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VOLUME 10
NUMBER 11
JUNE
1957

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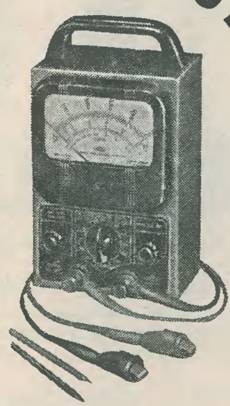

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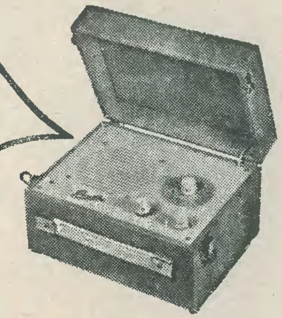

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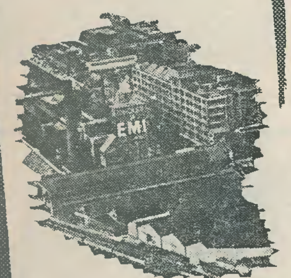

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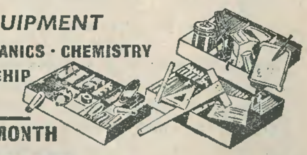

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9 x 7 x 2	6/6	12 x 7 x 2½	8/–	14 x 7 x 3	9/6	17 x 9 x 3	11/6
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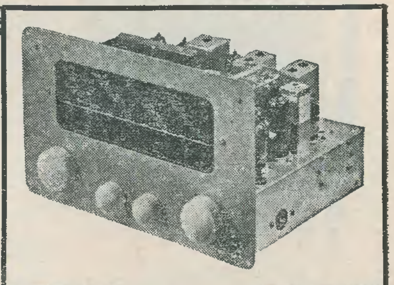

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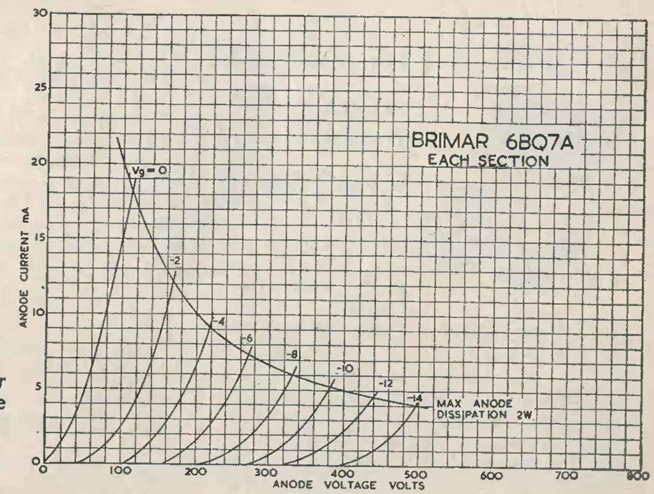
Grid cut-off voltage ($I_a = 10\mu A$)	—10 volts approx



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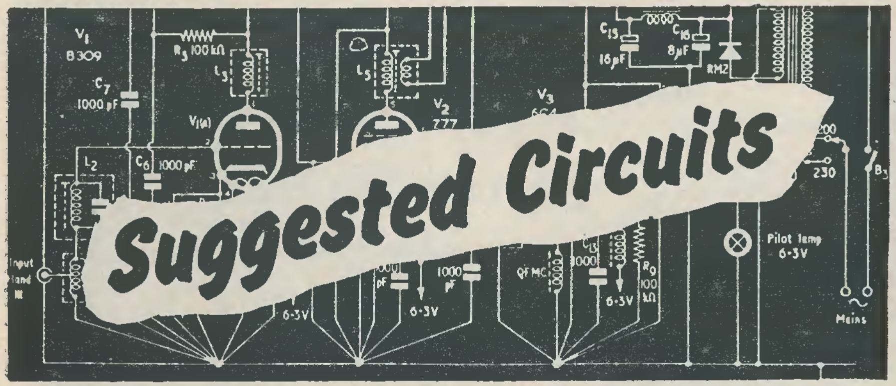

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No. 79. AN EXPERIMENTAL HYGROMETER

EVERY NOW AND AGAIN, THE WRITER feels that it is desirable to introduce a subject into these articles which does not fall readily within the limits of conventional electronics. Several devices which enter this category have appeared in the past, a typical example being an experimental photo-flash circuit which was published some years ago. Even now, letters concerning this circuit continue to arrive at *The Radio Constructor* offices! An advantage given by occasionally including out-of-the-way devices of this type is that they offer a welcome break from the more prosaic items of equipment with which we are familiar. The writer has also been given to understand that they help to provide readers with ideas for solving problems allied to, but not identical with, the particular circuit published.

This month's Suggested Circuit describes an electronic hygrometer (that is, an instrument designed to measure the relative humidity of the atmosphere). The writer must stress that the circuit is definitely in the experimental class, and that the results obtained are liable to depend, amongst other things, upon the care with which the "hygrometric detector" employed in the circuit is constructed. The device has a certain novelty value, although it could nevertheless be capable of fairly serious application if this were intended. The novelty value is given by the fact that, by merely breathing on to the detector, electric circuits may be set into operation. The factor causing the switching operation is, of course, the moisture present in the breath. Although the long-term stability of the device is liable to be low, it should be capable of giving reliable results over periods of several weeks or so. However, this point is not very serious because the chemical employed in the detector is easily obtainable and incurs negligible cost.

The Detector

The somewhat impressive term, "hygrometric detector," describes what is, in practice, an extremely elementary and inexpensive piece of equipment. This consists, quite simply, of two electrodes insulated from each other and covered by a thin layer of common table salt. The salt (sodium chloride) provides the humidity-sensitive material, and functions in the following

manner. When dry, it acts as an insulator and does not allow the passage of current between the two electrodes. On becoming damp it exhibits a certain amount of conductivity, the current which flows in consequence travelling through the salt solution provided. Within limits the resistance between the electrodes then varies according to variations in humidity, and a measure of the latter may, therefore, be made by purely electrical means.

For initial experimental work there is little point in going to excessive or expensive lengths in making the detector. A possible detector assembly is illustrated in Fig. 1. In this diagram a round electrode is mounted on to a tin lid such that a small space exists between its lower surface and the upper surface of the lid. The electrode is mounted by a bolt and insulating washers, as shown, these fixing it at a hole in the centre of the lid. The electrode, which may at this stage be made from any available metal, then forms one element of the detector, the lid providing the other. Relative dimensions are not very important, and the lid may have approximately the same size as that used on round tins of 50 cigarettes. Salt is next poured into the lid such that it just covers the electrode and fills the space underneath it. The detector is then ready for use.

Valve Circuit

In a device of this type, in which many parameters are experimental, the writer always feels a little hesitant at showing a circuit diagram with exact component values. It should be pointed out, therefore, that the circuit given in Fig. 2 is meant to be illustrative only, and that the home-constructor may find that alterations, notably to the values of R_1 and R_2, may need to be made to enable satisfactory results to be finally obtained. So far as the other resistors are concerned, components which are already on hand and are reasonably close in value to those shown could be pressed into service. The valve circuit functions, in practice, merely as a sensitive ohmmeter, the hygrometric detector being connected, via a limiting resistor R_1, between the h.t. positive line and the grid of the triode. When the detector is non-conductive the grid of the valve is held at cut-off potential by means of its grid-leak R_2 and the cathode voltage tapped off on the potentiometer R_6. A 0–10 milliammeter (or thereabouts) is connected in series with the h.t. supply to the triode anode, this measuring the anode current given when the grid potential rises. The series resistor R_3 is included to prevent excessive current passing through the meter in the event of zero bias at the valve grid. R_3 should always be set initially so that it inserts maximum resistance into circuit.

The operation of the hygrometer is very simple. When the salt in the detector is dry it passes no current, and the valve is held at cut-off. On becoming moist, the salt exhibits a proportional amount of conductivity. This causes the voltage at the grid of the triode to rise, with the result that anode current flows through the meter. When the circuit is correctly set up, the meter then provides indications proportional (within limits) to the degree of relative humidity in the air around the detector.

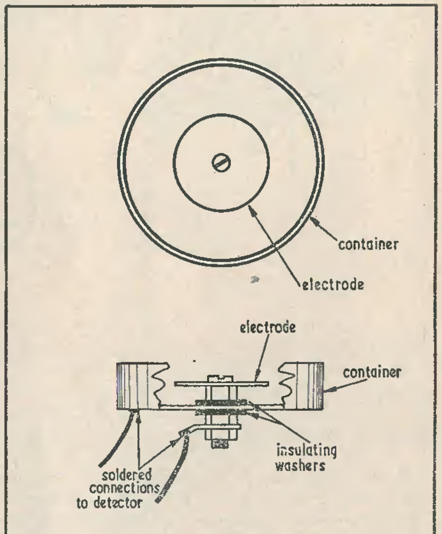


Fig.1

Practical Points

In order to obtain a range of sensitivity which is reasonably wide it is advisable to use a triode having a long grid base. A good choice would be given by employing one section of an ECC82 (12AU7). A number of other valves, including pentodes strapped as triodes, would be equally suitable. The values of R_1 and R_2 need to be found experimentally, although those shown in the diagram should be sufficiently near what is required for initial checks. The changes required in these two resistors may be quite large and, if it is found that R_1 needs to have a relatively low value, it would be advisable to connect a diode across the cathode and grid of the triode to prevent excessive grid current when the detector is conductive. Such a diode is shown in dotted line in Fig. 2 and could be provided, if desired, by a second triode with grid and anode strapped. (This would then enable both sections of a double triode to be effectively used.) The potentiometer R_6 is a sensitivity control and should be adjusted so that the triode is just cut off when the salt in the detector is dry. It should be noted that the recovery time of the detector will depend upon the warmth and humidity existing at the time of making the tests.

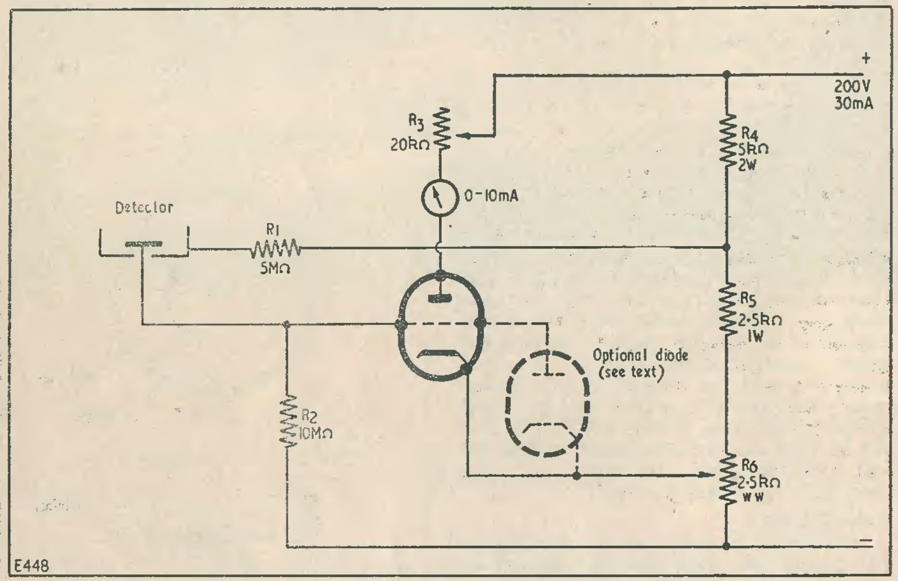


Fig. 2

After the valve circuit has been wired up, the device may be checked by initially connecting up the detector without its salt filling, switching on the power supply, and allowing the triode to warm up. R_3 should be in the position wherein it inserts maximum resistance into the circuit. The optimum setting of R_6 for grid cut-off is next determined. The resistance inserted by R_3 may then be reduced until a reading of approximately four-fifths of f.s.d. is given when the grid and cathode of the triode are connected together. (The alteration of the value of R_3 may necessitate a slight re-adjustment of R_6.) Dry salt should next be poured into the detector, whereupon the meter reading may increase slightly. The detector should then be breathed upon, whereupon a noticeable increase in meter reading should result. After the device has been found to function reasonably well, the final range of operation required may be found by varying the values of R_1 and R_2 with, possibly, some re-adjustments to the potentiometers R_3 and R_6. It

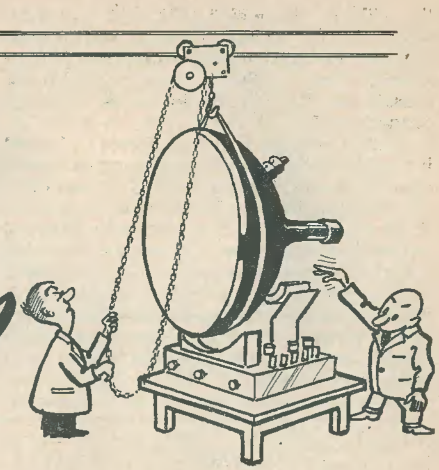
Final Points

The above description is intended to give details of a rather rough-and-ready hygrometer, and experimenters may wish to improve upon this after they have obtained some experience with its operation. The major field of experiment lies in the construction of the detector, wherein improvements could be effected by employing electrode metals whose surfaces would not corrode with time and by using a mechanical design which enabled the detector to be readily stripped down for cleaning.

It needs to be emphasised that, due to the manner in which it is connected into the circuit, the detector may assume a potential above earth which is high enough to cause shock. In this event care should be taken to ensure that it cannot be touched by people unfamiliar with its operation.

If it is desired to use the hygrometer to switch external circuits at certain levels of humidity, this may be achieved by connecting the coil of a suitable relay in place of the meter and R_3.

In your Workshop



Smithy the Serviceman, aided by his able assistant, Dick, continues to run the Workshop

"Smithy, I'm in trouble!"

With which wail of sorrow Dick announced to the world that he had become "stuck" in the repair of a particular receiver he had on his bench.

"What's the snag?" asked Smithy, looking up from his work.

"It's this t.v. set I've got here," replied Dick. "There's something wrong with the line timebase, but everything I've examined checks O.K. I've also swopped every valve in the circuit, but the trouble just refuses to clear up."

Smithy wandered over and examined the set. Straightaway he pointed to one of the valves on the chassis.

"You'll probably find that this is the culprit," he remarked. "Unfortunately, however, you may need to try quite a number of valves before you find one that'll work correctly. This particular set is a model which only works with selected valves in the position I've indicated."

Dick looked surprised.

"Well, that's a turn-up for the book, I must say," he commented. Smithy chuckled as Dick walked over to the valve cupboard.

Changing Valves

"It's all part of the business of being a service engineer," he remarked, as Dick checked a number of valves in the faulty chassis. "You don't often encounter sets which need specially selected valves to function properly, but they aren't entirely unknown. I must admit that the process of sorting out valves certainly puts up the time on the job so far as the serviceman is concerned, and it's liable to put a little extra on the customer's bill as well."

After a while Dick found a valve that seemed to clear up the trouble in the faulty receiver. Smithy, who had been watching him out of the corner of his eye, nodded with approval.

"I'm pleased to see that you switched the set off each time you changed the valve," he remarked. "It's a good habit to get into."

"As a matter of fact I only do it because you told me to," Dick confessed. "Actually, I'm a wee bit hazy as to the reason. Is it something to do with the surge currents which would flow when you put the new valve in and completed the heater chain again?"

"You're miles off the mark," said Smithy. "The real reason is that, when you have all the heaters of a television receiver connected in series, breaking the chain is liable to subject the heater-cathode insulation of some of the valves to a greater strain than they were designed to stand. If you look at this sketch I've made (Fig. 1a) you'll see what I mean.

"Let's start by supposing that V_8 in the heater chain becomes suspect and you decide to swop it for another valve you know to be good. If you leave the set switched on and pull V_8 out of its socket, all the heaters above it will rise to the same potential as that of the live side of the mains (Fig. 1b). In consequence the mains potential will appear between the heaters and cathodes of these valves; their cathodes being coupled to chassis via the circuits in which they are connected."*

"But surely," Dick protested, "valves intended for series heater operation can stand heater cathode potentials as high as this without breaking down! In any case, aren't you liable to have the same sort of breakdown if one of the valves burns out, as it can do in the ordinary course of events? If you followed your argument to its logical conclusion it would mean that, when one valve burned out all the valves which were higher up the chain would break down between heater and cathode as a result."

"The situation is by no means as bad as that" smiled Smithy, "and I would certainly admit that damage rarely results if valves are subjected to higher heater-cathode potentials than their manufacturers specify over a short period of time. Nevertheless, if you look at the maximum recommended heater-cathode potentials of some typical valves used in television receivers you may see that the situation is not quite as rosy as you think. Now, a valve which would probably be fairly safe in the event of the chain being broken below it is the PCF80. The limiting heater-cathode potential for this valve, in both its triode and pentode sections, is 200 volts d.c. or a.c. (r.m.s.). The latter assumes a sinusoidal supply. An EF80, on the other hand, has a limiting value of 150 volts only—d.c. or a.c. r.m.s.—between its heater and cathode; and it would be unwise to exceed this potential for long periods of time. As I said just now, we don't get the case in practice where valves go pop one after the other, like a Chinese cracker, if the heater of one happens to go open-circuit. At the same time a risk still exists, and I just don't believe in taking chances. That is why I always like to switch the set off before I remove a valve. There is, mind you, a minor snag in switching a set on and off continually if it is fitted with a valve h.t. rectifier. The reason for this is that the rectifier cathode may not be at the full emitting temperature when the set is switched on again, and the heavy surge currents which flow at that instant may damage this electrode. I don't think the risk of damage to the rectifier is very high, however, because its surge limiting resistor should keep such currents within safe limits. Metal h.t. rectifiers should be able to stand up to surge currents of this nature without any worry about damage."

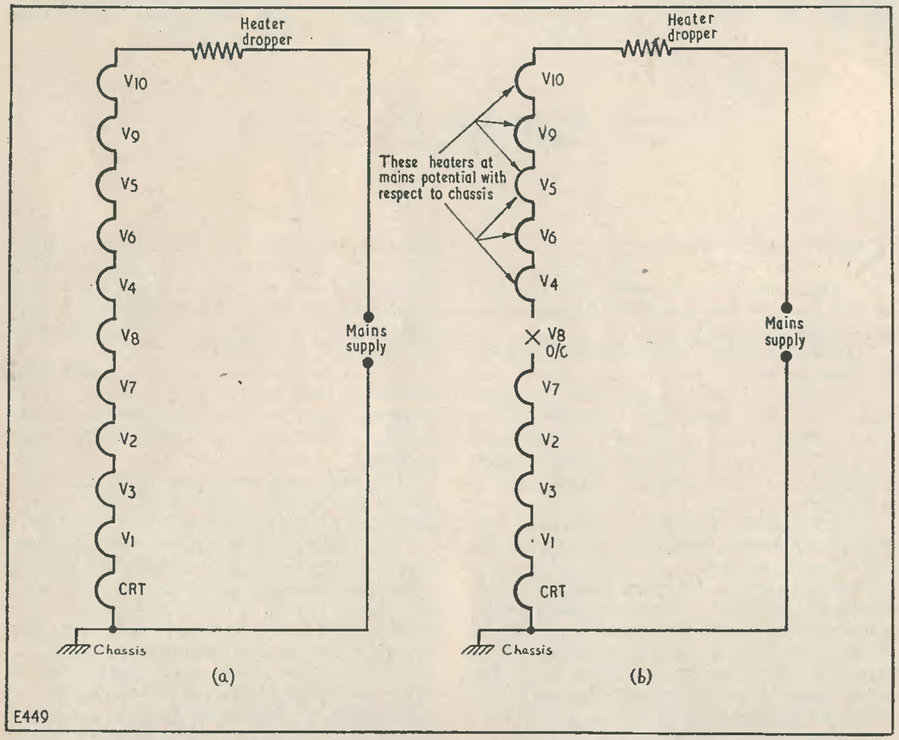


Fig. 1 (a). The heater circuit of a television receiver. (A full complement of heaters is not shown)

(b) If one valve in the heater chain is removed, or becomes open-circuit, all the heaters in the chain above it rise to mains potential

* In some cases cathode-heater potentials may consist of the mains voltage plus a d.c. voltage derived from the h.t. supply. However, most valves will connect to chassis via low-resistance cathode bias circuits and these are what Smithy is concerned with here.

"Thanks for the gen," Dick remarked. "I shall now continue to switch television sets off before I swap any valves I may suspect in them. Only from now on I'll know *why* I'm doing it! By the way, is there any special reason for the order in which valve heaters are connected up in a series heater string? One often sees heater wiring travelling all over a chassis to couple in the various valves, when much shorter wiring could be used if the heaters were wired up according to their position in the layout."

"The position which each valve takes up in the chain is quite important," answered Smithy, "and I should imagine that the business of working out the chain is quite a headache for the t.v. designer. The reason for this is that a good 50% of the valves in the set have excellent reasons for wanting to get down to the chassis end of the chain. In practice, the heater which is nearly always right at the chassis end of the chain is that of the c.r.t. There are two reasons for having the c.r.t. heater in this position. The first is that, whenever any point in a heater chain short-circuits to chassis, a heavier current than normal passes through that part of the chain above it. By having the tube heater at the chassis end, short-circuits to chassis cannot possibly cause it any harm. The second reason is that, if the tube heater is at chassis potential, the voltage between its heater and cathode is kept as low as the receiver circuitry will allow. Its heater-cathode insulation is, thereby, subjected to as little strain as possible. There is no purely technical reason for taking such especial care with the tube heater, of course: precautions are taken merely because the tube is a very costly item in the receiver.

"So far as the valves themselves are concerned, the major difficulty encountered, apart from keeping heater-cathode potentials within limits, is hum injection into cathode circuits from heaters. It is for this reason that the heaters of the first valves in the receiver—those of the tuner and the early i.f. stages—are nearly always very near the chassis end of the chain. Timebase valves occasionally require a low position in the chain. This fact applies especially to such valves as flywheel sync discriminators and the like whose cathodes may work into high impedance circuits and which cannot, in consequence, be decoupled to chassis via large value condensers. If valve diodes are used as sound or vision interference limiters their cathodes may be connected to high impedance circuits also, whereupon they, too, need to be positioned well down the chain. In some receivers the video amplifier cathode cannot be decoupled to chassis by a large value of capacity, and this valve similarly needs to take up a low position in the heater string. In the case of the video amplifier, however, this is not necessarily because hum may appear on the video applied to the c.r.t., but rather because it may be passed to the sync separator which follows it. The hum might affect the frame sync pulses."

"It all sounds pretty complicated to me," remarked Dick. "I don't quite see how hum would affect the frame sync pulses, though. Surely, if hum *did* alter the shape of the frame sync pulse the effect would be the same for each pulse?"

"Not entirely," replied Smithy. "Although I must admit that I've raised rather an academic point. Don't forget that, although the frequency of a mains supply running from the National Grid is the same as the transmitted frame frequency, the long-term phase relationship between the two may vary. If heavy hum were present on the frame sync pulse I could visualise the case where interlace would be good for one phase relationship and bad for another. More important, perhaps, is the fact that you need to keep hum out of the frame sync pulses in order to cover the instance where the receiver is run from unsynchronised mains. There are still quite a number of unsynchronised mains supplies in the country, and the set designer has, of course, to keep these in mind."

"I see," said Dick. "By the way, before finishing on heater chain questions, here's one little thing I'd like to ask you. As you know, it now and again becomes necessary during servicing to cut out a particular stage in a receiver in order to help in isolating a fault. If the set uses a mains transformer with parallel heaters you can put a stage out of action simply by pulling out the associated valve. How can you 'kill' a stage in a set which has its heaters connected in series?"

"Well, of course, you obviously can't pull out the valve in that case," replied Smithy. "I would say that, if the valve doesn't require too high a heater voltage, a fair solution would consist of shorting out its heater pins. The valve would soon lose emission and the chain would remain unbroken. I'm not really too keen on this process because the resultant current in the heater chain could be excessively high if the short-circuited heater dropped a high voltage. Also, if crocodile clips were used to do the job, there is a risk of shorts to chassis and adjacent valveholder pins. What is probably a much better idea is to replace the heater with a fixed resistor. A good scheme for inserting the resistor into circuit would consist of making up a couple of adaptors to fit into the appropriate valve-sockets instead of the valve, each adaptor having its own resistor. One adaptor could be a B7G type having the resistor connected between pins 3 and 4, whilst the other could be a B9A type with the resistor connected between pins 4 and 5 (Fig. 2). All other pins would be blank. A 40 ohm 5 watt component should prove satisfactory for the resistor. This would drop 12 volts at 0.3 amps and would not disturb the heater chain current too much if it was inserted in place of the heater of most valves likely to be encountered. The adaptors would be much safer and quicker to fit than temporary measures using crocodile clips. Admittedly, they wouldn't be required very often, but they'd be useful to have around."

"That's quite a good idea," commented Dick. "Are B7G and B9A adaptors easy to get hold of?"

