is not more than 30 degrees. During zooming, the relative aperture of the combined optical system remains constant, and consequently the brightness of the image also remains constant.

The aberrations of the system are corrected by balancing the positive and negative aberrations contributed by the different surfaces. Any change in the relative positions of the component lenses will, in general, upset this balance, and so it is necessary to restrict to a minimum the movements of the inner components 2 and 3. The conditions that result in minimum movement have been worked out and are satisfied by the lens. In addition, the optical conditions resulting from the refractions by the moving components have been studied and a relatively simple mathematical treatment for calculating them has been worked out. This treatment reveals the conditions that must be fulfilled if a satisfactory lens is to be produced, taking into account the inaccuracies, small but optically significant, that are unavoidable in the best available non-geometric cams.

Zoom lenses have previously been very complicated. Simplicity is one of the principal factors contributing to the success of the new lens, which has only four components and yet gives excellent definition. Furthermore, this economy of components results in a greater efficiency of light transmission and also in the elimination of stray light, compared with certain other zoom lenses.

Semi-Automatic Morse Key

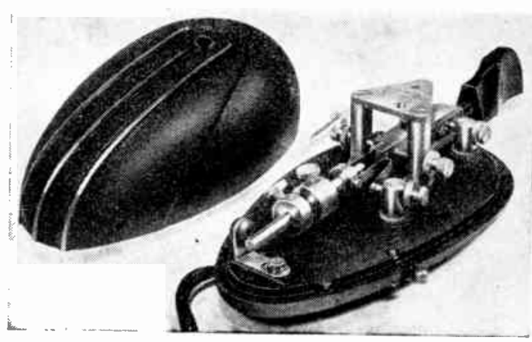
RADIO amateurs and many professional operators on this side of the Atlantic are beginning to acquire a liking for the semi-automatic type of morse key so popular in the U.S.A. Once the technique of handling it has been mastered it does unquestionably permit of sustained high speed sending with far less wrist fatigue than with most other types of key.

It gets its description from the fact that the dot constituents of the morse characters are formed automatically by a vibrating spring, the speed of sending being governed by the position of "bob" weights.

The Eddystone model of the key is very well engineered and lends itself for adjustment to almost any speed of sending likely to be required by amateurs and most professionals. It is not a key that would normally be used for slow sending as its special properties show up best at high speeds. None the less it is quite capable of operation at 8 w.p.m. if required. This key has two "bob" weights for coarse and fine adjustment.

A heavy die-cast base is used with rubber feet and there are also two holes for screwing it down. Actually the rubber feet counter any tendency to wander, but a more secure fixing is really desirable. It has a short-circuiting switch and the whole is enclosed by an attractive cover finished in black crackle enamel and chromium.

The makers are Stratton & Co., Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31, and the price is £3 17s 6d.

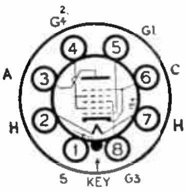

Eddystone semi-automatic morse key with cover removed. The "bob" weights are set for medium speed of sending.

When these special types arise you'll find it best to ★BRIMARIZE!

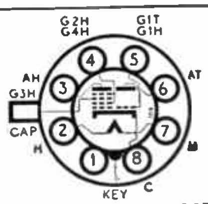
TYPES 6SA7 and 12SA7 are pentagrid frequency changers of specialised design, widely used in American radio receivers. They have now been superseded by the miniature types 6BE6 and 12BE6, but this substitution requires a change of socket.

Good results may often be obtained by the use of types 6K8GT and 12K8GT respectively, a slight connection change and a lead to the top cap being required. In all cases it will be necessary to re-align the receiver, preferably throughout.

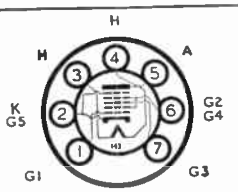
← PUNCH HOLES HERE →



TYPES 6SA7, 12SA7



TYPES 6K8GT, 12K8GT



TYPES 6BE6, 12BE6

CHARACTERISTICS

	TYPES 6SA7 6BE6	TYPES 12SA7 12BE6	TYPE 6K8GT	TYPE 12K8GT	
Heater Voltage ...	6·3	12·6	6·3	12·6	Volts
Heater Current ...	0·3	0·15	0·3	0·15	Amp.
Anode Voltage ...	250		250		Volts
Anode Current ...	3·4		2·5		mA
Screen Voltage ...	100		100		Volts
Screen Current ...	8·0		6·0		mA
Control Grid Voltage ...	0		−3		Volts
Anode Impedence ...	0·8		0·6		Meg.
Conversion Conductance ...	0·45		0·35		mA/V

6SA7
12SA7

CHANGE VALVE		CHANGE SOCKET		CHANGE CONNECTIONS		OTHER WORK NECESSARY
FROM	TO	FROM	TO	FROM OLD SOCKET	TO NEW SOCKET	
6SA7 12SA7	6K8GT 12K8GT	NO CHANGE		Pin No. 8 Pin No. 6	Top Cap Pin No. 8	Connect Pin 6 to Pin 8 Re-align R.F., Oscillator and 1st I.F. circuits
6SA7 12SA7	6BE6 12BE6	Inter-national Octal	Miniature 7 pin (B7G)	Pin No. 1 " " 2 " " 3 " " 4 " " 5 " " 6 " " 7 " " 8	Remove Pin No. 3 " " 5 " " 6 " " 1 " " 2 " " 4 " " 7	Re-align R.F., Oscillator and 1st I.F. Circuits

BRIMAR says.. Make sure of ordering your BRIMISTOR Cards.

BRIMAR
RADIO VALVES

INSTRUCTIONS: Punch holes where indicated, cut away this portion and file in order of appearance for a quick reference guide.

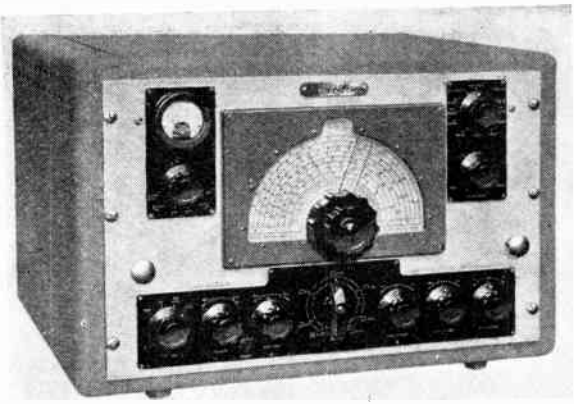
26

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.

TEST REPORT

REDIFON MODEL R50

Wide-Range Tropicalized Communications Receiver



The Redifon R50 communications receiver has an attractive front with well-balanced controls.

As one of the many functions of the general-purpose communications receiver with which we are here concerned is for merchant ship work, it has been designed to comply with certain requirements laid down by the Postmaster-General as to specification and performance.

One of the requirements for a set of this kind is that it must provide a continuous frequency coverage over the band 100 kc/s to 25 Mc/s. For certain ships a curtailed range may be permissible but in order to cater for all requirements the full coverage has been provided. In addition, an extra-low range of from 13.5 to 26 kc/s is included.

With this wide coverage the problem arises of where to place the intermediate frequency. Below 100 kc/s is not very satisfactory, especially for reception over about 1 Mc/s. In this receiver the problem is neatly circumvented by providing two i.f.s and selecting the most suitable for the band of signal frequencies in use.

The actual coverage of the receiver is somewhat greater than the minimum requirements for ship-borne apparatus. There are eight ranges marked, for convenience, A to H inclusive. A is the highest frequency range and H the lowest. H covers 13.5 to 26 kc/s; G, 95 to 250 kc/s; F, 240 to 600 kc/s; E, 585 to 1,550 kc/s; D, 1.5 to 4 Mc/s; C, 3.8 to 8 Mc/s; B, 7.7 to 16 Mc/s and A, 15.5 to 32 Mc/s. It will be seen that for ranges G to A inclusive there is a useful overlap in all cases.

As regards the use of the intermediate frequencies, on ranges H and F an i.f. of 110 kc/s is used since it is well outside the coverage of either. On ranges G, E, D, C, B and A, one of which includes the 95- to 250-kc/s band, an i.f. of 465 kc/s is employed. This i.f. could not, for very good reasons, be used on range F which covers 240 to 600 kc/s. Nothing is to be gained by employing 110 kc/s on the higher frequency ranges as the image signal discrimination would be somewhat unsatisfactory.

The changeover from one i.f. to the other is automatic, being performed by the waveband switching so that the operator has no need to concern himself with it and, of course, mistakes cannot arise. Two complete sets of i.f. transformers and two crystal filters are embodied in the i.f. unit. The arrangement of the circuit between the mixer valve and the first i.f. stage is given in Fig. 1 which shows also the circuit switching for the two narrowest bandwidths.

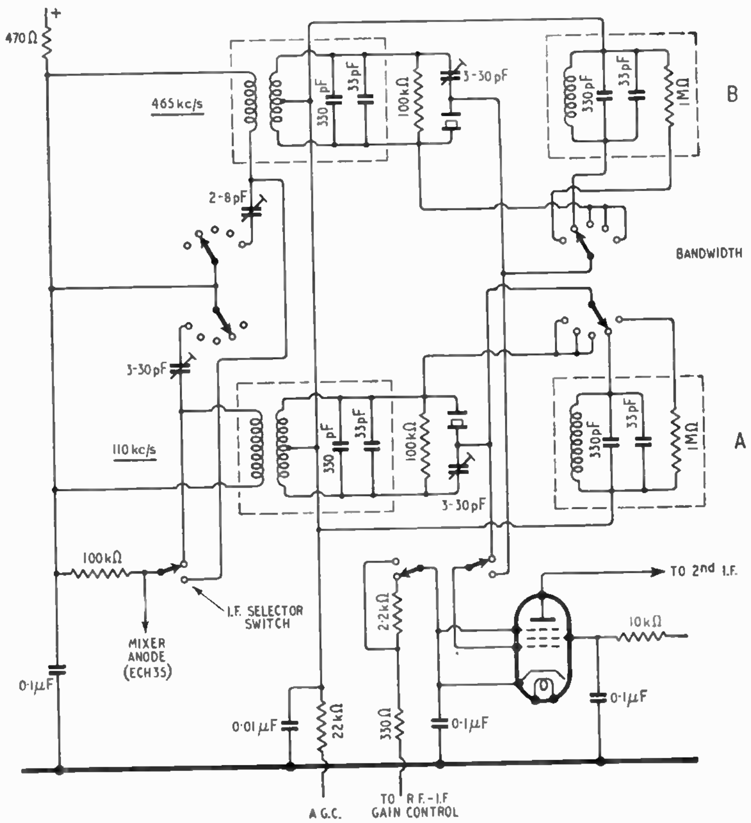


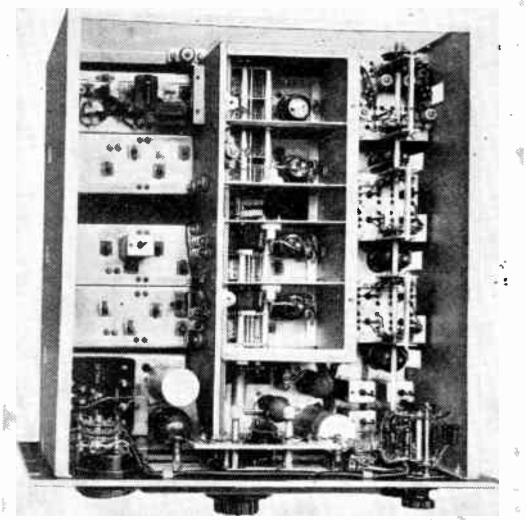
Fig. 1. Arrangement of the circuit between the mixer and first i.f. stages in the Redifon R50 receiver. This includes part of the bandwidth switching and i.f. switching.

Redifon Model R50—

In all there are five bandwidth positions; two include the crystal filter and give either 150 c/s or 1.5 kc/s. The three other positions without the filter give 4, 11 and 17 kc/s respectively.

The narrowest bandwidth is obtained with the crystal filter working into a high-impedance load which in Fig. 1 is the 1-MΩ resistor in the subsidiary circuits A or B. The next widest, 1.5 kc/s, is obtained by modifying the load into which the crystal works, in the case of either of the subsidiary circuits A or B, the former on 110 kc/s and the latter on 465 kc/s, they are adjusted to provide an impedance of the order needed to open the bandwidth to 1.5 kc/s.

With the waveband switch set to any of the other three positions the crystals are short-circuited and the bandwidth is determined by the coupling between the primary and secondary circuits of the transformers in the latter part of the i.f. amplifier. The couplings can be varied by switching in the appropriate parts of tertiary coils which augment the inductive coupling between the primary and secondary windings.



Looking down on to the top of the chassis with the screens removed can be seen, on the right, the i.f. sub-assembly; in the centre the ganged tuning unit and on the left the sub-sidiary units. The switch assembly in the right-hand front corner is the metering network.

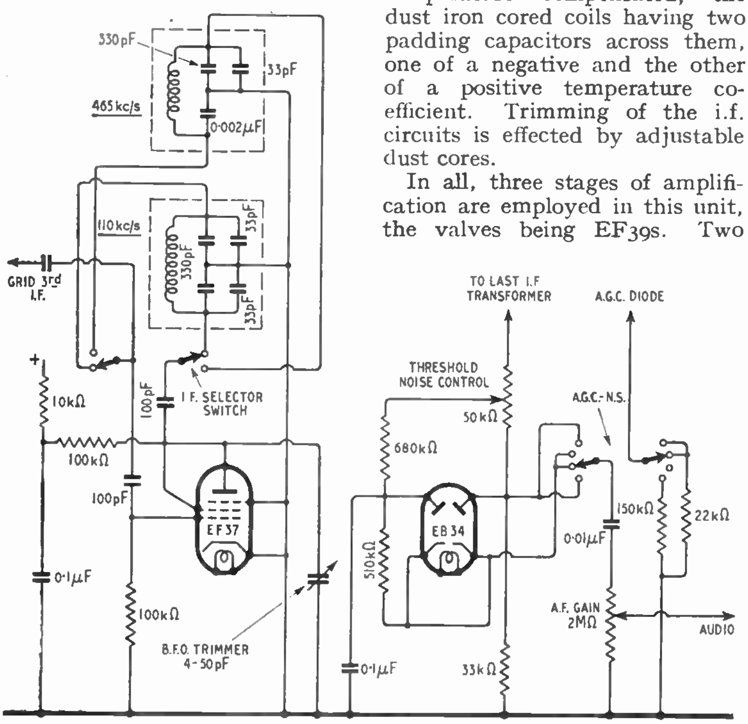


Fig. 2. The b.f.o. and noise suppressor circuits of the Redifon R50. Included also is the "AVC-NS" switch. It will be seen that two complete circuits for 110- and 465-kc/s i.f.s. are incorporated.

In order to achieve adequate selectivity with the crystal filters, twelve high Q tuned circuits are employed in the i.f. amplifier on either 110 kc/s or 465 kc/s. Each of the 24 circuits—12 only are, of course, in use at any time—are temperature compensated, the dust iron cored coils having two padding capacitors across them, one of a negative and the other of a positive temperature coefficient. Trimming of the i.f. circuits is effected by adjustable dust cores.

In all, three stages of amplification are employed in this unit, the valves being EF39s. Two only are included in the a.g.c. system and they receive a portion only of the total a.g.c. voltage available.

The rear end of the set is reasonably orthodox, a double diode (EB34) acting as detector and a.g.c. stage with another EB34 functioning as an optional noise suppressor. It can be switched in or out as required and there is also a control for setting the threshold point at which the suppressor begins to operate.

D.C. voltage for automatic gain control is derived from the primary circuit of the last i.f. transformer and applied, after some delay, to the two r.f. stages, and as already mentioned, in part to two of the i.f. valves but leaving the mixer and last i.f. uncontrolled.

In some communications receivers the a.g.c. system becomes inoperative when the b.f.o. switch is set for c.w. reception, but in the Redifon R50 a.g.c. continues to operate, but with a much longer time constant than for telephony.

A.G.C. can, however, be suppressed if desired and this facility is embodied in a four-position switch marked "AVC-NS." In one position a.g.c. functions as usual, in another it is inoperative and all control of volume is by the r.f. and a.f. gain controls, in a third position a noise silencer with a.g.c. is brought into circuit while in a fourth position the noise silencer is used without a.g.c.

Audio amplification is provided by an EF37 voltage amplifier and a 6V6 power valve with some negative feedback from the anode circuit of the 6V6 to the anode of the EF37.

Because alternative i.f.s are provided, the b.f.o. stage must generate heterodyne oscillations for either the 110- or 465-kc/s channels as required. An EF37 valve and a parallel-fed Hartley circuit, with entirely separate circuits for each frequency, is employed for this purpose. Both circuits are temperature compensated and the change from one to the other is synchronized with the i.f. selector. Details of the b.f.o. oscillator and of the noise silencer are given in Fig. 2.

In order to obtain a good signal-to-noise ratio and, perhaps what is of greater importance, an adequate image signal discrimination on the higher signal frequencies, two r.f. stages with EF39 valves are provided. These are followed by a mixer consisting of the hexode part of an ECH35 and a separate oscillator, which function is performed by a L63 triode with its grid joined to the normal oscillator grid of the ECH35 for voltage injection. The triode anode of the ECH35 is earthed.

There is little out of the ordinary in this part of the circuit except that each tuning capacitor has dual sections of 224-pF maximum. One section only is used on the three highest ranges but both are used in parallel on all other bands. These circuits, and those in the local oscillator, are frequency stabilized by a combination of negative and positive temperature co-efficient

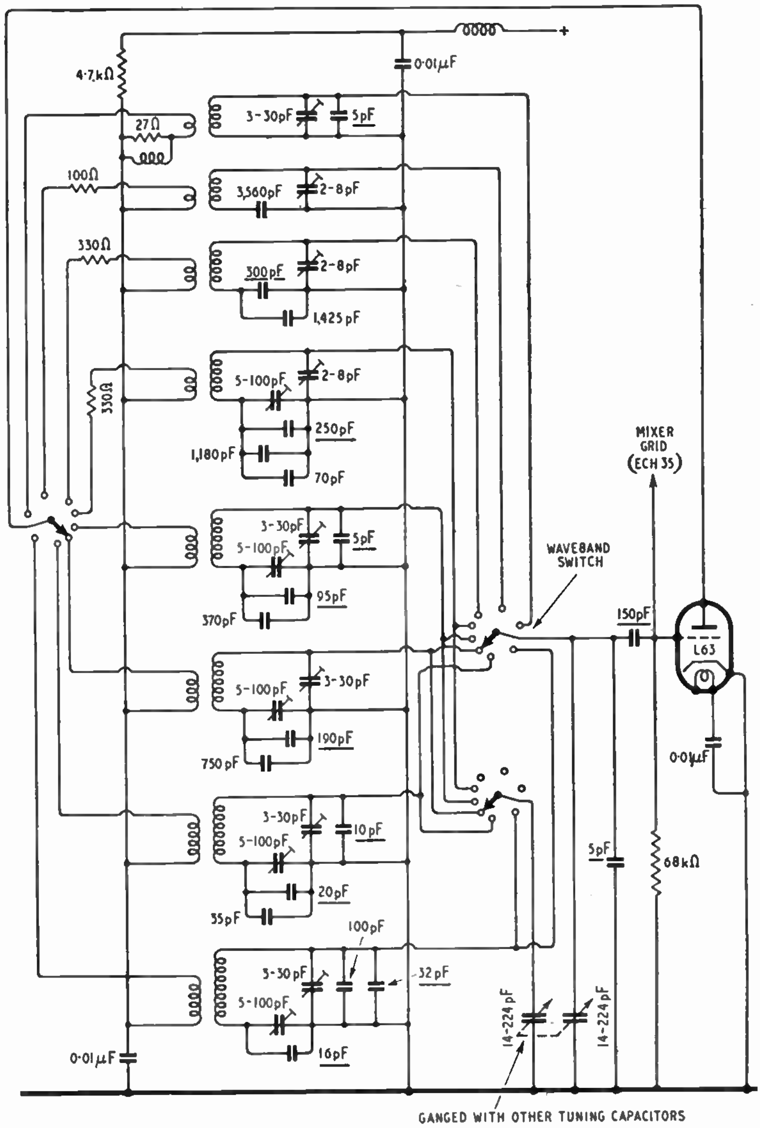


Fig. 3. A separate triode is used for the local oscillator with injection into an ECH35 mixer. Temperature compensation is used in all oscillator circuits, the negative co-efficient type capacitors being identified by a short horizontal bar below the capacitance value.

capacitors. The sectional circuit in Fig. 3, which shows the local oscillator, indicates these compensating capacitors, the negative temperature type having a short horizontal bar below the capacitance value. Also included is the dual tuning capacitor and the oscillator waveband switching.

This receiver has provision for remote control and also for diversity reception if required. The screen grid supply lead for the i.f. and r.f. valves is accessible at the output socket and by simple switching, or by a relay, the voltage can be reduced so that the receiver is de-sensitized to such a degree that it can be employed to monitor a telegraphy or telephony transmission. It can also be arranged for "break-in" operation when required up to a speed of about 40 words per minute. The time constants of the receiver permit recovery to full sensitivity in the "break" periods up to this speed of sending.

Power supply for this receiver is provided by a separate unit and normally this will be a.c. operated. In addition to the usual rectifying and smoothing circuits the power unit contains a voltage regulator tube giving a stabilized h.t. supply to the mixer g_2 grid and the oscillator anode. The a.c. consumption is 80 watts. For battery operation there is another power unit and this has a rotary converter for h.t. supply. There are also available supply units with rotary convertors for various d.c. voltages up to 220.

Redifon Model R50—

A receiver of such high selectivity as the R50 must of necessity possess extremely good frequency stability. From the brief foregoing description it will have been seen that quite a lot has been done to ensure that this condition prevails by the judicious use of temperature compensated circuits and stabilized voltages. But these precautions alone would be of little value unless they were supplemented by good mechanical rigidity. It is unusual to find quite such a massive construction as in the R50.

The individual sub-assemblies, as well as the main framework, are well braced to withstand the hazards of transit and to stand up to the stresses that must be imposed during rough weather on board ships at sea. Rubber suspension is used for the r.f. unit, with which is incorporated the ganged tuning capacitors, largely to combat any likelihood of microphony.

Although light alloy is used extensively in the construction of the set, it is not a light-weight receiver. The chassis alone weighs 55 pounds and, enclosed in a sturdy metal cabinet it weighs 92 pounds. The dimensions are $14\frac{1}{4} \times 21 \times 22\frac{1}{2}$in.

The set is fully tropicalized and while miniature components are included no attempt is made at miniaturization. When out of its cabinet every part of the set is readily accessible which makes for easy maintenance and testing.

In order that a quick check can be made on the set under working conditions a comprehensive metering system is embodied. A single meter is employed and this can be switched to measure the anode currents of r.f., oscillator and i.f. valves and the cathode currents of the a.f. amplifiers.

The performance of the R50 is fully in keeping with what might be expected of a set of this kind. With a little care in tuning and judicious selection of the bandwidth, a weak signal can be separated from between two quite powerful ones and held almost indefinitely provided the transmitter frequency is fully stabilized. After the initial warming up the oscillators settle down to their work and remain remarkably steady.

The h.t. smoothing is quite adequate and on the highest frequency range in the 30-Mc/s region, c.w. signals are receivable with pure beat notes and without a trace of ripple due to mains frequency modulation.

