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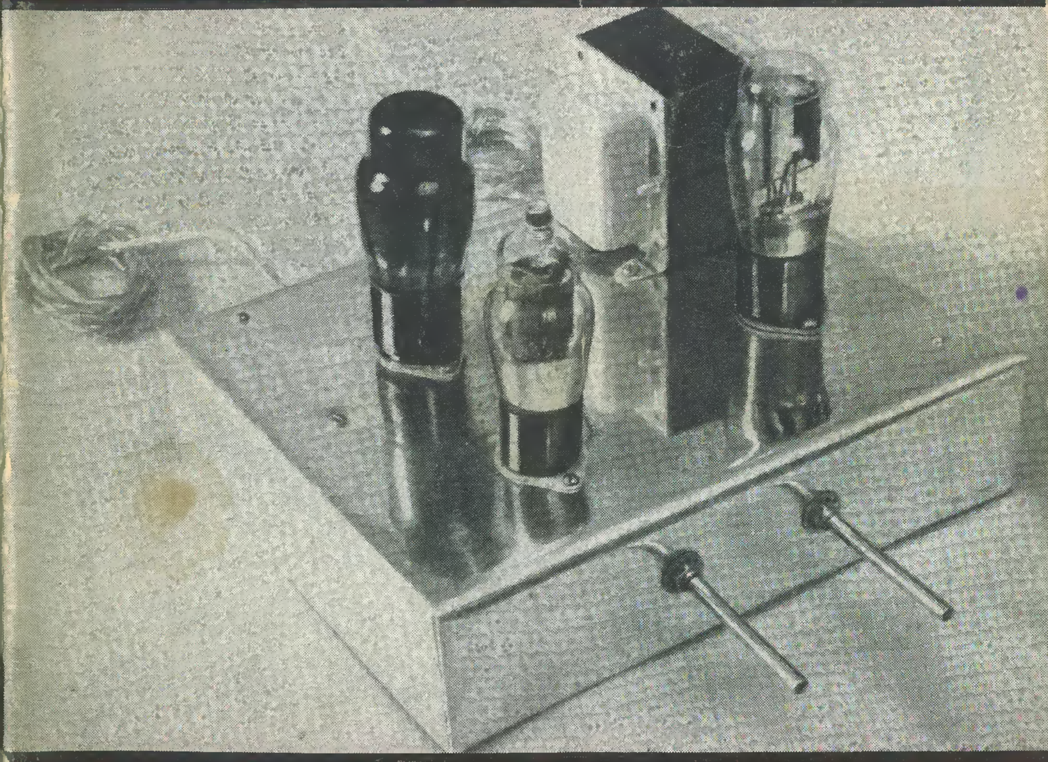
The RADIO CONSTRUCTOR

for the Radio and Television Enthusiast



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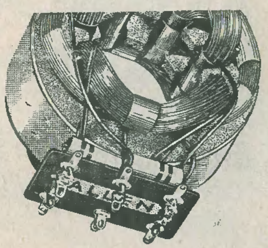

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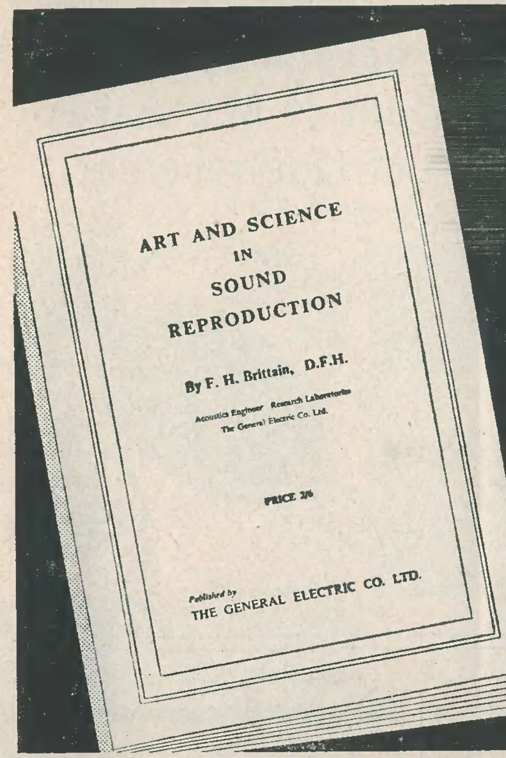

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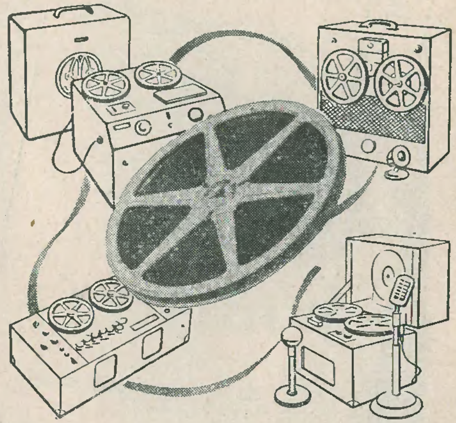

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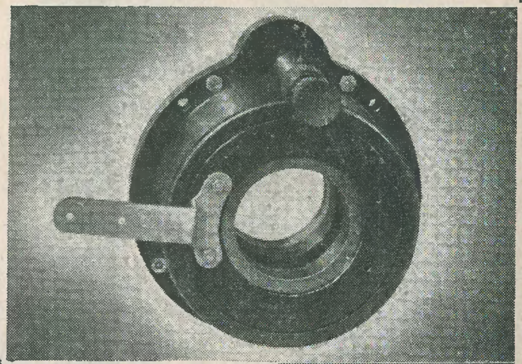

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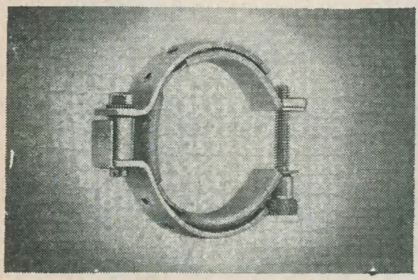

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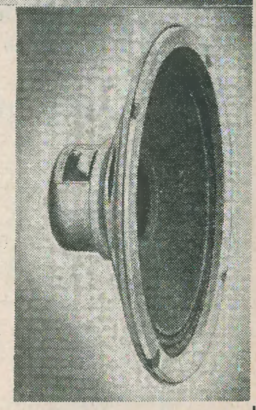

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The RADIO *Constructor*

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Advertising Manager: F. A. Baldwin

NOTICES

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but relevant information should be included. All Mss must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

ALL CORRESPONDENCE should be addressed to *Radio Constructor*, 57 Maida Vale, Paddington, London, W.9. Telephone CUN. 6518.

Suggested Circuits for the Experimenter

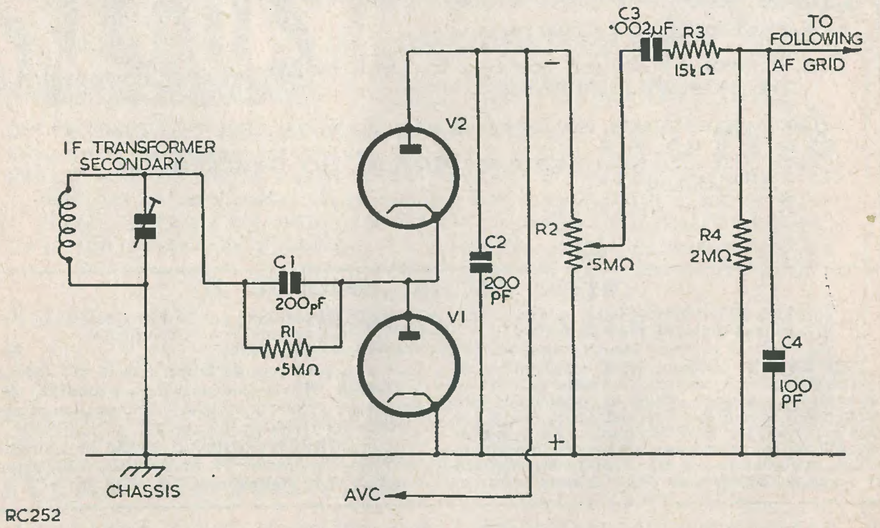
The circuits presented in this series have been designed by G. A. FRENCH specially for the enthusiast who needs only a circuit and the essential relevant data.

No. 33: A VOLTAGE DOUBLING DETECTOR

THIS MONTH'S CIRCUIT illustrates an unconventional method of obtaining gain at the detector whilst using diodes. The circuit gives a theoretical voltage gain of two. Fidelity of detection should be equivalent to that offered by a conventional diode circuit.

Operation

The circuit functions in the same manner, largely, as does a normal voltage doubler. When the AC voltage supplied by the IF transformer secondary is positive with respect to chassis, V1 conducts. This causes C1 to charge to the peak value of the applied AC, its right-hand plate being negative and its left-hand plate positive. The voltage across C1 then acts in series with that supplied by the IF transformer secondary, with the result that the voltage applied to the cathode of V2 varies between zero and twice the peak value of the applied AC. V2 conducts and charges C2 to a similar voltage. (*continued at foot of next page*)



A Voltage Doubling Detector

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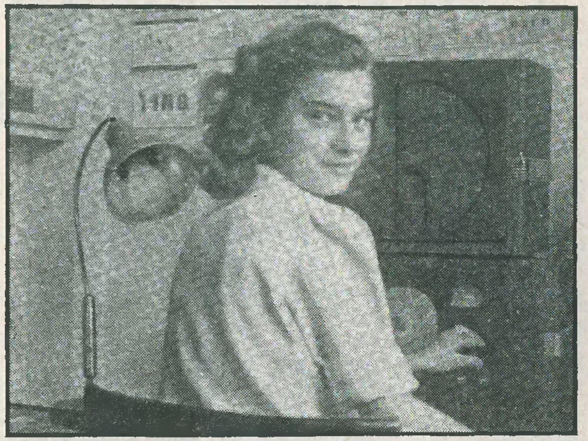


THIS is an example of a picture which might have been taken by any of our readers. Why not go through your own snapshots?

Details of a new competition will be found on page 43—and the photographs need not have been specially taken for the purpose. Any picture of radio interest is eligible.

(Sorry—but we are as intrigued as you are about this particular picture. We just haven't any information about it at all. Any clues?)

(*continued from preceding page*)

R1 and R2 are connected across C1 and C2 respectively in order to allow these capacitors to discharge slightly between successive peaks and thus "follow" the modulation envelope of the received signal. R2 can be considered as the resistive diode load.

In accordance with conventional detector practice the following grid leak should have a value at least four times that of the resistive diode load. In this instance R2 is 0.5MΩ and R4 is 2MΩ. Either R2 or R4 may be a volume control, but it might be easier to use R2 for this purpose since volume controls of this value are more readily obtainable.

Possibilities

As may be seen from the circuit, AVC is developed across R2; and it is here that the circuit will probably prove most useful. Whilst a voltage gain of two will give a noticeably increased audio output, with conventional receivers the effect will not be spectacular. On the other hand, a doubled AVC voltage should definitely give better control; as well as providing the incidental benefit of greater tuning indicator deflection.

Either V1, V2, or both, may be germanium diodes, if desired. Thus, when using conventional receiver design, V1 could be the diode section of a diode-triode or diode-pentode whilst V2 could be a germanium diode.

The
Editor Invites

articles from readers, of a nature suitable for inclusion in this magazine.

Articles submitted for publication should preferably be typewritten, but ordinary writing is acceptable if clearly legible. In any case, double spacing should be used, to allow room for any necessary corrections.

Drawings need not be elaborately finished, as they will usually be redrawn by our draughtsmen, but details should be clear.

Photographs should preferably be large (half-plate) but in any case the focus must be good. Much useful advice to prospective writers is given in our *Hints for Article Writers*, which will be sent free on request.

IN YOUR WORKSHOP

In which J. R. D. discusses Problems and Paints of Interest connected with the Workshop side of our Hobby based on Letters from Readers and his own experience.

READERS MAY REMEMBER my mentioning some time ago that I was away from this country and that there were liable to be some unavoidable delays with regard to correspondence. I am happy to say that I have now returned. In fact, by the time this appears in print I shall have been in the U.K. for several months. I must thank all those who have been good enough to write to me during the last ten months or so for having put up so patiently with the annoying delays which occurred before I could reply. In order to keep in touch as well as I possibly could, I took the precaution of opening two Monomark addresses before leaving; one for air mail, and one for surface mail. It sounds a little complicated, but this system enabled letters to reach me much more quickly than would otherwise have been the case. I shall now, of course, be able to deal promptly with any letters I receive.

Impressions

Whilst I was away I spent some time in Singapore and Hong Kong and I was able to gain a few impressions of things out there from the radio angle.

Amongst other things I attended the radio exhibition held in the Happy World Stadium at Singapore last year. This contained several interesting exhibits, including a broadcasting studio in actual use; but the item which captured the Singapore imagination, almost to the exclusion of everything else, was a demonstration of closed circuit television. Pye equipment was used for this exhibit, the reproduced pictures being shown on normal domestic receivers. Singapore was most definitely impressed by this demonstration and there has been some controversy since the exhibition over the erection of a television station for Singapore. Although it is claimed that a transmitter radiating sponsored programmes could be built fairly quickly, the Government has withheld permission. Whether a Government-run station is being planned or not is unknown; but it is doubtful whether such a station would appear for several years at the very least. To my mind this is rather a pity, because, apart from other considerations, television in Singapore would open a welcome overseas market to British manufacturers.

Without television, most radio interests are concerned with sound transmission and reception. So far as transmitted programmes are concerned, a large number of BBC recordings are used for English broadcasts both at Singapore and Hong Kong; these recordings consisting mainly of popular items such as "Take It From Here" and "P.C. 49." Radio Hong Kong caters for English and Chinese audiences, this being done fairly easily by using two separate wavelengths; but Singapore has to broadcast to a mixed audience of English, Chinese, Malays and Indians. Something of a headache!

There is a fair amount of interest both at Singapore and Hong Kong in high-fidelity reproduction but very little home-construction is attempted, listeners being satisfied with commercial units. LP records seem to sell quite well.

Apart from the peculiar factors raised by the very humid climate in Singapore, servicing seems to raise no unusual problems. Quite a lot of servicing work is carried out by Indians or Chinese, usually under European supervision, and this system works quite well in practice. I was interested to note that the old enemy—"tuning capacitor howl" on the short wave bands—hardly appeared at all; and, even when it did, only on the cheaper receivers. This trouble used to be a common complaint when I was in Southern Rhodesia five years ago. I was also a little intrigued at the comments of a friend in the trade at Singapore when he remarked that many Chinese are interested only in receivers which are simple to operate and give plenty of volume. They do not even want tone controls!

Aerials

One of the first things that caught my eye on returning to the U.K. was the vast array of TV aerials which have sprung up all over the country in the last year. Of course, TV aerials are going up continually all the time, but one needs to be away for a while to gain the full impression.

TV has now, fortunately, almost entirely overcome its early impression of being a "rich man's hobby." The initial cost of a commercial receiver is high; but to my mind such expenditure is an investment. Of course, the knowledgeable amateur can enjoy the best of both possible worlds, since he can gain pleasure from building his own receiver as well as saving money in the process.

I do honestly think, however, that the quality of the programmes transmitted could still be considerably improved. So far as vision is concerned the entertainment value of a talk, for instance, is only slightly higher than that of a test card. The BBC has always had a penchant towards educating us ignorant types; but I do wish they would suppress their zeal, especially in the evenings.

TV From Batteries

I seem to remember describing, several years ago, a radio set I fixed up for some relatives who live in the country. The point of interest in this particular set was given by the fact that the only available supply was given by a 24-volt battery system. This receiver has been relegated to the background because my relatives now have TV—also supplied from 24-volt batteries!

The set-up they use is as follows: a small ex-W.D. dynamo driven by a paraffin engine gives a floating charge of approximately 10 Amps to four twelve-volt accumulators connected in series-parallel and having a total capacity of 200 Amp hours at 24 volts; these accumulators provide lighting in the house (lighting consumption varying between 2 and 10 Amps), and, in addition, feed a rotary converter (ex-W.D. as well) which gives a nominal 230 volts at 50 cycles. The TV receiver, a conventional commercial model, then runs from the converter output. The converter is, of course, only switched on for viewing.

This arrangement has, to date, given no trouble. The converter and dynamo are sited about fifty yards from the set and the aerial, and they cause no interference at all. Indeed, apart from the obvious measures of earthing the frames of the dynamo and converter, and of connecting a couple of 0.01 μF capacitors between the brushes of the dynamo and earth, no precautions against interference from this source have been taken at all. TRS wire is used throughout for all connections and wiring. The converter is unregulated but, so long as the batteries are kept fairly well charged, the voltage supplied to the receiver remains quite stable enough for satisfactory viewing.

The only fault I have noticed on the equipment is a small frame "wobble" at the centre of the picture. The wobble occurs at a slow speed and is mainly noticeable on stills. The effect usually clears after half-an-hour or so.

This trouble is, of course, most probably caused by the frequency of the converter output varying from 50 cycles, with the result that the frame time base output is distorted at the "difference frequency," as it were. If this is the case it is quite fortunate that the converter settles down to a reasonably steady 50 cycles after half-an-hour's running!

For the sake of the record, I had better mention that probably the best method of running a TV set from battery supplies consists of using a converter with a DC output feeding an AC/DC receiver; and that converters of this type, designed for 50 or 110 volt DC inputs, are available commercially.

However, if any reader wishes to have more specific information on the particular 24-volt installation I have just described, I shall be only too pleased to pass on any facts I know. I would also be interested to hear of any other power supply problems which have been solved by similar means.

CAN ANYONE HELP ?

Mr. E. C. Newstead, c/o G.P.O., Hunstanton, Norfolk, would be particularly interested to hear from readers who have converted ex-W.D. units to 'scopes using VCR/97 or VCR138. Information about such units which are still available on the surplus market will also be welcome.

Valves and their Power Supplies

PART 10

BY F. L. BAYLISS, A.M.I.E.T.

Trouble Free Service

So popular is the mains-battery superheterodyne and so convenient and satisfying the facilities that it offers as a general purpose receiver, that, in discussing these receivers again, the writer can only offer this popularity as his excuse.

Moreover, at the present time, the supply of inexpensive metal rectifiers shows little signs of diminishing in the ex-WD markets.

Many of these rectifiers are highly suitable —almost ideal—for use in the power supply circuit of a mains battery superhet, and render the cost of the power pack so low as to tempt even those who require only a battery portable to go the whole hog, for a few extra shillings, and include the mains facility for possible future use.

