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TRANSISTORISED LIGHT-OPERATED SWITCH

VOLUME 12
NUMBER 8
MARCH
1959

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

Included in this issue
CORE-TUNED TRANSPORTABLE
THE AMPLIFONE
COMPREHENSIVE MIXER-FADER
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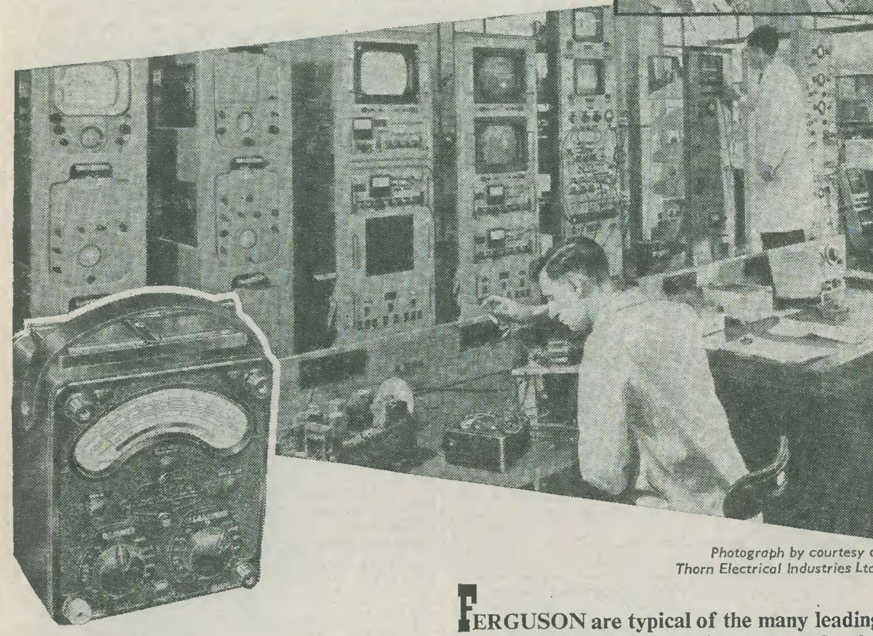

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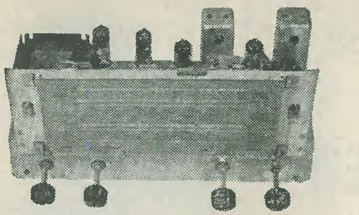

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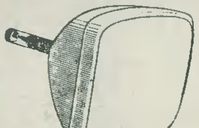

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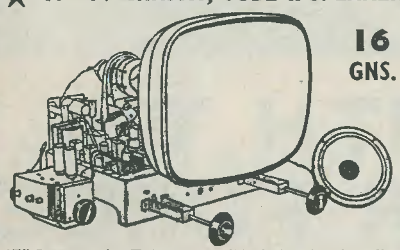

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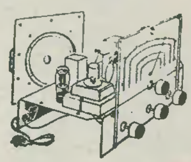
SUPER CHASSIS 99/6



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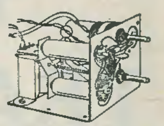

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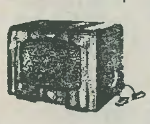

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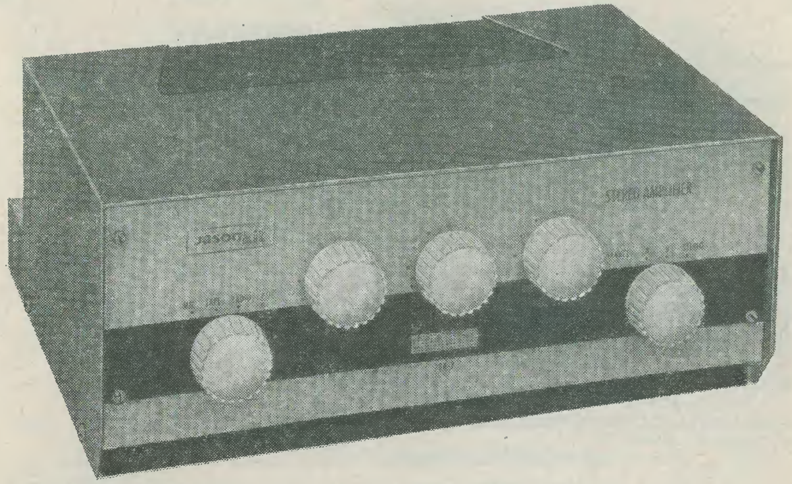

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CONTENTS

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ARTICLES appearing in this magazine which describe kits are inserted only on condition that such kits, or special components thereof, are freely available at a trade discount to all retail advertisers.

OPINIONS expressed by contributors are not necessarily those of the Editor or proprietors.

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included.

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

TECHNICAL QUERIES should be submitted in writing. We regret that we are unable to answer queries, other than those arising from articles appearing in this magazine; nor can we advise on modifications to the equipment described in these articles.

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Suggested Circuits

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

No. 100 A Transistorised Light-operated switch

In the November and December, 1956, issues of *The Radio Constructor*, the writer described switching devices capable of being operated by the incidence or interruption of light waves.[1] The light-sensitive element in these circuits was the phototransistor type OCP71, this having at that time just been introduced to the British market.

In these early devices the phototransistor operated a relay directly, and the circuits suffered from the disadvantage that this relay had to be a sensitive component capable of energising at currents of several milliamps only.

Some time after the articles had appeared the writer decided that whilst the circuits they described were practicable enough it would be desirable, when time and opportunity presented themselves, to design a circuit which obviated the necessity for the sensitive relay. This month's contribution in which a much more robust relay is employed, is the result of this decision.

