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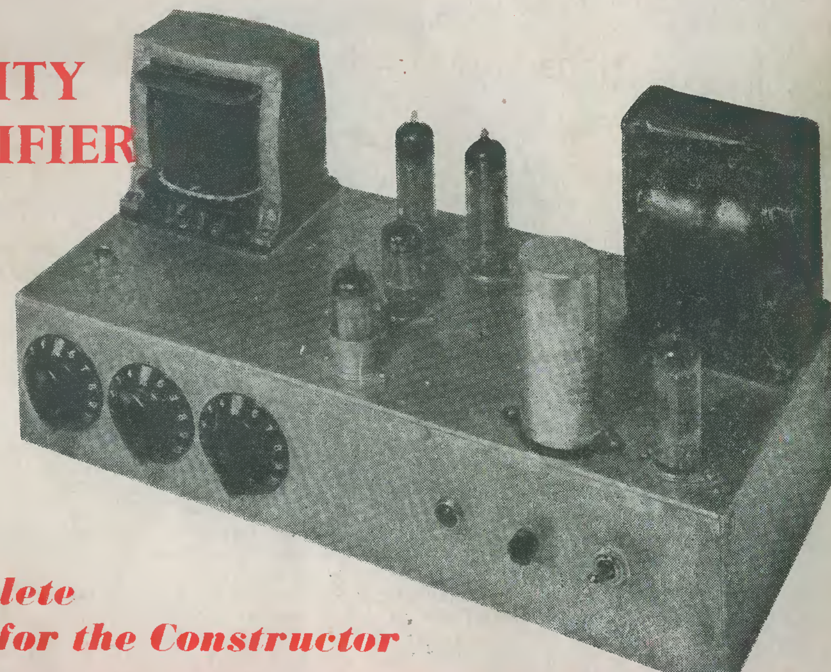
The
RADIO CONSTRUCTOR

Volume 8
Number 1
AUGUST 1954

incorporating The Radio Amateur
for the Radio and Television Enthusiast

The MULLARD 5-valve 10-watt HIGH QUALITY AMPLIFIER



a complete design for the Constructor

ALSO IN THIS ISSUE

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THE CONSTRUCTORS' PRE-SET FIVE
SUPPRESSING FLYBACK LINES IN HOME CONSTRUCTED TV'S
INEXPENSIVE AC BATTERY CHARGER · BEGINNERS BATTERY TWO-VALVER · EXPERIMENTS WITH LOOP AERIALS
Reproducing Records, Pt. 2 · Let's Get Started · Suggested Circuits · Query Corner · Radio Miscellany, etc., etc.

The
Radio Constructor
INCORPORATING *The Radio Amateur*

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VOL. 8 NO. 1

ANNUAL SUBSCRIPTION 18/–

AUGUST 1954

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NOTICES

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably 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 all 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 produce for review in this section.

ALL CORRESPONDENCE should be addressed to THE RADIO CONSTRUCTOR, 57 Maida Vale, London W.9
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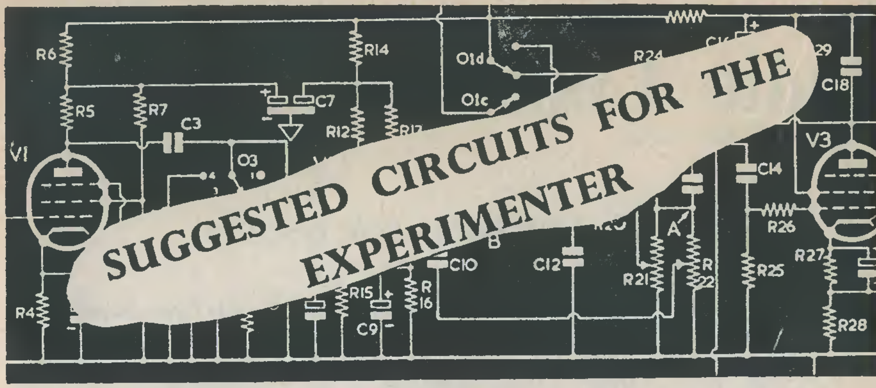


The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data.*

No. 45. DRIVING AC GRAM MOTORS FROM DC MAINS

As is well known, a considerable number of towns and districts in the British Isles are still supplied by DC electricity mains. Whilst a DC mains supply does not necessarily prevent the radio enthusiast from using equipment whose performance is as good, or nearly as good, as that given by equipment designed to work from AC mains only, it nevertheless imposes certain restrictions. One of the most noteworthy of these is the difficulty of obtaining DC motors which are suitable for the operation of three-speed gramophones and record-changers.

This month's circuit describes an experimental valve-driven inverter capable of overcoming this difficulty. The inverter described may be used also for driving other AC equipment whose power requirements does not exceed 25 watts or so.

The Circuit

The circuit of the inverter accompanies this article. It consists basically of a phase-shift oscillator, working at 50 cycles, which feeds into a phase splitter, and thence to the grids of two large pentodes biased approximately at cut-off. Each pentode thus passes half-cycles of the AC at relatively high power, these being "balanced" by a centre-tapped inductor, across which is connected the AC gramophone motor. It is probable that greater power with an improved waveform would be obtained from the inverter if the output inductance were "tuned," and a condenser for this purpose is shown in dotted line.

Considered in greater detail, it is worth while considering first the phase-shift oscillator, V1(a). Using the phase-shift components shown in the diagram (R1+R2, R3, R4, and C1, C2, C3) the frequency of oscillation should be a nominal 50 cycles per second. Whilst the writer has specified fairly high-tolerance components for this part of the circuit, the experimenter is strongly advised to commence by using normal low-tolerance components, which he may already have on hand, to initially construct the inverter. If these do not cope satisfactorily, the more expensive high-tolerance components can then be employed.

A degree of speed, or frequency control is of advantage. Theoretically, such a control should be given by varying either R1 (+R2), R3 and R4, or C1, C2 and C3, simultaneously. This would need a three-gang control. For the small frequency variations needed here, it should be sufficient to alter the effective value of one of the phase components only. The component chosen here is R1 (+R2), and its effect in the circuit is adjusted by means of the relatively small-value variable resistor, R2. The frequency given by the inverter is best measured after final construction, this being done by observing the speed of the gramophone motor it drives. A reasonably accurate method of checking the motor speed consists of counting the number of

turntable revolutions over a period of several minutes. A stroboscopic card cannot be used here, of course, as 50 cycle mains will not be available.

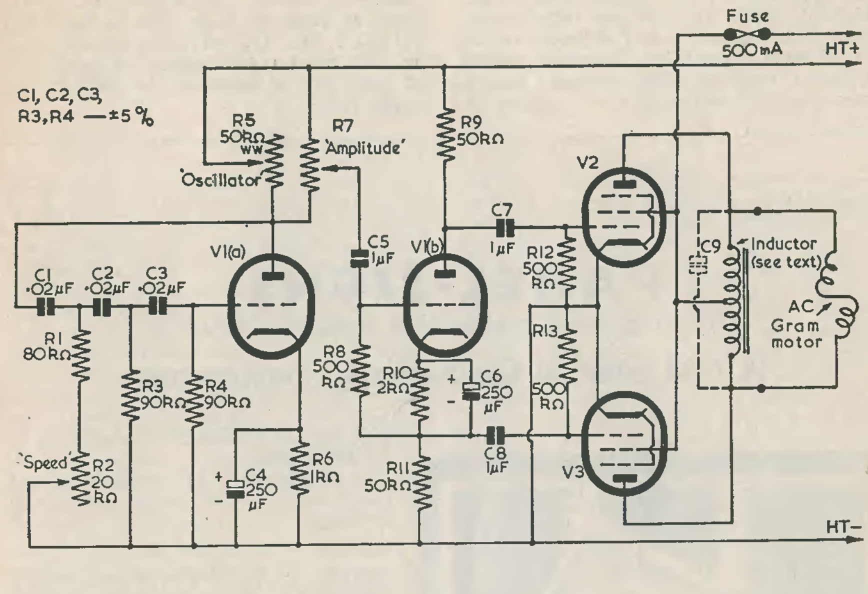
Phase-shift oscillators work at their best when the anode load is just sufficient to maintain oscillation. Unfortunately, in this case, it may be necessary to use a rather high value of anode load in order to obtain an output of sufficient amplitude. R5 should, accordingly, be adjusted to give the best compromise meeting these two conflicting requirements. The final setting of this component should not be too critical, however, and it is possible that it may be replaced by a fixed resistor of the requisite value after the inverter has been completed.

The phase splitter, V1(b), is quite conventional. A second pre-set control, R7, is connected to the input of this valve. Here again it should be possible to replace this control by fixed components, after completion.

The two output pentodes, V2 and V3, function as a conventional push-pull amplifier stage biased to cut-off. The bias is supplied by leaky-grid rectification, the appropriate components being C7, R12 for V2, and C8, R13 for V3.

A fuse has been connected in the HT feed to V2 and V3 in order to protect these valves against the lack of bias which would result from cessation of oscillation. This fuse would blow also if, after switching on, the cathodes of V2 and V3 attained emitting temperature before those of V1(a) and V1(b). In practice, the smaller valve (V1) should warm up well before the larger, output valves, and so the case does not apply. (Except, perhaps, in the instance when the inverter is switched on again shortly after switching off). It is possible that experimenters may prefer to use a more comprehensive protection circuit of their own devising. With some output valves it might be feasible to limit the cathode current under conditions of zero-bias by connecting limiter resistors between the HT positive line and the screen-grids. The screen-grids would then have to be decoupled to chassis, of course.

The centre-tapped inductor is of importance. This inductor must have a DC resistance which is less than 20 per cent of that of the gramophone motor, and sufficient power-handling capabilities to stand up to the currents passing through its windings on alternate half-cycles. A suitable inductor



F45

Driving AC gram motors from DC mains

would be given by the primary of a medium-sized mains transformer having a 110-volt input tapping. This tapping would then provide the centre-tap.

Operation

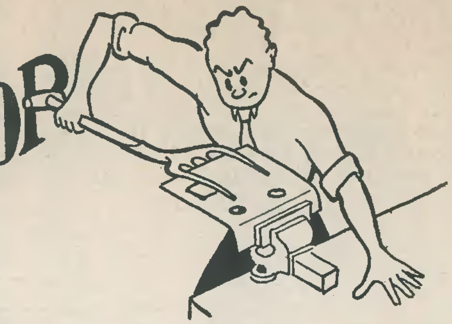
When completed, the inverter should be connected to the gramophone motor it is intended to drive. During the initial testing a reduced HT potential of approximately 150 volts should be applied to the output valves, and an AC voltmeter connected across the gramophone motor. The inverter controls should then be set to provide a reasonable (and probably, at this stage, somewhat low), AC voltage across the motor. Working empirically, different values of condenser should be connected across the motor until a value is found which causes the total inductance to resonate at approximately 50 cycles. Resonance will be indicated by an increase in the voltage appearing across the motor. If an oscilloscope is available, the waveform may then be observed.

After this process, the output valve HT voltage may be raised until the correct specified voltage is applied to the gramophone motor. As the HT voltage is raised, it will probably be necessary to re-set the "Oscillator" and "Amplitude" controls.

Valves

Suitable valves for V1(a) and V1(b) would be given by such types as the 6SN7 or 12AU7, etc. Output valves should be of the 6L6 class. An interesting possibility for this sort of work is the 50CD6 line output valve.

IN YOUR WORKSHOP



In which J. R. D. discusses Problems and Points of Interest based on Letters from Readers and his own experience

QUITE A NUMBER OF QUERIES HAVE reached *The Radio Constructor* during the past twelve months concerning the possibilities of fitting amplifiers to GPO telephones. A typical request came recently, for instance, from a reader whose occupation necessitates his having to use the telephone for considerable periods of time. This reader wanted a device which would drive a pair of headphones, thereby leaving his hands free. Another reader, several weeks ago, required an amplifier which would be of assistance to a friend who was hard of hearing. Other readers have asked for amplifiers of this type, for similar reasons.

Telephone Amplifiers

Unfortunately, the problem of fitting an amplifier to a telephone is not easy to solve without incurring a certain amount of expense. The main reason for this lies in the fact that it is contrary to Post Office regulations to make an unauthorised direct connection to any of the wiring installed by their engineers in a house or building. The motives prompting such a regulation are obvious and extremely sensible. In the first place, Post Office lines are usually balanced to 600Ω impedance (except perhaps for extension lines) and any improperly-designed subsidiary equipment connected to such lines would upset the terminal matching and performance. Secondly, the Post Office uses high-grade components maintained by their own engineers; and commercial amplifying equipment, if not kept directly under the eye of the GPO, could cause considerable havoc. Thirdly, the possibility of applying, by accidental breakdown, high voltages to Post Office lines might result in quite extensive damage. Post Office telephone wiring rarely carries potentials higher than 80 volts or so; and insulation is often of the enamel and cotton-covered variety. The damage which could be caused to, say, a length of forty-pair cable merely by applying a live mains voltage to one of the wires would be very costly, to say the least.

As direct connection to the telephone leads is out of the question, the problem of connecting an amplifier to the telephone becomes somewhat more difficult. One reader has suggested a microphone fitted against the telephone receiver. Whilst such an arrangement would definitely pick up the sound reproduced by the receiver, the acoustic distortion would be high.

Practically the only feasible solution, and one which is employed commercially, consists of using a pick-up coil mounted close to the transformer inside the telephone instrument itself. This method of coupling confers the advantage of low distortion, combined with the fact that no direct connection is made to Post Office lines. It has the disadvantage, however, of requiring a relatively high-gain amplifier after the coil.

Suitable coils for this purpose are available, and usually consist of a high-impedance winding on a laminated open core. The coil has sufficient sensitivity to pick up the stray fields built up around the transformer inside the telephone instrument, and its output impedance is normally around the $0.25M\Omega$ level. The coil is fitted to the underside of the telephone instrument or, with the aid of rubber suckers, to its side. A little experiment soon helps to find the position at which pick-up is at its strongest.

Most of the better known tape-recorder manufacturers supply telephone pick-up coils as an optional accessory to their equipment, and readers who are interested in the question of telephone amplification might be well advised to drop a line to these firms.

A word of warning about the amplifier to be employed may not be out of place at this point. If this is intended to drive a pair of headphones only, there is little point in using a large output valve. A valve of the 6J5 class will adequately load a pair of

see the filament of the fuse bulb begin to glow. He immediately switched off and checked for short-circuits or leakages across the HT line. There were none, so he cautiously switched on again. The fuse bulb once more glowed; but further tests showed that the amplifier was working perfectly. My friend presumed that everything was then in order and proceeded to use the amplifier without any further bother.

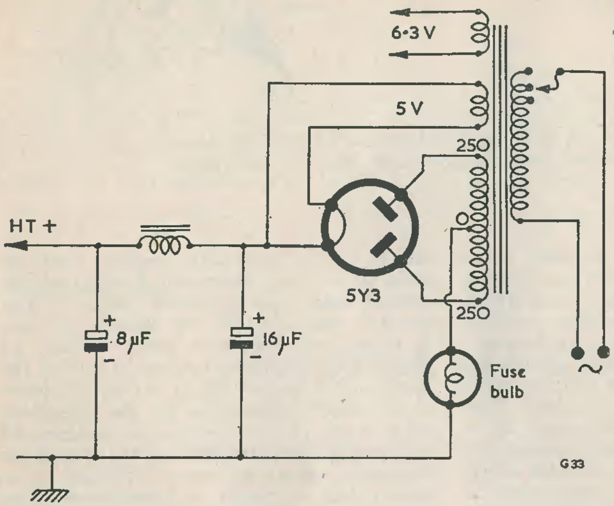


FIG. I.

Fig. 1. The simple power-supply circuit discussed in the text

eadphones. When more powerful output valves are employed, they will be capable of amplifying the occasional loud clicks and noises that occur on the telephone system to their full extent, with consequent severe discomfort, and even pain, to the wearer of the headphones.

The Glowing Fuse

A friend of mine, who dabbles in radio only occasionally, recently built a little audio amplifier based on a published circuit which employed a power supply arrangement similar to that shown in Fig. 1. The fuse in this diagram consisted of an ordinary flash-lamp bulb, and it was connected between the centre-tap of the HT secondary of the mains transformer and chassis. Any consequent HT short-circuit would then blow the fuse. It is reasonable enough to assume that a flash-lamp bulb will burn out around 500mA or so; and the circuit was, correspondingly, adequately protected.

When he completed the amplifier my friend switched on, and was dismayed to

After several weeks had elapsed my friend suddenly noted that the fuse bulb was not glowing dully but had begun to burn quite brightly. There was still no HT short-circuits and the amplifier was still working properly. He was quite mystified about this, and he called me in to have a look at the amplifier.

Most readers will, by now, have guessed what was happening; but it is nevertheless worth while recounting what I found, if only for the benefit of the newcomer. In the first case, the original continual glow of the fuse bulb was quite in order; even though, when I measured it, the total HT current drawn by the valves in the amplifier was only around 50 to 60mA (a value which would not normally be sufficient to cause the bulb to glow). The glow was due to the fact that the fuse bulb was not only passing the HT current taken by the valves but also the ripple current needed to charge the 16μF reservoir condenser. With the full-wave transformer circuit, this charging current would not be high, but would still

be sufficient to cause the bulb to glow when it was added to the current taken by the valves. (The power dissipated in a resistive circuit by the combination of an AC current superimposed upon a DC current is equal to the average DC current plus the RMS value of the AC current. This additional AC current would not be indicated, incidentally, by a moving coil meter).

The second case, given by the bright glow of the fuse bulb, occurred due to the fact that a fault had taken place in the rectifier valve, causing one of its anodes to become internally disconnected. The power supply circuit then functioned as a half-wave rectifier, with the result that the reservoir current, and the power consequently dissipated in the fuse-bulb, became much higher. Due to the smoothing arrangements and the relatively high value of reservoir condenser, this rectifier fault did not result in any noticeable increase in hum level or drop in HT voltage.

The fault was repaired by replacing the rectifier, of course; but this little story, amongst other things, does show rather forcibly the heavy charging currents which can occur in half-wave power supply circuits. When valve rectifiers are used in such circuits, a series limiting resistor between the rectifier cathode and the reservoir condenser should be considered as an essential component. Most valve manuals quote the value of resistor needed for individual rectifiers.

Getting Around

I was looking through the May issue of that excellent American magazine, *Radio-Electronics*, the other day when I saw a circuit which seemed familiar. On reading the text I found that it was a reprint of the power unit I described some time ago in *In Your Workshop* for re-forming electrolytic condensers.

When I mentioned the matter to my colleague, G. A. French, he informed me that a good half-dozen of his *Suggested Circuits* have appeared in *Radio-Electronics* as well. The very able contributor who conducts *Query Corner* has also had one or two of his circuits re-published in this magazine. (All the above were credited to *The Radio Constructor*, of course).

The main policy of *The Radio Constructor* has always been to cater to the needs of its readers with good, factual and reliable information. It is very pleasant to think that this policy has struck a responsive chord on the other side of the Atlantic.

Colour TV

At the time of writing, it appears that colour television hasn't quite got under way in America yet. The main reason seems to be that members of the public are a little chary of spending approximately £300 for a colour receiver with a 12-inch screen when larger screens have already been promised for the near future.

Some of the facts and figures about compatible colour TV are impressive. For instance RCA, who appear to have done most of the initial research work in the States, have spent over £10 million on development alone. One cannot deny that this represents a considerable act of faith. RCA is now converting existing television transmitters to colour working free of charge. It is anticipated that, in three years' time, the industry will be selling three million colour sets per year, rising to five million in 1958. To prepare for these sales, 30,000 television servicemen have already had training courses in colour technique.

A colour television receiver needs about 18 more valves than does the conventional monochrome set. Many of these valves are double-triodes, or triode-pentodes, and so the actual number of individual valves is probably greater than two dozen. They are all employed in sorting out the various colour signals *after* the video detector of what would otherwise be a conventional black-and-white receiver. The picture tube itself has three guns, of course; these activating primary colour phosphors after the electron stream has passed through a screen containing a large number of fine holes. The colour phosphors are arranged in triangular dot groups, so positioned that the electron stream from each gun, after passing through the screen, falls only onto those dots which correspond to its colour. At the present state of development, a 12-inch tube has over half-a-million of these dots. As may be imagined, the allowable tolerance in manufacture is infinitesimal.

Great care has to be taken to ensure that the electron stream from each gun arrives at its own particular group of phosphor dots. Even the earth's magnetic field is sufficient to upset the working of the picture tube, which has, consequently, to be completely shielded.

Safety First

Finally, here is a description of a little gadget which I fitted to my work-bench some time ago, and which has already saved me from receiving one or two nasty shocks.

All that is needed is shown in Fig. 2. The neon bulb illustrated in this diagram may be of any type, so long as it gives a reasonably bright and noticeable glow after striking. (Some neon bulbs will have the series resistor already fitted in the base).

In operation, it is intended that the wander lead from the neon bulb be clipped to any chassis which is being worked upon. If this chassis accidently becomes "live" the neon bulb glows; thereby warning the user, and allowing him to make the chassis safe before carrying out any further work on it.

With AC/DC chassis, the neon bulb gives warning when the mains plug has been fitted to its socket the "wrong way round," and is of considerable assistance for quickly connecting up equipment of this nature. The neon does not glow when the chassis is connected to the neutral side of the mains.

Some AC/DC chassis become "live" (usually through the heater chain) when they are switched off. When this indicator is used, however, it is at once possible to make a quick check for safety, with the chassis switch in both the on and off positions.

Bearing in mind the low cost of a "live-chassis" indicator of this type, together with its ease in use and the often-dangerous shocks it warns against, its inclusion amongst the work-bench gear represents a wise investment.