To those contemplating the inclusion of such a power pack, then, the metal rectifier has much to offer. Simplicity of wiring, robust construction and a lifetime's trouble-free service place it in a class by itself. Even at double the cost it would be worth quadruple in usefulness.

The Circuit

The circuit of Fig. 32 is offered as an arrangement to meet the demands of the most exacting of constructors.

A high degree of smoothing, low power dissipation, maximum safeguard of the valves, ease of switching and accuracy of supply voltages and current, all combine with the inherent simplicity to form a most suitable arrangement.

The 4-pole, 3-way switch gives " MAINS," " OFF " and " BATTERY " positions. The " OFF " position is central so that when switching from " MAINS " to " BATTERY" capacitors C2 and C3 are short-circuited to chassis in the central position, thus preventing high surge voltages from damaging the valves.

The switching arrangement has the slight disadvantage that the choke and capacitors C4 and C5 remain at mains potential in the " OFF " and " BATTERY " positions, but, in the writer's opinion, this is no more inconvenient than the usual arrangement where S2 is placed directly in the upper mains lead. As it is, S2 performs the very useful function of disconnecting the large value electrolytics C4 and C5 when running off batteries, and prevents possible battery leakage.

HT smoothing is effected by the smoothing choke, C4 and C5. It is desirable to prevent too great a voltage rise when running off AC mains—to keep the voltage about equal to the input voltage, in fact, if at all possible. To this end the values of C4 and C5 should each not exceed 8.0μF, the necessary degree of smoothing being catered for by a good quality choke having an inductance of not less than 20 henrys.

As the components used by constructors will doubtless vary, however, adjusting resistors R2 and R3 have been included to prevent too high a voltage being supplied to the valve filaments. A milliameter may be inserted between pin 1 of V4 and chassis, and, with the receiver switched on, the adjusting plug inserted to give a reading of approximately 50mA through the valve filament chain. Alternatively, of course, a 500Ω preset type wirewound potentiometer may be used in place of R2 and R3.

The HT voltage is dropped to 90 volts by resistor R1, whilst capacitor C3 gives some additional smoothing to the mains HT voltage, but acts primarily as an HT battery bypass capacitor.

Resistor R6 is used to by-pass the combined anode currents of V1 and V2 and to prevent this current adding to the normal filament current of V3 and V4.

Resistor R7 performs a similar function in respect of by-passing the cathode current of the half of V4 between pins 5 and 7, i.e. of preventing this current from flowing through the other half of V4 filament.

Final smoothing of the filament current, mains working, is provided by C2.

The correct value of bias resistor with this valve arrangement is 820Ω, but, on mains, the filament chain current also flows through this resistor on its way to the return side of the mains.

An additional resistor, for mains working only, is corrected in parallel with the 820Ω resistor R5. This resistor, R8, keeps the bias potential at its previous (battery) voltage.

Automatic Bias Voltages

By virtue of the series filament arrangement of the valves, the filaments of valves in the upper part of the chain will be positive with respect to chassis by the voltage across filaments of valves below them.

Thus, instead of returning valve grid leads to chassis, as usually, the grid return may be made to an appropriate point in the filament

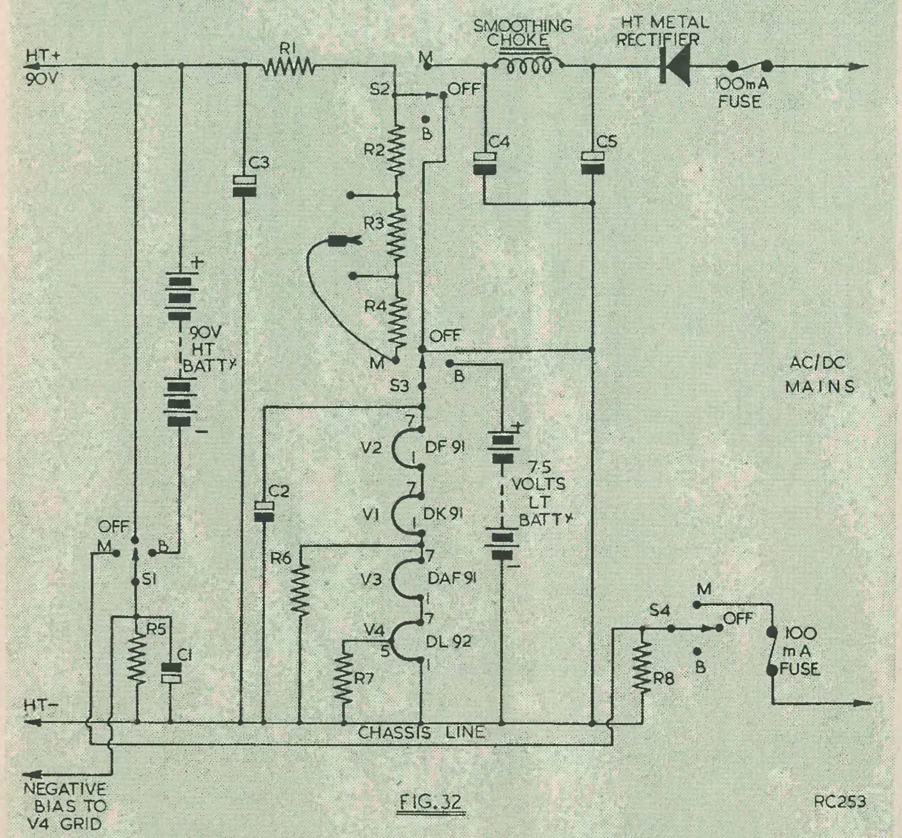
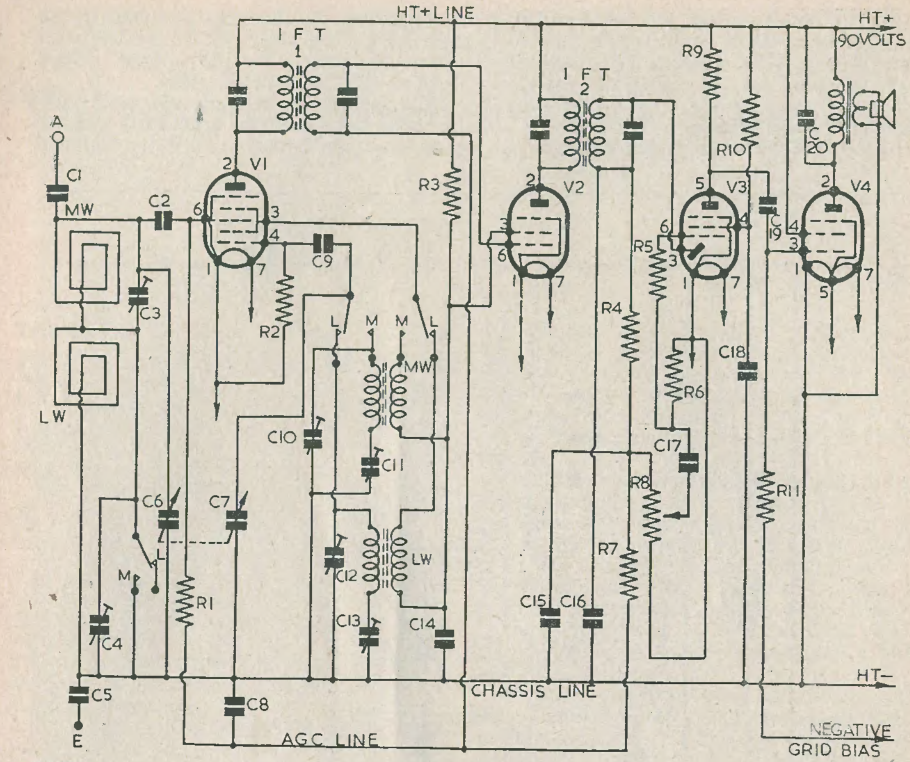


FIG. 32

List of Components for Fig. 32

R1	— 10kΩ, 3 Watts	2	— 100mA Fuses and Fuseholder.
R2, R3	— 390Ω, 1 Watt	C1, C2	— 25μF, 25 Volts Electrolytic
R4	— 4.7kΩ, 10 Watts	C3	— 2.0μF Electrolytic, 360 Volts Wkg.
R5	— 820Ω, ½ Watt		
R6	— 560Ω, ½ Watt	C4, C5	— 8.0μF plus 8.0μF Electrolytic — 450 Volts Wkg.
R7	— 270Ω, ½ Watt		
R8	— 150Ω, ½ Watt	V1	— Mullard DK91 (1R5)
1	— 4 pole, 3-way, Miniature Rotary Switch	V2	— Mullard DF91 (1T4)
1	— 20 Henrys, 60mA Smoothing Choke	V3	— Mullard DAF91 (1S5)
		V4	— Mullard DL92 (3S4)
1	— Metal or Selenium Rectifier, — 250 volts, 60mA	90 volts HT Battery	
		7.5 volts LT Battery.	



Circuit of a receiver suitable for use with the power supply shown in Fig. 32

List of Components for Fig. 33

R_1, R_{11}	— 1.0MΩ, ½ Watt
R_2	— 100kΩ, ½ Watt
R_3	— 27kΩ, ½ Watt
R_4	— 47kΩ, ½ Watt
R_5	— 22kΩ, ½ Watt
R_6	— 6.8MΩ, ½ Watt
R_7, R_{10}	— 2.2MΩ, ½ Watt
R_8	— 1.0MΩ Carbon Potentiometer
R_9	— 470kΩ, ½ Watt
C_1	— 0.002μF, Mica
C_2, C_9, C_{15}, C_{16}	— 100pF, Mica
C_3, C_4, C_{10}, C_{12}	— 100pF, Preset
C_5	— 0.1μF, 1,000 Volts Wkg.
C_6, C_7	— 500pF Two-Gang Tuner

C_8, C_{14}, C_{18}	— 0.1μF, Tub., Paper
C_{11}	— 500pF, Preset
C_{13}	— 200pF, Preset
C_{17}, C_{20}	— 0.005μF, Mica
C_{19}	— 0.01μF, Mica.

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MW and LW Oscillator Coils } Or Osmor Type "B" Coilpack

One pair 465kc/s IF Transformers (RSGB, Semi-Midget)
One Output Transformer Ratio 50:1
One 3Ω, M/C Loudspeaker.
One 2-socket "A" and "E" Socket Strip
Valves and Batteries as for Fig. 32.
One 4-pole, 2-way Rotary Wavechange Switch (Not required with Osmor Coilpack).

chain to give an automatic negative bias to the valve grid concerned.

This is an important point, and should be made clear by reference to Fig. 33.

The grids of V1 and V2 are connected together by R_7 and R_8. By connecting the lower end of the volume control R_8 to V3 pin 1 instead of to chassis, V1 will be given a bias of –1.4 volts—that due to the voltage across the V3 filament—whilst V2, the first valve in the chain, becomes biased by –2.8 volts due to V1 and V3 filament voltages.

V3 itself, which normally requires no bias voltage, has its grid resistor R_6 returned to its own negative filament-pin and thus remains unbiased.

V4 derives its bias from R_5 and R_8 (Fig. 32) as stated previously.

One further point: the diode anode of V3 is located, inside the valve, at the negative end of the filament. To maintain equivalent diode anode and filament potentials, therefore, the anode return lead, via R_4 and R_8, must be connected to its own negative filament, and, in Fig. 33, this is effected.

A Superheterodyne Circuit

Although strictly not within the scope of this series of articles, the power supply circuit of a mains-battery receiver is so tied up with the signal circuits that it is perhaps best to give the arrangement in its entirety.

The complete circuit of a 1.4 volt valves receiver is therefore shown in Fig. 33 and a list of components is appended.

Constructors possessing suitable coils and frame aerial will, no doubt, want to use these, and for these constructors the coil arrangement of Fig. 33 is intended.

Constructors wishing to buy new coils for this circuit, however, cannot do better than buy the Osmor type "B" coil pack for short, medium and long waves. This pack incorporates a medium wave frame aerial and long wave loading coil: the connecting data is given in the Osmor leaflets, and the padding and trimming components of Fig. 33 will not be needed. (C_3, C_4, C_{10}, C_{11}, C_{12} and C_{13}).

Note upon R_4

The value of R_4, 4.7kΩ, together with the 150Ω resistance of the valve filaments in series, allows a filament current of 0.05A to flow through the filament chain when the HT plus potential at C_4 is 240 volts.

Resistors R_2 and R_3 each cause a voltage drop of approximately 20 volts, when in circuit, and there is thus provision for an HT plus rise in potential (due to half wave rectification) to 280 volts.

In the writer's opinion, it is unlikely that the smoothed voltage will exceed this figure, even with higher values of capacitors C_4 and C_5. The circuit is thus safe, on AC.

Used on DC mains, however, it would probably be wise to reduce R_4 to 4kΩ—to substitute this value for the value 4.7kΩ quoted.

There will thus be a voltage drop of 200 volts across the new value of R_4, that may be raised to 240 volts by the inclusion of R_2 and R_3.

Constructors "on" freak mains voltages—and there are not a few, these days—may calculate the required value of R_4 from the simple formula:

$$R_4 = \frac{\text{Mains Volts}}{0.05} - 150$$

For instance, with a mains voltage of 190 volts:

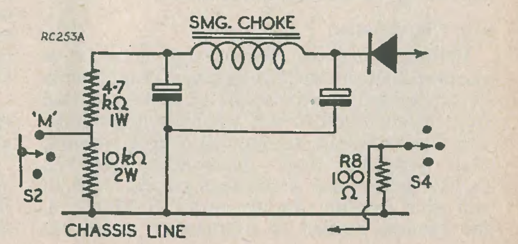
$$R_4 = \frac{190}{0.05} - 150 = 3{,}800 - 150$$
$$= 3{,}650\Omega.$$

The nearest commercial values obtainable will probably be 3,500Ω and 150Ω, and these two, of 10W and ½W rating respectively, may be used in series.

FOOTNOTE

The power supply circuit, as shown in Fig. 32 on page 15, allows some 220V to appear at the valve anodes in the event of one of the valve filaments breaking down.

By taking the HT+ lead from a two-resistor potentiometer, as shown in the accompanying illustration, the HT voltage rise is considerably limited should there be valve failure. The mains bias resistor is reduced to 100Ω, to allow for the additional potentiometer current.



The INEXPENSIVE

A CHEAP and EFFICIENT CAR RADIO

By A. Tiel

PART 2, *continued from p.635. Aug. '53*

The red indicator lamp holder was then wired up with a twisted pair from the heater connections of the RF stage. The white indicator holder should have one side earthed to the chassis and a long flexible lead soldered to the other pole, this lead being brought out at the rear with the other external connections. This lamp takes the place of the green dash lamp which indicates when the car side lamps are switched on, and is not part of the set, and can be dispensed with if the car is of a different make, or if the set is mounted elsewhere than in the Morris 8 dash. This completes the wiring and the set is then ready for alignment.

As mentioned earlier in this article, it is essential to have the use of a signal generator to align a superhet receiver. The 465 kc/s IF coils are accurately set up by the makers before dispatch, but need trimming when in position owing to additional capacity added by the various wires and components. If a signal generator is available, the technical bulletin from Denco (Clacton) Ltd. gives ample detail on the alignment of the coils. If the constructor has no access to one of these, then it is advisable for him to take the set to the local radio shop where this work can be undertaken for a small charge. The " hit and miss " method is most unsatisfactory and a great waste of time, besides giving disappointing results.

Car Compression

Before fitting any receiver into a car, it is essential that the various electrical components be suppressed, otherwise the noise transmitted from them would make listening impossible. The devices to be suppressed are as follows: each sparking plug, distributor, dynamo, electric pump and windscreen wiper. Not all will give trouble. In my series E Morris 8, the dynamo needed no suppression at all, but the wiper did. In this present car it is the reverse. The wiper gave no trouble, but the dynamo produced a whine which ruined the programme.

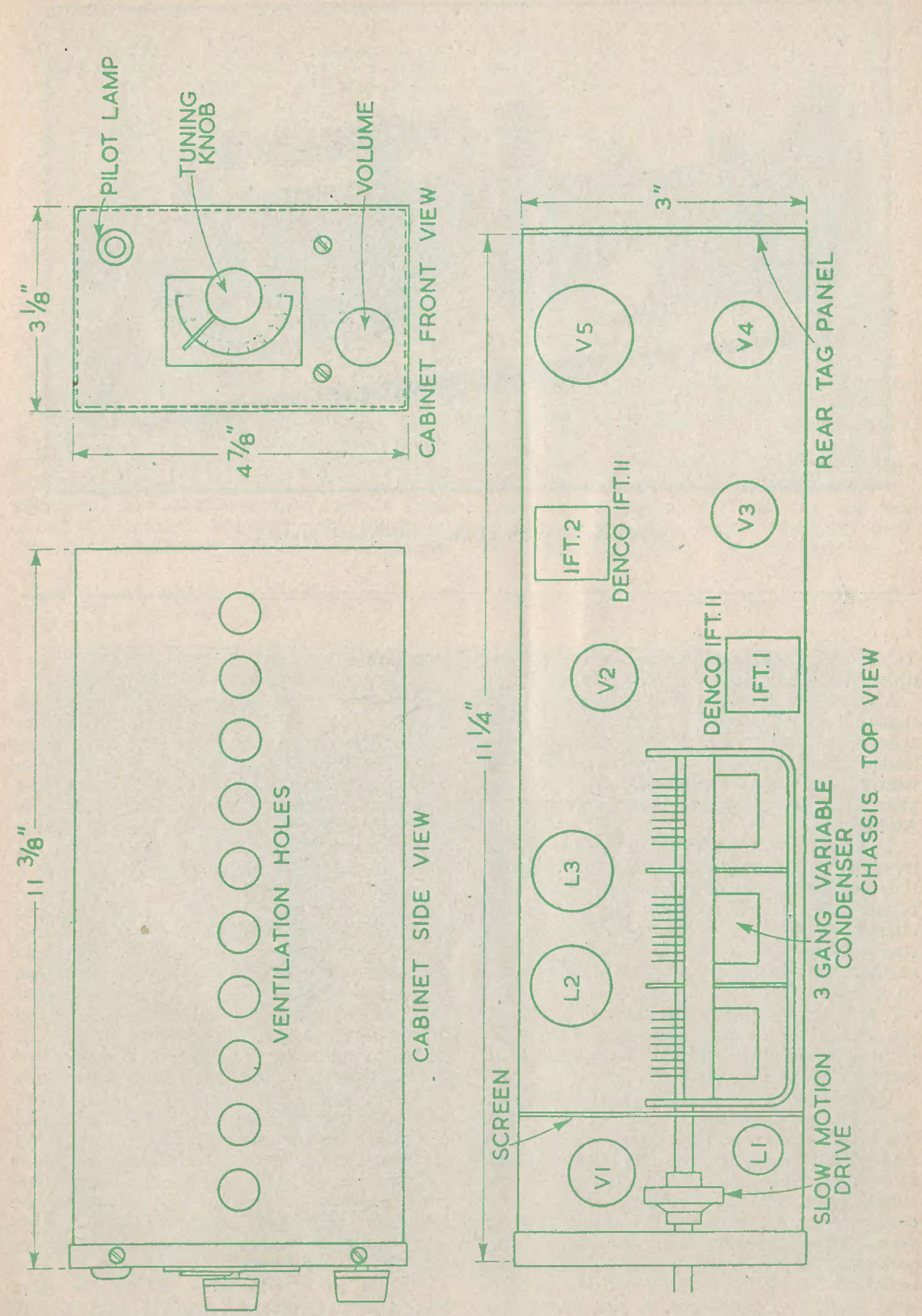
To start with, a complete set of plug suppressors are required. These, together with the distributor suppressor, are available at nearly every garage or electrical shop at a cost of around 12/6 a set. Fitting instructions are invariably included, and the fitting of these will also remove television interference.