The Circuit

The circuit of the new light-operated switching device appears in Fig. 1, and it will be seen that it is extremely simple and employs the minimum of components. Basic operation is very straightforward: current variations in the OCP71 phototransistor are amplified by the OC72, whose collector current then operates the relay. The device is powered by a 12-volt d.c. source.

Dealing with the circuit operation in greater detail, it will be helpful to commence with the phototransistor. When the OCP71 is connected up in the manner shown, its effective emitter-collector resistance varies according to the amount of light which falls upon it. It is quite permissible to leave the base of the phototransistor disconnected in a circuit of this nature; such a method of operation being, indeed, specified by the manufacturers when constant illumination is used. With an open-circuit base, phototransistor dissipation should be kept to a conservative level, and this point is carefully observed in the circuit of Fig. 1. The value chosen for resistor R_1 ensures that collector current cannot exceed 1mA (assuming the limiting case of zero volts drop in the OCP71) when resistor value and supply voltage are at their nominal figures. The maximum recommended value for OCP71 collector current is the markedly higher figure of 10mA.

The collector of the OCP71 connects directly to the base of the OC72 amplifier transistor, with the result that the following process takes place. When the OCP71 is illuminated it draws current through R_1, thereby keeping the flow of current in the base-emitter circuit of the OC72 to a low value. As a result the OC72 passes little collector current. When the OCP71 is not illuminated it draws a very small current through R_1 (if completely dark this current should be less than some 400μA), whereupon an increased current flows through the OC72 base-emitter circuit. In consequence, the collector circuit of the OC72 now rises. Employing the circuit values shown in Fig. 1 the difference in OC72 collector currents between the illuminated and non-illuminated condition was found, in the prototype, to be very marked. With the OCP71 in the illuminated condition OC72 collector current was less than 200μA. When the OCP71 was in the dark condition, OC72 collector current rose to 20.5mA. This very large change in OC72 collector current is, of course, more than adequate for reliable relay operation.

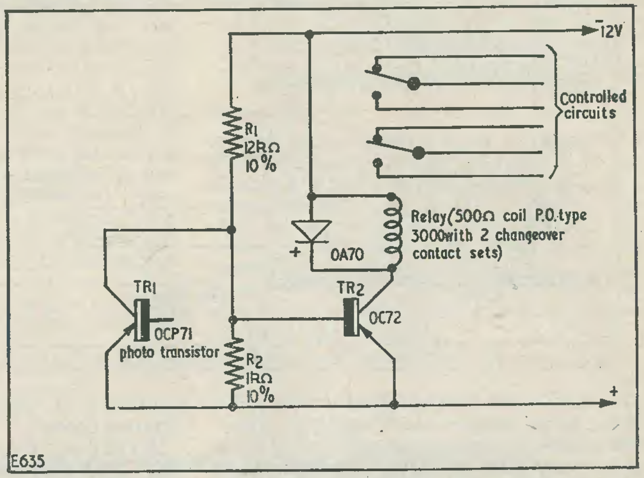

Fig. 1. The circuit of the light-operated switch

A coil resistance of 500Ω was chosen for the relay employed in the switching device because, from the point of view of economical construction and efficiency, it was desirable to select as low a resistance here as was commensurate with safe running of the OC72. The first limiting factor dictated by the OC72 was that, when this is connected as a grounded emitter amplifier having 1kΩ resistance between base and emitter, the recommended maximum collector voltage is 16 volts. In consequence it was decided that a supply voltage of 12 (conveniently available from an accumulator or a simple mains unit) would represent a good choice for powering the unit. An examination of energising currents and voltages for Post Office type 3,000 relays with two sets of change-over contacts showed that a coil resistance of 500Ω then fitted most comfortably into circuit requirements. A 500Ω relay of this type can energise reliably at a current of 20mA. Such a current would cause a drop of 10 volts in the relay coil, with the consequence that the remaining 2 volts would appear between collector and emitter of the OC72. This figure, 2 volts, together with the 20mA current flow, corresponds approximately to a collector dissipation in the OC72 of 40mW. At 30° C (86° F) the maximum allowable collector dissipation of an OC72 without a cooling fin is 112mW, and at 40° C (104° F) it is 87mW. When coupled to a heat sink the corresponding dissipation figures are 105mW and 117mW respectively. Thus, the working figure of 40mW offers a reasonable safety factor, although it would be desirable to couple the transistor to a heat sink in order to prevent excessive self-generated rise in temperature.

It will be noted that an OA70 crystal diode is connected across the relay coil. The purpose of this diode is to prevent the formation of a high reverse voltage in the relay coil if its energising current suddenly reduced in value, as might occur with sudden illumination of the OCP71. Such a reverse voltage would, of course, be the result of the consequently collapsing magnetic field in the coil. The crystal diode is so connected that it is not conducive when the lower end of the relay coil is positive. In the event of a sudden cessation of energising current, the lower end of the coil tends to swing negative with respect to the upper end, whereupon the diode conducts and prevents the reverse

[1] Suggested Circuits No. 72, "A Phototransistor Light-Operated Switching Circuit," and Suggested Circuits No. 73, "Phototransistor Control of Heavy Currents."

voltage from reaching too high a value. Without the diode the reverse voltage across the relay coil could reach a value which, added to the h.t. voltage, might cause the recommended maximum collector voltage for the OC72 to be exceeded.

Practical Points

A switching device of the nature we are considering here will find a number of applications, one of the most obvious being the operation of subsidiary circuits by the incidence or interruption of a light beam. In applications of this nature it will frequently be necessary for the OCP71 to be continually illuminated by a source of light. In such instances, a considerable economy in energising light power may be achieved by mounting the phototransistor in a tube fitted at one end with a convex lens, as is illustrated in Fig. 2.

to reduce OC72 collector current to its minimum value is all that is needed. As an aid to constructors, Fig. 3 illustrates the sensitive area of the OCP71.