An epicyclic drive giving an 80 to 1 reduction is employed for the main tuning control. It incorporates a spring-loaded chain of gears driving a subsidiary logging dial, which, in conjunction with an additional scale on the main dial, enables any station to be accurately logged. The logging dial is visible through an aperture just above the main scales and a single division represents about a 10-kc/s coverage at 30 Mc/s. At lower frequencies it is considerably less. Frequency calibrated scales are provided for each of the eight ranges.

The R50 is made by Rediffusion, Ltd., Broomhill Road, Wandsworth, London, S.W.18, and the price of the cabinet model is £180. The set is also available with a panel for mounting in the standard 19-in rack.

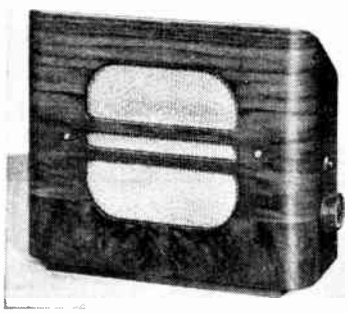
MORE COPIES OF "WIRELESS WORLD"

As announced last month, the Government's decision to increase the allowance of paper for technical periodicals makes it possible to print more copies of *Wireless World*. Starting with the August issue (published 26th July) there should be enough for all anticipated requirements. But the number of copies will still be limited, and so it will be necessary for an order to be placed with a newsagent.

REMOTE CONTROL EXTENSION LOUDSPEAKERS

TWO of the three new models in the "Stentorian" range of extension loudspeakers, made by Whiteley Electrical Radio, Mansfield, Notts, are fitted with push-button switches for remote control of the receiving set.

The system is the Whiteley "Long Arm" remote control in which a relay controlling the mains supply to the set is operated through three-wire extension leads from any loudspeaker position. When the set is switched on from another room, only the loudspeaker in that room is operative, all the others remaining silent. Alternatively, when the set itself is switched on manually, none of the extension loudspeakers will work unless specifically required.



"Beaufort" model with "Long Arm" remote control in the new "Stentorian" range of loudspeakers.

Six-inch permanent-magnet units with die-cast chassis are used in the "Bristol" loudspeakers which have plywood fronts with rounded corners and are enclosed at the back with perforations in the covers to relieve back pressure. Constant-impedance volume controls are fitted and a choice of output impedances is provided.

The frontal dimensions of the "Beaufort" are $12\frac{1}{2}$in x $10\frac{1}{4}$in and of the "Bristol" $10\frac{3}{4}$in x $9\frac{1}{8}$in; both are $3\frac{1}{2}$in deep. Prices, with and without transformer, are: "Beaufort" £3 15s, £3 7s 6d; "Bristol" £2 19s 6d, £2 13s 6d. A cheaper model, the "Bedford," with 5in unit, but without the "Long Arm" control feature costs £2 5s 6d or £1 19s 6d without transformer.

NEWS FROM THE CLUBS

Brighton.—Meetings of the Brighton and District Radio Club are now held on Tuesdays at 7.30 in the club's new headquarters at the Eagle Inn, Gloucester Road. Sec.: L. Hobden, 17, Harlington Road, Brighton, Sussex.

Exeter and District Radio Society is organizing a 7-Mc/s d.f. contest on Woodbury Common on July 3rd, which is open to other clubs. Sec.: E. G. Wheatcroft, 27, Lower Wear Road, Countess Wear, Exeter, Devon.

Slough.—Readers in the Slough, Bucks, area who are interested in the formation of a radio society in the district are invited to a meeting to be held at 7.30 on June 30th at the Slough Public Library. Acting Sec.: F. J. T. Tuckfield, 13, Quaves Road, Slough.

Southend.—The transmitter, G5QK, of the Southend and District Radio Society will be demonstrated at the Leigh-on-Sea Horticultural Society's Show at Chalkwell Park, on July 9th and also at the Scouts' International Jamboree at Rochford from August 13th to 20th. Sec.: J. H. Barrance, M.B.E., Swanage Road, Southend-on-Sea, Essex.

INDOOR TELEVISION AERIAL

Compressed Dipole for Strong-Signal Areas

By N. M. BEST and P. J. DUFFELL (Antiference Ltd.)

WITHIN a radius of approximately five to ten miles from the television transmitter at Alexandra Palace, the standard dipole-and-reflector aerial system, mounted at chimney level, provides a greater signal than is absolutely necessary for the operation of a receiver. For installations nearer to the Alexandra Palace, even a single dipole without reflector may be sufficient to overload the set at its lowest sensitivity level. The insertion of an attenuator between aerial and receiver then becomes necessary.

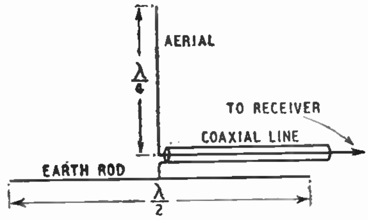


Fig. 1. Grounded quarter-wave aerial.

In practice, it is found that an aerial mounted indoors gives satisfactory results over a fairly wide area. The physical dimensions of the standard H-type aerial make it unsuitable for indoor installation, and the indoor aerial is usually made physically smaller than the standard dipole, with some attendant loss in electrical efficiency.

The most important factors to be considered are:—

(a) Sensitivity.

(b) Bandwith (the aerial must cover sound and vision channels).

(c) Feeder matching (normal receiver input is approximately 70 ohms and the feeder must have the same impedance).

The first two factors (a) and (b) may be affected by altering the shape of an aerial, and (c) is affected by any change of aerial input impedance.

There are several possible ways of constructing small television aerials.

The grounded quarter-wave aerial is one in which the earth is replaced by a half-wave horizontal rod, the centre of which is at earth potential. It is sketched diagrammatically in Fig. 1 and in practice, using co-axial cable, the inner conductor is connected to the bottom of the vertical quarter-wave rod, and the outer conductor to the centre of the earth rod.

The input impedance of this type of aerial is approximately 40 ohms, and the effective height is half that of a standard dipole. Although it is suitable for installation in a loft, it is physically cumbersome because of the earthing system.

A second form of aerial is known as the bent-rod type, and is probably patterned on an American type of aircraft antenna. The effect of bending the rods is an increase of bandwidth and a loss of sensitivity. Commercial types of this aerial are made to be installed in the V of the roof. The sensitivity is usually low because the pick-up portion is the projection of the inclined rod on the vertical plane.

A dipole of normal shape can be physically shortened by capacitance end loading or inductance loading. Capacitance loading involves mechanical difficulties and may be ignored, but an inductively loaded aerial is comparatively simple to construct.

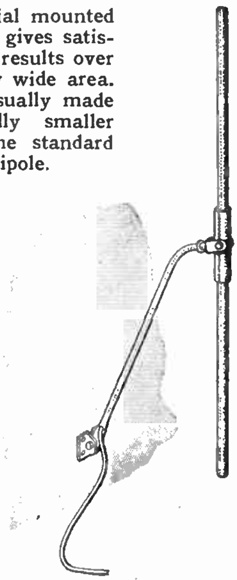
The first two kinds of aerial referred to are only really suitable for installation in a loft. Many set owners, however, live in blocks of flats and similar buildings, and are often not permitted to install outside aerials. One disadvantage of an aerial installed in a living-room is that it is particularly susceptible to alterations of the electrical field due to movement of persons in the room; but with a careful choice of aerial position this effect can be greatly reduced. In any case, during a television broadcast it is hardly likely that there will be sufficient movement of persons to cause annoyance. A useful type of indoor aerial, therefore, would be one suitable for either the living-room or the loft, and the design of such an aerial is discussed in this article. It is based on a simple inductively loaded dipole with a maximum overall length of approximately five feet six inches.

Consider the case of a dipole shortened to five feet and using rods of ⅜-in diameter.

In order to make the system resonant at 45 Mc/s it requires loading with an inductance of approximately 2.0 μH, and it then has an input resistance at 45 Mc/s in the region of 20 to 30 ohms.

The coil loading, of course, narrows the bandwith, and it is estimated to be approximately 3 db down at 43.6 and 46 Mc/s. Objections to this method are, therefore, the narrow bandwidth and the low input resistance. If the feeder mismatch is considered throughout the band, then the bandwidth becomes narrower still. Some improvement can be obtained by increasing the diameter of the rods, but they have to be unwieldy in size to get the necessary bandwidth.

An aerial mounted indoors gives satisfactory results over a fairly wide area. It is usually made physically smaller than the standard dipole.



The reactance of a dipole varies with frequency either side of resonance in the manner shown in

Indoor Television Aerial—

in Fig. 8. The uncompensated compressed dipole, curve (b), shows a reactance varying from $-j57$ ohms to $+j57$ ohms and considered in conjunction with curve (b) of Fig. 7, shows a very poor ratio of reactance to resistance at the edges of the band. The compensated compressed dipole, curve (c) is inductive throughout the band varying from $+j22$ ohms to $+j4$ ohms. It can be seen that the ratio of reactance to resistance compares favourably with that of the standard dipole, and provided that the measured input resistance is mainly useful radiation resistance and not loss resistance, the aerial bandwidth should be comparable with that of the standard dipole. Actual field strength

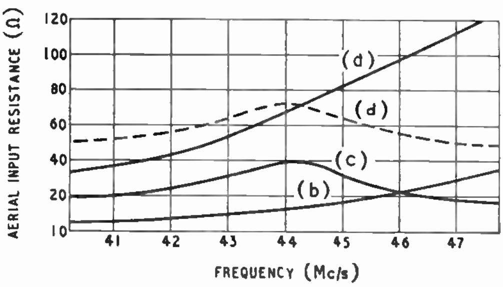


Fig. 7. Curves of aerial input resistance.

measurements showed the compressed dipole to be − 6 db ± 1 db down in sensitivity on the standard dipole throughout the band, thus substantiating the results expected from impedance measurements.

In order to match the compressed dipole to a 70-ohm feeder a series resistor of approximately 30 ohms was added, but as the aerial was only intended for use in high signal-strength areas the additional loss is tolerable. The dotted curve (d) in Fig. 7 shows the input resistance presented to the feeder by the combination, and the aerial-to-line matching (70-ohm feeder) is shown for the

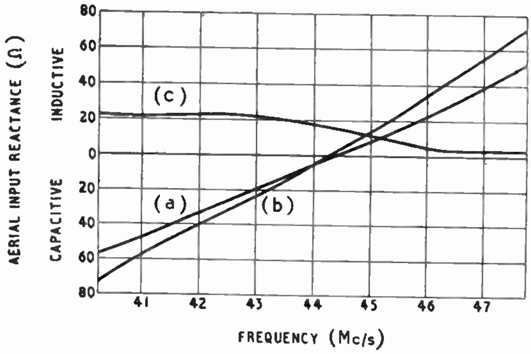


Fig. 8. Curves of aerial input reactance.

standard dipole and the compressed dipole with and without series resistance in Table 2. The Table shows comparisons of matching in terms of the reflection coefficient ρ.

$$\rho = \frac{Z_R - Z_K}{Z_R + Z_K}$$

and becomes zero when Z_R, the terminating impedance, equals Z_K, the line impedance; i.e., reflection is eliminated.

Inductively loading a dipole aerial in order to reduce its overall length and make it suitable for indoor installation, results in loss of bandwidth and sensitivity. Successful compensation for the loss of bandwidth can be obtained, however, by the use of a short-circuited stub matching line of very low impedance which, in combination with the loaded dipole, provides useful reactance cancellation over the television band and gives a picture definition comparable with that of the standard dipole.

As the aerial is mainly intended for use in areas of good signal strength the loss of sensitivity is tolerable and is far outweighed by the advantage of the reduced size, approximately to one-half of that of the ordinary dipole.

TABLE 2

Comparison of aerial to line matching of normal dipole and compressed dipole (Z of line = 70 ohms).

Frequency (Mc/s)	Reflection Coefficient (Percentage)		
	Normal dipole	Compressed dipole with matching resistor	Compressed dipole without matching resistor
41	44%	25%	56.2%
42	38%	19.7%	48.2%
43	19.7%	14.3%	40.8%
44	6.3%	6.3%	31.5%
45	11.6%	6.1%	38.0%
46	21.8%	9.9%	48.2%
47	22.6%	13.5%	52.5%

"DIALLIST'S" PROBLEM

THIS should not be read until the simple problem set in "Random Radiations" (page 279) has been tackled. The correct answer is (*b*). When capacitors are connected across a source of h.t. voltage the p.ds across them depend on their leakage resistance and not on their capacitance. Suppose 2,000 V is applied to two series capacitors, one of which has an insulation resistance of 300 MΩ and the second an insulation resistance of 100 MΩ. Then there will be a p.d. of 1,500 V across the first and of 500 V across the second. If both are rated at 1,000 V d.c. working the first will soon break down. The full voltage will then be applied to the second, which will also break down.

In practice it is not possible to manufacture capacitors of identical insulation resistance. In France, at any rate, the provision of individual shunt resistors is compulsory. The resistance of these is less than the insulation resistance of the capacitors, but high enough to ensure negligible losses.

Owing to the presence of these resistors it does happen that the capacitors are discharged rapidly when the source of h.t. voltage is switched off. Hence, if you plumped for (*c*) you may award yourself a gentle pat on the back

Civil Aviation Communications.—A second edition of the Civil Aviation Communications Handbook (MCAP5) has been published. It contains the international regulations and communications procedures with which aircraft registered in the United Kingdom have to comply. It is obtainable, price 7s 6d, from H.M. Stationery Office. The pamphlet "Radiotelephony Procedure" (MCAP46) continues in use as the standard reference document for Part I of the qualifying examination for the Flight Radiotelephony Operator's Certificate of Competency.

THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference

The Siting of Aerials

We claim that "Belling-Lee" television aerials are mechanically and electrically superior, but if erected without due regard to local interference, and/or the proximity of a corrugated iron shed or gas holder, then the "Belling-Lee" best is no better than the cheapest worst.

No aerial is a "cure all," some are made better than others, stand up to the weather, without leaning away from the prevailing winds, etc. Some have had superior electrical knowledge built into them, which tells when used in fringe areas.

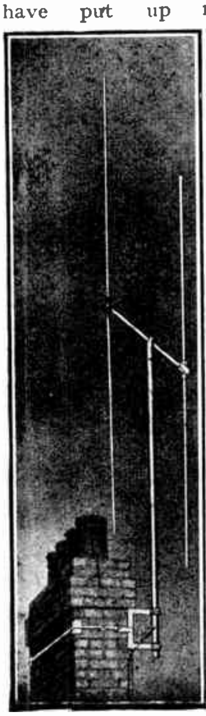
We consider it bad practice to recommend the most expensive aerial of a range when a cheaper model will suffice.

Both the "H" type *1 and the "Veerod"*2 (inverted "V") are, in their own way, ideal for the elimination of interference; the "H" is the most expensive in our range and the "Veerod" one of the cheapest.

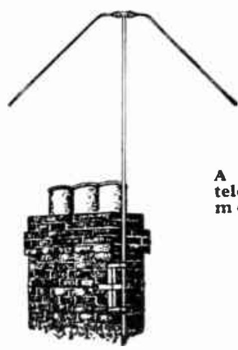
We have seen an announcement in a Midland paper to the effect that it is not possible to know what will be the best television aerial to erect until the Midland Transmitter is on the air. "Belling-Lee" have put up many hundreds of aerials for the Midland Transmitter and many hundreds more have been erected by worthy competitors. If the installations are entrusted to recognised firms with plenty of experience of this work in the London and home counties, then there is no need to worry.

If however, someone without the necessary experience puts up a television aerial, then there may be trouble from double images or "ghosts," or the obvious local source of interference may be ignored and consequently the wrong type of aerial installed. To take a case in point, the "Belling-Lee" "Veerod" has sharp minima at right angles to the direction in which it is pointing, whereas the "H" type has a minimum behind the dipole: one experienced in these matters makes full use of such characteristics for the removal of "ghosts" or interference. Again, sometimes it is advantageous to use the building on which the erection is being carried out to screen the dipole from obvious interference such as a busy cross road, and in other cases height is the most important thing. Experience of hundreds of such cases is most useful.

The average wireless Dealer will not make mistakes that he cannot rectify when the time comes



A "Viewrod" 'H' type aerial.



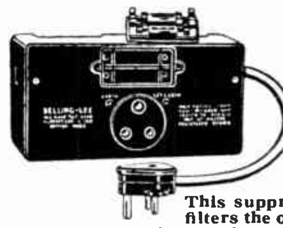
A "Veerod" television aerial mounted on a chimney.

Hum in the Receiver.

We have heard a lot about humming aerials, and we have cured this trouble, but we have recently had a number of requests to cure hum in the receiver. Now, this is a form of interference that we do not claim to cure. The hum is a low frequency phenomenon which may be mains borne on D.C. mains or an inherent property of the receiver itself.

Our interests are in radio frequency interference, which, as readers of this page know, shows up on the picture of a television receiver as "ghosts," spots, feathering, or bars, and on the sound channel, or on broadcast receivers as crackles, plops, bangs and sizzling noises whch may be eliminated from the receiver by the use of one or more of the following methods :—

1. Correct choice and siting of an outdoor aerial.
2. For broadcast reception, an anti-interference aerial*3.
3. **Fitting a mains filter*4.**



This suppressor filters the output of a mains outlet socket. List No. L300/3 1 amp.

Wires that carry and re-radiate interference.

We have recently been asked to confirm whether or not "wires used for wired wireless" radiate interference. The answer is that they can and do. So do telephone wires, and overhead fire alarm wires, but of course the worst offenders are overhead mains, in villages where the houses are wired with V.I.R. taken in at roof level.

*1. "Viewrod" television aerials for Midland frequencies.
L652/LM "H" type with 8ft. light alloy mast and chimney lashings, **£6/5/-.**
L652/C "H" type with mast head cap for customer's own wooden mast, **£2/17/6.**
L652/L "H" type with mast head cap and chimney lashings (less mast), **£5/7/6.**
The London equivalents for items 2 and 3 are L502/C, **£4/8/-,** L502/L, **£6/6/-.**

*2. "Veerod" television aerial. Attic mounting. L605 London, **£2/12/6.** L646 Midland, **£2/5/-.** "Veerod" chimney mounting with metal mast. L606 London, **£4/10/-.** L635 Midland, **£4/2/6.**

*3. "Skyrod" vertical collector with "Eliminoise" anti-interference transformers and cable. L638/K Chimney mounting, **£10/-/-.** L638/CK Mast mounting (less mast), **£8/15/-.**
L308/K "Eliminoise" kit with 60ft. wire span and cable etc. Complete **£6/6/-.**

*4. Set lead suppressors. L300/3 1 amp., **£2/19/6.** L305 (2 amp.), sometimes suitable for television, **£3/3/-.**

"Viewrod," "Skyrod" and "Eliminoise" are registered trade marks. "Veerod" registration applied for.

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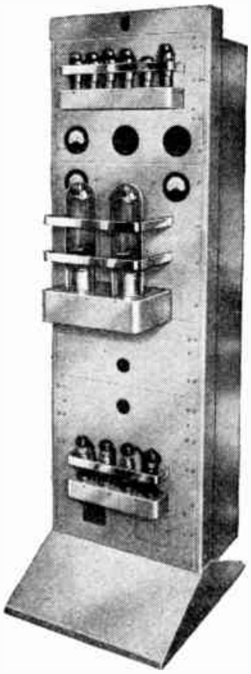
CAMBRIDGE ARTERIAL RD., ENFIELD, MIDDX., ENGLAND

S.R.E.* for all purposes



Philips have supplied through traders and others throughout the world S.R.E. for almost every conceivable application. While specialized equipment is produced whenever necessary, a very wide range of standard apparatus units minimizes the need for this, and simplifies installation and maintenance.

As it can be shown to be much better engineering practice to use one large amplifier instead of a lot of little ones to feed one load, the standard range includes three large rack amplifiers.

Features include triode valves throughout, four push-pull stages, no electrolytics, and three separate anode supplies.

* What expression should be used to refer *generally* to amplifiers, and related apparatus? "Public Address?" This hardly applies to gear that may well be used in private for purposes other than addressing. "Sound Equipment?" This can also mean tom-toms, or brewery apparatus in sound condition!

We have adopted the Navy's term "S.R.E." or "Sound Reproducing Equipment", as in our submission there is no other so accurate or so generally applicable.

250 watt ....List Price **£255**

500 ,, ...List Price **£325**

1,000 ,, ...List Price **£425**

S.R.E. available through the trade on hire purchase or rental terms.

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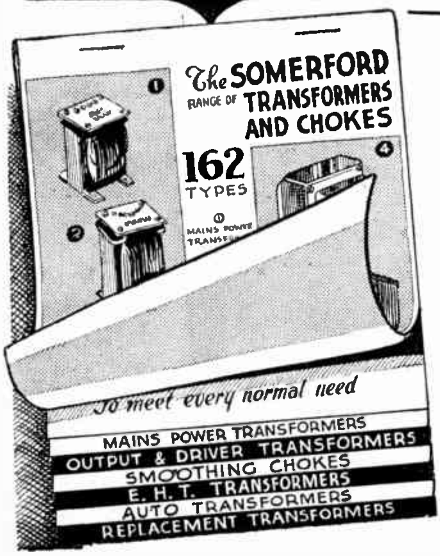
LIMITED

Amplifier Dept., Century House, Shaftesbury Avenue, London, W.C.2.
(A481)

You MUST get this List . .

This is the new list giving descriptions of the 162 Standard types of "Somerford" Transformers and Chokes together with details of 28 types of Replacement components suitable for commercial receivers



This COMPLETE range will meet ALL your normal needs

The requirements of the Electronic Industries are many and varied. It is to meet such demands that the "Somerford" range of Transformers and Chokes exist. No matter whether you are engaged in radio, the manufacture of industrial or domestic appliances, or laboratory work, if you are looking for components that will give you accuracy and dependability at an economical cost, you will do well to choose GARDNER products. Research, skill and modern manufacturing methods have been combined to produce components that will withstand the most arduous working conditions and meet the exacting demands of present day standards. The "Somerford" range comprises 162 different types—a type for every normal need.

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Full details and specifications will be sent on request

GARDNERS RADIO Ltd

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ELECTRONIC CIRCUITRY

Selections from a Designer's Notebook

By J. McG. SOWERBY (*Cinema Television Ltd.*)

Electronic Counters

LAST month a scale of two counter was discussed and its mode of operation explained. It will be remembered that by combination of n scale of two circuits, a division ratio of $N = 2^n$ can be obtained. This series of numbers (2, 4, 8, 16, 32, 64, . . . etc.) is only occasionally useful, so it will be worth discussing how other division ratios can be obtained.

It was pointed out last month that the scale of two shown was essentially a symmetrical circuit, and it may be said to possess two-fold symmetry. If now an analagous circuit can be designed having r-fold symmetry, where r is any number greater than 2, it may be expected to have a division ratio of r. Many such circuits have been developed at different times, and they are commonly called ring counters.[1] One with which the writer is familiar[2] [3] will now be discussed as a representative of its class. In order to see how such a ring circuit is constructed, it is only necessary to consider a ring of 3, as from it rings of greater number can be derived by analogy.

Fig. 1 shows a ring of three which follows much the same plan as the scale of two already discussed. All those components which have the same value are similarly labelled in order to make the symmetry more apparent. In the waiting condition only one valve is conducting, and since there are three valves there are three possible stable states. As before the energising pulse is applied to the common cathode connection across the resistor R_k. Each valve has associated with it a potentiometer network R_2, R_3, in order to repeat a fraction of the anode potential changes at a d.c. potential suitable for the grids. The grids of the three valves are connected to the points P_A, P_B and P_C through "averaging" resistors R_4, and it will be seen that each grid is connected to the anodes of all other valves. As the circuit is entirely symmetrical when power is first applied any valve may become conducting—it is a matter of chance.