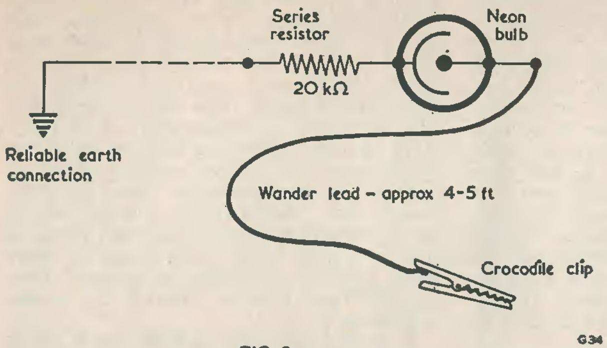


Fig. 2. An inexpensive addition to the work-bench. The neon bulb should be mounted in a prominent position

QRP SOCIETY TRANSISTOR TEST

During the month of August, transistor transmissions are to be made by stations G31EE and G3JNB in order to ascertain the maximum possible radiation distance using the present power and equipment. Whilst it is not a contest, all licensed amateurs running transistor transmitters on Top Band are invited to participate in these tests and all SWLs are asked to monitor such transmissions as they may be able to hear.

Schedule *Dates*—Sunday, Monday, Tuesday, August 15th, 16th and 17th. *Times*—2130/2145 hrs BST. *Procedure*—All stations to transmit on CW for the entire quarter-hour, text as follows: "QRP test TTX de G——." Every third round announce stations QTH. *Speed*—10 wpm max in order that SWL stations may copy calls accurately. *Frequencies*—G31EE (Kington-on-Thames) 1875 kc/s, G3JNB (Surbiton, Surrey) 1856 kc/s. These two stations will work duplex on 'phone—3750 kc/s–1856 kc/s—at 2115 hours each night, confirming full list of participants and frequencies.

Stations hoping to take part in the tests are asked to inform G3JNB by post and all SWL reports should be sent to him at 137 Surbiton Hill Park, Surbiton, Surrey.

Inexpensive AC Battery Charger

By **CENTRE TAP**

The summer months are upon us, and portable receivers come in for heavier use. Field Days are in season, the broadcasts of sporting events coincide with picnic times, and the latest Test Match scores come while we are in the Wide Open Spaces. In other words, the accumulator, and the matter of its re-charging, becomes an important factor in our hobby.

Battery charging from DC mains is a comparatively simple business. The battery is merely joined to the mains (correct polarity being observed, of course,) and a suitable resistor inserted in the positive lead. More or less any form of resistance can be used provided it will regulate the current to a suitable value. The most popular form is the carbon filament lamp. With the aid of an ammeter the charging rate is adjusted so that it does not exceed the figure recommended in the manufacturer's instructions. Where this figure is not given, the 8-hour rate (nothing to do with Trades Unions) should be taken as the very maximum. The 8-hour rate is a useful rule-of-the-thumb for a *maximum* rate of charge. This simply means that a battery must not be charged at a faster rate than that which would re-charge it fully in less than eight hours. Thus the maximum rate for a 16 Amp/Hour battery would be 2 Amps, but for preference it should be re-charged at 1 Amp. In any case, at the 2 Amp setting a battery will charge at a faster rate when it is "flat," and the rate will slow down as it becomes charged. There is then a danger of generating excessive heat, or buckling the plates; perhaps even splitting the container.

AC Mains

In the early days of broadcasting there were, of course, no mains operated receivers. One had to decide between getting small batteries which would last only a few hours but could be transported to the local charging station with reasonable ease, and a big one which lasted several evenings but which nearly broke your back when you carried it a couple of hundred yards. Nor was the risk of slopping the acid on one's clothes as inconsiderable as the designers of unspillable stoppers tried to persuade us. After all, you had to have a ventilator – and where the air went in, the acid would come out.

To be able to re-charge the accumulator also meant that you need only buy *one* – and in the early days, particularly, they were expensive things. Thus the keen amateur with AC mains got down to the charging situation in real earnest. We used to have to do it chemically – and a messy business it was. A large glass jar was filled with the electrolyte (ammonium phosphate) and slabs of lead and aluminium for the electrodes. Nor was that the finish of it. From time to time one had to add a solution of ammonia to neutralise the electrolyte. Happy were the days when the metal rectifier became popular – and cheap. To-day, a wide range of metal rectifiers can be picked up at knock-out prices, and suitable transformers can be readily obtained, or a partially burned-out one (or any discarded mains transformer) can easily be re-hashed by the patient enthusiast.

The Transformer

Many junk boxes will contain an old mains transformer with a sound primary winding. After the other windings have been removed, a suitable secondary of 18 gauge enamelled copper wire is wound on, the appropriate number of turns-per-volt being strictly observed. The turns-per-volt would, of course, be of the same ratio as that of the discarded winding.

If the transformer is a complete strip down, the primary too, will have to be re-wound. The chief factor governing the number of turns-per-volt is the cross section of the core, and for the guidance of beginners, the following table will be helpful.

Cross section of core in square inches	*Turns-per-volt*
1.5	5.5
2.0	4.25
2.5	3.5

In calculating the cross section of the core, only the part which passes through the bobbin is considered, of course. Thus, if the centre arm is one inch wide, and the stack of laminations is one inch thick, the cross section is one square inch.

Upon this basis the secondary winding is arranged to give outputs of 4, 7, 10 and 17 volts AC. These will give suitable final rectified DC voltages for the charging of 2, 4, 6 and 12 volt batteries respectively. It is advisable to wind the secondary as one continuous winding with tappings taken off at suitable points.

By doing this, it is impossible to get two sections of the secondary windings out of "sense" when, if as separate windings, they are connected in series to give a higher voltage. There is no other objection to making separate windings of the 4, 7, 10 and 17 volt sections, but a burn-out will ensue if two of them are connected the wrong way round. For this reason alone it is as well to safeguard against such a contingency in the actual design by making the winding continuous.

The Rectifier

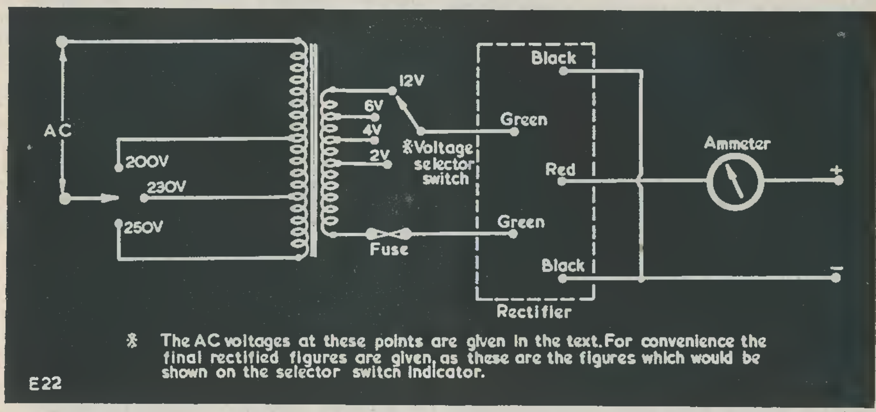
The charging rate will depend on the type of rectifier. Different types have different resistances and the transformer output voltage may vary slightly. For this reason, whenever the makers give special instructions these should be followed. Otherwise a temporary hook-up should first be made and the output measured. A high-resistance meter is not required – any cheap meter will serve as long as it is known to be reasonably accurate. The DC voltage output should not be greater than 50% higher than the voltage of the battery under charge.

The rectifier itself must be mounted in a horizontal position so that the plates are vertical, to allow a free circulation of air for heat dissipation. This will of course, be negligible at low charging rates, but it is sound practice.

fully charged or not! This is determined by a hydrometer, and those of the floating bead type can be bought quite cheaply. The ammeter can well be one taken from an old car dash-board or motor cycle headlamp. Such meters are certain to be "overscaled," and there will be scarcely any deflection on the needle at the rates we shall want to have indicated. This is easily overcome by making a suitable shunt from an inch or two of resistance wire, and substituting this for the existing one (usually a strip of metal across the meter terminals). By varying the length a greater or lesser needle deflection will be obtained. If the resistance is too high (as is quite likely) two pieces should be used, in parallel.

The rectifier is shown in the circuit in block form with the connections as they would appear from above. The wiring is soldered direct to the fins – which in the case of new rectifiers are colour coded. The AC connections are marked with green. The centre terminal is positive, and the outer connection points negative.

Whilst charging, the accumulator stoppers are best removed even when charging at slow rates. Vents have been known to get choked. A film of vaseline is kept on the terminals, lead bars or other exposed parts,



Refinements

A fuse inserted at the point indicated will serve to protect both the rectifier and the transformer secondary. It can take any form, the cartridge type being perhaps the most convenient.

Any ammeter can be used. Once the charging rate has been measured with a reliable meter, all that is needed is some indication that current is flowing. It will certainly not show whether the battery is

to prevent corrosion by the fumes which are given off while charging.

Two or more batteries can be charged at the same time. They are simply connected in series and the output connected to the appropriate voltage. If it is desired to re-charge, say, two 2V and one 4V battery, they can easily be done at the same time despite the fact there is no 8V output. Simply connect them in series-parallel and charge as for a 4V battery.

SUPPRESSING FLYBACK LINES in Home Constructed TELEVISORS

By **F. A. SHAW** *and* **P. JOHNSTONE**

IT HAS BEEN FOUND with a certain percentage of home-constructed televisors, that when they are operated under fringe conditions with the brilliance control turned fairly high, flyback lines are liable to appear during some transmitted scenes. It has been rumoured that the DC level of transmissions is not always maintained as accurately as it could be by the BBC; but this is a moot point. It is, nevertheless, a fact that many commercial televisors are fitted with flyback suppression circuits as a matter of course.

This article describes a method of suppressing, or reducing the effect of, flyback lines on all home-built televisors which use the Allen Components frame output transformer type FO305, or its Denco (Clacton) Ltd equivalent. Whilst the circuit may not work so well with some individual televisors as it does with others, experimental work on representative samples of different models has given such excellent results that at least partial, if not total, suppression is perfectly feasible in almost every case. Further, as the necessary alterations to the televisor consist merely of adding a condenser and two resistors, the cost of the modification in time and money is negligible.

The Magna-View

Since the Magna-View is one of the most well-known wide-angle home-constructor televisors in this country, we may as well commence by describing the alterations needed with this particular receiver to achieve flyback suppression.

Fig. 1 shows detail of the existing frame output circuit and picture tube supply network used. It will be noticed that the Magna-View employs grid modulation. This point is of advantage for the present modification.

The frame output valve, N78 (or 6AG6 in the Brimar version), draws current through the primary of the frame transformer during the scan period of the scanning cycle in normal fashion. On arrival of the frame sync pulse, the output anode current is reduced immediately, resulting in the formation of a positive-going pulse. If this pulse is then fed to the cathode of the picture tube, the tube will blank out completely during the frame flyback, and no flyback lines can appear.

Fig. 2 illustrates the additional circuitry needed. The extra components consist of the 0.001µF condenser, C101, and two resistors, R101 and R102. (Components suffixes commencing at 101 have been chosen to avoid confusion with existing values). The condenser C101 is mounted on the timebase chassis itself, and receives the positive anode pulse via the feedback condenser, C16.

The other side of C101 then connects to a dummy tag on the picture tube base via a normal unscreened flexible cable; the conductor of which should have a small diameter to reduce its capacity to chassis and to other leads. R101 and R102 are then mounted at the tube base.

These two resistors form a fixed potentiometer. The value chosen for R102, 3.3kΩ, is sufficiently large to enable a pulse voltage to be built up across it without inserting too high an impedance between the picture tube cathode and the decoupling condenser, C8.

R101 is experimental. It should have a resistance lying between 250 and 15 kΩ, the value finally chosen being that which is just sufficiently low to give adequate flyback suppression. Resistors of such values should have negligible effect on frame amplitude or linearity. It is most probable that the final value chosen will be around 100 to 60 kΩ.

R101 may be empirically determined by initially setting the brilliance of the receiver sufficiently high to noticeably bring up the flyback lines; this being done preferably during transmissions of Test Card "C," or tuning signals. Starting at 250kΩ, the value of R101 should then be experimentally reduced until the flyback lines are completely, or, in obstinate cases, very considerably suppressed. Too low a value for R101 may cause loss of the first few lines of the frame scan.

The modification is then complete and R101 may be wired in permanently. It must be mentioned, at this point, that care should be taken to ensure that the dummy tags of the picture tube base used for mounting R101 and R102 do not correspond to any "Internal Connection" pins.

This modification applies also to the Brimar and English Electric "Large Screen TV" booklets; these being, of course, re-writes of the original Magna-View.

are very similar to those of the Magna-View, and the circuit of Fig. 2 can be applied directly, with the following alterations in component suffix numbers.

These are:

For C8, read C27
For C16, read C50
For R8, read R36
For R37, read R64
For VR1, read VR3.

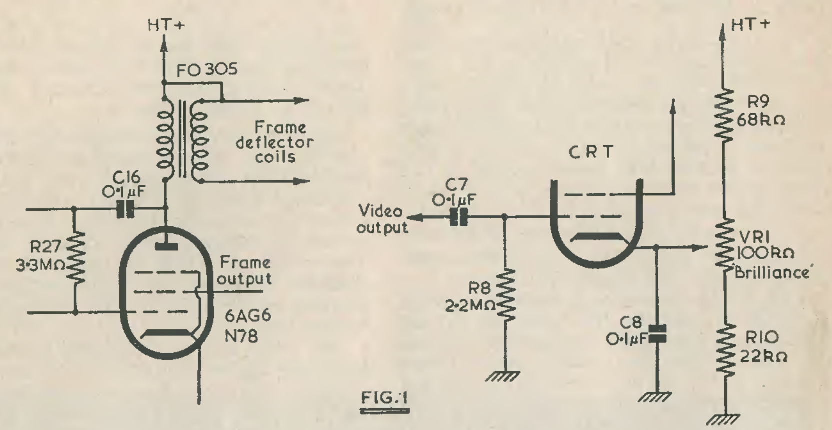


FIG. 1

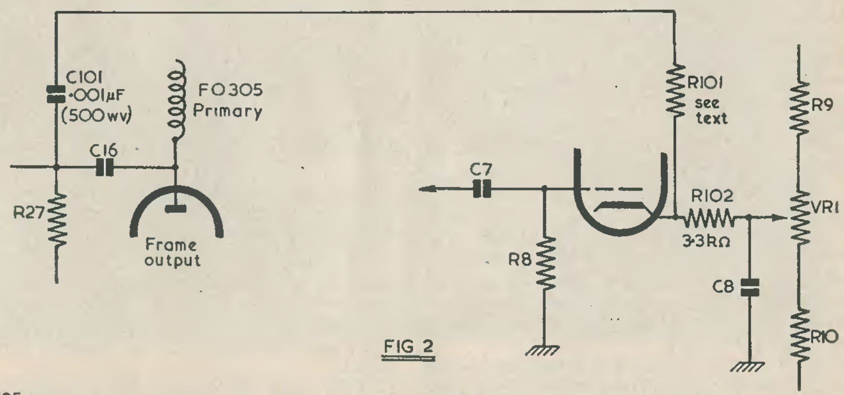


FIG 2

E35

Fig. 1. *The frame output and tube supply circuits of the Magna-View*

Fig. 2. *The modifications to Fig.* 1 *needed for flyback suppression*

The Universal

The Universal may also be modified in a similar manner. The frame output and picture tube supply circuits of this receiver

Other Receivers

One or two other televisors have been described (*after* the Magna-View circuit was published in *The Radio Constructor*), which

employ the Allen FO305 frame output transformer, and grid modulation. If the frame output and tube supply circuits of these are examined, it will be found that they are similar to Fig. 1. The modification of Fig. 2 then applies.

Cathode Modulated Receivers

Some home-constructors receivers use cathode modulation for the picture tube (or a combination of cathode and grid modulation). Although this complicates matters,

Flyback suppression may then be obtained by using the circuit of Fig. 4. In this case the positive blanking pulse is taken, via C102, direct from the frame output anode; and the resistor R102 of Fig. 2 is now replaced by the video output load itself. R103 is again experimental; lying, as in Fig. 2, between 250 and 15 kΩ.

Unfortunately, in this case, too low a value for R103 will cause a large proportion of the blanking pulse to be fed back to the sync separator, resulting in erratic timebase

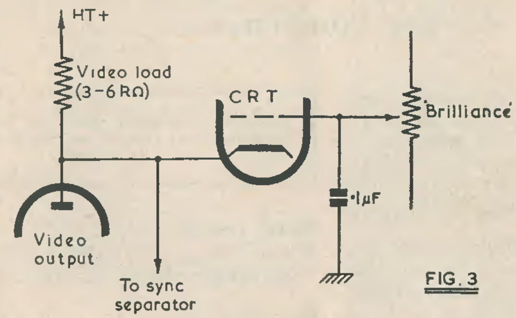


FIG. 3

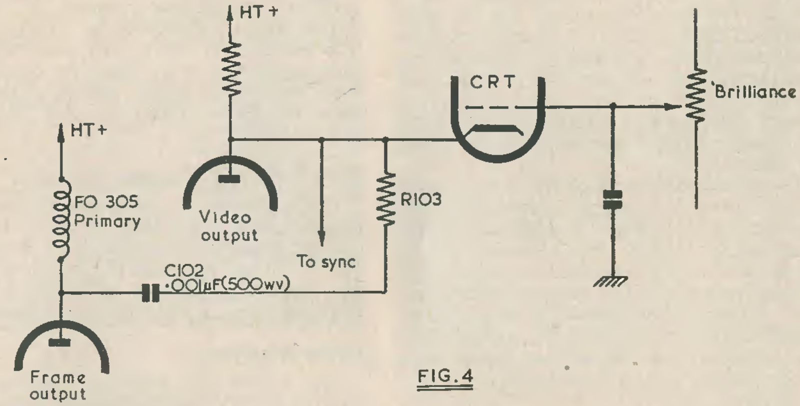


FIG. 4

E36

Fig. 3. *Typical video circuit of a cathode modulated receiver.*

Fig. 4. *Modifying Fig. 3 to obtain partial, or complete flyback suppression*

partial, if not total, suppression of the flyback lines is still possible.

Fig. 3 shows a circuit representative of these receivers. It will be seen that the picture tube cathode is now connected to chassis (so far as VF is connected) via the video output load, and that this point also feeds into the sync separator.

operation. Nevertheless, it should still be possible in many cases to find a practicable value for R103 which is sufficiently low to afford reasonably good or complete flyback suppression, without affecting the operation of the timebases to too severe an extent.

[END

The MULLARD 5-valve 10-watt HIGH QUALITY AMPLIFIER*

a complete design for the Constructor

THERE IS A RAPIDLY GROWING enthusiasm for high quality sound reproduction, and Mullard Ltd. have designed a five-valve, ten-watt high quality amplifier circuit which will enable home constructors to build a high performance amplifier at a comparatively low cost.

Although only four amplifying valves and one rectifying valve are used, the amplifier is sufficiently sensitive to be driven by many popular gramophone pick-ups without recourse to expensive pre-amplifying stages. Circuits for tone control and for the compensation of recording characteristics have been developed. Harmonic distortion has been kept to a very low figure – less than 0.4 per cent at 10 watts output. The frequency response is extremely wide and level, being almost flat from 10 to 20,000 cycles per second.

The circuit of the amplifier is of conventional form. A single-ended high-gain pentode (EF86) feeds a cathode-coupled phase-splitter using the high-mu double triode ECC83. The balanced output voltages derived from the ECC83 are used to drive the grids of two EL84 pentodes in push-pull. Negative voltage feedback is applied from the secondary of the output transformer to the cathode of the input valve.

Valve Line-up

EF86 Low noise pentode voltage-amplifier.
ECC83 High-mu double triode as cathode-coupled phase splitter.
2×EL84 Push-pull pentode output stage
GZ30 Full-wave rectifier Or
EZ80 Full-wave rectifier.

Note: The EZ80 may be used so long as it is not required to supply a current in excess of 90mA. Thus it should not be used when sine wave testing is to be undertaken up to full output power, or when FM units and the like are to be supplied in conjunction with the amplifier.

The cover illustration shows the layout of the Amplifier above chassis, and the arrangement of the controls.

Power Output

Rated output 10W.
Maximum output 12-13W.

Sensitivity

600mV at tone control input.

The actual sensitivity of the amplifier with feedback is 50mV. However, when the tone control unit is used in conjunction with the recommended pick-ups the input must be about 600mV to give maximum power output.

Loop Gain and Frequency Response

Fig. 1 shows loop gain, overall frequency response, and phase shift. Relative to 1,000 c/s, the response is not down by more than ½db at the two extremes of 10 c/s and 20,000 c/s. Over-all feedback of 26db is taken from the secondary of the output transformer.

Power Response

Fig. 2 shows the maximum output power relative to 10W for frequencies between 15 and 30,000 c/s. The measurements were made for a sine wave drive, and with the output stage operated under its normal loading conditions (anode-to-anode load of 8,000Ω).

From 40-10,000 c/s, max. output is 1db relative to 10W.
From 20-16,000 c/s, max. output is 0db (10W).
From 16-30,000 c/s, max. output is –2db relative to 10W.

* Please note that amplifiers are not manufactured by Mullard Ltd., who did, however originate the design.

Distortion

Less than 0.4 per cent at 10W.

Total harmonic distortion has been measured at 40 c/s, 400 c/s, and 2,000 c/s (Fig. 4). For the rated output of 10W the total distortion is:

Less than 0.4% at 40 c/s
Less than 0.2% at 400 c/s
Less than 0.3% at 2,000 c/s.

Hum and Noise

73 db below 10W.

With the ear close to the loudspeaker no hum can be detected, and residual noise is only a slight rustle. Under normal listening conditions hum and noise are completely inaudible.

Hum and noise is 73db below 10W, or 74db blow the maximum rated output of 12.5W.

Output Resistance

0.9Ω on 15Ω output.

The output resistance of 0.9Ω on a 15Ω output is sufficiently small in practice to ensure adequate electrical damping of the speaker coil.