"Oh yes," Smithy replied. "I understand that they are available from one or two stockists."†

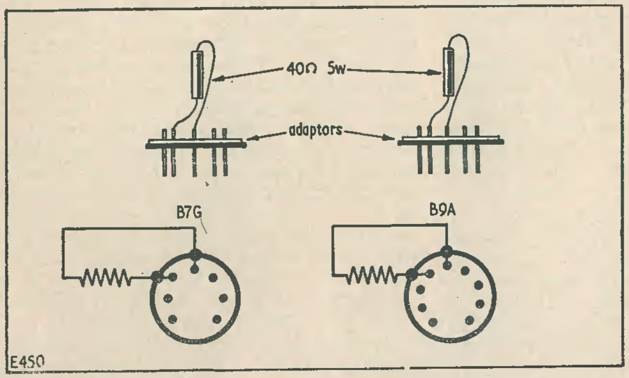


Fig. 2. Valve "cheaters." If it is necessary to put a stage out of action during servicing, the appropriate valve may be replaced by one of the adaptors shown here

Varying H.T. Voltages

"By the way," said Dick, "I hope you'll excuse a rather drastic change of subject, but a friend of mine who does a little servicing recently ran into rather a queer fault, and I'd like your comments on it. He was checking a television receiver in a customer's house and he found that the h.t. voltage was rather low; it being about 185 volts instead of the 195 it was supposed to be. He was rather worried about this because the set was only just coping at this voltage and, on a hunch, he disconnected it from the 5 amp socket it was running from and connected it to a 15 amp power socket nearby. At once the h.t. voltage came up to approximately 194, which cleared up his main worry. However, the surprising thing about the whole story is that, when he checked the a.c. voltages on the 5 and 15 amp sockets, they both read the same. Have you any idea what caused the different h.t. voltages?"

"There's a fairly well-known reason for the discrepancy," replied Smithy, "although the case you've just quoted appears to be rather extreme. Would I be correct in assuming that the nominal mains voltage of the particular district concerned was low—say, about 210 or so?"

"Yes, that would be true," said Dick.

"Well, that partly explains the large change in h.t. voltage," Smith said. "The story you have just told me is, to a certain extent, symptomatic of one of the difficulties which are always present in television power supply circuits. I don't need to remind you that practically all television receivers in this country employ a half-wave rectifier, this feeding into a high capacity reservoir condenser via a low value limiting resistor. The arrangement you get is something like this (Fig. 3). I've shown a valve rectifier, but a metal rectifier would be equally at home in the diagram. As you can see, the circuit employs three input taps, these allowing for mains voltages of 200–210, 220–230 and 240–250. The voltage taps function by connecting different values of resistance in series with the half-wave rectifier.

"Now the h.t. drawn by a television receiver is usually relatively high, being of the order of 200 to 250mA. This current is provided, after the smoothing filter, by the reservoir condenser. The only time that this condenser receives current to make up for that discharged into the receiver is during the peaks of positive half-cycles from the mains. The voltage appearing across the condenser is rather like this (Fig. 4), wherein we have a long discharge period followed by a short charge period.

† For instance, H. L. Smith of Edgware Road. B7G 2s., B9A 2s. 3d.

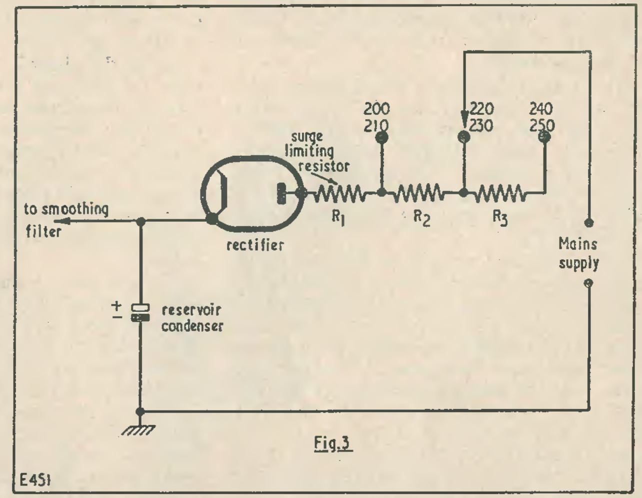


Fig. 3. The h.t. rectifier circuit of a conventional televisor. R1 is usually a limiting resistor having a relatively low value

"During the short charge period quite a heavy current is passed by the diode, and it is the purpose of the limiting resistor to keep this to a value which is safe both for the rectifier and the electrolytic reservoir condenser. You will note that in the circuit (Fig. 3), the only resistance which is in circuit between the lowest mains tap and the rectifier is the limiting resistor itself. For the two higher taps extra resistance is put into circuit.

"When at work on his set, the television receiver designer is usually searching for all the h.t. volts he can safely obtain, so you often find that the resistor brought into circuit on the lowest voltage tap approaches the smallest value which the circuit will take. Values as low as 25 ohms for this resistor are not uncommon in practice. If you experiment with a circuit of this type you will find that increasing the value of the limiting resistor by quite a small amount can cause a disproportionately large drop in h.t. voltage. For instance, if you increased a 25 ohm limiter to, say, 35 ohms, you might find that the h.t. voltage would drop by as much as 10 volts. The reason for the large drop is that, by increasing the limiter resistor, you are reducing the heavy reservoir condenser charging currents which flow during positive peaks.

"On the lowest voltage tapping, therefore, the resistor in series with the rectifier usually has, of necessity, a relatively low value. More resistance must obviously be inserted for the higher mains tappings but, even here, resistor values are still low. Average values for R_2 and R_3 (Fig. 3) could easily be around the 20 to 25 ohm figure. Once again, slight increases of resistance in series with R_2 or R_3 can cause disproportionately large drops in rectified h.t. voltage but, for the same number of ohms increase, the drop is not so large.

"So far, so good. But now we come to the snag! As you are aware, we can represent pretty well everything in radio by an equivalent circuit, and the mains supply is no exception. Here is an equivalent circuit for the mains supply as given at the two contacts of a mains socket in a house (Fig. 5). This supply consists, quite simply, of a generator in series with a resistance. The resistance represents the internal resistance in the generator plus the resistance in the wires between its terminals and those of the socket. To be really accurate we should call the resistance an *impedance* as, with a.c. mains circuits, there is usually a certain amount of capacitive or inductive reactance knocking around. However, for our purposes here, we can assume that the reactances are low and that the impedance is well-nigh entirely resistive.

"Now the internal resistance of the mains generator should normally be as near to zero as the electricity suppliers can make it. The generator will usually be a sub-transformer somewhere in the neighbourhood whose secondary windings will have very low resistance indeed."

"To be really accurate, shouldn't we take into account the resistance in the primary circuit of the sub-transformer as well?" interjected Dick, who had been following Smithy very closely. "Theoretically, I can see us chasing the internal resistance of the mains all the way back to Battersea Power Station!"

"I can see that you have far too much imagination to be a successful student, even if it might make you a successful engineer!" chuckled Smithy. "Anyway, I think we had better take the internal resistance of Battersea Power Station as being read. So also may we consider the internal resistance of the sub-transformer, plus the resistance of the street wiring which brings the current up to the house. It is usually in the house wiring, after the meter, that ohms begin to raise their ugly heads; especially in the 5 amp circuits, where they are liable to go unnoticed."

"I can see that I shall have to take the high-resistance six inch nails out of our fuse box at home!" commented Dick, "and invest in some genuine high-conductivity copper fuse wire."

"Well, even six inch nails aren't too troublesome," laughed Smithy. "On the other hand, long runs of relatively thin wiring can introduce quite high resistances. I daresay you've seen a number of installations in people's homes wherein 5 amp sockets are run from ordinary lighting flex stapled to the wainscoting. These installations are usually highly dangerous; as well, incidentally, as being illegal when the flex connects to a 'regular' mains point outside the room in which the socket is installed. I've been told by a friend who handles this sort of thing that up to ten ohms or so quite often appears in series with the 5 amp sockets in some houses. So far as a 50 watt reading lamp is concerned, a series resistance of 10 ohms only means a drop of approximately 2.5 volts on a 200 volt mains supply. If, however, you connect a t.v. set to that socket you could lose as much as 10 to 15 volts h.t. quite easily, simply because the 10 ohms in the mains supply becomes effectively connected in series with the limiter resistor in the set. At higher mains voltages the effect is not so bad for reasons I have just described, but it can still be severe enough to cause trouble at times. It can be especially embarrassing if the district in which the set is installed has a mains voltage which drops badly during peak periods and where you're after every h.t. volt you can get."

"Well, that seems to explain my friend's particular snag," Dick remarked. "So far as the 15 amp sockets are concerned I suppose one could assume practically zero internal resistance in almost every instance."

"Oh, definitely," Smithy concurred, "if only for the very good reason that 15 amp circuits are almost certain to be installed by competent engineers with heavy, adequate wiring. In any case, when you have fires and stoves taking currents of five and ten amps you simply *can't* have any sizeable resistance in series with the supply. Unless, of course, you're thinking of having central heating in the house!"

"I have just thought of something," said Dick. "What happens if you run a television receiver from a 1 : 1 isolation transformer during servicing? Isn't the isolation transformer likely to introduce an effective series resistance and give false h.t. readings?"

"That's quite possible," said Smithy, "and you've raised a very good point there, because small isolation transformers can introduce quite noticeable series resistances. That's a thing to watch for when using such transformers."

"Well, you've given me a few more items to add to my stock of knowledge," said Dick. "But I think I would be safe in saying that internal mains resistances are by no means the only things which cause low television h.t. voltages."

"You would be perfectly safe," confirmed Smithy, "because there are quite a number of other contributing factors. The h.t. rectifier is often a cause of trouble in this respect. Although things aren't so bad these days, metal rectifiers used to give a certain amount of difficulty some years ago. What used to happen was that when the t.v. receiver left the factory its h.t. rectifier would have a nice low forward resistance‡, and the set would have a comfortably high h.t. voltage as a result. As time went by this h.t. voltage used to drop, quite steadily and regularly, until the occasion finally arose in which it was too low to operate the set. Not *all* metal rectifiers behaved in this fashion, of course; it was just a certain percentage.

"Nowadays, this sort of thing doesn't happen so often, although one still finds that the forward resistance of some rectifiers increases slightly during the first few months of use. It would be inadvisable to generalise on this sort of thing; but one quite often

‡ Forward resistance is the resistance exhibited by the rectifier when conducting.

finds, during these first few months, that the h.t. of the receiver drops by 10 volts or so, after which it seems to 'settle down' for the rest of the life of the set."

"I seem to remember seeing somewhere that metal rectifier ratings depend to a large extent on the temperature at which they work," Dick interjected.

with the result that higher watts-losses appear in the elements. These cause the generation of more heat, further increased forward resistance, higher watts-losses again, and so on; with the consequence that, over a period of time, you get a 'snowballing' effect which is only terminated by the final demise of the rectifier."

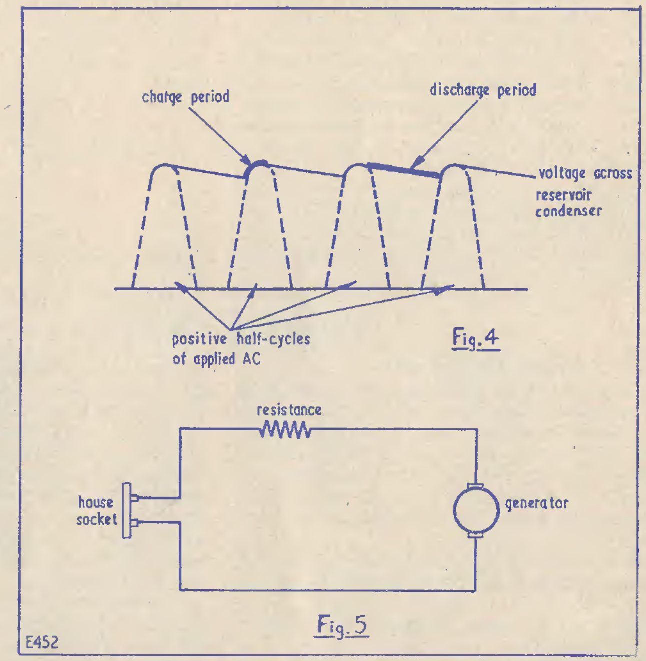


Fig. 4. The voltage waveform appearing across the reservoir condenser of Fig. 3 takes up the appearance illustrated here.

Fig. 5. An equivalent circuit illustrating the presence of resistance in a mains circuit

"That's quite true," said Smithy. "If you look up the maximum ratings of selenium rectifiers you will find that they have to be derated when their operating temperature rises above a certain figure. By 'derated' I mean that the maximum ratings have to be reduced. Metal rectifiers are often operated fairly close to maximum temperatures in television receivers, with the result that you have to be careful to ensure that cooling arrangements are not prevented from operating efficiently. If t.v. sets are put on small tables with their feet overhanging the edge you often get bad ventilation and cooling, because the flow of air through the bottom of the cabinet is impeded.

"One of the reasons why it is important to avoid overheating metal rectifiers is that these components have a tendency towards self-destruction once they exceed the temperatures corresponding to the currents they are passing. Increases in temperature in a selenium rectifier cause increases in forward resistance,

"The moral of the story," Dick commented, "is, therefore, to ensure that metal rectifiers run as cool as possible. I suppose that most rectifiers are kept cool by convection currents."

"This is usually the case," agreed Smithy, "hot air rises from the rectifier and cool air comes in to take its place. Quite a lot of heat is lost by radiation as well. Of course, the metal rectifier isn't the only component on a t.v. chassis which needs to be kept cool, and convection currents have to serve other parts as well. That's where good cabinet design and chassis layout assist each other; and you may find in some sets that all the heat-generating components combine in the formation of a steady convection current. Indeed, some t.v. sets exhibit almost a 'chimney' effect, and have ventilation holes at the bottom of the cabinet, and at the top of the rear cover, with none in the middle. The resultant air current is almost in the nature of a forced air draught, and you might actually *decrease* cooling efficiency if you added extra holes in the middle of the rear cover! Quite a good method of seeing what convection currents exist in a television cabinet consists of blowing in a little cigarette smoke at the bottom. With some sets, and particularly with compact designs, you'll be surprised to see how soon this re-appears at the top!

"To return to the metal rectifier. Much of its heat is taken away from this component, as I remarked, by convection currents. Incidentally, this fact emphasises the importance of mounting heavily-loaded metal rectifiers horizontally, so that the cooling air has greatest contact to the fins as it passes by them. There is a particular type of rectifier, however, which is not cooled in quite the same way. This is the contact-cooled rectifier. Contact-cooled rectifiers have no fins and are bolted flat to a chassis, with the result that the heat they generate is conducted away by the metal of the chassis itself. You could then consider the chassis as acting as one very large cooling fin for the rectifier."

That Problem

"Well, you've certainly told me a lot about rectifiers that I hadn't known before," remarked Dick. "Incidentally, I hope you haven't forgotten that 'hocus-pocus' problem you raised the other day. I might point out that I spent half of Saturday afternoon trying to get the darned thing out!"

"Well, it took me nearly an hour myself," confessed Smithy. "But, as I say, the time limit for the 11-plus examinees who did it was five minutes only—or so I understand. You may remember that the original went:

```
  H O C U S
  P O C U S
 -----------
P R E S T O
```

"When translated into figures the result is:

```
  9 2 8 3 6
  1 2 8 3 6
 -----------
1 0 5 6 7 2
```

Simple, when you know the answer, isn't it?"

TRADE NEWS

Vidor Television Replacements

A number of set manufacturers are making arrangements for Direct TV Replacements, of 134-136 Lewisham Way, S.E.14, to maintain the supply of their older type replacements. Vidor are the latest company to operate in this manner, and so assure that replacement parts are available for all their t.v. models.

The Vidor models for which Direct TV Replacements have been appointed official suppliers are:—

Model 377 Line Output Transformer Uniscan, 39/–.

*Models 390 Line Output Transformer Type 15623, *391, *405, *406, *4201, *4202, 50/–.

*Note.—Two types of line output are used on this model. The above type is used where a single winding width coil is employed. In models using double wound width coil the line output transformer has to be sent to D.T.V. for special rewind, taking 48 hours.

Models 4206, Type of Line Output 15747, 4207, 4208, 4209, 4212, 45/–.

Deflector Coils CP.77916 for the above models, 45/–. All above are retail prices.

Low-Microphony Pentode for A.C./D.C. Audio Equipment

A new addition to the Mullard range of 100mA a.c./d.c. valves opens up important possibilities for the design of high quality audio amplifiers for a.c./d.c. operation.

Until now, lack of a suitable low-noise pentode for the pre-amplifier or mixer stages of high-gain amplifiers has made really low hum and microphony levels difficult of achievement in a.c./d.c. apparatus.

The UF86, which has just been announced by Mullard, is a low-hum, low-microphony pentode with a heater rating of 12.6 volts at 100mA. Its characteristics are virtually identical with those of the well-established World Series pentode type EF86. Used in circuit with other Mullard 100mA valves it makes possible the design of compact, economical a.c./d.c. apparatus having signal-to-noise ratios approaching those of the best a.c. apparatus.

For example, a UF86 feeding two UCL82 triode-pentodes, and with a UY85 half-wave rectifier, would form the basis of an inexpensive push-pull amplifier giving a sensitivity of 10mV for 7 watts output at a low distortion level, and a signal-to-noise ratio of 55db.

The UF86 is available for immediate delivery.

Sellotape's New Polythene Electrical Tape

A recent addition to the range of Sellotape self-adhesive tape products is polythene electrical tape.

The tape, with a tensile strength of 16lb per inch width, has been developed with a number of new special characteristics to provide a reliable, waterproof insulating tape, with enough elasticity to enable it to conform closely to surfaces and ensure a tight seal. Its elongation at breaking point is 175 per cent.

Good ageing properties are provided by an adhesive which is immune from corrosive effects. Plasticiser migration from the tape is eliminated by the absence of plasticisers in the polythene film.

(continued on page 760)

TELEVISION for the HOME CONSTRUCTOR

PART 12 *by* **S. WELBURN**

In this, his last article for some time, S. Welburn deals briefly with the past and the present, then discusses a number of important questions embracing existing controversies and the future progress of television.

Writing a regular monthly article is an occupation which can provide both pleasure and pain! It must be admitted that, so far as the present articles are concerned, pleasure has constituted by far the greatest proportion of the writer's sensations. Pain only becomes evident when he finds that the monthly date of submission to the Editor appears, uncomfortably, far nearer than he had anticipated. Normally, it is possible to have articles prepared well in advance but, due to unforeseen circumstances, last month's contribution was somewhat delayed. When the writer *did* start work on it he also started the first few days of a bout of 'flu! Apart from a mysterious "kink" in one of the waveform diagrams—which was fortunately straightened out just before the block was made—the article concerned doesn't seem to have suffered too much by the conditions under which it was written.

Speaking seriously, however, the author would like to point out at this stage that this is going to be the last of the present series of articles, and that he will be taking a holiday from writing for a number of months. During this time the continuity of articles on television in *The Radio Constructor* will be maintained by other contributors. If all goes to plan the writer will be returning, refreshed, ready for the fray and full of new ideas, in the autumn.

In Retrospect

There is, usually, little to be gained in persistently looking back into the past, but a very brief excursion every now and again does not normally do any harm. Indeed, it can often help to bring both the present and the possible future into truer perspective. Readers may recall that the first of the regular television articles appeared in the July 1955 issue of this magazine; appearing, therefore, at a time when very considerable interest on the part of the technical and the non-technical public was focused on the reception of Band III transmissions. The first article confined itself to a description of the Valradio Tuner Unit type TP20P, this being employed for the conversion of the Magna-View for Band III operation. Later articles were devoted also to Band III topics, the September and October issues describing the Teletron Mark I and Mark II converters respectively. It was, in fact, the October article which introduced the Mark II version to the home-constructor for the very first time, and the writer obtains a certain pleasure from the association he has had with this now extremely well-known and successful unit. It would be difficult to say how many Teletron converters have been built, but the number must be considerable. What is more, these converters are still being constructed at the present time in various districts in order to receive Band III transmitters as they come on the air.

After the first twelve articles it was decided to widen their scope, and so a second series was started. This commenced, in the July 1956 issue, with a description of the line flywheel sync circuit developed by R. G. Young and intended especially for the amateur. Later articles, coming up to the present date, dealt with many of the problems encountered in modern television engineering, including the design of diplexing and splitting circuits, remote control arrangements, and discussions of the various parts of television circuitry which are most applicable to the home-constructor.

The Present

So much for the past, which has provided many interesting topics, and which has also demonstrated how quickly new techniques in television become taken for granted. The present scene exemplifies the continually changing developments which occur in television design, even though some of these, due to their complexity, may not be immediately applicable to the home-constructor sphere. To attempt to sum up the amateur position it could be said that, at the immediate moment, the construction of *complete* televisors seems to be following well-established techniques which have become familiar over the past three or four years. "Wide-angle" (70 degree) tubes are practically standard equipment in present-day receivers, both home-constructed and commercial, and the timebase and scanning circuits for these have not undergone any major alteration. So far as commercial receivers are concerned there is a trend towards 90 degree tubes, but at the time of writing it is difficult to calculate how this will be reflected in home-constructor fields of interest. One of the major advantages of 90 degree tubes is that they require less cabinet volume, thereby enabling a cheaper receiver to be manufactured as a result. A disadvantage given by the 90 degree tube is that greater power is required for horizontal scanning and that scanning components have to meet higher specifications than heretofore. From the amateur point of view it seems feasible that the saving in a cabinet cost (rather problematic in this context) may be considerably outweighed by the circuit complications involved. At any event, much depends upon the components which will become generally available for use with 90 degree tubes.

Apart from the new tubes, and, of course, Band III, general receiver design has for some time remained fairly stable. This remark applies both to commercial and to home-constructor design. There is a current commercial leaning towards the manufacture of "portable" television receivers, but these mostly consist of more-or-less conventional chassis served up with new dressing. Once again, home-constructor reactions are problematic.

Band III has completely altered the front-end of the television receiver, but this aspect is one which amateurs have taken very confidently in their stride. The availability of commercial tuners, such as the Valradio unit mentioned above, has helped considerably to ease difficulties in this sphere. The writer has, in the past, given design details for reasonably simple Band I–Band III tuners capable of being made by the more experienced amateur, and he understands that his notes have been of assistance in this field.

As was mentioned above, some of the previous articles in the series have dealt with television remote control circuits, and it would seem that this is a subject in which a surprisingly large amount of interest is shown.

All in all, therefore, it seems safe to say that present home-constructor interests lie not so much in the construction of television receivers as a whole, but rather in the improvement of existing techniques, with especial reference to equipment ancillary to the televisor proper.

The Future

It is when we commence to consider what television holds for the future that we enter into the most interesting field of discussion. The essential function of television is that of representing visually, as a complete picture, information which is transmitted sequentially. At the time being we have only one device which is capable of carrying out such representation cheaply and successfully—the cathode ray tube. Some years ago the writer held the opinion that the cathode ray tube was a relatively clumsy and cumbersome device which must eventually be replaced. Nowadays, he is not so sure. The reasons for his earlier opinion were given mainly by the purely mechanical limitations of the cathode ray tube. Unless projection was employed, it was impossible to obtain a picture larger than the maximum flat area given by the glassware of the tube; and the total amount of glass employed had to be made proportionately very large in order to obtain a bulb shape that would withstand the heavy atmospheric pressures to which it was subjected and which would enable the basic requirements of scanning to be achieved. One could only have a large picture at the expense of a structure which was very much more bulky than the part on which the picture appeared.

Whilst trying to avoid a "science-fiction" approach, it cannot be gainsaid that, if deflection and modulation could be applied not to an electron beam but to a beam of light, a picture of almost any size whatsoever could be obtained simply by projection on to a screen. A beam of light is, of course, weightless, and even small deflection angles could give a sizeable picture, if the "throw" to the screen were sufficiently long. The only major limiting factor to screen size would be the brightness available after modulation. The question of modulating and deflecting the light beam is by no means insurmountable, and it is possible that a device of this type may, one day, rival the cathode ray tube. The writer would like to add that the idea of obtaining a television picture in this manner is by no means a new thing at all: a receiver employing this principle and functioning on 405 lines was manufactured before the war!