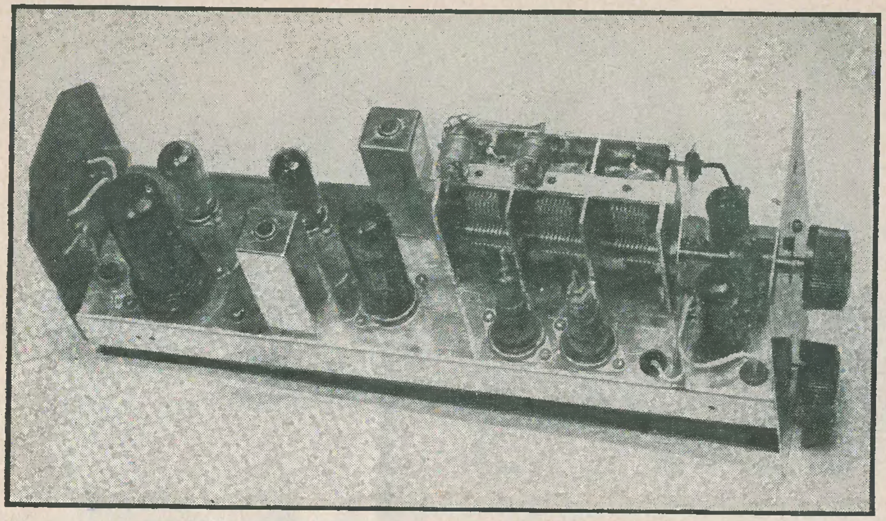
Next the electric pump. Various values of condensers can be fitted to eliminate the " click " as the points make and break. A 1μF low voltage condenser is suitable, and same can be purchased for around 1/– from any shop selling surplus material. First secure the condenser by means of a clip or screw as close as possible to the pump, and take as short a lead as convenient from one terminal to a near point on the chassis, having first thoroughly cleaned the surface to which the lead is being secured. Take another lead from the other terminal and screw under the live terminal of the pump.

To suppress the dynamo, again fix as close as possible to it a 0.01μF condenser, preferably mica (this stands up better to the heat). As before, keep the leads short, fix one to an earth point, and the other to the live insulated terminal of the dynamo. Make sure this is the one connected to the brushes and not to the field. The brush terminal is always the larger or heavier one.

In the case of the wiper, if noisy, follow the same procedure as for the dynamo; a 0.01μF condenser usually being satisfactory.

It is also advisable to earth the engine back to the chassis by means of a piece of heavy flexible copper braid. Secure one end under the cylinder head bolt and the other to a point on





Above-Chassis View of the " All-New " version

the chassis, keeping the lead as short as possible. Allow sufficient slack for engine rock.

Always remember to thoroughly clean the chassis, i.e. scrape away any paint or oil from around the hole to which you are bolting the leads. This is essential, otherwise you may be wasting your time as suppression will not take place. Also keep all leads as short as possible.

Aerials

There are two types of aerials available, the metal rod pattern (whip) which fits either to the roof or chassis of the car, or the underboard aerial which is fitted beneath the car chassis. In the case of the former, it may be necessary to screen the lead down to the set; earth the screening braid as close as possible to a point near where the aerial enters the car, and again adjacent to where it plugs into the set. M.B.C. screen plugs and sockets are ideal as connectors and can be purchased at most Radio Dealers.

Quite a satisfactory underboard aerial can be made by using about 20-ft. of VIR cable fixed by means of clips around the boards underneath the car, or as in my particular case by winding them around the hydraulic copper tubes connected to the brakes. It was, however, noticed that interference was picked up when braking due to static electricity being generated at the brake drums. As this only occurred during the braking periods no steps were taken to eradicate it, as the interference was not sufficient to warrant it.

Installation

This applies to the 1949/52 Morris 8.

First remove the grille which, in the earlier models, is secured by three small nuts at the rear of the dash. The later type have pegs, which are held in position by spring clips, so by gently pulling, the grille slides out. Next remove the dash indicator lamp which is secured by the locking nut on the choke control. It may be necessary to lengthen the leads to the wiper switch in order to have a clean entry into the dash.

Gently slide the case through the hole and fix panel in position by two self-threading screws and brace if necessary to the cross members of the scuttle below. Join the wire which was removed from the green indicator lamp to the lead connected to the white lamp on the panel, so that it lights when the car side and head lamps are switched on. Choose your own position for the loudspeaker, which may be in the hole under the dash or in the glove box, after removing the medallion, or mounted as in my own case under the lower tray behind the gear change lever. Do not use the small $2\frac{1}{2}''$ speaker, it will not handle the output comfortably and distortion will result. It was found that the 5″ speaker gave good volume and quality. The writer uses a Goodman T27/470 Elliptical P.M. Loudspeaker 4″ × 7″ which sits comfortably behind the gear lever and gives pleasing quality. Connect the lead from the plate of the 12A6 to one side of the Transformer. The other side of the transformer joins to the HT lead from the set (see connection diagram). From the power supply, whether rotary or vibrator, take the positive HT to the HT side of the speaker transformer and the negative HT to the frame of the set. Heaters are connected across the battery. Finally connect the aerial, which may be the roof or underboard type. The set is then ready for operation. Do not run the receiver with the speaker transformer disconnected, or damage will be done to the output valve.

GENERAL

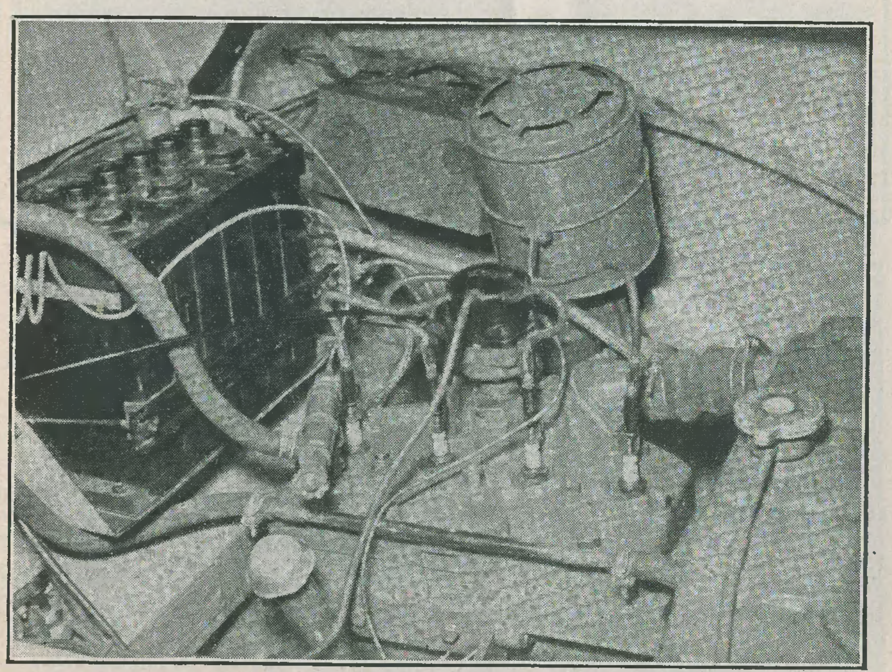
Power Supplies

Either small Rotary Converters or Vibrator Packs with an input of 12 volts and an output of 250 volts 50mA. will be satisfactory as an HT supply.

For the 12 volt car, a surplus rotary transformer type 104 Ref. 10K/238 gives ample output for the satisfactory operation of the set. It is rather a large unit, as there is an additional low tension output from a third 6 volt commutator. This is the unit which has been used consistently over the past 12 months with the prototype. The approximate current drain when running under load with a 12 volt supply is $3\frac{1}{2}$ Amps, plus $\frac{3}{4}$ Amps for the heater supply, giving a total drain of approximately $4\frac{1}{4}$ amps. There are available much smaller rotary converters with an output of 250 volts at 50mA, which draw just over 2 Amps from the battery.

For 6 volt car owners, the dinghy rotary transformer type 1, Ref. 10K/13043, will be suitable. It is advisable to remove the handle and gear wheels from this machine. If 6 volts are fed into the low tension end an output of about 220 volts will be obtainable. Do not forget to close the shunt circuit, i.e. join LT "A" negative to the terminal marked " F " in the centre of the frame. Another useful rotary is the type 57 6 volt. Ref. 10K/706. All these units can at present be obtained from Messrs. Jobstocks, 91 Beulah Road, Walthamstow, E.17.

For further information, the total HT draw from the rotaries using the surplus 12 volt valves is approximately 47mA. In the case of the two 6 volt units already mentioned, these are without smoothing. Invariably, a 0.01μF



Under-Bonnet view of Author's car, showing Converter mounted to the left of the Air Filter, also Plug and Distributor Suppressors in foreground.

FOR BEGINNERS—Resistor Colour Code

Resistors are valued in ohms (Ω), and to denote this value each is painted in colours which conform to a standard code. There are three arrangements, the first of which employs a body colour, a coloured end, and a coloured spot superimposed on the body colour. In the second method this spot is replaced by a coloured band. Where either the spot or end colour, or both is not apparent, then the appropriate colour is the same as that of the body. In the third method of marking, four bands of colours are used, grouped towards one end of the resistor. The innermost band of these, and any silver or gold band which may appear in the other two methods, are used to indicate the tolerance percentage and for the purposes of this article may be ignored.

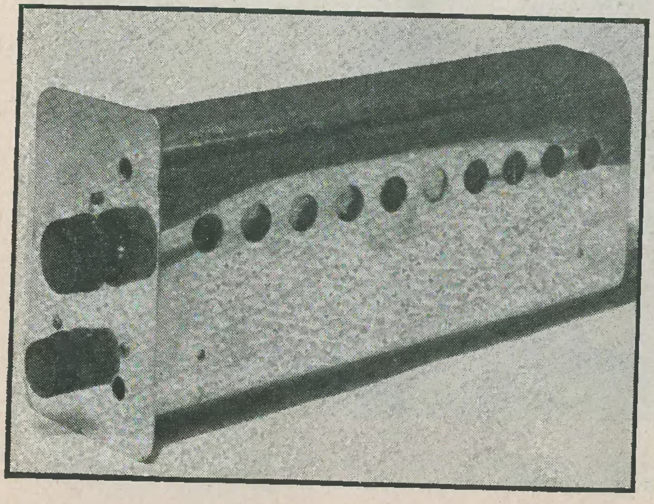
The body colour, or outermost band, indicates the first significant figure of the value. The end colour, or second band, gives the second significant figure. The colour of the dot or band superimposed on the body, or that of the third band in the other method, gives the number of " noughts " to follow these two significant figures.

Colour	*Figure*	*Colour*	*Figure*
Black	0	Green	5
Brown	1	Blue	6
Red	2	Violet	7
Orange	3	Grey	8
Yellow	4	White	9

Examples

First, in the parts list it will be noticed that some values are given in Ω (ohms), whilst others are in kΩ and MΩ. k and M are, respectively, abbreviations commonly used to denote thousands (kilo) and millions (Mega). Thus, R2, 33 kΩ, is 33,000 ohms, and R12, 2 MΩ, is 2,000,000 ohms—which is more often called 2 Megohms.

Taking the colour code given above, R2 will in the first two methods be totally orange in colour (with perhaps a silver or gold marking to denote the tolerance) and with the third method will have orange for the three outermost bands. R18, on the other hand, will have an orange body and end with a brown spot or band superimposed on the body, or alternatively the outer two bands will be orange, and the third band brown. It also has a 1 Watt rating as against the ½ Watt for R2, and will thus be larger physically.



The " Inexpensive " Car Radio Receiver Cabinet, which may be mounted either vertically or horizontally, according to the space available.

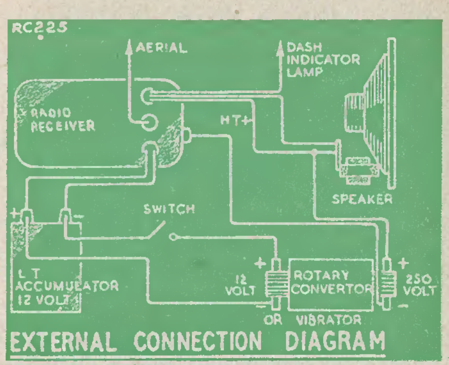
condenser sweated from each brush box to a point on the rotary frame will considerably reduce interference. In some cases, however, it may be necessary to insert chokes. These units can be fitted quite satisfactorily under the bonnet or car chassis. Don't forget to mount them on a piece of rubber if possible, so as to stop mechanical noise transmission and vibration, and earth the frame to the car chassis.

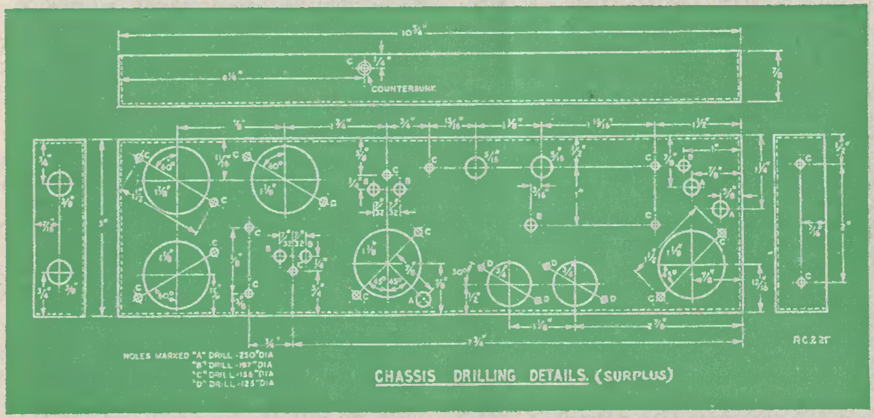
In some cases it may be necessary to screen all leads where interference is noticed, but invariably if the car electrical equipment and rotary transformer is efficiently suppressed no screening of the leads is at all necessary.

When a larger rotary is used with an output of 250V at 125 or 200mA, a dropping resistor may be necessary in the HT feed. This is because the machine having only 50mA drawn from it has, in consequence, a higher voltage output, which, in some cases, may cause instability, or oscillation. The set will give very satisfactory results with an HT applied voltage of from 200 to 250 volts, drawing approximately 50mA dependent upon the supply.

A constructor's envelope containing the wiring diagram and layout can be obtained from Denco (Clacton) Ltd., Old Road, Clacton-on-Sea, Essex, price 2/6.

The writer would like to take this opportunity of thanking Mr. Fred Ruth, of Ilford, for his help in the mechanical construction and aligning of the set.





Experimental Transmitter for Television Students

The Television Society has built an experimental 405-line transmitter to operate on 427 Mc/s with a peak power of 12 watts. The equipment is being installed at the Norwood Technical College, and in addition to providing a test signal for members interested in U.H.F. reception it will serve as a demonstration for students attending the television training classes in the College.

The call sign is G3CTS/T, and it is expected to put a signal on the air by the end of July.

The Society also has under consideration a 625-line transmitter, which will be designed and operated in collaboration with the radio industry. This will enable commercial receivers built to continental standard to be tested under working conditions.

It is not intended that either transmitter shall be operated as a commercial station, and their construction has been undertaken as part of the Society's policy of aiding the development of television technique.

Radio Miscellany

When that mighty midget, the transistor, was first announced in 1948, many constructors began to look forward to a real breakaway in contemporary radio design. With the big American corporations eagerly competing to put it into harness few guessed that to-day, five years later, transistors would still be beyond our practical experience. For us they are "just around the corner" and it seems it will be a year or two yet before we can use them in our circuitry.

It is doubtful that, even in its perfected form, the transistor will supersede the thermionic valve. There are a lot of jobs the germanium wonder cannot do, for the uses of the valve have now become legion. Even in its present state of development there are many production snags to be ironed out before the manufacture of transistors on a large scale can be achieved, and Defence and National services rightly have priority. Germanium itself is plentiful enough but its refinement to a meticulous degree of purity has to be made before it is fit for use. Then impurities have to be introduced, with equally meticulous care!

Possibilities

The lack of access by British constructors has given rise to some doubt whether the transistor is all that it is cracked up to be. Early reports are invariably over-enthusiastic. Most of the apparatus described which incorporates them has come from American sources, and over there they are still in short supply and very expensive. The general impression in Europe is that, as a substitute for the valve, they are not yet the valve's equal, and this seems (at present) to fairly summarise the position. Thus interest in them is not so great as it might be if the transistor was as revolutionary as the early enthusiasts claimed. It is natural that constructors should ask themselves why pay a high price for a substitute of doubtful efficiency.

True, they require very little power — it is claimed that some of the later types will oscillate or amplify with a total power as low as 10 microvolts — but modern valves are economical and, after all, for most radio purposes we are able to draw our power from the mains supply. Their advantages for portable use are obvious. The power supply is the bulkiest, and by far the heaviest part of portable equipment. A little reflection, however, suggests a wide extension of many existing radio uses as well as new applications.

The transistor might easily make the battery TV receiver an everyday affair. We cannot have a germanium CRT, but a battery CRT combined with an all-transistor receiver, is a readily conceivable probability. When that becomes cheaply possible our present TV system may have become old-fashioned, but doubtless the transistor, once established, will keep pace with other developments.