Tone Control

10db boost in treble and bass. 10db attenuation in treble and 5db attenuation in bass.

The tone control unit provides boost and attenuation at both treble and bass frequencies (Fig. 3). Measurements for curves No. 1 and 2 have been made with the treble control set flat, and show the effect of varying the bass control. The reverse procedure was adopted for curves No. 3 and 4. In curve No. 5, a flat response has been obtained by a suitable setting of the treble and bass controls.

The range of control should be sufficient to compensate for widely differing listening conditions.

CIRCUIT DESCRIPTION

Tone Control

Details of a well-known type of tone control using a wide range, passive circuit are included on the circuit diagram (Fig. 8). The treble control is RV23 and the bass control RV24.

This circuit produces an attenuation of about 12 times. Because of the high sensitivity of the amplifier – 50mV at Y-Y with feedback – the tone control unit is suitable for use with a crystal pick-up having a relatively large output, without the need arising for a separate valve pre-amplifier. The input voltage at X-X must be approximately 600mV to load the amplifier fully.

Pick-Ups and Equalising Networks

The Collaro 'O' and 'P' "Studio" pick-up heads and the Acos Hi-g microgroove and standard pick-ups are particularly suitable

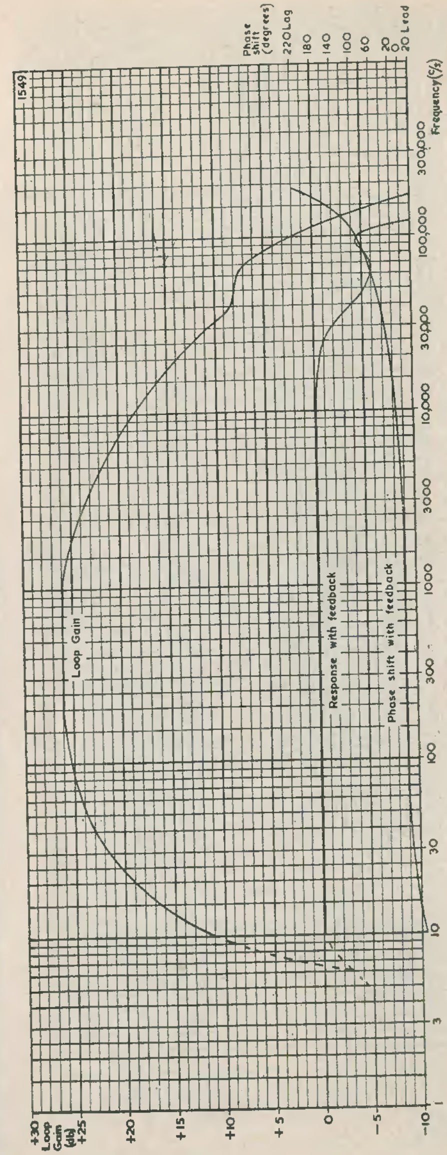


Fig. 1. Typical phase shift and response characteristics of complete amplifier

for use with the amplifier. Details of some equalising networks which have been found very satisfactory are given in Fig. 6. They are designed to match into the input impedance of the tone control circuit, and were derived using the Decca K1804A (78 rpm) and Decca LXT2695 (33⅓ rpm) recordings.

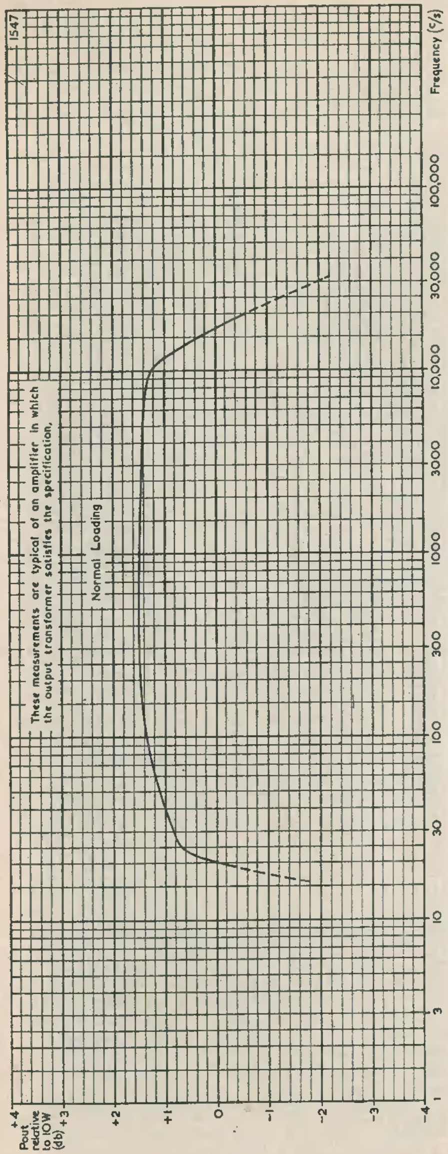


Fig. 2. Maximum output power of amplifier plotted against frequency

First Amplifying Stage

The first stage of amplification is provided by the EF86, in a circuit having a gain of approximately 150 times. The negative feedback voltage from the secondary of the output transformer is introduced across the 100Ω resistor, R5, in the cathode circuit. In a feedback amplifier with a wide frequency response, stability can be achieved only if the required difference in phase is maintained between the input signal and the feedback voltage.

The EF86 has accordingly been coupled directly to the following stage in order to reduce the phase shift at low frequencies. The C-R network (C13, R22) shunting the anode load produces an advance in phase, which increases the stability of the amplifier at high frequencies.

Phase Splitter

The output stage is fed by an ECC83 double triode operated as a cathode-coupled phase splitter. The two grids are coupled together by R8, the second being capacitively earthed by C7. ~~The cathodes of the ECC83 are biased to have the same voltage as the anode of the EF86 (=70V).~~ * Anode resistors R9 and R10 (=100kΩ) should be matched within 5%, R10 being given the larger value.

The use of the cathode-coupled circuit provides for low distortion and facilitates direct coupling to the first stage. The gain obtained with the cathode-coupled circuit is about half that obtained from each valve section operated as a normal voltage amplifier. Nevertheless, it is sufficient as the ECC83 has an amplification factor of 100.

Output Stage

The output stage is equipped with two EL84 output pentodes operated in a self-biased push-pull circuit. The anodes are fed from the reservoir capacitor C1, the screen grids and the rest of the amplifier being supplied via R18 and C2. Separate bias resistors R16, R17 are used. Stopper resistors (R14, R15, R19, R20) are included in the control- and screen-grid leads.

A resistor with a value of about 1kΩ may be placed across the output terminals to prevent instability from occurring with a disconnected loudspeaker.

Operating Conditions

Alternative modes of operating two EL84's in a push-pull output stage can be compared by referring to the curves showing total harmonic distortion plotted against output power (Fig. 5). Curve No. 2 is plotted for cathode bias and refers to a sine wave input. It is obtained under the conditions given for Class AB operation in the valve data; these conditions are necessary for testing the amplifier with a sine wave input up to full power. They can be referred to as the 'normal loading' conditions, the anode-to-anode impedance being 8,000Ω and the quiescent anode current 2×36mA. With speech and music inputs, however, the output stage operates with approximately fixed bias. As a result, when the normal loading conditions are used for speech and music (Curve No. 1), the distortion above 10W is considerably greater than might be expected from the data. It can be seen that above 12.5W the distortion for speech and music inputs would be nearly twice that obtained for a sine wave input.

* The correct value of 1·5V grid to cathode bias is produced when the anode voltage of the EF86 is 70V.

Low Loading Operation

For low loading operation

An alternative set of operating conditions (Curve No. 3) will result in lower distortion when the amplifier is used for the reproduction of speech and music. Under these alternative conditions, the anode-to-anode load is reduced to 6,000Ω and the quiescent anode current to 2×24mA. This may be termed 'low-loading' operation.

For low loading operating the appropriate value of both cathode resistors R16 and R17 is 437Ω (=390Ω+47Ω), as compared with the value of 270Ω each for normal loading (that is, for the Class AB conditions given in the data.)

The HT consumption is considerably smaller when the output stage is adjusted for low loading. In consequence, the standing dissipation in the output stage is reduced from 11W at each anode to 7.5W at each anode, the output valves then being run well below their maximum permissible anode dissipation of 12W. There will also be less ripple on the HT line. As a measure of economy, the mains transformer can be given a lower rating provided the amplifier is to remain permanently adjusted to low loading.

Effective distortion for the low loading adjustment cannot be measured easily because standard measurements of harmonic distortion and intermodulation distortion are not practicable when the maximum output is approached. A low level sine wave, however, may be used to measure frequency response on condition that the output power does not exceed 1-1.5W, otherwise excessive distortion will occur. Normal square wave testing can be undertaken, but the input should not exceed a level similar to that used for the low level sine wave.

Peak Handling Capacity

Larger peak currents are produced in the output stage under low loading conditions than with normal Class AB operation.

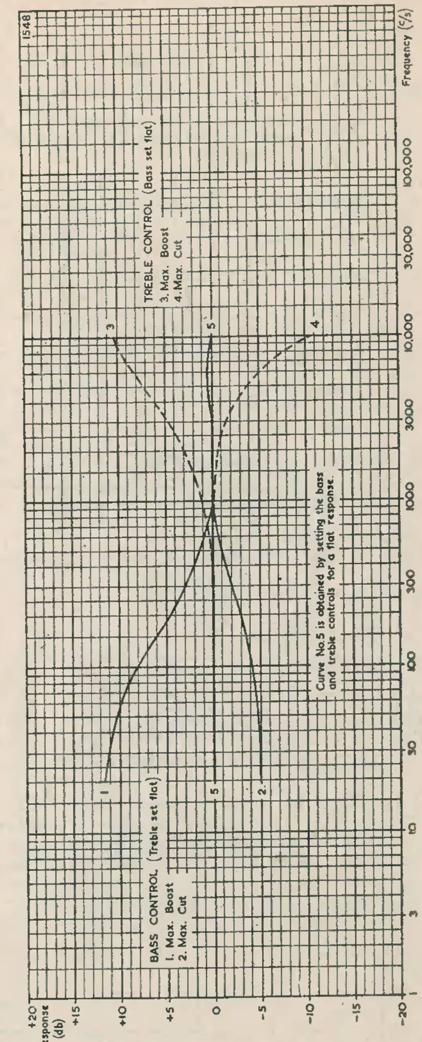


Fig. 3. Frequency response of tone control circuit

These peak currents are of short duration with a speech and music input. They are supplied by the reservoir capacitor C1 which is of large value (50µF). When the amplifier is at the point of overload on peak signal, the momentary fall in line voltage should not be more than 2V on the nominal line voltage of 320V.

As the current in the output stage increases, there follows an increase in the bias voltage

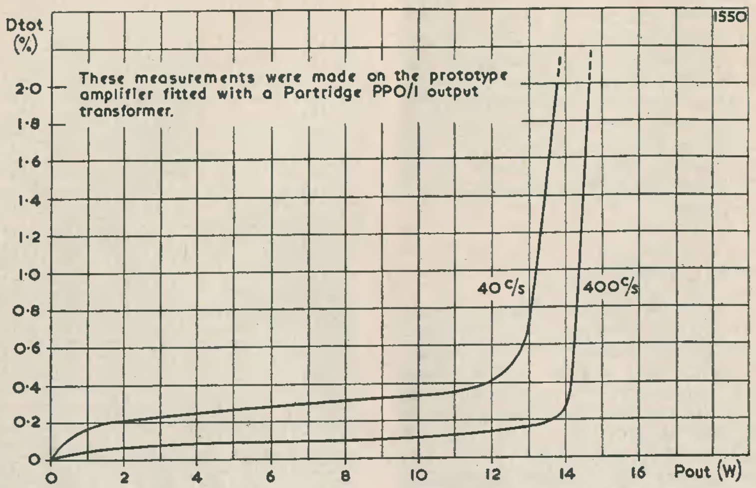


Fig. 4. Total harmonic distortion plotted against output power for the complete amplifier

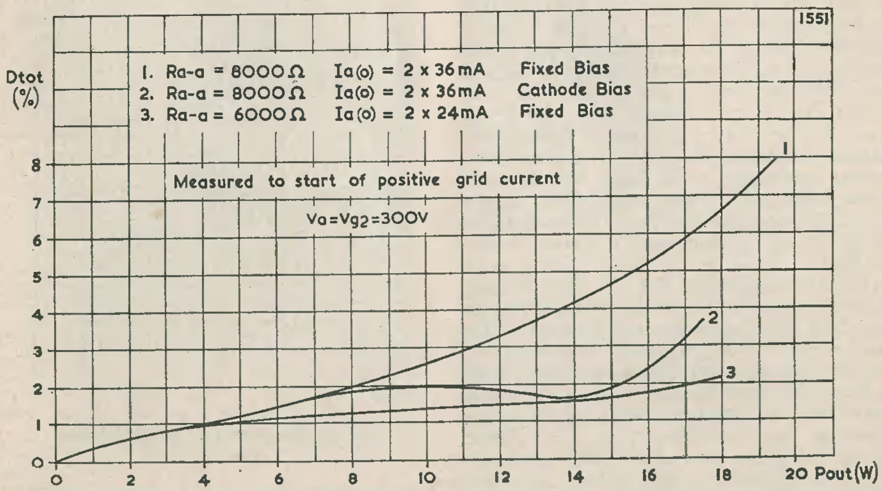


Fig. 5. Total harmonic distortion plotted against output power for two EL84's operated in push-pull, with anode and screen grid voltages of 300*V*

across the cathode resistors at a rate determined by the time constant of the bias networks. Measurements have shown that in practice this increase in bias is not likely to exceed 1V. The working conditions of the output stage are such that the output valves are then driven back into a region where lower distortion is obtained.

As a result, however, of any change in the bias of the output stage, a variation in gain will occur; but the distortion which is introduced in this way is held to a low level by the large amount of negative feedback.

Output Transformer

A detailed specification for the output transformer is given later.

The output transformer is the most important component in a feedback amplifier, and it is essential that it shall give adequate performance. It is therefore advisable to obtain the output transformer from a manufacturer who has undertaken to build this component specially for the amplifier. It is essential that a component meeting the minimum specification be used, otherwise there will be instability and deterioration in performance.

Of the output transformers currently available, the Partridge PPO was selected as being suitable. The distortion curves (Fig. 4) were obtained with the prototype amplifier fitted with this output transformer.

Rectifier

The GZ30 full-wave rectifier can supply a current drain of 125mA and is completely suitable for all applications of the amplifier. With the GZ30, sine wave testing can be pursued up to full output power. Under practical conditions, with speech and music inputs, the GZ30 will have sufficient current reserve to supply an FM unit in conjunction with the amplifier.

The GZ30 has a 5-volt heater and is mounted on the Octal base.

Most home constructors will not have the necessary equipment to undertake sine wave testing at high output powers. Rectifier type EZ80 can then be recommended, the restriction being that the EZ80 must not supply a current in excess of 90mA. Thus the EZ80 can be fitted when the amplifier is to be permanently adjusted to 'low loading' conditions, since sine wave inputs can then be used to produce an output power of up to 1-1.5W. Under 'normal loading' conditions the power output can be increased up to 6W before overloading of the EZ80 will occur. Square wave testing can be used with the EZ80 for both the normal loading and low loading adjustments, provided the input is of a similar level to that used for the corresponding sine wave testing.

The EZ80 should not be expected to supply the additional current required for FM units and the like.

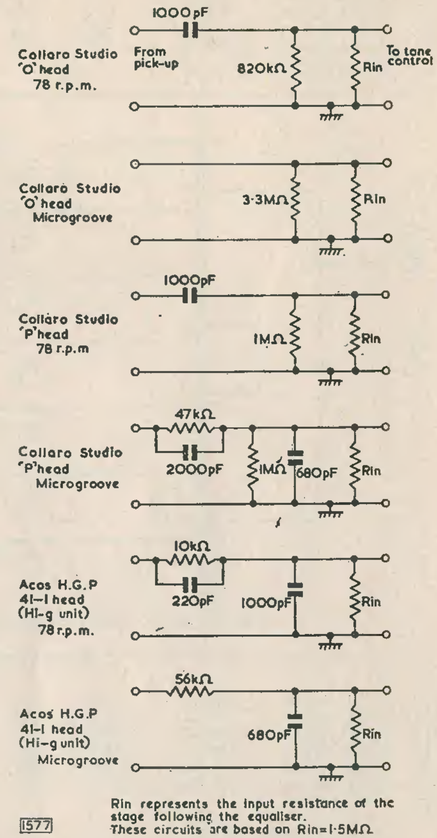


Fig. 6. Equalising networks suitable for use with tone control circuit

The EZ80 has a 6.3 volt heater and is mounted on the B9A (noval) base.

It can be seen that before making up the amplifier some consideration must be given to the way it is to be used, and how this will affect the choice of rectifier.

PARTS LIST

Resistors

Circuit Ref.	*Description*	*Value*	*Tolerance*	*Rating*
RV1	Variable, carbon	1MΩ (log law)		
R2	Fixed, carbon (high stability)	180kΩ	±10%	1W
R3	Fixed, carbon	1MΩ	±10%	¼W
R4	Fixed, carbon	1.8kΩ	±10%	¼W
R5	Fixed, carbon	100Ω	± 5%	¼W
R6	Fixed, carbon	100kΩ	±10%	¼W
R7	Fixed, carbon	68kΩ	±10%	1W
R8	Fixed, carbon	1MΩ	±10%	¼W
R9	Fixed, carbon	100kΩ	±10%	½W

choice of rectifier. They must be chosen to make the total effective limiting resistance of each anode of the rectifier up to the required value.

The total limiting resistance, Rlim, in series with each anode of the rectifier must be at least 47Ω for the GZ30 or at least 215Ω for the EZ80. The amount of series resistance, Rt, contributed by the transformer is:

$$Rt = \tfrac{1}{2}Rs + n^2Rp$$

where Rs = resistance of secondary
Rp = resistance of primary
n = voltage across half the secondary divided by the voltage across the primary.

Thus if Rt is less than Rlim, then R27 and R28 must both be chosen equal to the difference between them.

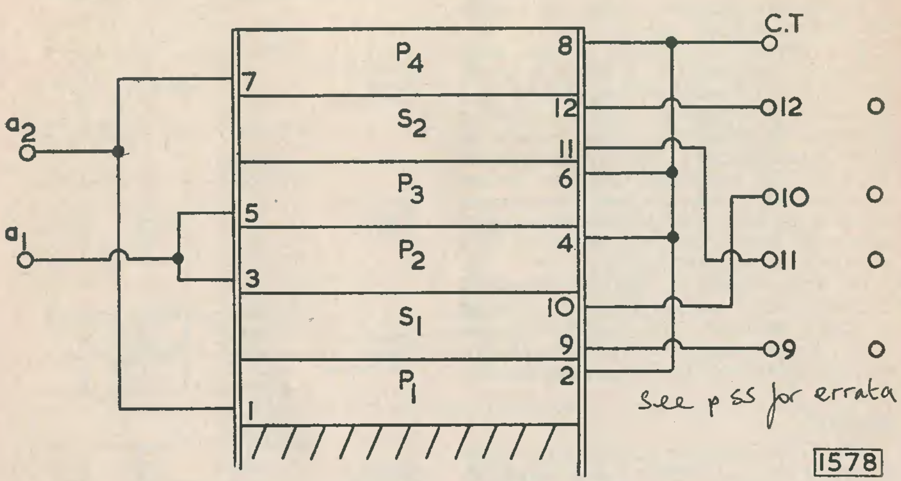


Fig. 7. Interconnection of windings on output transformer

R10	Fixed, carbon	100kΩ	±10%	¼W
R11	Fixed, carbon	33kΩ	±10%	¼W
R12	Fixed, carbon	820kΩ	±10%	¼W
R13	Fixed, carbon	820kΩ	±10%	¼W
R14	Fixed, carbon	4.7kΩ	±20%	¼W
R15	Fixed, carbon	4.7kΩ	±20%	¼W
R16	Fixed, carbon			
R17				
	Normal Loading	270Ω	± 5%	3W
	Low Loading	390+47Ω	± 5%	3W
R18	Fixed, carbon	1.2kΩ	±10%	1W
R19	Fixed, carbon	47Ω	±20%	¼W
R20	Fixed, carbon	47Ω	±20%	¼W
R21	Fixed, carbon	(See below 3)	±5%	¼W
R22	Fixed, carbon	18kΩ	±10%	¼W
RV23	Variable, carbon	2MΩ (log law)		
RV24	Variable, carbon	2MΩ (log law)		
R25	Fixed, carbon	1.5MΩ	±10%	¼W
R26	Fixed, carbon	150kΩ	±10%	¼W
R27	Fixed, carbon	(See below 2)	±20%	1W
R28	Fixed, carbon	(See below 2)	±20%	1W

1. The resistors for R9 and R10 should be matched to within 5%, and the larger used for R10.
2. The values of R27 and R28 depend on the winding resistances of the mains transformer and on the

Capacitors

Circuit Ref.	*Description*	*Value*	*Rating*
C1 } C2 }	Double Electrolytic	50+50μF	350V DC wkg.
C3	Electrolytic	10μF	350V DC wkg.
C4	Electrolytic	10μF	350V DC wkg.
C5	Electrolytic	100μF	12V DC wkg.
C6	Paper	0.02μF	350V DC wkg.
C7	Paper	0.1μF	350V DC wkg.
C8	Paper	0.1μF	350V DC wkg.
C9	Paper	0.1μF	350V DC wkg.
C10	Electrolytic	100μF	25V DC wkg.
C11	Electrolytic	100μF	25V DC wkg.
C12	Ceramic or Mica	(See below 3)	
C13	Ceramic	100pF	±20%
C14	Ceramic	33pF	±10%
C15	Ceramic or Mica	680pF	±10%
C16	Ceramic or Mica	270pF	±10%
C17	Ceramic or Mica	3300pF	±10%