It was mentioned above that it would be preferable to couple the OC72 to a heat sink in order to prevent excessive self-generated temperature rise. Such a coupling may be achieved by lightly clamping the OC72 to a heat sink having the minimum dimensions of 1½-in square. A very adequate sink could be provided in practice by clamping the OC72 to a small metal chassis which also held the relay and, say, one or two tag-strips for lead-out connections and the like. This chassis should be kept cool and should not have any heat-dissipating components mounted on it. The clamp securing the OC72 to the chassis should be of metal and should encircle the metal case of the transistor over a large pro-

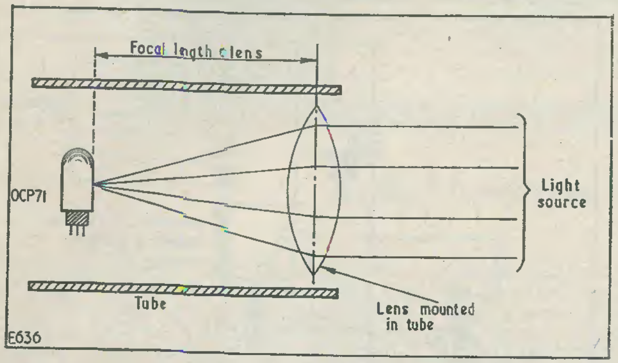

Fig. 2. When the OCP71 is illuminated by a single light source a considerable economy in energising light power may be achieved with the aid of a simple convex lens

The convex lens does not need to be a costly item, as an inexpensive "magnifying glass" costing one or two shillings only should prove to be more than adequate. The focal length of such a lens may readily be found by using it to throw an image of the sun or of an electric light bulb on to a piece of paper. When the image is correctly focused, the focal length will then be the distance between that image and the lens. In the writer's prototype it was found possible with the aid of a cheap lens having a diameter of 1¼in to obtain reliable operation from a 12 watt bulb, without reflector, mounted some 6ft away. An advantage of the tube and lens arrangement of Fig. 2 is that extraneous light does not reach the phototransistor and cause unwanted actuation of the relay. Indeed, the circuit should function quite satisfactorily under normal conditions of ambient illumination. It must be mentioned before concluding on this particular subject, that there is no point in employing excessive light energy to illuminate the OCP71. Sufficient light energy

portion of its area in order to ensure good thermal contact.[2]

Some care needs to be taken to ensure that the 12-volt supply is sufficiently well-regulated to prevent the h.t. potential approaching the recommended maximum collector voltage for the OC72 (with 1kΩ base-emitter resistance) of 16 volts. Thus, it would be unwise to power the circuit with a 12 volt accumulator which was on continual charge, as the accumulators terminal voltage could rise dangerously close to the maximum figure or even exceed it. The requirements for voltage regulation apply similarly to mains power units.

Attention must also be paid to ensuring that the crystal diode connected across the relay coil is in good condition before it is soldered in position. A quick check for low forward resistance and high back resistance may easily be carried out with the aid of an ohmmeter. It is important to connect the diode across the relay coil with correct

[2] A suitable clamp is described in the manufacturer's literature.

polarity, as incorrect connection may cause the OC72 to pass excessive collector current. Crystal diodes from "surplus," or otherwise dubious, sources should not be used in this circuit.

Finally, it must be pointed out that the circuit specifies a 500 ohm Post Office relay type 3,000, and that the reader is strongly advised to use a relay of this type for his own unit. A P.O. 3,000 relay with one or two sets of contacts will function satisfactorily, but energising current requirements may be excessive for reliable operation if more than two sets of contacts are fitted.[3] The writer has not checked circuit operation with any other type of relay.

Setting Up

Due to the fact that the OC72 runs at a fairly high dissipation level it would be advisable, after construction, to check the unit for correct wiring, etc., at a reduced h.t. voltage before bringing it into full operation. For this check a milliammeter should be connected in series with the relay coil and the h.t. negative line, and an h.t. potential around 6 volts applied. With the OCP71 in the unilluminated condition a milliammeter reading of approximately 6mA should be given at this voltage, and should drop to a negligibly low value when the OCP71 is illuminated. Provided the preliminary test is satisfactory the full h.t. voltage may be applied, whereupon it should be found that the relay coil current lies

[3] A suitable relay, fitted with two sets of change-over contacts, is available from H. L. Smith & Co. Ltd., 287 Edgware Road, London, W.2.

between 17 and 22mA with the OCP71 non-illuminated. If the current reading obtained for the dark condition falls slightly outside these figures it may be decreased by a small

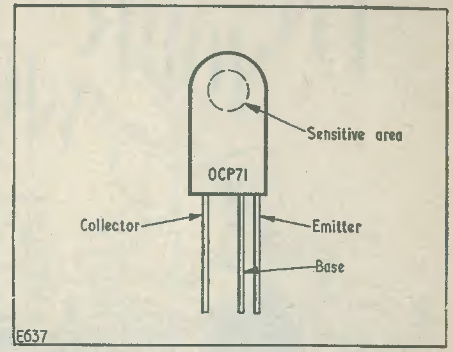

Fig. 3. This diagram shows the light-sensitive area of the OCP71. The type number should be on the same side of the phototransistor as is the light source

increase in the value of R_1, or increased by a small decrease in value of this resistor. In the absence of a milliammeter capable of reading currents of the order of 20mA, a high resistance voltmeter may be connected across the relay coil, and the readings provided by this instrument converted to current figures. Thus, to take an example, a voltage reading of 10 volts across the 500Ω relay coil would indicate a current flow of 20mA.

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A comprehensive set of teaching notes is supplied with the strip, which is available from the distributors: Unicorn Head Visual Aids Ltd., 42 Westminster Palace Gardens, London, S.W.1, price 20s. a copy.