Problems

Since the introduction of transistors it has seemed that as soon as the production of one type gets going, a new model that greatly out-performs earlier patterns emerges from the laboratory. Thus we can console ourselves that our lateness in having them available has some silver lining, however small.

On the practical side they still have a few disadvantages. In operation they are noisier than valves, particularly at audio frequencies. At RF, however, the noise lessens, decreasing inversely with the frequency. In the Megacycle range (that is for those types which can get there) operational noise is claimed to be low. The types that do work on the higher frequencies are liable to be erratic in behaviour, and much remains to be done to overcome their "stop-and-go" tendencies.

Also in the Picture

The American periodicals have widely publicised the transistor and given much prominence to the development work carried out by their big radio corporations. The result has tended to produce an impression that it is an all-American device.

This is far from the truth. The extraction of germanium (from chimney soot) was a discovery of British scientists made before World War II — in 1937 in fact. We still produce all the pure germanium we need. Should they run short of raw material I can let them have a few bags of soot to go on with and no doubt many others will oblige in a like manner. In exploring its possibilities a whole lot of other experimental work has been done in Great Britain, too.

One very useful feature of the transistor is the absence of a warming-up period, and while this is of only minor importance for broadcast and communication uses, it is of great advantage in many electronic applications.

The economy in size, weight and power drain, are of paramount importance for many uses, and on these points it will score heavily over the valve. Its employment for deaf-aids, etc. are obvious. Less apparent are uses such as those in miniature transmitters and receivers. Such a transmitter attached to a roving microphone and fed back to the main transmitter or recording point would enable commentators, or actors on screen or TV studio sets, to roam about freely without the need for long wires to trip over, or microphone booms to keep clear of the top edge of the frame.

Centre Tap *talks about* TRANSISTORS—TVI—QSL MANNERS

Wot! No D.F. ?

The interference which marred TV reception over much of south-eastern England during the week or so prior to the Coronation fortunately stopped in time for the telecast of that ceremony. It appears that the B.B.C. were inundated with complaints and enquiries. In fact they had to appeal to viewers to desist from 'phoning them.

It was astonishing to hear the announcer, even after a week of the interference, refer to it as an "unidentified" signal being the cause of the trouble. Surely someone has some D.F. equipment ? Even without, one might make a pretty accurate guess.

In my own locality it greatly varied from house to house, depending on the aerial siting. At home, signals from A.P. are quite adequate with an indoor dipole stood on the floor at ground level, at the back of the house. At the front, the dipole has to be at least twelve feet clear of the ground to pick-up a comparable signal.

At the time of the trouble the only other band I was equipped to check on was around 145 Mc/s. There the conditions were on the poor side and no DX at all was to be heard. So sporadic-E seemed the answer.

When the full number of transmissions between 40 and 60 Mc/s get in their stride, what fun and games we are going to have each time similar conditions occur.

No Names, No Pack Drill

Thinking of 145 Mc/s reminds me of a complaint by a reader regarding the failure of certain amateur users of this band to QSL. Presenting a new angle, he says those most lacking in courtesy seem to rank in inverse proportion to their prominence in the hobby. QSLing on the VHF bands has some additional importance in qualifying for awards, etc., apart from the question of good manners. This reader complains particularly of a number of prominent amateurs who had either requested a card from him or promised one and subsequently failed to respond. A check with a few others shows that they had not only been guilty of letting this reader down.

This column cannot normally concern itself with specialised interests, especially as there are periodicals primarily devoted to transmitting affairs. As he points out, one of these has on several occasions vaguely threatened to "black-list" such offenders, but he believes they dare not do it. Perhaps the recently formed International V.H.F. Society will take a more courageous line in this matter through the columns of their lively paper *The Upper Spectrum*.

Among the absentees common to several lists appear two members of the R.S.G.B. Council, a regular writer of the VHF commentary, and one or two others well known in amateur circles. It is a rather perturbing state of affairs when the chief offenders appear to be the very people who might be expected to best exemplify the amateur spirit.

K.1., P.2., Tog.3.

Last month's problem. No. 3 size referred to knitting needles which happen to be $\frac{1}{4}''$ diameter. As they are available in a wide range of plastics and similar insulating materials of all colours, they make excellent and cheap extension rods, etc. For those who didn't guess, please look back at the clue to check if it really helped to make it as easy as I thought.

The "UNIVERSAL" Large Screen AC/DC Televisor

Part 4. Described by A. S. Torrance, A.M.I.P.R.E., A.M.T.S.

(by kind permission of IKOPATENTS LTD.)

Wiring of Components

PREVIOUS SKETCHES AND THE TEXT have explained the procedure for voltage selection, but the actual mechanical connections require special treatment. These should not be soldered to the tapping points anywhere. The wire-ends must be made into ringed shapes and tapping connections effected by nuts and bolts.

It sometimes happens that considerable heat is generated or dissipated in these components, and your writer has known soldered joints to melt. Subsequent damage can be caused by the solder falling on other parts.

Readers residing in AC areas may be dubious about building a receiver employing series-heater technique. Without discussing matters of economy, although quite a considerable saving is made in this TV, it is a fact that with a properly designed series arrangement the stability, regulation, and life factors of the heaters, both in the valves and CRT, are very high indeed.

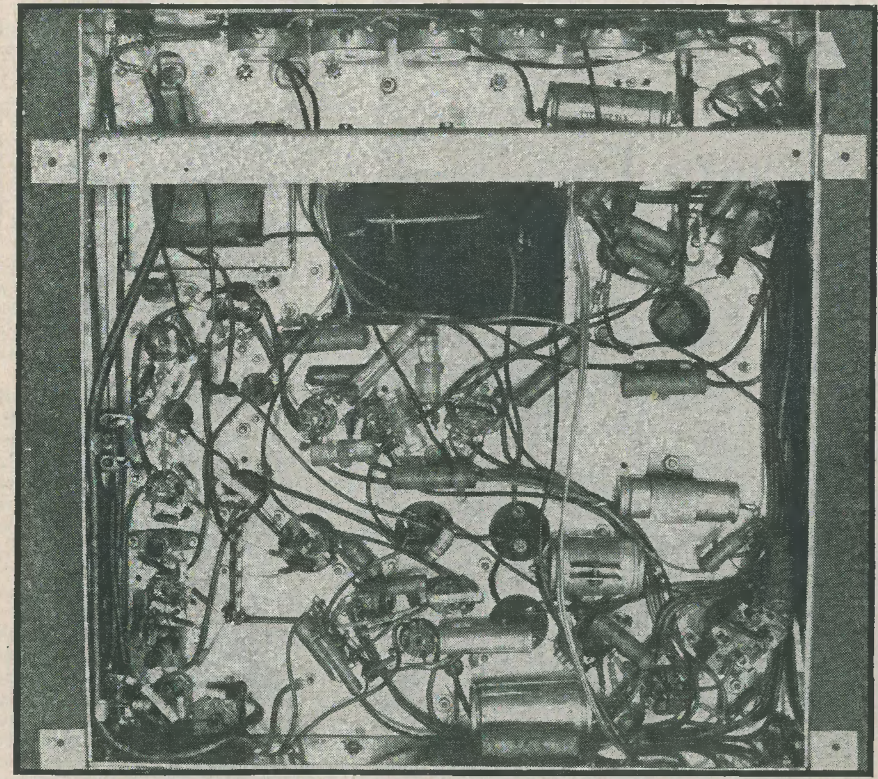
In a parallel heater line-up, a considerable surge is experienced due to the transformer employed. In the series system this is easily controlled; in this case by the VA1800, and the A2/1 (750Ω resistor). Evidence of this is given by the fact that the warming-up period of the "Universal" is approximately Two Minutes Before the Picture Appears. Readers should make a note of this lest they experience any apprehensions when switching on for the first time.

Photographs and Sketches

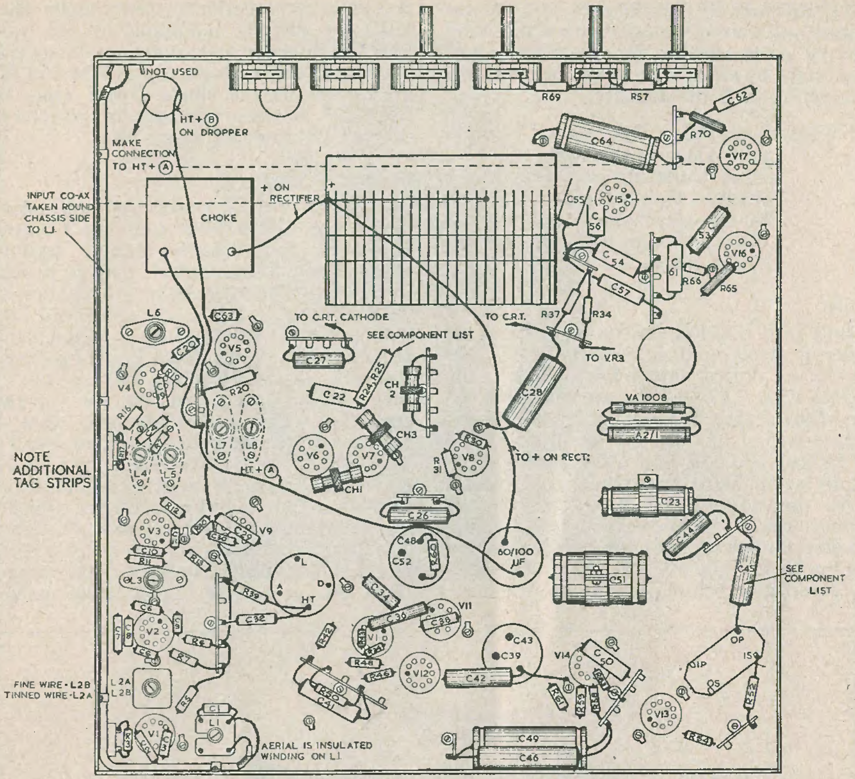
The "Universal" TV has been well illustrated and it was felt that with a point-to-point heater wiring diagram, and by showing the disposition of a reasonable number of resistors, condensers etc., adequate direction was available. Where a group of resistors shown are numbered, say, R3, R6, R7, quite obviously in that stage R4, R5 etc. would be present in the actual receiver, but perhaps not visible in the illustrations.

One such example: R4 and similar resistors throughout the receiver.

R4 is soldered directly to pin 8 and to pin 7 of V1. Then from pin 8, R5 is soldered to the tag-strip where connection is made to the HT+B supply. The constructor, by



Under-Chassis View—Compare with the sketch on opposite page.



Note: Components shown not to scale but mainly emphasised for clarity
For heater chain wiring see appropiate drawing

UNDERSIDE OF CHASSIS SHOWING LOCATION OF MAIN COMPONENTS

TV17/12

cross reference to the sketches and photographs and careful recognition of the valve internal parts seen in the valve base chart may, stage by stage, wire in the components, completing each in sequence.

NOTE—The Black Dot shown beneath each valve in the valve drawings is, of course, the equivalent of the recessed or missing pin hole seen in the valveholders. The CRT base is wired with the key or slot as guide.

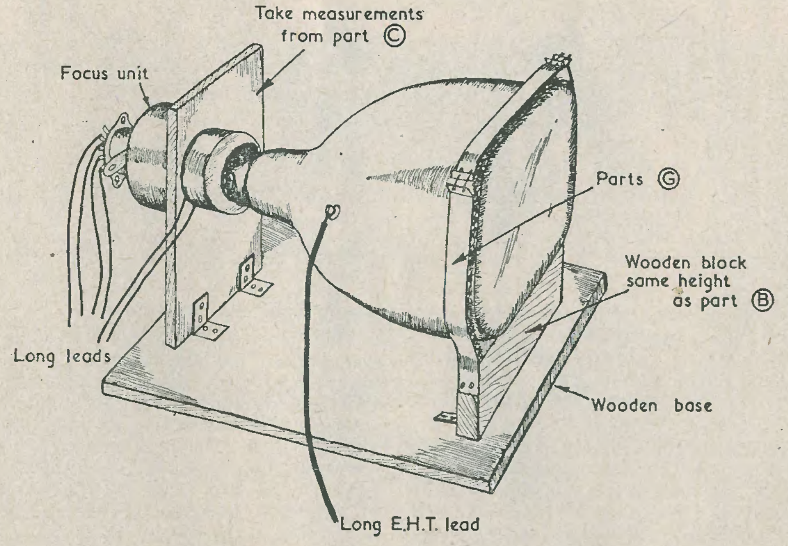
Coils

Bolt into position the tuning coils in the order as shown and note carefully the coils shown in dotted lines, L4, L5—L7, L8. These, with L12A/L12B, are mounted on top of the chassis, the remainder underneath. Before wiring up, test L1 aerial coil (Red PVC) and grid-coil, and make sure no continuity is possible to chassis before proceeding.

At the completion of the first stage connect the HT+ circuit and bring a connection to the tag-strip of this supply for joining to R5. In this way, each stage may be completed before moving to the next. It should be possible to have really short leads by directly mounting to the valve pins the resistors and condensers associated with each valve. Notice that R24 and R25 are shown as the single 2-watt type, but this may be two resistors in parallel as described in the component list.

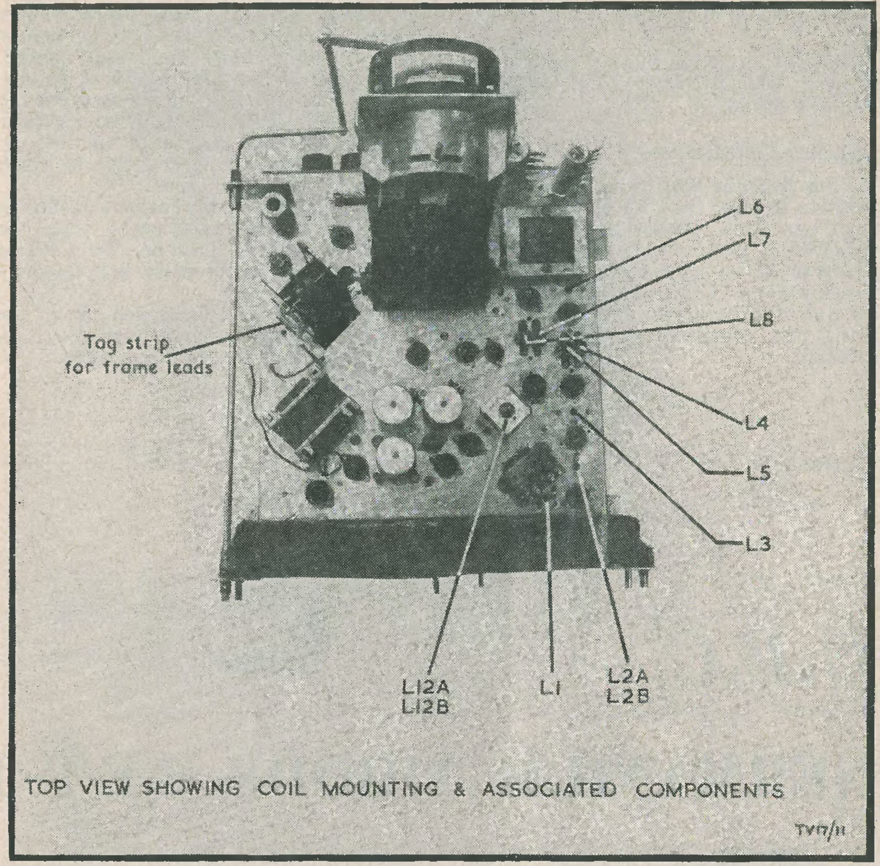
General Wiring

A solder tag is placed for convenience under one of the bolts near the Contrast, Brilliance, and Volume variable resistors. The leads for these controls may be brought through the two large holes provided on the chassis front. It is recommended that coloured PVC or sleeving be employed in the wiring-up. Thus, Black could be chassis, Red–HT, Green–Heaters, and so on. In this way final checking is greatly simplified. Coloured leads may now be attached to the deflection coils, to 4–6–1–3. These are brought down beside the Linearity and Width coils for subsequent attachment to Line-output and Frame-output transformers. (Make a note of the colours selected). The Deflection coils can now be placed into position and lightly bolted to the support (Part D). A washer of insulating material



TEMPORARY MOUNTING OF TUBE ASSEMBLY

TV17/13



TOP VIEW SHOWING COIL MOUNTING & ASSOCIATED COMPONENTS

TV17/11

is placed between the coils and focus unit to prevent shorting the deflection connections. The Line-output transformer may now be installed. This is drilled especially for small Parker-Kalon self-threading screws. The EHT rectifier is carefully soldered into position as shown in the sketch. The greatest consideration must be given to the soldering —sharp points should be avoided. The EHT lead is attached as shown.

Note Orientation of transformers on chassis. The frame transformer is positioned by the side with black-white leads. These are adjacent to the Line-output transformer.

Mains Connections

These are made directly to the two fuses (2A) and from there direct to one side of the double-pole switch. Check the switch with continuity meter to ascertain the correct contacts, thus avoiding a short when first switching on. Take a connection from the other side of switch to chassis on the adjacent solder-tag. The remaining contact is taken to " Negative " on the rectifier, which provides an excellent anchorage for connection to the Heater Dropper.

Note The power supply sketch has shown the switch in the wrong position. It should be after the fuse.

Testing Circuits

Make sure that the cans for L4—L5 and L7—L8 are not fouling the coils and condensers. Check the heater-chain again as outlined before. Ascertain that the voltage droppers are tapped to suit the local mains supply.

Test mains input connections to make certain there are no dead shorts.

Test HT circuit to chassis to detect possible shorts.

(Readers not possessing a meter may improvise with a battery and bulb for continuity testing).

Installation Considerations

At this stage the constructor is virtually in a position to instal the CRT and valves, and switch on. This requires carefully sliding the MW43-64 in from the front and bolting up parts G. When tightly bolted, it is possible to work with the "Universal" in any position. However, it is recognised that a great many readers may experience misgivings at this procedure.

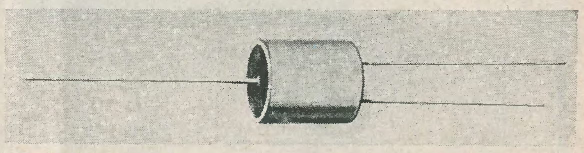
A simple and easily made answer to this situation would be the creation of a temporary CRT mounting away from the chassis. Longer leads to the tube would, of course, be required. With such an arrangement the constructor would undoubtedly have greater access to the entire chassis, or alternatively may be planning a cabinet design in which this would be a permanency.