Definition

The writer does not want to give the impression that he considers that large pictures are the prerequisites of all television design, although he must point out that it is desirable to be able to obtain reasonably large pictures without incurring excessively high costs. At present, very large pictures—in the home at any rate—are not attractive owing to the definition given by our present 405-line sys-

tem. On the other hand it needs to be emphasised that, when correctly set up and accurately interlaced, a 405-line picture can provide a surprising amount of sharpness on really large screens. Due to the fact that Great Britain was the first country in the world to have a regular high definition television service we are now tied to the standard of 405 lines which we chose in 1938. (Nearly twenty years ago!) From the point of view of definition, incidentally, it should be pointed out that 405 lines is not so bad as some commentators would have us believe, and the writer can assure readers that not a great deal is gained visually (indeed, some horizontal resolution may be lost) by changing over to the American 525 or C.C.I.R. 625-line standards. Apart from the argument that it may assist in the design and manufacutre of export receivers, for Great Britain to convert to 525 or 625 lines would, quite simply, just not be worth the heavy expenses involved. If an increase in the number of lines of the television picture is to take place, then it needs to be one that is really worth while; say to 1,000 lines or more. There is no reason why such an increase should not take place at *some* time in the future, even if transmissions could only be received in the first instance by those residing in the more heavily populated areas of the country. It would be necessary to move the large bandwidth signals required into the u.h.f. bands, and the necessary transmitters could, initially, be centralised in areas of dense population. Experience has always shown that television service areas are, in practice, larger than those originally anticipated, and it may be that the u.h.f. transmitters would give a coverage extending outside their initial service areas by a significant amount. The rather disappointing results given by u.h.f. transmissions in the United States need not necessarily be repeated in this country, as the prevailing conditions would be different. The problem of making higher definition signals "compatible" with existing 405-line standards would be the least of the difficulties. One way out of the problem could consist of originating programmes in the higher definition system, and "converting" these to 405 lines with techniques similar to, or improved upon, those currently used for Eurovision. Alternative schemes employing entirely electronic methods of conversion may be feasible.

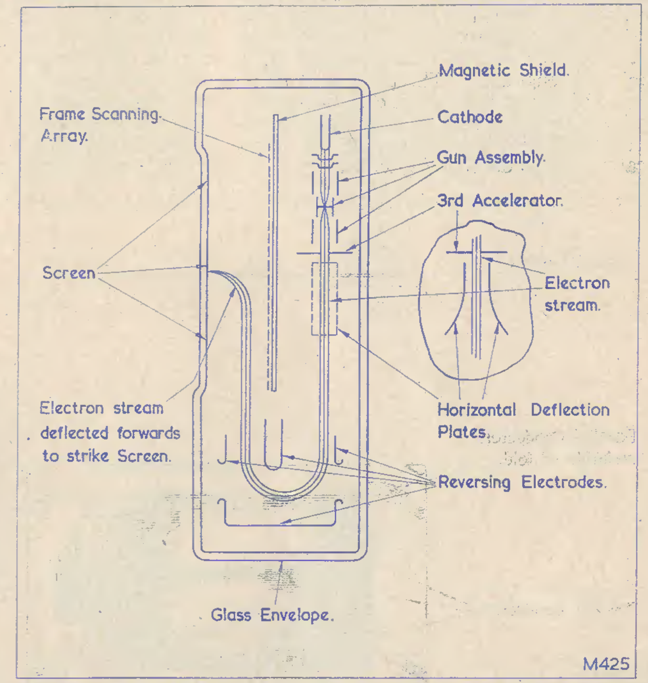


Fig. 1. Simplified diagram, showing a cross-section across the Gabor tube. The shadow-mask and cathode ray tube employed for colour reproduction are not shown

The Gabor Tube—A New Approach

Earlier on the writer referred to the c.r.t., and remarked that he is nowadays not so sure that this is quite so clumsy a device as he had hitherto considered it to be. It is worth while returning to the subject of the c.r.t. because this opens up yet another interesting aspect of television of the future. So far as the writer's change of view is concerned, this is partly due to the fact that he has recently been able to inspect a modern 110-degree tube, and he feels that this marks a definite step in achieving a ratio of supporting glass area to screen area which is not cumbrously large. Indeed, if it were not for the inevitable neck protruding from its rear, the 110-degree tube would begin to approach the "picture on the wall" concept that has been predicted by a number of engineers. The process of scanning a 110-degree tube is not easy but it can, of course, be done; and the advantages given by the tube may well outweigh the complication of the deflection circuits.

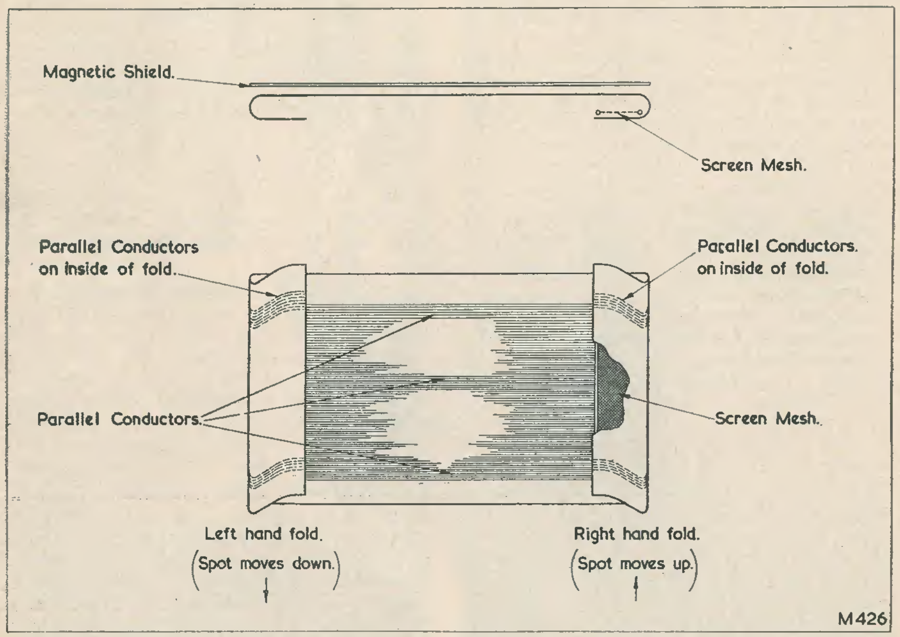


Fig. 2. The frame scanning array of the Gabor tube. The cross-section of Fig. 1 cuts across the centre of this array which, in that diagram, is at right angles to the paper

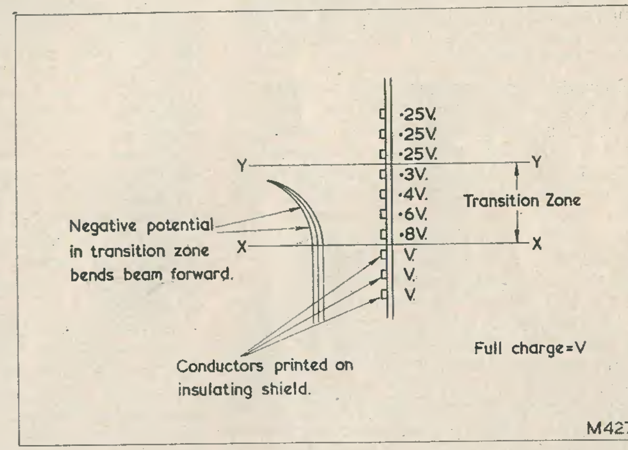
Another reason which may tell considerably in favour of the cathode ray tube type of presentation is the possible manufacture of a new type altogether. This new tube, at present in the experimental stage, falls very closely into the "picture on the wall" concept; and it has been the subject of much comment in the technical press. The new device is the Gabor tube (named after its inventor, Dr. D. Gabor of London). The Gabor tube was described in a lecture to the Television Society in 1956, this being subsequently reported in the *Wireless World*.* Descriptions of the tube have also appeared in the American press,† on the Continent‡ and in Australia.†† Other references to the Gabor tube have, doubtless, appeared elsewhere. It is difficult to describe the functioning of the new tube in a short space, but the simplified outline which follows may give a reasonably good idea of how it works.

Briefly, the Gabor tube employs a "flat" construction; there being no necessity to have a tube neck or any of the scanning components associated with the conventional c.r.t. The flat construction is achieved by bending the electron beam from a conventional cathode through 180 degrees before it enters the vertical scanning section of the tube and, thence, the screen. Fig. 1 gives an idea of the construction of the tube, as well as showing the route covered by the electron beam in travelling from the gun to the screen. Horizontal deflection of the beam is achieved *before* the beam is bent; the deflecting force being provided by two deflecting plates, these being somewhat similar to those employed in electrostatic deflection tubes. Vertical deflection is achieved by a technique which is unfamiliar and completely new.

Just in front of the magnetic shield which divides the two halves of the tube (Fig. 1) is what is described as the "frame scanning array." This consists of a relatively large number of parallel conductors (approximately 120) which are printed on to a sheet of insulating material. The exact number of conductors is unimportant and does not need to have an exact relationship with the number of lines in the picture. The sheet on which the conductors are printed is bent round at either end so that the electron beam, on leaving the screen area, falls on the inside of either the left-hand or right-hand fold (Fig. 2). The purpose of the frame scanning array is to provide an electrostatic potential which bends the electron beam forward to make it strike the screen. The conductors of the scanning array are not connected physically to any source of voltage, and they obtain their potentials entirely by holding electrostatic charges.

Fig. 3 illustrates a typical potential relationship which may exist at some position down the scanning array. The conductors below line XX in this diagram hold a full positive charge. Above the line XX, the charge held by successive conductors becomes less positive until we reach line YY, above which all conductors hold minimum charge. Minimum charge is approximately equal to one quarter of the full positive charge. The zone between lines XX and YY may be described as the "transition zone," the change from full charge to minimum charge being distributed gradually over this zone.

Fig. 3. A possible distribution of potentials on successive conductors in the transition zone. This diagram is intended for illustrative purposes only, and is not intended to exactly represent the potentials existing in an actual tube



When the electron beam, after bending through 180 degrees, travels up from the bottom of the tube (Fig. 1), it is not deflected by the full positive potential of the conductors below line XX because the phosphor screen is held at an equivalent positive potential by an external source. In consequence the beam travels through an equi-potential field, and proceeds upwards in a straight line. However, once the beam approaches the transition zone, it becomes deflected by the gradually reducing positive charge, the deflecting force being greatest around line YY and the conductors above. These conductors are negative with respect to the potential of the screen and the beam is consequently deflected towards the latter, finally striking it at a height which corresponds to the height of the transition zone. Since the beam undergoes deflection by the changing potentials of the transition zone it becomes focused at the point of impact on the screen. (Electron beams tend to focus when subjected to deflection.)

The potentials held by the conductors of the scanning array are, as was just mentioned, held electrostatically. These charges are controlled by the beam itself. In order to consider the overall scanning operation, it is advisable to commence half-way through a frame, at a time when the spot is tracing a line half-way down the picture, with the transition zone in a similar position behind it.

At the end of its line scan the spot flies back to, and rests on, the inside of the left-hand fold of the insulating sheet holding the parallel conductors (Fig. 2). Whilst resting on the conductors on the inside of the fold the beam partially discharges them, causing

* "Flat Tube for Colour T.V.," *Wireless World*, Dec. 1956.

† "Flat T.V. Tube," Eric Leslie, *Radio-Electronics*, March 1957.

‡ "Platte Beeldbuis Voor Kleuren-Televisie," *Radio Electronica*, March 1957.

†† "A Projected Flat Display Tube for Colour T.V.," *Radio Television and Hobbies*, Feb. 1957.

them, therefore, to become less positive. Due to this discharge the transition zone moves down slightly with the result that, when the beam scans the next line, it travels across the screen at a position slightly lower than that of the previous line. At the end of this second line the beam returns to the left-hand fold once more and again partially discharges the conductors on which it rests. Once more the transition zone moves down, and once more the following line is a little further down the screen. As may be readily imagined, the speed at which the transition zone moves downwards depends on the rate at which discharge takes place during each flyback period. (It will be appreciated that at the end of each line the beam rests on the conductors only long enough to cause partial discharge; discharge to the minimum potential occurring after a number of these partial discharges have taken place. It is possible that the beam is somewhat defocused when it rests on the inside fold.)

Whilst the beam automatically controls its own downward deflection, it becomes obvious that some alternative process is needed to deflect the spot upwards again at the end of the frame scan. Here, again, the beam controls its own deflecting process. At the end of the frame scan the beam moves to the right-hand fold of the scanning array instead of to the left. In this case the beam does not strike the conductors directly but has first to pass through a mesh which has a high positive potential applied to it from an external source. The behaviour of the mesh and the conductors is rather similar to that of the screen-grid and anode of a tetrode valve when the anode potential is lower than that of the screen-grid. What happens in the Gabor tube is that the beam, on striking the conductors at the bottom of the right-hand fold, releases secondary electrons which are attracted to the positive mesh. Since the conductors struck by the beam lose electrons, they become, once more, positively charged. Being positively charged they cause the transition zone to move upward, to be followed by the beam. In travelling up, the beam falls on conductors higher up in the array, makes these positive by secondary emission, and causes the transition zone to rise yet again. The process carries on until all, or almost all, of the conductors are positively charged and the beam is at the top of the tube once more. The device is then ready to scan another frame by the downward-going method we have already discussed.

It may have been noted, in Fig. 2, that the parallel conductors appear to be "staggered upwards" at the right and left-hand folds. This staggering is necessary in order to obtain the correct register between the position at which the beam is deflected and the height of the transition zone.

Colour T.V.

The above provides a simplified description of the scanning action of the Gabor tube. Although its principles are complicated—or seem complicated when first encountered—its mechanical construction does not necessarily fall into the same category. It should be noted, incidentally, that receiver circuitry may be simplified by the absence of magnetic scanning, and the fact that line deflection is electrostatic. All in all, there is little reason to suppose that the Gabor tube may not eventually prove to be a formidable rival to the conventional cathode ray tube when it has been finally developed into a form suitable for production. This is definitely a tube of the future.

A considerable advantage of the Gabor tube is that, by fitting a shadow-mask close to the phosphor screen, and the appropriate three guns, it may be used for colour reproduction without excessive departure from the principles employed for black-and-white operation. Without going into details of the additions needed for colour presentation, it may be said briefly that they should not cause the same increase in cost as is occasioned by the conversion of a conventional black-and-white tube to existing tricolour shadow-mask design. A Gabor colour tube may also be considerably less sensitive to external magnetic fields.

It is on the question of colour T.V. that the writer would like, finally, to devote his space. Fostered perhaps by the daily press, public interest is being continuously whetted by reports predicting the early arrival of colour television. Apart from Oxo advertisements (!), what the future does actually hold in the way of colour television is anyone's guess. The writer's own private opinion is that we will be lucky if we see anything approaching regular public schedules before, say, 1962. The writer bases this opinion partly on the economic conditions prevailing at present. In just the same way that colour photography is inevitably more expensive than black-and-white photography, so also must colour television be more expensive than black-and-white television.

Another point delaying the start of colour television is the fact that no real agreement has yet been apparent amongst responsible engineers as to the standards which will be employed. Many important questions have yet to be settled. For instance, is it worth going over to colour television whilst still employing a 405-line system? Should the American N.T.S.C. system, or a modified version of this system, be used, bearing in mind the known disadvantages of its complicated and expensive receiver design? (Although things have probably speeded up since then, about a year or so ago it used to take a service engineer a full *day* to instal and set up a colour television receiver.) Again, is it really worth while embarking on a colour system which *must* be compatible, or would it be better to forget about compatibility altogether and concentrate only on optimum colour reproduction? These, and many more, questions need to be satisfactorily answered before colour television becomes an economic proposition in the U.K.

The writer has seen B.B.C. colour transmissions reproduced on a colour receiver, and was considerably impressed by the life which colour brings to the screen. But, after the first impact had worn off, he found himself looking more critically at the picture and noticing imperfections which had escaped his notice at the onset. Perhaps the same reactions would be given by the general public if we embarked on colour television in its present state.

BOOK REVIEWS

UHF TUBES FOR COMMUNICATION AND MEASURING EQUIPMENT. Book XI in the Philips Technical Library. 60 pages, 76 illustrations and diagrams. Distributed in England by The Cleaver-Hume Press Ltd., 31 Wrights Lane, Kensington, London, W.8. Price 9s. 6d.

Devoted to specialised types of valves for use in u.h.f. techniques. This book contains descriptions of a few valves, their characteristics, and discusses some of their applications.

Some examples of apparatus are shown, such as an h.f. section for a receiver to use in the 300–400 Mc/s range, a u.h.f. oscillator for 470 Mc/s, a push-pull oscillator for 440 Mc/s, and an oscillator using the disc-seal EC55 for frequencies in the 730–1,350 Mc/s range.

Some klystrons and several noise diodes are also included.

A GUIDE TO AMATEUR RADIO—6th Edition. Edited by John Clarricoats, O.B.E. 40 pages, 24 illustrations and diagrams. Published by the Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1. Price 2s. 6d., postage 4d.

This popular handbook has been brought right up to date and contains practical information for those seeking to find out about the interests of amateur radio.

The nine chapters, though short, are free from frills. The first chapter answers many of the questions that are in the minds of those about to venture into amateur radio. There follow chapters on simple receiving apparatus and station equipment, short instructions on learning the Morse code, correct operating procedure, QSL cards, and the Tests and Contests into which operators can enter. Information is given on how to obtain a transmitting licence, and some advice is proffered on taking the Radio Amateur Examination.

The last chapter indicates the advantages of belonging to the R.S.G.B., and sets out many of the facilities the society offers to members. Appendices contain details of the International Q-code, call-sign prefixes, and abbreviations commonly used by amateurs.

TV CONVERSIONS FOR I.T.A. By C. E. Lotcho. 240 pages, 145 illustrations and diagrams. Published by George Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 25s.

A considerable amount of information has been gathered within the pages of this book, mainly from manufacturers' service manuals.

The first section of the book contains brief discussions on conversion methods for Band III, aerial installations, and r.f. interference problems. Some more might have been said about cross-over filters to make the part on aerials more complete.

The major part of the book, running into 188 pages, is given over to comprehensive descriptions of the conversions necessary for several current receivers. No less than 31 makers' products are dealt with here, and there is considerable useful information to be found therein.

Reference data in Section 3 is also comprehensive. Details of the BBC and ITA transmitting stations are given, and it is thought that here the effective radiated power of the stations might well have been included. A most useful set of tables gives details of i.f. frequencies of 41 makers' sets. A noteworthy point is the table containing details of models suitable only for upper sideband reception. Two indexes complete the book, one being a general index for the receivers mentioned in the various sections, the other being an index to converters.

TUBE SELECTION GUIDE: 1956–1957. Compiled by Th. J. Kroes. 118 pages. Distributed in England by The Cleaver-Hume Press Ltd., 31 Wrights Lane, Kensington, London, W.8. Price 9s. 6d.

A handbook in the Philips Technical Library devoted to listings of receiving valves, cathode ray tubes, and valves for industrial and transmitting applications.

The introductory remarks and the list of technical terms are given in several languages. Section 1 is an index of tube types listed in the book which indicates in which one of the following six sections that further information is to be found. Sections 2 to 7 then list tubes for receivers and amplifiers, cathode ray tubes, transmitting valves, tubes for micro-wave equipment, industrial tubes, and miscellaneous types. Each section has its own index which also gives near or direct equivalents, and the tables in each section indicate essential characteristics of current equipment types, together with lists of replacement types and obsolete ones.

There is no data quoted such as is more likely to be given in lists which show static and dynamic characteristics; the information given in the listings of current equipment types is more concerned with the applications of the tubes.

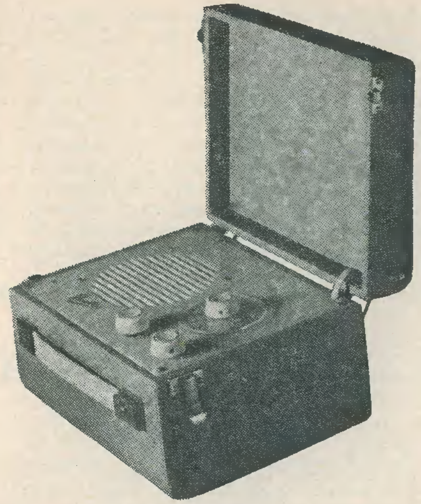
TUBES FOR COMPUTERS. Book XII in the Philips Technical Library. 52 pages, 59 illustrations and diagrams. Distributed in England by The Cleaver-Hume Press Ltd., 31 Wrights Lane, Kensington, London, W.8. Price 9s. 6d.

Technical data and descriptions of valves specially developed for counters and computers. The introductory chapter discusses briefly the binary system of notation upon which the circuits for such apparatus are based, various forms of multi-vibrator, and gating circuits.

Some details of the construction and basic circuits of plug-in units are given, for applications such as low and high-speed counters, multivibrators, decade counters, etc.

W. E. THOMPSON

The "RAMBLER" PORTABLE SUPERHET



A Receiver for Home and Countryside

PART 2. *by* JAMES S. KENT

Alignment

With the assembly and the wiring of the receiver completed, and with batteries and frame aerial attached, the alignment is the next step. The use of a signal generator is by far the best and surest method of aligning this, or any other, receiver; however, it is possible to obtain satisfactory results by using broadcast stations as a signal source. The i.f. transformers having been pre-aligned to 470 kc/s, it should not be necessary to touch the cores of these; only the cores of L_1, L_2 and L_3 should be adjusted as shown in Fig. 4.

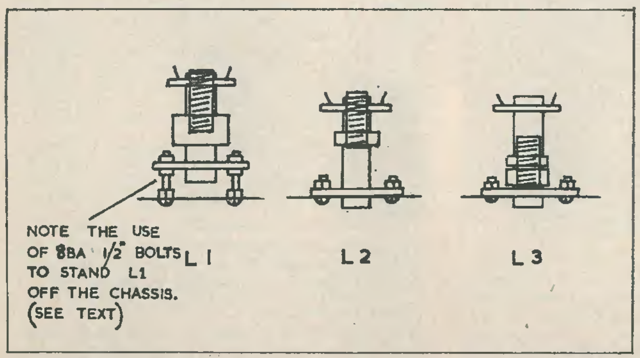


Fig. 4. Showing approximate positions of cores

It may be necessary to utilise an external aerial in order to receive broadcast signals for alignment purposes. Wind a few turns of an external aerial around the frame aerial (the lid of the cabinet will suffice if the frame aerial has been already fitted), in order to provide signals of reasonable strength.

Set the wavechange switch to the Medium Wave position and adjust C_3 and C_4 to mid-capacitance. Set the volume control to maximum and rotate the tuning control until a signal is received. At this stage it may be necessary, in some cases, to carefully trim the i.f. transformer cores in order to peak the signals. Care should be taken, however, not to move these excessively as they have already been set to the required frequency. Ensure that the cursor is fitted correctly to the tuning condenser spindle. With the gang fully closed, the cursor should be in that position shown in Fig. 5. Adjust the tuning control to the loudest signal (this will probably be the Home Service on 330 metres), and note whether the cursor line is high or

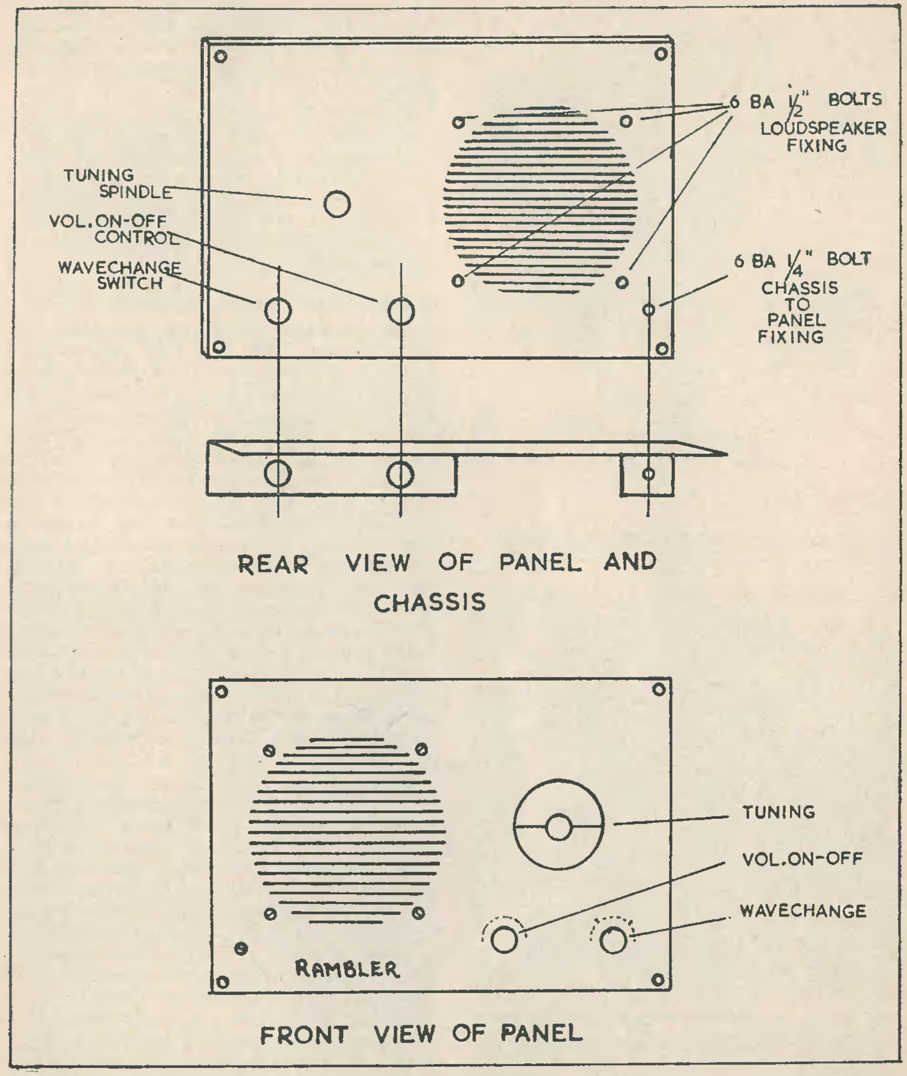


Fig. 5

low on the dial reading. Should the station be tuning in too high (towards the high wavelength end of the dial) screw in L_2 core until the correct setting is obtained.