3. The values of the resistor R21 and its shunt capacitor C12 in the main feedback loop depend upon the impedance of the loudspeaker. A selection of values is given below:

Speaker Impedance	*C12*	*R21*	*Tolerance*
3.75Ω	180pF	15kΩ	±5%
7Ω	120pF	22kΩ	±5%
15Ω	82pF	33kΩ	±5%

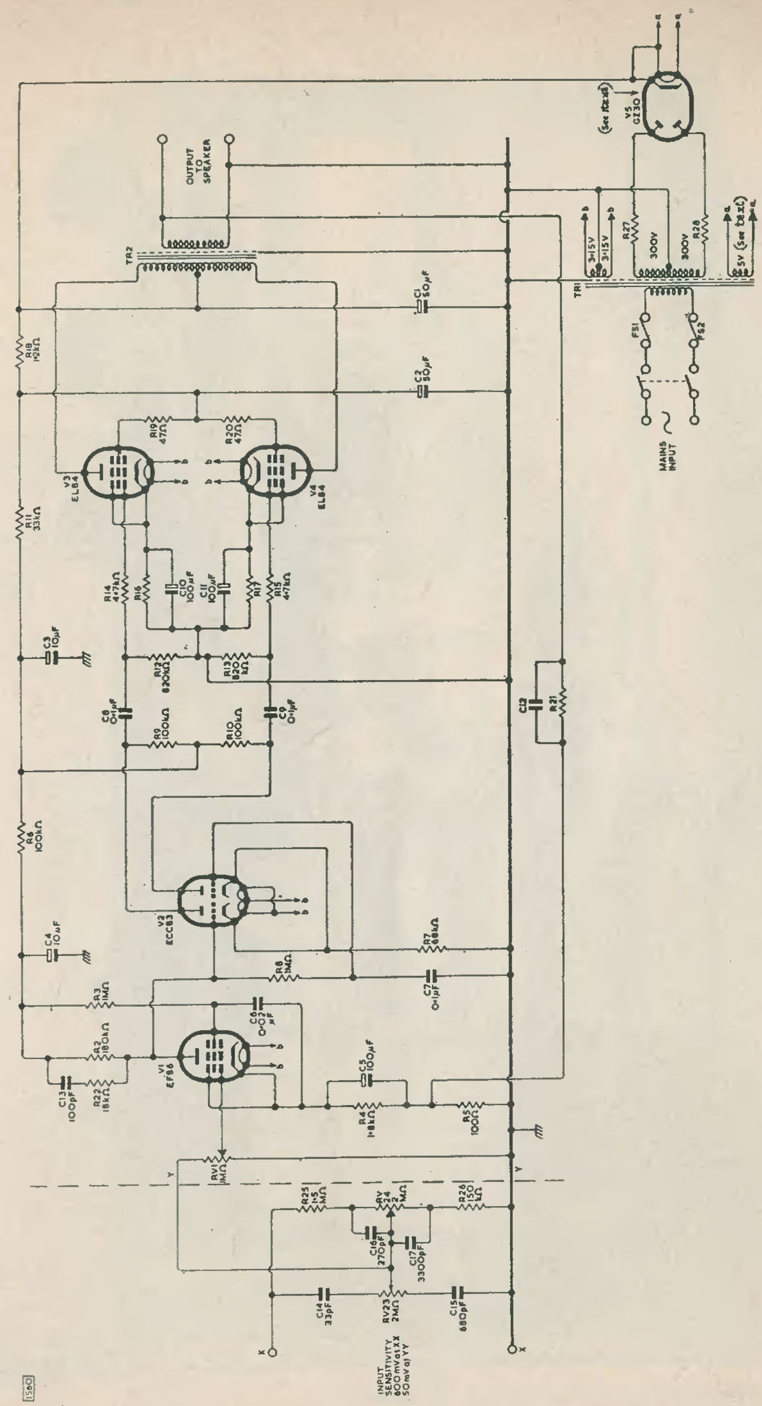
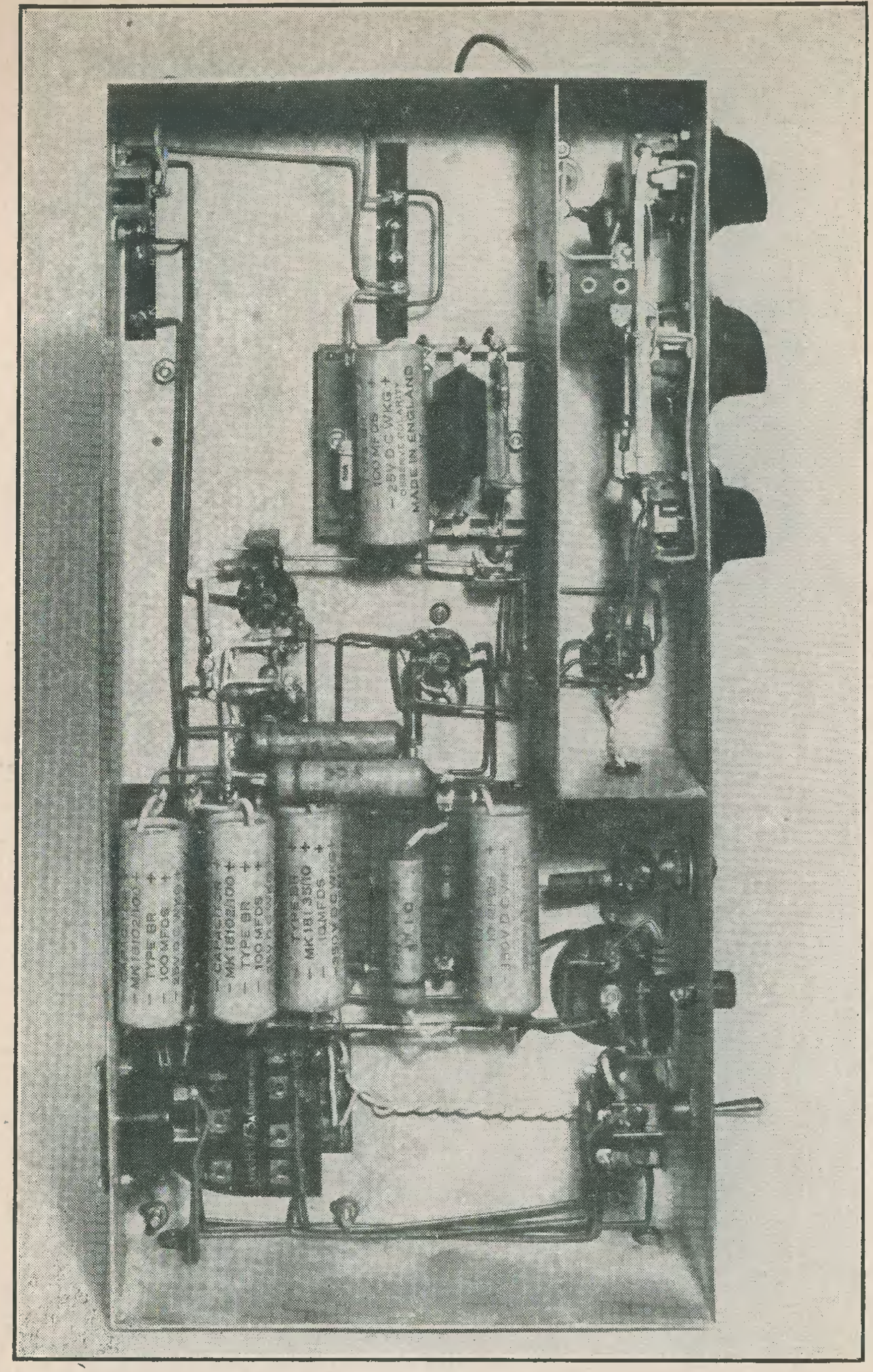


Fig. 8. Circuit diagram of main amplifier and tone control unit



Below chassis view of complete amplifier, showing screening of control section

Valves

Circuit Ref.	*Make*	*Type No.*
V1	Mullard	EF86
V2	Mullard	ECC83
V3, V4	Mullard	2×EL84
V5	Mullard	GZ30 or EZ80 (See note 4 below)

4. The EZ80 must not supply a current of more than 90mA.

Mains Transformer (TR1)

	Voltage Tappings	*Current Ratings*
Primary	10-0-200-220-240V	
Secondaries:		
Normal loading:	300-0-300V	100mA
	3.15-0-3.15V	2A
	0-5V	2A
Low loading:	300-0-300V	60mA
	3.15-0-3.15V	2A
	0-6.3V	1A

Fuses (FS1, FS2) 1 amp.

SPECIFICATION FOR OUTPUT TRANSFORMER (TR2)

Matching

8000Ω or 6000Ω primary to 15Ω or 3.75Ω secondary

Note: In winding table (A) refers to 8000Ω primary, (B) to 6000Ω primary.

Winding Data

Core: Square stack of $1\frac{1}{8}$" centre limb, E and I laminations, "NO WASTE" series.
Pattern No. Sankey No. 158, proposed British Standards No. 29.

Core Material: 4% Si steel, 0.014" laminations

Core Size (External); 3.375×2.8×1.125 inches.
Bobbin to suit.

Winding Table

Winding	*No. of Turns*	*No. of Layers*	*Turns per layer*	*Wire*
P1	1650(A) 1450(B)	7	236(A) 207(B)	40 swg.
S1	76	2	38	22 swg.
P2	1650(A) 1450(B)	7	236(A) 207(B)	40 swg.
P3	1650(A) 1450(B)	7	236(A) 207(B)	40 swg.
S2	76	2	38	22 swg.
P4	1650(A) 1450(B)	7	236(A) 207(B)	40 swg.

Wire: Enamelled Copper

Width of Windings: 1.35 inches.

Insulation: Between layers of primary sections: 0.001" paper.
Between layers of secondary sections: 0.003" presspahn.
Between various sections: 1 layer of 0.003"-0.004" presspahn, and 1 layer of 0.002" paper.

If P1 and P2 are wound clockwise, then all other windings are wound anti-clockwise. All windings to be in the same sense.

The following windings are connected in parallel:
P1 and P4 to form one half of primary;
P2 and P3 to form other half of primary. wound from Right *

S1 and S2 are brought out separately for series (15Ω) or parallel (3.75Ω) connection.

Electrical Characteristics

Primary shunt inductance (8000Ω), 40H at 10V 50 c/s.
Primary leakage inductance, 25mH.
Primary DC resistance, 240Ω per half primary (8000Ω).
Secondary resistance: S1 approx. 0.5Ω
S2 approx. 0.5Ω

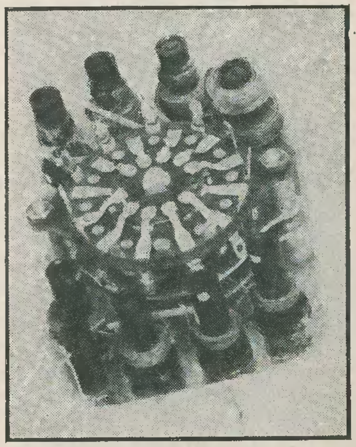
CIRCUIT VOLTAGES

Testing Point	*Voltage DC*	*Voltage AC*	*Meter Range*
C1	320V	Normal loading 4V	1000V DC
		Low loading 2.5V	V.V. AC
C2	310V		1000V
Cathodes V3, V4	12V		100V
Anodes V3, V4	310V		1000V
Screen grids, V3, V4	310V		1000V
C3	255V		1000V
Anodes V2	210V		1000V
Cathodes V2	70V 71.5V		1000V
C4	182V		1000V
Anode V1	70V		1000V
Screen grid V1	65V		1000V
Cathode V1	1.5V		25V

These voltages were measured with Model 8 Avometer (20,000Ω/V) with zero input signal.

Mullard Ltd. have informed us that suitable output transformers can be obtained from Messrs. Partridge, type P.3650; Parmeko, type P.2629; or Goodsell Ltd., type Output Transformers for Mullard 5-Valve 10-Watt Amplifier.

Trade Review



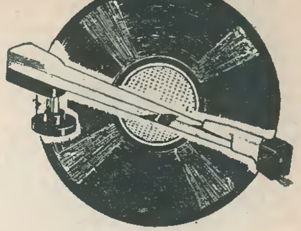
Denco (Clacton) Ltd., 357 Old Road, Clacton-on-Sea, Essex, have supplied us with details of their new type coil packs – both pre-set and normal types. These have been developed from the coil packs previously reviewed in our May issue (see page 596). Since the appearance of these many requests were received by Denco (Clacton) Ltd., for similar packs fitted with a Gram switch position. This has now been done, and the illustration alongside shows the popular CP4L/G. All of these packs are of the single hole fixing type. Each coil is tuned to resonance by means of an adjustable iron dust slug, and the pack is extremely well produced and robust. The types now available are as follows:

CP4L/G Pre-set Long and 3 Medium Wave stations	41/4
CP4M/G Pre-set 4 Medium Wave stations	41/4
CP3/G 3 waveband for use with Jackson 500pF condenser and SL8 scale	52/0

This range of coil packs should prove extremely popular with constructors of home built equipment. In this issue, on page 33, will be found a constructional article incorporating one of the packs which we previously reviewed.

* to left. All other windings to be from left to right.

REPRODUCING RECORDS



Part 2

By **O. J. RUSSELL,** B.SC., A.INST.P., G3BHJ

To reproduce gramophone records with correct tonal balance requires the use of correction circuits for the reasons previously discussed. In general, we have to correct for both the bass and the treble recording characteristic. Let us consider the correction of the treble first, as this is the simplest case.

The circuit of Fig. 1 gives a typical treble "equalising" circuit. At low frequencies, the condenser has practically no effect upon the frequency characteristic, as it is chosen to have a very high impedance at low frequencies. However, at higher frequencies the reactance of the condenser becomes comparable with the series resistance, so that the grid is, in effect, shunted across a potentiometer. The potentiometer arm represented by the condenser gets progressively smaller in value as the frequency rises, so that the overall output drops steadily with frequency. Thus the "rising top" characteristics of gramophone recordings can be compensated by making the condenser and resistance of the correct values.

To make the condenser and resistance the correct values for a given recording characteristic, we should consider the graph of Fig. 2. This shows that in the upper register the response of the condenser and resistance falls off at a value which is approximately 6db per octave. This slope is a characteristic of RC correction circuits. It is also that associated usually with gramophone recordings, where the record characteristic is determined by suitable RC correcting circuits in the recording amplifier. Generally, by choosing the *right* values we can precisely correct the record characteristic and thus obtain an overall flat characteristic.

Inspection of Fig. 2 reveals that at the lower frequencies the correction becomes less steep until the curve becomes flat. However, if we continue the steep part of the curve down, as shown by the dotted line, it intersects the flat level of the curve at a frequency F. This is known as the "turnover frequency," and the attenuation at this point is actually 3db. It is also known as the "three db point." This turnover frequency is the one used as a basis of design, for at the "turnover" frequency the *reactance* of the condenser is equal in magnitude to the *resistance* of the series condenser. Thus if R is in ohms, and C is in Farads,

$$R = \frac{1}{2\pi FC},$$

where F is the turnover frequency. This is a little inconvenient to use, as we usually like to make R a suitable load for the amplifying stage in front of it, so that R is often of the order of 100,000 ohms. Thus if C is in microfarads, and R in thousands of ohms, then we have

$$1{,}000R = \frac{1}{2\pi FC}$$

which is more convenient to work with. Thus if the turnover frequencies are known, a correction circuit can be devised by calculating suitable values to place in this circuit.

As already stated, HMV and EMI Group Recordings need no top correction. Decca FFRR recordings have a turnover frequency of approximately 8,000 cycles. The American and LP recordings use a rather wide range of turnover frequencies, and this at first sight seems a hopeless number of characteristics to cater for. Fortunately, however, almost perfect correction for these U.S.A. character-

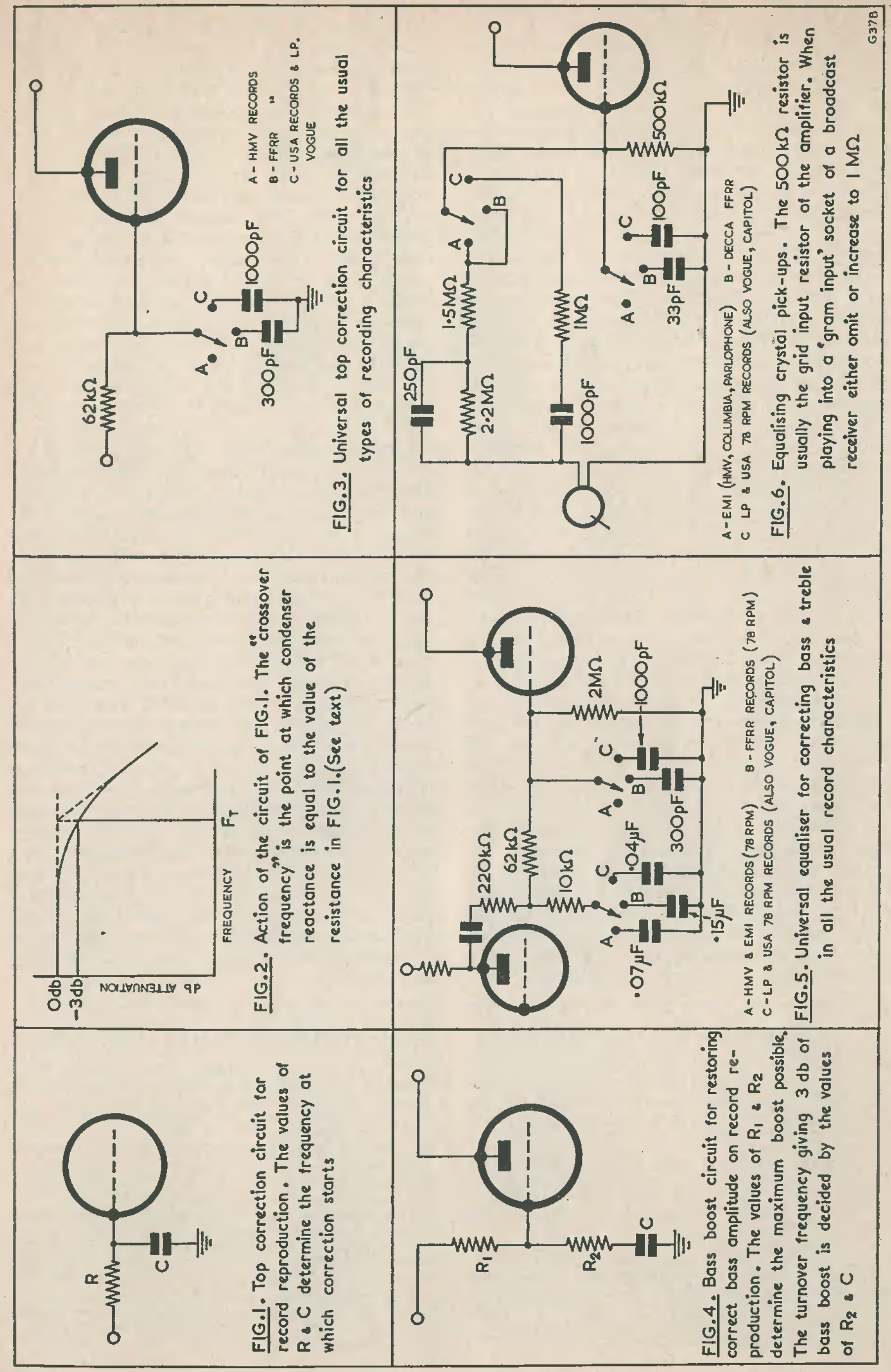


FIG.1. Top correction circuit for record reproduction. The values of R & C determine the frequency at which correction starts

FIG.2. Action of the circuit of FIG.1. The "crossover frequency" is the point at which condenser reactance is equal to the value of the resistance in FIG.1. (See text)

FIG.3. Universal top correction circuit for all the usual types of recording characteristics

FIG.4. Bass boost circuit for restoring correct bass amplitude on record reproduction. The values of R_1 & R_2 determine the maximum boost possible. The turnover frequency giving 3 db of bass boost is decided by the values of R_2 & C

FIG.5. Universal equaliser for correcting bass & treble in all the usual record characteristics

FIG.6. Equalising crystal pick-ups. The 500kΩ resistor is usually the grid input resistor of the amplifier. When playing into a 'gram input' socket of a broadcast receiver either omit or increase to 1 MΩ

istics is obtained by choosing the crossover frequency as 2,500 cycles.

To save the reader the bother of calculating these networks, typical values for a "universal network" are given in the circuit of Fig. 3. The first switch position (A) has no correction condenser and serves for HMV and other EMI Record Companies that employ no treble boost on recordings. The second position gives correction for the Decca FFRR treble boost, and the third position serves for both Long Playing records and for 78 rpm American recordings. As previously explained, many records made with American characteristics are issued on British Labels. Thus Vogue and Capitol records may have either a U.S.A. characteristic, or in a few cases a Decca FFRR type of recording curve, according to information supplied by the Vogue Record Company.

The bass correction circuit is shown in Fig. 4. This is similar to the previous circuit. At high frequencies the condenser reactance is low, so that the grid receives a voltage tapped down by the potentiometer formed by R_1 and R_2. At low frequencies the condenser reactance rises, so that the voltage applied to the grid increases. The ultimate slope of this "bass boost" curve is again 6db per octave, and the 3db point, or turnover frequency, is determined by the reactance of the condenser being equal to R_2. Thus from a known turnover frequency in the Bass recording characteristic, we can calculate the constants necessary for the bass correction circuit. However, notice that the ratio of R_1 to R_2 determines the total bass boost possible. At the lowest possible frequency there is no attenuation, while at the high frequencies we have the potentiometer step-down formed by R_1 and R_2. Thus if we make R_1 ten times the value of R_2, then the maximum possible boost is about 10:1 in volts, which is 20db of boosting. However, in some cases a little more boosting than this is necessary, so that 20:1 is a preferred ratio for the boost resistors.