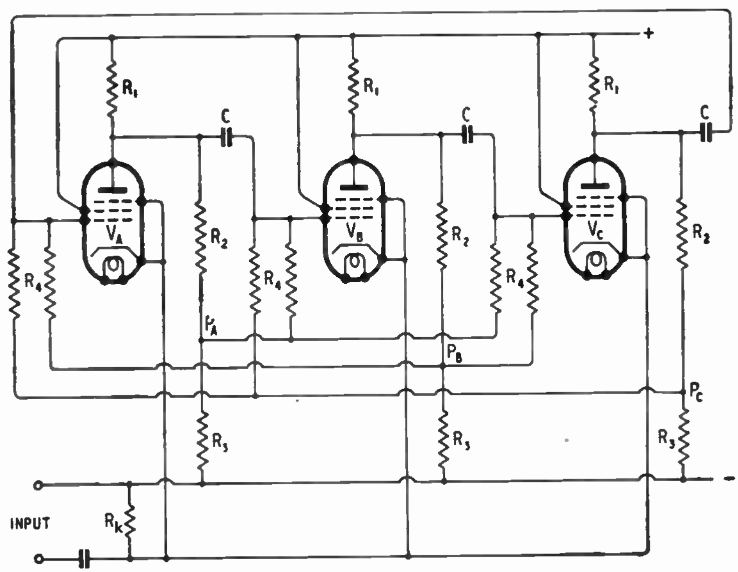


Fig. 1. Ring of three counting circuit.

Let us assume that V_A is conducting initially. Then the potential at P_A is less than that at P_B and P_C. We may loosely say that the potential at P_A is "negative" and that it is "positive" at P_B and P_C. Now consider the grid of V_B. It is fed through equal resistors, R_4, to one positive (P_C) and one negative (P_A). The grid of V_C is connected to one positive (P_B) and one negative (P_A). The grid of V_A is connected to one positive (P_B) and a second positive (P_C). Hence the grid of V_A must be positive with respect to the two grids by an amount sufficient to ensure that V_A continues to conduct. As V_A alone is conducting, the common cathode potential must rise slightly above the grid potential of V_A (assuming no grid current). Consequently the grid potentials of V_B and V_C must be more negative with respect to the common cathode than that of V_A by an amount sufficient to hold both at or beyond cut-off.

If now a short positive pulse of sufficient amplitude is applied to the input terminal, V_A will be momentarily cut-off. Its anode potential will rise in consequence and this rise is preferentially transferred to the grid of V_B through the coupling condenser. When the input pulse subsides the grid of V_B is left momentarily more positive than that of any other grid, so that the circuit locks itself into the second stable state with V_B conducting, and the other two valves cut off. It is easy to see that another input pulse transfers the conduction to V_C, and after a third pulse the original state is resumed. Obviously one (positive)

[1] For example. C. E. Wynn-Williams, *Proc. Roy. Soc.*, Vol. 132, p. 295, 1931. C. E. Wynn-Williams, *Proc. Roy. Soc.*, Vol. 136, p. 312, 1932. W. B. Lewis, "Electrical Counting." C.U.P., 1942.

[2] T. C. Nuttall, Brit. Pat. No. 572,884.

[3] S. S. West, *Electronic Eng.*, Jan. 1947, p. 3; Feb. 1947, p. 58.

Electronic Circuitry—

pulse can be derived from any one of the anodes for three input pulses, and the circuit divides pulses by three. The buffer stage discussed last month is quite suitable for driving this ring, and also for extracting an output pulse.

A ring of greater number than three can be derived directly from Fig. 1 provided it is remembered that there must be a symmetrical d.c. connection from every grid to every other anode, and at first sight there seems to be no reason why a ring of any number should not be made. There is a practical limit here, however, because conduction in one valve must provide a potential change at all other grids sufficiently large to hold all other valves at or beyond cut-off. If we make the simplifying assumption that the resistances R_4 of Fig. 1 are infinite, it is found that the potential available to cut off each valve other than the conducting one is only $\frac{a}{r-1}$ times the change of anode potential of the conducting valve; where $a = \frac{R_3}{R_2 + R_3}$ and r is the number of valves in the ring. Hence the larger r is made, the more difficult does it become to design for entirely reliable operation. In practice, of course, the resistances R_4 are not infinite, so that the position is rather worse than is indicated above.

The maximum number r which can be attained in practice depends on factors additional to those mentioned. For example by making the R_1 resistances of Fig. 1 very large the anode potential change of the conducting valve can be increased, but as this resistor is shunted by stray capacitance a reduction in maximum counting rate must be expected. With sufficient care in design and using modern high-slope valves with a very short grid base, a ring of ten, capable of operating at 50–100 kc/s, could probably be constructed successfully.

In practice, of course, there is little point in attempting a ring of ten directly, as it is both easier and more economical to use a scale of two and a ring of five in cascade. A scale of 12 might be constructed from two scales of 2 and a ring of three. A scale of 100 could conveniently be made up thus:— $2 \times 5 \times 2 \times 5 = 100$; and a scale of a gross:—$2 \times 2 \times 3 \times 2 \times 2 \times 3 = 144$. Since any number other than a prime can be reduced to a product of primes, it is obviously only necessary to make rings whose division ratios are prime numbers. Of these, 3, 5 and 7 are quite practicable, while 11 or more would usually be regarded as tricky and doubtful. Thus with rings of 3, 5 and 7 allied with scales of two, a division ratio of any number reducible to factors not exceeding 7 can be made. By this means division ratios of 2, 3, 4 5 6 7 8 9 10, 12, 14, 15, 16, 18, 20, 21, 24, 25, 27, 28, 30 . . . etc. can be obtained and next month we shall consider how the missing numbers may be filled in.

Extinguishing Thyratrons

THYRATRONS are frequently used in d.c. circuits as sensitive relays, firing on the application of a small voltage pulse. It is a property of a thyratron that once the valve has broken down the grid has no further control. To extinguish the arc it is usual to break the h.t. supply temporarily, as shown in Fig. 2(a), with the resetting switch S.

An alternative method of resetting a thyratron, which is occasionally useful, is shown at (b). A resistance R_s is placed in series with the load, and a condenser C is momentarily short-circuited to the negative h.t. line with the switch S. The time constants CR_s is long enough to maintain the potential across C less than the running voltage of the thyratron for the time required to ensure de-ionization—generally 200 microseconds is sufficient. The resistance R is used to ensure that C is discharged immediately prior to the closure of S. This arrangement is sometimes useful, for example when only a single-pole change-over contact is available for resetting, and some secondary circuit must be reset with the other contact as shown at (b). There is nothing very novel about this arrangement; the same method of arc extinction is often used in d.c./a.c. convertors.

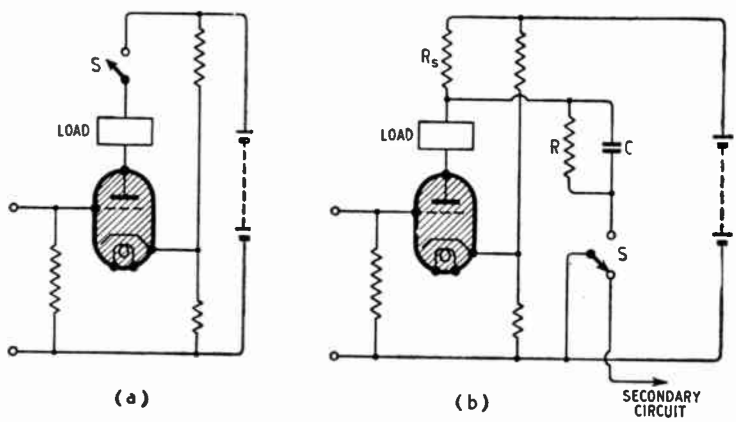


Fig. 2. Two methods of resetting a thyratron.

OUR COVER

VIBRATOR TESTING at Plessey's, Ilford, forms the subject of this month's cover illustration. With the equipment illustrated input and output voltage and current are tested using a standard vibrator and transformer capable of taking a load up to 30 watts output. The frequency of the vibrator reed and contact closure times are also given, as percentage figures. The oscillograph provides a cross check of the operating conditions and the waveform illustrated indicates that the three essential components — transformer, buffer capacitor and vibrator — are matched.

CATHODE-RAY TUBES FOR TELEVISION

Diameter of Tube Neck

By **HILARY MOSS**, Ph.D., M.Brit. I.R.E. (Chief Engineer, Electronic Tubes, Ltd.)

(Concluded from p. 205 June issue)

IN all the foregoing work, when comparing tubes of different sizes, it has been assumed that *all* linear dimensions except those of the actual triode have been multiplied by k. This assumption does not wholly agree with normal commercial practice, since it is customary to maintain constancy of neck diameter.

It was stressed in the introduction that the solution of these cathode-ray tube problems depends entirely on the postulates made. However the complexity of the solutions varies greatly with the postulates. We saw for example that to postulate constancy of cathode loading involves appreciably more working than the assumption of constant beam current. And if we inject the still additional requirement that the neck diameter is to be constant then the treatment is still further complicated.

This arises because we can no longer use postulate (1); that is, the principle of geometrical scaling. This principle requires that *all* the linear dimensions of the system must be scaled and we are now deliberately departing from this by multiplying the screen diameter by k, while maintaining constancy of size in the deflector-coil region.

A solution therefore demands special knowledge of the effects of deflection. The following additional fact is necessary and sufficient to solve the problem of change of screen size at constant resolution.

"If the beam width, coil shape and size, and the scanning angle, are all kept constant, then the deflection defocusing is proportional to the distance between the centre of deflection and the screen."

In this statement the term 'deflection defocusing' means the difference in the *linear* size of the spot at the centre and the edge of the screen. The application of postulate (2) enables us to deduce that the deflection defocusing is independent of the anode potential.[2]

We now illustrate this by repeating the solution of the first problem, with the additional requirement that the neck diameter and scanning coils are to be unchanged. The general theory is a little too cumbersome to be given here, but the method can be seen by reference to Fig. 3. In the original tube the crossover at T is imaged by the thin lens at XY on to the screen at S. CD represents the centre of deflection. The derived tube has its screen at S', where it is assumed that the axial position of S' is such that for constant scanning angle the diameter of S' is k times the diameter of S. Now the resolution of the derived tube is to be the same as that of the prototype. Therefore the deflection defocusing is to be k times as great as on the prototype just as the spot diameter when undeflected is also to be k times as large. But the distance from the centre of deflection to the screen on the derived tube will be very nearly k times that on the prototype. Hence it follows from the extra fact given about deflection theory that the condition of making the deflection defocusing k times as large on the derived tube is closely approximated by maintaining constancy of beam width B in the deflector coils. Since we are keeping constant beam angle from the triode, the new position for the focusing coils is found by projecting back lines from S' through C and D. These cut the rays from the triode at X'Y' which is the new position for the focusing coil.

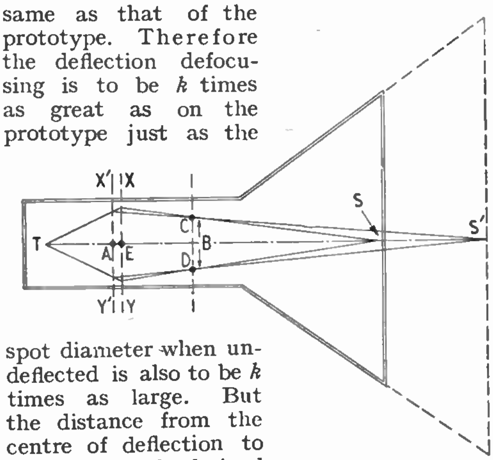


Fig. 3. Geometrical derivation of tube of larger screen diameter keeping neck diameter and scanning angle constant. Note that only the conical portion of the glasswork is changed.

On the prototype tube the linear magnification between the triode and spot is $M_1 = \frac{ES}{TE}$ and on the new tube it is $M_2 = \frac{AS'}{TA}$. Let the crossover diameter on the prototype tube be Δ. Then with the previous notation, the requirement of constant resolution gives

$$\frac{kM_1\Delta}{\sqrt{V_1}} = \frac{M_2\lambda\Delta}{\sqrt{V_2}} \quad .. \quad (8)$$

Equation (8) compares with (2) and differs only on account of the change in geometrical magnification brought about by the alteration of the position of the focusing coil.

As in the first problem equation (1) defines the condition of equality of screen brightness, so that (1) and (8) permit us to calculate V_2 and λ. M_1 and M_2 are most easily found graphically

Approximation based on the value of M_2/M_1

Provided that the process of extrapolation is not carried too far, examination of the geometry of typical television cathode-ray tubes will convince the reader that the ratio M_2/M_1 is very nearly equal to k. If we now insert this value in equation (8) we immediately get, after cancellation of common terms,

$$1/\sqrt{V_1} = \lambda/\sqrt{V_2} \quad .. \quad (8a)$$

[2] "Simplification of Cathode Ray Tube Design by Application of the Theory of Similitude." H. Moss *J. Tel. Soc.*, March 1946.

Cathode-Ray Tubes for Television

which oddly enough is exactly the same equation as that relating to the earlier case where the neck diameter was varied in proportion to the screen diameter and the spot size was to be held *constant*. The solution of this equation together with (1) has already been given (2nd column, Table 1) this being the case of constant beam current. The solution of (8a) with (3), (4), (5) and (7) has also been given (column 4, Table 1) this being the case of constant cathode loading.

However to avoid any possible confusion this working is repeated in Table 2, since the postulates are entirely different, and the identity of (8a) with a previous equation is merely coincidental.

One important fact emerges from a comparison of Tables 1 and 2. Compare column 2 in Table 1 with column 1 in Table 2. Both operations result in a picture linearly k times as large as on the prototype and of the same surface brightness. Both operations require the same increase in anode voltage and the same increase in cathode loading. But the operation on Table 1 where the neck diameter is increased in proportion to the screen diameter gives no increase in spot size, whereas the operation on Table 2 maintaining constant neck diameter results in the spot diameter being multiplied by k. We are entitled to conclude that the operation on Table 1 yields a tube of higher intrinsic performance than that given by Table 2, since we *normally* seek to obtain the smallest spot size, all other factors being constant. *This fact is a result of the use of a larger neck diameter (and greater neck length) on the tube derived by Table 1.* It is a valid general deduction that the absolute electrical performance of a tube of given screen size can be improved by an increase in neck length and neck diameter.

TABLE 2

Basic Operation		Screen Diameter multiplied by k	
Associated Operations		**Neck diameter, scanning coils constant. Position of triode in neck constant. Focus coil moved towards triode (if $k>1$). Scanning angle constant, see Fig. 3.**	
Geometrical Changes Made	Triode Dimensions	$\times\ k^{1/n}$	$\times\ k^{1/(1+n)}$
	Cathode-grid Spacing*	$\times\ k^{2/n}$	$\times\ k^{2/3(1+n)}$
Electrical Changes Made	Anode Voltage	$\times\ k^{2/n}$	$\times\ k^{2/(1+n)}$
	Cut-off Voltage	$\times\ 1$	$\times\ k^{4/3(1+n)}$
	Grid Drive	$\times\ 1$	$\times\ k^{4/3(1+n)}$
	Scanning-Coil Current	$\times\ k^{1/n}$	$\times\ k^{1/(1+n)}$
Effects Produced	Beam Current	$\times\ 1$	$\times\ k^{2/(1+n)}$
	Spot Diameter	$\times\ k$	$\times\ k$
	Beam Angle α	$\times\ 1$	$\times\ 1$
	Screen Brightness	$\times\ 1$	$\times\ 1$
	Cathode Loading	$\times\ 1/k^{2/n}$	$\times\ 1$

* This adjustment to be made *additionally* to that effected by the scaling of the whole triode.

APPENDIX

Grid voltages are always referred to cathode potential. The triode is said to be modulated when the grid potential is such that cathode current flows. For any fixed geometry and fixed anode voltage, denoted by V, there is a definite negative grid voltage, denoted by V_c, at which cathode current just ceases to flow. V_c is termed the cut-off voltage. The grid voltage V_g is always assumed to lie between the cut-off voltage and zero, but positive grid voltages are excluded. The grid drive, V_d, is defined as the magnitude of the difference between the cut-off voltage V_c and the actual grid voltage V_g. It is the grid voltage measured with respect to the cut-off voltage. It is clear from the above definitions that negative grid drive has no useful meaning and that we are only concerned with positive values of V_d.

TABLE 3

Anode potential (kV)	Grid potential (V)	Width of raster to make 400 lines just merge (S) (mm)	$S\sqrt{V}$
3	− 30	73	127
4	− 40	69	138
5	− 50	62	139
8	− 80	48	136
9	− 90	45	135

For all practical purposes the cut-off voltage V_c is proportional to the anode voltage V, geometry being held constant. Furthermore the author has shown elsewhere[1] that to useful engineering accuracy, the cathode current I_k in most normally proportioned triodes is given by Equation (6). Thus the cathode current increases as the 7/2 power of the grid drive for constant cut-off voltage.

This equation, it will be noted, does not explicitly involve the triode geometry except in so far as this affects V_c for a defined anode voltage V. In point of fact it would be astounding if so simple a law could accurately represent the cathode current for an arbitrarily wide range of triode shapes. Although it does not do this it is a useful guide. Reference 1 gives further information on the limitations of this formula.

When the grid of the tube is made

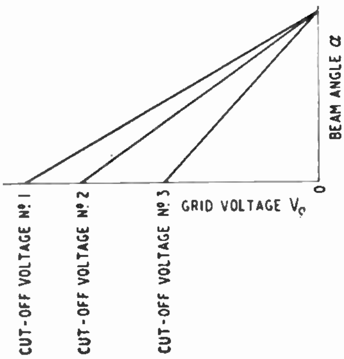


Fig. 4. The relation between the beam angle α and the grid voltage of the tube.

more positive (i.e., the grid drive is increased) then the beam angle in Fig. 1(b) is also increased. Very roughly, the beam angle increases linearly with drive as shown in Fig. 4. Here the idealized shape of the beam angle/grid voltage curve for varying cut-off voltages is displayed *where the cut-off voltage variations are due to change in anode potential only and are not due to changes in triode geometry*. It will be seen that the maximum beam angle occurs at $V_g = 0$ and is independent of the anode potential. This last fact is a consequence of postulate (2). It can further be shown[1] that

$$\sin \alpha = \frac{0.27}{f^{3/4}} D \frac{|V_d|}{|V_c|} \quad .. \quad .. \quad \text{(a)}$$

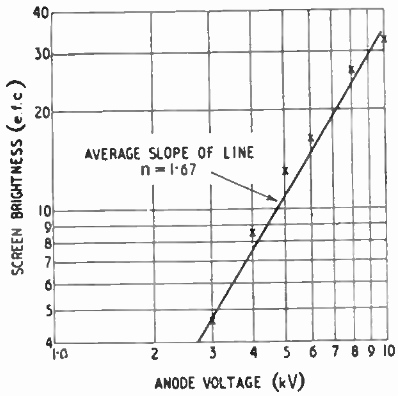
where D is the grid · hole diameter and f the anode-to-grid spacing.

Another very important consequence of Fig. 4 and Equation (a) is that the beam angle α remains constant if both the modulus of the grid voltage and the anode potential are multiplied by the same constant.

Fig. 5. The relation between tube anode voltage and screen brightness is shown here. The crosses represent measurement values for a raster 10 cm by 10 cm and a beam current of 30 μA.

Postulate No. 3 depends on experimental evidence which is given in Fig. 5. This shows a typical screen-brightness/anode-voltage curve for a 10-in diameter television cathode-ray tube. The beam current and raster size were all maintained constant throughout. The fluorescent material was zinc sulphide (mixed components—blue and yellow—giving an approximate white response). The curve can be approximated by a straight line on log/log paper thus revealing an approximate 'power' law. It will be seen that the curve bends over somewhat towards the higher voltages presumably due to partial onset of "screen piling." The value of '*n*,' which averages 1.67, is considerably higher at the lower voltages. This emphasizes the necessity of not extrapolating the results of Tables 1 and 2 too far.

Postulate No. 4 depends on the assumption that the definition of spot diameter is in terms of a *ratio* of current density at the 'edge' to maximum density at the centre. If screen saturation is negligible this is equivalent to a brightness *ratio*.



The measurement must therefore be based on a technique which is consistent with this definition. One such method is as follows.

A fixed number of lines is applied to form a raster, and the latter is contracted in a direction at right angles to the direction of each line until the lines *just* merge into each other. The width of the raster S is then proportional to the spot diameter.

Table 3 summarizes such measurements for a 10-in television cathode-ray tube. 400 lines each 150-mm long were used. The last column indicates that $S\sqrt{V}$ is nearly constant so justifying the principle. The latter however also has an appreciable basis in theory.

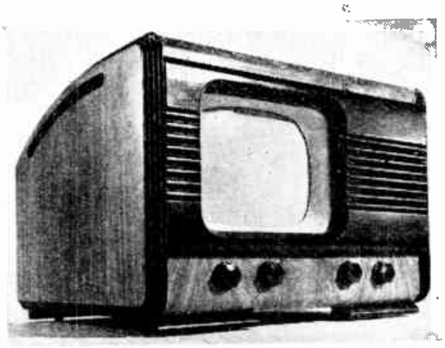
PORTABLE TELEVISION

THE Baird Portable Television set which measures $18\frac{1}{2}$ in × 17 in × $13\frac{1}{2}$ in and weighs 37 lb, is of the transformerless type and is suitable for a.c. or d.c. mains. It is a superheterodyne with one signal-frequency amplifier. There are two i.f. stages in the vision channel and one in the sound. Noise limiters are fitted to both channels. The e.h.t. supply is from the line flyback.

The unusual feature of the set, by which its title of portable is justified, is the use of the mains lead as an aerial. The mains lead is fitted with a filter unit at about one half-wavelength from the set. This effectively isolates the half-wave section from the mains and so enables it to function as an indoor aerial.

The set is listed at £47 15s 6d plus £16 17s 4d purchase tax and at a recent demonstration performed excellently under conditions of severe interference. It is manufactured by Scophony-Baird, Ltd., Lancelot Road, Wembley, Middlesex.

Another new product of this firm is a magnetic-tape recorder which is designed for use with 8, 9.5 and 16 mm cine-film projectors and permits a synchronized running commentary to be added to any silent film. The Cine-Soundmaster costs 75 gns, and can be used with 600, 1,200 or 4,800 ft reels of tape suitable for 200, 400 or 1,600 ft of film.



Baird portable television receiver.

[1] "Electron Gun of the Cathode Ray Tube—Part 2." By H. Moss. *J. Brit. Instn Radio Engrs*, June 1946.

WORLD OF WIRELESS

B.B.C. Charter ♦ Teleciné Equipment at A.P. ♦ Olympia Plans ♦ Birthday Honours

Committee of Inquiry

SINCE announcing the constitution and terms of reference of the B.B.C. Committee of Inquiry the Lord President of the Council has stated that Sir Cyril Radcliffe, who was appointed chairman, has had to resign owing to his appointment as Lord of Appeal. He is now Lord Radcliffe. His successor has not yet been announced.

The terms of reference of the Committee, which consists of eleven members including the chairman, are: "To consider the constitution, control, finance and other general aspects of the sound and television broadcasting services of the United Kingdom (excluding those aspects of the overseas services for which the B.B.C. is not responsible) and to advise on the conditions under which these services and wire broadcasting should be conducted after December 31st, 1951 [when the present Charter ends.]"