Measurements for this auxiliary mounting are taken from the chassis parts. When the receiver is properly lined-up, the CRT is restored to its proper place and the base connection shortened.

Note A temporary connection from the tube-coating is also required to chassis, to be made a permanency later.

(*To be continued*)

G.E.C.



GERMANIUM TRIODE GET 1

A GERMANIUM triode of the point contact type which has for some time past been exhibited by the Research Laboratories of the General Electric Co. Ltd. at the Physical Society and similar exhibitions, is now in pilot plan production in the Company's works and is available to equipment makers in sufficient quantities for experimental work and prototype equipment. The triode uses single crystal germanium, and the unit is hermetically sealed in a metal can insulated from all electrodes. Flexible leads are provided for the connections.

The triode is suitable for use in amplifiers, oscillators and for electronic switching applications. Its low power consumption and electrical characteristics make it idea for digital computer work.

Technical Details

The accompanying diagrams illustrate a typical circuit employing the new transistor (Fig. 2) and also characteristic curves of the device (Fig. 3). From these the reader can see that the current gain is greater than 2, that the "knee" voltage is less than 3, and that the collector current at −30V for zero emitter bias is less than 2 mA. The maximum D.C. collector voltage is −50V, but normal operation is with much lower voltage, supplies of 22½V being typical. Whatever the collector voltage used the dissipation should be kept below 100 mW.

The most reliable arrangement for the amplification of small signals incorporating G.E.C. point-contact germanium triode. A power gain greater than 17 dB can be obtained.

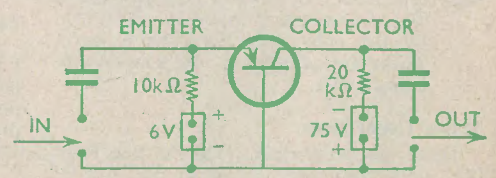


Fig. 2.

Static characteristics of G.E.C. point-contact germanium triode.

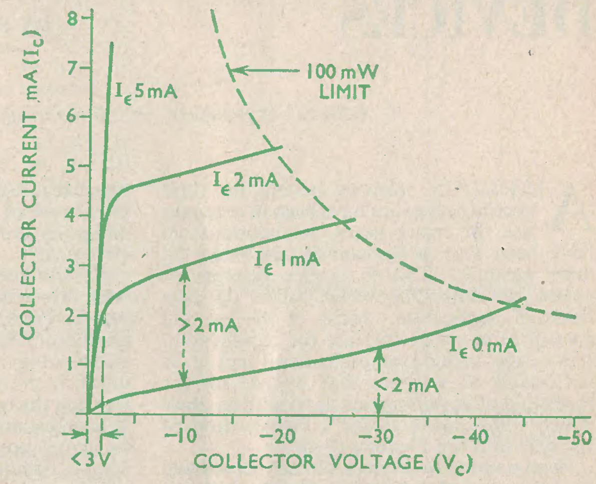
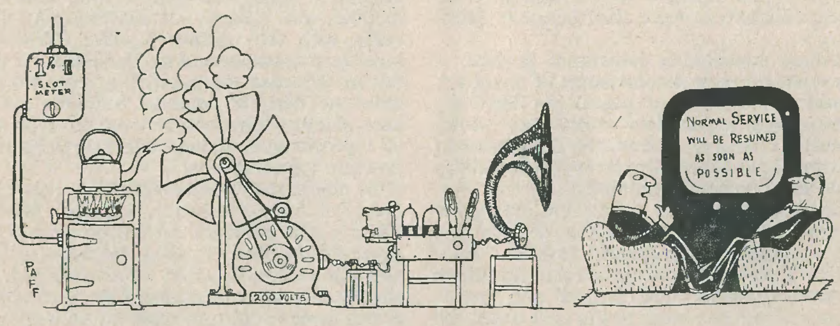


Fig. 3.



"There's a lot to be said for Steam Radio"

ERRATA

On Data Publications Order Form, page 53, under Miscellaneous Books, the third line should read **Receivers** (*R.S.G.B.*) **3/6** *postage* 2*d*, and the fourth line **Simple TX Equipment** (*R.S.G.B.*) **2/–** *postage* 2*d*.

SEMI-CONDUCTOR DEVICES

by A. L. PARDEW

A Survey of rectifiers, crystal diodes and transistors

ALTHOUGH DEVICES relying on their special properties have been in common use for many years, semi-conductors have been very prominent in the technical news recently. This is largely because of recent developments which open up new fields of application. Most of the existing uses of semi-conductors are for rectification. New uses include amplification, and it is reasonable to suppose that we are on the threshold of developments as fruitful as those which followed de Forest's introduction of the grid into the Fleming diode.

Semi-conductor devices already developed can do many of the jobs which were hitherto the exclusive prerogative of thermionic valves, and their advantages over the latter are due to the elimination of two features, namely, the hot emitter and the vacuum which, whilst essential to the operation of thermionic valves, were also the main weakness.

Before considering individual devices, a few notes on their general mode of operation would not be out of place, but anything approaching a complete explanation would require a highly advanced mathematical treatment, so the information which follows is necessarily highly simplified.

Semi-conductors as a class are crystalline in structure, which means that their atoms are arranged in an orderly fashion. In a perfectly pure state the electrons in the atoms of semi-conductors are 'bound' and unable to move from one atom to the next under the influence of an electric field; in other words, they are insulators. The presence of minute quantities of suitable impurities, however, gives a few 'free' electrons which allow conduction. This conductance is much poorer than that of common metals (about a million times poorer) because of the small number of current carriers, hence the term semi-conductors. Such a semi-conductor is called 'n' type because the current carriers are negative. In the case of germanium, traces of arsenic or antimony are typical providers of the excess electrons.

Certain other elements as impurities give what are called positive holes. These can best be described as gaps lacking an electron and into which electrons easily move. An electron moving into a hole leaves a gap from which it moved, so that the hole appears to move in the opposite direction to the electron. It is convenient to regard these positive holes as actual positive charges when considering semi-conductors.

When a metal whisker is put in contact with an 'n' type semi-conductor a potential barrier appears which makes it much more difficult for electrons to move from the metal into the semi-conductor than in the opposite direction, hence the combination forms a rectifier, the polarity of easy current flow being with the whisker positive. With 'p' type semi-conductors a similar effect occurs, but in this case the polarity of easy flow is with the whisker negative. Similar effects take place at junctions between 'p' type and 'n' type material, and this effect is the basis of junction type rectifiers.

By placing two whiskers closely spaced on a piece of semi-conductor, current in one whisker will influence current flowing to the other. This effect is called transistor action, and allows amplification to be obtained. A similar effect may be achieved by sandwiching a thin layer of 'p' type material between two of 'n' type material, or vice versa, and this is the basis of n-p-n and p-n-p junction transistors.

EDITOR'S NOTE—*Practical applications in preparation.*

Rectifiers

Before considering semi-conductor rectifiers in particular, a few general words on rectifiers will be a useful preparation. Although no such thing exists, a perfect rectifier would have zero resistance in one direction and infinite resistance in the other, i.e. its curve would be a right angle, and since there would be no voltage drop in the forward direction and no current in the reverse direction, there would be no dissipation to cause heat and infinitely large powers could be handled. In practice, all rectifiers are imperfect to some extent, and the purpose for which they can be used and their ratings depend on the degree of imperfection. A detailed study of rectifiers, therefore, is chiefly a study of their limitations. The thermionic valve is included below for comparison since it is probably the type of rectifier most familier to the majority of readers.

Vacuum Valve. Because of the vacuum between its electrodes this type of rectifier will withstand high reverse voltage. Receiving types will work at over 1,000 volts and the largest X-ray types go up to 250,000 volts. In the forward direction there is appreciable impedance, giving rise to voltage drop which not only lowers the rectification efficiency but also results in heating which means that a current limit must be set. The total amount of emission from the cathode also affects the rating.

Gas Valve. By introducing a suitable gas at low pressure, the thermionic valve can be given a much lower forward impedance by allowing gas ions to carry the current instead of electrons. This advantage is gained at the expense of certain other properties such as response to high frequency.

Copper Oxide. The first semi-conductor power rectifier to come into general use was the copper oxide rectifier. It has a low forward resistance, but compared with thermionic valves its back resistance is also low, and in addition it will only handle a limited reverse voltage without breaking down. To rectify mains voltage, a considerable number of elements have to be put in series. As in all semi-conductor rectifiers the back resistance falls with increasing temperature, so that cooling fins are necessary for efficient operation. The greatest advantage of this type of rectifier is its robustness and long life. Owing to the high self capacitance the frequency response is limited, and even with small rectifiers about one Mc/s is the extreme top limit. The main uses of this type of rectifier have been for power rectifiers, meter rectifiers and telephony modulators.

Selenium. Selenium rectifiers have largely replaced copper oxide in the power rectifier field. Their forward resistance is higher for each element, but because they withstand a higher back voltage, a smaller total number of elements is needed, so that the total resistance is less than that of copper oxide, and higher efficiency is obtained. Where low voltages are involved and only a single element is required they give in general a poorer performance than copper oxide and, therefore, the latter is still used in preference for meters and telephone modulators.

Silicon Crystal. The present day silicon crystal is a direct descendant of the crystal detector used in the early days of wireless. The most common material used in those

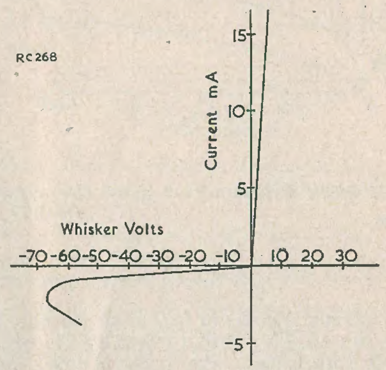


FIG.1. Static characteristics of typical germanium crystal diode

days was galena or lead sulphide, but silicon itself was not unknown. It was reinstated after its eclipse by the thermionic valve because of the need for an efficient mixer at centimetric wavelengths, and for this purpose it is still paramount. The silicon used for this purpose contains an impurity, usually boron, to give 'p' type conduction, and a tungsten whisker is used. Good efficiency and low noise can be obtained at frequencies in excess of 30,000 Mc/s. It has a forward resistance lower than that of a small thermionic diode, coupled with a moderate back resistance. It will only withstand a few volts in the reverse direction, but this is of no importance for mixer use. It is easily burnt out by overload and special precautions have to be taken in Radar equipment to prevent pulses from the transmitter reaching the crystal.

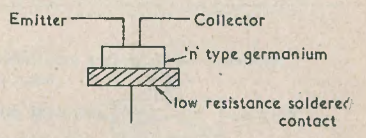


FIG.2. DIAGRAM OF POINT CONTACT TRANSISTOR

RC269

Germanium Crystals. In the search for a suitable Radar mixer, germanium was con-

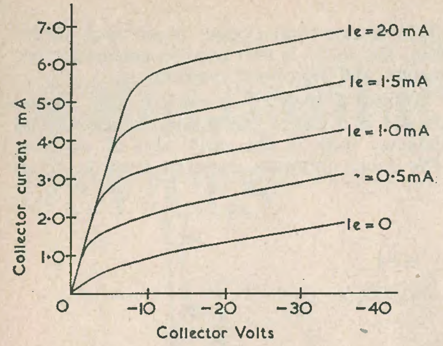


FIG. 3. Static characteristics of typical point contact transistor

RC270

sidered but rejected in favour of silicon. It was, however, noted that it was able to withstand surprisingly high back voltage, and after the war the germanium crystal was developed for radio and television applications in competition with the thermionic diode, and is now coming into wide use. Its special advantages include small size, low capacitance, good high frequency performance, very long life and absence of a heater. Its back resistance is, in present production, often less than a Megohm and exhibits a considerable variation. Selection is, therefore, carried out into various types, graded according to back resistance, and in general the higher the back resistance the higher the price. In selecting a crystal for a particular purpose it is usual to select the grade with the lowest back resistance that the circuit will tolerate. The exact properties depend on the impurity content, and as improved techniques are introduced high back resistance and high back voltage types tend to fall in price.

The characteristic curve of a typical germanium crystal is shown in Fig. 1. This is a general purpose type such as the GEX45/1

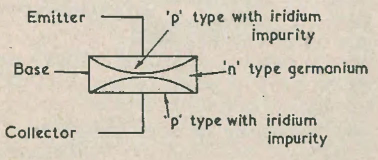


FIG. 4. Diagram of p-n-p junction transistor

RC271

or the American IN34. Its reverse current is measured at −50 volts, and has to be less than 800 μA. No measurements of back current or limits are imposed at other values of voltage, but the back resistance will tend to increase with decreasing voltage, reaching a maximum at about −3 volts. This variation in back resistance with applied volts is sometimes overlooked, but it is very important to take the effect into account when designing circuits around crystals. At very small values of applied voltage the forward impedance rises and the back impedance falls, so that the front to back ratio falls to a lowish figure.

The most widespread use of germanium diodes at the present moment is probably in the sound and vision detector stages of T.V. sets, but their small size and other convenient features have resulted in large numbers of miscellaneous applications in electronic equipment.

Junction Diodes. The rectifier formed by a junction between 'p' and 'n' type material gives a power rectifier which is superior to either copper oxide or selenium. Efficiency is so high that size can be enormously reduced. Germanium junction rectifiers are in production in U.S.A. but are not yet available in this country. Silicon can also be used for this purpose, and has the advantage of giving better performance than germanium at higher temperatures.

Point Contact Transistors. The action of the current in one whisker affecting that in the adjacent one is best explained by regarding the first whisker as injecting positive holes into the semi-conductor and making it more conductive. The whisker used for this purpose is known as the emitter, whilst the other whisker is called the collector. The 'n' type germanium which is the usual semi-conductor material employed in these devices is called the base. The device is shown diagrammatically in Fig. 2. Its family of curves shown in Fig. 3 bears some similarity to that of a thermionic pentode but this similarity does not extend very far. It will be noted that the collector current is plotted against collector voltage for various values of emitter current instead of voltage. The input impedance of a transistor is low and usually below 500 Ω. The output impedance is in the region of 20,000Ω. Circuits to use them have to be different in many respects from those which are familiar for thermionic valves, and a new approach is needed. It is better to regard the devices as current amplifiers rather than voltage amplifiers. No attempt will be made here to go into detailed applications, but it is thought that the most fruitful fields will be in computors and in Services equipment where space and ruggedness are at a premium. It will be noted that a negative H.T. supply is needed for point contact transistors, and that positive

bias is applied. Input and output signals are in phase and, since there is a current gain within the device, negative resistance effects are readily obtained. The upper frequency limit of transistors at present in production is in the neighbourhood of 2 Mc/s, but by special techniques operation up to hundreds of Megacycles has been achieved. Two rather severe limitations of the point contact transistor are its high noise factor and its limited power dissipation. These devices are now available in limited quantities in this country at a price which at present is high but will fall as production builds up. More complex transistors using additional contacts are the subject of experiment.

Junction Transistors. The junction type transistor is more recent than the point contact type, and in some directions has distinct advantages over it. It is, however, not necessarily better in every case and does not render it obsolete. It can handle higher power, but has a lower limit of frequency. Its noise factor is appreciably lower. One method of producing the necessary junctions is by diffusing a metal called indium from both sides into a piece of 'n' type germanium. If properly controlled this produces two zones of 'p' type germanium separated by a thin layer of the original 'n' type material. The device is shown diagrammatically in Fig. 4. The junction transistor is capable of giving good amplification at extremely low values of applied voltage, as can be seen from the curves in Fig. 5, and amplifiers can be made with a high tension supply of 1.5 volts or less. Obvious applications for this device are in deaf aid amplifiers and local telephone amplifiers. A truly enormous field of application is available when these devices can be produced in quantity at a reasonable price. At present there is limited production in America, but none in Great Britain. Here

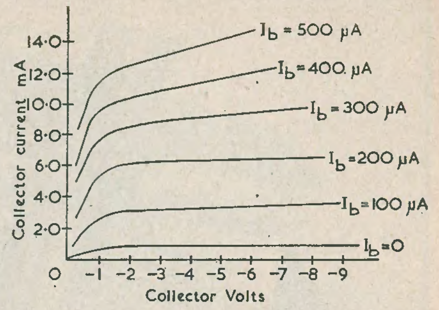


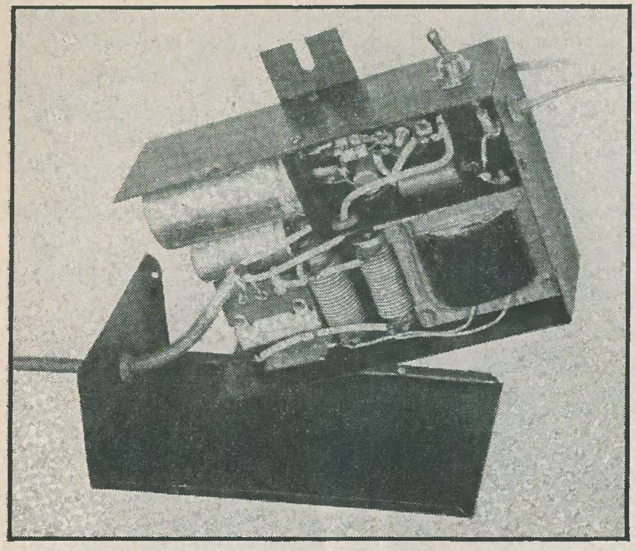
FIG. 5. Collector characteristic of typical p-n-p junction transistor

RC272

again more complex devices with additional junctions are being explored.

Photo Transistors. The reverse current in a point contact germanium diode can be increased by shining light on it. This is the basis of the photo transistor which gives a photo cell of extremely high sensitivity and excellent frequency response coupled with minute size. These devices are not yet in production, but an obvious application would appear to be in calculating machines using punched cards.

An enormous amount of effort is being expended all over the world on the study of semi-conductors, and it is reasonable to suppose that the future holds the development of devices which will make those at present available just as crude, in comparison, as the early bright emitter valves now seem compared with modern button based miniature valves. There seems no doubt that semi-conductors will remain in the news for many years to come.



TRADE NEWS

Stern Radio Ltd., of 109 and 115 Fleet Street, London E.C.4., have designed a Vibrator Power Pack which, apart from its other uses, is eminently suitable for the "Inexpensive" car radio receiver currently being described in this magazine.

The power pack is completely self-contained in its own metal case, and may thus be fixed in any suitable position, the input and output leads being screened to prevent any interference.

The accompanying illustration clearly shows that economy of space has been achieved without any undue cramping, and that the construction should present no difficulty at all to any reader.