To save the reader calculations, the top correction and the bass correction circuits can be combined into one circuit. This is given in Fig. 5, and with a three-position two-pole switch will give satisfactory correction for all the types of record characteristic mentioned. It is intended to follow a pre-amplifier stage, assuming that a HiFi straightline pick-up is used. However, crystal pick-ups have one or two peculiarities of their own, and require slightly different treatment in some cases. A crystal pick-up usually has a high output, so that a correction circuit may be placed immediately after the pick-up without an intermediate amplifier.

An example of a modern High Fidelity crystal pick-up of first class performance is the ACOS 20 HiG, which is available with the HGP 39 heads for both standard and LP recordings. (HGP 39 Std and HGP 39 LP). These heads may be equalised to a "record-to-amplifier" input flat from 40 c/s to 14 kc/s, a truly "hifi" performance. Due to the special "high compliance" construction, the pick-ups can successfully track recordings with the maximum top boost employed in recording with negligible distortion, so they can be recommended as a High Fidelity pick-up at a very modest cost. Their popularity focuses attention upon suitable equalising circuits, and Fig. 6 gives a suitable switched equaliser for all the usual recording characteristics mentioned. This operates directly from the pick-up itself, and the high output of the crystal heads usually enables the equalised output to be fed directly into the "gramo" terminals of the average BC receiver. However, the superb quality possible with such pick-ups is done less than justice by the average domestic receiver, and deserves something in the nature of a HiFi amplifier. It is hoped shortly to describe simple but effective HiFi reproducing units to enable reasonable HiFi home reproduction to be achieved at a moderate cost, using these pick-up units as a basis.

EVENING RADIO COURSES

READERS may be interested to learn of the radio courses listed below, which will take place at Brentford Evening Institute, commencing on Sept. 20th next. In all cases the registration fee is 15/–, and enrolment takes place on the evenings of Sept. 13-17 incl. (or subsequently).

The courses are:—

(1) *Radio Servicing I*, held on Mondays from 7-9 p.m. The course assumes no previous knowledge of radio. Some practical work is included.

(2) *Radio and TV Servicing II*, held on Tuesdays, 7-9 p.m.

(3) *Radio Amateurs Course*, held on Wednesdays, 7-9 p.m. This course is also designed to cater for those with no previous knowledge of radio, and prepares students for the C. and G. examination held in May 1955. This course does NOT include Morse instruction, since this is not a requirement of the City and Guilds Examination.

RADIO AMATEUR INVALID AND BEDFAST CLUB

Officers:

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Treasurer, J. Comben, "Oldborn," Gordon Avenue, Foxrock, Co. Dublin, Ireland.

The Secretary welcomes applications from Hams and S.W.L.'s who are invalids. There is no subscription to pay. He would also like to hear from active amateurs willing to act as visiting technical Reps. in and around their locality.

Unwanted Magazines and Books should be sent to John Gill, applications for membership and surplus components to Secretary and donations to Treasurer, Jack Comben.

The Constructors' PRE-SET FIVE

By **F. A. BALDWIN,** A.M.I.P.R.E.

This receiver design, using the new Maxi-Q coilpack type CP4/L and Mullard B8A valves, is an attractive proposition for those readers wishing to construct a pre-set tuned receiver. – Ed.

WITH THE ADVENT OF THE NEW Maxi-Q pre-set coilpack, which provides for a choice of three Medium and one Long wave channel (see Table 1), it was decided to design and construct a receiver using modern components in order to obtain first-rate performance. In the design offered this has been achieved. Negative feedback has been included to greatly enhance the quality and, furthermore, provision has been made for a pick-up connection. Incidentally, this last feature enables the receiver to be used as an audio amplifier in trying out various "front ends" which the enthusiast may care to construct from time to time. Used purely as a workshop receiver, such a provision is worthwhile in that it saves a separate amplifier for this and other purposes. One advantage in using the coil pack specified, of course, is the saving, both in space and cost, of a variable tuning condenser.

Several alterations to the circuit as shown (see Fig. 2) could be made, depending on the individual preferences or needs of the constructor. The first that comes to mind is the substitution for the output valves shown of a similar type giving greater output. Such a valve is the Mullard EL41 which is capable of an output of some 4.2 Watts, whereas the valve specified here is rated at some 2.5 Watts. No alterations either to the valveholder connections or the component values are necessary for this modification. If used as a receiver solely for the workshop, provision could easily be made for the power supply to be switchable and for an outlet to be provided so that the power could be fed into any other unit under construction or test. Thus, three units in one would be the result, i.e., a receiver, audio amplifier and a power supply suitable for the average radio receiver.

Circuit

The heart of this is, of course, the Maxi-Q coil pack used in conjunction with the Mullard ECH42 frequency changer. The condensers C1, and C5 replace the conventional variable ganged capacitor. These should be close tolerance condensers if maximum efficiency is to be obtained from this stage. The remainder of the mixer circuit is entirely conventional and should present no difficulty, provided the component values specified are closely followed. Several voltage readings

TABLE I

PRINCIPLE BROADCAST STATIONS

Station	*Wave length Metres*	*Freq. kc/s*
LONG WAVE:		
B.B.C. Light Prog.	1500	200
MEDIUM WAVE:		
B.B.C. Third Prog.	464	647
B.B.C. North	434	692
Hilversum I	402	746
B.B.C. Scottish	371	809
Paris I	348	863
B.B.C. Welsh	341	881
B.B.C. London	330	908
Berlin..	303	989
Hilversum II..	298	1007
B.B.C. West	285	1052
B.B.C. Midland	276	1088
B.B.C. North and North Ireland	261	1151
B.B.C. Light Prog.	247	1214
Luxembourg II	208	1439
B.B.C. West	206	1457
B.B.C. Third	194	1546

have been given on the diagram, and these should be of some assistance to the constructor (meter 1mA FSD).

The IF stage is straightforward and requires no further comment, although it would be as well here to remind readers that the valve base spigot of this and the other stages should be earthed. This effectively forms a screen between pin 2 (anode) and pin 6 (grid).

The Detector (EBC41), has been made as simple as possible, as indeed has the whole circuit, both to aid beginner constructors and to reduce the cost somewhat. Note should be taken of the screened leads; this is particularly important if hum is to be avoided, especially when the unit is used as an amplifier. A further modification here could be the inclusion of a switch in the IF screen grid supply to cut the HT supply when using the pick-up. In the prototype, it was found that removal of the aerial from the input socket effectively silenced the receiver for radio with the station selector switch on position 4, where a Continental station had been pre-set.

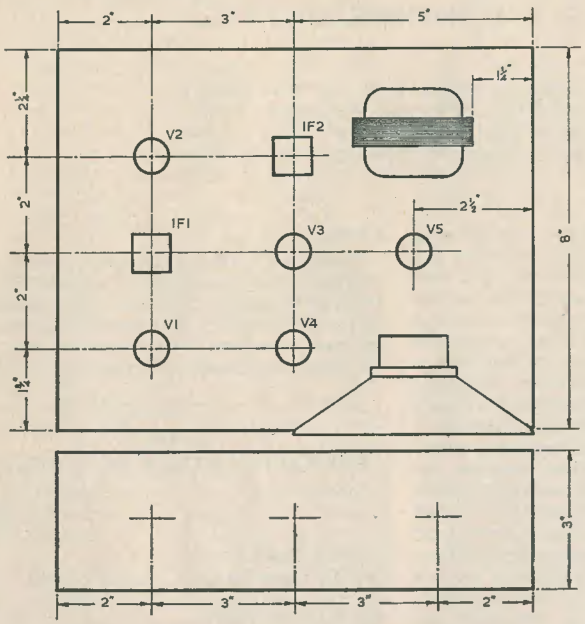
The audio gain control R11 also includes the mains on/off switch, this control occupying the centre position on the chassis front "drop." As an RF filter, C18 has been included to ensure that no residual RF reaches the output stage grid.

The AVC voltage derived from the IF anode circuit is fed both to the IF and mixer stages.

The output stage is built around the EL42; it will be seen that a tone control has been incorporated in the anode circuit (C20 and R20). Negative feedback has been incorporated in order to obtain a fair degree of quality. When first trying out the receiver, this should be disconnected at the point marked X. With the receiver functioning satisfactory, connection should then be made. Should oscillation occur, the connections to the speaker should be reversed. If negative feedback is not required, both R9 and R12 should be omitted from the circuit and C13 taken direct to chassis.

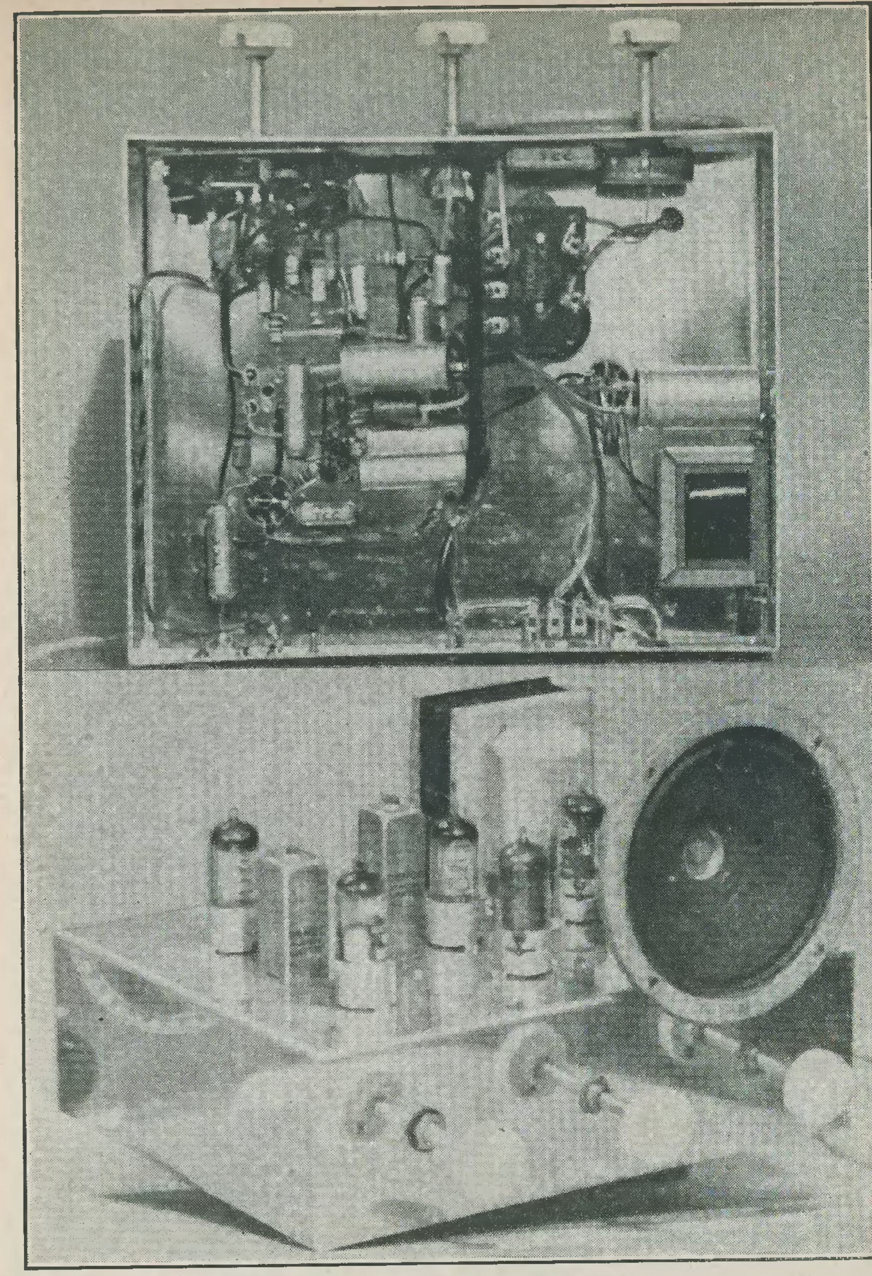
Construction

Care should be taken to obtain a chassis of the correct depth in order to accommodate the coil pack without undue cramping. Fig. 1 shows both the main component layout and chassis dimensions required for this receiver. The speaker is bolted direct to the chassis deck and no cut-out is necessary. The position of the valves



E39

Main component layout and chassis dimensions of the Constructors' Pre-Set Five



Above, below-chassis, and below, three-quarter front view, of the Constructors' Pre-Set Five Receiver and IF transformers may be ascertained from the illustrations shown herewith.

From the under chassis view, it will be noted that two tag panels have been incorporated. One is used for anchoring the mains input leads, while the larger is utilised for HT+ and earth connections, etc. Little more need be added to these details; the photos and circuit drawing fully explain both the theoretical and physical aspects. Construction could be commenced by even the beginner with every chance of success.

Once having aligned the receiver to the frequencies most desired, it will be found a most pleasing performer from all points of view. The output and quality are excellent and fully adequate for normal purposes, and the design is altogether an attractive proposition for those readers requiring a pre-set quality receiver.

Component List

R1	33kΩ ½watt ±10%
R2	1MΩ ½watt ±10%
R3	150Ω ½watt ±10%
R4	47kΩ ½watt ±10%
R5	22kΩ ½watt ±10%
R6	33kΩ ½watt ±10%
R7	150Ω ½watt ±10%
R8	100kΩ ½watt ±10%
R9	1kΩ ½watt ±10%
R10	470kΩ ½watt ±10%
R11	500kΩ pot. with switch
R12	100Ω ½watt ±10%
R13	3.3kΩ ½watt ±10%
R14	1.5MΩ ½watt ±10%
R15	1.5MΩ ½watt ±10%
R16	470kΩ ½watt ±10%
R17	22kΩ ½watt ±10%
R18	150kΩ ½watt ±10%
R19	150Ω ½watt ±10%
R20	50kΩ pot.

C1	200pF Silver Mica ±1%
C2	0.02μF TCC Type CP33N
C3	100pF Silver Mica ±1%
C4	0.02μF TCC Type CP33N
C5	200pF Silver Mica ±1%
C6	50pF Ceramic
C7	100pF Ceramic
C8	200pF Silver Mica ±1%
C9	0.1μF TCC Type CP37N
C10	0.02μF TCC Type CP33N
C11	0.1μF TCC Type CP37N
C12	100pF Silver Mica ±1%
C13	25μF Electrolytic, 25V wkg, TCC Type CE32C
C14	0.02μF TCC Type CP33N
C15	2μF TCC Type CE18P
C16	50pF Ceramic
C17	0.02μF TCC Type CP33N
C18	100pF Silver Mica ±1%
C19	25μF Electrolytic, 25V wkg, TCC Type CE32C
C20	0.1μF TCC Type CP37N
C21	16μF, 350V wkg, Electrolytic
C22	8μF, 350V wkg, Electrolytic

Valves

V1	Mullard ECH42
V2	Mullard EF41
V3	Mullard EBC41
V4	Mullard EL42
V5	Mullard EZ41

Coil Pack – Maxi-Q Type CP4/L
Valveholders – McMurdo
Speaker – Truvox 5″
Output Transformer – Goodmans Type 74/243
Mains Transformer – Ellison Type MT162
LF Choke – 10 Henry, 60mA.
IF Transformers – Maxi-Q Type IFT11.
Chassis – H. L. Smith and Co., or Denco (Clacton) Ltd.

NEW MULLARD MULTI-PURPOSE BEAM TETRODE

A NEW BEAM TETRODE VALVE LIKELY TO be of great value to designers of compact audio, video or radio frequency equipment has recently been made available by the Communications and Industrial Valve Department of Mullard Ltd. This is the QV06-20, which has an anode dissipation of 20 watts. The new valve is intended for operation at full ratings as a power valve at any frequency up to 60 Mc/s, and at reduced ratings to 175 Mc/s. It has been designed to meet the requirements of a very wide variety of applications, from servo amplifiers to video modulators, and it will function equally well in radio transmitters as driver, frequency multiplier, power oscillator, or output valve.

A single QV06-20 in Class "C" will deliver 69 watts at 60 Mc/s, while at audio frequencies a pair in push-pull, Class AB1 will provide 120 watts output. The mutual conductance of 7mA/V ensures high power sensitivity even at low anode voltages.

As a precaution against internal feedback, the anode is brought out to a top cap and the lower part of the valve is provided with a short metal screen connected to one of the pins. The heater voltage is 6.3V and the base is International octal. The QV06-20 is a direct replacement for the American 6146.

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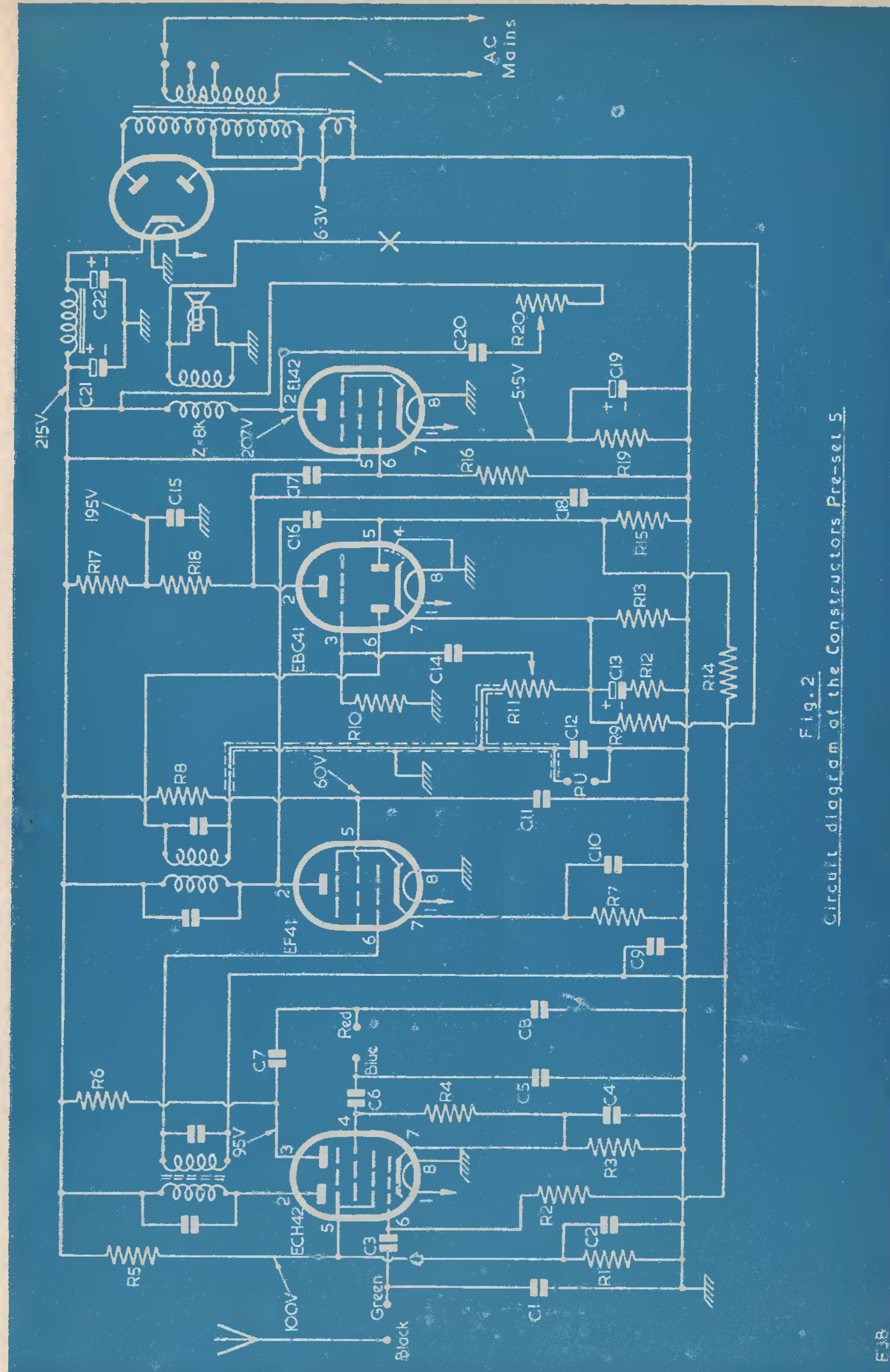


Fig. 2 Circuit diagram of the Constructors Pre-set 5

Radio Miscellany

SINCE MY USUAL COMMENTARY LAST month, I have spent practically the whole time out of Britain, and as a consequence feel I have lost track of current events. As usual, I looked up a few old friends among European amateurs, and was rather depressed to find their enthusiasm for amateur communications radio at a low ebb. They, too, have their TVI troubles, and TV viewing has grown enormously in popularity during the last winter. In fact, the changing face of Europe is most apparent in its TV aerials! Multi-element aerials high over the house-tops are often a matter of great pride to their owners.

I had the *Bulletin* sent to me, and to add to the resultant depression found the Editorial dealing with much the same sort of recession I had in mind. However, the many other aspects of our hobby show no signs of a decline. On the contrary, the TV constructional interest continues unabated everywhere and, whatever may be happening in other fields, the circulation of *The Radio Constructor* continues to expand. There is certainly no cause to be gloomy about the more general outlook, and, after all, these are the "outdoor" months.

Eurovision

While I was in Brussels I happened to pick up an old copy, and re-read my own observations written at the time when experimental and part-time TV transmissions were the only programmes available in most European countries. At that time I was far from convinced that their higher definition systems gave a much better picture than our own. In those days spot-wobbling was only used experimentally, and only the most advanced commercial TV's were thinking of incorporating it. The 9″ tube, too, was the most popular size, and when viewed from the normal distance, little was lost by the lower definition.

To-day, screen sizes are often double that figure, that is four times the viewing area, and seem to be getting bigger annually. As the size increases, the advantages of higher definition become more and more apparent. If projection TV really arrives, perhaps even the ordinary viewer will begin to wonder about the lines!