If, however, the station is tuning in too low, then the core of L_2 must be slightly unscrewed from the holder. It will only require a couple of turns, perhaps, to bring the station to the correct setting.

Next, adjust the tuning control to the low wavelength end of the dial; i.e. the Light programme on 247 metres. Should this station be tuning in too low, unscrew C_4 slightly and, if tuning too high, reverse the procedure. At the same time adjust C_3 for the maximum signal strength. It will now be necessary to repeat the above adjustments a few times by continuing to adjust both C_4 and the core of L_2 until the selected marker stations are received in agreement with the dial readings. Finally, adjust C_3 for maximum signal strength at the low wavelength

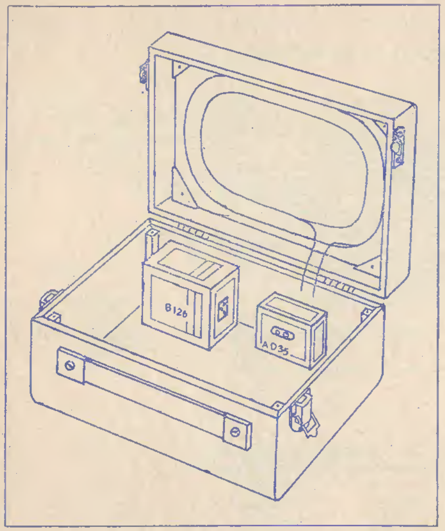


Fig. 6. Showing position of batteries

position with the external aerial removed.

It is quite probable that broadcast signals will be received without recourse at all to any external aerial for alignment purposes.

To align the Long Wave band, switch to the appropriate position and couple the external aerial as before, should this be necessary. Ensure that the cores of L_1 and L_3 are in the approximate positions as shown in Fig. 4. Next adjust the trimmers C_1 and C_8 to mid-position. Do not alter the i.f. transformer core settings. Tune in the 1,500 metre (200 kc/s) Light programme by rotating the tuning control and adjust the core of L_3 for the correct setting of the dial cursor. Having completed this, tune to the low wavelength end of the dial (800–1,000 metres), locate a known signal and adjust C_8 for the correct dial setting. Repeat the foregoing instructions several times until the marker stations tune in at the correct dial settings. Finally, adjust the trimmer C_1 for the maximum signal at the low wavelength marker station position.

A short list of broadcast stations for calibration purposes is reproduced herewith. It is important to remember that it is preferable to use marker stations on each band as far apart as possible with respect to frequency. Cores should be adjusted at the high wavelength end of the bands and the trimmers at the low wavelength limits.

Station List for Calibration Purposes

Station	*kc/s*	*Metres*
Allouis (Paris)	164	1,829
Moscow	173	1,734
BBC Light	200	1,500
Warsaw	227	1,322
Luxembourg	233	1,286
Prague	272	1,103
Athlone	566	530
BBC Third	647	464
BBC Scottish	809	371
BBC London	908	330
BBC Midland	1,108	276
BBC N. Ireland	1,151	261
BBC Light	1,214	247
Luxembourg	1,439	208

Alignment by Signal Generator

The Medium wavelength alignment frequencies are 1,500 kc/s (200 metres) and 550 kc/s (550 metres). The Long waveband frequencies are 160 kc/s (1,900 metres) and 300 kc/s (1,000 metres). The i.f. is 470 kc/s. Feed in a modulated signal of 470 kc/s between the grid (pin 6) of V_1 (1R5) and the chassis. Short the a.v.c. line to chassis (short across C_6 or C_{11}). Set the waveband switch to Medium Wave and the tuning control to approximately mid-position. The volume control should be set at maximum. The i.f. cores should require very little adjustment; but should this be necessary, tune the cores in the following sequence for maximum output —top core i.f.t.$_2$; bottom core i.f.t.$_2$; top core i.f.t.$_1$; and bottom core i.f.t.$_1$. Reduce the signal generator output at each step in order to avoid overloading. Repeat once again for the final trim. This completes the i.f. alignment.

To align the Medium and Long Wave bands, it will be necessary to couple the signal generator to the frame aerial. The best method of doing this is to connect a short length of insulated wire to the generator output and wind this around the frame aerial. The other earthy lead is connected to chassis. It may be necessary to vary the degree of coupling in order to obtain optimum results. This method effectively prevents undue damping of the aerial circuit that would otherwise result from a direct connection.

Having aligned the i.f.'s, continue with the Medium Wave alignment. Adjust the signal generator to 550 kc/s (550 metres) and the tuning dial cursor to the same frequency. Adjust the core of L_2 for maximum signal. Tune the dial to 1,500 kc/s (200 metres), set the signal generator to 1,500 kc/s and peak the trimmer C_4 for maximum signal. Next retune to the 550 kc/s alignment point and repeat the process. Finally, peak the trimmer C_3 at the 1,500 kc/s alignment setting.

Set the wavechange switch to Long Wave, tune the dial to 1,900 metres (160 kc/s), and set the signal generator to 160 kc/s. Adjust the core of L_3 for maximum output, at the same time peaking the core of L_1. Next set the dial at 1,000 metres (300 kc/s) and set the generator to the same frequency. Trim C_8 and C_1 for maximum response. Repeat the above until the alignment is correct at both ends of the band. Remove the short circuit from the a.v.c. line. This completes the alignment instructions.

Conclusion

The "Rambler" is, without a doubt, not only pleasing to the eye, but also a wonderful performer over its entire frequency range. It has been thoroughly tested and tried in all sorts of localities by the writer, both within and outside a car, and has been found to more than fulfil all expectations. Reasonably inexpensive to purchase, easy to construct, with all the component parts readily available from several advertisers, it is unquestionably one of the finest portable radios available at present on the home constructor market. For that portable radio, most needed at this time of the year, one cannot do better than to construct the "Rambler."

Note: All trade enquiries should be addressed to the distributors, V. L. Dewitt Ltd., 24–26 Hampstead Road, London, N.W.1.

Technical Forum

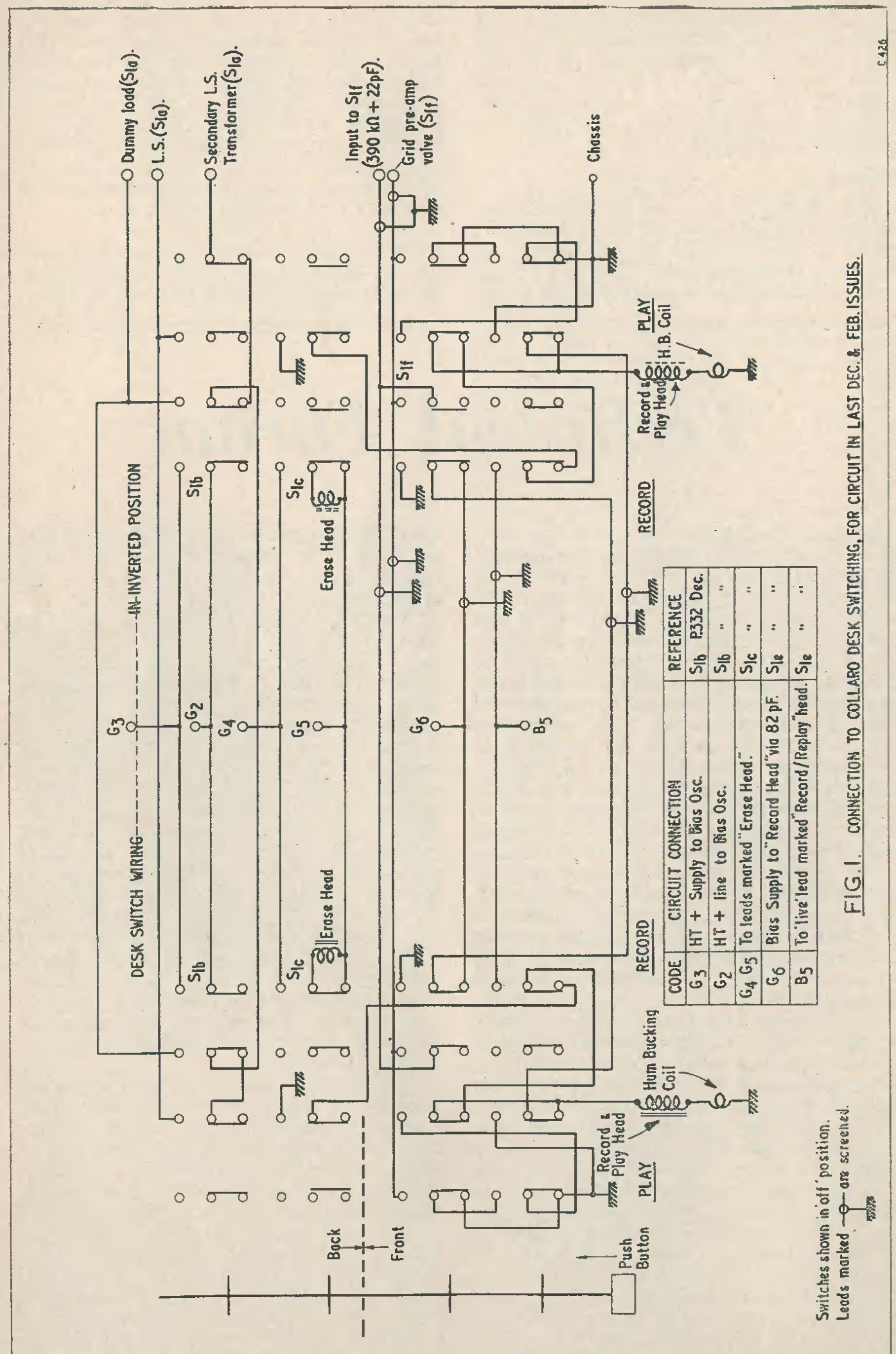
Tape Deck Switching

In the November, December and February issues last we ran a short series on the simple use of standard tape decks in conjunction with existing amplifiers. It was shown that with quite elementary additions to the amplifiers very good results could be obtained from a wide choice of tape units, and this has been confirmed by readers who have already completed their equipment. Generally it was possible to employ two separate wafer type switches as suggested in the original circuit diagrams; but some readers encountered difficulty when attempting to use a tape deck which incorporated built-in switches, as it was found that the deck switching did not altogether meet the circuit requirements. This particularly applied with that very excellent tape deck which is designed and produced by Collaro, and for the benefit of readers who are using this deck, we are considering this month its application to the original circuit.

The Collaro tape deck, or Tape Transcriptor as it is sometimes known, is a fairly ambitious unit having provision for three tape speeds and double track recording. This latter is achieved by running the tape first from the left-hand spool to the right-hand one and thence back from right to left. In so doing, the need for rewinding the tape between using the top and bottom tracks is avoided. This does, however, necessitate the use of two sets of heads, one for playing from left to right and the other for right to left. Thus it is that the Collaro deck is fitted with four heads, a record/replay and an erase head for each direction of the tape. There is no doubt that this is one of the best ways of achieving twin-track working; but the extra set of heads does involve additional switching, which is perhaps one of the main reasons that complications arise in the application of this tape unit.

The Collaro deck is equipped with four slide switches each of which has an eight-pole two-way section making a total of 32-pole 2-ways. In addition there is the mechanical speed change switch assembly which is capable of being altered so that it can also operate the equalising switch in the amplifier unit. A clear understanding of the way in which the slide switch functions will greatly facilitate the task of connecting it up. Each section consists of three separate contacts located side by side on the static portion of the assembly, whilst on the central sliding part there is a shorting bar. As the switch is moved from one position to the other, this bar joins either the bottom pair of contacts or the top pair. In other words, the centre contact of each trio is connected to its neighbour either directly above or below it. In each case the centre of three contacts is the pole of the switch, with the two adjacent contacts the alternative ways.

When the tape deck is purchased, the switch assembly is ready mounted on the motor board, but none of the wiring is connected up. Each of the record/replay heads has a short length of screen cable coming from it, whilst the leads from the erase heads are unscreened. Of the 32 poles on the switch, 10 are employed to switch the heads and the remainder are free to switch the input circuit, the tuning indicator used for level indication, and tone control networks should these be employed. This switch cannot, of course, be employed to operate the tone equalising circuits for various tape speeds. This function is best



CODE	CIRCUIT CONNECTION	REFERENCE
G_3	HT + Supply to Bias Osc.	S_{1b} P332 Dec.
G_2	HT + line to Bias Osc.	S_{1b} " "
G_4 G_5	To leads marked "Erase Head."	S_{1c} " "
G_6	Bias Supply to "Record Head" via 82 pF.	S_{1e} " "
B_5	To 'live' lead marked "Record/Replay" head.	S_{1e} " "

FIG. 1. CONNECTION TO COLLARO DESK SWITCHING, FOR CIRCUIT IN LAST DEC. & FEB. ISSUES.

performed by a separate switch or one which is mechanically linked with the speed change mechanism on the deck itself. But more about this later.

The diagram of Fig. 1 shows the complete switch assembly and its connection in the circuit of the simplified tape recorder already described (Nov., Dec. and Feb. issues). The original switch designations have been employed to avoid confusion. The switch recommended for the circuit was a 6-pole 3-way unit arranged to give "Record," "Erase" and "Replay" in the three positions. The centre or erase position is by no means essential, as the tape can be cleaned by running it through the machine with the switch on the "Record" position and the amplifier gain turned down to minimum. To accommodate the Collaro switching, this position has been eliminated and the circuit wired up for 6-pole 2-way working. This change is a very minor one and simply involves omitting the centre contact of the three-position switch shown in the original circuit (Fig. 1, p. 332 Nov. issue). The diagram shows the switch assembly wired as a complete unit with the heads in position; several flying leads are then used to join the assembly into the amplifier circuit, and these have been clearly labelled. It must be remembered when examining this diagram in conjunction with the original circuit that these flying leads are those which were shown going to the switch S_1. The resistor or capacitor value shown by the leads in Fig. 1 indicate the components to which they are connected on the original circuit.

To avoid hum pick-up a number of the leads must be screened, and as many of these are interswitch contact connections a little patience is required to make a neat job, and avoid the outer screening accidentally shorting some of the contacts. One of the miniature soldering irons is ideal for doing a job of this nature, as it permits better access to certain of the rear switch connections.

The slides of the switches in Fig. 1 are shown in the "off" position—as each of the four buttons is depressed the slides move up towards the viewer, as the assembly is pictured in the inverted position as it would be for wiring up. Each of the four sections has eight poles arranged in two banks designated front and rear to indicate which is nearer the observer.

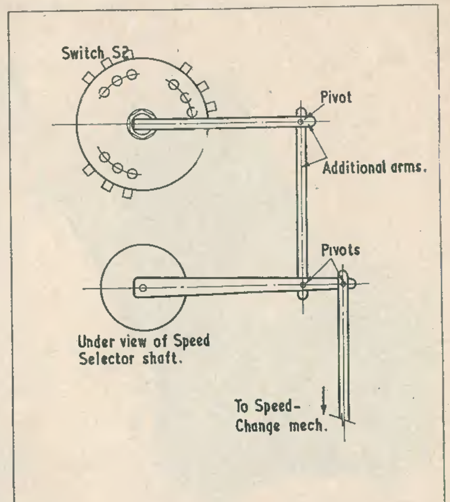
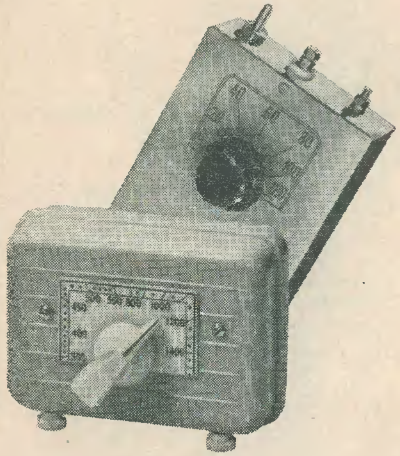


FIG. 2.
Showing method of operating equalising switch from speed control on desk.

The Collaro tape deck is of the three-speed type with the speed selector knob mounted in the top centre of the motor board. This knob actuates the mechanism through a pivoted arm, and the more ambitious constructor may wish to employ this knob to also select the correct equalising components in the main amplifier. This is achieved by means of switch S_2 in our original circuit. This switch may be coupled to the cross arm on the main knob shaft as shown in Fig. 2. The additional operating arm is attached to the switch shaft by means of a ¼in collar taken from an old flexible shaft coupling, the collar being soldered to the arm. A little experimental work will be necessary to determine the length of this arm, but the work involved will be well repaid by a most reliable and simple switch operating mechanism.

COMPONENT REVIEW

We have received from Messrs. R. Fagelston, 46 Hardwicke Road, London, N.13, samples of Transistor Holders now being supplied by them. These holders are truly miniature and of very light weight. Intended to be suspended in the wiring, they have three small tags to which other components associated with the circuit may be soldered, the transistor wires being inserted into the holder. By this method, the heat damage hazard to transistors is obviated, and replacement during experimental work becomes a matter of moments. On these accounts alone, they are well worth the cost of 1/- each, 5 for 4/7, 6 for 5/6, postage 2½d.



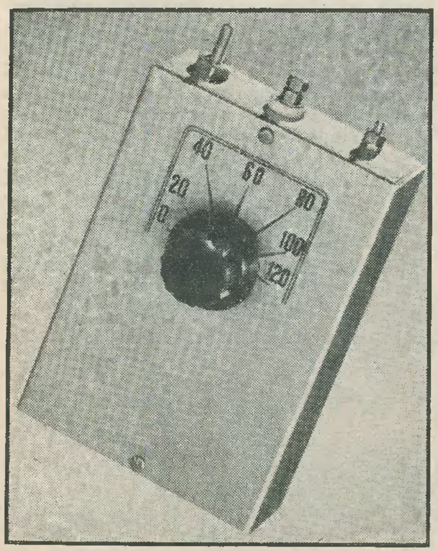
TRANSISTOR TWINS

The RADIOSETTE and NURSERYETTE

Miniature Receivers

Described by **E. GOVIER**

WITH THE INTRODUCTION OF THE transistor and the crystal diode, the demand for, and the popularity of, simple local station receivers has risen and continues unabated among home-constructor circles. Of these, two that have proved to be popular are the R.C.S. "Radiosette" and "Nurseryette," both being simple, easy to construct, inexpensive and efficient head-phone-receivers. These are ideal sets for the beginner in that the total construction time involved, and the cash outlay, is very small indeed. Moreover, a complete kit of parts for either receiver is available from several advertisers in this magazine.



The "Radiosette"

Circuit

From the circuit of Fig. 1 it will be seen that both are two-stage receivers utilising a crystal diode as a detector followed by a p-n-p junction type transistor in cascade working as an l.f. amplifier in the earthed emitter mode.

In order to achieve the maximum signal output which is required in all receivers of this type, the design includes the new R.C.S. Vari-Loopstick transistor inductance—the "Q" of this being of an extremely high order. The design of this inductance enables a micrometer adjustment of the iron dust core to be made by the operator, as an additional external control.

The miniature variable tuning condenser C_2, with which is incorporated two earthed and two holding tags, effectively permits the whole receiver ("Radiosette") to be contained within a case measuring only some 4in × 2¾in × ⅞in. Thus, the completed receiver may be held in the hand or contained within a pocket.

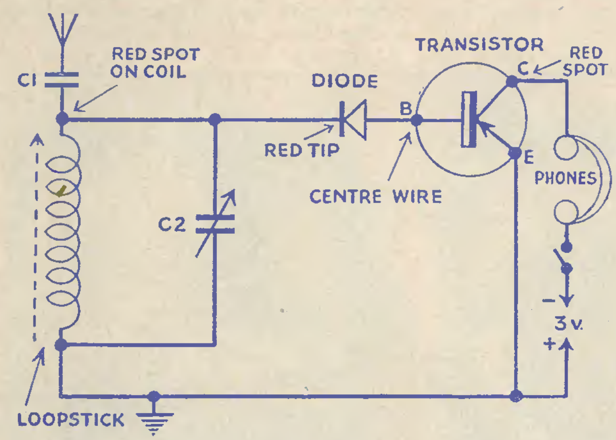


FIG. 1 Circuit of both Receivers

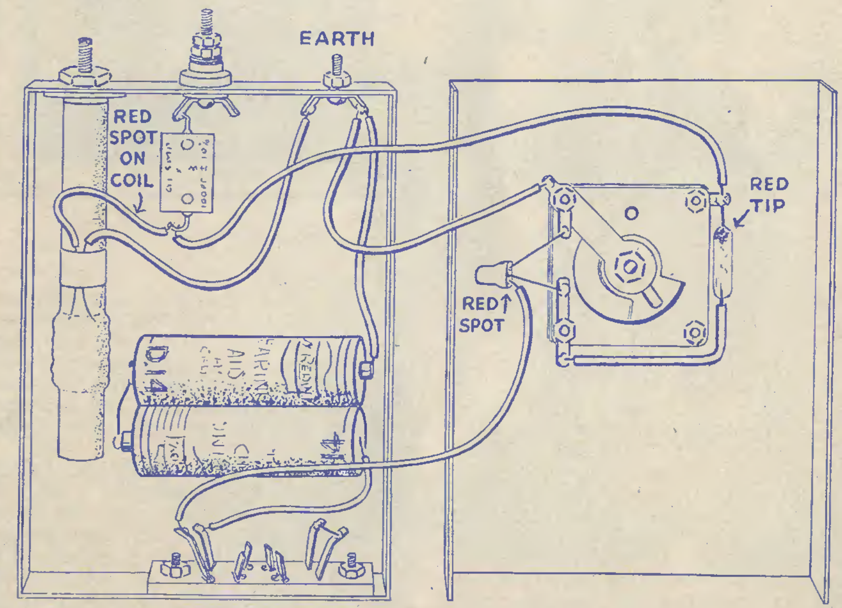


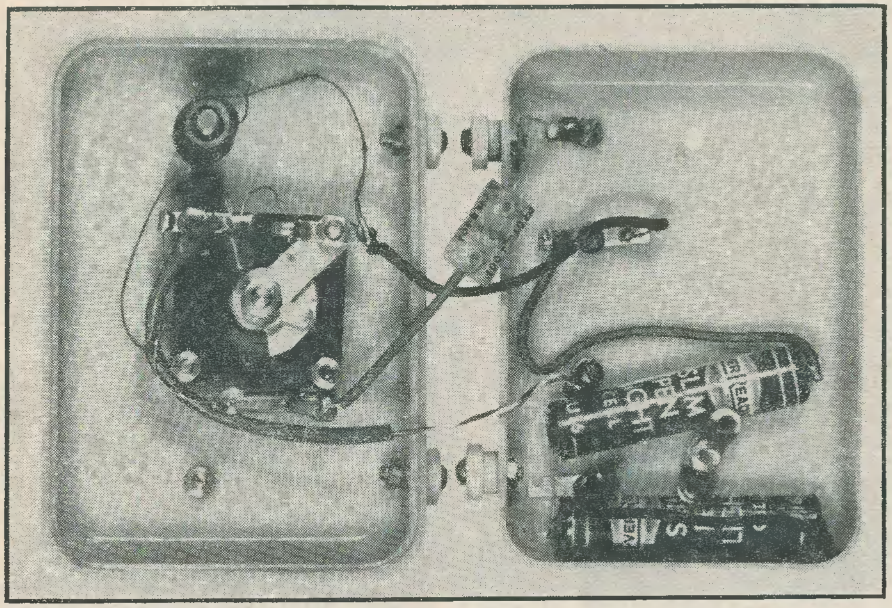
FIG. 2: 'Radiosette' layout & wiring

Assembly Instructions

"Radiosette"

The assembly of this small receiver is simple in the extreme and no difficulty should be encountered. Provided the following instructions are carefully followed, it may be completed in a very short time indeed. The utmost care should be taken to ensure that the transistor is connected into circuit correctly, and also that the batteries are placed in the right manner with respect to polarity as shown in the diagrams. Failure to comply with either of these precautions will probably result in the destruction of the transistor.

other ceramic washer (from the outside of the case), and follow this by screwing into position one of the nuts, taking care that the small paxolin washer is located in the actual aperture through the top of the case. Pro-



Internal view of "Nurseryette" showing layout

vided the above instructions have been carefully followed, the aerial terminal should now be effectively insulated from the case itself, this, of course, being of the utmost importance. Finally, the remaining 6BA nut is then located on the aerial terminal bolt, this being used for securing the aerial wire to the terminal.

The first component part to assemble is the phone socket strip at the bottom of the case; but before doing so a short length of wire should be soldered across the two tags coloured *yellow* and *blue*, this being much easier to accomplish while the strip is outside the case. The strip should now be fixed into position, as shown in the drawing, using two 6BA screws—at the same time ensuring that the *white* and *blue* tags are located against the corresponding *white* and *blue* spots on the inside of the case. The object of this correct location procedure is to ensure that the strip is finally mounted in the right position.