The pack may be used with either 6V or 12V input, depending upon the type of vibrator and transformer which is employed. Either series or shunt types of vibrator may be used. The output is 220V at 50 mA.

A complete outfit of components, case, sleeving, wire, screws and everything necessary to build the power pack costs £3, but components can also be supplied separately. This is a useful point where the constructor may already possess some suitable items. There is also available, at 1*s*, a set of instructions with circuit and wiring/layout diagrams, and component price list.

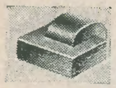
Messrs. A. T. Sallis, of 93 North Road, Brighton, Sussex, have sent us a copy of their latest list, No. 10. This contains over 400 items of ex-WD gear, many of them useful types which are not normally advertised. Amongst them we spotted a gun firing switch, comprising a bakelite pistol grip holder with thumb switch, which has many uses. Your writer recently used one of these in the construction of a solder gun. A bargain at 2*s* 6*d*. Another useful item, at 6*d*, are coils which are wound just right for the 27 Mc/s radio control band. This list is well worth the 6*d* charged for it.

Messrs. Radio Servicing Co., now of 82 South Ealing Road, London, W.5., have forwarded to us their latest catalogue No. 12.

This is a very well produced publication indeed; on art paper, and with a very durable cover, it will "last" well in the shack—and we can forsee it being used quite often for reference purposes. One useful item not always incorporated in catalogues is an index, but this has one which is also comprehensive.

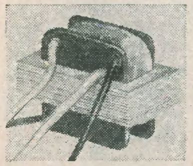
All the items listed, by the way, are currently manufactured, not ex-WD, and they are well illustrated with, in many cases, such useful information as dimensions included. There are 70 pages and 250 illustrations—and the price is only 1*s*.

John Bell and Croyden, 117 High Street, Oxford, have sent us the following information on two of the miniature transformers which they are manufacturing and which are now available.



This illustration shows as near as possible the exact size of the 'O' type unit, which is, we believe, the smallest transformer at present in production in this country.

Its measurements are ⅜″×⅜″×¼″ and it is an inter-stage transistor transformer or general coupling transformer. The inductance is 4H at 0.4 milliamps over the normal A.F. frequency band. The step-down ratio is 4.5:1 with a D.C. resistance of 870 ohms primary and 170 ohms secondary. This transformer has a mumetal core, and can be supplied with a screening can if required.



This illustration, again to size, shows the 'A' type unit, measuring ¾″×9/16″×7/16″ across the bobbin.

It is an interstage transformer for matching a high gain pentode to a transistor, and has a primary of 12.5H at 50 microamps. The step-down ratio is 30:1; the D.C. primary resistance is 6,000 ohms; the secondary resistance is 80 ohms.

The Edison Swan Electric Co., Ltd., are now producing a Cathode Ray Tube with a 14″ round bulb. Designated type CRM.141 this tube is fitted with an ion trap tetrode gun assembly and has an aluminised screen. The face plate is of clear glass and the tube has a B12A duodecal base. List price of this tube is £14 15*s* 0*d* plus £5 15*s* 1*d* Purchase Tax.

A further addition to the Ediswan/Mazda range is the 20P4, a new line time base output tetrode. This valve has a re-designed screen (G2) the dissipation of which has been greatly reduced, thereby enabling the valve to handle considerably higher current pulses on the active portion of the operating cycle. Owing to the improved mutual conductance figure the power sensitivity of the valve has also been increased. List price of the 20P4 is 17/6*d* plus 5/9*d* Purchase Tax.

THE "SIMPLEX" THREE

A Simple Gram Amplifier for the Beginner

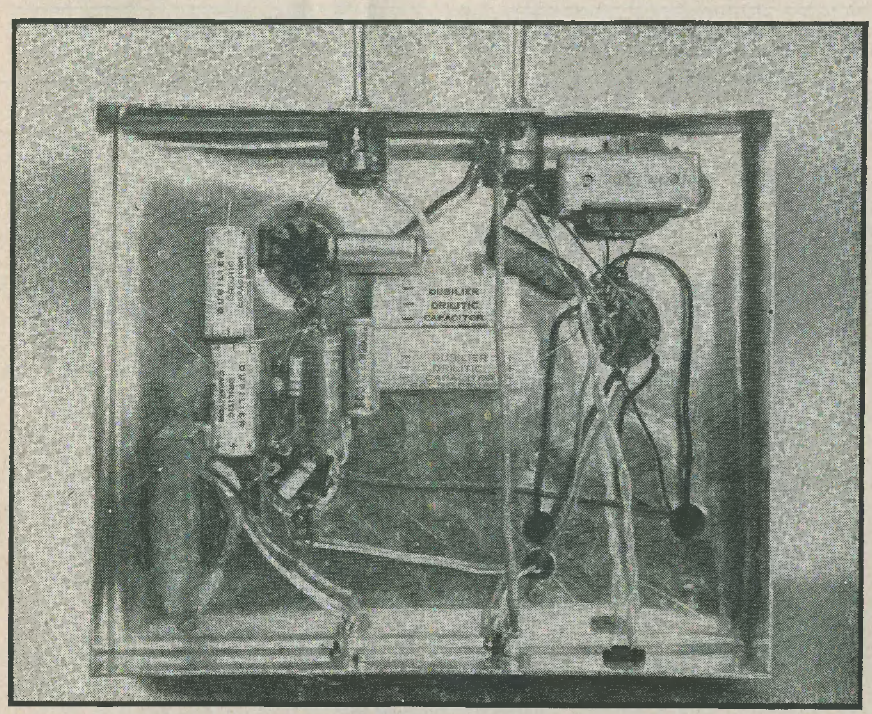
by E. GOVIER

MANY BEGINNERS, at some time or another, have probably felt the need for a simple yet inexpensive amplifier for use with a gramophone pick-up, or even a one or two valve receiver. To judge from readers' letters in "Mailbag," many of them beginners in the art of radio construction, it would appear that the following specification would be most popular:—Output 4 watts approximately, few component parts, cheapness, simplicity of construction and last but not least, availability of parts. All of these considerations have been complied with in the circuit presented herewith. No attempt has been made to provide negative feedback, and, being a simple amplifier, the only refinement incorporated is a simple top-cut tone control.

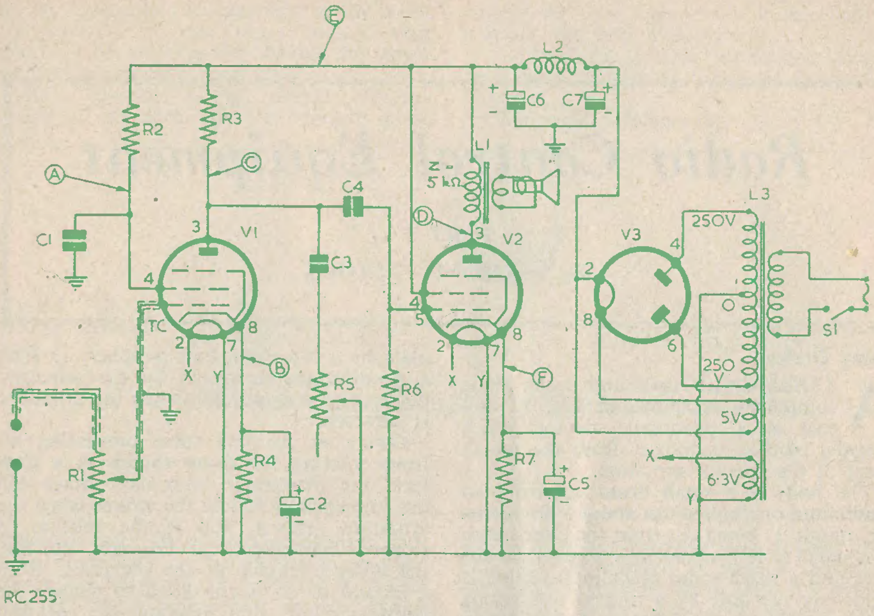
A good idea of the layout, both above and below chassis, will be obtained from the photographs and these, together with the circuit diagram, should present intending constructors with a clear picture of the unit —both theoretically and physically.

Circuit

This is shown in Fig. 1, from which it will be seen that it is a two stage amplifier with built-in power pack. The first stage comprises a 6J7 pentode with variable input circuit



Showing that the "Simplex" is well named!



Component Values

R1	250kΩ pot.	C2	25μF 25v wkg. Dubilier
R2	100kΩ, $\frac{1}{2}$ watt	C3	.05μF 350v wkg.
R3	22kΩ, $\frac{1}{2}$ watt	C4	.02μF 350v wkg.
R4	1kΩ, $\frac{1}{2}$ watt	C5	25μF 25v wkg. Dubilier
R5	250kΩ pot. with switch	C6	16μF electrolytic 350v wkg.
R6	470kΩ, $\frac{1}{2}$ watt	C7	8μF electrolytic 350v wkg.
R7	270 ohms $\frac{1}{2}$ watt	T1	Output transformer
V1	6J7	L1	Smoothing Choke, 20H
V2	6V6	T2	Mains transformer. See text.
V3	5Y3		
C1	.05μF 350v wkg.		

suitable for any high impedance moving iron pick-up. Should a low impedance pick-up be used, a matching transformer will be required—in which case the manufacturers will advise the type of transformer and input impedance required. For those that have the valves at hand, the 6J7 could be replaced without circuit alterations by an EF36 or an ex-Government VR56. A simple top-cut tone control is incorporated in the anode circuit (C3 and R5) and this has been found to perform satisfactorily in the final design.

The output from V1 is fed into the grid of V2 via C4. This stage, comprising a 6V6 output pentode, is entirely conventional and should present no difficulty to the beginner. Provided the circuit values given are adhered to, and a similar layout used as shown in the prototype photographs, no trouble should be encountered. Again, for those with a stock of valves, most other pentode output valves could be utilised here, although the value of the bias resistor R7 may require modification in order to obtain the correct bias voltage.

The power pack is also conventional and any mains transformer capable of supplying 250—0—250 volts at 60mA may be used. The one shown in the photograph is an Ellison Type M.T. 162 (see component list). The rectifier valve is a 5Y3 although any similar type could be employed. No hum trouble was experienced in the original model, and the power pack layout should be closely followed in order to obviate any 50 c/s mains ripple being induced into the circuit. S1 is incorporated in the potentiometer R5.

(*continued on page* 43)

Radio Control Equipment

PART 7

By RAYMOND F. STOCK

Delay Device

A COMMONLY USED and easily made component is shown in Fig. 32 and this is a pneumatic device which actually receives its power from the movement of the selector armature.

The body is a small drum cut from an aluminium or tinplate can about 1″ in diameter, about ¼″ being cut from the closed end.

A small hole is made with a needle in the end, and a small scrap of balloon rubber is held over the hole by a ring of draughting tape as shown. This forms a non-return valve.

A piece of rubber is then stretched lightly over the open end and secured by rubber solution smeared on the edge of the can and by a thread binding. A small circle of copper (no sharp edges here) is cemented to the centre of the rubber diaphragm. Opposite this is bent a thin contact so that the two connections touch when the diaphragm is flat. The contact strip is retained by being trapped under the thread binding, as shown, and the contact stuck to the diaphragm has a thin flexible lead soldered to it.

These contacts form a delayed connection. The complete unit is clamped to the selector plate by a clip around its periphery in such a position that a striker on the armature depresses the diaphragm when the armature is attracted.

Owing to the flap valve preventing air from entering the drum except as a slow leak, the diaphragm with its contact will not immediately follow the striker when the armature returns, and if the selector is stepped immediately to the next position the delayed circuit is not energised. If a ¼ second or so is permitted to elapse, the contacts close and operate the delayed circuit.

This device can be used in 'reverse' in one special case.

Where a three-way steering selector is used (as in Fig. 23) it may be very desirable to avoid adding a separate motor control position (as explained in the next section). In this case the delay device can be used from the other side of the armature so that the contacts are held permanently *open* by the armature at rest.

When normal short steering pulses are sent, the delayed contacts never close; but if a long pulse is sent they operate the motor selector. Admittedly this long pulse will introduce a spurious steering step, but it can immediately be cancelled by the quick transmission of two short pulses, thus restoring the steering (but leaving the motor selector advanced by one step).

Since selectors always operate on the *return* of the armature, the spurious pulse does not take effect on the steering until it ends, and thus can be effectively cancelled by the two short signals following it. Selectors are made to operate on the return stroke largely because the power then comes from the tension spring and is not subject to variation as the batteries run down.

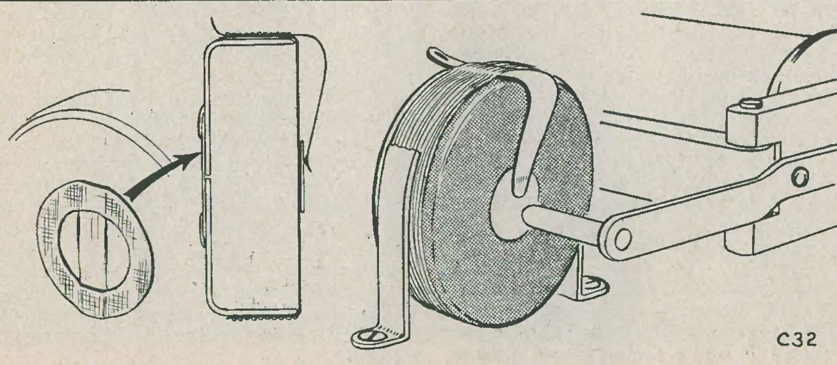


Fig. 32. Construction of pneumatic delay.

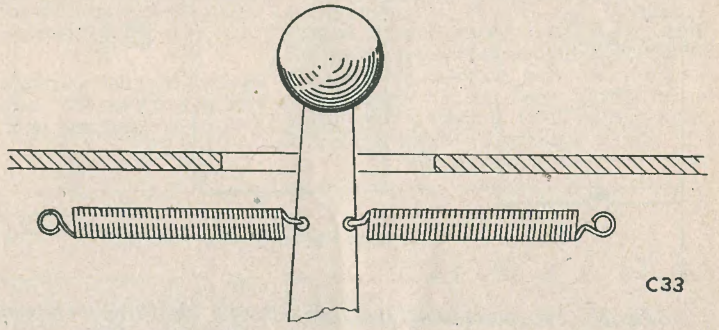


Fig. 33 Spring loading of control lever.

Control Box for Selector Systems

All selector systems may be controlled by a simple rotary switch as described for escapements, and when the steps are limited to 3 the device shown in Fig. 18 can be used and is very effective. In this application, since the port and starboard positions of the control lever represent port- and starboard- *going* positions rather than definite angles, the control lever should be spring-loaded to the central position as shown in Fig. 33. This will be found more natural in use, since the knob is pressed over in the correct direction and when released springs back to central; this central position now means 'Hold' (whatever rudder angle is applied) and not necessarily 'Amidships.'

To operate the motor control in this system involves the transmission of one long and two short pulses. These can be sent by the manual microswitch, but more realism is obtained by fitting a separate knob having on the inside of the control box a wiper arm moving over three contacts, one long and two short. Fig. 34 shows the rear view, and it will be seen that by 360° rotation a suitable signal is sent for stepping the motor selector on.

To avoid having to remember the motor sequence, the wiper shaft can be driven by 4:1 gearing from another shaft which is rotated 90° at a time; its knob can then be marked out with 4 positions.

In either case a 'click' mechanism should be fitted, accurately to locate the knob after its travel.

Clockwork pulsing units (as in Fig. 17) can be used for stepping steering selectors, and may be adapted as already described for manual pulsing units: but no simple mechanical device can code signals from *more than one* control knob (e.g. steering-wheel *and* engine 'telegraph').

The general way in which movements of more than one control may be coded is indicated by the circuit of Fig. 35. This assumes that the selector in the model has a sequence of 6 steering positions, a motor selector position and one other (for control of a hooter, etc.) all these to be controlled by the appropriate knob or lever at the control box.

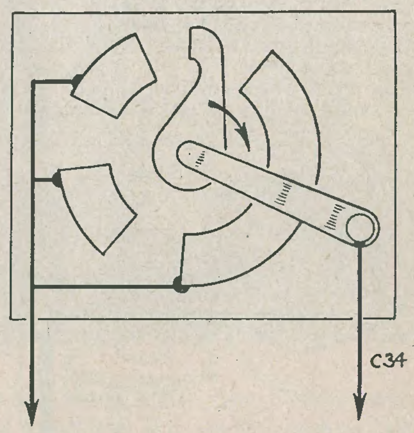


Fig. 34. Motor control switch

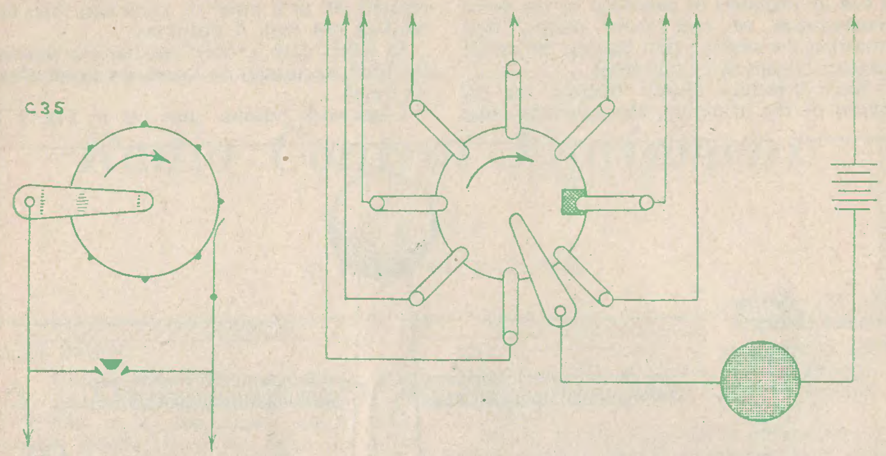


Fig. 35. The pulsing wheel (left) and follow-up wheel (right) are mounted on one shaft geared down from the motor

The apparatus is divided into two parts. On the left is shown a pulsing disc having 8 contacts around the edge, working against a fixed contact. One keying lead goes to the latter and the other to a light brush bearing against the wheel to preserve continuity. A micro switch is in parallel with the contacts, for manual keying.

Rotation of the disc sends pulses, and the selector in the model follows the movements of the disc.

The disc is mounted on a shaft geared down from an electric motor, and current goes to the latter via a metal wheel on the pulsing disc shaft and one of 8 brushes. These brushes are connected to the various positions of the control switches and knobs which may be press buttons, Yaxley switches etc. as required.