IN YOUR WORKSHOP

In this month's episode, Smithy the Serviceman passes on to his assistant, Dick, some useful advice on video detectors and printed circuits

"IF," SAID DICK, LEANING CONFIDENTIALLY over Smithy's shoulder, "you stuff a turkey with sage and onions, what do you stuff a parrot with?"

Recognising the signs, Smithy heaved an almost silent sigh. He allowed his attention to be detracted from his work.

"I wouldn't know," he remarked with resignation. "What *do* you stuff a parrot with?"

"You stuff it with Polyfilla," replied Dick.

After which, he retired to his bench laughing loudly. Despite himself, Smithy the Serviceman grinned; and he decided to accept the fact that Dick was in one of his joke-telling moods and that he would just have to be given his head until he had run out of gags. Dick's jokes sessions occurred every two months or so, and Smithy had discovered, after careful questioning, that his assistant picked up all his new stories from that uncle of his who happened also to be the steward of Smithy's club. The main thing that annoyed Smithy was that he himself never heard any of Dick's jokes at his club yet, whenever he tried to repeat them, everybody else at the club *had* heard them.

Crystal Diodes

On this particular morning, however, Dick's output of jokes was somewhat short-lived. Almost immediately after he had left Smithy's side he ran into trouble and had to call upon the Serviceman for assistance.

The first of Dick's troubles became evident as he was looking thoughtfully at a rather venerable television chassis on the bench before him.

"Smithy," he called out after some moments, "what do you do with a television set whose video detector keeps breaking down?"

"It all depends upon the circumstances," replied the Serviceman briefly.

Leaving his own work he walked over to inspect the chassis on Dick's bench.

"Look," said Dick, "I had this chassis in a few months ago suffering from a lack of vision whereupon, after a little hunting around, I discovered that the video detector had shuffled off its mortal coil. The video detector employed in this receiver is a straightforward crystal diode, and, after removing its screening can so that I could fit a new unit, I got the chassis working O.K. The set has now come back to me again with exactly the same fault and I find that the video detector has once more gone kaput. I just don't get it."

"Not to worry," Smithy remarked. "This sort of thing is quite liable to happen every now and again with older sets of this type. Did you fit exactly the same type of crystal during your previous repair?"

"Not exactly," admitted Dick. "The original diode was an OA60, and I replaced it with the somewhat more up-to-date OA70."

"That shouldn't make any difference in this application," remarked Smithy. "Both types are intended as video detectors. Now let's take a closer look."

Smithy examined the faulty diode.

"Well," he remarked slowly. "I can see no evidence of your having over-cooked the crystal when you soldered it in. To begin with, you've left a good half-inch of wire between the body of the diode and its solder joints, and this is an excellent thing to do. I usually assume that a quarter of an inch is the absolute minimum safe distance between the body of a crystal diode and its solder joint, and your half-inch exceeds this comfortably. In addition, I see that you've taken good care not to bend the lead-out wires too close to the glass, where they could cause weakening of the structure."

"As a matter of fact," put in Dick a little proudly, "I remember that I even used a heat shunt during soldering."

"Very good," approved Smithy. "There are many people who would laugh their heads off at the very idea of using a heat shunt when soldering in crystal diodes, but I can't say that I agree with their point of view. I must concede, though, that one often-advocated method of applying a heat shunt by using a pair of taper-nosed pliers (Fig. 1 (*a*)), can only be seriously recommended to three-handed service engineers! However, there's no need to do that sort of thing if you're sensible. As you know, we use crocodile clip heat shunts (Fig. 1 (*b*)) in the Workshop and the time and inconvenience incurred by their use is negligible."

"You have to admit, Smithy," said Dick, a little plaintively, "that there are very many people who solder crystal diodes into circuit without heat shunts at all, and that they seem to get away with it. Do you think, perhaps, that we're being just a little *too* fussy?"

"Not at all," replied Smithy. "I would say with some confidence that those people who don't use heat shunts will find that a small percentage of the diodes they connect up refuse to work properly, have shifted characteristics, or fail at an early date. Mark you, this percentage may be quite low, but I still think it's good practice to obviate it altogether. Another point is that the heat shunt habit is a very useful acquisition when you start tackling transistors, as these are definitely susceptible to overheating.

"Anyway, we're getting off the beam. What started our present discussion was this chassis which causes video detectors to become faulty at regular intervals. I'm quite happy that your previous replacement diode was O.K., and so we must look elsewhere. I presume that no h.t. was getting on to the diode?"

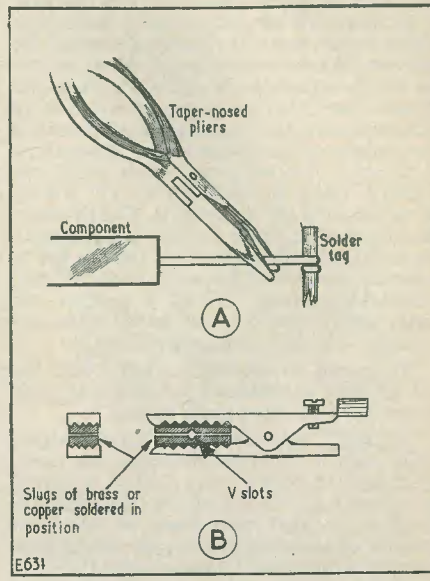


Fig. 1 (a) An often recommended method of applying a heat shunt. The taper-nosed pliers, applied to the component lead-out wire as shown, prevent the transference of excessive heat from the tag to the component body during soldering. (b) A much more convenient method of applying a heat shunt consists of clipping a crocodile clip, modified as shown here, to the lead-out wire. The slugs of brass or copper should have approximately the volume indicated by the diagram. The small V cuts ensure a positive location with the lead-out wire, together with somewhat greater thermal contact area

"Not a scrap," replied Dick. "The detector circuit is extremely simple: it consists of the secondary of the last i.f. coil, the crystal, and the load resistor in series. It would be extremely difficult for any h.t. to find its way across the diode."