N.P.L. Annual Visit

MUCH interest was shown by visitors this year in the Electronics Section, where component parts of the A.C.E. (automatic computing engine) are being developed and made to the requirements of the Mathematical Division. Generators of pulses of $\frac{1}{4}$-μsec duration and 1-μsec spacing were demonstrated, and also a "dynamicizing" circuit for translating decimal numerals into binary form, in which the presence or absence of any power of 2 in sequence is indicated either by a pulse or space. With this system a number with 10 significant figures on the decimal scale is registered in 30 μsec, and can be kept in storage until required by circulating in a closed circuit, part of which involves the transmission of sound waves in a column of mercury.

Also in the Electronics Section was a display comprising the N.P.L. moisture meter and some simple devices involving photo-cells and capacitive effects to advertise the fact that the N.P.L. is willing to collaborate with manufacturers in the application of electronics to industry.

New Equipment at A.P.

TWO new sets of teleciné equipment, one made by Cinema-Television, and the other by E.M.I., have been installed at Alexandra Palace, where they are now being used for televising films.

TELEVISING FILMS. General view of the new teleciné apparatus recently installed at Alexandra Palace. On the left is part of the E.M.I. equipment and on the right that supplied by Cinema-Television.

The method employed is broadly the same in both sets. The principal components are a projection cathode-ray tube, an optical system, a film projector, and a photo-multiplier tube. A scanning pattern, with an aspect ratio of 5:2, is traced on the fluorescent screen of the cathode-ray tube by the electron beam, and two images of this pattern are projected by the optical system onto the gate of the projector.

The film runs continuously through the projector at a speed equivalent to 25 frames per second, and each film frame is exposed for 1/50th second first to one scanning image, and then to the other, by the action of a rotating shutter. The light that passes through the film is focused on to a photo-multiplier tube, which generates the picture signal, and the signals corresponding to the exposure of each frame to the two scanning images combine to give an interlaced signal. Though the aspect ratio of the scanning pattern on the face of the cathode-ray tube is 5:2, this is increased to an effective ratio of 5:4 by the motion of the film.

Radiolympia

PLANS for Radiolympia (Sept. 28th to Oct. 8th) are going ahead steadily and space has now been allocated to over 150 exhibitors—a reduction of some twenty on the 1947 figure. Although details of manufacturers' exhibits are not yet known some of those to be shown by Government Departments have been announced.

A supersonic experimental tank demonstrating the principles of radar will be among the exhibits of the Radar Research and Development Establishment of the Ministry of Supply. T.R.E. will be showing a radiosonde balloon which automatically transmits variations in the humidity, temperature and pressure during its ascent to 39,000 feet. The need for tropicalization of components and packages will be exemplified by samples having undergone tests at the Ministry's Tropical Testing Establishment in Nigeria.

The Dept. of Scientific and Industrial Research will be showing for the first time at this year's exhibition. The plotting of storm areas by radio—from information received from four forecasting centres—will be shown by D.S.I.R. which will also be demonstrating the means employed for forecasting the maximum usable frequencies for radio communication.

The radio and radar control of aircraft at London Airport will be shown on a working model of the main runway.

B.B.C. Appointments

CONSEQUENT upon L. W. Hayes' resignation as head of the B.B.C. overseas and engineering information department to take up the post of vice-director of the Comité Consultatif International des Radiocommunications in Geneva, changes in the organization of the

F. C. McLEAN, M.B.E., B.Sc.

B.B.C. engineering division have been announced.

The overseas engineering information department, the engineering secretariat, and the engineering training department have now been formed into what is to be known as the engineering services group with F. C. McLean, M.B.E., B.Sc., as head of the group and E. L. E. Pawley, M.Sc., as his assistant. H. Wilkinson, B.Sc., becomes head of O.E.I.D., and F. Williams, B.Sc., head of the engineering secretariat. Dr. K. R. Sturley continues as head of the engineering training department.

BIRTHDAY HONOURS

H. Faulkner, B.Sc., M.I.E.E., deputy engineer-in-chief, G.P.O., has been appointed a C.M.G. He joined the designs section of the G.P.O. engineer-in-chief's office in 1913 and after serving in the Royal Engineer's Signal Corps (1914-1918) he was transferred to the G.P.O. radio section. He was a member of the team responsible for the design of the Rugby station and was its first officer-in-charge (1925). He has held a number of executive offices and is now responsible for the radio development and radio maintenance branches. He was joint leader of the British delegation to the recent high-frequency broadcasting conference in Mexico.

C. S. Franklin, M.I.E.E., the "creator of beam wireless" who was recently awarded the Faraday Medal by the I.E.E., has been appointed a C.B.E. He retired from Marconi's W.T. Co., after 40 years' service, in 1939.

T. A. Davies, inspector of wireless telegraphy, G.P.O., is appointed an O.B.E. He was deputy inspector from 1940-1944 and was in the G.P.O. overseas telecommunications department until 1948 when he was appointed inspector.

W. H. Oliver, controller of telecommunications in Malaya, becomes an O.B.E.

S. A. Williams, A.M.I.E.E., engineer-in-charge of the B.B.C.'s high-power short-wave transmitter at Skelton, Cumberland, is appointed an M.B.E.

J. Leiper, chief rigger at the Cable and Wireless receiving station at Somerton, Som., has been awarded the British Empire Medal.

OBITUARY

We record with regret the death of **N. R. Campbell,** Sc.D., who was in the G.E.C. research laboratories from 1919 to 1944 when he retired. He was aged 69. Prior to joining the G.E.C. he was appointed to the Cavendish Research Fellowship at Leeds University and was for a short time at the National Physical Laboratory. His research work was very varied ranging from investigations into the mechanism of the discharge of spark plugs to the theory of "noise" in thermionic valves and circuits. It was on the latter subject that he contributed, with others, a number of articles to our sister journal, *Wireless Engineer*. He was a Fellow of the Institute of Physics.

We also record with regret the death of **J. G. Wright,** a founder member of Wright and Weaire, Ltd. He retired in 1945 from active participation in the company which he formed in 1919.

The death is also announced of **R. E. Gale,** who was manager of the high-frequency and instrument sections of Philips works at Tooting. He was aged 47 and had been with the company twenty years.

PERSONALITIES

Sir William Coates has been appointed chairman of the Government Television Advisory Committee in succession to Lord Trefgarne who has held the position for nearly four years. Sir William is also a member of the recently appointed B.B.C. Committee of Inquiry.

Kathleen A. Gough, B.Sc., A.M.I.E.E., chief physicist in the research and development laboratories of the Dubilier Condenser Company, has been elected a Fellow of the Institute of Physics.

Brigadier E. J. H. Moppett has been seconded from Army duties to become chief inspector of electrical and mechanical equipment in the Ministry of Supply. Most of his 26 years Army service has been in Royal Signals. He was in charge of signal communications during the evacuation of Palestine and has just vacated a Deputy Director of Signals' appointment at the War Office.

E. C. Cherry, M.Sc. (Eng.), A.M.I.E.E., has been appointed to the City and Guilds Readership in Telecommunications endowed by Standard Telephones and Cables to provide facilities for post-graduate teaching and research in this field. He was attached to T.R.E. during the war and has been on the staff of the City and Guilds College since 1947.

IN BRIEF

Increases of 63,100 "sound" licences and 6,750 television licences during April brought the total in Great Britain and Northern Ireland at the end of the month to 11,823,000.

St. Paul's Sound System.—A sound reinforcement system has been installed in St. Paul's by Pamphonic Reproducers, a subsidiary of Pye, to combat the famous echo of the cathedral. This has been done by fitting the loudspeakers under the chairs. To obviate the need for connecting wires, an induction system has been adopted. The output from the amplifiers is fed via a control desk in the nave to large wire loops on the ceiling of the crypt. Copper bands round each of the rows of chairs equipped with speakers provide the necessary pickup.

"Radio Valve Data".—This publication is now available in a second impression (with amendments to date of issue). It gives characteristics of 1,600 British and American receiving valves and replaces the former Valve Data Supplement which, in pre-war days, was a much-appreciated annual feature of *Wireless World*. The price is 3/6, or, by post from our Publisher, 3/9.

E. L. E. PAWLEY, M.Sc. (See "B.B.C. Appointments").

Birmingham Television.—The modifications to the "Superheterodyne Television Unit," described in the February and March, 1949, issues, necessary for the reception of transmissions from Birmingham will be given in our next issue.

C.R.T. Guarantee.—Although the British Radio Valve Manufacturers' Association does not consider an extension of the basic guarantee period of six months on cathode-ray tubes justifiable or economic, it has decided to amend the provision of the existing guarantee. Up till now the guarantee period for free replacement of tubes has been six months and that on a replacement tube the balance of the

World of Wireless—

guarantee period on the original tube. It has now been decided that for a trial period of twelve months from June 1st, each tube, including free replacements, shall carry the full six months' guarantee.

S.T.C. Endowment.—Standard Telephones and Cables has endowed a Readership, to be known as the Henry Mark Pease Readership in Telecommunications, in the City and Guilds College of the Imperial College of Science and Technology, South Kensington. The late Henry Mark Pease was managing director of S.T.C. until 1928 and took an active part in the formation of the British Broadcasting Company being one of its original directors. E. C. Cherry, M.Sc. has been appointed to the Readership. (See Personalities.)

Moulded Insulating Materials for use at frequencies greater than 10 kc/s are covered by a new British Standard (B.S. 1540: 1949). It deals with six classes of materials—fused silica, vitreous materials, ceramics for insulators, ceramics for dielectrics, rubber-base materials and synthetic resins. It specifies tests for the mechanical strength and electrical properties of each class. The Standard is obtainable from the British Standards Institution, 24 Victoria Street, London, S.W.1, price 5s.

Receiver Cabinet Design will be among the subjects illustrated at the exhibition provided by the Chicago Institute of Design which will be held in Murray House, Petty France, London, S.W.1, from June 28th to July 29th.

Electronics Exhibition.—The fourth annual electronics exhibition organized by the North-Western Branch of the Institution of Electronics will be held at the College of Technology, Manchester, on July 19th from 2.30 to 9 p.m. and on July 20th and 21st from 10 a.m. to 9 p.m. An exhibition of scientific films arranged by the Manchester Scientific Film Society, will be included. Admission will be by ticket obtainable from Dr. J. A. Darbyshire, 1 Kershaw Road, Failsworth, Manchester.

"**The Ionosphere** and the Propogation of Radio Waves" is the main subject for consideration at the summer meeting of the Physical Society to be held in Cambridge from July 14th to 16th. The speakers will include Professor S. Chapman (Queen's College, Oxford), J. A. Ratcliffe (Cavendish Laboratory, Cambridge), Dr. A. C. B. Lovell, (Manchester University), G. Millington and S. B. Smith (Marconi's W.T. Co.) and representatives from the Radio Research Board and the B.B.C. The fee for non-members is 10/- per day. Further particulars are obtainable from the Physical Society, 1 Lowther Gardens, London, S.W.7.

Television Construction.—A constructors' group of the Midlands Centre of the Television Society has been formed and particulars of the monthly meetings, which are held in Bournville, are obtainable from the Secretary, R. Baxendale, 50, Alcester Road, Birmingham, 13.

Cavity Magnetron Award.—The Royal Commission on Awards to Inventors has granted £36,000 to be shared among the three scientists responsible for the development of the cavity magnetron. They are Professor J. T. Randall, Professor of Physics, London University, Dr. H. A. H. Boot, and Professor J. Sayers, both of Birmingham University.

Radio Navigation.—The Thomas Gray Memorial Prize (1948) of £50 was awarded by the Royal Society of Arts to Capt. J. Klinkert, an instructor at the Sir John Cass Nautical School, London, for his essay on "The Applications of Radar to Navigation."

Eddystone "680".—A typographical error appeared in Stratton's advertisement on page 3 of the June issue. The length of the scale was given as "equal to nineteen inches per range." This should be *ninety*.

Scottish Branch of the Engineers' Guild was inaugurated at a meeting held in Glasgow recently. This is the fifth branch of the Guild to be formed during the past few months.

FROM ABROAD

Italy has ordered 46 high-constancy crystal-drive equipments from Marconi's for synchronizing its many broadcasting stations which will have to share wavelengths as, under the Copenhagen Plan, Italy has only three exclusive frequencies. The monthly frequency drift of these equipments is given as not more than 2 in 10^8.

Finland is to install a new 100-kW medium-wave Marconi broadcasting transmitter. The special aerial coupling and tuning units for the directional aerial to be used in conformity with the provisions of the Copenhagen Plan are also to be provided by Marconi's.

Pakistan's Director of Radio is proposing to install receivers in schools and for community listening and is desirous of securing information from British manufacturers on sets that they are in a position to supply for the purpose. Most of the sets will need to be battery fed. Particulars should be forwarded to Z. A. Bokhari, Radio Pakistan (H.Q.), Karachi, Pakistan.

Exporting Television. — Scophony-Baird have appointed D. E. Wiseman, who was, until recently, the company's production and sales director, as overseas representative and he is now visiting North America to investigate potential markets for the Baird transformer-less a.c./d.c. television set which employs a mains aerial.

South Africa.—Four more 5-kW medium-wave transmitters, making ten in all, are to be supplied by Marconi's to the South African Broadcasting Corporation.

India.—The Indian Minister of Industry and Supply has stated that the output of the four firms manufacturing broadcast receivers is 25,000 a year. He also stated that it is proposed to establish a State radio factory for the manufacture of a variety of equipment ranging from transmitters to components and valves.

South Africa.—Provisions are made in the amended Broadcast Bill now before the South African Government for the South African Broadcasting Corporation to be permitted to erect transmitters outside the Union. Under the existing Act the activities of the S.A.B.C. are restricted to within the Union. Tenders have been invited by the Corporation for the supply of transmitters for the new commercial programmes which it is hoped to radiate by the end of the year.

Denmark.—Transmissions from Denmark's experimental television station began on May 1st. Some details of the Philips transmitter were given in our May issue.

Nairobi's bilingual broadcasting service, which is provided by Cable and Wireless, Ltd., is to be augmented by the addition of a new 2-kW medium-wave transmitter ordered from Marconi's.

INDUSTRIAL NEWS

Marconi's marine communication receivers "Mercury" and "Electra" have been granted the P.M.G.'s certificate of type approval as conforming to the recently issued specification for ships' general purpose receivers.

Welwyn Electrical Laboratories.—All departments of this company, except the London sales office, are now at the new factory at Bedlington Station, Northumberland. (Tel.: Bedlington 2181.)

Ekco.—The Public Hall, Hadleigh, Essex, which was purchased by E. K. Cole in 1946 for use as a store, is to be used by the company for the production of broadcast receivers thereby releasing space at the main factory for the additional production of television sets.

Advance Components, Ltd., advise us that the damage caused by the recent fire at their factory at Back Road, Shernhall Street, Walthamstow, London, E.17, is not as extensive as was at first estimated. Production has been resumed but deliveries of some types of signal generator and constant-voltage transformers may be delayed a little.

Lee Products (Great Britain), Ltd. have transferred their head office and main distributing centre to 90 Great Eastern Street, London, E.C.2. (Tel.: Bishopsgate 3093.)

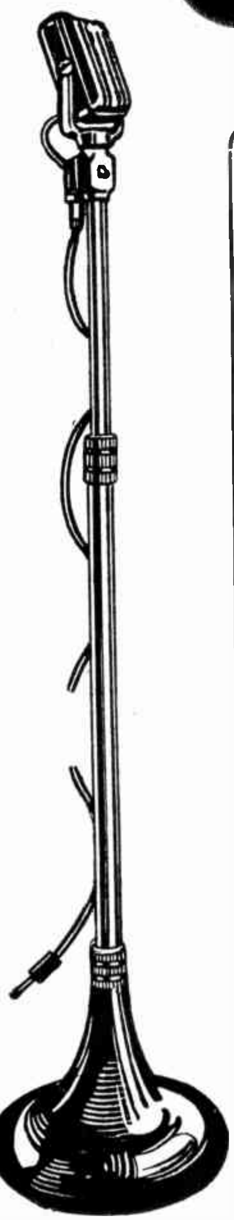
Kaysales, Ltd., manufacturers of "Precision" receivers, have taken over the Electronics Section of the business of S. H. Muffett, Ltd., of Mount Ephraim Works, Tunbridge Wells, Kent, and M. Lebar has joined the company as chief engineer.

G.E.C. Research Laboratories have taken a 21-year lease of a building in the Wembley Exhibition Grounds as an additional laboratory.

Industrial Finishes Exhibition.—The exhibition of industrial finishes planned to be held in September has been postponed to September, 1950. Details are obtainable from the Organizing Secretary, 26 Old Brompton Road, London, S.W.7.

"SUPER FIFTY WATT" AMPLIFIER

This **AMPLIFIER** has a response of 30 c/s. to 25,000 c/s. within ½db, under 2 per cent. distortion at 40 watts and 1 per cent. at 15 watts, including noise and distortion of pre-amplifier and microphone transformer. Electronic mixing for microphone and gramophone of either high or low impedance with top and bass controls. Output for 15/250 ohms with generous voice coil fedback to minimise speaker distortion. New style easy access steel case gives recessed controls, making transport safe and easy. Exceedingly well ventilated for long life. Amplifier complete in steel case, with built-in 15 ohm mu-metal shielded microphone transformer, tropical finish. *As illustrated*, Price **36½ Gns.**



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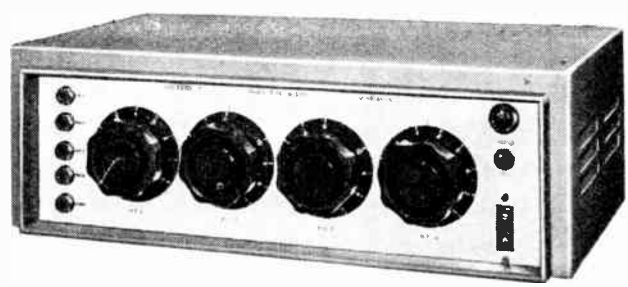

This unit with 4 built-in, balanced and screened microphone transformers, normally of 15-30 ohms impedance. Has 5 valves and selenium rectifier supplied by its own built-in screened power pack: consumption 20 watts.
Suitable for recording and dubbing, or large P.A. Installations since it will drive up to six of our 50 watt amplifiers, whose base dimensions it matches. The standard model has an output impedance of 20,000 ohms or less, and any impedance can be supplied to order. *Price in case with valves, etc.,* **£24**

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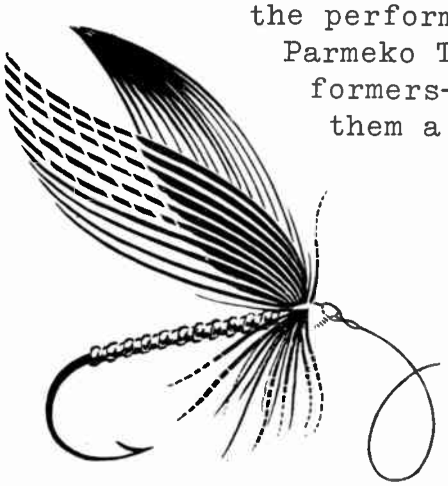

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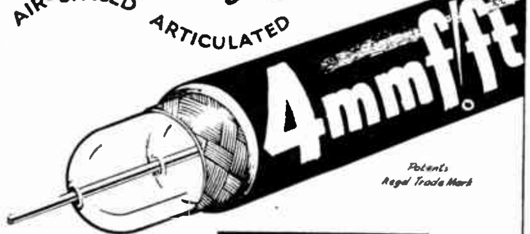

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C 1	7.3	150	2.5	0.36	
P.C.1	10.2	132	3.1	0.36	PHOTOCELL CABLE
C 11	6.3	173	3.2	0.36	
C 2	6.3	171	2.15	0.44	
C22	5.5	184	2.8	0.44	
C 3	5.4	197	1.9	0.64	
C33	4.8	220	2.4	0.64	
C44	4.1	252	2.1	1.03	VERY LOW CAPACITANCE

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The course covers the examination for the Television Service Engineer's Diploma set jointly by the Radio Trades Examination Board and the City & Guilds Institute.

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E138

Q How Many Kinds Are There?

By "CATHODE RAY"

THIS symbol (presumably short for "quality factor") has become generally accepted as the prime virtue where r.f. components are concerned. It has even been incorporated in trade names. So recent statements that Q-meters don't read Q may have sounded to some like a tampering with the eternal verities.

What exactly is Q? Although it has been in common use for so long it has been slow to be officially recognised. Perhaps that is because a thing that has gone about with several different meanings seems hardly respectable in official circles.

Its roots lie in the early days of broadcasting, when transmitters were low-powered and none too easily heard with the single-valve or crystal receivers of that period. So the demand was for tuning coils that would make the most of the feeble r.f. voltages picked up. Next, when stations multiplied in number and power, the problem was not so much to tune in the wanted station as to tune out the unwanted ones. All this time the wireless amateurs' papers were full of advice on coils—practical advice on how to wind better coils, and theoretical advice on the underlying principles. It was shown that the coil which could give the strongest signals was also the most selective (though the optimum tapping or coupling depended on which quality was needed most).

The first prescription for achieving this double benefit was to reduce the r.f. resistance as much as possible. While quite true so far as it went, this was not the whole truth—it was soon realised that coil A might have a lower r.f. resistance than coil B and yet be less efficient in the two essential respects of sensitivity and selectivity. A resistance of 20 ohms would be bad in a medium-wave coil, but good in a long-wave coil. To make a fair comparison one had to take into account their inductances, and the frequencies at which they were used. So the need was felt for a single figure that would include all the factors concerned.

As a matter of general principle a standard of goodness, or a "figure of merit," is preferable to a standard of badness such as r.f. resistance.

That was where the term "circuit magnification" or "magnification factor" (abbreviation "m") came in.* It was based quite simply on the elementary principle of resonance, as shown in Fig. 1. If the frequency of the "input" or series voltage, v, is adjusted to make the reactances of L and C equal, they cancel one another out, leaving R as the sole impedance of the circuit so far as v is concerned. The current is therefor equal to v/R. But this current flows through C and L, and sets up voltages across them, equal to the current multiplied by their reactance. As the reactances are equal and the current is the same, the voltages are equal, and can both be denoted by V. Reckoning from the inductive reactance, $2\pi f\mathrm{L}$ (abbreviated to $\omega\mathrm{L}$), we have:

$$\mathrm{V} = \frac{v\omega\mathrm{L}}{\mathrm{R}}$$

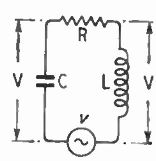


Fig. 1. Simple resonant circuit, with injected voltage v. The resulting voltages across C and L are in opposite phase and (at resonance) equal, so that reactances of C and L cancel one another out and the strength of current in the circuit depends only on R.

The interesting thing, of course, is the ratio of V to v, because V is the "output" voltage, which can be used or passed on to the next stage; v being the input, derived perhaps from an aerial or a valve coupled by a primary winding. In any reasonable tuning circuit V is considerably greater than v, so it was natural to call V/v the magnification. We have, then:

$$m = \frac{\mathrm{V}}{v} = \frac{\omega\mathrm{L}}{\mathrm{R}}$$

If we reckon from the capacitive reactance, $1/\omega\mathrm{C}$, we get $m = \frac{1}{\omega\mathrm{CR}}$, which comes to the same thing—in Fig. 1, at least.

Instead of approaching the matter in this theoretical way, one may prefer to inject an actual voltage into a real tuned circuit and measure the output voltage across it; m is then directly $\frac{V}{v}$.

In the course of time the Americans, thinking on similar lines, began to use the expression "Q" As it was usually defined as $\frac{\omega\mathrm{L}}{\mathrm{R}}$, it was generally assumed to be another name for "m," which it has tended to oust. But some slightly different definitions of Q appeared from time to time; and in the absence of prompt and firm action by acceptable authority, a state of uncertainty set in, and the term "Q" was generally avoided by the most precise people. Everybody else, however, found it too convenient for such scruples to prevail, and a Q-meter became one of the most used tools in almost every radio laboratory, while lots of people who hadn't the least idea what it really meant discovered in Q a

* As far as I have been able to trace, the earliest use of voltage magnification as a standard of coil efficiency was made by S. Butterworth (*Experimental Wireless and Wireless Engineer*, May, 1926, p. 267).

valuable addition to their sales talk.