The metal wheel has one insulating segment and, when a brush is energised by moving one of the controls, the wheel rotates until the insulation is under the brush (and thus cuts off the supply from the motor). This part of the device is, in fact, another homing mechanism, though the wheel always follows up in one direction rather than by the shortest route. Provided the leads from the brushes to switches are connected in the right order to correspond with the set sequence, any movement of the controls will cause the correct number of pulses to be sent.

In practice the pulsing disc and contact wheel are combined in one, and Fig. 36 is a drawing of the main parts of this unit.

The disc is of brass, about 1½" diameter, and is soldered to a shaft supported by a brass bush. A light copper foil brush is arranged to bear on the disc near the centre to make connection (earth) for both the keying and operating circuits.

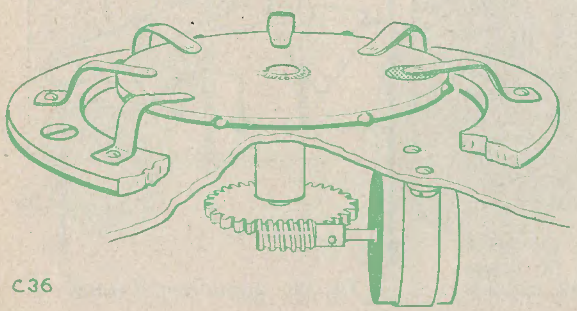


Fig. 36. Construction of a motor-driven coding switch. Keying brushes are not shown

8 small silver or copper rivets are soldered to the edge of the disc, and the static keying contact is supported on a perspex block which forms the base of the unit. 8 copper brushes are riveted to the base and press lightly on the disc near the edge. The insulating segment can be a simple cut-out in the disc, or a hole filled with some thermoplastic insulation filed off flush with the surface.

It is necessary to arrange that the keying contacts 'make' about halfway through the travel of the disc from one position to the next.

The shaft supporting the disc carries a worm wheel driven by a worm on the motor shaft, but a simple gear train from a clock can be used. The ratio should be such that the keying is carried out as fast as possible within the capabilities of the selector to follow signals.

Any number of separate control switches and buttons can, in this way, be used to transmit their orders through a single channel, and there is no theoretical limit to the number of complete sequence positions. A local power supply for the motor is required, of course, and a separate torch battery within the control box is a convenient source.

(to be continued)

THE "SIMPLEX" THREE—*continued from page* 39.

Voltage measurements as made with an AVO Model 40 are given for those with such an instrument or similar type. Measurements **A**, **C** and **D** were made on the 480 volt range and were as follows:—**A**, 75 volts; **C**, 115 volts; **D**, 190 volts and **E**, 200 volts. Cathode measurements were made on range 12 and were—**B**, 2.5 volts and **F**, 8 volts.

The output obtained is approximately 3 watts with good quality. With this inexpensive and easy to construct amplifier, the reader will find it comparatively easy to add further refinements at a later date as finances and time permit.

Radio Snapshots

THERE can be but few readers who neither own, nor have access to, a camera, and to encourage an increase of readers' photographs in our columns we have devised a simple contest.

Readers with inexpensive cameras will stand an equal chance with those possessing "all the gadgets," for the subject of the photograph—so long as it will reproduce satisfactorily—will be the deciding factor, and not the pictorial merit.

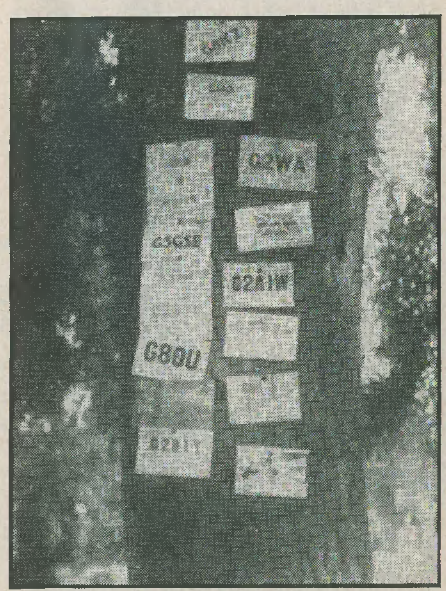
Many subjects suggest themselves; Ham Shacks, Listening Dens, home built equipment, novel tools and gadgets, field days, workshops—these are but a few.

There is but one simple condition. The photograph(s) must be the copyright of the entrant.

An award of three guineas will be made to the sender of the picture which, in the opinion of the Editor, is the best submitted. A reproduction fee of 10*s* 6*d* will be paid to the sender of each photograph published.

In order to allow overseas readers to participate, the latest date for receipt of entries has been fixed at November 5th (easily remembered!)

A short description should accompany each photograph submitted.



VHF Amateurs leave their "calling cards" at Chessington Zoo, on the occasion of their annual outing, June '53

A MODERN 3-WAVEBAND SUPERHET RECEIVER

By JAMES S. KENDALL Assoc. Brit. I.R.E., M.I.P.R.E.

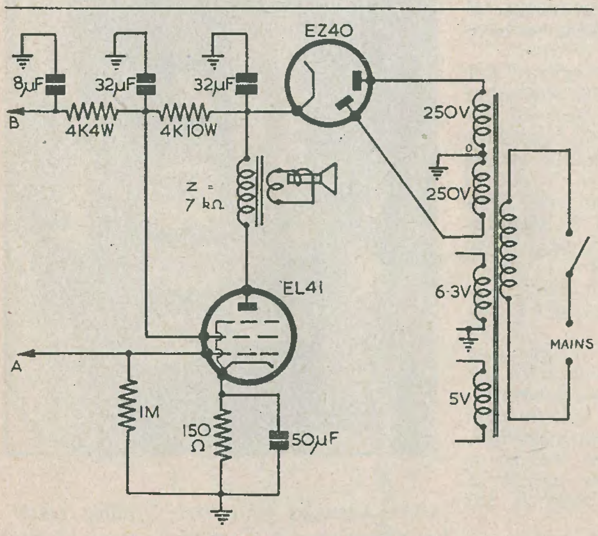
An article on the construction of a receiver of conventional design using modern B8A valves. The construction of both AC and AC/DC circuits is described. There is nothing outstanding claimed over the performance but it is as good as most sets of the same type when properly aligned.

THE BASIC CIRCUITRY of the superhet receiver has changed little over the last ten to fifteen years, but in this time there have been many changes in the valves. To-day on the market there are some very efficient valves with all glass bases, the B8A base as it is known. It is around these British types of valves that this circuit is designed. The valves chosen are the ECH42, EF41 or 6F15, EBC41, EL41 and EZ40. These are all 6.3 valves, including the rectifier which is run off the same heater chain as the other valves. After the AC version had been made, an AC/DC version was devised on the same circuit.

The original chassis used was 11″×7″×2″ deep, but an extra ½″ on the depth would allow an easier mounting of the trimmers on the coils. An "L" layout was devised, with the frequency changer, 1st IF transformer and the IF valve forming the short arm, whilst the long was formed by the IF valve, 2nd IF transformer, and double-diode-triode followed by the output valve. At the extreme end of the chassis was placed the 32-32μF smoothing condenser.

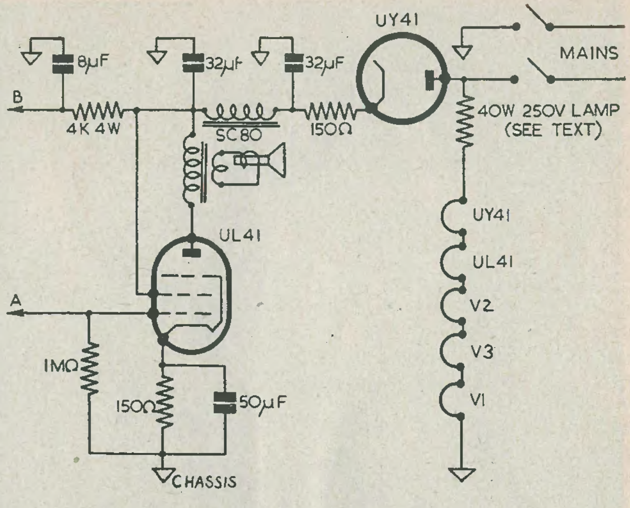
The power unit or section consists of an Elstone SR/250 transformer, which gives 250-0-250V at 80mA, 6.3V and 5V. The 5-volt winding was used for the dial lights with 6.3 volt bulbs; this ensures that the winding is not left unused and that the life of the dial bulbs is kept at a maximum. It might be mentioned here that the designer ran into quite a queer noise fault whilst constructing the set; this was traced to one of the two dial bulbs.

The transformer can be mounted one of three ways; in the prototype a hole was cut and the transformer dropped through. The home constructor, however, does not always have the tools to cut such holes, and can bolt the transformer to the top of the chassis. If this is done two holes should be made either side, and grommets fitted so that the sharp edges of the chassis do not chafe the wiring. The rectifier valve-holder was mounted at the side of the transformer. A hole ⅞″ diam. was cut with the aid of a "Q-Max" cutter, and two suitably placed ⅛″ holes drilled to take the fixing screws for the holder. The 32-32μF condenser was mounted over a 1⅛″ diam. hole made with the aid of a cutter for octal holders; this allowed the tags to be dropped through the hole without letting the can follow, a much neater job than if the hole is cut too large and the condenser dropped half-way through.



AC OUTPUT & POWER PACK

RC 257



RC258

UNIVERSAL OUTPUT & POWER UNIT

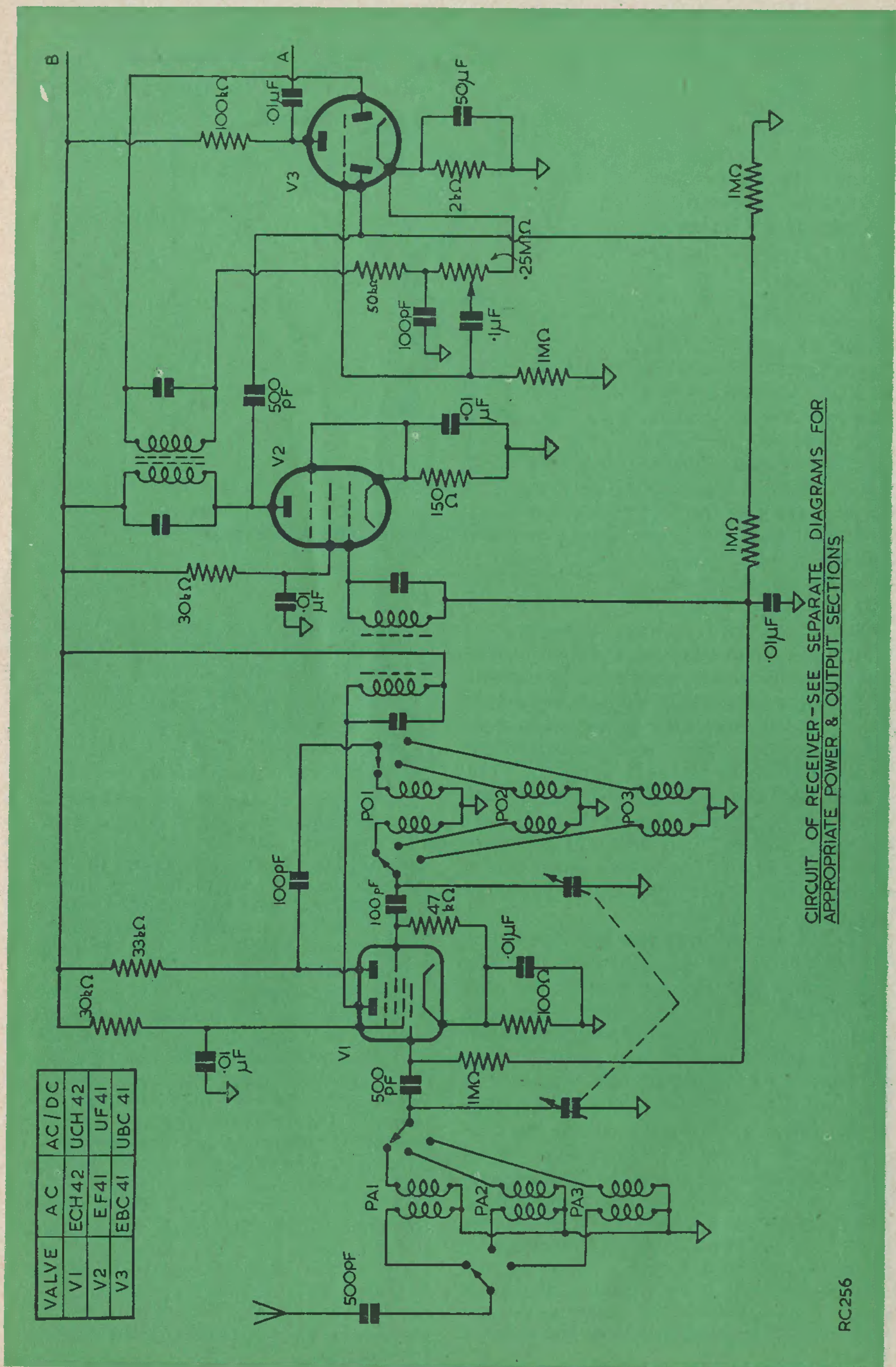
Next the holes were made for the other valves and the IF transformer. The way the IF holes were made may seem at first a little crude, but the holes, although an odd shape, are symmetrical, and leave enough metal under the coil to act as a support. Four ⅞″ holes were made so that the four projecting wires can be passed through with a good clearance, then a ⅜″ hole drilled in the centre to take the bolt of the chassis cutter and a further 1⅛″ taken out. This allows the tuning slug to be got at easily.

The tuning condenser was left until last as the coils had to be mounted under it. The coils chosen, although not a new type, were the Wearight "P" coils. The writer has used these coils on many occasions with great success. The ones used are PA1, PO1, PA2, PO2, PA3 and PO3, which cover the long, medium and short wavebands. Coils in this series are arranged so that the constructor can make a receiver that has a continuous coverage from 7 to 2,000 meters. It is only a matter of altering the switching of the wavebands to do this. If the chassis is 2½″ or more in depth it is a simple matter to mount the 40pF trimmer direct on the tags of the coils, with a saving of chassis space. This system has the further advantage that one can see the coil to which the trimmer is attached.

The position of the tuning condenser was then chosen, and two suitable ⅜″ holes made at equal spacing from its spindle to take the volume control and the wavechange switch. The dial drive used was one of the W.B. range. It covers the correct bands, has a good slow-motion action and is low in price, the latter being a consideration these days.

If, as was the case in the prototype, the chassis is not deep enough to take the trimmers mounted directly on the coils, then they will have to be mounted on the side of the chassis. Be careful here as the stray capacities can lead to instability. A fixed padder was used for the shortwave band, but a double variable was used for the medium and long bands.

The smoothing is simple. The anode of the output valve is fed via the output transformer direct from the reservoir condenser. This does not result in hum, as might at first be thought, as it is the amount of hum on the screen that causes the hum to appear in the output. The reduced current through the smoothing resistor allows one of 4,000Ω to be used; this is a value as high as the impedance of a quite good smoothing choke and at a very much lower cost. The smoothing condenser is the other 32μF, and the screen is taken direct from this. The remainder of the circuit is decoupled with the aid of a 4,000Ω resistor of lower wattage rating and an 8μF condenser. This extra smoothing removes all trace of hum from the RF side of the receiver.



VALVE	AC	AC/DC
V1	ECH42	UCH 42
V2	EF41	UF41
V3	EBC41	UBC 41

CIRCUIT OF RECEIVER—SEE SEPARATE DIAGRAMS FOR APPROPRIATE POWER & OUTPUT SECTIONS

Full use should be made during the wiring of "Tag" strips, which can be obtained at the cost of a few coppers each and very greatly improve the standard of construction. This ensures that there are no bundles of poorly soldered wires suspended in space, ready to sag and short out on to some component that won't like the extra volts!

If a little thought is applied there should be no trouble with the wiring. A good solder of the 60/40 type is recommended, also the cleaning of the wires of all resistors and condensers with the aid of fine emery cloth. Emery cloth lasts longer than glasspaper.

Next the alignment has to be done. Here a signal generator is indispensable; suitable circuits have from time to time appeared in the pages of this journal, a particularly good one being described in the December 1952 issue. The method of alignment is to turn the volume control of the set to "full on," and with the signal generator joined to the grid of the IF valve, and tuned to 465k/cs (as low a signal as possible should be used), a maximum should be tuned for on both windings of the second IF transformer. As there is usually some interaction between windings it is advisable to repeat the process several times to ensure that correct tuning is obtained. The trimmers can then be sealed, or if slugs are used a mixture of candle wax and vaseline melted together can be smeared on. This mixture gives the necessary amount of "bind" whilst allowing enough ease of turning to facilitate tuning.

The first IF transformer is tuned at 470 and 460kc/s so that a good bandwidth can be obtained for broadcast listening. The short wave enthusiast will no doubt prefer to sacrifice fidelity for selectivity, and will tune to 465kc/s on both windings. The tuning is effected by moving the signal generator from the grid of the IF valve to that of the frequency changer, then setting the receiver tuning knob so that there is no "beat" from the oscillator section of the frequency changer, and with the signal generator set to the required frequency trimming the appropriate winding. Then set again, and trim the other to the correct frequency. Repeat several times until there is no change required to be made.

The various wavebands are aligned by setting the generator to a frequency at the high end of the scale and adjusting the trimmers on both the grid and oscillator coils, then repeating several times to get good tracking. This should be done for each waveband in turn. The signal should, of course, be fed into the aerial terminal.

No mention has been made of the tone control, but then there are so many and nearly every constructor has his own favourite circuit.

The AC/DC version is, in the main, the same, the difference being in the types of valve used. Again these are the B8A type, and of the 100mA type that are now so popular. A dropping resistor is placed where the transformer was in the AC version. If the receiver is to be used on 230 volt mains, the dropper can quite well be in the form of a 250 volt 40W electric light bulb. This will give a circuit that will ensure that the current through the valves does not rise to too high a value during the warming up period. If a lamp is not used it is advisable to insert a BRIMISTOR in series with the mains dropper resistor. The valves used are the UCH42, UF41, UBC41, UL41 and the UY41. These require a total drop of 117 volts, at a current of 100mA. It is therefore quite a simple matter to work out the value of the dropping resistor that will be required. The wattage required will be, in this case, one tenth of the voltage drop.