"Fair enough," remarked Smithy. "All I can then diagnose is that the crystal is burning out because of the application of too high an i.f. voltage."

"Hey?"

"I'm quite serious," continued Smithy. "In some of these early sets, many of which had either a very rudimentary a.g.c. system, or none at all, it is easily possible for the customer to accidentally turn up his contrast or sensitivity control too high and cause a fantastically high video i.f. voltage to be passed on to the video detector. This assumes, of course, that the set is being used in a strong signal area. If maladjustment of the contrast or sensitivity control occurs before the set is switched on, then the customer doesn't see the resultant over-contrasty picture until e.h.t. appears—by which time the damage will have been done. I can think of all sorts of other eventualities which can similarly result in too high an i.f. voltage being passed to the video diode. For instance, the customer may have a wonky connection to his aerial, whereupon he finds that he has to screw up the gain of his set in order to get a reasonable picture. All of a sudden, the aerial connection becomes good again and —bingo!—bang goes another diode!"

"It sounds to me," remarked Dick, "as though this business of overloaded video diodes is by no means new to you."

"It isn't," said Smithy. "That's why I made such a confident diagnosis just now. If the set had been a more modern job with, say, mean a.g.c. coming off the sync separator grid,[1] I wouldn't have been so confident because conditions of overload would then have been much less liable to occur."

"That's fair enough, I suppose," said Dick, dubiously, "but where do I go from here? If I put another crystal into this set how long will it be before *that* goes?"

"You do have something of a problem there," admitted Smithy. "When I bumped into this trouble in the old days, I used to warn the customer against over-running his set, and this warning usually resulted in fairly reasonable protection for the diode. Nowadays, however, I use a completely different idea, this consisting of replacing the diode with a type which has a higher turnover voltage. In your case I would recommend that instead of fitting another OA70 you fit an OA79. The maximum inverse voltage of an OA79 is twice that of an OA70 and it is intended for use in fairly low impedance circuits, such as f.m. ratio detectors and the like. You should find that it gives just as good a picture. I know that I've never had one go faulty since I started using them in receivers suffering from this sort of trouble."

"That's fine," said Dick enthusiastically, "I'll pop an OA79 in straight away. Incidentally, Smithy, why are video detector circuits nearly always screened?"

[1] In many receivers the grid of the sync separator goes negative with respect to chassis by a voltage proportional to the mean picture level. This voltage may be employed for a.g.c. purposes.

"For the same reason," said Smithy, "as are many other receiver detector circuits which rectify signals at high level. The process of detection causes the rectified half-cycles to resemble square waves, and these are liable to be very rich in harmonics of the detected frequency. Unless you apply a reasonable amount of screening to the detector circuit these harmonics may find their way back to the front end of the set. O.K.?"

"Sure," said Dick. "By the way, have you heard about the last word in automation?"

Smithy raised his eyes to the ceiling in mock despair.

"Go on," he intoned dolefully.

"Well," said Dick, "it consists of a black box with a switch on the front."

"Yes?"

"To set it in motion you push down the switch. Whereupon there is an immediate and furious whirring inside the box, the lid opens, and an arm comes out and turns the switch off."

Dick stopped and looked expectantly at Smithy, whose expression remained unaltered.

"That's it," finished Dick lamely.

"Oh," said Smithy.

With no further remark he returned to his bench where, unseen by his assistant, he allowed his face to relax into a wide grin.

Printed Circuits

Crushed, Dick returned to the receiver in front of him. He soldered in a new crystal of the type advised by Smithy, found that he obtained a satisfactory picture, and fitted the chassis back into its cabinet. A final check of the boxed set showed that all was well, whereupon Dick stowed it away on the "repaired" rack.

The next set Dick took to his bench was of a much more modern type. Dick quickly checked the performance of the receiver and removed its cabinet. After a while he gave a sharp exclamation of surprise.

"What's up?" said Smithy, turning round.

"Would you credit it?" asked Dick, "but I'm blowed if I haven't got another video detector up the wall!"

"That's very nice for you," commented Smithy. "The same fault twice running should give your diagnostic powers a pleasant rest."

"Do you think that this one went faulty due to too much signal level also?" asked Dick.

"It's doubtful, if it's a recent receiver," replied Smithy, "although I should check the a.g.c. line for shorts to chassis just in case."

He noticed that Dick's expression was becoming more and more disgruntled as he examined the chassis he had selected.

"What's the matter?" queried the Serviceman.

"I'm going to have a deuce of a job replacing *this* diode," said Dick lugubriously. "The manufacturers have parked it inside the same can as the coil it's connected to, and the coil is soldered to a printed circuit board by at least half a dozen tags."

The Serviceman walked over to look at the chassis.

"All I can say," he remarked eventually, "is that if you intend unsoldering the coil from the board, you must positively like unnecessary hard work. As you can see, the coils in this receiver are just the same as the coils in most other printed circuit television sets, insofar that the cans are held by spring clips and can be pulled off quite easily. Why don't you simply remove the coil can, nip out the faulty diode, and solder a new one in its place whilst the coil assembly is *in situ* on the board?"

"I must be getting a little dim in my old age, because that thought never even occurred to me," commented Dick. "Now that you mention it, your idea seems to be the obvious thing to do."

"Most definitely it is," replied Smithy. "Nevertheless, you'd be surprised at the number of people who go to all the trouble of unsoldering a coil from a printed board when all that's wrong with it is something which can be just as easily fixed by merely taking the can off. Even if the winding itself has gone faulty you can still quite often effect a repair after merely removing the can. Quite a few of the more modern television i.f. coils are wound with T.N.A. wire, so you don't have to bother about stripping it—you merely apply solder and a hot iron."