The next component to assemble is the aerial terminal, this being composed of a bolt, solder tag, two ceramic insulators, a small paxolin washer and two nuts. Holding the bolt firmly, place one solder tag on this and then follow by placing on the bolt one ceramic and one paxolin washer in that order. This small sub-assembly is then placed into the pre-punched hole (see diagram) in the top of the case *from the inside* (i.e., threaded portion protruding through the top of the case). Next place on the bolt threadway the

Next affix the earth terminal in the case by placing a 6BA screw with solder tag through the terminal and through the correct pre-punched hole in the top of the case (see diagram). This screw, of course, should be mounted from the inside of the case—a nut now being secured over the screw from the outside in order to hold the assembly into position. Finally, a further nut should now be threaded on to the same screw—this being used to secure the earth wire to the receiver.

The Vari-Loopstick aerial coil should now be placed in position from the inside of the case, ensuring at the same time that the packing washer is placed on the coil before the one-hole fixing bush of the coil is placed through the hole in the case (see diagram). Then, having done this, the one-hole fixing

nut is placed into position from the outside of the case and secured.

The last item of assembly is the 400pF variable tuning condenser, this being placed in position on the front panel of the case, as shown in the diagram, with one nut left on the spindle bush and the other secured into position from the outside of the panel.

Wiring Instructions
"Radiosette"

Wire No. 1.—One side of the 100pF fixed condenser is soldered to the aerial terminal tag, as shown in the diagram, the other end of the condenser being soldered to *red* coloured tag on the 400pF variable condenser. The coil lead marked with the *red* spot is also connected to this latter side of the 100pF fixed condenser.

Wire No. 2.—The remaining coil lead, marked with a *green* spot is connected to the earth terminal solder tag.

Wire No. 3.—This wire is connected from the earth terminal solder tag to the tag coloured *green* on the 400pF variable tuning condenser.

Wire No. 6.—A short length of wire is next soldered to the *red* spot lead of the transistor and covered with a length of insulating sleeving which is supplied. The other end of this wire is then soldered to the tag on the phone socket strip coloured *red*.

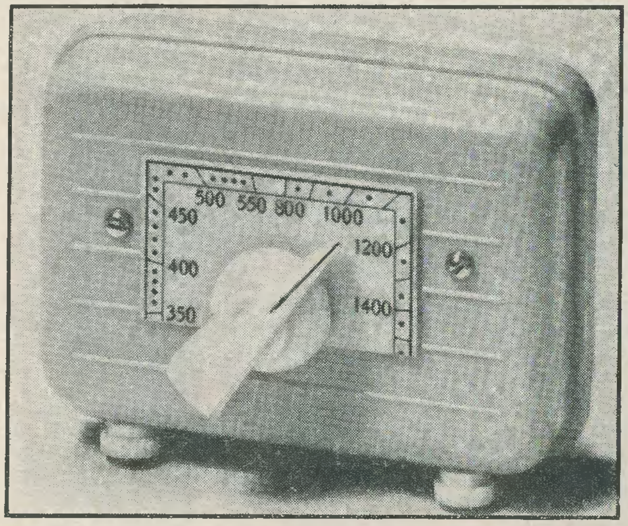
Wire No. 7.—The remaining wire of the transistor is now connected to the tag coloured *green* on the variable tuning condenser.

Wire No. 8.—Next two Ever-Ready batteries No. D14 are connected in series, as shown in the diagram, i.e., with the brass cap of one cell connected to the metal bottom of the other cell. The two cells are then secured together, around the centres of each, with a small strip of Sellotape or any other adhesive tape.

Wire No. 9.—A short length of *red* wire is now soldered to the remaining brass cap on one cell, the other end of this wire being connected to the end of the earth terminal solder tag.

Wire No. 10.—A length of *black* is now soldered to the bottom of the other cell, as shown in the drawing, the other end of this

The "Nurseryette"



Wire No. 4.—The *red* end of the crystal diode detector, this being the small glass tube component, is connected to the tag coloured *red* on the variable tuning condenser. The remaining end of the diode should now be connected to one side of the tag coloured *blue* on the same tuning condenser.

Wire No. 5.—Connect the *centre* wire of the transistor to the tag coloured *blue* of the variable tuning condenser.

wire being soldered to the tag coloured *red* on the phone strip. It is advisable now to place adhesive tape lengthwise, from end to end, of the cells—thus completely covering both soldered ends; this will ensure that the cells will not short circuit to the metal case.

Phones.—The ends of the phone leads should now be soldered to the two pins with a coloured *red* spot on the phone plug. The other two pins should be connected together

Component List
(both receivers)

C_1 100pF Silver Mica
C_2 400pF miniature variable (RCS Products Ltd.)
Crystal Diode Mullard OA71
Transistor p-n-p junction type, Red Spot
Phones 1,000Ω impedance (RCS Products Ltd.)
Case and Panel (R.C.S. Products Ltd.)
Insulators, wire, etc. (RCS Products Ltd.)
Vari-Loopstick Inductance (RCS Products Ltd.)

externally with a short length of wire. This latter connection ensures that when the phones are inserted into circuit, the receiver is switched on. Conversely, when the phone plug is withdrawn, i.e., phones disconnected from the set, the receiver is automatically switched off, and it follows, therefore, that the phones should be withdrawn when the receiver is not in use. Failure to do this will result in an unwanted battery drain.

Operating the Receiver

The aerial should now be connected to the aerial terminal on the top of the receiver. In many localities the earth connection may not be necessary owing to the very high "Q" of the Vari-Loopstick aerial. In some districts probably only a very short aerial will suffice. Cut and try is, of course, the answer here. It is probably best to connect both an aerial and an earth in the first instance, and follow this by experimenting as outlined above.

Stations should be tuned in by rotating the variable tuning condenser. Variation of the micrometer adjustment of the aerial core will provide a large degree of variation with respect to the waveband range of the receiver.

The "Nurseryette"

This is the front receiver featured on our front cover for this issue. In essence it is the same receiver as the "Radiosette"—except that the case is, of course, the more attractively styled. The circuit is exactly the same as that of Fig. 1. From the front cover illustration and that shown here, an excellent idea of the layout may be obtained. The assembly instructions for the "Radiosette" will, of course, largely apply here, except that the layout is somewhat different.

The rear half of the case (which is detachable from the front), contains the batteries and their holding strip, the phones output and the aerial and earth tags. Connection of the headphones automatically switches the battery into circuit.

The front half of the case contains the miniature variable condenser, the diode and the transistor—both of these latter components being soldered directly on to the condenser. Also contained in this front portion of the case is the Vari-Loopstick aerial coil. In this version of the receiver the aerial former itself has been cut down in size, so that only a portion of the threaded brass dust core adjustment protrudes through the rear of the case once this is closed together.

The "Nurseryette" is an ideal receiver for the children of the household to handle. It is absolutely safe—no high voltages being present—easy to operate, attractively styled in three colours—either in red, blue or green, and will provide endless hours of fun and enjoyment for the youngsters.

TRADE NEWS *contd. from page 742*

The tape, which has an insulation resistance of five million meg. ohms, and a dielectric strength of 13,300 volts, is available in red, black, blue, green, yellow and white rolls of 25 yards. Widths are half, five-eights and three-quarters inch, and increasing widths at quarter-inch intervals.

It is marketed by the Industrial Sellotape Division of Gordon & Gotch Limited, 8-10 Paul Street, London, E.C.2.

New Firm Marketing V.H.F. Aerials

The ever-increasing use of v.h.f. radio in business and professional fields is emphasised by the announcement of a new company specialising in v.h.f. aerial systems.

Radio Telephone Aerial Systems Ltd., directors John H. Theakston (managing) and J. H. Theakston, Snr., has been formed (in association with J-Beam Aerials Ltd. and Sky-Masts) to handle Sky-Beam v.h.f. aerials.

These Sky-Beam aerials, designed by Mr. B. Sykes and developed in the laboratory at J-Beam Aerials, Northampton, have been used by Sky-Masts for their important installations throughout the country, during the past few years.

The volume of enquiries for these highly efficient End Fed Dipoles, Yagis and Skeleton Slots has become so heavy that a separate company is needed to handle marketing.

Radio Telephone Aerial Systems Ltd., with its close contacts with J-Beam Aerials Ltd. and Sky-Masts, will be able to offer complete and sound advice on all aspects, technical and practical, of v.h.f. aerial systems.

This is the first time radio telephone users have been offered a complete specialist service. Main clients will be exporters, manufacturers of v.h.f. equipment, installation agents and all users of radio telephone equipment such as ambulance services, police, car hire and other business firms.

The new firm will operate from offices, workshops and showrooms now being prepared at Redan Street, W.14, with telephone numbers Shepherds Bush 6426 and Riverside 7878.

Radio Miscellany

On two occasions this column has been pleased to remark on the gratitude of readers who have received friendly assistance from fellow-hobbyists in the way of information, circuits, etc., through the medium of our "Can Anyone Help" columns. This time I have the unhappy experience of being called upon to place on record the opposite side of the picture. A reader suggests I might pass on his experience to serve as a warning to others to be at least a little circumspect when asked to forward money. In response to his appeal he received an offer of a "Manufacturer's circuit. Very useful" which the writer was willing to sell for 7s. 6d. As my correspondent wanted the fullest details rather urgently he sent off the money. After a pause of several days he received a small single sheet containing only a skeleton circuit showing nothing more than the values of the major components.

Readers who are familiar with regular Servicing Sheets will know how detailed they are. They cover such points as re-threading the drive cord, etc.; and not unnaturally from the description it was a Service Sheet of this type the reader expected to get for his money. Despite his anger at being "caught," he realised that there was little or nothing he could do about it. Any attempt to do so would have simply been throwing good money after bad. The circuit was obviously prepared by the manufacturer (probably part of something else), and it was useful—within its limitations. Even had a bigger sum been involved, legal redress on a question of misrepresentation would have been far from easy. He simply had to write the money off as "Experience, dearly bought."

A further touch of irony. He later received the loan of the manufacturer's full Service Manual from another reader. Unfortunately this offer arrived a week or so after that of the profiteering gentleman.

The incident recalls an occasion when the wife of a friend, a well-known transmitting amateur, was similarly taken in. A few days before the Coronation she saw a small ad. in the Personal Column of a national daily: "Coronation seats. Two guineas. Box . . . ." Imagining them to be seats on the route, she sent £4 4s. for herself and a friend. A couple of days before the event she received two flimsy camp-stools. Crudely stencilled on the canvas were the words "Coronation 1953."

After their disappointment and annoyance wore off they did at least get a good laugh out of it. My correspondent is not likely to get much of a laugh out of his but, as he says, his experience will be less dearly bought if it serves to save others from the same sharp practice.

That Little Something—.

A considerable part of this column in recent months has been given over to readers' (and my own) views on f.m. tuners and receivers. As is so often the case, letters are now arriving from those holding somewhat different views. There is quite a strong feeling that too much of *our* magazine is already given over to f.m., and a.m. design and construction has had to suffer in consequence.

T.S.D. (A.M.I.C.E.) of Merrion Avenue, Blackrock, Co. Dublin, another Old Timer and former transmitting amateur, is one of these. He particularly enjoys many of the continental orchestras—a taste which, if it is to be reasonably satisfied whenever listening time is available, demands a really first-class superhet receiver or a converter with a quality amplifier. Nor is he alone in this matter. In fact, at least a couple of readers mention they want consistently good reception from European stations for language study and practice, and a great number of others want occasional reception from more distant stations either for special items or by way of a change from too much BBC.

These are very reasonable requirements, and I am sure the vast majority of readers will readily agree that a set capable of certain, and good quality, Dx reception—given an average aerial—is a decided asset. As these correspondents point out, in recent years the superhet receivers offered for home construction might well have been designed ten or fifteen years ago, and are little better than the normal run of factory-built receivers. What is wanted is an up-to-the-minute design with a truly efficient r.f. stage. The latter is the minimum requirement. True, such a receiver would cost a bit extra to build; but just as the hi-fi fans cheerfully pay that bit more for a few kc/s at each end of the musical register, receiver constructors are equally willing to go to the extra expense and trouble for super performance. What about it, you designers?

Stuck Up

Some weeks ago a non-hobbyist friend wanted a midget universal receiver, and I recommended him to one of really tiny dimensions based on a design in one of our back numbers. He 'phoned me to say he was pleased with the result, and when I visited him last week he seemed to be well on the way to becoming an enthusiast, plying me with scores of questions about transistors and further miniaturisation. But what impressed me most was the cabinet he had made for the midget. It was the most perfect I have ever seen. He made it entirely of resin-bonded mahogany-faced plywood. It was not only of most eye-pleasing proportions, but beautifully grained, and fitted the tiny chassis like a glove. There wasn't a single piece of reinforcement used at any point, which made the inside as sleek as the outside. For all that, it was remarkably strong, and the mirror-like finish seemed to sparkle like cut-glass.

CENTRE TAP *talks about* *Items of General Interest*

Knowing he does not have a workshop worth mentioning, and precious few tools, I was naturally curious to know how he produced such a result. Apparently the only secret about it is lots of attention to detail, and I will try to briefly outline the points he stressed.

Start with a larger area of the best faced plywood you can get and don't worry about the wastage. By using carefully selected areas you can add greatly to the effect by matching the grain to suit the design. Cut all holes, speaker and dial apertures with a fretsaw. Whatever you do, don't use a drill on the surface. They split or tear the surrounding area. Wherever possible, cut with a really sharp chisel along a steel rule, or a fine-toothed saw held at the shallowest possible angle. Go slowly at the end of the cut and avoid chipped corners. If the cabinet is to be small, the joints can be "butted-in" by cutting away layers of the ply from the back. Use a cross-cut file for truing the edges; not a plane. Glue it together with one of the modern rubber-bonded impact adhesives. They make tremendously strong joints and internal reinforcement is not necessary. Don't use fillers on the surface. Repeated applications of amateur types of French polish sanded off with "flour" variety sandpaper give more certain results for the tyro.

It all adds up to nothing more than lots of attention to every little detail, but if the superlative finish achieved by my friend is the result, my previous attempts at cabinet making must have been slap-dash affairs. By the way, what he says about impact adhesives is true. Once you have seen the effect you are so nervous about placing the surfaces to be joined slightly out of position that your hands start to tremble and you feel you are more likely than ever to misfire. Once the surfaces touch, whoosh, you've had it!

Taped

Despite the fact that in recent issues "Radio Miscellany" has been allowed to run well over its allotted two pages, I still haven't found opportunity to touch on several subjects of current interest. These have included the cost of c.r.t.'s and the Monopolies Commission, a recently introduced computor in kit form, I.G.Y. Satellite programme, the BBC's new plan for sound radio starting in the autumn, and the probable further delay before colour t.v. starts in Britain (my guess, 1963), and the B.A.T.R.S. The latter has been most unfortunate because twice I have written about it and each time it had to be omitted on account of space considerations. The initials, of course, stand for the British Amateur Tape Recording Society. With links in Australia and the U.S., an International organisation has been formed to further extend their already numerous services and activities, which include a sound "magazine," technical information bureau and library, and tape-respondence between members. Readers, and I know there are many, interested in tape recording wishing to have further details, should write to the General Secretary, Edward Yates, G3ITY, 210 Stamford Road, Blacon, nr. Chester, Cheshire.

Such is Fame

Having used the nom-de-plume *Centre Tap* for over twenty years, it is at last becoming famous. I have had my first letter requesting my autograph! True, I was asked for an autograph some years ago. I felt so flattered about it that I was sorely tempted to give the autograph-hunter a half a crown to go with it. I well recall my hand shaking so nervously that I scarcely recognised my own writing. He took one searching look at it and let out a snort of disgust. Scrutinising me carefully, he muttered: "Blimey, you *are* like Raymond Massey," and went off. Was I glad I kept my half-crown in my pocket?

That one doesn't really count, but this request is genuine—in writing, too!

P.S.: I have a couple of partly worn hats that seem to have shrunk a bit. Any offers?

STRONG CHASSIS MAKING

QUICKLY, EASILY & CHEAPLY

by **J. D. LOADER,** *G3HVO*

THE WRITER, WHILST ENGAGED ON THE production of prototype radio gear, had a need for making strong chassis of different shapes and sizes without using the facilities offered by the machine shop, except for the use of two pieces of angle iron, a pair of tin snips and a 4in-metal engineer's vice. This type of vice is a useful investment for any home constructor, even if only to hold potentiometer spindles whilst sawing to length.

At first, chassis were made in the standard way as shown in Fig. 1. This proved uneconomical in material, and did not result in a very strong chassis when using 18 s.w.g.

(*continued on page 782*)

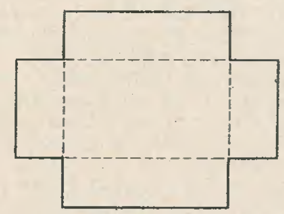


FIG. 1.

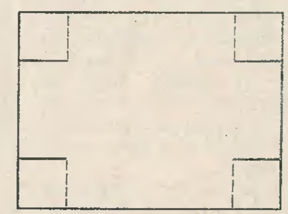


FIG. 2.

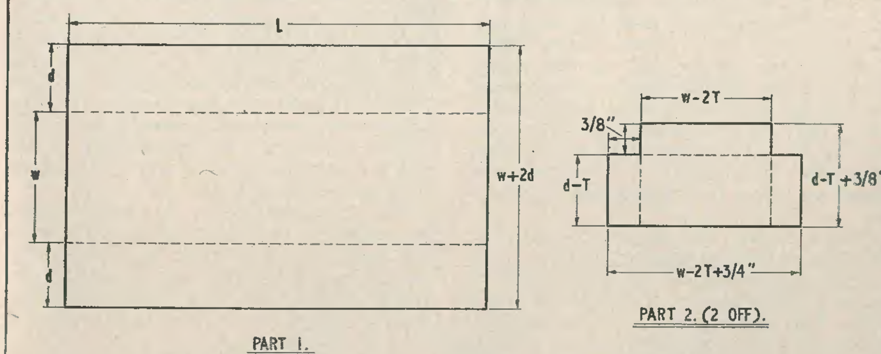


FIG. 3.

ALTERNATIVE ☆

☆ SUPERHET

by **A. S. CARPENTER**

THIS RECEIVER IS EMINENTLY SUITABLE FOR building into one of the many cabinets being offered today at attractive prices. Many of us are capable of building receivers satisfactorily, but when it comes to fitting a cabinet we are up against it; and unless one is skilled in cabinet construction the completed receiver is viewed unsympathetically by our friends and acquaintances. Of course we say, like the car dealer, that it is what's under the bonnet that counts. True enough, but an attractive outside sets off the inside—the same applies to radio.

One can quite easily purchase a complete kit of parts including the cabinet to build either a t.r.f. or a superhet receiver, and this may appeal to some. Construction then consists of nothing more than assembling and wiring up—a dull project for the keen constructor who prefers to have something he can fiddle about with and use his own initiative on. A great deal of enjoyment and extra knowledge is gained from one's own experimenting.

Why not purchase a suitable cabinet and its fittings and have a go at building something different?

Many firms in advertising their kits state that "all parts are available separately." A cabinet, dial and mechanism, control knobs, speaker to fit, and blank aluminium chassis (16 swg) is required. The chassis should have the same dimensions as that normally supplied with the kit, and it is best obtained blank so that holes can be cut as and where required. The chassis supplied in the usual way may not be made of aluminium and may consequently be hard to cut. Also, the holes may not be in the places required, as these chassis are often pre-drilled. With the blank chassis the layout can be arranged to suit the case.

There are scores of designs to choose from, both of the t.r.f. and superhet variety.

A t.r.f. is easy to build and is cheap, but if one wishes to listen to, say, Radio Luxembourg in the West country (the author's location), then nothing less than a superhet will do if fading and selectivity problems are to be avoided.

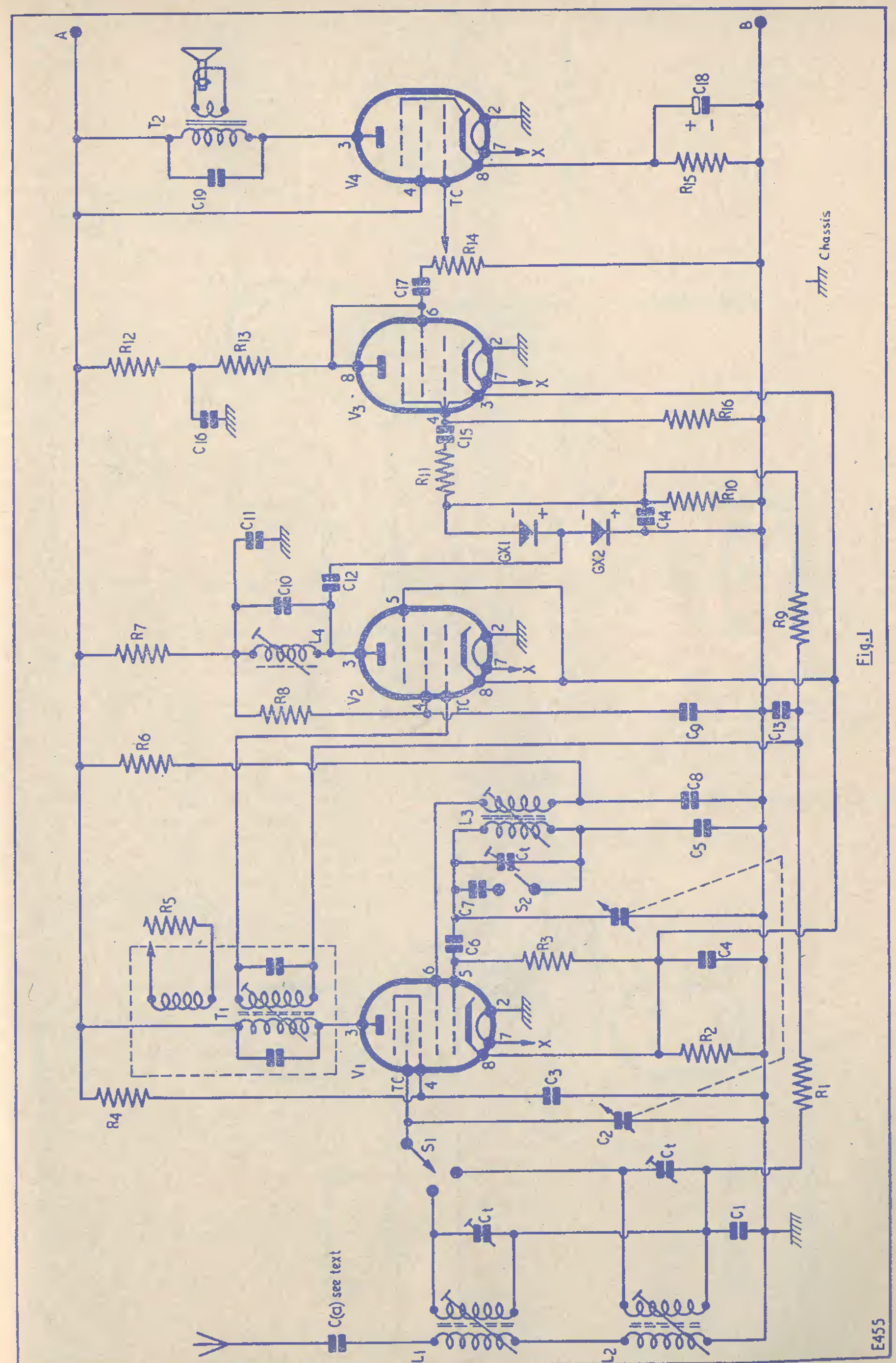
The receiver described here meets both these requirements admirably, and output power is really more than sufficient.

It employs four valves plus a rectifier and two germanium crystal diodes for demodulation purposes. Consider Fig. 1. The first valve is the frequency changer, providing at its anode an intermediate frequency of 465 kc/s for feeding to V_2, the i.f. amplifier. Only a single i.f. transformer has been used, and this is one supplied by The Teletron Co., whose advertisements appear in these pages. These are superb little transformers, and the type used is fitted with a tertiary winding to provide variable selectivity in conjunction with the control R_5. Variation of this control permits a greater or lesser degree of coupling at will, and considerably improves quality on the local transmissions. Where one wishes to listen to a transmission adjacent to a local one which is inclined to "spread," the control R_5 will be found very useful.

Provision has been made for both Medium and Long wave reception. Note that when receiving Long waves a capacitor, C_7, is switched across the Medium wave oscillator coil—so saving a coil. Tracking on the Long waveband is necessarily poor, but as the Light Programme is the only one that was considered in the original, this is of no consequence as this station can be tuned in perfectly. A value of 500pF has been specified for C_7, although slight variation may be necessary due to differing tolerances; but by varying it a little and by altering the core setting of L_2 no great difficulty should be experienced. If Long waves are not required, L_2 may be omitted or a Short wave coil used instead; but in this case a corresponding oscillator coil must be switched for use with it.