In Reverse

It struck me that our BBC programmes are looked forward to more eagerly on the Continent than theirs are here. Maybe this is a false impression. Widespread viewing has only recently reached big proportions in many places, and our own viewers only two or three years back were thrilled by programmes that to-day produce only yawns. I made a special point of seeing *Cafe Continental* via the Brussels transmitter, as my first Eurovision in reverse. Unhappily, the picture was all over the place and only in the very last minutes, when we saw Big Ben, was it steady. However, subsequent British programmes were seen equally as well as the European programmes in Britain. Incidentally, they received the Coronation telecasts well.

I asked an American viewer what he thought of Eurovision. He told me (as if we didn't know) that in the U.S. programmes are sent over 1,000 miles as a matter of routine. I pointed out that this is a simple matter when using identical systems, but converting the picture from one system to another is quite a different kettle of fish. He was still unimpressed. It is funny that the non-technical so rarely appreciate a really magnificent feat. Yet the same people will often express amazement over some simple novelty. I wonder what proportion of British viewers who watched the World Football series have any inkling of the difficulties which had to be overcome to make Eurovision available to them!

Speakerines

In France and Belgium, particularly, a great fuss is made of their speakerines. Personally I think all TV announcers are a waste of a camera. Announcers are better heard, not seen, and I consider a pictorial or motif background would be more effective. (Your Editor does not agree!) I hear unofficially that the BBC are considering doing something like this, and by the time this reaches you they may have arrived at a decision on the point.

As a poor linguist I often cannot follow the speakerines, so perhaps I have more time to look. You can probably get a similar effect by turning the sound off. Two of our own lady announcers look utterly absurd when seen in close-up, simpering in front of the camera and patently turning on an artificial charm. When they also blink in front of the lights I don't know whether I am the more irritated by them, or embarrassed on their behalf.

The technique of TV announcements has remained static since 1936, and a new approach to the problem is overdue. Anybody got any bright ideas?

Puzzle Corner

An experimenter wanted to buy the smallest number of resistors which would enable him to make up any given resistance (to the nearest ohm) between one and a thousand.

What values would he have to buy and how many?

It's a lot less than you might at first think. In fact, you could count them on your fingers and thumbs.

Answer next month for those too lazy to have a go.

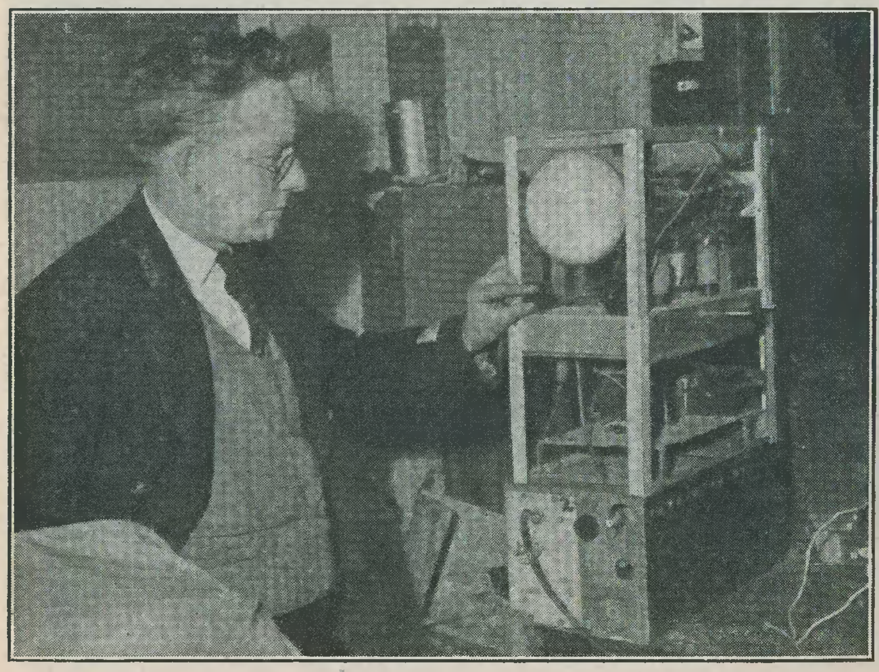
Post Script

I see our Printer last month, when I referred to dead spots, quoted me as writing about "Dead Shots." Either he thinks I was right on the target – or else he's been reading too many Westerns.

ANOTHER "INEXPENSIVE"

THE photograph shows reader R. W. Hubbard, of Stradbroke, Diss, Norfolk, with his version of the *Inexpensive* televisor.* The signals and pictures received at some 100 miles from A.P. are very good, although the aerial is only a dipole 20*ft* high. The photograph was taken by Mr. Hubbard's friend G. Smith, using a flashlight which he had brought for re-wiring to Mr. Hubbard. As the latter says, the photo provides a good evidence of their combined hobbies.

* *Data Book* 4.



Query Corner

A *Radio Constructor* Service for Readers

Filter for Tuner

I have constructed a radio tuner unit for use with my high fidelity amplifier, and whilst the results are very good during the day, night reception is marred by the usual whistles. I have read with interest your comments on the general subject of whistle suppression in the February 1954 *issue of the* Radio Constructor, *and I wonder if you would extend your advice to cover my particular need. As I wish to retain as far as possible the high frequency response of the equipment, I require a very sharply tuned filter which will in effect remove only the offending whistle frequency.*

D. Hallam, Sanderstead

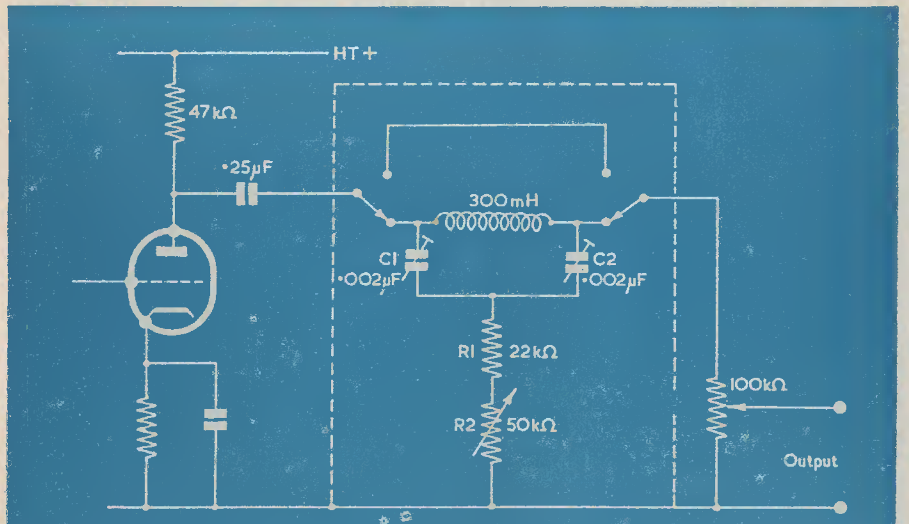


FIG. 1. The whistle filter in the output circuit of a tuning unit. C1, C2 can conveniently consist of a 1000pF preset in parallel with a 1000 pF fixed

As our correspondent points out, we have already had quite a lot to say about the subject of whistle suppression. In certain localities this form of interference can be very troublesome, particularly to those who appreciate high quality reproduction and consequently use wide band tuning units. The simple tuned circuit type of whistle rejector is adequate for most receivers, but in a quality tuning unit a filter having a sharper cut-off characteristic is required.

The circuit of such a filter is shown in Fig. 1, and its response curve in Fig. 2. The curve gives a very good indication of the sharpness of the response and the fact that the rejection of the unwanted frequency is at least 40db below the wanted level. The filter is tuned by adjustment of the two pre-set capacitors C1 and C2. This process is simplified if an audio oscillator is available, to supply a steady 9 kc/s note, the capacitors then simply being adjusted to give minimum response. After this the variable resistor R2 is adjusted for optimum rejection and alignment is then complete. A switch is provided to cut the filter out of circuit when not required.

The complete filter, but in particular the coil, will be very susceptible to pick up stray magnetic fields and cause hum. It is therefore advisable to enclose the components in a small screened compartment in which holes have been cut to allow for adjustment of the pre-set controls. It is unlikely that the constructor will have a coil of suitable inductance available, but one may be easily wound up on the former shown in Fig. 3. The end cheeks of the bobbin are made from paxolin sheet whilst the cylindrical centre piece is most conveniently of wood. A hole is drilled in the centre to allow for the brass fixing bolt. The winding consists of 2,100 turns of 36 swg enamelled copper wire. It is important that the wire is wound on evenly and not allowed to pile up on one side of the bobbin. Coils of this nature are best wound with the aid of a breast drill. The former is first placed on a bolt of suitable dimensions and clamped in position with a nut and washer. The bolt is then placed in the chuck of the drill and the drill clamped in a vice. Then by noting the gear ratio of the drill it is a relatively simple matter to count the rotations of the handle until the correct number of turns have been wound on the bobbin.

The coil should not be clamped up against the side of the screening box, but spaced

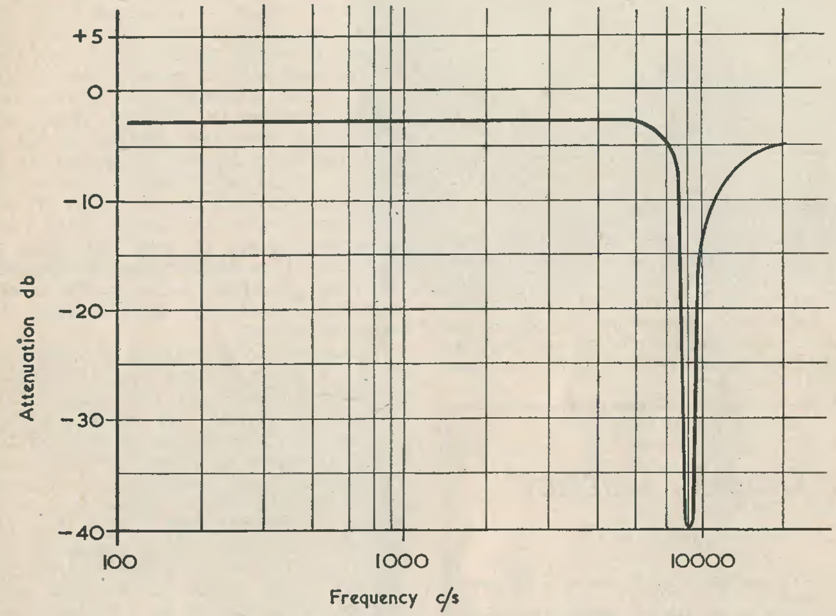


FIG. 2. FREQUENCY RESPONSE OF THE FILTER

away from the sides by at least ½". It is essential that the filter is fed from a source impedance of some 15kΩ and is terminated by an impedance of 100kΩ. These conditions are fulfilled in the circuit of Fig. 1 which shows the filter between the output of the tuning unit and the input of the main amplifier.

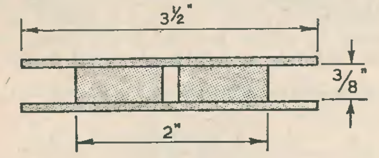


FIG.3. DIMENSIONED CROSS SECTION OF THE COIL FORMER G40

Cleaning Switch Contacts

Our comments on this subject in the May issue have aroused quite a lot of interest. Reader Jackson of Christchurch has obtained excellent results by combining the cleansing and lubrication solutions, by dissolving ½ ounce of lanolin in a bottle of "Scrubbs Dry Cleaner" which is obtainable from most chemists. The switch cleaning solution is recommended to other readers, and we are indebted to Mr. Jackson for his advice.

Query Corner

RULES

(1) A nominal fee of 2/6 will be made for each query.
(2) Queries on any subject relating to technical radio or electrical matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like.
(3) Complete circuits of equipment may be submitted to us before construction is commenced. This will ensure that component values are correct and that the circuit is theoretically sound.
(4) All queries will receive critical scrutiny and replies will be as comprehensive as possible.
(5) Correspondence to be addressed to "Query Corner," Radio Constructor, 57 Maida Vale, Paddington, London, W.9.
(6) A selection of those queries with a more general interest will be reproduced in these pages each month.

Signal Generator Radiation

I have made a signal generator following faithfully the circuit recommended by a leading technical radio journal. Whilst the generator appears to function satisfactorily, it is impossible to reduce the output to zero; this makes alignment of highly sensitive receivers a very tricky business, as the early stages overload badly. What can be done to reduce the output from the generator, as the output potentiometer does not seem to be adequate?

E. Hislop, Essex

The output control of the normal signal generator consists of a stepped attenuator and a low value potentiometer, one side of which is usually earthed. Thus, when the potentiometer is set to zero the slider should be at earth potential, and a resistance measurement made between slider and earth should give zero reading. If this is not found to be the case, the potentiometer must be suspected of being defective. It occasionally happens that the slider of these components does not make good zero resistance contact at one end, and an improvement can often be made by reversing the outer connections and using the control backwards; that is, anti-clockwise for maximum output.

If examination shows that the potentiometer is in good working order, the inability to reduce output to zero must be attributed to radiation between the signal generator and the receiver under test. It is imperative that a generator be perfectly screened, all components being assembled on a metal chassis and the whole encased in a metal cabinet. Ventilating holes or slots should be covered by a metal mesh or gauze, and the various sections of the cabinet well bonded. That is, each section must make good electrical contact with its neighbours and not be insulated by a layer of paint. Finally, do not forget the dial aperture. If the scale panel is made from a non-conducting material it is advisable to arrange a metal screen immediately behind the dial to prevent radiation through the aperture.

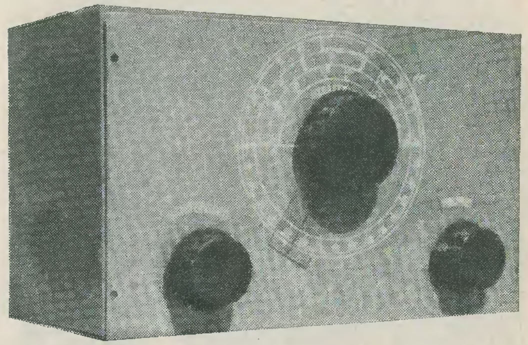
INDEXES FOR VOL. 7

These are now ready, and direct subscribers will find their copy in this issue. Other readers desiring a copy should forward a stamped, self-addressed envelope (preferably 9" × 6") marked RC INDEX in top left-hand corner, to THE RADIO CONSTRUCTOR, 57 MAIDA VALE, LONDON, W.9.

BUILDING THE RCS BATTERY RECEIVER*

Part 2

A TWO-VALVER



By **JAMES SINCLAIR**

HAVING COMPLETED THE ONE VALVE receiver as described in last months issue, we now describe the addition of a further low frequency amplifying stage, thus advancing a stage further and making this set a two-valve (otherwise known as O-V-1) receiver. All the components may be obtained from R.C.S. Products (Radio) Ltd.– see advert pages – and all these component parts are colour coded to avoid confusion and to greatly simplify construction.

The resistors and condensers are mounted on a correspondingly numbered card so that no possible confusion can arise in the mind of the beginner.

Modification Instructions

Fasten Valveholder No. 2 in position, taking care that the soldering tag is in position as shown in Fig. 3.

STEP No. 1. White on Valveholder No. 1 to White on Valveholder No. 2.

„ No. 2. Red on Valveholder No. 2 to Blue on Valveholder No. 2, and then to soldering tag on Valveholder No.2.

„ No. 3. The wire which goes from the RF choke to Red on the phone socket is disconnected at the phone socket end and then pushed through hole in chassis, first covering the wire with a length of insulating sleeving, as shown in photo Fig. 2, and soldered to one side of C5.

STEP No. 4. The other side of C5 goes to R3. A short length of flex is also connected to the soldered joint between C5 and R3 and a valve clip is joined to the other end of the flex.

„ No. 5. The other end of R3 is taken to Red on Valveholder No. 2.

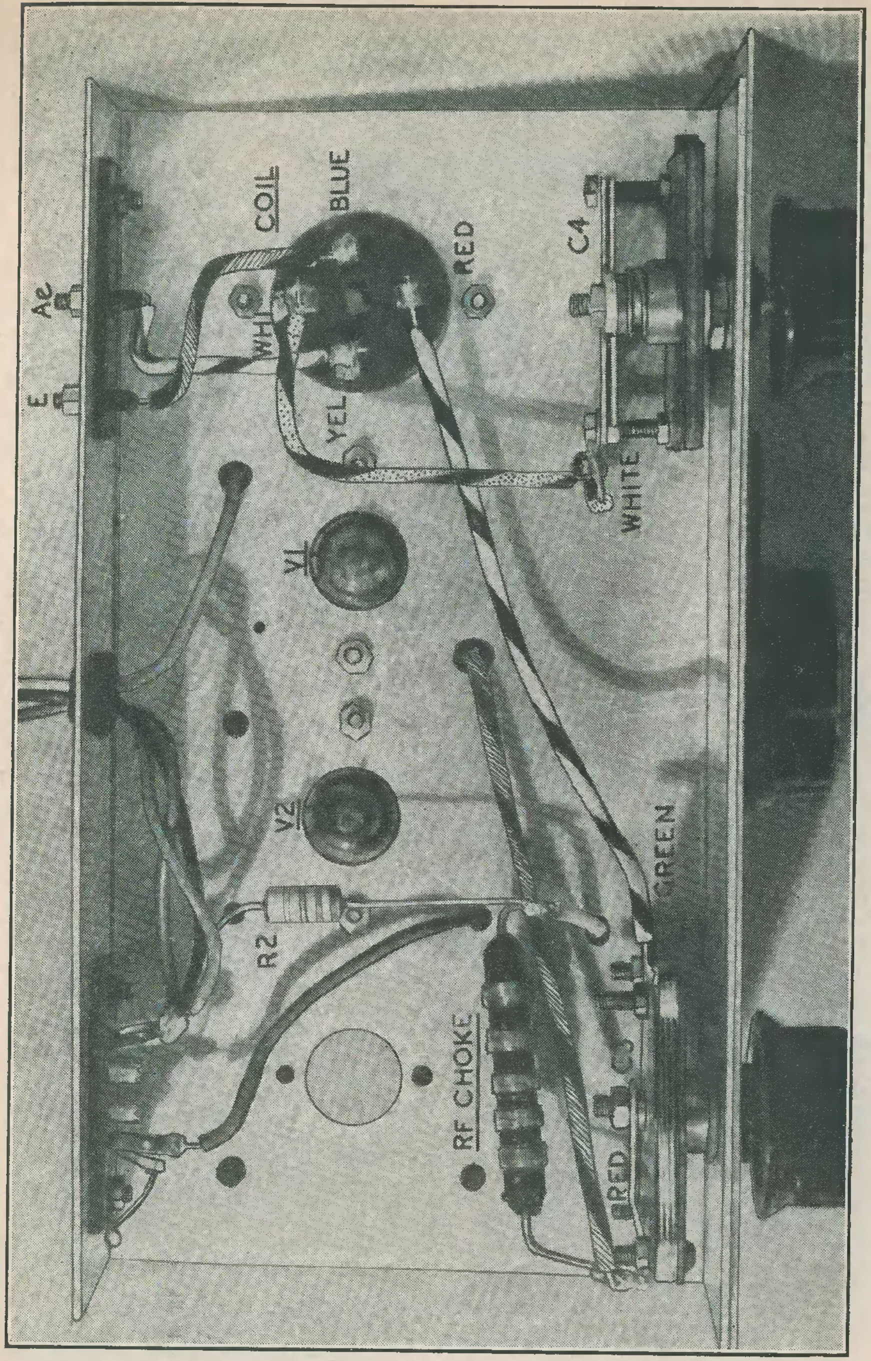
„ No. 6. One end of R2 goes to Yellow on the phone socket, and the other end of R2 goes to the choke (Fig. 2.)

„ No. 7. Finally a wire is connected, from Yellow on Valveholder No. 2, through the chassis, to Red on the phone socket. This completes the modifications.