"It sounds to me," remarked Dick, "that you have decided to evolve your own techniques for printed circuits. What about components, other than i.f. coils, which are soldered to the board by a relatively large number of tags?"

"Well, you have to regulate your repair system according to the circumstances of each particular case," conceded Smithy, a little guardedly, "but there are quite a few components as well as i.f. coils which can be repaired whilst in position on the board. For instance, I've had one or two cases of supposedly open-circuit audio output transformers wherein the primary wire was taken from the winding to two tags on its periphery. All that was wrong with these transformers was that the primary wires had broken away at one or other of the tags. It was quicker to repair these wires than it was to unhitch the whole tranny from the board."

"Ah, yes," persisted Dick, "but the occasion must arise at some time when you *have* to unsolder multi-tag components from a board. What then?"

"There are one or two bright ideas to fall back on then," replied Smithy. "If you possess a solder gun, one of these consists of making up a circular bit which is some $\frac{5}{8}$ to $\frac{3}{4}$in in diameter (Fig. 2). You can then apply this bit to the board if you want to remove, say, a valveholder; whereupon it melts all the solder joints at once. Such a bit will usually tackle all the joints on i.f. coils and things like that as well, should this be necessary.

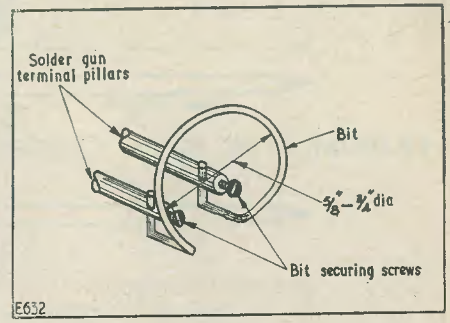


Fig. 2. A solder gun bit, shaped as shown here, can prove useful in removing valveholders and similar components from printed circuit boards

"An alternative idea consists of tackling one by one the joints which secure multi-tag components to the board. What you do in this case is to apply a wiped iron to each joint so that it automatically removes most of the solder. Whilst the joint is still hot you then brush it quickly with a toothbrush, thereby dispersing the remainder of the solder. When you've done this to all the joints holding the component, it is usually possible to lift it out quite easily. This process sounds a little long-winded, I must admit, but after you've done it a few times you soon get the knack of it.

"There is one method, however, that you should never use. You should never try to remove a multi-tag component by unsweating one tag at a time and simultaneously trying to rock the component. That's one of the surest methods of lifting the copper at the other tags that I know about."

"O.K.," said Dick. "I'll bear those points in mind. This printed circuit business certainly seems to have resulted in service engineers dreaming up new dodges."

"Service engineers," said Smithy, a little pompously, "have been dreaming up new dodges ever since radio started. It's part of the trade. As you go around you'll probably hear a few service engineers beefing about printed circuits and pining for the old days when everything was conventionally wired. But I don't lay much store by such complaints. Service engineers are rather like farmers, they just love to grumble!"

Test Prods

"Talking about grumbles," remarked Dick, "you've just reminded me about a recent complaint of yours concerning the serviceability and upkeep of the test prods in this Workshop."

"I seem to remember saying something of that order," said Smithy, cautiously.

"I have an idea," continued Dick, "that your complaint occurred when you were checking the mains voltage a week or two ago. You may recall that the rubber insulation at the top of one of the prods you used had slipped away from the metal underneath." Dick paused for a moment, as though savouring a pleasurable memory. "You jumped around a little," he added.

"Merely an expression of *joie de vivre*."

"Quite so," said Dick. "At any event the occasion has resulted in my producing a pair of super-duper test prods which are not only strong but have really *tough* insulation.[2] As you are doubtless interested in their construction, I'll tell you how they're made. The metal part of each prod is a 5in length of ⅛in brass rod having a ½in flat filed at one end and a point at the other (Fig. 3 (*a*)). After filing the flat and the point, the former is tinned and the whole rod cleaned, if necessary, with emery cloth. The next job consists of soldering the lead to the flat (Fig. 3 (*b*)). A little p.v.c. tape over the joint provides extra strength here. The final process consists of covering the rod and the joint with 6in of 3mm plastic tube of the type used for the fuel lines of model aircraft, the requisite type being that which is knurled longitudinally on the outside. The plastic tube is a very tight fit on the rod, but if it is held in hot water for a few minutes it can be forced on. The tube should be passed over the rod until it is some ⅜in past the solder joint. The final job consists of trimming the tube at the pointed end of the rod to leave, say, ¼in of brass showing (Fig. 3 (*c*)). The result of all this is a really tough and reliable test prod."

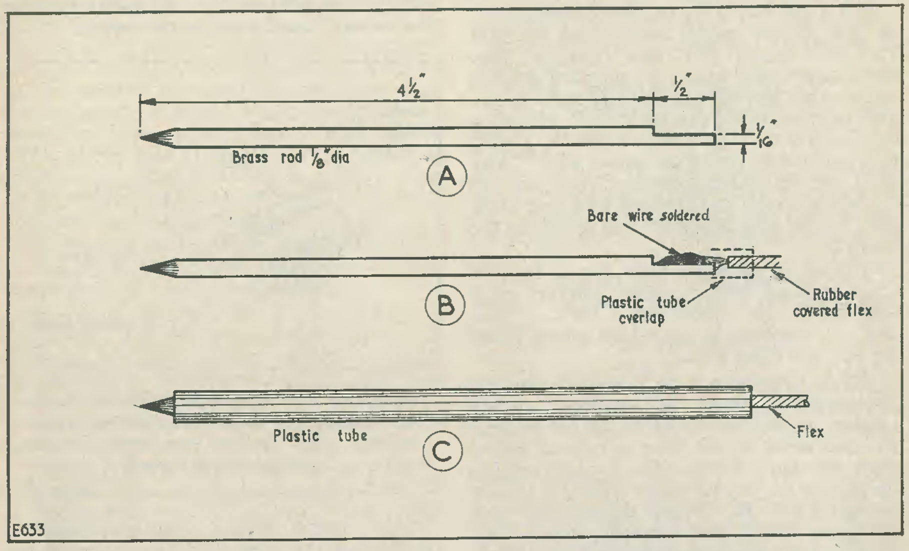


Fig. 3. Successive steps in the construction of the test prods described by Dick

"It certainly seems to be good and strong," remarked Smithy, examining the prods which Dick showed him. "I think you'd better knock up a few more."