The i.f. is amplified by V_2 and passed for demodulation to a pair of crystal diodes. The anode of V_2 contains L_4 tuned to the intermediate frequency and decoupled by means of R_7, C_{11}. This is, of course, the familiar tuned anode coupling, which is capable of large gain.

Demodulation is carried out by the two crystal diodes operating in a voltage mul-



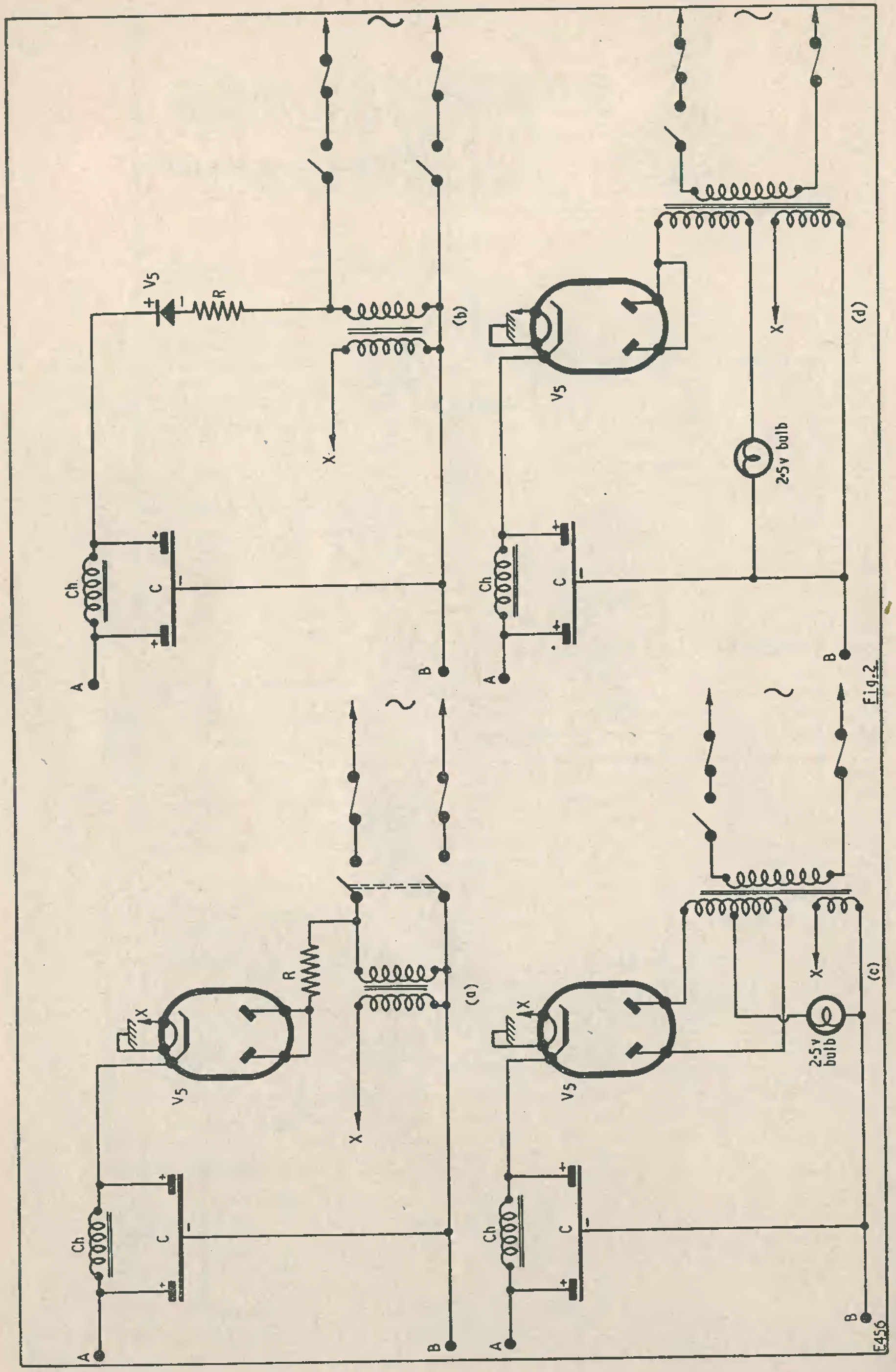


Fig.2

tiplying circuit, the output being taken from the anode of GX1 which is negative with respect to the chassis. Capacitor C_{12} should be as large as possible providing selectivity is not impaired, and an even lesser value than that specified may be necessary in some cases.

The d.c. load of the demodulating circuit is R_{10} and from this point the a.v.c. is taken and fed back to valves 1 and 2 via the decoupling network, R_9, C_{13}, R_1, C_1.

The a.c. is passed on to V_3 for l.f. amplification and thence to V_4 for output to the speaker transformer T_2.

The resistor R_{16} has been made four times that of R_{10} as the a.c. load comprises these two resistors plus R_{11} in parallel, ignoring the reactance of C_{15}. The a.c. load is, therefore, less than the d.c., which is unavoidable. If R_{16} is reduced, distortion will increase. If R_{10} is reduced, distortion will be decreased—as will be output.

Standing bias for the first three valves is secured by means of the voltage drop across R_2, and C_4 is its decoupling capacitor. This saves the use of two capacitors and two resistors.

A fixed capacitor C_{19} across the primary of the output transformer provides a certain amount of tone correction in the form of top-cut; should more cut be required, this capacitor may be increased in value. Alternatively, it may be connected from the anode of V_4 to chassis; or a mica type of approx. 100pF can be connected between anode and grid to provide feedback.

On/off requirements are best met by including them in the volume control potentiometer R_{14} (see later under Power Supply regarding the type of switch to use), but care should be taken to ensure that "off" corresponds with minimum volume. If, when switching on, the reverse is found to be the case, then switch off and reverse the connections to the potentiometer.

The front of the chassis will carry four control knobs, viz. tuning, wavechange, volume, selectivity; if there are only three holes provided on the cabinet, the selectivity control can be mounted at the rear or alternatively another hole can be cut in the cabinet. If it is a bakelite or plastic type, this can be done by burning a small hole with a large needle or something similar and then enlarging it carefully by means of a circular file. It will more than likely make an unholy stink, so be warned against family repercussions.

Is it necessary to stress holding the wires of the germanium crystal diodes with a pair of pliers to form a heat shunt when soldering? It is a point that can save two crystals.

The Power Supply

As will have been noticed, Fig. 1 does not include any power supplies. This does not mean that a separate power chassis is used—it is shown like this so that the constructor can choose either one of those shown in Fig. 2 or one of his own design. Decide this before you start building; and if you choose one from the four shown, connect A to A and B to B. incorporating the components on the same chassis.

A 6X5 valve rectifier is suitable for use in either Figs. 2 (a), (c) or (d) as it does not require a separate heater winding on the main transformer. In (a), (b) and (d) half-wave rectification is used for h.t., the l.t. being supplied by a small heater transformer in (a)

COMPONENT LIST

Capacitors

$C_{1, 3, 4, 8, 9, 11, 13, 15, 16, 17}$ 0.01μF
C_2 500pF twin-gang variable (see text)
C_5 500pF
$C_{6, 12}$ 100pF
C_7 500pF (see text)
C_{10} 150pF
C_{14} 200pF
C_{18} 50μF 25V electrolytic
C_{19} 0.006μF
C_a 100pF mica (see text)
C_t 50pF trimmers (3)

Resistors

$R_{1, 9}$ 1MΩ
R_2 100Ω
$R_{3, 4, 6, 11}$ 50kΩ
R_5 5kΩ pot
R_7 1kΩ
R_8 20kΩ
$R_{10, 11}$ 500kΩ
R_{12} 5kΩ
R_{13} 250kΩ
R_{14} 1MΩ pot with switch (see text)
R_{15} 500Ω 1W
R_{16} 2MΩ

Cabinet and chassis complete with p.m. speaker (see text)

Coils

L_1 QA8
L_2 QA12
L_3 QO8
L_4 IF1 (all Osmor)

I.F. transformer 465 kc/s, type N/S Teletron
2-pole, 2-way Yaxley type switch (S_1, S_2)
Germanium Crystal Diodes (2)
I.O. holders (4)
Output transformer 66 : 1 or to suit speaker

Valves

V_1 EK32, 6K8, ECH35
V_2 6K7
V_3 6SH7
V_4 EL32

Power Supply (see text)

V_5 6X5
L.F. choke 20H, 80–100mA
16 + 16 μF electrolytic
Transformer to suit

and (b). This is an inexpensive method, but if either of these is used the on/off switch should be of the double-pole variety and R should have a value of 100 ohms, $\frac{1}{2}$ watt. *It is essential that this resistor be included, and also C_a in Fig.* 1. The resistor is a protection against an h.t. current overload should a cathode/heater short develop—in V_5, for instance—and the capacitor is necessary to isolate the aerial as *the chassis will be live to the mains and must not be earthed directly.* These are the disadvantages. In (c) and (d) an isolating transformer is used. The on/off switch can now be of the single-pole variety and C_a may be omitted. The chassis will not be live to the mains and can be handled or earthed if required—it is quite safe. It is, of course, more expensive to construct this type of power supply, but suitable cheap transformers are often obtainable for a few shillings. Considering that a heater transformer will cost in the region of six or seven shillings, the isolating transformer is well worth the added expense. Of the four shown, (c) is the most satisfactory as it provides full-wave rectification and it is also possible to use a 1,000 ohm resistor (3 watts) instead of the choke. In all the others the choke (Ch) should be rated at 20 henrys.

The electrolytic capacitors (C) can be 16 + 16μF or similar.

Note that in (c) and (d) a 2.5v torch bulb is included as a safety fuse in the mains transformer secondary.

Alignment

This is best carried out with a signal generator; details of procedure have been included in these pages many times. If one is not available, the best that can be done is to get T_1 and L_4 "in line" with each other. The precise value of i.f. may not be exactly 465 kc/s, but there is a certain amount of tolerance given by the variable dust cores of $L_{1, 2, 3}$. Once any kind of signal has been obtained by means of rotating the twin-gang, the i.f.t. cores can be adjusted for maximum strength, and also the core of L_4. Trimming and padding may then be carried out on the signal frequency cores and trimmers and the oscillator coil and trimmer. Trim at the high frequency end of the scale and pad at the low.

Note: R_5 should be at minimum when finally aligning T_1.

Radio on the "Mayflower"

When the *Mayflower II* left England she was, in almost all respects, a facsimile of the original ship which left her mark on the pages of history. There was one detail, however, in which the new ship differed from its predecessor: Board of Trade regulations required that she carried radio.

The fitting of the radio equipment makes interesting reading in a recent Press release (redolent with 17th century nautical terms) from the Marconi International Marine Communication Co. Ltd. The equipment installed was the Marconi "Transarctic II" transmitter/receiver, this being run from a bank of 24 volt batteries supplied in duplicate and charged by a small diesel generator. Due to lack of space for fuel storage this generator can only be run for limited periods. The batteries themselves are fitted in a box in the Great Cabin, ventilation being provided by running a 3in pipe from this box through the bulkhead to a mushroom ventilator on the top deck.

The earth connection presented a problem due to the wooden hull. A solution was found by fitting a copper plate, 30in square, to the outside of the hull below the waterline, and running a 35ft earthing strip from this to the transmitter/receiver in the Great Cabin.

The transmitting aerial also offered difficulties. This aerial was, eventually, run from the top of the foremast to the mainmast and, thence, to the top of the mizzen mast at the stern of the ship. The 70ft mainmast of the *Mayflower II* has a considerable amount of whip, this being sufficient to snap a taut aerial. In consequence the aerial was secured at the foremast only, being free to run through the block insulators at the main and mizzen masts. The receiving aerial was seized (or lashed) to the after starboard shroud of the mainmast.

A Marconi Marine radio officer, Mr. J. D. Horrocks, sailed with the ship on her epic voyage to America. The equipment was installed by Mr. E. A. Kitt.

RIGHT—*From the Start*

PART 15

TRANSMITTERS

by A. P. BLACKBURN

So far in this series, the majority of the articles have been devoted to receivers or general matters connected with them, but no mention has been made of transmitters. As usual, there are innumerable types, but generally speaking the amateur is only concerned with amplitude modulation, so the field is narrowed somewhat. The coming of frequency modulation has turned considerable attention to f.m. receivers, but not a great deal to transmitters, as yet.

We will briefly recall what a transmitter has to do. The mechanism of radio communication is to generate a high frequency signal and radiate it electromagnetically from an aerial. This radiation must now have some form of intelligence impressed upon it. One way is to control it in bursts in the form of the morse code. Another is to modulate it, with speech or music, etc.

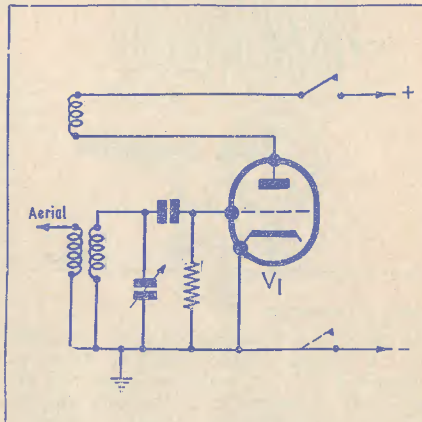


FIG. 1.

C.W.

Transmitters which radiate an unmodulated signal are called "continuous wave" or c.w. transmitters. The intelligence may easily be superimposed by switching the transmitter on and off in a coded manner; for example, the Morse Code.

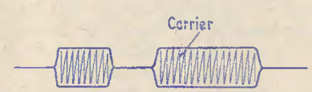


FIG.2.

In the simplest case, the transmitter need only consist of a simple oscillator with the morse key interrupting the h.t. as shown in Fig. 1. The output coupled in the aerial would look something like Fig. 2; an "envelope" filled with the oscillation or "carrier" when the key is closed. The key in the anode circuit will, of course, be "live," i.e. at h.t.+. A safer way would be to place the key in the negative lead, as shown dotted. Another way is to bias the valve beyond cut-off, and remove the bias when the key is depressed, as shown in Fig. 3. When the bias is removed the circuit will oscillate.

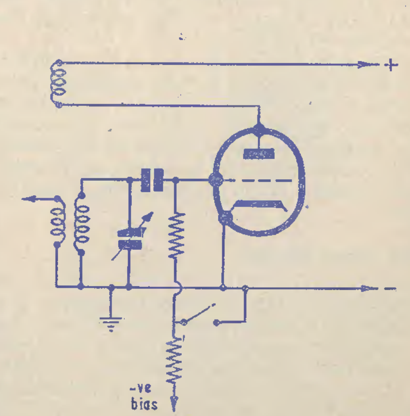


FIG.3.

Morse transmission, then, can be fairly simple—merely stopping and starting oscillation. What of speech and music transmission? First we will have a look at the modulated waveform required, as shown in Fig. 4. This shows the carrier being changed in amplitude in sympathy, so to speak, with the modulation. This is what we have to do, then—to produce a modulation envelope not starting and stopping like the Morse one, but varying in amplitude as the modulation varies in amplitude.

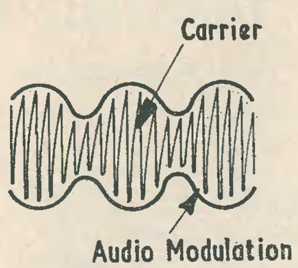


FIG. 4.

Anode Modulation

A commonly used method is to modulate the h.t. voltage of the oscillator valve, as shown in Fig. 5. V_1 is the oscillator, and the amplitude of the carrier it produces may be varied by varying the h.t. voltage to the valve. If we interpose a resistance R_1 in its h.t.+ lead, and connect V_2 as shown, variations of current in V_2 will produce similar variations in voltage across R_1. Say, for example, the grid of V_2 were made suddenly a little more positive, then the current in V_2 would increase. The voltage dropped across R_1 would also increase, leaving V_1 with a smaller anode voltage. It is pretty clear now, then, that if we feed an audio signal into the grid of V_2, the anode voltage of V_1 would be "modulated" by it, thereby producing the envelope of Fig. 4.

Naturally, this simple system has its drawbacks. The greatest is that variation of the anode voltage of the oscillator will almost certainly cause the oscillation or carrier frequency to change as well as the amplitude. This is undesirable for a number of reasons, and so some method of overcoming it must be found.

The Power Stage

Probably the most universally used method is to separate the functions of oscillator and modulated stage into two or more valves. An oscillator working under as nearly ideal conditions as possible (for stability reasons) feeds a power amplifying stage. The modulation is now applied to the anode of the latter, as shown in Fig. 6.

V_3 is the power amplifier, and its anode is common with that of the modulation stage more or less as in Fig. 5. This time a choke has been substituted for the resistor R_1. This is more efficient, because even in the absence of modulation a considerable amount of power would be dissipated in R_1 due to the valve currents flowing through it. To return to the power amplifier, however, V_3 thus serves two purposes; it increases the oscillator power and enables the oscillator to work with a constant h.t. voltage and therefore to remain more stable in operation. In very high power transmitters there may be many stages of amplification between the oscillator and the final power amplifier.

A feature of anode modulation is that the modulation valve must be able to produce as much modulation power as the power amplifier produces r.f. power. If the power amplifier produced 1kW of r.f., the modulator valve must produce 1kW of audio power, or greater. This consideration leads to the choice of other modulation methods for many purposes.

The grid of a valve really represents a point at which a large power may be controlled by a relatively small power. For example, a power of microwatts at the grid of the first stage in a receiver controls an anode power of milliwatts in that valve, and so on through the receiver until the speaker is driven by watts of power.

So, in the case of our transmitter, the large carrier power at the anode could be controlled by a smaller power at one of the grids in the P.A. stage. This may be done by applying the modulation at the control grid as shown in Fig. 7. In effect, the audio is changing the grid bias of the power amplifier. The radio frequency choke in the grid circuit is used instead of the more conventional grid leak resistor, because modulation *power* must arrive at the grid and a resistance would dissipate some of this and the system would be inefficient. C_1 and C_2 are important.

The reactance of C_1 should be large at the highest audio frequency in use but small at the carrier frequency, so that audio is not passed through it, but the carrier arrives at the grid unimpeded. C_2 should have a small reactance to the carrier and large to audio, like C_1. The purpose of C_2 is to bypass any r.f. to earth and prevent it reaching the modulation circuits.

If a pentode is used in the power amplifier stage, suppressor grid modulation may be used. Here the control grid is used exclusively to deal with the carrier, and the audio modulation is fed to the suppressor grid. The action is very similar to that of control grid modulation.

A half-way method of modulation is cathode modulation. The basic circuit is shown in Fig. 8, where it can be seen that the modulating valve is placed in the cathode circuit of the power amplifier. A higher power modulator is required for this than in the case of grid modulation, but not so high as for anode modulation. The circuit is really a combination of grid and anode systems.

choke L_1 becomes the secondary of the transformer and the anode of V_2 is connected to the primary. This transformer has to be designed, of course, to cope with the modulation power required, and in a large transmitter may be a very bulky item indeed.

Frequency Multiplication

At higher frequencies, crystals to control

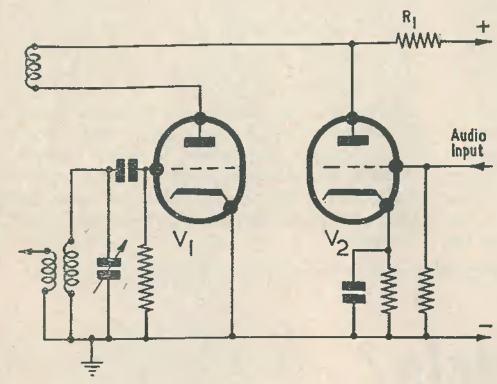


FIG. 5.

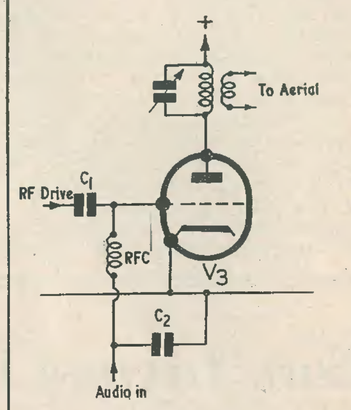


FIG. 7.

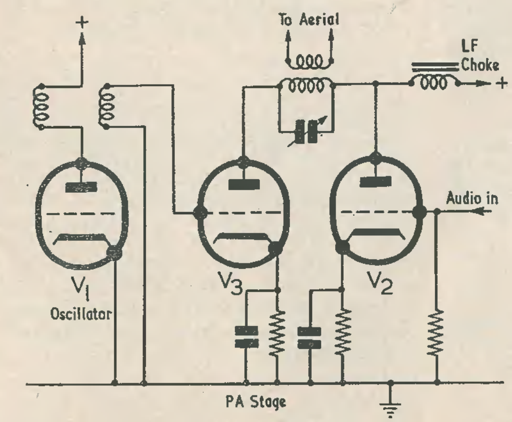


FIG. 6.

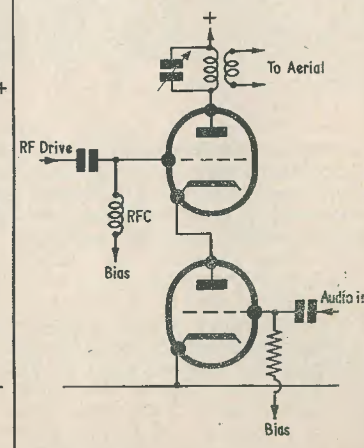


FIG. 8.

Coupling

In all these systems of modulation the greatest efficiency is obtained when the modulator is correctly matched to the power amplifier. In order to achieve this simply, a transformer is often used. The connection is perfectly simple; for example, in Fig. 6 the the master oscillator driving the power amplifier stage are not available. To enable the transmitter to operate at these frequencies the power-amplifier can be made to multiply its driving frequency.

The method is an extension of one used to obtain high efficiency. This is class "C" operation. The bias of the power amplifier is such that the valve is cut-off. When the carrier drive is applied, the positive waves cause the valve to conduct suddenly. The anode current is, therefore, in pulses of current which kick the tuned circuit into oscillation. In normal operation this tuned circuit has a resonant frequency equal to the drive frequency, i.e. it is tuned to the drive frequency, and produces an output in the aerial at that frequency.

If, now, the anode circuit is tuned to three times the drive frequency, it will receive a "kick" from the drive waveform for every three cycles it produces. The efficiency is obviously lower in this mode of operation.

It can be shown that in the normal mode of operation (not frequency multiplying), class C operation is the most efficient. By efficiency in this sense is meant the relation between the r.f. power in the aerial and the d.c. power supplied to the anode of the valve. Class "C" operation of the P.A. valve has the advantages that high efficiency may be obtained and frequency multiplication may be used if required.

Aerial Coupling

As a conclusion to this very thin scratch on the surface of transmitter topics, a word should be said about the coupling of the transmitter to the aerial.

This depends in detail to a great extent upon the type of aerial used. However, the aim always is to get as much of the power generated into the aerial as possible, just as one wishes to transfer as much power as possible from an amplifier to a loudspeaker. The transmitter condition is very similar—the transmitter must be matched to the aerial.

Very often this process takes the form of a transformer just as in the amplifier-loudspeaker case, but the primary or secondary of the transmitter "output" transformer is usually tuned to the frequency of the carrier.

Can Anyone Help?

Requests for information are inserted in this section free of charge; subject to space being available

G. Watson, 8 Linn Drive, Muirend, Glasgow S.4, would be very pleased to hear from any fellow-reader who has successfully converted the BC.453.A Command Receiver to a car radio.

* * *

G. Gibbins, 106 Windermere Road, Reading, Berks, would like to purchase or borrow the circuit and information for converting the Command Receivers BC.454 3–6 Mc/s or BC.455 6–9 Mc/s to a car receiver.

* * *

C. B. Raithby, School House, Martin, Lincoln, wishes to obtain the circuit for the 9.72 Mc/s I.F. Strip reference 10U/254.

* * *

G. H. Price, 128 Kingsbury Road, Coundon, Coventry, Warwicks, would greatly appreciate any information on the ex-A.M. Receiver type 1466.

* * *

A. L. Stevenson, 195 Borron Street, Glasgow, C.4, urgently requires the circuit diagram of the Regentone W66 (a.c./d.c.) and will pay for same.

D. Willcox, "Tudor Gate," Henfield, Sussex, wishes to obtain a service sheet for a Pilot (U.S.A.) T.47 a.c./d.c. radio set.

* * *

R. Low, 100 Millar Road, Saltcoats, Ayrshire, Scotland, wonders if anyone can supply him with the circuit or any information on the Etronic T.V. model ETV.1536 in exchange for other radio or t.v. circuits.

* * *

A. R. Larkin, 3 Stag Close, Stag Lane, Edgware, Middx., wishes to buy or borrow a handbook or manual on the Hallicrafters S.20.R receiver.

* * *

E. Jones, Highlands, Station Road, Epping, Essex, wishes to obtain a circuit or servicing data for the Philips 785.AX receiver, serial No. 5778.