Many people in the radio business can get along quite well with the single easily-absorbed fact that a high Q means good selectivity and signal amplification. That is the great merit of the expression; it means something in terms of practical results. One does not need a university education to grasp its general significance. I take it, however, that if you were content with rough ideas you wouldn't be reading this; so we will now proceed to consider the meaning of Q in greater detail.

Most of the controversy on the subject arises from the fact that no actual circuit is so simple as Fig. 1. L, C and R are shown there as separate components, but of course that is a theoretical simplification. R represents the total of the various forms of resistance and loss throughout the circuit. Normally most of it is the resistance of the coil, so L and R together are often assumed to represent the coil: but the capacitor is bound to have some resistance, so for more exact analysis one would divide R into two portions, attached to L and C respectively. We shall see later that if R is not substantially smaller than ωL and $1/\omega$C it is necessary to be particularly careful how *m* and Q are defined or measured.

Other complications occur because in practical circuits the

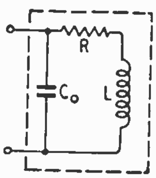


Fig. 2. A tuning coil can be represented fairly accurately by this equivalent circuit.

capacitor contains some inductance, and the coil contains some capacitance. The inductance of a well-designed capacitor is usually negligible except at very high frequencies; but the self-capacitance of a coil is by no means negligible, and is responsible for the largest discrepancies between different ways of arriving at Q. For one thing, as we shall see, it raises questions about how the input voltage *v* is brought into the circuit.

At very high frequencies there is not even an appearance of L and C being separate—the tuning circuits are composed of parallel

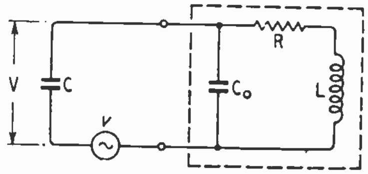


Fig. 3. When a real coil is substituted for L in Fig. 1, the "coil equivalent circuit" of Fig. 2 shows that the complete circuit is not quite the same, and measurements based on the assumption that it is will be wrong.

rods or cylinders, or of hollow spaces, in which L and C are inextricably mixed up and distributed. What about Q then?

We shall leave that question until later, and assume first that the frequency is moderate enough to let us represent the actual tuned circuit reasonably accurately by a diagram made up of separate lumps of L, C and R. That being so, it is usually satisfactory to consider the coil as if it were composed as shown in Fig. 2, in which C_0 is the self-capacitance.

Comparing this with Fig. 1 we see that the coil is itself a complete resonant circuit. It is not possible to open the circuit to insert a signal source directly in series as in Fig. 1—the dotted line is a reminder that the items within it are only theoretically separable—but its equivalent can be performed by inductive coupling. The frequency at which a coil resonates on its own is called the self-resonant frequency. Although coils (especially if permeability-tuned) can be employed in this fashion, it is unusual to do so, because it allows the resonant frequency to be affected so much by stray capacitance. Nearly always the coil is used with a separate tuning capacitance.

Although the r.f. resistance of a capacitor can be kept very much smaller than that of a coil, it may not always be negligible. So it is necessary to make quite clear whether one is considering the Q of the coil alone, of the capacitor alone, or of the whole circuit. Just now we shall assume that the capacitor is perfect (zero resistance; infinite Q), so the Q of the coil is the same as the Q of the circuit.

Assuming also that the voltage *v* is introduced in series with L (in practice, by inductive coupling) connecting a perfect tuning capacitor across the terminals in Fig. 2 makes no difference in principle. It comes directly in parallel with C_0, and for purposes of calculation two capacitances in parallel can always be replaced by one equal to their combined values; so the actual circuit is unchanged. But if the signal source is connected in series with the *coil* (which is not just L, but the whole combination inside the dotted line), we have a different circuit arrangement, Fig. 3. The question then arises; are we concerned with the true inductance of the coil (L) or the inductance as it appears to be at that particular frequency, supposing that the

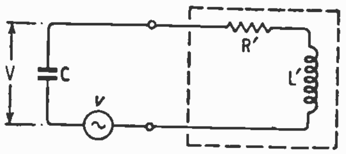


Fig. 4. At any particular frequency the coil equivalent circuit can be replaced by an apparent inductance and apparent resistance in series, which enables the principles of Fig. 1 to be applied.

dotted line contained only inductance and resistance is in Fig. 4? The apparent inductance (L′) is not quite the same as L—it must be greater, to make up for ignoring C_0—and R′ is not the same as R. If they both differed in the same ratio, then the value of Q (taking it to be ωL/R) would be unaffected, but as it happens they are not. The textbooks show that

$$R' = R\left(\frac{C + C_0}{C}\right)^2$$

and $$L' = L\left(\frac{C + C_0}{C}\right)$$

so what we may call the apparent Q, denoted by Q′ and equal to ωL′/R′, is

$$Q' = \frac{\omega L'}{R'} = \frac{\omega L}{R}\left(\frac{C}{C+C_0}\right) = Q\left(\frac{C}{C+C_0}\right).$$

When the external tuning capacitance C is very much larger than the self-capacitance C_0 the difference between Q and Q′ is not worth bothering about. A typical self-capacitance is 6pF, and if the added capacitance were, say, 300pF, $Q' = \frac{300}{306}Q = 0.98Q$; the difference would be only 2%, which is less than the probable error of most Q-meters. But if no C is used the apparent Q is zero, no matter how high the true Q may be! So the distinction ought not to be completely ignored.

Opinions have differed as to which Q is the right one, or in fact whether either as defined above is right. To settle the question some people appeal to basic principles and others to practical sense. To serve its purpose of expressing the goodness of a tuning circuit or component it would obviously be a great advantage if the definition corresponded to the method of use. So we had better consider how tuning circuits are used.

In a typical broadcast receiver there are three main kinds of tuned circuits, shown in rough outline in Fig. 5. There is first the r.f. circuit, L_1C_1, into which the input voltage is inductively injected from the aerial, and the output taken from across C_1. Next there is the i.f. primary, in which the mode of operation is reversed; the input is received directly across the terminals of C_2 and the output is imparted inductively, proportionately to the current flowing in L_2. Lastly the secondary, L_3C_3, which works similarly to L_1C_1.

None of these tuned circuits corresponds to Fig. 3; in all of them the self-capacitance of the coil is effectively in parallel with the external tuning capacitance, making a total of $C + C_0$, tuned by the true inductance L and damped by the true r.f. resistance R. There is no need to bother about L′ or R′ —or Q′. The typical examples just shown cover the vast majority of tuned circuits in actual use. It is clear then that Q corresponds to practical affairs more closely and more often than Q′.

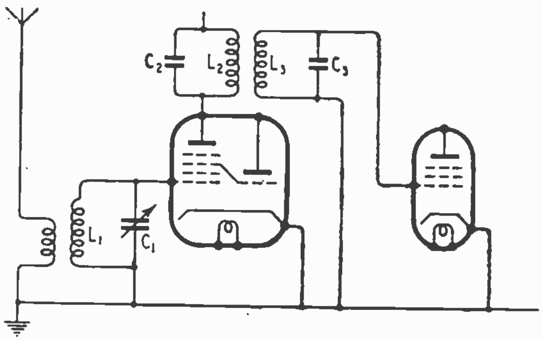


Fig. 5. Three typical ways in which tuning circuits are used in a broadcast receiver. In all of them it is true Q that counts, rather than the apparent Q.

But what about the methods used for measurement? The bare bones of the usual type of Q-meter are shown in Fig. 6. A variable-frequency oscillator is provided to pass a measurable current (I) through a known low resistance r. The r.f. voltage developed across r is therefore Ir, and it corresponds to the signal source in Fig. 3. The output voltage V is measured by a valve voltmeter across C, when C or the frequency of the oscillator has been adjusted to cause resonance, indicated by maximum V.

We must conclude, then, that the quantity which applies to the commonest methods of use is Q, but that the quantity actually measured by the commonest method is Q′. And therefore that when these methods giving Q′ are used, the readings should be multiplied by $\frac{C + C_0}{C}$ to bring them to Q. The instruments are, or should be, calibrated in C, and can be used to measure C_0. As we have already seen, the correction is hardly worth applying when C is many times greater than C_0; but omitting to apply it when C is not much greater than C_0 gives results which differ largely from the true Q.

A Q-meter is very handy to use, but is subject to another error—serious at the higher radio frequencies—due to r, which makes the instrument read lower than it should by increasing the resistance of the circuit being tested. Even if r were directly in series with R, so that it could just be deducted from it, one would have to calculate R, which is a nuisance with an expensive instrument that is supposed to read Q directly without any need for calculation. But actually r is in series with R′, so to be strictly correct one would

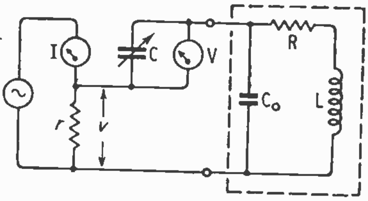


Fig. 6. Outline circuit showing the principle on which most Q-meters work.

have to apply the factor relating R to R′. In fairness to Q-meters I must admit that r is usually small enough to be neglected except in high-Q, very-high-frequency circuits, and also that some Q-meters work on different principles. When measuring very good coils one might also have to allow for the losses due to the valve voltmeter and the tuning capacitor. So it is as well not to be too impressed by the apparent direct-readingness of an instrument having a pointer moving over a scale marked "Q." Its great advantage is that it does give quite quickly and easily a figure that can be used for comparing one coil with another, even though that figure may often differ appreciably from the true Q. The instrument can also be used for a variety of other measurements if one is prepared to do a few simple calculations.

But if one is prepared for that there is a lot to be said for an alternative method—the method in which the frequency of the oscillator is read at resonance and also at the two settings, one on each side of resonance, at which the voltage across the tuned circuit is 70.7% (i.e., $1/\sqrt{2}$) of its maximum reading (Fig. 7). Then if f_r is the resonant frequency and f_1 and f_2 respectively the higher and lower of the other two:

$$Q = \frac{f_r}{f_1 - f_2}$$

In this method, the oscillator

Q—

is loosely coupled to the coil under test; there is no need for the r.f. ammeter or the resistance r; the result is given directly in true Q; and the method can be used in circumstances where the Q-meter fails. And of course it is very much cheaper.

The reason why it gives true Q is that the input voltage is inductively coupled to the coil under test, so is in series with the tuned circuit as a whole. In Fig. 6, by contrast, the input voltage is in series with only one of the two capacitance branches; C_0 forming a sort of bypass.

There is another feature about Fig. 6, which is of practical importance only when Q is exceptionally low, but is interesting theoretically. We have not defined "magnification factor," and I have yet to come across a really water-tight definition, but it seems to be generally agreed that it is V/v in Fig. 4 when the circuit is at resonance, as indicated by a maximum reading of V. If you ask whether this is not identical with what we have been calling Q', the answer is—not exactly. If you look up any good textbook that deals with resonance you will see that the frequency at which the voltage across the resonant circuit is maximum is not quite the same as the frequency giving series resonance. As a matter of fact, it depends on whether the maximum is arrived at by adjusting the frequency or by adjusting the tuning capacitance. Now Q (and Q'), as we saw in connection with Fig. 1, are based on the theory of series resonance. But Q-meters, which are the practical embodiments of Fig. 4, are so arranged that resonance is judged by the maximum reading of V. So really they are magnification-factor meters.

The relationship between m and Q' can be worked out. The calculation is rather involved, but as a matter of interest the result, assuming resonance is obtained by varying the frequency of the oscillator, is:

$$Q' = \sqrt{\frac{m^2 - 1 + m\sqrt{(m^2 - 1)}}{2}}$$

For example, if $m = 2$, $Q' = 1.8$—a 10% discrepancy; but if $m = 10$, $Q' = 9.96$—only 0.4% different.

If resonance is obtained by varying C:

$$Q' = \sqrt{(m^2 - 1)}$$

The discrepancy is slightly larger in this case, but is still utterly negligible for normal tuning circuits. It should not be forgotten when dealing with very "flat" circuits, however.

In the alternative (Fig. 7) method, too, resonance is judged by maximum V; but the resulting error is even smaller than in the previous cases. The calculation is still more complicated, and the final result too bulky to be worth printing here.

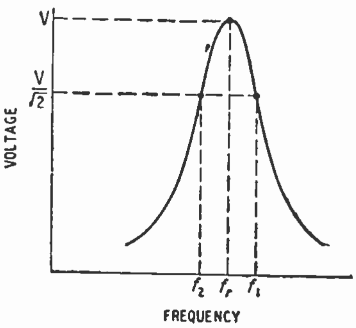


Fig. 7. Principle of an alternative method of Q measurement

The fact that Q is a measure of the effectiveness of a tuning circuit as regards signal strength is brought out obviously enough in the Q-meter method. The frequency-variation method, on the other hand, brings out the relationship of Q to selectivity. What one does, in fact, is to measure the sharpness of resonance. But that is not quite the same thing as selectivity in its most directly-useful terms. What we generally want to know is the bandwidth, in cycles per second, irrespective of the mean or carrier frequency. To tune in Droitwich, f_r in Fig. 7 would have to be 200 kc/s, and one might decide that the 70% points (f_1 and f_2) of a single tuning circuit ought to be, say, 6 kc/s above and below f_r, giving a bandwidth of 12 kc/s. The required Q would therefore be $\frac{200}{12} = 16\frac{2}{3}$. For tuning-in a station on 1200 kc/s with the same selectivity, the bandwidth would still have to be 12 kc/s, but the Q to give that selectivity would be $\frac{1200}{12} = 100$.

For constant selectivity, then, Q has to be proportional to frequency; so the quantity that indicates narrowness of bandwidth is not $Q = \frac{\omega L}{R}$, but $\frac{L}{R}$, the "time constant." At any given frequency, however, it is true to say that selectivity is directly proportional to Q.

This may be a good moment at which to point out another advantage of Q as a standard, compared with R. We have already seen that it is a fairer guide to the effectiveness of a coil because it takes into account its inductance, and also it is a measure of goodness rather than badness, and directly tells one the output voltage produced at resonance by a given input voltage. The other thing is that R, unlike ordinary d.c. resistance, is by no means constant. Most of the losses included in it tend to increase with frequency. Over a limited range of frequency, such as that covered by a tuning coil, the resistance R is usually roughly proportional to frequency. So, since $Q = \frac{2\pi f L}{R}$, over the same range of frequency Q is roughly constant. Only roughly; but at least it is more nearly constant than R.

So far we have been considering Q as a property of a coil, which is the same thing as the property of the whole tuned circuit, if losses outside the coil are negligible. But one often sees references to the Q of a capacitor or other component. The same principle holds: it is the ratio of reactance to series resistance; with capacitive reactance, $Q = 1/\omega CR$.

When considering a resonant circuit it is often useful to know its equivalent parallel resistance, or dynamic resistance. Denoting it by R_d, and the reactance (inductive or capacitive) by X, the ratio R_d/X is the same as X/R, which is what we know as Q. So if we know that the reactance of a tuning coil in the anode circuit of a valve is, say 1000 Ω, and its Q is 100, then it acts as a coupling resistance of 100,000 Ω. (Because $R_d = QX$). And of course its series r.f. resistance is 10 Ω (= X/Q).

Nowadays most of the interest is focused on those frequencies which the Editor conveniently gathers together under the single abbreviation "e.h.f." (i.e., everything over 30 Mc/s). At such frequencies the concept of a circuit composed of lumped L and C more or less breaks down. That being so, the concept of Q, if it can be made to apply, is more useful than ever, because of the difficulty of measuring L and C and of knowing what they signify when one has measured them. So Q has recently been redefined in more general terms as:

$$\frac{2\pi \text{ times the energy stored}}{\text{energy dissipated}}$$

in the circuit per half-cycle.

Simple lumped circuits such as Fig. 1 are particular cases, in which Q as defined in this general way simplifies to $\omega L/R$ or whatever is appropriate. So accepting the newer definition doesn't make it necessary to unlearn the old. There are, however, a few bogus definitions, such as the reciprocal of the power factor, that ought to be scrapped, however nearly right they may be in most cases.

You may ask how the energy stored per cycle in an e.h.f. circuit can be measured. Well, the most convenient form for definition is not necessarily the most convenient form for measurement; and in this case measurement is best tackled indirectly. It is sometimes possible to measure the decrement, or rate of dying-away of oscillations. But the most generally convenient is the Fig. 7 method, which holds good even with resonant cavities for centimetre waves. Frequency is the most accurately - measurable quantity there is; so the only other thing to provide is an indicator to show when the voltage or current amplitude is 70% of maximum—roughly 3 db down.

Summing up the main points:

(1) The modern definition of Q, completely general in its application, is based on the ratio of energy stored to energy dissipated in the circuit.

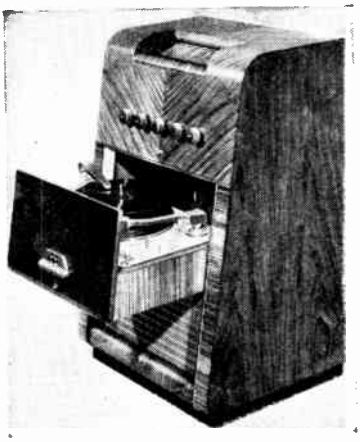
(2) Applied to lumped circuits, this is equal to the ratio of the reactance (purely inductive *or* capacitive) to the series resistance (in its widest sense, covering all losses).

(3) This X/R ratio is also equal to the ratio of V, the voltage across the whole reactance of one kind in a circuit at series resonance, to v, the voltage injected in series—the ratio known as circuit magnification factor (m). But when, as is usual, resonance is judged by the maximum parallel voltage, there is a discrepancy between m and Q, which is negligible unless Q is in the lower single-figure range.

(4) If Q or m is measured by the type of circuit shown in Fig. 3, (such as the usual type of Q-meter, Fig. 6), the result is the apparent Q, or Q′, equal to $Q\left(\frac{C}{C + C_0}\right)$. Since this is almost the only practical way of directly measuring m, in practice m is the same as Q′ (neglecting the discrepancy mentioned above).

(5) Q, however, can be measured by other methods (such as the frequency-variation method, Fig. 7) which give true values directly, and these correspond with the conditions under which tuned circuits are most commonly used (Fig. 5).

NEW RADIO-GRAMOPHONE

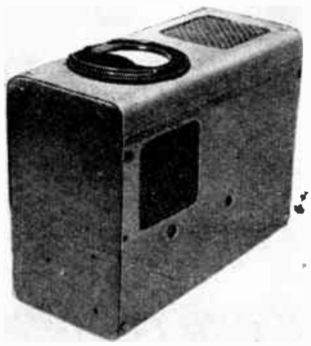


A two-position tone control gives normal and extended frequency range on gramophone records in the latest Marconiphone Model ARG19A. The auto-changer handles up to ten 10in or 12in records. On the radio side, a four-valve plus rectifier superhet. covers short, medium and long waves. Three extra positions on the waverange switch give two preset stations on medium and one on long waves. The price is £84 11s. 4d. including purchase tax.

TRIODE-DIODE VOLTMETER

Made from War Surplus Parts

By T. A. LEDWARD, A.M.I.E.E.



A general view of the voltmeter

INTENDED for audio-frequency work, the voltmeter to be described has a linear scale from 0.1 to 1 volt. It is not suitable for d.c., but this limitation enables a stable zero to be obtained without special balancing arrangements.

The instrument was constructed from ex-Government components, including the metal case, at low cost.

A Type No. 194 receiver provided the case and valves. This receiver contained many additional parts, including two further valves, a VR91 and an EF50. The 0-100 microammeter, ex-Admiralty pattern W6022, had a speci-

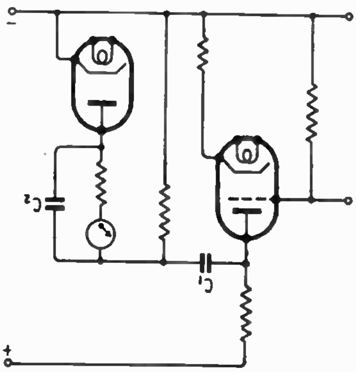


Fig. 1. Basic circuit.

ally marked scale which required repainting and scaling.

The circuit arrangement was considered with some care and it will be useful to explain the reason for certain features. The first requirement was an approximately linear scale of 0-1 volt. The second was a reasonably high input impedance.

The linear scale requirement was met by the use of a diode, but a range of 0-1 volt with diode only and a 0-100 microammeter would have meant an input impedance of only about 5,000 ohms.

A pre-amplifier valve was therefore used. The input impedance now depends upon two things: the grid shunt resistance and the effective input capacitance of the valve. The latter factor, of course, lowers the input impedance as the frequency is raised.

A value of 1 megohm was

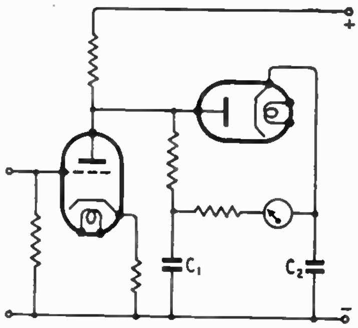


Fig. 2. Modifications of Fig. 1 to reduce the effect of stray capacitances of C_1 and C_2.

chosen for the grid shunt resistance. The effective value of the input capacitance, using a VR65 valve is approximately 75pF.

An important feature is the arrangement of circuit whereby the stray capacitance to earth from the anode circuit of the amplifying valve is maintained as low as possible.

Consider Fig. 1: in order to deal satisfactorily with the lower frequencies, the condensers C_1 and C_2 must be large, say 4μF. They must also have a very high insulation resistance, which rules out electrolytics. The bulk will, therefore, be appreciable, and the capacitance to earth will be fairly high. Fig. 1 is, therefore, unsatisfactory for a wide range of frequency. Now consider Fig. 2: by placing C_1 and C_2 on the earth side of the circuit, the stray capacitance from anode to earth is unaffected by the size of these

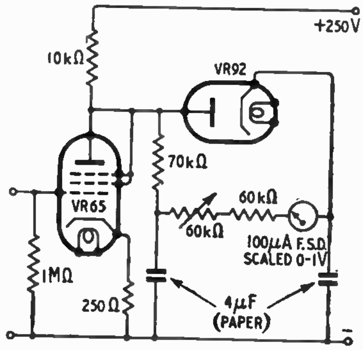


Fig. 3. Final circuit with component values.

condensers. The indicating instrument is now raised to about 180 volts d.c. above earth potential, but the a.c. potential above earth is negligible and there will be no hand capacitance effects.

The final circuit of the voltmeter, together with values of components, is shown in Fig 3. Separate 6.3-volt heater supplies will be required and the h.t. supply should be approximately 7 mA at 250 volts.

Higher voltage ranges may be included, if desired, by adding a voltage divider similar to that described in *Wireless World* dated June, 1944.

BOOK RECEIVED

Elements of Electromagnetic Waves. By Lawrence A. Ware. Pp., 203+x, with 69 illustrations. Sir Isaac Pitman & Sons, Ltd., 39, Parker St., London, W.C.2. Price 20s.

This book is of American origin and treats electromagnetic waves mathematically. There is an introductory chapter explaining vector algebra which is freely used in the subsequent text. The book finishes with a chapter on radiation in which simple forms of aerial are considered.

SHORT-WAVE CONDITIONS

May in Retrospect : Expectations for July

By T. W. BENNINGTON and L. J. PRECHNER (Engineering Division, B.B.C.)