"O.K.," said Dick. "Incidentally, talking about hot water reminds me of a joke I want to tell you concerning a commercial traveller who ran out of petrol . . ."

[2] The design of these prods is due to reader D. R. Lett of Liverpool, who has had a pair in use for two years without failure.

UNDERSTANDING TELEVISION

PART 15

By **W. G. MORLEY**

The fifteenth in a series of articles which, starting from first principles, describes the basic theory and practice of television

LAST MONTH WE CONSIDERED, IN RATHER general terms, the overall requirements of the i.f. amplifier in a modern television receiver. We shall now carry on to a more detailed consideration of this part of the receiver.

The Vision I.F. Amplifier

The function of the vision i.f. amplifier is to amplify the vision i.f. signal passed to it by the tuner unit at the front end of the set. In consequence, the vision i.f. amplifier must have a frequency response which enables all video frequency sidebands to be amplified at correct level. A complicating factor is that the transmitted signal has one of its sidebands only *partially* suppressed. Fig. 81 illustrates the ideal British transmitter characteristic.[1] As may be seen, the sidebands resulting from the lower modulating frequencies appear on either side of the carrier.

Fig. 82 shows the response curve of an i.f. amplifier which would be capable of amplifying the video i.f. signal satisfactorily. It will be seen that the response is flat between approximately 35.9 and 37.65 Mc/s, after which it falls rapidly to a very low level at the sound carrier frequency of 38.15 Mc/s. Below 35.9 Mc/s the response falls more gradually, it crossing the 34.65 Mc/s line (the intermediate frequency which corresponds

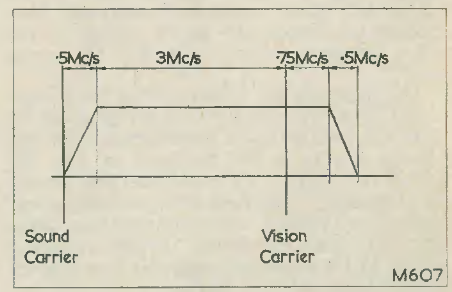


Fig. 81. The ideal British transmitter characteristic

to vision carrier) at a level which is approximately 50% of the total amplitude of the response. The response reaches a low level at 33.6 Mc/s approximately, this low level being maintained at the adjacent channel frequency of 33.15 Mc/s.[2]

[1] This characteristic is based on the information given in Fig. 20 and Table II of Understanding Television, part 4, published in the April 1958 issue.

[2] See last month's article.

The reason for the gradual drop in the response of Fig. 82 below 35.9 Mc/s is that this helps to counteract the effect of the partially-suppressed sideband on the vision carrier. If the i.f. response of the receiver were flat from 37.65 to 34.65 Mc/s, the lower modulating frequencies, which appear

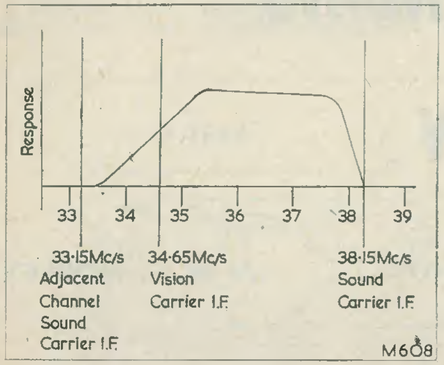


Fig. 82. *A vision i.f. response capable of handling the transmitter characteristic of Fig.* 81. (*It will be remembered that, after conversion, the vision carrier i.f. falls below the sound carrier i.f.*)

in both sidebands, would be passed to the video detector at a higher amplitude than the high frequencies which appear in one sideband only, and a distorted picture would result. The fall-off in response in Fig. 82 below 35.9 Mc/s causes both high and low modulating frequencies to be passed to the video detector at approximately the same level.

The necessity for ensuring that the sound signal does not reach the video detector at sufficient level to cause interference with the picture results in the response of Fig. 82 falling rapidly to a very low level just before 38.15 Mc/s. The desirability of ensuring protection against interference from the adjacent channel sound carrier similarly results in the response being at a low level at 33.15 Mc/s.

In practice it is difficult to obtain a vision i.f. response curve equivalent to that shown in Fig. 82 whilst employing the small number of valves and tuned circuits dictated by commercial manufacturing requirements. As a consequence, the vision i.f. response in practical receivers may be degraded by small amounts. These should not, however, cause any very noticeable degradation of the reproduced picture.

The response of Fig. 82 is flat between 37.65 and 35.9 Mc/s. In practice it is permissible for a deviation in response amplitude of 2dB to occur before any visible effect becomes obviously noticeable in the reproduced picture. (Some authorities give a figure of 3dB in response amplitude as the maximum obviously-noticeable variation.)[3] Thus, the flat-topped response of Fig. 82 may change in amplitude level by 2dB and still be considered "flat."