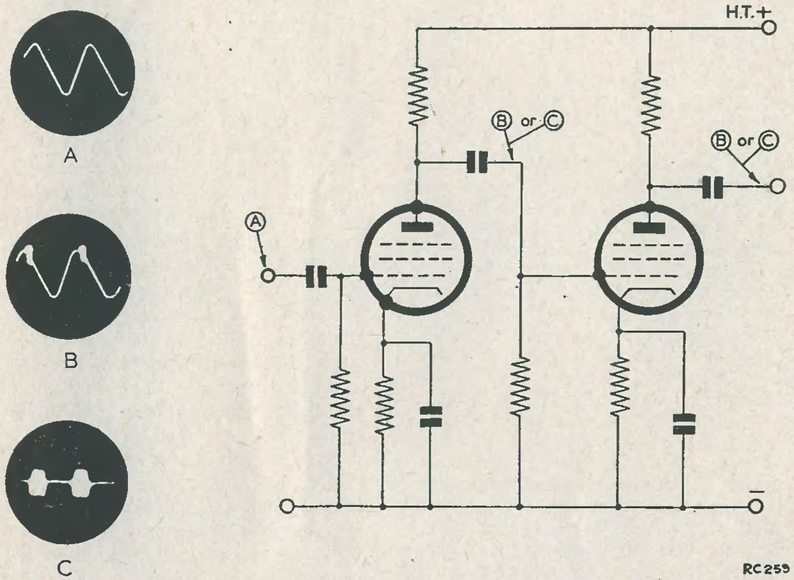
As the circuit is being fed direct from the mains, a resistor of 150Ω 1W should be joined from the cathode of the rectifier to the reservoir condenser. With the very few volts to spare, it is recommended that a good smoothing choke such as the Elstone SC/80 be used, and the anode and screen both fed from the smoothing condenser. The reason for this change in the circuit is that the UL41 is made to work with a lower anode voltage than the EL41.

The remainder of the circuit is the same as for the AC version, but this does not mean that the heaters are joined in parallel. As in all universal circuits they must be joined in series. Dial lamps should be of a max. current of 150mA—this prevents them from blowing during the current surge before the valves are properly warmed up.

As the chassis is live, both the aerial and the earth should be fed via condensers of suitable capacity and of at least 750 volts DC working. The user should be protected by placing the chassis in a wood or bakelite cabinet, so that it cannot be touched. Care should be taken that the tuning dial frame, if of metal, does not make contact with the chassis. The same precaution should be taken if a metal speaker grille is employed. It is also wise to fill the holes in the control knobs with a little wax so that it is impossible to get a shock off the grub screws.

OSCILLOSCOPE TRACES

BY A.B.



No. 3 AMPLIFIER PARASITICS

HIGH GAIN AF AMPLIFIERS — such as those used for tape recording — sometimes suffer from parasitic oscillation. The frequency of this oscillation is often very high — well out of the audio range. Although it cannot be heard, it makes itself felt by a general deterioration in performance, a fault which normally takes one of two forms: (i) it only occurs when an input voltage is applied to the amplifier; (ii) it is independent of input.

The shape of the input waveform is not critical but its amplitude should be kept small to avoid any overloading. A shows a sine wave input.

The type of parasitic oscillations which depend upon input appear as thick blobs on a part of each cycle, as shown in B. If the amplifier input is reduced they may disappear, only to reappear again as the input is increased.

The other type appears as shown in C. No input is applied, and if no parasitics are present the timebase line should remain undisturbed as each point in the amplifier is checked.

A third and rather remote possibility is that oscillation is occurring constantly and not in spurts as in B and C. This would appear as a thick bright line on the screen.

Your Copy of the Index to Volume 6 will be sent on receipt of your self-addressed stamped envelope.

Let's Get Started . . .

4: Valves as Detectors and Oscillators

BY A. BLACKBURN

Because there are some fundamental principles of radio which, although they have to be learned, do not make particularly interesting reading, I have ventured to talk first of those techniques which appeal more to the reader's curiosity.

But the hard graft has to be tackled sometime—it is no good leaving things in mid-air purely because it is a dull subject. However, knowing as you now do, some of the more advanced aspects of radio theory, you should be sufficiently interested in the ultimate effect to want to know more of the cause.

In our last article we spoke of how we can select signals, but we did not explain how these selected signals are detected, which is the process coming between selection and amplification. Detection simply means translating a selected carrier into an audio signal.

Suppose you were blindfolded, handed an object and asked to describe it. You could either feel its shape, and so say whether it were a cube, a globe, a cone, etc., and give an approximate idea of its size. Or you could take the bandage from your eyes and describe it more fully.

In either case you are using a sense as a means of detection in order that that sense may transmit its observations to your brain.

That virtually is what happens in radio. Once a signal has been selected, the detector picks it up and converts it into a form which can eventually become a recognisable sound.

Now the valve has been put to many uses, some of which we have discussed. Two more applications of ' the most important technique in radio ' as we called the valve in our first article, are as a detector and an oscillator. There are other types of detectors and oscillators, of course, but we shall be dealing with these later.

The Diode Detector

The diode valve was the first type we described at the beginning of this series. If we have appeared to ignore it, it is only because its function is rather different from the other types with which we have dealt.

You will remember that the diode has only two electrodes—the filament and the anode. Current will only flow in the valve if the anode is positive with respect to the filament. Therefore, if an AC voltage were applied between anode and filament, current would only flow on positive half-cycles, as can be seen from Figs. 1a and 1b.

If the waveform shown in Fig. 1c in last month's article were applied to the diode in Fig. 1 below, the diode would remove one half of this waveform either above or below a horizontal line drawn through the middle of the waveform, leaving the waveforms shown in Fig. 1c.

The modulation has now been effectively separated except for the half-cycles of carrier which can easily be removed by connecting, between points A and B in Fig. 1a, a capacitor of such a value that they would be by-passed. Remember that the carrier frequency is very much higher than the modulation frequency. Therefore, a condenser of, say, 100 pF will have a very low reactance at carrier frequency and a very high reactance at modulation frequency.

This process of separating the modulation from the carrier is known as *demodulation*, *detection* or *rectification* of the signal, and is a very important application of the diode valve. If we were to reverse the diode connections, that is to say apply the input at the filament of the diode and take the rectified output from the anode, the waveform shown in Fig. 1c would be upside down. The reason for this is that the diode would then conduct on negative half-cycles.

You might ask, why go to all this trouble when the audio-modulation still has some carrier associated with it even after detection? The point to realise is that (referring to Fig. 1c last month) the waveform is symmetrical and if we were to apply it to headphones direct, the " bumps " on top of the waveform and the " bumps " underneath would cancel one another out. What the diode really does is to make this waveform asymmetrical.

However, the diode is not the only device which will detect a signal in this way. In fact, the cat's whisker and crystal so much beloved by the early amateur were amongst the first detectors in radio chronology. A crystal-cat's whisker combination produces the same effect as the diode in that it tends only to pass current in one direction. In the last war the crystal detector returned to popularity with the advent of radar and it is now obtainable commercially.

Physically very small—it is normally about $\frac{3}{8}$*in* long and $\frac{1}{8}$*in* in diameter—the crystal detector is very efficient. Fig. 2 shows a circuit of a crystal set, incorporating one of the principles we discussed last month of coupling the aerial to the tuned circuit. The crystal detects the selected signal operating the headphones, across which the 0.001 μF capacitor by-passes the carrier as described above.

millions of cycles per second have to be produced, and this is where the valve comes into its own.

As we already know, any small voltage change at the grid of a valve produces a magnified voltage change at the anode. If this magnified voltage were fed back to the grid an even larger signal would appear at the anode which in turn would be fed back. With the grid signals being supplied from the anode, the voltages at the grid and anode would, therefore, go on increasing until a limiting condition were reached, when continuous oscillation would occur. The other condition for maintained oscillation is that the

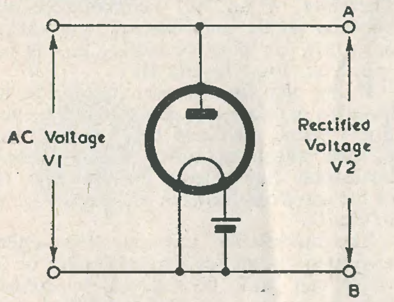
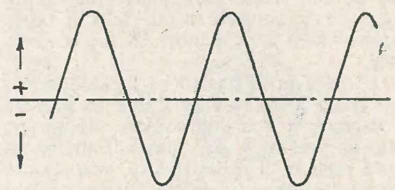
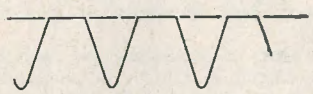


FIG. 1 (a)



VOLTAGE V1



RECTIFIED VOLTAGE V2

FIG 1 (b)

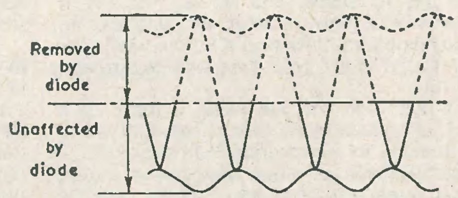


FIG 1(c)

ILLUSTRATING THE EFFECT OF A DIODE UPON AN APPLIED AC VOLTAGE

Fig 1(c) is a "detected" modulated carrier wave

RC.246.

The Valve as an Oscillator

Basically, the oscillator is a device which produces a continuous train of waves. The simplest electric oscillator is the electric bell which, provided a battery is connected, will continue " oscillating " indefinitely. Obviously, the highest frequency at which such a system could operate is limited by the weight of the moving parts. In radio work, oscillations of

anode voltage fed back must be " in phase " with the grid voltage.

This means that the circuit which is connected from the anode to grid must be designed to automatically ensure that as the anode voltage becomes, say, more positive, the grid voltage must become more negative. And that involves changing the phase of the signal in the feedback circuit. If you examine valve action you will see why.

As the grid voltage becomes more positive, more current flows in the valve and in the anode load, resulting in an increased voltage drop across the load. The anode voltage falls, therefore, at the same time as the grid voltage rises. (Readers who are familiar with AC theory will recognise these voltages as being 180° out of phase). So, if the anode signal voltage were fed back to the grid without changing its phase, it would be in opposition to the grid signal voltage, which produced it, and no oscillation would occur. One common method of ensuring correct phase between anode and grid is by coupling them with two coils as shown in Fig. 3.

Very often an oscillator is required to operate over a wide range of frequencies, and the best way of achieving this is to use a variable tuning circuit. Fig. 3 shows an oscillator using a triode valve, inductive feedback coupling and a tuned circuit to determine the frequency. We will assume that, upon switching on, a small disturbance occurs in the grid circuit which will cause a similar but larger disturbance to occur in the anode circuit.

The feedback coil, or reaction coil as it is sometimes called, will induce this larger disturbance back into the grid circuit in the correct phase. Oscillation builds up as we already know, and frequency will be determined by the tuned circuit. Thus we have an oscillator which, like the electric bell, will continue to run for as long as we require it, at frequencies suitable for radio applications.

The conclusions we have reached on the necessity for signals at the anode and grid to be in phase may be easily verified. Supposing that you have built the oscillator in Fig. 3, connected it to suitable power supplies and switched on, and also that the coil and condenser are suitable for tuning in the medium waveband.

There are three methods of discovering whether or not the oscillator is working. By placing a milliammeter in the anode circuit at the point marked X in Fig. 3, an indication of the current flowing in the valve will be obtained. If the circuit is oscillating, shorting the grid to earth will cause a rise in the reading on this meter. However, if the oscillator is not working no change will be observed.

Another method is to remove the grid leak from earth and connect a micro-ammeter between the free end of the grid leak and earth, the negative terminal of the micro-ammeter being connected to the grid leak. The meter will only give a reading if the oscillator is operating correctly.

The third method involves no meters, but an ordinary radio set only is used. For this system to be effective, the oscillator must be in close proximity to the aerial of the radio set.

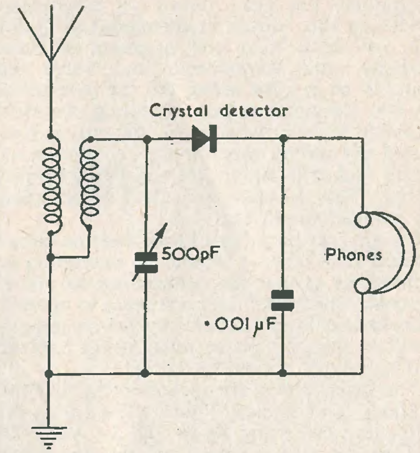


FIG. 2. THE CRYSTAL DETECTOR

RC.247.

The set is tuned just off the station, somewhere in the medium waveband, so that the station can still be heard but the reproduction is distorted. Switch on the oscillator and with the tuning condenser (C_1 in Fig. 3) tune slowly over the band. If the oscillator is working a whistle will be heard superimposed on the station at one setting of the tuning condenser. Some readers may remember how a selected

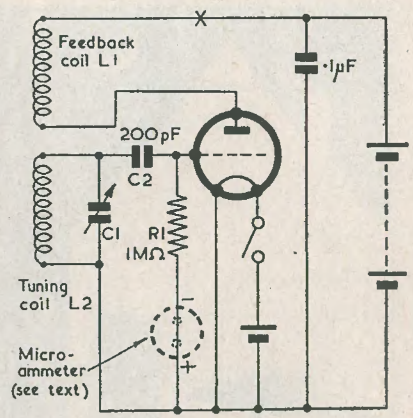


FIG. 3. A SIMPLE OSCILLATOR

RC.248.

programme has been ruined by neighbours producing this whistle in their sets.

If you have tried one or more of these methods, and components and valve are found to be in good order, but the indications are that the circuit is not oscillating, the most probable fault is that one of the coils is connected the wrong way round, i.e., the anode circuit and grid circuit are not in the correct phase. This is easily remedied by reversing the connections of one coil.

Should you have been lucky and the circuit worked first time, it would be interesting to deliberately reverse the connections to one of the coils, when the circuit will cease to operate. This demonstrates most effectively how important it is that the phase relationship between anode and grid should be correct.

The behaviour of the meters in the first two methods is of interest. Both these effects are a function of C_2 and R_1 in Fig. 3. When the oscillator is first switched on, we know that oscillation builds up until a limiting value is reached. Each half-cycle charges C_2, but, because R_1 is of too high a resistance to allow it to leak away completely before the next half-cycle arrives, the charge becomes greater with the increasing amplitude of oscillation, until the grid of the valve becomes so negative, i.e. has such a high grid bias value, that any further increase of oscillation would completely cut off the current in the valve.

Should the amplitude of oscillation try to increase further, the bias it produces will increase and tend to limit the amplitude. Therefore, the circuit will settle down automatically and produce a constant amplitude voltage.

When the meter is connected to the anode circuit, shorting the grid to earth has four related effects: oscillation stops; negative bias is removed; more current flows in the valve; and the reading on the meter rises. With the meter connected between the grid leak and earth, an indication is given of current flowing through the grid leak. No current will flow, however, if no signal, i.e. no oscillation, is present at the grid. Therefore, if current is flowing, the circuit must be oscillating.

Uses of Oscillators

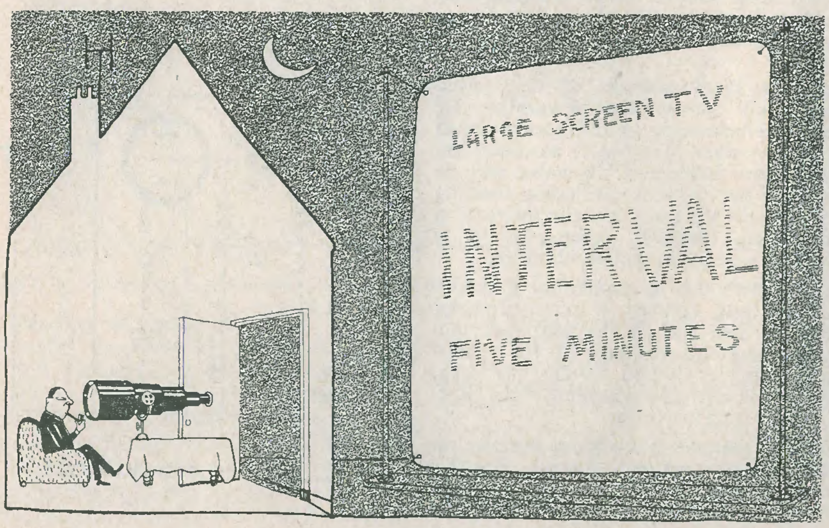
Because it is possible to use a radio set to detect signals from an oscillator, it can be seen that the oscillator may be used as a transmitter.

An oscillator of some sort is used in every transmitter to produce the carrier, and in high powered transmitters the oscillator output is amplified before being fed to the aerial.

You have all seen those advertisements which, with discreet claims to supremacy, offer expensive "superhet" radio sets? Eye-catching word — superhet, although its actual implication may be lost on most people. But an oscillator is used in every superhet set.

Oscillators also find many applications outside the field of radio for producing high frequency voltages in many sciences, including medicine, metallurgy and atomic physics.

Further references to their uses will be made in subsequent articles.



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continued on page 59

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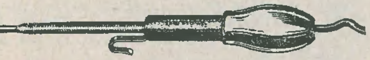

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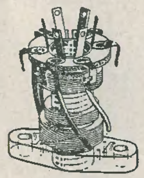

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continued from page 57

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continued on page 60

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continued from page 59

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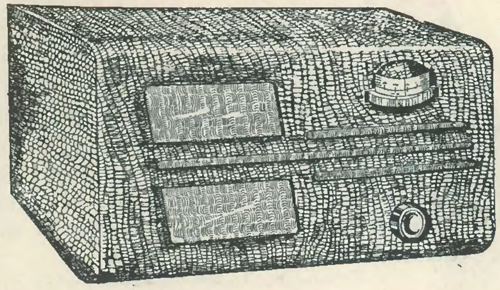

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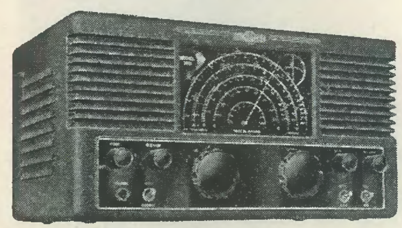

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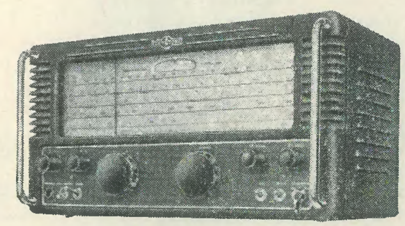

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