DURING May, maximum usable frequencies for this latitude decreased very considerably by day, in accordance with the normal seasonal trend. The night values, however, instead of showing the usual increase, decreased very slightly, perhaps owing to the disturbed conditions during the first half of the month.

The month was slightly less disturbed than April, ionosphere storms being observed on 2nd-9th, 11th-14th and 31st, 12th and 13th being exceptionally disturbed, and a very great magnetic storm also being recorded during that period.

Working frequencies for the month were, on the whole, very low, relatively few contacts being established over 30 Mc/s. Thus long-distance communication on the 28-Mc/s band was seldom reliable, particularly in eastward and westward directions. During the night no frequencies below 7 Mc/s were really necessary.

There was a marked increase in the rate of incidence of Sporadic E, in accordance with the usual trend, and many amateur openings via this layer have been recorded for the first time this year, mostly from Eastern and Southern Europe. Frequencies as high as 50Mc/s were occasionally propagated by this medium.

Four "Dellinger" fadeouts were recorded in May, on 5th, 7th, 8th and 9th, the fadeouts on 5th and 7th being particularly violent.

Sunspot activity in May was considerably less than in April. Three large sunspot groups crossed the central meridian of the sun (on 5th, 11th and 31st), and all of them were associated with reception disturbances which occurred around those periods, the disturbances following the second group being particularly intense.

Long-range tropospheric propagation was observed on a number of occasions, particularly in the second half of the month.

Forecast.—It is probable that there will be very little difference between the m.u.fs for July and June, as in the Northern Hemisphere daytime and night-time m.u.fs usually reach their respective annual minimum and maximum values during this period.

As in June, although daytime communication on very high frequencies, like the 28-Mc/s band, is not likely to be frequent, over many circuits frequencies like 15 and 17 Mc/s will remain regularly usable until midnight. During the night frequencies lower than 11Mc/s will seldom be required. For medium distances, up to about 1,800 miles, the E and F_1 layers will control transmission for considerable periods during the day.

Sporadic E is usually very prevalent in July, and communication over distances up to 1,400 miles may be possible by way of this medium on frequencies greatly in excess of the m.u.fs for the regular E and F layers. Frequencies as high as 60Mc/s may be occasionally reached for a short time However, it is impossible to predict when such communication may occur, owing to the irregular behaviour of Sporadic E.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during July for four long-distance circuits running in different directions from this country. (All times GMT). In addition, a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25 per cent of the time during the month, for communication by way of the regular layers:—

Montreal :	0000	15Mc/s	(19Mc/s)
	0100	11 ,,	(15 ,,)
	1200	15 ,,	(19 ,,)
Buenos Aires :	0000	17Mc/s	(22Mc/s)
	0100	15 ,,	(19 ,,)
	0500	11 ,,	(16 ,,)
	1000	17 ,,	(23 ,,)
	1500	21 ,,	(26 ,,)
	1900	17 ,,	(22 ,,)
Cape Town :	0000	15Mc/s	(20Mc/s
	0100	11 ,,	(15 ,,)
	0600	17 ,,	(24 ,,)
	0800	21 ,,	(28 ,,)
	1800	17 ,,	(22 ,,)
	2100	15 ,,	(19 ,,)
Chungking :	0000	11Mc/s	(14Mc/s)
	0500	15 ,,	(20 ,,)
	2300	11 ,,	(14 ,,)

Ionospheric storms are not very common in July, and relatively undisturbed conditions may be expected. At the time of writing it would appear that storms are more likely to occur during the periods 1st-2nd, 6th-9th and 27th-29th, than on the other days of the month.

Unbiased

By FREE GRID

Nauseating Nomenclature

A GREAT many laymen, led astray by glib-tongued and facile-fisted lay journalists, seem to have got it into their heads that there is some subtle difference between radio waves and what they call radar waves. It is difficult to explain to them that there ain't no sich animal as a radar wave, any more than in the realm of sound there are such things as echo waves, or audar waves, as I have little doubt that some of these cliché coiners would term them.

Loathsomely learned.

I was trying to explode the radar wave superstition the other day by means of a mechanical analogy—always a dangerous thing, as invariably it breaks down and brings the creator down with it, as it did in this particular case in more senses than one.

To lend force to my argument I used a punch-ball to demonstrate my analogy. In an unguarded moment, carried away by my enthusiasm, I was floored physically by what I termed the ball's radar wave, and metaphorically by a bespectacled and loathsomely learned-looking schoolboy who pointed out, quite rightly, that the ball's return was not due to any reflection effect but to the release of the energy which my original blow had caused to be stored within its spring support. This regrettable *contretemps* and consequent collapse of both myself and my analogy had the unfortunate result of destroying faith in my main thesis and establishing "radar waves" still more firmly in the minds of my youthful audience.

This incident made me give up further attempts to educate the technically illiterate masses, but a recent report from the U.S.A., which states that cooking is now being carried out by what it calls "radar waves," has brought my missionary zeal to the fore once again. I can stomach this sort of thing with as little success as I can stomach the results of this offensive inside-out sort of cooking. According to the newspaper report the innards of a chicken, instead of being first removed, were cremated, and the flesh done to a turn, whatever a turn may be.

Apart from my æsthetic objections to this sort of cookery, which causes my physical gorge to rise as much as the misuse of the term radar causes my technical gorge to perform the same evolution, I object strongly to it being termed new. I, myself, was privileged to be present, over three years ago, at a private demonstration of this sort of inverted cookery by one of its pioneers, which I duly reported in these columns (March, 1946). For the benefit of those of you who have perverted gastronomic tastes, I would mention that the American demonstration was on a frequency of 23 Mc/s; but to me giblets are giblets, whether cremated or not, and I will have none of it.

Wrist Radio

THE vogue of the personal portable or miniature receiver threatens to develop into an epidemic or even become a permanency as more and more manufacturers give us their versions of it. Quite frankly, I don't like any that have so far appeared. My complaint is that none of them is small enough to shove into one's pocket without making an unsightly bulge. The ignorant and ill-informed may well ask "why do you want to shove one into your pocket anyway?"

This is, of course, precisely the question which was asked of an ancestor of mine when he made a similar complaint about the bulkiness and unpocketability of turnip watches. My point is that the whole idea of the personal portable is that it is intended to be carried on one's person. It should, therefore, be no larger than a watch or a cigarette lighter.

Seven years ago (March, 1942) I published in these columns a photograph illustrative of the American trend in personal portable design, which was towards something like a Leica camera. Both British and American "Leica" models of an improved type are now available, but they would be still more improved if they were made less conspicuous to carry and protected from damage by means of an ever-ready leather case like their photographic counterparts.

But now that ultra-midget valves, components and batteries are available for pocket hearing aids surely we can get down to something smaller than the Leica camera. In my opinion, it can be done by once more borrowing an idea from the photographic world; there is no shame in it, or at any rate the photographic fraternity do not think so as they don't hesitate to borrow the micro-ammeter and the photocell from us and call the combination an exposure meter.

Apparently the Germans regard the Leica as a bit old fashioned as they now go in for a "wristwatch" camera weighing less than a couple of ounces and giving a negative of 4×3 *milli*metres. I need hardly say that this puts users of conventional miniature cameras into the same class as they have so often contemptuously consigned me and my old wet-plate outfit.

What I would like to see is British radio manufacturers following this thoroughly praiseworthy example and turning to the production of wrist radio. The volume from such a set would enable me to hear, without disturbing others, all that I wanted to when away from my home receiver. This surely is the sole aim and purpose of a "personal" receiver.

Courtesy "Foto Spiegel"

Radio manufacturers please copy.

Whilst on the subject of miniaturization there is another piece of equipment which could more readily be carried on one's person if suitably adapted. I have often wondered why the practice of the Melanesian native, who carries his treasures slung in the pierced and extended lobe of his ear, has not been copied by users of hearing aids.

LETTERS TO THE EDITOR

Export Opportunities ♦ Why Record Supersonic Frequencies? ♦ Circuit Diagram Conventions ♦ Measuring Circuit Magnification ♦ Simple Wobbulator ♦ B.B.C. South Coast Service

Canadian Trade Possibilities

THERE would appear to be little effort on the part of many British manufacturers of electronic apparatus and components to realize the market potential for their products here in Canada.

I came to Canada eighteen months ago from the U.K., and, in my present work as Senior Communication Engineer, the Canadian prospects for many British lines have been brought forcibly to my notice.

Contrary to expectations, some American products retail at higher prices than their British counterparts and are frequently of inferior quality.

In view of Britain's present economic plight and the favourable import position applying to British products in the general class of electrical, wireless and radio apparatus (with the important exception of domestic radio receivers) the apparent sales lethargy on the part of many manufacturers in my opinion warrants the strongest censure.

Some British manufacturers have done nothing, possibly overawed at entering the arena with the American Juggernaut; others have blindly accepted the first Canadian agency enquiry without regard for status or coverage check-ups. Where agencies have been given to Canadian firms of standing there appears to be little control over the Canadian selling price, which rises steeply.

In view of this adverse selling factor, direct British group representation would appear to have many points in its favour. In short, is there any valid reason why bodies such as the Radio Component Manufacturers' Federation, S.I.M.A., etc., should not set up their own Canadian distributor units?

Such a step should ensure more effective representation to the retailer and customer with more reasonable distribution overheads. It would also permit more adequate range or spare stocking and customer service than can be expected from an agent handling a product for the most profit with least effort.

In conclusion, may I stress the part that *Wireless World* itself could play in fostering increased electronic exports to Canada. Every effort should be made to increase the Canadian circulation with paper restrictions eased on this account. I can assure you that your coloured issue for March last agreeably surprised Canadian colleagues and, in particular, many of the advertisements and prices. In a country where American periodicals serve as a buyer's guide, the vital role of *Wireless World* cannot be over-estimated and, indeed, wider Canadian circulation is a vital prerequisite to increased British exports in this field.

T. S. DUTTON.

Valois, Quebec, Canada.

Thévenin's Theorem

IN my recent article on Thévenin's Theorem (March issue), I showed, perhaps, some disrespect towards M. Thévenin in suggesting that he was something of an interloper and that credit for the theorem really belonged to Helmholtz.

M. Simon, of "SOTELEC," Paris, gently implied as much in sending me a copy of his biographical appreciation of Thévenin, containing a reproduction of Thévenin's original paper setting out the theorem in question.

As a result of correspondence with M. Simon and with Prof. G. W. O. Howe (on whose *Wireless Engineer* Editorial of July, 1943, my remarks were based) the following concise summing up in the words of Prof. Howe seems to be a fair statement of the facts:

"(a) Thévenin deserves the credit for setting out the theorem very clearly and making it generally known, and

(b) Helmholtz had described and used it thirty years before."

To which may be added that Thévenin, like nearly everybody else, was unaware of Helmholtz's statement.

I am indebted to M. Simon and Prof. Howe for kindly contributing from their knowledge to an agreed conclusion on what seemed at first rather controversial.

"CATHODE RAY."

Recorded Supersonic Frequencies

IN the report of the discussion on commercial disc recording, following the lecture by Mr. Mittell (*Wireless World*, February, 1948, p.

Letters to the Editor—

67), it was stated that "even when the response of the reproducer, or of the ear of the listener, was restricted, the subtle improvement resulting from the records of high, even ultrasonic, frequencies could be detected. It was thought that this might be explained on the basis of improved transient response."

If the ear responds to a transient sound by virtue of its waveform, as seems to be substantiated by certain evidence, then it is conceivable that a person who is deaf to high frequencies could hear a steep-fronted transient almost, if not quite, as well as a person with normal hearing. The conventional explanation in terms of Fourier Analysis would lead to the conclusion that a person whose hearing is deficient in high frequencies would be unable to hear a steep-fronted transient.

The quoted improvement which occurs with the recording of inaudible frequencies may be explained by either of two mechanisms. First, it might be through hearing the intermodulation products of two or more frequencies, of which at least one is above audibility. Alternatively it might be through the greater fidelity with which the transients are recorded.

It should not be difficult to devise tests, if this has not been done already, to determine (1) whether the ear responds to transients by virtue of their waveform and (2) whether intermodulation products or transients or both are responsible for the improvement from supersonic recording.

Can any of your readers give a lead in this direction?

F. LANGFORD SMITH.
Amalgamated Wireless Valve Co.,
Sydney, N.S.W.

"*Drawing Circuit Diagrams*"

L. BAINBRIDGE-BELL, in the May *Wireless World*, appears to be flogging a horse that has already passed the post. Precise recommendations on all the subjects raised have been made in British Standard 530:1948, which he himself quotes; surely it is better to accept these recommendations as they stand.

It is because of individual preferences, both in circuit-drawing practice and in symbols generally, that so much confusion has arisen in the past. This confusion can only be reduced by general acceptance of recommendations made by a fully representative body. If, for some particular reason, a given organization finds it necessary to depart from a specific British Standard, by all means let it do so; it is a different matter if such an organization or individual tries to foist its preferences on others.

Bainbridge-Bell over-stresses the risk of draughtsmen's errors. The danger of a blob at a junction being obscured can be avoided by making the blob big enough to be seen. Ordinary letter stencils provide the means; thus, the "O" of a standard No. 1 stencil, fully inked in, is admirable for most purposes, though when the drawings are used for line blocks the size must be related to reduction wanted.

Such innovations as that suggested in Bainbridge-Bell's penultimate sketch are commendable provided the reader knows what they mean; generally an explanation is necessary. In the instance quoted "the path BC" is sufficiently explanatory without resorting to a symbol which is meaningless to those not in the know.

J. W. GODFREY.
London, N.W.

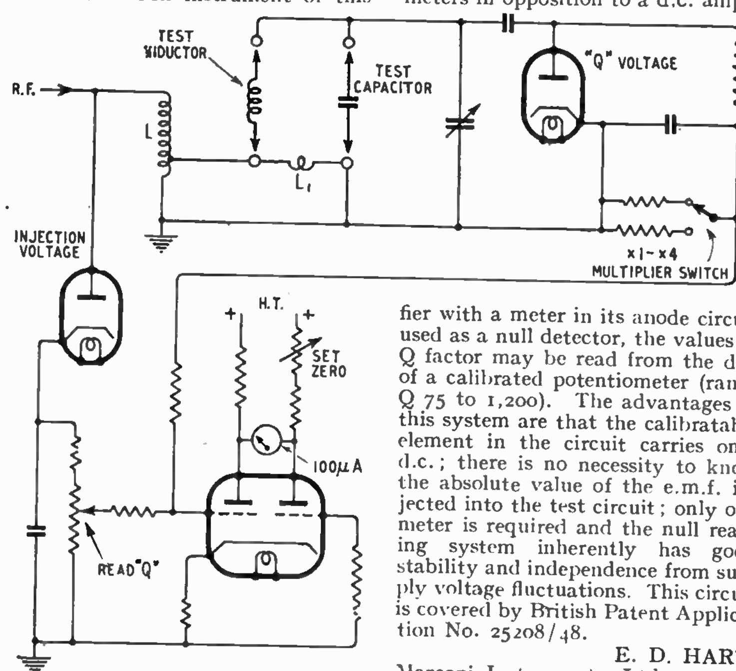
"*Q-Meter Controversy*"

I WAS interested in the correspondence printed in the June *Wireless World* concerning "Q" meters. As my firm are the manufacturers referred to by "P. H." as making the first British instrument of this kind, may I add two further comments?

Our instrument was called a Circuit Magnification Meter as, like "P. H.", we felt that the use of the term "Q Meter" was, to say the least, inappropriate and rather smacking of technical jargon. We continue to use the longer title.

Dr. Sheridan notes with surprise the use of an injection resistor and points out its shortcomings at higher frequencies. This type of circuit is used in our Circuit Magnification Meter, but its defects are well realized. By careful design it will give reasonable performance up to about 30 Mc/s, but begins to fall off above that. In a high-frequency circuit magnification meter covering 15 to 170 Mc/s, the system has been abandoned and an inductive injection method is used. This is shown in the attached functional diagram. Series injection is still used, but the virtual injection resistance is made so small that the reactance of its residual inductance L_1 is very much greater than its resistance, even at the lowest working frequencies. To facilitate measurement of the voltage applied to the test circuit, the injection inductance L_1 is tapped down on a much greater inductance L, so that a known fraction of the voltage is taken. The voltage across L is measured by one diode voltmeter and that across the tuned circuit by another.

A further interesting arrangement is that by feeding suitable fractions of the d.c. outputs of the two voltmeters in opposition to a d.c. amplifier with a meter in its anode circuit used as a null detector, the values of Q factor may be read from the dial of a calibrated potentiometer (range Q 75 to 1,200). The advantages of this system are that the calibratable element in the circuit carries only d.c.; there is no necessity to know the absolute value of the e.m.f. injected into the test circuit; only one meter is required and the null reading system inherently has good stability and independence from supply voltage fluctuations. This circuit is covered by British Patent Application No. 25208/48.



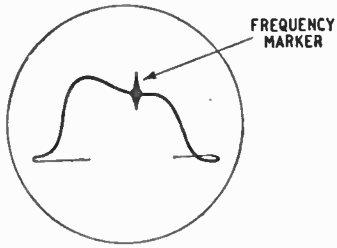
E. D. HART.
Marconi Instruments, Ltd.
St. Albans, Herts.

Calibrating a Wobbulator

WITH reference to the article by K. C. Johnson on his new wobbulator circuit, I feel he has over-emphasized the difficulty of calibrating it on the television band.

I have the circuit in use, and have devised a simple but very accurate method of continuous calibration, or "strobing," as it might be termed.

The normal circuit is set going, with the unit feeding the receiver and the receiver feeding the 'scope; then the signal generator is loose-coupled to the input tuned circuit of the receiver. As the wobbulator sweeps through the signal generator frequency a "blip" is produced on the curve on the 'scope; this marker pip moves along the curve as the generator is tuned through the band, and enables the exact frequency of any humps, etc., to be read instantly, and also enables the scope to be used without any paper scale.



The accompanying sketch was drawn from a 'scope trace, using a normal t.r.f. vision receiver.

As will be seen from the sketch, the heterodyne pip is fairly sharp and narrow. This is due to the narrow frequency response of the 'scope amplifier, which, for this purpose, is clearly desirable.

DOUGLAS M. GIBSON.
Ashford, Kent.

"*Copenhagen Comments*"

I SHOULD like to reply to the comments of Mr. R. Cleghorn (*Wireless World*, May, 1949).

Germany not having been represented in the Broadcasting Convention at Copenhagen did not get three channels, but two for each zone of occupation; i.e., in total eight channels. Indeed, none of them is a clear one, and, moreover, the limit of power to 105 kW each is very unfavourable.

Whether the consequence Mr. Cleghorn is afraid of will appear and whether Germany will annex some further channels must be doubted. Germany will remain occupied for many years to come and the broadcast branches of military governments surely will supervise the German Broadcasting System in future.

The allocated channels are insufficient and the German broadcasting companies like Nordwestdeutscher Rundfunk and Bayrischer Rundfunk are preparing schemes to procure proper possibilities of reception to their listeners by erecting c.h.f. (f.m.) stations. About 20 of such stations, each with 10 kW power, are provided for the British Zone alone. In the meantime, in Hanover, Hamburg and Munich f.m. transmitters with 0.1 kW each have been erected for testing purposes; further ones will follow.

KARL TETZNER.
Emden, Germany.

B.B.C. Coverage

MAY I appeal for improved facilities for high fidelity reception in this area?

Including as it does fairly large centres of population, the coastal strip of Sussex is very badly served on the Light and Home Services, although the recent opening of the Third Programme transmitter at Kingston-by-Sea has provided signals of good quality, but of appeal to only a limited taste. It will hardly be contested that the large proportion of recorded items on the Third Programme limits quality.

Signal strength from the long-wave Light Programme is fairly good, but reception is marred by atmospheric interference during the summer months in particular. On the medium waves, the West Regional transmitter at Start Point provides the strongest signal, but fades, whilst the quality appears generally slightly inferior to that from Brookmans Park, on the same programme, presumably due to landline defects. The latter transmitter is free from fading since the installation of the new mast aerial, although signal strength does not appear appreciably greater, and is certainly inadequate to stand out from the many sources of interference, whether man-made or natural.

Would it not be possible, even if the need for economy prevents the installation of any further transmitters, for the Kingston transmitter to radiate the Home or Light Programme during those hours when it is not needed for its own service?

D. C. SMITH.
North Lancing, Sussex.

CORRECTIONS

The last paragraph of the article "When Negative Feedback Isn't Negative" (May issue) should read " . . . try using a *high* anode coupling resistance for the middle stage and *lower* values for the two outer ones." Incidentally, the reference to the article by C. F. Brockelsby in *Wireless Engineer* should have been to the February, 1949, issue.

In "Contrast Expansion" (June issue) in the 29th line of Col. 3, "40½c/s" should read "40·50c/s."

The price of the Labgear electronic relay (advertisement on p. 22, June issue) should be £5 5s.

In the Valradio advertisement on p. 60, June issue, the model number should be 230/110; for "H.F. and R.F." read "R.F. and A.F."

RANDOM RADIATIONS

By "DIALLIST"

DX Television

SPENDING A FEW DAYS recently at a little place on the Suffolk coast which is just about 100 miles as the crow flies (or the wave waggles) from Alexandra Palace, I was surprised to notice quite a sprinkling of the H-type television aerials, which are now such familiar objects of the sky line of Greater London and the Home Counties. In this small East Anglian town I counted five during casual strolls and probably the number would have been doubled or trebled had I set out on a determined search for them. The owner of one television set told me that reception, though chancy, was quite excellent at times. He was kind enough to invite me to "look in." Unfortunately, it was just one of those days. A hazy image might appear for a second, but it could not be held; most of the time there was nothing on the screen but "noise." He and the other owners of television receivers in the locality have, I imagine, something of the thrill that old hands used to get out of long-distance radio in the early days of medium-wave and short-wave broadcasting. All of us were very certain that DX work was worth while, no matter how many profitless vigils into the small hours it entailed; for there were wonderful periods of loud and clear reception, which made up for everything.

They Want It

THE FACT THAT PEOPLE living in places far beyond the normal service area of the London television station think it worth while to install televisors is clear proof of the urgency of the demand for television services all over this country. People definitely want television; they are prepared to pay for receiving sets and they will put up with poor or chancy reception rather than have nothing at all. To me, at any rate, it seems that the B.B.C.'s progress in providing a network of transmitters should be speeded up. All sites should have been selected by now, or should anyhow be chosen within the next few months. Since the Powers That Be have guaranteed the continuance of the 405-line, 50-frames-per-second transmissions, the B.B.C. would do well to decide upon a standard design for its transmitters and to place orders right away for ten or a dozen of them. If these and the necessary radio links were ordered in bulk, both time and money would be saved. There's a point, too, about those radio links. The main centres will presumably have their own studios, O.B. equipments and so on; interconnections will enable any of them to originate programmes to be radiated by all or any of the others. But has it occurred to anyone to combine some or all of the radio links (or coaxial cable repeater stations) with small, unattended and automatically operated transmitters? Were this done, to take one example, in the country traversed by the London-Birmingham links, the whole service area might have the form of a dumb-bell —circles of 30 or more miles radius round London and Birmingham and between them an area of approximately rectangular shape some 15 to 20 miles in width. There are, of course, difficulties; but are they too formidable to be overcome?