* * *

J. Teasdale, 10 Barker Road, Linthorpe, Middlesbrough, Yorks, asks if anyone can help with data and circuit of the ex-A.M. Test Set type 5A, ref. No. 10S/20. All letters acknowledged.

Valve Nomenclature

PART 2

by V. T. ROLFE

Ferranti

As with most manufacturers, a large number of American types now appear on the Ferranti list, and in addition a number of Continental types. In fact, all the current types shown in the latest "Radio Valve Data," published by *Wireless World*, have either American or Continental type numbers.

The Ferranti code only applies, therefore, to replacement and obsolete types: it consists of a letter group to indicate the type of valve, followed by a number indicating the heater voltage, with a further letter if necessary to differentiate between similar types. The following letters are used:

*D—Diode
DD—Double-diode
H—Triodes
HL—Triodes
L—Triodes
LP—Power triode
PT—Pentode
QPT—Q.P.P. valve
SPT—"Straight" pentode
VHT—Vari-μ hexode
VPT—Vari-μ pentode
VFT—Tuning indicator.

* In the case of a double-diode triode or double-diode pentode, a single D is used as a suffix, e.g. H2D, H4D, PT4D. The letters used are rather similar to those used by Cossor, but precede the number.

The heater designation is comparatively simple. Two volt valves are distinguished by a figure 2, four volt valves by a figure 4, and 6.3V types by a 6. A.C./D.C. types having odd values of heater voltage are distinguished by the letter Z (e.g. PTZ).

Marconi

Many Marconi valves have the same type numbers as Osram valves, and the same letter code holds good. With more recent valves, a serial number is used to indicate the "range" a valve belongs to. Thus the "145" range consists of the X145, W145, Z145, N145, DL145 and U145; these being the frequency changer, variable-mu r.f. pentode, "straight" r.f. pentode, output pentode, double-diode triode and rectifier respectively. This letter code is dealt with under the Osram section which follows.

Apart from all valves in the same range having the same number, there is no significance in the numbers themselves.

Osram

The present code consists of a letter (or letter group) which indicates the valve type (triode, pentode, etc.) followed by a number with either two or three digits. The letter code has been in existence for a number of years, and the principal letters used are shown below:

B—Double-triode
D—Diode or double-diode
H—Triode (high-mu)
KT—"Kinkless" tetrode
L—Triode (low-mu)
N—Output pentode or tetrode
U—Rectifier
W—R.F. pentode (variable-mu)
X—Frequency changer
Y—Tuning indicator
Z—R.F. pentode ("straight").

Combinations of these letters are often used. DH indicates a double-diode triode, KTW indicates a variable-mu r.f. beam tetrode and LN a triode/output pentode.

The numerical group may consist of two or three digits. No rigid rules can be applied to the numerical groups, but the following notes may prove useful. 1.4V battery valves on octal bases use the numbers 14, 15 and 16. The miniature B7G range use the numbers 17 and 18. The older 2V valves used numbers in the "20" series.

Numbers in the "60" range were used to indicate octal-based valves having 6.3V heaters, and in the "30" range for valves with 300mA heaters.

With the introduction of the miniature range an attempt has been made to rationalise the system, the first figure being used to indicate the heater rating and the last figure the base. In the case of three-figure numbers, the centre figure can be regarded as a serial number. The first figure code is as follows:

7—6.3V heater (for parallel operation)
1—100mA heater (for series operation)
3—300mA heater (for series operation)

The last figure code is as follows:

7—B7G base
9—B9A base

In some cases an "8" may be used to indicate a B7G base. All the 100mA and 300mA range have three-figure numbers. In the case of the former this avoids confusion with the 1.4V battery valves, e.g. X17 and X18 are 1.4V battery-operated frequency changers, whereas X109 is a 100mA frequency-changer on a B9A base.

Mullard

The present Mullard system is well established and gives more information than most valve codes. It is also in use on the Continent, which is a great advantage.

Basically it consists of two (or more) letters followed by a two-figure number.

The first letter gives the heater rating, according to the following code:

A 4V heater
C—200mA heater
D—1.4V filament (or heater)
E—6.3V heater
G—5.0V heater
H—150mA heater
K—2.0V filament
P—300mA heater
U—100mA heater.

In addition to the above, V is used on the Continent—but not in this country—to indicate a 50mA heater.

The second, and any subsequent letters, indicate the electrode structure, in accordance with the following lists:

A—Diode
B—Double-diode
C—Triode
D—Output triode
E—Tetrode
F—R.F. pentode
H—Hexode or Heptode*
K—Octode or Heptode*
L—Output pentode
M—Tuning indicator
N—Thyratron
†P—Secondary emission valve
Q—Nonode
X—Gas-filled rectifier
Y—Half-wave rectifier
Z—Full-wave rectifier.

* Heptodes used as "single stream" frequency changers are denoted by K (e.g. DK96). In the case of triode heptodes, CH is used (e.g. ECH81).

† Used only as a third letter.

These letters may be used together to indicate multiple valves: e.g. EABC80 is a triple-diode triode with a 6.3V heater.

The first figure indicates the type of valve base:

No figure —Side contact
2—Loctal (B8G)
3—Octal
4—Rimlock
5—Special
6—Subminiature 5-pin (B5G/F)
7—Subminiature 8-pin (B8D/F)
8—Noval (B9A)
9—Miniature 7-pin (B7G)

A "1" is used on the Continent to indicate a special German base, the Y8A. The "5" can mean anything from wire-ends (as in the case of EY51) to B9G (as in the case of the EF50). The "7" is used on the Continent for a type of B8G base (e.g. EM71).

The final figure is a serial number. Because a valve bears this nomenclature it is not necessarily a Mullard type. The EM71 mentioned above is made only by Brimar in this country, as is also the PY83. There are also one or two valves of Continental origin which contravene the code, notably the UM4 and the D20 range (DAC21, DF21, DF22, DK21 and DL21), all of which have octal bases, but "Continental" connections (heater or filaments on pins 1 and 8, instead of the normal 2 and 7). Of these, only the UM4 is a Mullard type.

Previous Code

Prior to adopting the European type numbering system, a single code consisting of a letter group to indicate the type of valve and a numberical group to indicate the heater voltage was employed.

The letters used were as follows:

ACO—A.C. mains output valve
DO—Directly-heated output valve
DW—Directly-heated full-wave rectifier
FC—Frequency changer
HVR—High-voltage rectifier (e.h.t.)
IW—Indirectly-heated full-wave rectifier
PEN—Output pentode
QP—Quiescient push-pull valve
SP—"Straight" r.f. pentode
TDD—Double-diode triode
TH—Triode heptode or Triode hexode
TSP—Television screened pentode
TT—Triode
TV—Tuning indicator
UR—Half-wave rectifier
VP—Variable-mu pentode
2D—Double-diode

With the exception of the ACO's, DO's and all the rectifiers, these letters may be followed by a figure (or figures) indicating the heater voltage. For example, the FC2, FC4 and FC13 have 2V, 4V and 13V heaters respectively. In the case of full-wave rectifiers (IW and DW) the number group consists of two parts, the first giving the heater voltage, and the second the maximum anode voltage. The DW4–350, for example, is a directly-heated full-wave rectifier with a 4V filament and a maximum anode voltage of 350V r.m.s.

There are also a large number of Mullard valves of early vintage, which have the suffix "PM." Judging by old Mullard catalogues, this appears to be an abbreviation for "Pure Music."

Tungsram

The majority of modern Tungsram valves bear either the American or European nomenclature. As these are explained elsewhere in this article, it is only necessary to deal with the older types of valves here.

A letter prefix is used with Tungsram types indicating the class of valve, followed by a number giving some information on the heater ratings.

The following letters have been used:

A—Prefix used for some 4V a.c. mains valves
CB—Class-B output valve
DDT—Double-diode triode
HL—Triode
HR—Triode (for use as resistance-capacity-coupled amplifier)
HP—H.F. pentode
LD—L.F. triode
LL—Driver triode
LP—Low power triode
MH—Heptode frequency changer
P—Power triode
PP—Power pentode
PX—Super power triode
PV—Power valve (i.e. rectifier)
SE—Screen-grid valve
SP—"Straight" r.f. pentode
SS—"Straight" screen-grid valve
TX—Triode hexode
VO—Variable-mu octode
VX—Variable-mu hexode

Several codes seem to have been used as far as the numbers are concerned. A number of older valves have just a single figure, a 2 or a 4, which indicates 2 and 4V heaters respectively. There is also a series of 13 volt valves (HL13, DDT13). Similarly, the TX21 which is a triode hexode with a 21-volt heater.

But the vast majority of valves have four-figure numbers which indicate the heater voltage and current. The HP4100, for instance, is an r.f. pentode with a 4V 1A heater; the HP2018 is also an r.f. pentode, with a heater rated at 20V, 180mA. (There is a whole range of these valves with 180mA heaters.) The PV4201 is a full-wave rectifier with a 4V, 2A heater.

There is also another system which was used at one time to specify rectifiers. The RV200/600 is an example of this. This can be "translated" as meaning "*R*ectifier *V*alve" giving an output of 200mA at 600V.

Miscellaneous

BVA Code

During the war years a very limited range of valves was manufactured, and no makers' names were marked on the valves. They were marked with a three-figure code which distinguished battery and a.c. mains valves, valve function and manufacturer. The details of this code are shown below.

1st figure—Heater group
1—Battery type
2—A.C. mains type

2nd figure—Valve type
1—Rectifier
3—Double-diode triode
4—R.F. pentode
6—Output pentode
7—Frequency changer

3rd figure—Manufacturer
1—Cossor
2—Mazda
3—Ferranti
4—G.E.C.
5—Marconiphone
6—Mullard
7—Brimar

Service Codes

As most readers will be aware, the Armed Forces now use a common valve or "CV" code. Each valve used is allocated a type number. The numbers in themselves do not indicate anything, but are merely serial numbers. The Americans have a somewhat similar system of "VT" numbers.

Prior to the adoption of the CV code, each Service used its own number. The prefixes VR, VT, VI and VU were used by the R.A.F. to indicate valve, receiving; valve, transmitting; valve, indicating; and valve, rectifier. VCR was used for cathode ray tubes. The Navy used such prefixes and NR and NT, and the Army AR, AT, etc.

Literature Received . .

Catalogue No. 13.—We have received from Arthur Sallis (Radio Control) Ltd. a copy of their latest Catalogue containing over 500 itemised components and units, etc. Attractively produced and comprising 80 pages plus heavy cover, it costs but 2/– post free in this country, which is refunded against any order over 20/– in value.

Of especial interest to radio control enthusiasts are the many types of escapements and relays displayed therein; indeed, this catalogue is claimed to be the only one of its kind in this country in this respect. Of appeal to the radio enthusiast are the many items of surplus units, equipment and components available. Lavishly illustrated throughout, this latest edition of a well-known catalogue should find a place in most workshops.

Technical Bookguide

Published by Hansom Books Ltd., 21 Lower Belgrave Street, London, S.W.1, this handy monthly reference to the latest books published is available from bookstalls at 6d. per copy.

AN UNUSUAL AUDIO OSCILLATOR

by W. E. THOMPSON, *A.M.I.P.R.E.*

SOME EXPERIMENTS WITH A MODIFIED multivibrator circuit were described by Louis E. Garner, Jr., in the September 1956 issue of *Radio and Television News*, in which it was shown that the basic circuit, Fig. 1, could be regarded as having the two triodes connected in parallel across the h.t. supply. Altering the circuit to that shown in Fig. 2 produces what Garner calls a series multivibrator, because the two triodes can now be seen as in series or cascade. The circuit is not unlike the configuration that has become known as the cascode. Garner also showed that variations on the basic circuit of Fig. 2 could be produced, from which different waveforms could be obtained at the low and high impedance points.

One example is the simple circuit of Fig. 3, a series multivibrator whose output has a sine waveform at both the low and the high impedance points indicated by the dotted connections.

Experiments by the present writer have shown that some further development can provide a useful audio source which has a sine waveform, at a resonant frequency of 1,000 c/s. With the circuit of Fig. 4 there is good sine waveform free from harmonics, producing about 2.5V r.m.s. at low impedance.

There are several uses to which such a source can be put, two examples being (*a*) modulation for an r.f. signal generator, and (*b*) a frequency source for certain bridge measurements. The writer has used it successfully as a source of alternating voltage in a Maxwell bridge for inductance measurements.

The resonant frequency can be altered by changing the values of C_1 and C_2. It has been found, for instance, that when $C_1 = 0.004\mu F$ and $C_2 = 0.02\mu F$ the resonant frequency is 400 c/s, which is the usual modulation frequency for signal generators. Altering the value of either C_1 or C_2 will, of course, change the operating frequency, though it seems that C_2 has the greater effect. For example, if C_2 in Fig. 4 is increased in value from $0.01\mu F$ to $0.02\mu F$, the resonant frequency falls to 500 c/s, and retaining this new value for C_2 and increasing C_1 from $0.001\mu F$ to $0.004\mu F$ reduces the resonant frequency from 500 c/s to 400 c/s. The values of all other components remain unchanged in these examples.

Perhaps the most noticeable feature of the circuit is the absence of inductive components and, if more modern audio oscillators are considered, the apparent absence of conventional phase-shift networks. Even though the circuit is so simple, its frequency stability is good. There is no noticeable drift with long periods of operation, and stable operation is reached as soon as the valve has warmed up. Oscillation commences readily even when the h.t. rises gradually from zero. These conditions applied with any sample of 6SN7 which was tried in the experiments. One valve, tried purposely because it has a heater-cathode leakage of 4MΩ, did not seem to do any more than produce a mere trace of 50 c/s intermodulation.

A fairly stable h.t. supply is an advantage, though not essential. Measurement shows that the resonant frequency drifts slightly with changes of h.t. voltage, but fortunately it is not serious. Small changes of h.t. voltage are almost insignificant, but a drop from 200V to 150V causes a rise in resonant frequency of about 30 c/s.

The current drawn from the h.t. supply is extremely small. The maximum value registered with the several 6SN7's tried in Fig. 4 was 0.8mA. The same circuit, at 400 c/s, drew about 1.2mA.

A rather unusual feature noticed during the experiments is that disconnecting the decoupling capacitor C_3 causes oscillation to cease. This curiosity can be put to advantage for at least one purpose, for if the earth return for C_3 is taken via a morse key, one has quite a useful code practice oscillator! It was also found that the value of C_1 cannot be made too large, otherwise oscillation will stop. In fact, one of the difficulties first encountered was found to be due to a value of $0.05\mu F$, specified by Garner, being too large; this had to be reduced to $0.01\mu F$ before oscillation started.

This circuit does not seem to lend itself readily to operation as a variable audio oscillator. On the other hand, it is easy to make it work on a number of chosen spot frequencies controlled by a switch to change the values of C_1 or C_2, or both. It is not inconceivable that with other circuit configurations producing different waveforms, one could make a simple musical instrument. This thought, for what it is worth, is offered to those who like to try out new ideas for making weird and wonderful noises.

As far as components are concerned, they can all be found in practically any junk box, and the circuit takes but a few minutes to wire up.

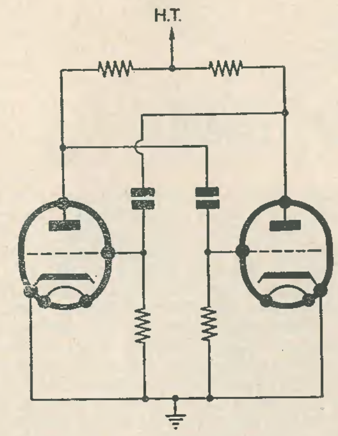


FIG.1. Basic 'Parallel' Multivibrator Circuit.

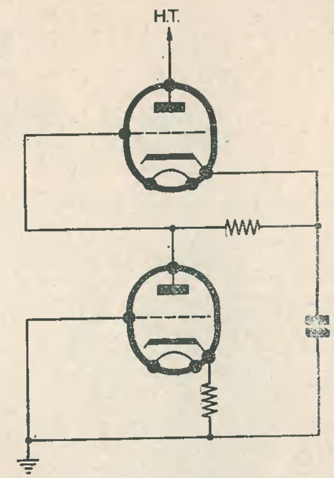


FIG.2. Basic 'Series' Multivibrator Circuit.

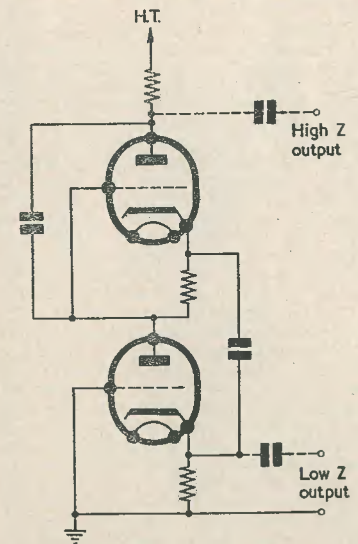
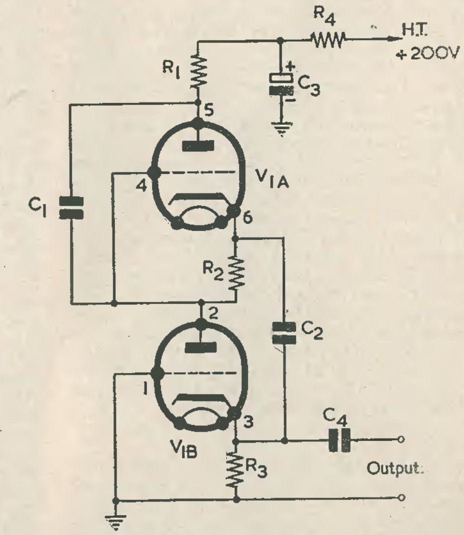


FIG.3. Basic Sine Wave Multivibrator Circuit.



R_1 = 15kΩ	C_1 = ·001μF	V_1 = 6SN7
R_2 = 3·3kΩ	C_2 = ·01μF	
R_3 = 3·3kΩ	C_3 = 8μF	
R_4 = 120kΩ	C_4 = ·01μF	

FIG.4. 1000c/s Audio Oscillator.

M428

A Constructor Visits . .

THE 1957 AUDIO FAIR

At an exhibition devoted to an art such as the design of high fidelity reproducing equipment, wherein perfection overall remains only a tantalisingly small fraction out of reach, it is hardly to be wondered at that practically all products shown achieve exceptionally high standards of workmanship and of performance, and that an attitude of keen enthusiasm exists amongst the exhibitors. The Audio Fair is, to the writer's mind, unlike any other large "electronic" exhibition staged in London. At most exhibitions one finds that the scene is dominated by the salesman rather than by the development engineer, and that technical queries often cannot be handled because the stand personnel simply do not know the answers. Occasionally one is able to unwinkle from some remote fastness an engineer who is fully conversant with the technical details of his firm's products; but, even here, one occasionally finds oneself tempering inquisitiveness with sympathy for his obviously boring tour of stand duty.

At the Audio Fair the whole outlook is different. Here the engineer is almost completely in control, and talk is not so much of sales but of performance specifications. In many cases, exhibitors' representatives are themselves high fidelity enthusiasts, and they welcome the questions of neophytes just as warmly as they do those of seasoned devotees. Discussion of individual products is largely objective—it is probably only at the Audio Fair that an exhibitor is prepared to detail both the advantages *and* the shortcomings of his particular equipment. To the engineer the essential charm of high fidelity work is that, by judicious use of the resistors, condensers, and other components with which most of us have been playing all our lives, a device can be created which truly adds to the very best things of this world. There have been many craftsmen in the past who have built exquisite musical instruments: *electronic* craftsmen are now beginning to join their ranks.

The Fair

The Audio Fair this year was held at the Waldorf Hotel, Aldwych. This is the second London Fair; the first, an overwhelming success, having been held in the more confined accommodation of the Washington Hotel. In a report of this nature it is almost impossible to detail everything that was shown. Such a report would read, in any case, rather like a catalogue of the various firms' products. Comment on the performance of particular equipments is also difficult, but the reader can rest assured that the performance of all those mentioned below is very good indeed. In general, the writer attempted to discover products which were new or whose specifications were of major interest.

Philips Electrical presented an interesting development in what they describe as their Hi-Z output circuit. This circuit employs no output transformer, thereby deleting a rather troublesome link in the reproducing chain. The Hi-Z arrangement is used in the Philips 12-watt amplifier type NG5200, the output stage of which contains four pentodes in a series-parallel arrangement, this number of valves being necessary to produce the required output power and to bring the output impedance to a usable value. The four valves of the output stage are driven by a triode splitter, and the speaker is fed from the output cathodes via a blocking condenser. The impedance of the speaker employed (a Philips model) is 400 ohms and the damping factor given by the circuit is 60. It is claimed that the new output circuit enables full rated power to be delivered throughout the a.f. range, with negligible phase shift and superlative transient response.

The General Electric Company demonstrated their stereophonic sound equipment and announced modifications to some of their equipment. For instance, minor modifications have been made to the BCS 2417/8 amplifier, which is now available in unit-form under the type number BCS 2417/8A. (Incidentally, the writer understands that the letters BCS—so common on G.E.C. equipment—stand for Broad-Cast Sound.) G.E.C.'s v.h.f./f.m. tuner unit has been re-designed to give improved sensitivity and generally improved performance, with a considerable reduction in h.t. power requirements. This latter enables the unit to be fed, via suitable decoupling circuits, from existing amplifier power packs. However, the main item of G.E.C. news at the Fair was the introduction of their "Periphonic" speaker system. Briefly, the "Periphonic" system works in the following manner. When a moving coil loudspeaker is fed by an amplifier, its cone does not follow perfectly the movement transmitted to it by the voice coil. Some flexure is inevitable, particularly at the periphery. This flexure causes distortion. In the "Periphonic" system two loudspeakers are mounted very close together with their cones moving in opposite directions. Because of this, distortions introduced by flexure in one speaker are cancelled out by an equal and opposite flexure in the other. Radiation of the sound is then obtained from the exposed surfaces of the cones. The air compression between the two speakers working in anti-phase is considerable, and a very robust assembly, such as is provided in G.E.C. metal cone speakers, is essential. The "Periphonic" system requires a specially designed cabinet, details of which may be obtained from G.E.C.

A very interesting new microphone, the "Cadenza," was the feature of an impressive demonstration by Simon Sound Service Ltd. The demonstration consisted of the reproduction of a recording by the full choir and organ of St. Matthias, Richmond Hill. The reproduction showed excellent balance between the choir and organ, and was equivalent to any similar performance the writer has heard. The recording had been made with *one* "Cadenza" microphone positioned 40 feet away from the source of sound.

"Watt's Folly"

An excellent reproducer, type "CQ", available from R.G.A. Sound Services (Plymouth) Ltd., was exhibited at the Fair. This consists of a relatively small rectangular enclosure mounted on four legs, and it should prove ideal for the living-room of the enthusiast who does not wish to invest in a heavy outlay. The price of this unit is twelve guineas only and, in the writer's opinion, its performance was as good as that of many others in the Fair at much higher cost. Power handling is of the order of six watts. Considering the compactness of the unit, bass response was exceptionally good. The reproducer employs a 10-in elliptical speaker and a 4in m.c. tweeter.

Also shown in the same demonstration room was a much larger reproducer. This has been designed by Mr. Cecil Watts and was described by the demonstrator as "Watt's Folly." Apparently there is only "one off" of this reproducer available at the time being, and "nobody knows what's inside it"! The cabinet stands some four or five feet high, and looks rather like a truncated mummy-case. There are two round apertures at the flat top, with lateral apertures around the uppermost foot or so of the body. Whilst the writer was in the demonstration room, the reproducer was switched in for a record of "Hernando's Hideaway." "Just wait for that knock on wood," said the demonstrator. "It's out of this world." It certainly was. This reproducer may be going into production soon.

H. J. Leak and Co. have always been a very active firm, both in the home and in the export markets. New production techniques made possible by this company's large sales have now enabled it to tackle this year's equipment both from the point of view of increased performance standards and of reduced prices. H. J. Leak have also paid considerable attention to the styling of their products, a very important point in the U.S. where hubby has less say in the purchase of high fidelity equipment than has his spouse. The new Leak Varislope III pre-amplifier now supersedes the Varislope II, and is one guinea cheaper. The new pre-amplifier is styled by Lonsdale-Hands and presents an exceptionally pleasing appearance. New facilities in the Varislope III include a rumble filter, independent treble control, and two pick-up input circuits. A tape recorder input is also available. Harmonic distortion is less than 0.02% at full output, and hum and noise are 66 db down. A new, improved, Leak amplifier is the TL/12-plus which succeeds, at a much lower price, the original well-known TL/12. Despite its reduced cost, the new amplifier provides lower distortion and greater power output. Yet another new amplifier is the TL/25-plus, which, whilst being less expensive than its predecessor, again gives better performance. This amplifier uses an ultra-linear output stage, and, with the other two units just described, was exhibited at the Fair for the very first time.

It is worth mentioning that, to avoid visitors asking the same obvious questions over and over again, the Leak demonstration room sported a very large sign on one wall stating exactly what equipment was being demonstrated. This was a sensible move which did much to prevent the formation of crowds of enquirers around the demonstrator, an irritating feature in other rooms.