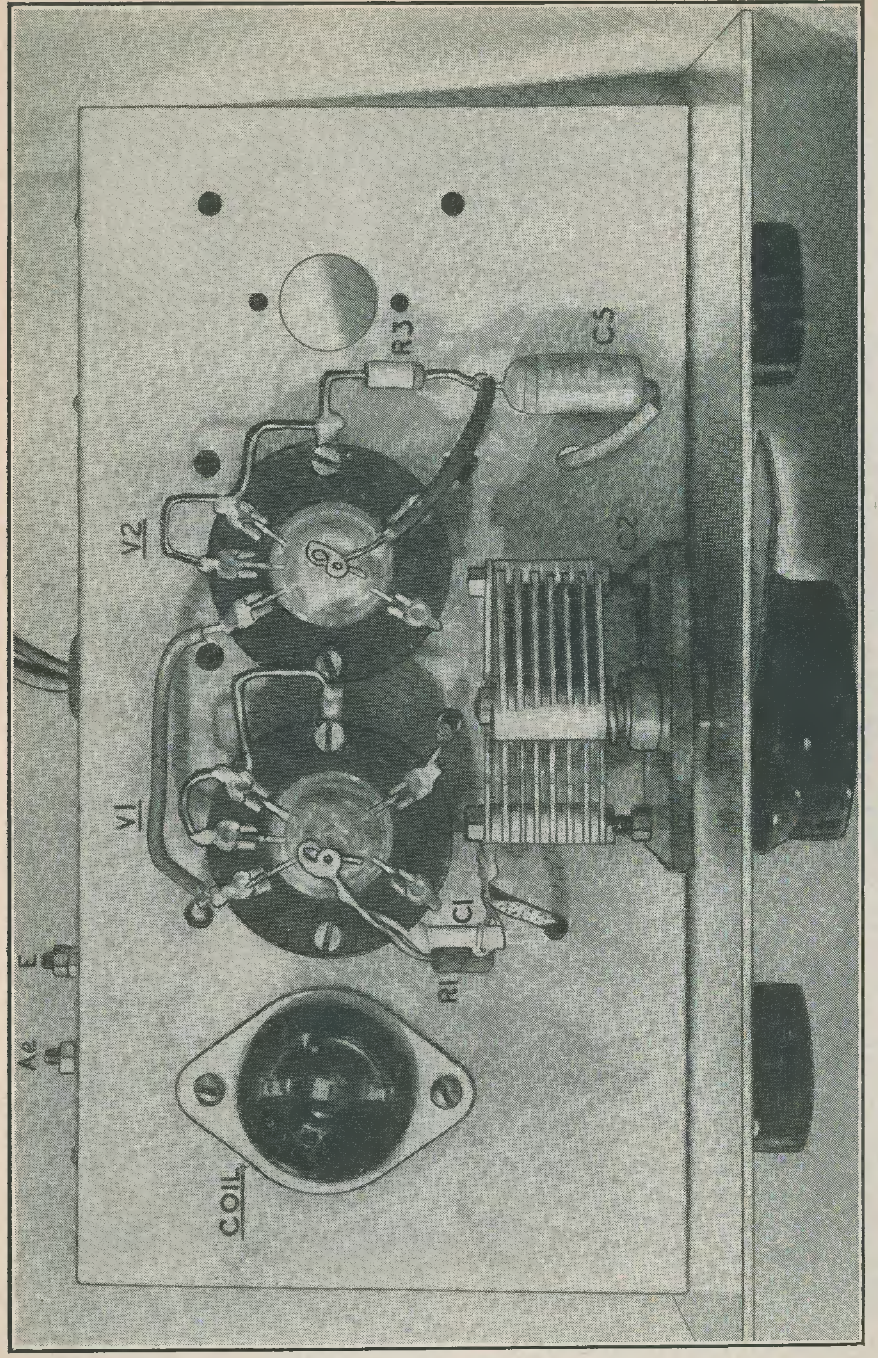
In order to obtain the best results from the now-completed two-valve receiver, it will be necessary to change the HT+ supply from one of 30 volts to one of 60 volts, and this may be done simply by obtaining a further 30 volt HT battery and connecting the two in series, i.e., connecting the negative of one battery to the positive of the other, thus obtaining the required voltage.

The accompanying illustrations clearly show how this second valve has been added,

* *See advert on page 59*



Under-chassis arrangement of components and wiring



Above-chassis view of the two-valve receiver and no difficulty should be encountered on this point.

Conclusion

With the set now working, the beginner may care to experiment and thus learn more of the principles involved. Alternatively, various aerials could be tried out and notes made of the performance under varying conditions, etc. Many happy and instructive hours may be spent in this manner.

Next month we will continue with the addition of yet another valve, thus again converting the receiver, this time into a three-valve set (O-V-2).

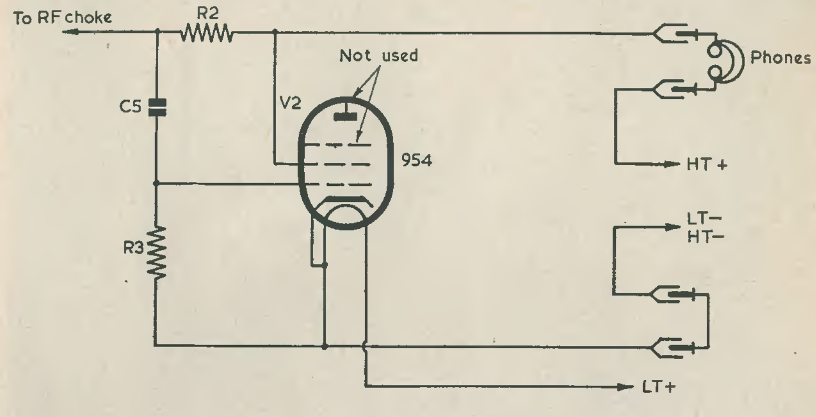


Fig.1
Circuit diagram of additional LF stage

CLUB NEWS

Details for insertion in this section should reach us not later than the 8th of the month before publication.

THE SOUTH SHIELDS AND DISTRICT AMATEUR RADIO CLUB (G3DDI)

The South Shields and District Amateur Radio Club will be exhibiting at the South Shields Annual Flower Show to be held August 27th-29th in the Bents Park, South Shields.

An amateur station will be operated on 3.5, 7 and 14 Mc/s under the special call sign GB3SFS (South Shields Flower Show).

We shall welcome all contacts, which will be QSL'd 100 per cent with a special QSL card. QSL's can be forwarded to the South Shields and District Amateur Radio Club, Trinity House Community Centre, Laygate, South Shields, Co. Durham.

Secretary: W. Dennell (G3ATA), 12 South Frederick Street, South Shields (*Telephone* St. Hilda 4107).

TORBAY AMATEUR RADIO SOCIETY

At the next meeting – on 17th July – an "inquest" will be held on the recent NFD of the RSGB – in which several members took part. This will be followed by a general discussion.

At the August meeting – which will be held on 21st August, a talk on "Aspects of Crystal-Grinding" will be given by W. A. Launder, B.SC. (G3FHI).

Meetings are held on 3rd Saturday each month, at 7.30 p.m., at the YMCA, Torquay. Intending visitors to this area are always welcome, and are invited to contact G3JD, 46 Dower Road, Torquay.

ROMFORD AND DISTRICT AMATEUR RADIO SOCIETY

Although the winter lecture programme has now ended the Club will continue to hold meetings every Tuesday at 8.15 p.m. at the R.A.F.A. House, 18 Carlton Road, Romford. A Junk Sale will be held on the first Tuesday of every month.

New members will be warmly welcomed and it is hoped to commence Radio Theory classes in addition to the Morse classes already running.

The Club station G4KF, will be on the air, usually on top band, from the above QTH on meeting nights.

Hon. Sec., N. Miller, 18 Mascalls Gardens, Brentwood, Essex.

CLIFTON AMATEUR RADIO SOCIETY

Programme for August:

6th and 20th — Constructional Evenings
13th — Junk Sale
27th — Quiz.

The Clifton Amateur Radio Society, catering for all ages and tastes, meet every Friday evening at 7.30 p.m. at the clubrooms 225 New Cross Road, London, S.E.14. Visitors and anyone wishing to become a member are invited to call any Friday evening when they will receive a warm welcome.

Secretary: C. H. Bullivant, G3DIC, 25 St. Fillans Road, Catford, London, S.E.6.

NORWOOD AND DISTRICT GROUP R.S.G.B.

At the meeting in August, to be held, as usual on the third Saturday in the month, a lecture will be given by C. H. L. Edwards, G.8TL, about equipment for the Radio Amateurs Emergency Network.

All members and others who are interested are invited to attend the meeting on August 21st, at Windermere House, Westow Street, Crystal Palace, commencing at 7.30 p.m.

14: *Let's Get Started*

SHORT and SHORTER WAVES

By **A. BLACKBURN**

THE DEVELOPMENT OF LONG RANGE communications on short waves has been considerably influenced and assisted by the experiments of the radio amateur in this field. Not a surprising fact when you remember that the enthusiast has been restricted to exploiting the short wave bands in his efforts to successfully transmit and receive signals. It is to his credit that his ingenuity and perseverance have contributed to what is now universally used for long distance work.

The first experiments in radio were carried out in 1887 by Hertz, when the wavelength he used for his demonstration was only a matter of centimetres. Development continued slowly, and concentrated on increasing wavelengths, rather than shortening them. Commercial channels were inaugurated on wavelengths up to 10,000 metres, and broadcast transmissions for entertainment confined to wavelengths down to 200 metres.

In 1923, thirty-six years after the first Hertz experiment, two-way amateur communication was established between France and the U.S.A. on 100 metres. This advance encouraged a return to the short wave development again.

Wavelengths down to 1 metre were in use for normal purposes before the second World War, and during the war, the development of radar led to the use of wavelengths as short as 1 cm.

Amateur work is carried out mainly on bands between 160 metres (1.5 Mc/s) and 2 metres (144 Mc/s). It is usually more convenient to think in terms of frequency rather than wavelength on short waves. There are further amateur bands, up to 10,000 Mc/s, but these are seldom used, if at all.

Skip

One of the most useful natural phenomena in short wave communication is the layer of ionised gas surrounding the earth. Beamed transmissions are reflected from this layer and returned to earth at some way from the transmitter. Before reaching a distant receiver the transmitted wave may make a number of 'hops' between earth and the layer. Actually, there are a number of layers at different heights, but for the sake of convenience we will group them together as one.

The distance between each complete hop is called the skip distance. The use of this phenomena, combined with the fact that high frequencies are easier to beam than lower frequencies, enables a maximum of transmitted energy to be concentrated in a given area.

If the wavelength is too short, however, the waves are not reflected from the layers, and therefore continue into outer space. As radio waves (in common with light) do not bend appreciably, communication on these wavelengths is limited to line-of-sight distances, i.e., from horizon to horizon. This is the main reason why wavelengths shorter than 10 metres are not used for long distance communication.

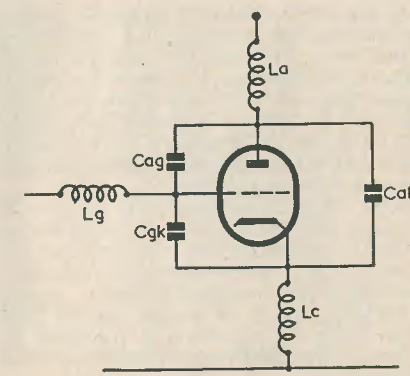


Fig.1
Capacities & inductances in valve

Another factor in favour of short waves is that a great number of stations can be packed in without overlapping. For example, the long wave band from 1,000 to 2,000 metres contains only half a dozen or so stations. That commonly used short wave band, however, from 16-50 metres, contains hundreds.

Put it all in terms of frequencies, assume 8 kc/s separation for stations, and work out the maximum number of stations one could get into these two bands. You will probably be surprised at the result!

Some Problems

In the early days of high frequency circuits, the radio engineer found that the quality of the components became of increasing significance as the frequency was raised. Insulation in particular was important.

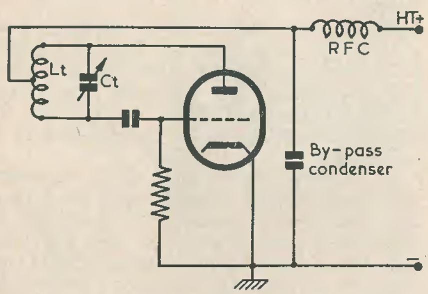


Fig.1a
UHF Oscillator

E41

At ordinary broadcast frequencies, almost any material will do for, say, a valveholder or coil former. I wonder how many youthful enthusiasts have wound coils on cardboard pepper cartons! This may have produced splendid results at a megacycle or so, but tried at 50 Mc/s, the result is totally ineffectual. At this frequency, the cardboard might just as well be a conductor.

Some more depressing effects are caused by valve capacities and lead inductances. You may remember that the reactance or equivalent AC resistance of a capacitor decreases as the frequency is raised. A grid to cathode capacity of a valve may be 5pF. At 1 Mc/s this represents a reactance of approximately 30kΩ, but at 50 Mc/s it has become 600Ω.

An ordinary straight piece of wire may have quite an appreciable inductance at these frequencies. In the older type of 'based' valve, the leads from the pins to the electrodes were often an inch long. This represents an inductance of only a fraction of a microhenry. However, as the frequency is raised, the reactance also is raised. At a frequency of 50 Mc/s, this inductance has 50 times the reactance it had at 1 Mc/s. Fig. 1 indicates how these inductances and capacities appear in the valve. The cathode lead inductance produces negative feedback, which may easily prevent an oscillator from working. These 'invisible' components occur within the envelope of the valve. What is often more serious is the wiring to the valve. Careless wiring, involving long leads, can produce inductance and capacity effects far worse than those encountered in the valve itself.

At really high frequencies of 100 Mc/s and over, the ordinary valve has another serious shortcoming. The electrons leaving the cathode take a very short, but finite, time to reach the anode. Now suppose that one cycle of RF at the grid took exactly the same time to complete as the time the electron took to pass through the grid. The electron would emerge from the grid as though no signal has occurred to affect it, and no fluctuation in anode current would result. The times need not be exactly equal, of course. The point is that if the duration of one cycle is *comparable* to the time taken by the electron in transit, a loss of gain will result.

This is called 'transit time effect'. It does not assume serious properties until the frequency is very high.

Some Solutions

Before the reader despairs completely of ever attempting short wave work, let us see how simply most of the problems may be overcome.

Before the war, the most frequently used low-loss insulating material was ceramic. Various types were available and they were quite efficient. The war brought about the development of many plastics of incredibly good electrical characteristics. Good enough, in fact. to be of real use up to 10,000 Mc/s and beyond. They are well known now under

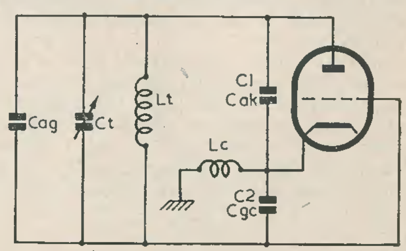


Fig.2
Redrawn fig.2 with stray capacities (supplies not shown)

E42

such titles as PVC, Distrene, PTFE, etc. For amateur purposes, they leave little to be desired.

Valve capacities have been enormously reduced by the simple expedient of reducing the physical size of the valves. Leads within the envelope have been reduced by the use of glass bases through which the leads emerge as the connecting pins.

For very high frequencies, special valves have been developed, but they do not normally come within the scope of amateur work.

Oscillators

As any system of radio communication depends primarily upon an oscillator to

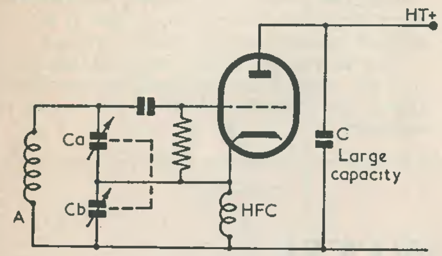


Fig.3
Colpitts oscillator

E43

produce the carrier frequency, we will start by having a look at the type of oscillator used at high frequencies.

Fig. 1a shows one which is quite popular for ultra-high frequencies. It looks at first rather different from the types normally found at low frequencies, but if the stray capacities are taken into account, the circuit appears similar to that shown in Fig. 2. The similarity may not be particularly recognisable even now, but compare it with Fig. 3. This is an oscillator known as the 'Colpitts' type, and is a stable design often used at low frequencies. If the capacitor C in Fig. 3 has a very low reactance at the frequency of the oscillator, the anode may be regarded as being connected to the tuning coil at the point marked A.

The connection between Figs. 2 and 3 then becomes more obvious. The operation of the Colpitts oscillator depends upon the 'capacity centre tap' of C_a and C_b. As in the high frequency version, the operation still depends upon these two capacities, but in this case they are the anode to cathode and grid to cathode capacities of the valve, combined with the coil capacities C_1 and C_2. In other words, the oscillator depends for its operation upon the 'invisible' components in the circuit.

The inductance L_c in Fig. 2 is the cathode lead inductance. If its inductance value is large, the presence of the cathode lead inductance may seriously affect the operation of the circuit.

Of course, the extra capacities in the circuit affect the frequency at which the oscillator works. At 50 Mc/s for example, the main tuning capacitor may be approximately 30pF. The stray capacities may be between 5-10pF, and as they are in parallel with the tuning capacity, the frequency will be very different from that obtained with the tuning capacitor alone.

Still Higher

When an attempt is made to generate power at frequencies much in excess of 100 Mc/s, problems arise in the tuned circuits. A typical example is that at 100 Mc/s the required values of inductance and capacity could be 10pF and 0.25μH.

Firstly, as we have already seen, the stray capacities may already be of a similar order to 10pF. The coil, being of such a low inductance, would probably be one or two turns of heavy gauge wire.

What happens, however, when the frequency becomes so high that less than one turn is required? The answer is to be found in a device known as the parallel line or Lecher line. This consists of two parallel wires, their length depending upon the frequency to be used.

With certain reservations, the properties of Lecher lines are analogous to the acoustic properties of a hollow tube. It is well known that a hollow tube may be excited into acoustic resonance by blowing across one end. The pitch of the note produced is decided primarily by the length of the tube. A Lecher line may be excited into electrical resonance, and, if the line is connected to

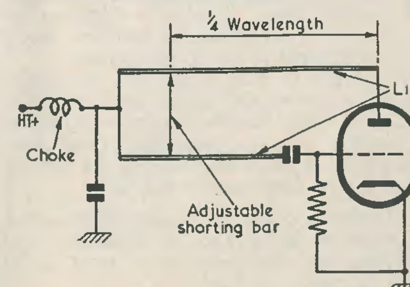


Fig.4
Parallel-line oscillator

E44

the valve circuit, continuous oscillation will result. The simplest type is shown in Fig. 4. The frequency of oscillation is dependent upon the length of the line. Resonance will be obtained when the length of the line is one quarter of a wavelength long.

For instance, there is a model control band at approximately 460 Mc/s. This represents a wave length of 0.65 metres. The line would have to be one quarter of this, i.e., 0.16 metres long. Tuning is achieved by moving the short circuiting bar along the line. The wavelength will not be exactly four times the length of the line because the valve capacities represent a lengthening of it. It would be difficult to fix the exact end of the line at the valve end, because the valve leads, etc. would be added to it. However, an approximate calibration may be achieved by placing a piece of metre rule beside the line, and comparing the position of the short circuit with it.

The lines are connected between anode and grid, just as the tuned circuit is connected in Fig. 1a. In fact, the circuits are electrically similar.

The spacing between the lines is not critical, but it is normally made closer as the frequency increases. The arrangement will normally operate satisfactorily if the spacing is small compared with the length of the line. Such a circuit may be used as the local oscillator in a superhet, or as a transmitter oscillator.

The type of valve used in circuits of this type is normally of the 'acorn' type. The physical dimensions of these valves are very small and all the pins are brought out through a radial glass ring at the base of the valve.

Remember, these very high frequencies are confined to an optical range, and high transmitter power is, therefore, unnecessary. Amplification at these frequencies is a very difficult problem and is usually avoided.

Due to the low power required, however, and the short distances involved, amplification is not important at either transmitter or receiver.

EXPERIMENTS WITH LOOP AERIALS

By **F. R. PETTIT**

THE VARIOUS USES FOR A LOOP AERIAL can be summed up as follows:—direction finding and homing, reduction of interference from unwanted sources, and a pick-up element in portable receivers.

The types of loop aerial are the plain, tapped, screened and tuned, and the shape of any of these may be square, rectangular or circular. As the basic use of the loop aerial is its directional property, the various types will be compared on this basis.

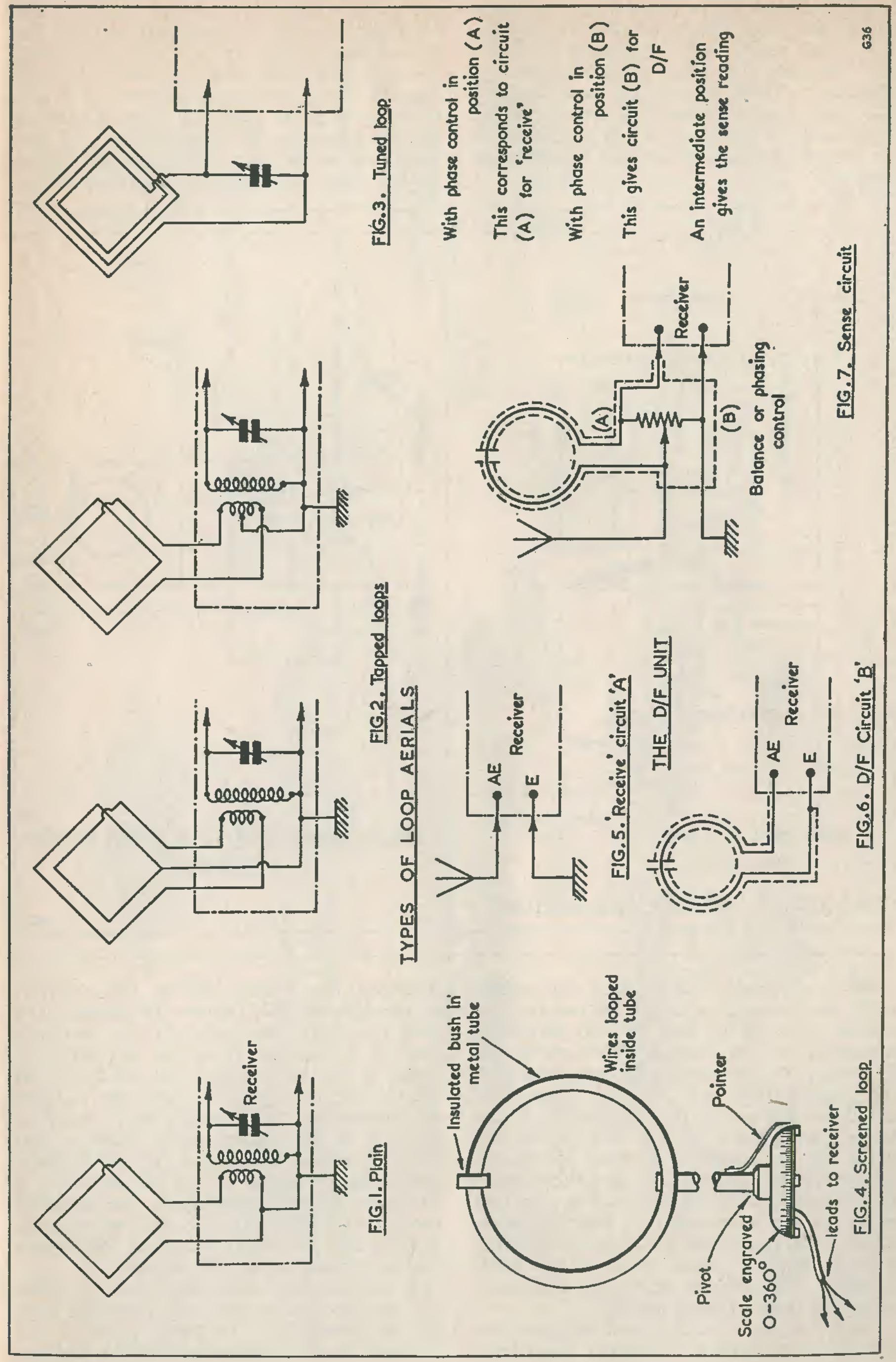
(1) The plain loop. The unequal distribution of capacity gives rise to inaccuracy of bearings, and this may be as great as 10 or 12 degrees.