Aerials and Amplifiers

IT WOULD, I FEEL SURE, pay those concerned with the manufacture of television aerials and of signal-frequency amplifying units not only to study reception conditions in outlying districts, but also to conduct instructional campaigns in "fringe" areas and those still farther from transmitting centres. In talking to people living in such parts of the country I've found, first of all, that the ordinary man who buys a televisor and hopes for the best does not realize that there are means whereby his chances of good reception could be improved; secondly, that not a few of the radio dealers who supply the sets are not much better informed. One of them assured me that the multiple aerial array was just a stunt of no real value, and another was equally sceptical about signal-frequency amplifying units. I'm not going to say that any kind of complex aerial, even with a perfectly matched feeder, will make good reception a certainty in places where it is now the exception rather than the rule. Nor would any sensible person claim that additional s.f. amplification will always do the trick. Either or both, however, may so much increase the chances of good reception in such places as to make all the difference between its being worth while or not to invest in a television receiving set.

A Tricky Business

THE NEW YORK MAGAZINE *Radio-Electronics* has just inaugurated a scheme which may have interesting results. Publishing a letter from a resident in Borneo, who wants to buy American components and so on but can't owing to currency export restrictions, the Editor suggests that the only way out of the difficulty at the moment is a return to primitive bartering methods by making swaps. He fully appreciates the difficulties and the exasperation of those radio addicts who yearn to possess this American gadget or that, but can't get leave to send so much as a lone dollar abroad. To help them he proposes to run free of charge a section of classified advertisements by radio folk living in such countries. In these adver-

CONSOLE RECORD PLAYER

Designed primarily for use with the "500" series of radio receivers, this record player cabinet by Ace Radio, Tower Road, London, N.W.10, contains an automatic record changer and provides storage for records. The price is £35 13s. 10d., including tax.

tisements (which must not exceed 40 words) the dweller in a currency-restricted country can state what he wants and what he has to offer in exchange. It's a grand idea and a generous one in these hard times. The big snag, though, may prove to be the fact that most of the currency-restricted countries have also a mass of complicated import regulations. Were you to succeed in swapping this or that for, say, an f.m. receiver kit, you might find it impossible to steer your prize through the offshore minefield of import licences, etc. !

Effects

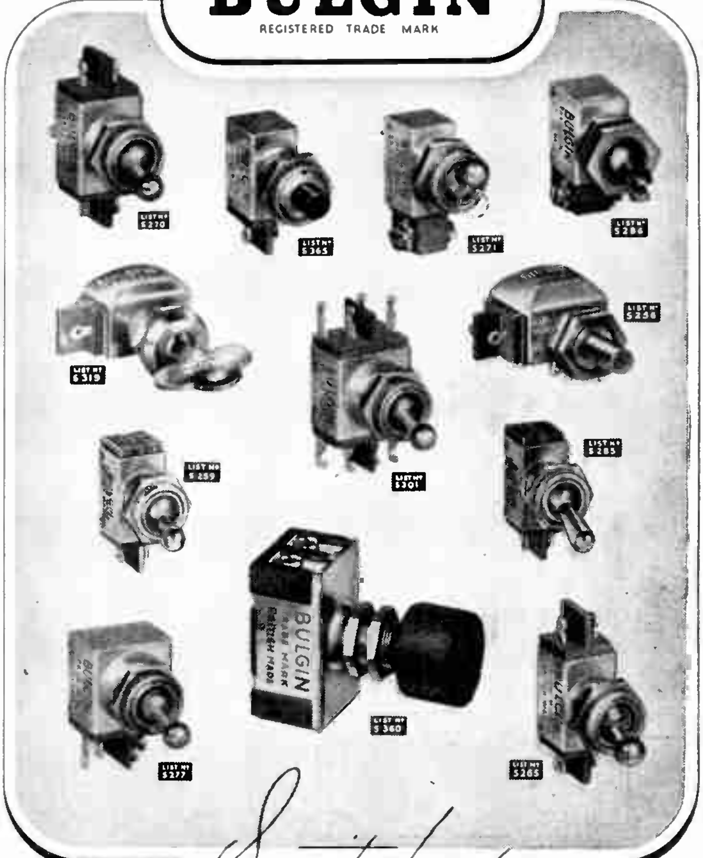
A COUSIN OF MINE who writes plays for the B.B.C. invited me recently to go to a rehearsal of one of hers. I had a good many surprises, not the least of which was that, for a half-hour item due to be broadcast at 5 p.m., morning rehearsals took place from 10.30 to 1 o'clock and that these were followed by another lot from 2 to 4. The effects in particular have to be rehearsed most carefully for timing. Most of them were produced from records on the four turntables of a play-back instrument and I was able to see the working of the apparatus which enables any part of a record to be selected with absolute certainty. The pick-up is held by a rigid arm mounted tangentially to the grooves of the disc and travelling along a finely graduated scale. Shortly before a particular effect is required the needle is lowered into the groove; the controller then fades it in and out at the proper moments.

Another One to Try

IN ITS JUNE ISSUE *Toute la Radio* had a quiz which contained one poser that may be of interest to readers of *Wireless World*. Here it is. If the output terminals of a high-voltage d.c. supply have two or more capacitors connected across them in series, these capacitors are always shunted individually by resistors of high values. This precaution is necessary:

(a) To reduce ripple;
(b) To prevent the capacitors from "blowing up";
(c) To discharge the capacitors when the h.t. voltage is switched off and so to guard against accidents.

What's your view? The answer is given on page 258.



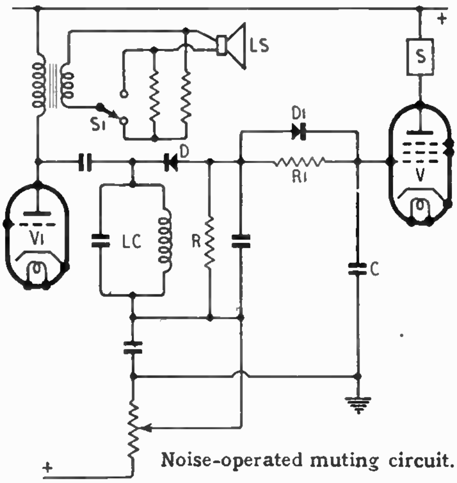
RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

Automatic Muting

VALVE noise produced by inherent thermal effects is utilized to short-circuit the loudspeaker automatically when no signals are present. It is known that the noise voltage is considerably increased during such times, and this is stated to be due to the action of the automatic volume control in the case of amplitude-modulated signals, and to the fact that the presence of the carrier shortens the actual duration of the thermal effect in the case of frequency-modulated signals.

In the "no-signal" condition shown, a circuit LC in the anode of the a.f. amplifier V1 collects the noise voltage, which lies well above the normal signal frequencies fed to the loudspeaker LS, and passes it through rectifier circuits D R and D1 R1 to the grid of a valve V, to operate a relay S controlling short-circuiting contacts S1 on the speaker. When a signal is received, the charge built up on the condenser C quickly leaks away through the rectifier D1 and low resistance R. The charging of the condenser takes place more slowly through the rectifier D and high resistance R1, so preventing the relay from being operated during brief periods of fading.



Noise-operated muting circuit.

The General Electric Co., Ltd., and L. S. Stenning. Application date, May 15th, 1946. No. 612024.

Super-regenerative Circuits

RELATES to the type of circuit that is designed to respond to the receipt of a pulsed signal, as used in radar, by the instant transmission of an identification signal. To ensure satisfactory threshold conditions, it is necessary to reduce the free oscillations that normally occur in the tuned circuit of the super-regenerator to negligible proportions, and for this purpose the circuit is usually damped by a low-resistance shunt. This involves a serious loss of power in the response signal, since the same tuned circuit is used both for transmission and reception .

According to the invention, the difficulty is solved by using as the damping device a diode which is connected across the tuned circuit, and also to a source of positive potential. During standby conditions, the positively biased diode has a comparatively low resistance; but when the super-regenerator is triggered into transmission, oscillations rise to a high level and then serve automatically to "open-circuit" the diode by charging a condenser connected between its anode and the tuned circuit.

Ferranti, Ltd.: M. K. Taylor and R. S. Paulden. Application date, February 25th, 1946. No. 608103.

Television Cabinets

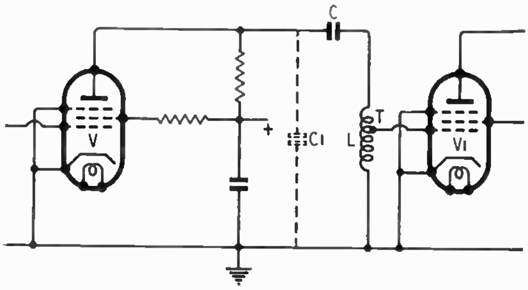
THE cabinet is made in two parts, the upper of which contains the viewing screen and is arranged to telescope inside the lower or main casing, with a vertical movement, so as not to disturb anything that may normally be placed on top of the cabinet.

The main casing contains the cathode-ray tube, which is mounted to project the picture downwards on to a spherical mirror, from which it is reflected back through a correcting lens or to an inclined plane mirror, fixed in the upper part of the casing, and finally on to a vertical ground-glass or opalescent viewing screen. The lifting and lowering movement of the upper part is conveniently controlled by means of a small electric motor, through worm gearing and vertical guide rods, an automatic stop and slip clutch unit being provided to prevent damage to the equipment.

Marconi's Wireless Telegraph Co., Ltd. (assignees of R. V. Beshgetoor). Convention date (U.S.A.), October 18th, 1944. No. 607221.

Intervalve Coupling

THE grid of the amplifier V1 is coupled to the anode of the previous stage V through a step-down tapping on a coil L, which is chosen so that the impedance of the whole coil bears the same ratio to the impedance of the part of the coil between the tapping T and the ground, as the capacity between the grid and all the other elements of the amplifier V1 bears to the capacity between the anode and all the other elements of the amplifier V. More particularly, the grid-cathode capacity of V1 is reflected by the coil as a smaller capacity between the anode and cathode of V. The sum of the capacities concerned is represented in dotted lines at C1, and is calculated to resonate with the coil L at the working frequency, the normal coupling condenser C being too large to have any appreciable effect.



Low-loss interstage coupling.

A useful increase in effective amplification is secured by the arrangement shown. In an eight-stage receiver for pulsed signals the overall gain is stated to be more than three times that normally given.

The British Thomson-Houston Co., Ltd. Convention date (U.S.A.), May 20th, 1945. No. 612472.

Remote Control System

SIGNALS transmitted in the form of televised symbols, grouped into characteristic patterns, are used for the selective control of distant apparatus. A chequered arrangement of black-and-white squares will, for instance, provide a very large number of distinctive patterns by suitably regrouping the unitary squares. Further variety can be introduced by the stepped rotation of any given pattern.

At the distant end, a photoelectric relay is operated only when the pattern reproduced on the viewing screen of a television receiver conforms to a predetermined code. In order to ensure secrecy, provision is made to vary the line and frame frequencies, and to switch over from progressive to interlaced scanning, from time to time, in accordance with master control signals radiated from the transmitter.

H. W. K. Jennings (communicated by J. H. Homrighous). Application date August 30th, 1945. No. 610528.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 2/- each.

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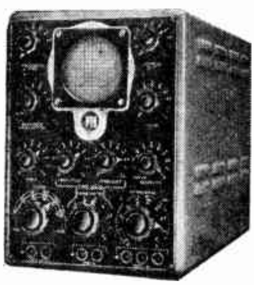

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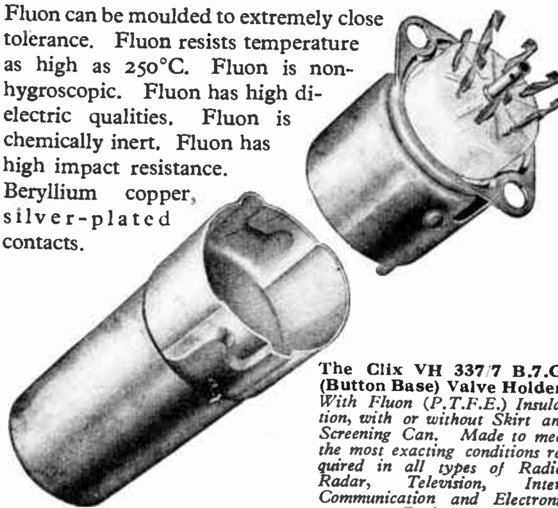

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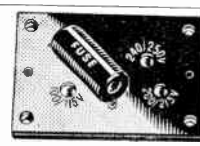

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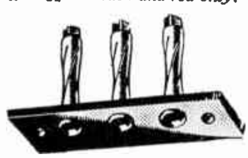

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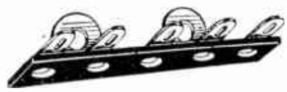

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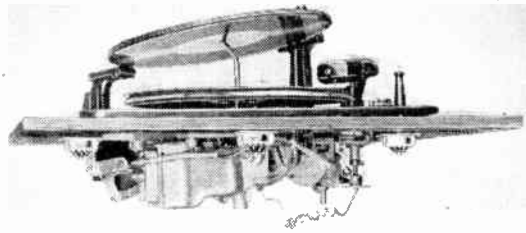

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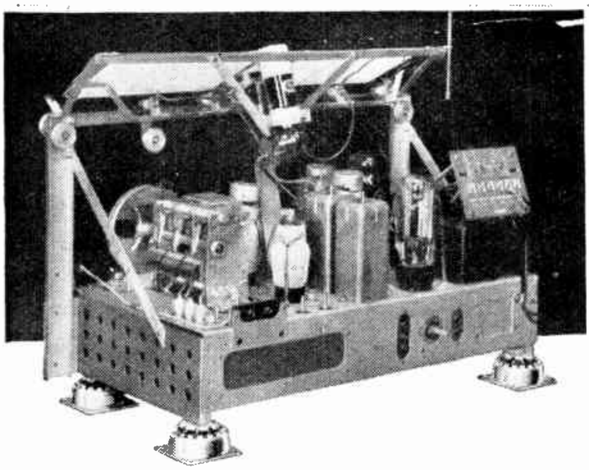

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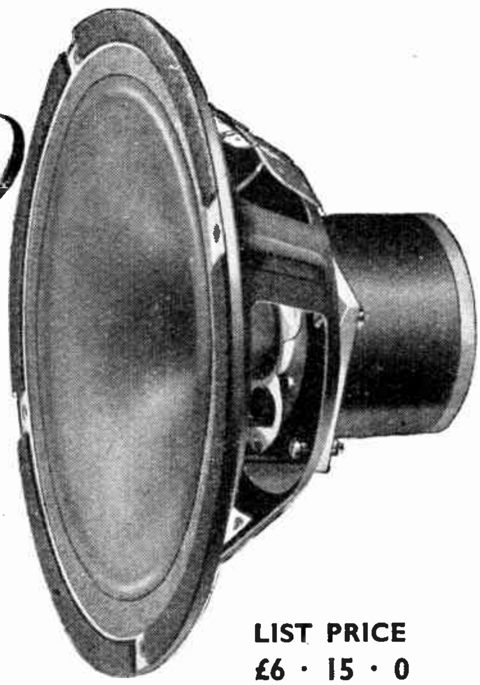

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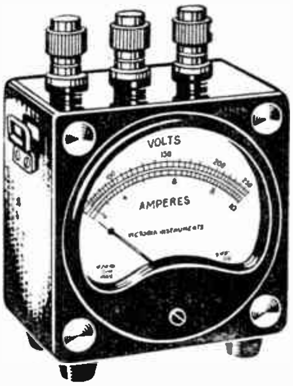

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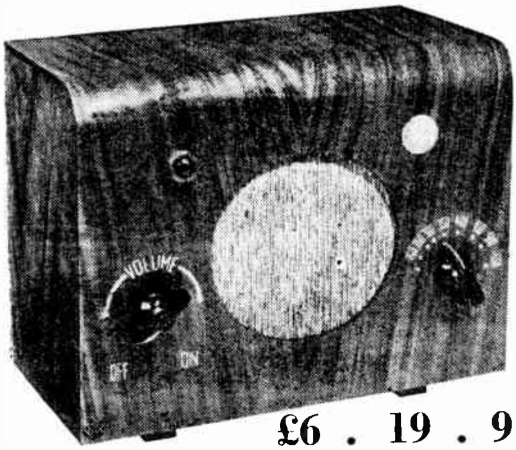

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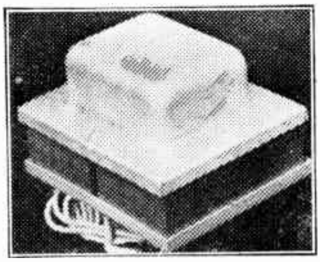

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(c) 250-0-250 v. 80 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	19 0
(d) 300-0-300 v. 80 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	19 0
(e) 350-0-350 v. 80 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	19 0
(f) 250-0-250 v. 100 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	22 0
(g) 300-0-300 v. 100 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	22 0
(h) 350-0-350 v. 100 mA. 0/4/6.3 v. 4 A. C.T., 0/4/5 v. 2 A.	22 0
(i) 350-0-350 v. 150 mA. 0/4/6.3 v. 6 A. C.T., 0/4/5 v. 3 A.	39 0
(j) 425-0-425 v. 180 mA. 6.3 v. 4 A. C.T., 6.3 v. 4A. C.T., 5 v. 3 A.	44 6
(k) 425-0-425 v. 180 mA. 4 v. 8 A. C.T., 4 v. 4 A. C.T., 4 v. 4 A.	44 6
(l) 425-0-425 v. 180 mA. 6.3 v. 4 A. C.T. 4 v. 2 A. C.T., 4 v. 2 A. C.T., 5 v. 3 A.	47 0

Types (a) (b) (c) (d) (e) (f) (g) (h (k) illustrated on left.
Types (i) (j) (l) upright shrouded type.

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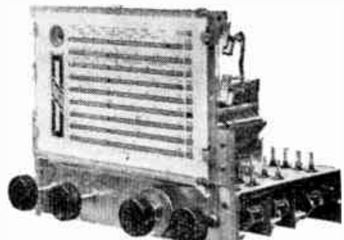

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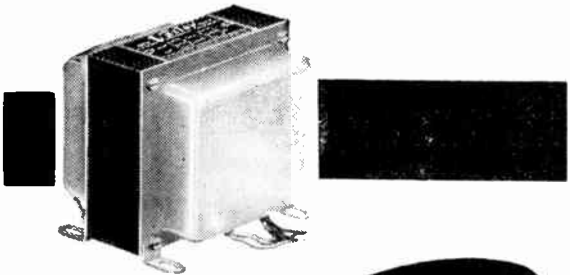

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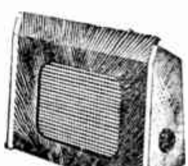

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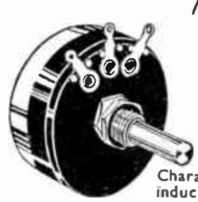

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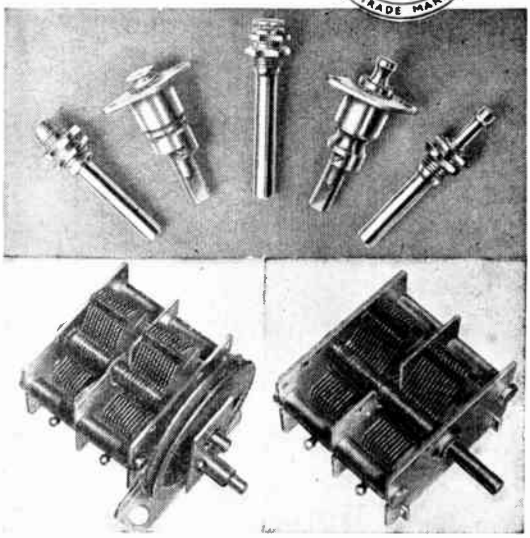

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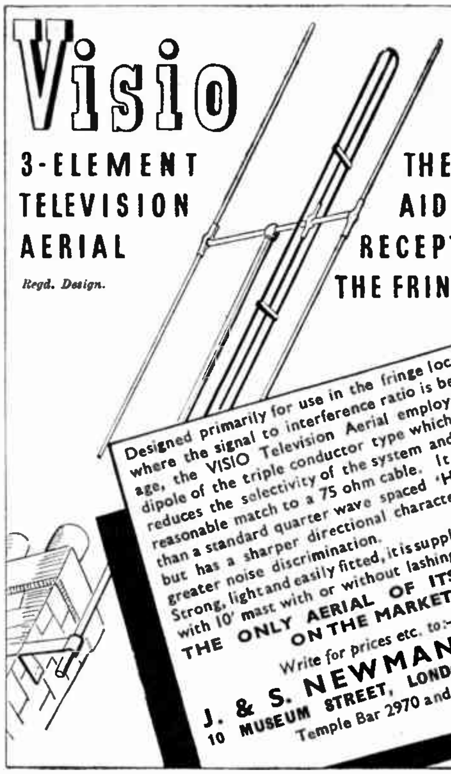

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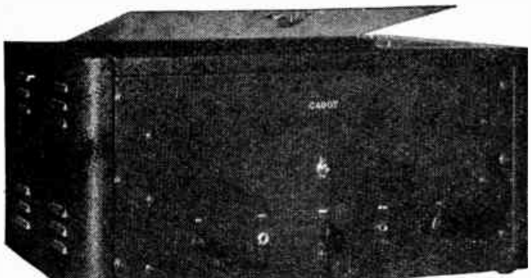

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Readers are warned that Government surplus components which may be offered for sale through our columns carry no manufacturers' guarantee. Many of these components will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such components purchased.

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HARTLEY-TURNER S7 with valves and h.t. Piezo crystal pickup; offers.—Box 6839.

R1155, int. power pack, speaker, working; £7/10.—Sticklepath, Okehampton. [3684

HALLICRAFTER S.27, for 27-144 meg., F.M. or A.M.; demonstration in London; £16.—Box 6776. [3620

W.W. quality amplifier with 2-valve tuner with valves; £4.—Davies, Ockbrook House, Ockbrook, Derbys. [3464

TELEVISION, Pye B.16.T, table model, perfect condition; £45; buyer collects.—Hartland's Radio, 24, High St., Sedgley, Staffs. [3672

GRAMPIAN 15watt P.P. mike/gram amplifier with mic. and loud speaker, £20.—Webb, 10, St. Barnabus St., London, S.W.1. [3662

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AR88 with cabinet, vibrator unit, spare valves, speaker, 'phones and handbook; recently overhauled; £45 or near offer.—81, Lime Grove, Newark. [3668

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HANDY Talky transceivers, 145mcs, world's smallest 11in×3in×3in, recently imported from U.S.A.; pair £28.—Scott, 66, Braxted Park, Streatham, S.W.16. [3649

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32/6 Bendix Rx BC-624-A, 11 valves: 3-9003, 3-12SG7, 1-9002, 1-12H6, 1-12J5, 1-12AH7, 1-12C8.—B. E. R. 39, Brighton Rd., Birmingham. [3679

H.R.O. receiver, power pack, speaker and coils, perfect order, £28; Hallicrafters Sky Champion, realigned and in perfect order, £21.—T.E.C., 101, Senhouse St., Maryport, Cumberland. [3706

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15watt gram. amplifiers complete, rack mounting, twin chassis, heavy duty iron cored components; 2 PX 25 in pp with valves, £6/15; less valves, £4/10, plus carriage.—Broadcast & Acoustic Equipment Co., Ltd., Tombland, Norwich. [2907

LEAK TL/12 amp. and RC/PA pre-amp., Hartley p.u., Turner T.R.F. feeder, coil, Collaro motor, sound sales non-magnetic T.T. in walnut cabinet, Barker 148A in Charles tricorne to match, as brand new, £65 or offer.—Box 6786. [3665

20-Valve Philco radiogram without cabinet, 5 wavebands, magnetic tuning on multidial as well as hand tuning, 3 speakers, Garrard autochanger, lovely condition, perfect quality, suitable connoisseur; deafness reason sale.—Dr. Morey, Minster Yard, Lincoln. [3612

UNUSUAL offer, Pye television console 9in tube, coupled to ASB-8 and 1355 modified with built-in power pack, making very neat and efficient long range television receiver; can be seen working with results, in Leeds by appointment; £70, or near.—Thompson, 28, Hillcourt Drive, Bramley, Leeds. [3680

CR100 (B28), 11-valve communication receivers, covering 10-2,000 metres in 6 wavebands, 200/250v a.c. mains, Marconi equiv. of AR88, 2RF, 3IF stages with Xtal gate, 3watt O.P., overhauled, aligned, remetalised cabinets, first rate condition; a large purchase enables us to offer these magnificent receivers (usually valued around £35), at the amazing price of 19gns, carr. forward; secure yours while they last; money back if not satisfied guarantee. THE AMATEURS DEN, 181, Lake Rd., Portsmouth. [3747

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The first practical moving coil speaker came from America somewhere around 1926. It was a great improvement over anything else but we thought it didn't go as far as it could. As a result the Hartley-Turner speaker was born.