Another firm which pays attention to styling is Electric Audio Reproducers Ltd. Two of the record reproducers made by this firm have been selected by the Council of Industrial Design for exhibition at the 1957 United States World Trade Fair as examples of British design and craftsmanship. E.A.R. do not believe in holding back information in their literature. Leaflets include a full circuit diagram of the amplifier used, complete with component values.

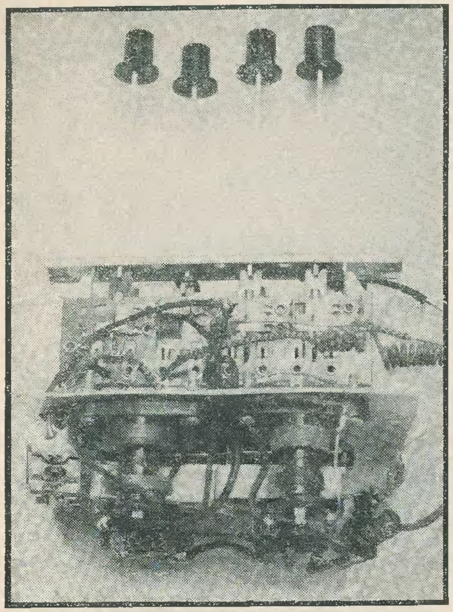
There are, of course, a number of very large firms who make high fidelity equipment in addition to a wide range of other goods. As readers will know, Decca have been a high fidelity pioneer in this class for many years now. Provisional specifications for a new amplifier to be made by this company (the model "ffr 25") show a power output of 25 watts with 0.05% total harmonic distortion. The circuit uses an ultra-linear output stage, and hum and noise are quoted as 90 db down at 25 watts. The Control Unit for this amplifier houses the pre-amplifier and employs an input circuit which enables pick-ups of any impedance to be quickly and accurately matched, irrespective of output.

Next Year—

Thus we see the end of the second Audio Fair held in London. Despite the larger space available it was still fairly crowded—though not, during the writer's visit, anywhere near as badly as occurred last year at the Washington Hotel. In order to keep numbers down, the organisers limited entry to those with complimentary tickets, and this course has apparently been successful in preventing overcrowding. Nevertheless, complaints were apparent from some enthusiasts who could not obtain tickets in time, and the ticket situation may perhaps be a little easier next year. In these busy days not everybody can afford to plan their movements a fortnight or so in advance.

Since this article was written, it has been reported, in *Hi-Fi News*, that the official attendance figures were: for Friday, 12,000; Saturday, 13,000; Sunday, 14,000; and Monday, 10,000—a total of 49,000.

Errata.—Owing to a typographical error in the "Rambler" Component List on page 685 of the May issue, the l.t. battery was given as 5V instead of 1.5V. The type number, AD35, was correct.



AUTO-SELECTION COIL UNIT

by **F. G. RAYER**

It is a great convenience to be able to select two or three local stations accurately and instantly by some automatic tuning method, and the unit described here provides for this. It is a self-contained coil assembly, with pre-sets, and can be used in any standard mains or battery superhet having a 465 kc/s intermediate frequency. Manual tuning by means of the usual gang condenser is also possible. If this is not required, as in the case of local-station quality sets, an additional pre-selected station can be arranged for with this switch position.

The whole assembly is mounted directly on the push-button switch, as shown in Figs. 1 and 2. A 4-button switch is used, but a larger switch may readily be employed if more pre-selected stations are wanted. As illustrated, an aluminium plate 3in by 4in is bolted to the switch, being spaced from the back of the latter so that the button plungers can operate. The coils are bolted to this plate. A further metal strip, about 3½in by ⅜in, is bolted in the position shown in Fig. 1, so that the pre-sets can be mounted. These are shown in Fig. 2. The actual values chosen will depend to some extent on the stations required, as 500pF pre-sets have too high a minimum capacity to tune to the low wavelength end of the band. In Fig. 2, one double 500pF pre-set is used for the Light Programme on 1,500 metres; the other is for the Third Programme near the upper end of the Medium waveband. The 50pF pre-sets were for the required low-wavelength M.W. station. It is suggested 500pF be used for L.W. and for 300 to 550 metres on the M.W. band, with 200pF for about 230 to 300 metres, and 50pF for wavelengths below 230 metres. If the minimum capacity is too high for a desired station, it is usually possible to remove a plate or so from the condensers. Another twin pre-set will be required for any further pre-selected station.

The coils actually employed were obtained from "Supacoils," but there is no reason why other coils of suitable type should not be used with equal success. These coils require a L.W. padder of 200pF, and M.W. padder of 500pF. If manual tuning is to be used, the correct padder values must be employed. For pre-set tuning only, the actual padder values are not of much importance. The push-button switch was obtained from Astral Radio Products.

Switching Circuit

Such circuits may, of course, be wired up in many ways. That adopted is shown in Fig. 3. When the L.W. button is depressed,

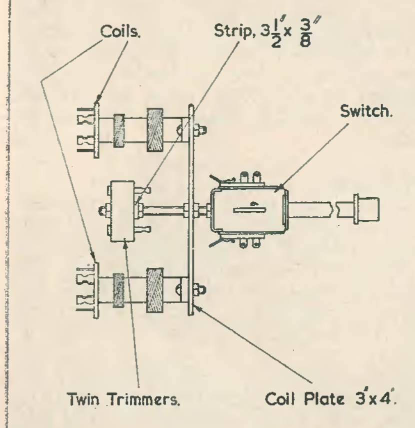


FIG.1.
Side View of Assembly.

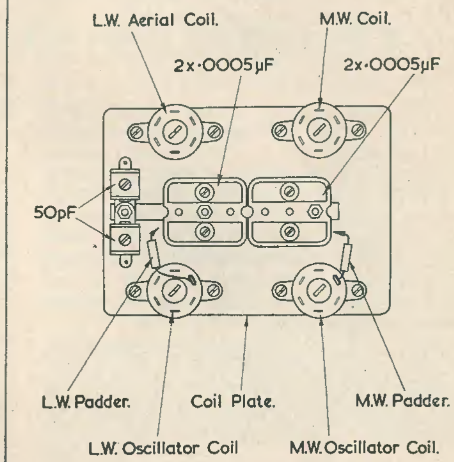


FIG.2.
Rear View of Unit.

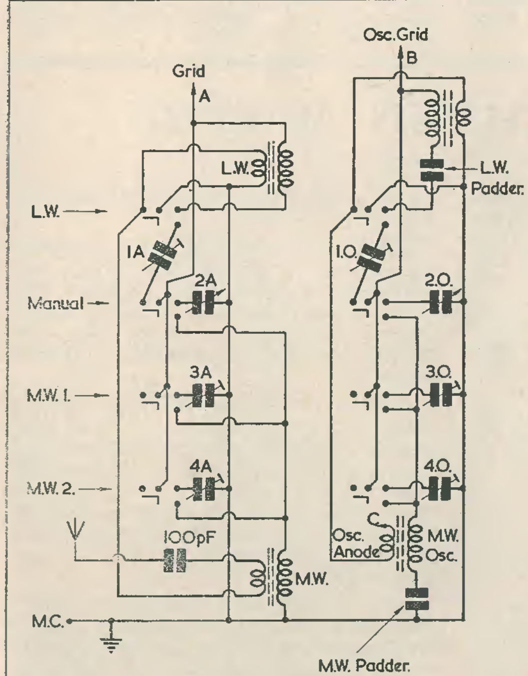


FIG.3.
Theoretical Circuit.

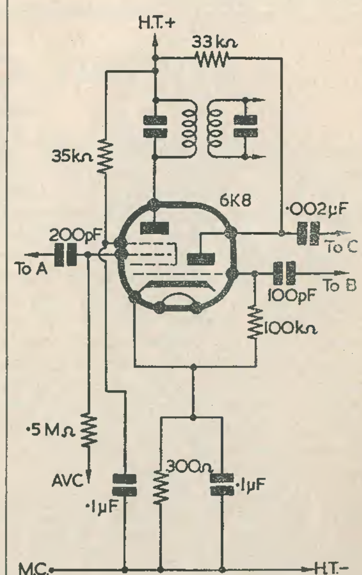


FIG.4.
F.C. Stage for Unit.

M430

pre-sets 1_A and 1_O are brought in, for L.W. Aerial and Oscillator tuning. Both L.W. tuned windings are switched in, and both L.W. primaries (for aerial coupling and oscillator) are in circuit. These two pre-sets are thus tuned for the desired L.W. station.

When the "Manual" button is depressed, the L.W. button springs out, shorting the L.W. primaries out of circuit, and disconnecting both L.W. pre-sets and the L.W. coils. The M.W. coils are now in circuit, with the 2-gang condenser (500pF each section) 2_A and 2_O, for Aerial and Oscillator. With either the M.W.1 or M.W.2 button depressed, the coil circuit is the same, pre-sets 3_A and 3_O, and 4_A and 4_O being in circuit, for Aerial and Oscillator tuning.

The coils mentioned operated satisfactorily in both circuit positions with M.W. and L.W. primaries in series, on the L.W. band. If manual tuning is not wanted, further pre-sets are wired in instead of the gang condenser.

The unit is best wired up separately, with coloured leads to identify Aerial, Grid, Osc. Grid and Osc. Anode connections. These four leads are then taken to the appropriate points in the receiver. The coil unit chassis is also wired to the receiver chassis. Two further fly-leads can be attached for the gang condenser connections.

A frequency changer stage suitable for 6.3V or 0.3 amp operation is shown in Fig. 4. It will be noted that a.v.c. is applied through a leak, so that the coils may be taken directly to the chassis. The oscillator primaries are also condenser fed so that no h.t. circuit is required here. Other types of standard frequency changer stage can be equally suitable.

Adjustments

If manual tuning is provided this button should be depressed. The M.W. coil cores are then adjusted for maximum sensitivity, at a high-wavelength point on the dial. The gang condenser trimmers are adjusted at a low-wavelength point. The pairs of pre-sets are then adjusted, each button being depressed in turn.

If a slight reduction in efficiency is not objected to, the coil primaries may be left in series, unswitched, on both M.W. and L.W. bands. The unused contacts can then be taken to the bottom ends of the M.W. tuned windings (the padder being in circuit in the case of the oscillator coil). This will provide L.W. manual tuning in addition to the three automatically selected stations and M.W. manual tuning. For L.W. manual tuning, both L.W. and "Manual" buttons will be depressed simultaneously.

STRONG CHASSIS MAKING

continued from page 763

duralumin, unless unsightly corner brackets were added. The second method tried by the writer was as shown in Fig. 2, bending along the dotted lines and so utilising the previously wasted corner pieces for strengthening by bolting or riveting these to the shorter sides.

This method, although providing quite a strong chassis, was not at all easy to manouvre whilst bending, and did not look very pretty. The last method tried, and used for many hundreds of jobs since, is far easier and quicker to make, and has the advantage that should the piece of gear built be scrapped, the sides can be removed and used again. It makes an extremely strong chassis and wastes very little material indeed.

Three pieces of material are required, one piece forming the rear, top and front, whilst the other two pieces form the sides. The writer has made chassis from 2in × 4in to 17in × 10in by this method. There are four factors to be taken into account, requiring only a few minutes calculation before marking, cutting and bending. These are the length l, width w, depth d and thickness of material T. The diagrams (Fig. 3) are self-explanatory. 4-BA screws and nuts every ¾in or so along the edges 3/16in in are used for securing the sides.

Cut out part one with tin snips to the correct dimensions. Drill the side fixing holes 4BA clearance 3/16in in and ¾in apart along the side of length w + 2d working outwards from a marked centre point, then bend between the pieces of angle iron along the dotted lines.

Next cut out the two ends, and 3/16in in along the side of length w − 2T drill 4-BA clearance holes ¾in apart working outwards from a marked centre point. Drill no holes along the other edges yet. Then bend the three edges dotted in the same direction between the two pieces of angle iron as above or, if a small chassis, in the vice jaws themselves.

Bolt the sides on to the underside of the chassis top and then, and then only, drill the smaller edges of the sides by drilling through the marker holes in the material forming the top, front and rear. Then insert screws in these holes and use serrated washers below the nuts. This will produce a fine, strong chassis in a minimum of time.

A "DIRECT-COUPLED" TRANSISTOR RECEIVER

This article describes an interesting transistor receiver which has been designed by a reader

One of the most fascinating branches of transistor receiver construction is provided by the possibility of designing extremely small headphone receivers which are capable of giving high levels of volume with negligible battery drain. Receivers of this type offer many practical advantages, and amply repay the low costs incurred in their manufacture. Simple transistor receivers falling into this category have many uses and have been described in this journal from time to time, with quite a number being successfully built by home-constructors.

An extremely interesting new circuit for a set of this type has been designed by Mr. S. S. Smith of Surbiton, Surrey, and this circuit is the subject of the present article. Mr. Smith's receiver employs ingenious circuitry and has the advantage of requiring an exceptionally small number of components.

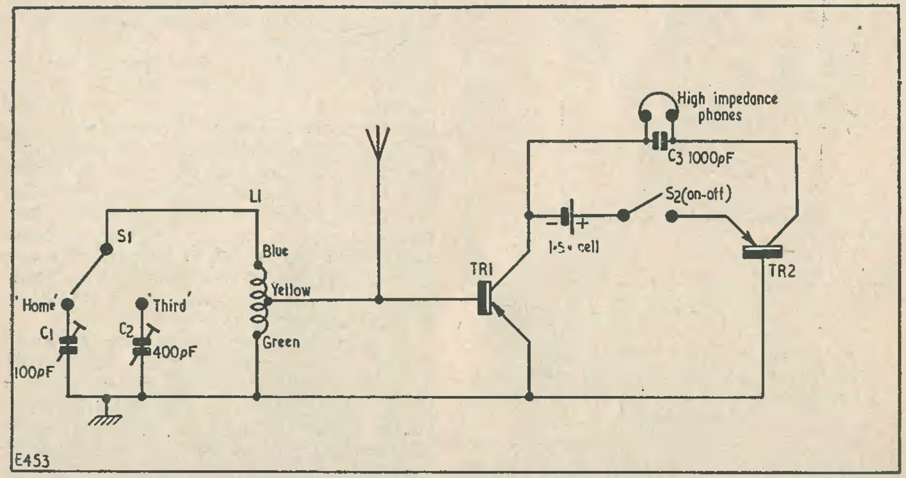


Fig. 1. The circuit of the prototype receiver. The coil is a Repanco component type DRR2, and the transistors are "Red Spot" units

The circuit of the receiver is illustrated in Fig. 1. As will be seen from this diagram, the set consists of a conventional tapped-down medium-wave tuning coil feeding into two transistors. The aerial tuning arrangement employs pre-selected station switching, the two trimmers C_1 and C_2 being adjusted for reception of the Home and Third programmes, as applicable. (The maximum values shown for these trimmers in Fig. 1 are applicable to the frequencies available in the district in which the prototype was built; and it may be necessary to employ alternative values in other localities or for the reception of different transmitters.) If desired, the two-station pre-tuned arrangement can, of course, be replaced by a continuously variable tuning circuit, this employing a conventional 500pF variable condenser connected directly across the aerial coil.

In Fig. 1 the aerial is connected to a low-impedance tap into the coil, this ensuring that the tuned circuit is not too heavily damped when large aerials are employed. An earth connection is desirable due to the fact that, in common with other battery-operated receivers of this size, the chassis has such small dimensions that it cannot offer itself as a useful counterpoise to the aerial. The coil tap employed by the aerial is also used for applying the selected signal to TR_1.

The Transistor Section

It is the transistor section which is of greatest interest in this receiver, and it is necessary to examine the circuitry involved in several steps, if its operation is to be fully appreciated.

Transistor TR_1 functions both as detector and a.f. amplifier, and it is powered by the 1.5 volt cell. The negative terminal of this cell connects directly to the collector of TR_1, whilst the positive terminal connects to the emitter via the emitter-base path of TR_2. Apart from the impressed signal voltage, the base of TR_1 is held at the same potential as its emitter by reason of the d.c. circuit existing between these two points. Due to the zero bias consequently obtained, only a low current passes through the emitter-collector circuit of TR_1. The opposition offered to this small current by the emitter-base path of TR_2 is low, because the current flow is in the forward direction for the P-N section involved. As a result, almost all the 1.5 volt potential available from the cell appears across the emitter and collector of TR_1.

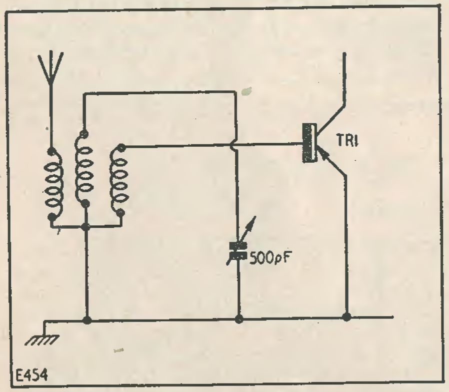


Fig. 2. An alternative aerial input circuit using a triple-wound coil such as the Teletron type HAX. The continuously-variable tuning shown here may, of course, be replaced by pre-tuned switching, if this is desired

The base and emitter of TR_1 form a diode which detects the applied r.f. signal in the following manner. The diode does not conduct (to any great extent) when the half-cycles applied to the base are positive with respect to the emitter, but does do so when the half-cycles are negative. The flow of current in the base-emitter circuit during negative half-cycles results in a corresponding change of current in the collector-emitter circuit, this change of current being proportional to the average level of the detected signal. Summed up, it may be said that TR_1 detects and causes an a.f. current, superimposed on the standing d.c. current, to appear in the collector-emitter circuit.

The transistor TR_2 is also powered from the 1.5 volt cell. In this case the emitter connects directly to the positive terminal, and the collector connects to the negative terminal via the headphones. TR_2 represents, therefore, an earthed emitter amplifier, with its base receiving bias current via the collector-emitter path of TR_1. In consequence, the base of TR_2 receives a standing bias current, plus the a.f. current flowing in TR_1. TR_2 amplifies this a.f. and applies it to the headphones.

Circuit Details

There is little which needs to be stated about the receiver from the practical point of view, as the extreme simplicity of the circuit ensures that few troubles are likely to be encountered in a built-up version. The current drawn from the 1.5 volt cell is very small, having a value of approximately $100\mu A$. Since it will need to be replaced at infrequent intervals only, this cell may, therefore, be soldered into circuit. It should be remembered that neither terminal of the cell is at earth potential. There is little to be gained, incidentally, by employing a voltage higher than 1.5 to power the set; checks having shown that increased voltages have negligible effect on gain.

It will probably be found that C_3 may be deleted in many practical versions of the receiver. This is due to the fact that quite a high capacity normally exists between the leads of a conventional pair of headphones, and this residual capacity may be quite sufficient to bypass any r.f. voltages present in this part of the circuit. There is also the fact that, because of the low r.f. amplification provided by the transistors themselves, whatever r.f. is present at the headphone terminals may, in any case, have too low an amplitude to cause any difficulties.

An alternative and more selective aerial circuit is illustrated in Fig. 2. This circuit employs a Teletron medium-wave coil type HAX, and provides a very selective input circuit whilst still retaining the low-impedance tapping required for TR_1. If long-wave reception is required, a coil type HAXL may be used instead of the HAX. The use of the alternative aerial coil causes no increase in the number of components required for the receiver. It is worth mentioning that the HAX coil is now available in miniaturised form, whereupon it becomes possible to make the receiver very compact and small indeed.

The transistors employed in the prototype were "Red Spot" units, available through the normal suppliers.

FIELD REPORT ON THE ISOTRON

by **PETER PENLENHAM,** *A.M.S.D.B.*

When the writer released advance details of the Isotron amplifying device in the April issue of this magazine, he anticipated that a considerable amount of interest would become apparent from readers. Events confirmed this prediction, and quite a number of letters have since been passed on to him by the Editor.

For some reason which the writer cannot wholly ascertain, nearly all the letters he has received refer to the Isotron and to his article in terms—almost—of levity. Typical of these is the following, received from a lady in Bridlington, Yorkshire.

"I must write," she says, "and congratulate you on a very good April Fool. I had been trying to make my husband listen to me talking to him, all the time he kept saying 'be quiet, dear, I am reading something really marvellous.' At the end you should have seen his face, your names were dirt."

In the same vein, B. H. Whitehead, Yardley, Birmingham, asked that the following be inserted in the "Can Anyone Help?" column:

"V. Hardup of Upper Jumper Street, Birmingham 2, would like to acquire a gas-tight reservoir (capacity 4 galls.) for use with an Isotron. The present one has to be relieved of helium gas every four days or it commits suicide."

A letter in more serious vein was received from C. H. Bigmead of Southway, London, N.W.11:

"I was more than somewhat cut up about the article in your April issue giving details of the 'Isotron' self-powered amplifying device. I have recently perfected a system of self-powered valves for use in a pocket binary encoder/decoder of my own design, which proved extremely useful in the Oxford and Cambridge General Certificate of Education Examination at Ordinary Level. Naturally enough, the publication of what I feel sure to be an inferior system (I rigged up the circuit published using an 'Isotron' constructed from a carefully annealed gin bottle, and obtained very poor results, an overall distortion of approximately 12 cycles/ft. for every decibel of amplification) rather took me aback, and it is clear that these rather unfortunate circumstances force me to publish my system earlier than I had intended (I meant to wait until the world was ready for it), and consequently I am preparing an article for publication in April next year.

"Mr. Penlenham may be interested to know that I wrote to the Mongolian Electronic Manufacturing Co. Ltd., enclosing a stamped-addressed envelope, a sixpenny P.O. and an old sock. I received no reply. On making enquiries I found it had gone into voluntary liquidation as the result of a disagreement with its landlady."

The writer would like to point out that the statement, in Mr. Bidmead's letter, that the Mongolian Electronic Manufacturing Co. has gone into voluntary liquidation is quite untrue. But more of this later.

Several letters purporting to come from the manufacturers of the Isotron were also received, these claiming that the article contained what they described as incorrect production figures, technical details, and the like. It is felt that these letters were intended as a form of practical joke aimed at the writer because, after he had checked up (and he is nobody's fool), he found that they did not originate from the Mongolian Electronic Manufacturing Co. at all.

Only one reader wrote directly to the company at its address at Lower Puderley, and he found that his letter was returned by the Post Office as "not known." This reader sent the returned envelope, marked clearly in the top left-hand corner with the words "April Fool," to the offices of *The Radio Constructor*, and asked indignantly for an explanation.

To satisfy this last point and that raised earlier, the writer would like to take this opportunity of mentioning that the Mongolian Electronic Manufacturing Co. has now removed from Lower Puderley. This is due to the fact that an Isotron was inadvertantly left running with its leakage resistors disconnected, with the result that the company's premises disintegrated. As, also, did Lower Puderley. A new development laboratory has since been set up in temporary hutted accommodation on South Uist, and it is anticipated that any further delays will soon be overcome. Due to Mongolian's active policy, it may be safely stated that the Isotron will be in full production by the fourth month of next year.

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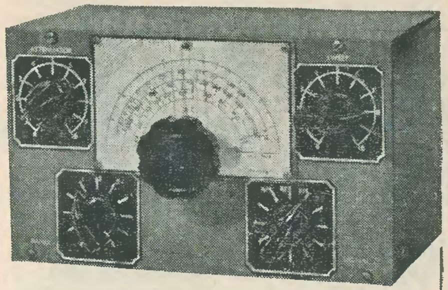

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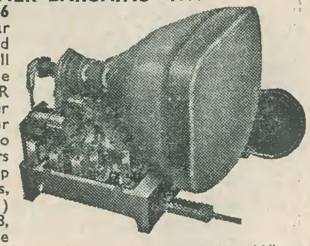

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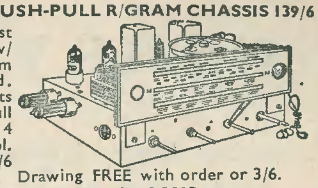

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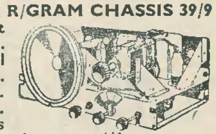

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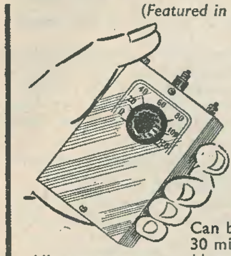

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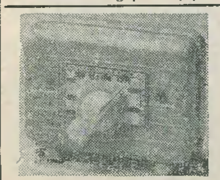

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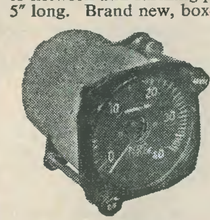

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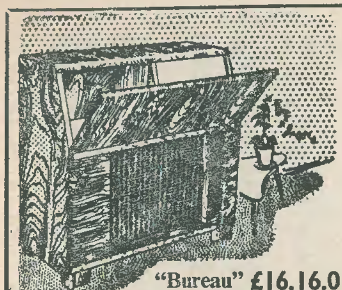

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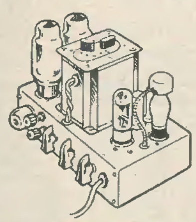

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