(2) The tapped loop. Considerable improvement on the above, but the difficulty of obtaining true electrical balance causes some inaccuracy of bearings, possibly 3 or 4 degrees.

(3) The tuned loop. Owing to phase changes, the tuned loop is inaccurate unless well damped, and this causes a loss in sensitivity.

(4) The screened loop. The screened loop is essentially a plain loop encased in a metal tube which has a gap in it so that currents cannot flow around the tube. The comparatively large capacity introduced by the screening swamps the capacity of the loop itself and gives a more even distribution of capacity, and the accuracy of bearings depends upon the receiver sensitivity.

For normal DF work a screened loop is most satisfactory, and may be constructed from a piece of multi-cored lead-covered cable. About 4*ft* of multi-cored cable is bent to form a square or loop as required, and the wires inside are all connected in series to form a coil of as many turns as there are wires in the cable. A piece of 20 cored telephone cable gives excellent results over the long waveband. Alternatively, between 10 and 20 wires could be drawn through a piece of cable or brass tubing and connected in series as before. Having constructed the loop, connect it to a receiver, the screen to earth and the loop wires to



aerial and earth, and tune in a station. Now rotate the loop slowly on a vertical axis, when two points will be found at which no reception from the desired station is obtained. These points are separated by 180 degrees of rotation, and are known as minimums. They occur when the plane of the loop is at right angles to the station being received.

When direction finding with this equipment, an ambiguity arises in the fact that the station may be in one of two directions separated by 180 degrees. To remove this difficulty, the loop output is compared with the output from an ordinary open wire aerial as shown in the diagrams. If the output amplitudes of the two aerials are equal (at the direction of loop maximum) the combined outputs will give the cardoid form shown in Fig. 13, where it is seen that only one minimum occurs. This minimum is, however, unsuitable for accurate direction finding owing to phase shifts in the aerial systems. The process of finding this minimum is known as sense finding.

Referring to Fig 13, it will be seen that the minimum occurs 90 degrees away from the point of minimum reception for the loop aerial only, as indicated in Fig. 11. This comes about in the following way. In the directions zero degrees and 180 degrees the loop output is zero, but the open wire aerial gives its normal output. In the direction 90 degrees (Fig. 11) the output from the loop aerial adds on to the output from the open wire aerial, thereby doubling the voltage fed to the receiver. In the direction 270 degrees the phase of the loop aerial is reversed, and the resultant sum of the outputs from the two aerials is zero. It should be noted that the directions quoted are purely relative for the purpose of explanation, and would only occur in practice if the station being received was in the direction zero degrees or 180 degrees. From the foregoing it will be seen that if the loop output connections are reversed the cardoid (Fig. 13) will also be reversed, so that the minimum occurs at 90 degrees and the maximum at 270 degrees.

It can be seen now that three pointers are required to traverse the direction scale of the loop. Two of these pointers will indicate the two minimum direction bearings

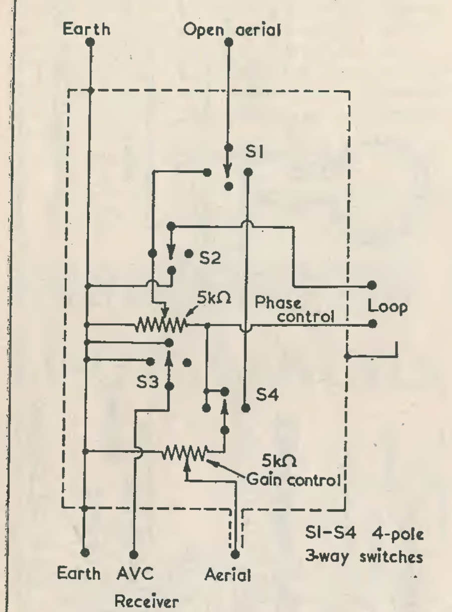


FIG.8. THE D/F UNIT WITH GAIN CONTROL

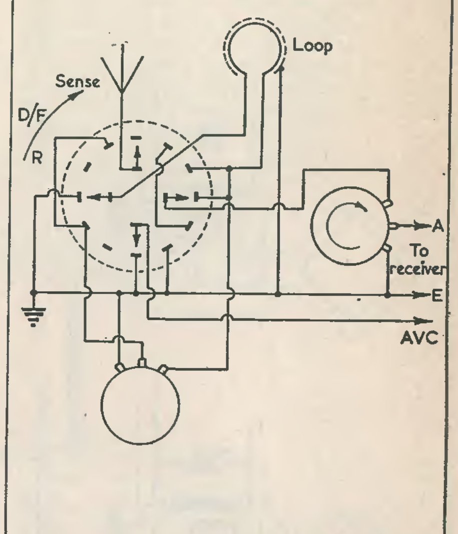


FIG.9. WIRING OF 4-POLE 3-WAY SWITCH IN D/F UNIT

G36A

POLAR DIAGRAMS OF OPEN WIRE & LOOP AERIALS

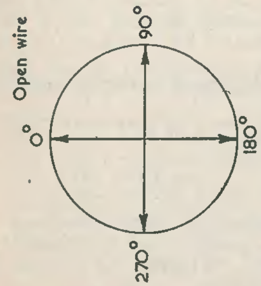


FIG.10. Equal pickup in all directions

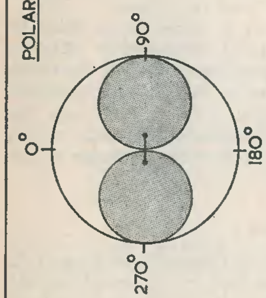


FIG.11. Maximum pickup when loop direction is in line with the station. Zero pickup with loop at right angles to the direction of station (see fig 12)

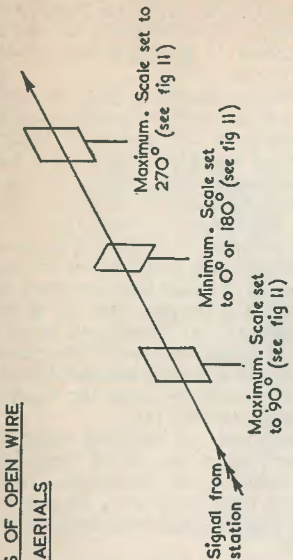


FIG.12. An electrical phase difference of 180° occurs when loop is rotated 180°

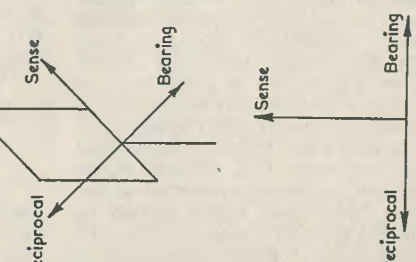
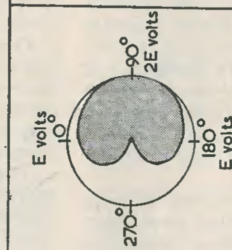


FIG.12B. The Pointers



If max: loop output equals open wire output = E volts sum of ⊙ & ∞ gives ⟶

FIG.13.

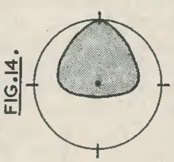

With loop output greater than open wire output

FIG.14.

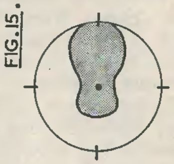

With loop output lower than open wire output

FIG.15.

POLAR DIAGRAMS OF COMBINED AERIALS

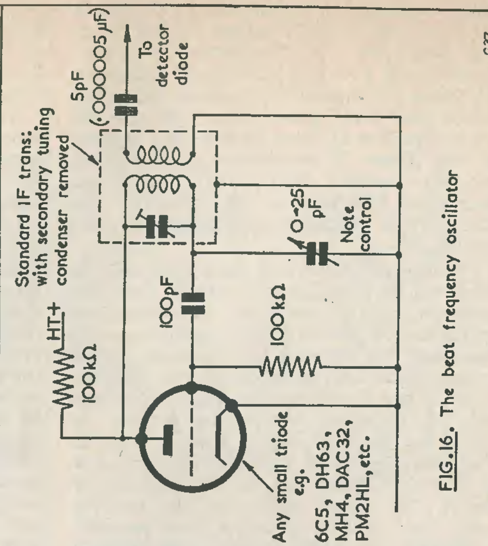


FIG.16. The beat frequency oscillator

G37

when the circuit is switched to DF, while the third, set at right angles to the other two, indicates the minimum on sense. When finally set up with a loop and sense unit these pointers will be marked "bearing" "reciprocal" and "sense" (Fig. 12b) and the actual direction of these pointers will depend on the phase of connection of the loop into the "sense" unit. This should be determined experimentally by "finding" the direction of a station whose bearing is already known.

At different frequencies the outputs of the plain and loop aerials will vary by amounts depending on circumstances. It is therefore convenient to have a control box containing equipment for selecting the necessary circuit arrangements and controlling the outputs from the two aerials, so that the true balance may be obtained, eliminating errors. A circuit for such a unit is seen in Fig. 8. The gain control is provided on this unit so that AVC need not be switched out of circuit, the signal input to the receiver being kept at a level below that required to operate the AVC system. The ultimate accuracy obtainable with this system depends upon the receiver sensitivity and signal-to-noise ratio. An insensitive receiver will give no output when the loop is set two or three degrees from its minimum position, but a sensitive receiver may give a useful output when only one degree away from the minimum position.

The equipment so far described will give useful results on long or medium wavebands (provided the receiver is well screened) on any amplitude modulated signal. To receive unmodulated waves or ICW with a straight receiver, the reaction control must be set to the point of oscillation. With a superhet receiver a BFO is necessary. This may be an external unit or part of the receiver proper. In a DF device some means is required for indicating the minimum signal positions of the loop. The indicator may consist of a magic eye operated by the detector load (CW and MCW) phones, or loud-speaker (all types of wave) and output meter (strong stations only).

As mentioned earlier, the receiver signal-to-noise ratio plays a large part in determining the accuracy obtainable. Site noise and interference are equally important factors and must be kept as low as possible. It is therefore usual in DF receivers to incorporate a noise limiter of some sort. Examples are shown in the diagrams. To modify a standard receiver for DF work, fit a BFO as shown in Fig. 16 with its output connected to the detector. A double-pole switch should be used to switch the BFO and AVC for DF work. Fit an RF gain control (not required if control has been fitted in DF control unit described earlier), and insert a noise limiter between the AF amplifier triode and the output valve. Try to make provision for two indicators to give flexibility under various conditions.

To find the bearing of a given station, tune the receiver to its wavelength with the sense unit switch set to "receive." Switch to DF and swing the loop, noting the directions of the two minimums. Switch to sense, rotate the loop through 90 degrees, then slowly rotate the phase control to see if a minimum is obtained. If so, the sense pointer is now pointing towards the station. If no minimum is obtained the loop must be rotated through 180 degrees and the above procedure repeated. As mentioned earlier, the minimum obtained on sense is unsuitable for accurate direction finding and should only be used to differentiate between the bearing and reciprocal of the DF result.

The direction scale on the loop must, of course, be set by means of a magnetic compass to indicate the directions north, south, east and west, east being 90 degrees and west 270 degrees as in ordinary navigational practice.

One interesting use for the circuits described above is the reduction of interference. Either the DF or Sense circuits may be used according to circumstances; both are more sensitive to signals (and interference) in certain directions than in others.

The Q factor of a tuned loop may be increased by reducing the number of turns in the loop and inserting a suitable dust-iron cored coil in series to bring the inductance back to its normal value. Although the number of turns is reduced, the total circuit Q is increased and the output voltage is also increased.

Mathematical Data

Field Strength is normally expressed in volts (or μV) per metre (of aerial height), so that a vertical wire aerial 10 metres in height situated in a field of 5μV will give an output of 50μV.

The sensitivity of a loop aerial is usually stated in terms of its effective height (h_e). A loop aerial whose h_e=1.5 metres will give the same output as a vertical wire 1.5 metres long.

The effective height of a loop is given by

$$h_e=\frac{2\pi NA}{\lambda}=\frac{\omega NA}{3\times10^8}$$

where N=number of turns, A=area of loop, λ=wavelength, $\omega=2\pi\times$frequency. The Greek letter "Gamma" (γ) is used to denote field strength.

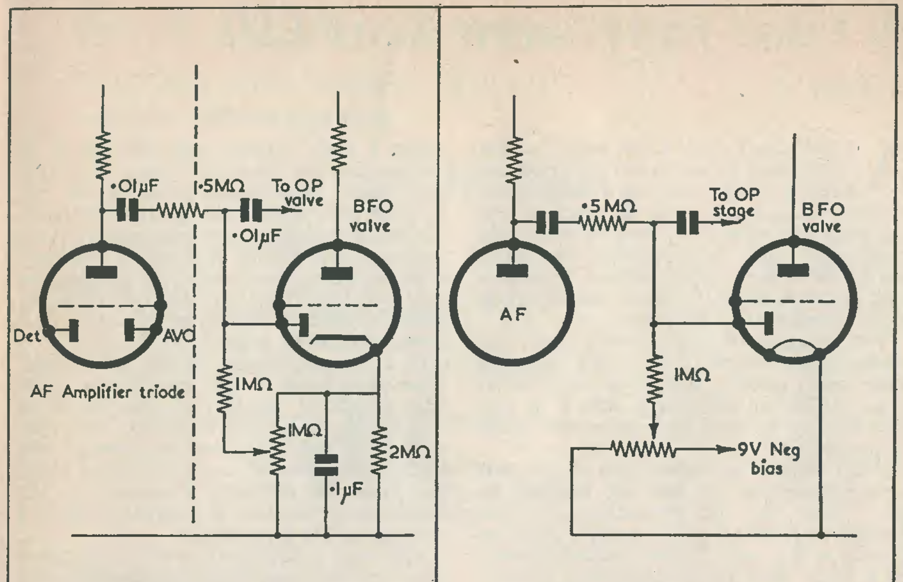


FIG.17. Mains circuit

FIG.18. Battery circuit

NOISE LIMITER CIRCUITS

Example

Loop area=1.5m; N=20; γ=100mV =$10^5\mu$V; λ=159 kc/s; loop set in direction of maximum pick-up.

$$V_o=\frac{\omega NA\gamma}{3\times10^8}=\frac{10^4\times20\times1.5\times10^3}{3\times10^8}$$
$$=100\mu V.$$

From these figures it can be seen that the open aerial used in sense finding need be only about 5 yards long for general use.

The output from a tuned loop is given by

$$V_o=h_e\times\frac{1}{\omega CR}=\frac{NA}{3\times10^8\times CR}$$

where C=tuning capacity; R=RF resistance of loop.

When a loop is rotated, its output varies according to the angle (θ) between the direction of the station and the loop, or $V=V_o\sin\theta$. This is the equation of the curve of Fig. 11.

The sense equation is given by the sum of open aerial voltages when equal to V_o, or $V_{sense}=V_o+V_o\sin\theta$. This is the equation of the curve of Fig. 13. [END

ERRATA

Since printing of the magazine began the following amendments have been received from Mullard Ltd.

Mullard 5 Valve 10w High Quality Amplifier pp. 20-29 this issue

Page 22. *Phase Splitter*
Paragraph 1 the 3rd sentence should read "The correct value of 1.5V grid to cathode bias is produced when the anode voltage of the EF86 is 70V."

Page 23. Paragraph 2 line 1 should start "For low loading operation . . . "

Page 29. Amend lines 10 and 11
("If P1 and P2 . . . " etc.) to read "All windings to be in the same sense"
Line 14 should read "P2 and P3 to form other half of primary, wound from right to left. All other windings to be wound from left to right."

Page 29. Heading *Circuit Voltages*
Voltage on screen grids V3, V4 is 310V.
Voltage on cathodes V2 is 71.5V.

Page 26. Figure 7.
Connections 6 and 4 should be joined together and go to a1, and not to 2 and 8 as shown. The junction of 5 and 3 does not go to a1 but to 2 and 8. For 15 ohm secondary; link 10 and 11, and make connections to 12 and 9. For 3.75 ohms secondary; link 12 and 10, link 11 and 9, and make connections to the 12/10 link and 11/9 link.

A Fuse may save You ££'s

By G3XT

A FUSE COSTS ONLY A FEW PENCE; a new set of valves for a superhet costs pounds. Even a single valve, or a single component, costs many times as much as the fuse that will protect it. So it is obviously penny-wise and pound-foolish to build any piece of radio gear, worked from any kind of power-supply, without incorporating proper fuses in the right places.

Yet in spite of this obvious fact one comes across scores of sets – not only the home-built variety, but even commercial ones – which are completely devoid of any sort of fuse to safeguard vulnerable parts of the circuit.

Fuses should be chosen with due regard to the particular job they are required to do. Those for the protection of valve heaters or filaments, for example, must be of a type that will "blow" instantaneously on a fairly small percentage-rise in current. Otherwise, you will find that the valves have protected the fuse, instead of the other way about !

For connecting the mains leads to the primary of a mains transformer in a receiver or transmitter, a special safety plug-and-socket connector of the type having twin tubular fuses in the two mains leads is a good idea. These fuses can be rated to "blow" a little quicker than the ordinary domestic supply fuses in the house fuse-box, and the latter will not be affected in the event of a short-circuit occurring in the set. It is far easier and quicker to replace these cartridge fuses in the connector than to re-wire a domestic fuse. Moreover, they confine the breakdown to the radio apparatus and leave the lights or other electric appliances on the same circuit unaffected.

Apart from valves, there are other things in the average set which should certainly be protected against overload. One such item is a metal rectifier. Excessive current overloading the rectifier will not only damage the component itself, but may in some cases give rise to unpleasant and harmful fumes through overheating. Metal rectifiers should always be run as cool as possible. When used correctly they have an extremely long and trouble-free life.

The low-tension (heater) windings on a mains transformer are seldom fitted with any form of protection against the effects of accidental short-circuit. Admittedly the voltage on these secondaries is low – seldom more than 12 volts at most – but they are capable of giving a very heavy current under a dead "short," and this can do a lot of damage in some cases. It might even cause inflammable parts of the set to catch fire. If you want convincing proof of the current obtainable from one of these windings, try putting a piece of ordinary domestic fuse-wire across it ! The 5-Ampere kind will blow instantly, and even 10-Amp fusewire will heat red-hot in a fraction of a second, and blow at once.

If a fuse is placed in the LT circuit, however, it must be of a type having negligible resistance, so that it does not drop the voltage on the valve heaters. Probably an inch of domestic fuse-wire between two small terminals or screws on a slip of bakelite would be all right, if inserted in the heater circuit as close as possible to the LT winding on the transformer.

Although I have never seen it suggested anywhere that fuses form a safeguard against electric shock, this does seem a feasible idea. If an instantaneous-blowing fuse can protect such a delicate thing as a valve filament, I imagine it could be equally effective in protecting the human body against the effects of excess current. And, contrary to the popular idea, I understand that it is actually the current rather than the voltage which constitutes a fatal shock. That probably explains why fatal shocks have been known to occur at what are normally considered safe voltages. I believe there is at least one case on record of a fatality occurring with a shock from less than fifty volts ! The amount of current passing through the body from a given voltage would presumably depend on the electrical resistance of the body, and I believe this varies very widely at different times and possibly with different individuals.

Although one should not necessarily place any deliberate reliance on a fuse as a protection against shock, I think it stands to reason that a set with sensitive fuses would be much safer to handle than one with no fuses; but don't try any rash experiments to test the truth of this assumption !

When a fuse blows, never replace it without first tracing the fault which has caused it to blow. If you fail to clear the fault before replacing the fuse, the latter will immediately blow again. And make sure you replace with a fuse of the same rating as the original – if the new one fails to react as efficiently to overload as the original one did, something more expensive will go instead !

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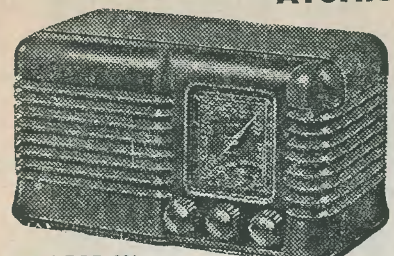

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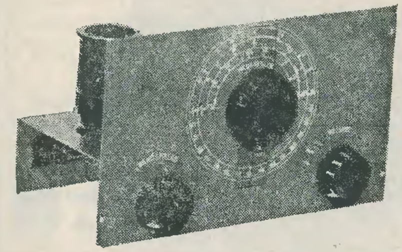

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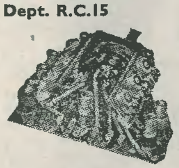

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continued from page 61]

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[continued on page 64

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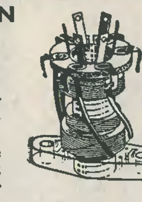

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1S5	6/6	6BW6	8/–	15D2	4/–
1T4	6/6	6CH6	8/6	220P	4/–
1U5	6/–	6K7	4/–	AL60	4/6
3Q4	7/6	*6SH7	5/–	EF36	7/–
3V4	6/6	6V6	7/–	EF50	5/–
6AL5	7/6	6X4	6/6	EL32	7/–
6AM6	6/6	7D5	6/–	OZ4	4/–
6AT6	7/6	7D8	6/–	*SP61	4/–
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