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But . . . the Hartley-Turner 215 sells in the U.S.A. at $45 and we have written testimony from sound experts stating that on direct switch-over tests it is a closer approach to the real thing than others costing $500. You can believe it or not, but the proof is in our files, and it is proof supplied by men to whom perfection of performance is more important than price.

The solution of *your* high fidelity problem is here at the absurdly low price of £9; but always remember that what we say doesn't matter. It is what the user says—and he says "buy Hartley-Turner." Literature free for the asking, and "New Notes in Radio" at 2/6 will tell you how to overcome all the other snags.

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BARTON'S T.R.9 receivers, complete with six popular battery valves, give excellent S.W. results, or may be converted to broadcast bands, just ready to connect up, 16/- carr. paid; if interested in 144mcs, send for details of various receivers including American 522 RX, complete with button base valves, etc.—Barton's, 41, Bedminster Down Rd., Bristol, 3. [3719

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BRAND new: Sangamo Weston synchronous miniature electric motors, enclosed gears, 1 rev per minute, ideal for timers, clocks, etc., 19/- ea; c.w.o.—Dept. M. 46, King's Ave., New Malden, Surrey. (Include postage). [3712

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BC221AK frequency meter, full range, spare crystal; £6/10.—Box 6880. [3730

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MARCONI TF 144G. S. generator, as new, several other types; also a very few communication receivers still available; s.a.e. for full particulars.—Eldridge, 254, Grove Green Rd., E.11. Ley. 4986. [3753

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METERS.—0-7v, 2½in, m/c, 9/6; 15v, 2½in, m/c, 9/6; 150v 2in, m/c, 10/-; 300v, 2½in, m/i, 13/6; 3,500v, 3½in, m/c, 20/-; 6,000v, 3½in, m/c, 57/6; 15/600v, 2in, m/c, double reading, 8/-; 100ma, 2in, m/c, 7/6; 40/120ma, 2in, m/c, double reading, 8/-; 3.5amp, 2in T.C., 5/-; 4amp 2½in T.C. in case with switch, 7/6; 20amp, 2½in, m/i, 9/6. Meter movements, 2in size with magnet and case (500microamp), 2/6; Units containing two movements, 5/-, or with two 100microamp, 5/6. All meters post extra. Ex-R.A.F. 2valve (2volt) microphone amplifiers, as used in plane inter-com., in self-contained metal case, can be used to make up a deaf-aid outfit, intercommunication system, or with crystal set, complete with valves, 20/-, post 1/6; wooden box to hold amplifier, 2/- extra; crystal sets, with permanent detector, 9/6, in oak case, 18/6; headphones, 5/6, 7/6, 10/- and 12/6 pair; permanent detectors, 2/6; soldering irons, streamline, 50w, 9/-, standard 60w, 9/6; heavy duty, 150w, 12/6, all post extra; letters only; new illustrated list sent on request with 1d stamp and s.a.e.
HIGHSTONE UTILITIES 58 New Wanstead, London E.11. [3540

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PROFESSIONAL recording equipment, blank discs, amplifiers, microphones and magnetic tape recorders, gramophone motors with non-magnetic turntables; pressings produced from your own masters in any quantity; full trade terms available.—Sound Discs (Supplies), 37, Hoghton St., Southport, Lancs. [3486

M.S.S. portable recording machine fitted with Marconiphone pick-up, all new, £65; B.S.R. special recording amplifier, as new, £40; B.S.R. PA.20.B, high gain amplifier, new, £26; M.S.S. pick-up with sapphire, £5; Collaro motor with latest lightweight crystal pick-up, new, £8; B.S.R. twin speakers, £7/10; Vitavox 20w speaker, in cabinet, £10; mikes & stands.—H. & E. M. Porteous, "Quality Recordings," Queens Garage, Rhyl, N. Wales. [3735

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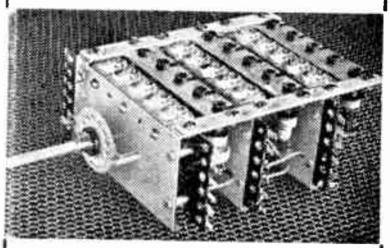

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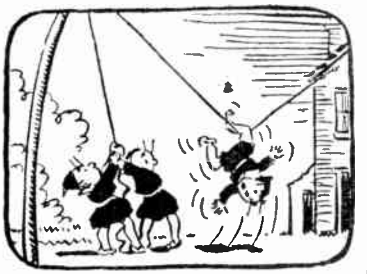

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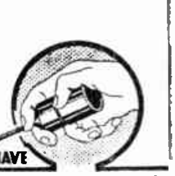

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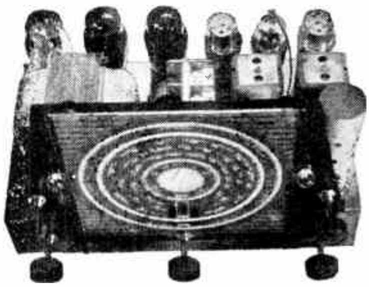

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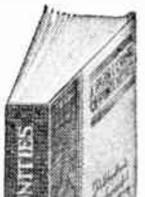

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(Continued on next page.)

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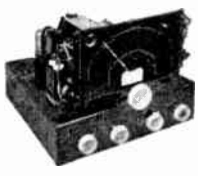

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RADIO supervisors and technicians should join their appropriate trade union, the Association of Supervisory Staffs, Executives and Technicians.—Write for free pamphlet to ASSET, 110, Park St., London, W.1. Tel. Mayfair 8541-2.

ENGRAVING.—Amateurs and trade requirements, panels, plates, metal and plastic, attention to urgent deliveries; one knob or repetition equally entertained.—Call or write Newman, 19a, Windmill Rd., Wandsworth, London, S.W.18. [3640

RADIOGRAM cabinets in walnut, £18; a so corner cabinets to take up to two 10in speakers in oak or walnut, £4/15; write for illustrated leaflets; trade and export enquiries invited.—Cabinetware, Summit Works, Heyes St., Blackburn. [3707

FLUORESCENT lighting, white batten fitting 4ft 40w with complete control gear, tested, but less tube, 55/-; kits of essential parts with circuit, less tubes, 40w 31/9, 80w 35/9, all 210-240v A.C.—Malden Transformer Supplies, 200-202, Cambridge Rd., Norbiton, Surrey. [3717

FESTIVAL of Britain.—The Council of Industrial Design have opened a 1951 stock list to which they invite manufacturers to send photographs or drawings of their best products.—Address to Stock List, Council of Industrial Design, Tilbury House, Petty France, London S.W.1. [3627

COPPER wires enamelled, tinned, Litz, cotton, silk covered, all gauges; BA screws, nuts, washers, soldering tags, eyelets; ebonite and laminated bakelite panels, tubes, coil formers; Tufnol rod; headphones, flexes, etc.; latest radio publications, full range available; list s.a.e.; trade supplied.—Post Radio Supplies, 33, Bourne Gardens, London, E.4. [1454

SITUATIONS VACANT

Vacancies advertised are restricted to persons or employments excepted from the provisions of the Control of Engagements Order, 1947.

SUDAN GOVERNMENT.

THE Posts and Telegraph Department require an executive officer (stores and workshops), aged 28 to 35, for service in the Sudan; the duties consist of taking full control of all stores work, stores accounting and costing, responsibility for ordering stores and general supervision over the workshops; candidates must have had wide experience in the handling and ordering of telecommunications stores, knowledge of stores accounting and costing and ability to control staff.

APPOINTMENT will be either on long term contract on a salary scale £E.480 to £E.936 with special post-services gratuity; or on Provident Fund contract at slightly higher rates of pay and different post-service benefits.

COST of living allowance varying between £E.180 and £E.390 per annum according to the number of dependants, is at present payable, and, subject to certain limitations, an outfit allowance of £E.60 is payable on appointment; there is at present no income tax in the Sudan; free passage on appointment; full particulars and general information may be obtained on application to: Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1. Please mark envelope "Telestores." [3785

CROWN Agents for the Colonies—Applications from qualified candidates are invited for the following posts:—

WIRELESS OPERATORS required for Government of Falkland Islands Dependencies Survey for service in the Antarctic for one tour of 18 or 30 months; salary £325 a year; free quarters, food and clothing and free passage in research ship leaving United Kingdom in October; candidates, unmarried and not over 30, must be able to transmit and receive morse at 25 words a minute and be capable of maintaining internal combustion engines and diesel generator sets; apply at once by letter, stating age, and full particulars of qualifications and experience and mentioning this paper to—The Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M/N/24761(3B) on both letter and envelope. [3695

CROWN Agents for the Colonies.—Applications from qualified candidates are invited for the following post:—

RADIO Telegraph Inspector required by Nigeria Government Posts and Telegraphs Department for one tour of 18 to 24 months. Salary £850 a year (including expatriation pay). Outfit allowance £60. Free passages. The duties of the post are those of a construction foreman engaged on the installation of radio diffusion or relay systems including fitting central receiving stations with diversity reception receivers, aerial arrays, etc., and subscribers lines and apparatus. Candidates should have had experience with a company operating radio relay services.—Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, and mentioning this paper, to the Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M/N/24719 (3B) on both letter and envelope. [3609

ENGINEERS required for test and development work on electronic test equipment. Inter B.Sc. standard preferred.—Apply Furzehill Laboratories, Ltd., Boreham Wood, Elstree 1137. [3647

TELEVISION engineer required for progressive radio firm, highest rates for man with ability; radio sales assistant also required.—Apply "Leytonia Radio," 828 High Rd., Leyton, E.10. [3613

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APPLICATIONS are invited for Electronic Engineers and Mechanics for reconditioning V.H.F. wireless equipment; Wellington-Salop area.—Box 6918. [3784

FERRANTI, Ltd., Moston Works, Manchester, have staff vacancies for engineers and scientists of all grades in connection with long-term development work on an important radio telecontrol project.

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THE company has a staff pension scheme and will give housing assistance in special cases.

APPLICATIONS should be addressed to the Staff Manager, Ferranti, Ltd., Hollinwood, Lancs. [3646

SALES engineer, experienced in selling radio test gear and electronic equipment to industry, required by small group of companies, London headquarters; write giving date of birth, full details of experience and remuneration required to Box 6842. [3697

FOREMAN to take charge of transformer division of West Country manufacturers; experience of coil winding and assembly of transformers up to 50kva essential, and some previous executive experience desirable; give details of experience with dates to Box 6837. [3685

PILOT RADIO, Ltd., requires immediately fully experienced chargehands for radio and television assembly lines; five day week with good rates of pay. Apply or write to 31/37, Park Royal Rd., N.W.10. [3634

ELECTRONIC technician required by Oxford University laboratory to design, construct and maintain apparatus and test-gear used for research; experience of electronics other than radio desirable; wages according to University scale.—Apply, giving full details to Box 6778. [3625

PROGRESSIVE firm of radio and electronic manufacturers, in N.W. London area, require senior design draughtsman to take charge of drawing office, experience in radio and television design essential.—Apply in writing, stating experience, salary required, etc., to Box 6784. [3660

WANTED, service engineer for elec. control instruments, preferably conversant with automatic telephone technique; required to travel servicing apparatus after training at works, good personality, opportunity advancement, age 25-35; £400-£500 according to qualifications.—Box 6782. [3652

INTERESTING vacancies now exist for senior intermediate and junior draughtsmen on industrial electronic equipment with large well-known engineering company in their office near Victoria Station, London.—Please quote Ref. D6/59, and apply, giving full particulars, to Box 6780. [3645

ELECTRICAL component manufacturers require man for maintenance of test equipment; applicants must be experienced and possess good knowledge of radio and valve technique; West London area; five-day week; write stating age, experience and wages required to Box 6838. [3688

RADIO engineer for technical publications dept., with experience of compiling service literature on domestic radio and television receivers.—Applications by letter only, stating age, experience and qualifications, salary, etc., to The Personnel Manager, Bush Radio, Ltd., Power Rd., Chiswick, W.4. [3610

RADIO and electronic development engineers, senior and junior draughtsmen, radar mechanics, H.F. repairers, radio prototype wiremen, inspectors, testers, television and P.A. equipment service engineers, and other positions vacant.—Technical Employment Agency, 179, Clapham Rd., S.W.9. (Brixton 3487.) [3710

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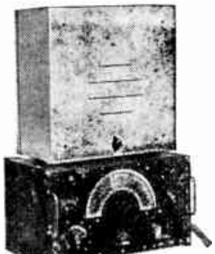

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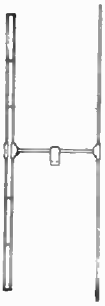

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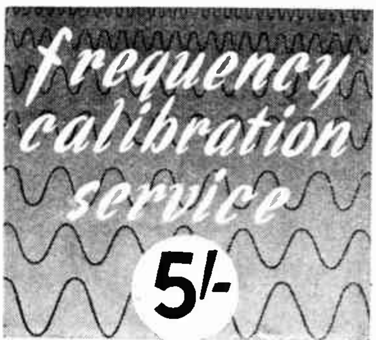

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AN engineer required for the design and construction of special purpose electronic test gear by large company in East London; applicants should have technical education to at least Higher National standard and previous experience of this work.—State age, experience and salary required, to Box 6878. [3709

RADIO engineer required for work in London on domestic receiver designs for export; applicants must have had previous experience of this work, and preferably at least one model successfully mass-produced; send particulars of education, training and experience, also date of birth and salary required, to Box 6841. [3696

WANTED immediately, electronic draughtsmen with at least 2/3 years' experience in diagrams, mechanical design and layout of electronic industrial and laboratory equipment; permanent positions offered in the Midlands area; salary according to qualifications and experience.—Apply quoting ref. D6/58 to Box 6777.

APPLICATIONS are invited from engineering and physics graduates by the Research Laboratories of The General Electric Co., Ltd., East Lane, North Wembley, Middx., for work on telecommunications equipment and radio navigation aids; details of age, academic record and experience should be sent to the Personnel Officer. [3687

RADIO service engineer required for provincial firm of high standing, must be to first-class technical standard, and have considerable practical experience, knowledge of television an advantage; wage according to ability and confirmed after one month's probation. Apply to Messrs. Barnes & Avis, Ltd., 140/1, Friar St., Reading, Berks. [3639

RADIO-ELECTRONICS technician required by Boots Pure Drug Co., Ltd., Nottingham, for their plant laboratory with ability to construct, service and trace faults in industrial electronic equipment such as pH meters, d.c. and a.c. amplifiers and R.F. generators.—Applications, stating salary required, to Personnel Manager, Station St., Nottingham. [3671

DESIGNER-DRAUGHTSMEN required for mechanical design of radio components, receivers, television and electrical domestic appliances; applicants must have had three years experience on at least one of these products; good salary paid to men with ability and qualifications.—Apply in writing to Ref. S.E., Messrs. Burndept, Ltd., West St., Erith, Kent. [3608

ENGLISH ELECTRIC Co., Ltd. Stafford, require urgently electronic draughtsmen of all grades for research development and production drawing offices; experience in this field essential; good conditions and prospects.—Please quote Ref. D.O.53 when sending full details to Central Personnel Services, English Electric Co., Ltd., 24-30, Gillingham St., London, S.W.1.

AN assistant engineer is required for radio laboratory in the Witham area; applicants should have previous experience in a radio development laboratory and should be between 23 and 30 years of age; salary will be in accordance with qualifications and experience.—Applications should be made in writing, with full details, to Personnel Manager, The Plessey Co., Ltd., Ilford. [3607

A. H. HUNT, Ltd., have vacancies for laboratory engineers for work on design and manufacture of capacitors; duties will require a basic knowledge of power and radio frequency engineering with a general understanding of applied physics and chemistry; previous work on capacitors not essential.—Write or call, A. H. Hunt, Ltd., Bendon Valley, Garratt Lane, Wandsworth, London, S.W.18. [3596

BRITISH INSULATED CALLENDER'S CABLES, Ltd., require a Physiscist for the development of sound recording media; candidates should be experienced in physical, electromagnetic and electroacoustic measurements and be capable of carrying out development work on own initiative: permanent position; salary according to age and qualifications. Apply in writng to Staff Officer, B.I.C.C., Ltd., Prescot, Lancs. [3643

REQUIRED by a firm engaged in the development and design of telecommunication equipment near Maidenhead, engineers having degrees in physics or engineering science, preferably with experience of electronic switching technique; salary scale with annual increments and pension fund; starting salary according to experience and qualifications. Apply in writing Box No. 454, Dorland Advertising, Ltd., 18-20, Regent St., S.W.1. [3636

FOREMAN required for assembly shop concerned with the manufacture of radio receivers and associated equipment—situated in West London district; applications will only be considered from people who have had previous experience of mass production of radio receivers, and who are capable of controlling up to 400 female operators; when writing please give full information of previous experience and state salary required.—Box 6781. [3651

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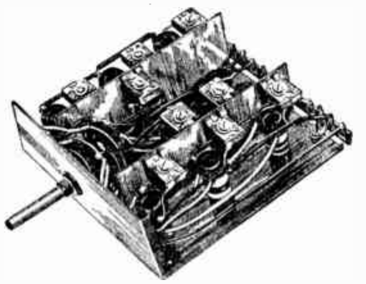

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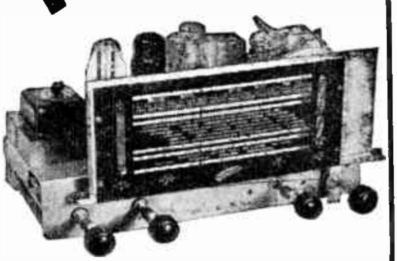

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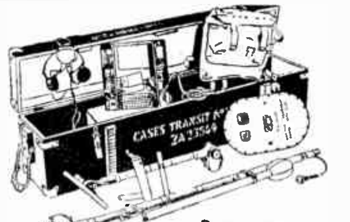

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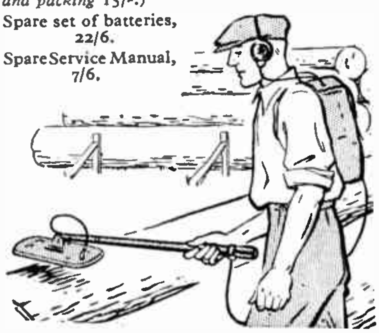

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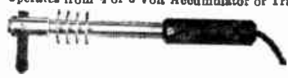

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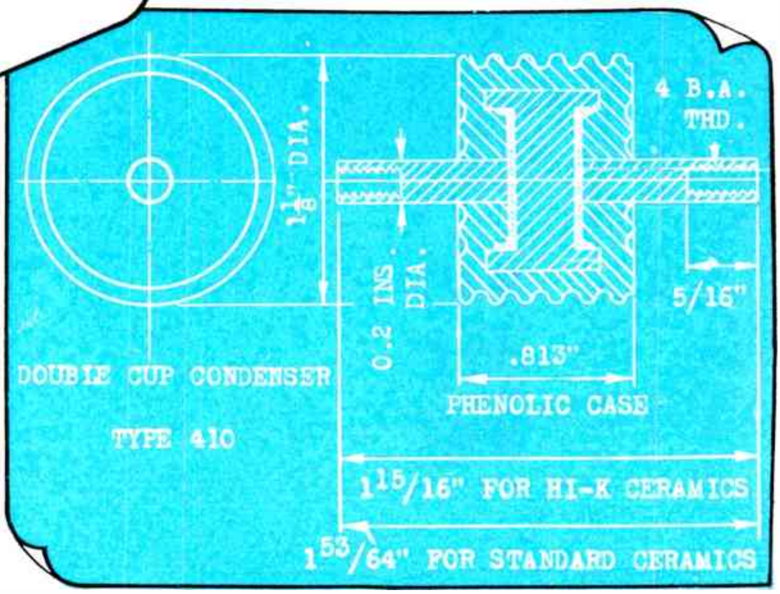

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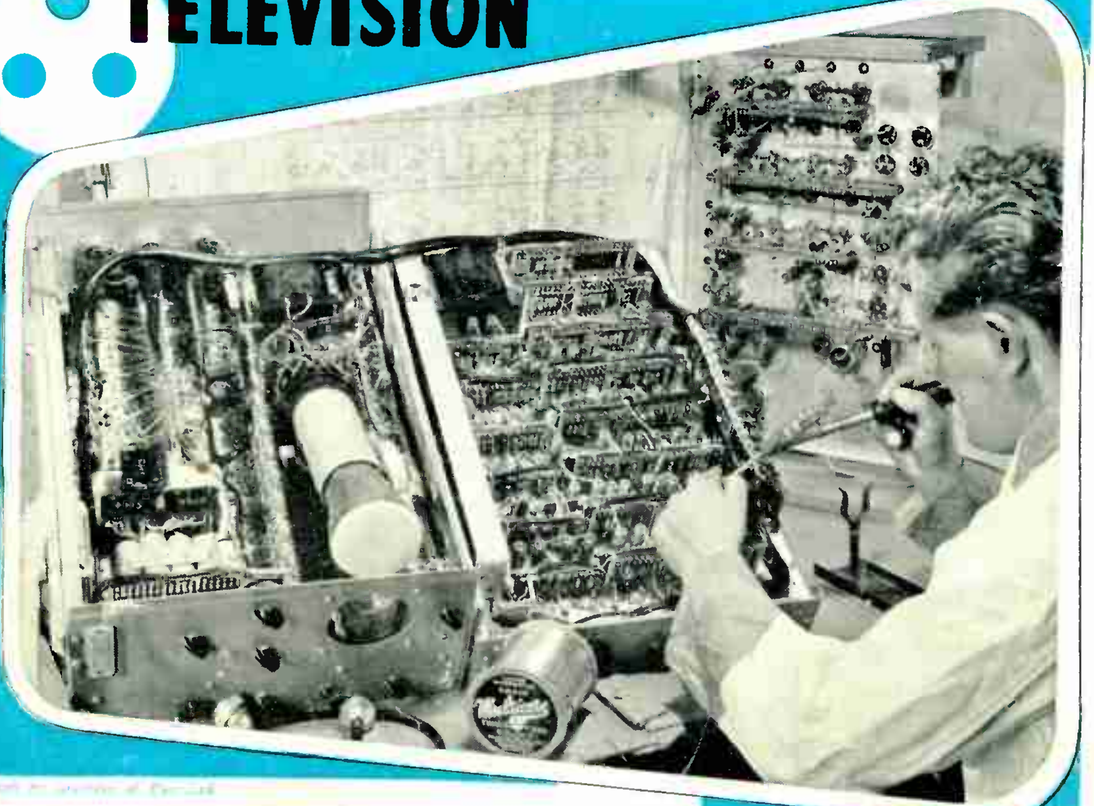

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