Another manner in which the response curve of Fig. 82 may be modified in commercial receivers is concerned with the overall frequency range covered. Ideally, the response should be "flat" up to 37.65 Mc/s so that the highest modulating frequency of

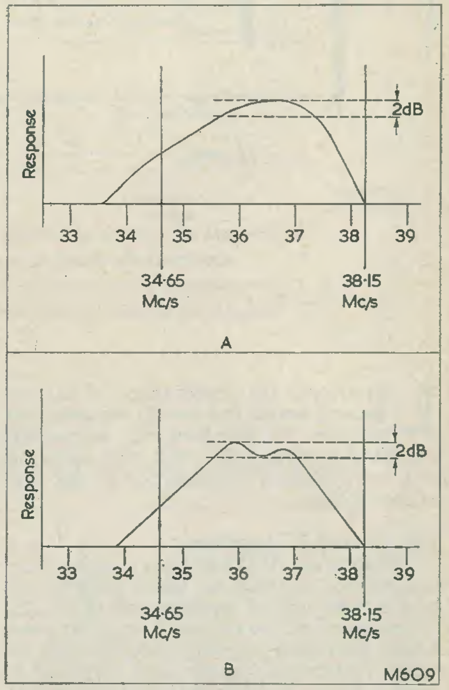


Fig. 83 (*a*) *and* (*b*) *Typical examples of how the response of Fig.* 82 *may be degraded without excessive loss of picture quality. In both cases the sidebands of modulating frequencies above* 2.5 *Mc/s suffer attenuation*

3 Mc/s may be amplified at correct level. In many practical televisors the vision i.f. response commences to drop at a frequency markedly below 37.65 Mc/s, with the result that modulating frequencies approaching 3

[3] 2dB and 3dB are equivalent to voltage ratios of 1:1.26 and 1:1.41 respectively. The expression "dB" is an abbreviation for "decibel."

Mc/s are not amplified at full strength. Usually, such fall-off commences around 37.15 Mc/s, so that full amplification is provided for modulating frequencies up to 2.5 Mc/s only. A fall-off in response at a frequency lower than 37.15 Mc/s may be encountered in some receivers, but this is not a very desirable state of affairs.

An i.f. response curve typical of those liable to be found in commercial receivers is given in Fig. 83 (*a*). In this diagram we see a response which is "flat" within 2dB between, approximately, 35.9 and 37.15 Mc/s, which is consequently capable of handling the sidebands of video modulating frequencies up to 2.5 Mc/s without any obviously noticeable difference of level in the reproduced picture. The response curve of Fig. 83 (*b*) may occasionally be encountered; and this can similarly handle the sidebands of modulating frequencies up to 2.5 Mc/s. It will be noted that the response of Fig. 83 (*a*) is, in reality, a broad single-peak response, whilst that of Fig. 83 (*b*) has the double-humped shape normally associated with bandpass circuits.

Individual Tuned Circuits

The process of designing a vision i.f. amplifier capable of providing even the slightly degraded curves of Figs. 83 (*a*) or (*b*) is not by any means a simple process, and considerable care has to be taken to ensure that a number of conflicting requirements are satisfactorily met.

Whilst it may, at first sight, appear that a satisfactory response may be obtained by the use of a number of tuned circuits which are damped (by, say, connecting resistors across them) so that they individually give a broad response, such a technique has to be used with caution. This is due to the fact that the gain provided by an amplifier whose tuned circuits are excessively damped tends to be low. Despite this, damped tuned circuits are frequently encountered in vision i.f. amplifiers, a compromise being struck between gain and frequency response. Conflicting with the gain requirement is the point that, if a tuned circuit in a video i.f. amplifier functions very efficiently, giving thereby a sharp response, such a tuned circuit is liable to *ring* if shock-excited by an intermediate frequency equal to that to which it is tuned. The process of ringing may perhaps be a little better understood with the aid of Fig. 84 (*a*). In this diagram the tuned circuit oscillates in sympathy with the intermediate frequency during the time that it exists (points A to B in Fig. 84 (*a*)) but, when the intermediate frequency disappears, the tuned circuit continues to oscillate at the frequency to which it is tuned, causing a "damped train" of oscillations (i.e. a series of oscillations continually decreasing in amplitude) to be passed on to the video detector. Such a damped train will appear on the picture. A tuned circuit having a sharp response curve may also be shock-excited into ringing when there is a sudden and large change in amplitude in the signal (say, from black to white or vice versa) whereupon, once more, a damped train of oscillations is passed to the video detector. (See Fig. 84 (*b*).)

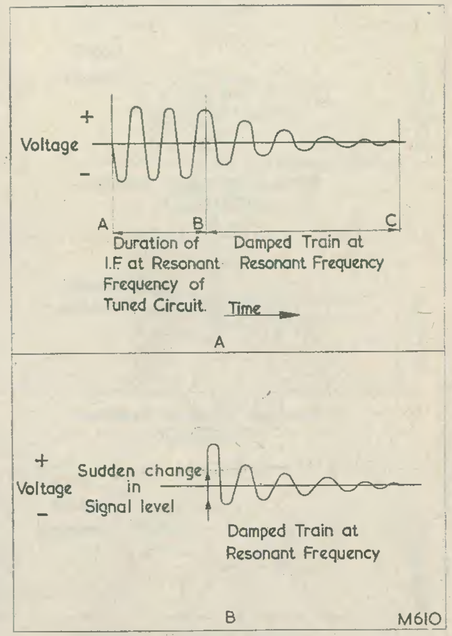


Fig. 84. *A tuned circuit having a sharp response curve is liable to ring if excited by* (*a*) *several cycles of i.f. at its resonant frequency, or* (*b*) *a sharp change in signal amplitude*

Another conflicting factor affecting the design of a vision i.f. amplifier is that this must be capable of offering a good transient response. Sudden changes in amplitude of the i.f. signal must be handled without the introduction of excessive distortion and must be passed to the video detector without appreciable delay or overshoot.[4] As a rule of thumb it is normal to assume that if any tuned circuit in a vision i.f. amplifier has an excessively sharp response, the transient response may become degraded.

With the points just mentioned in mind, we may now consider the various manners in which the individual responses of a number

[4] Transient response was dealt with in Understanding Television, part 2, February 1958 issue.

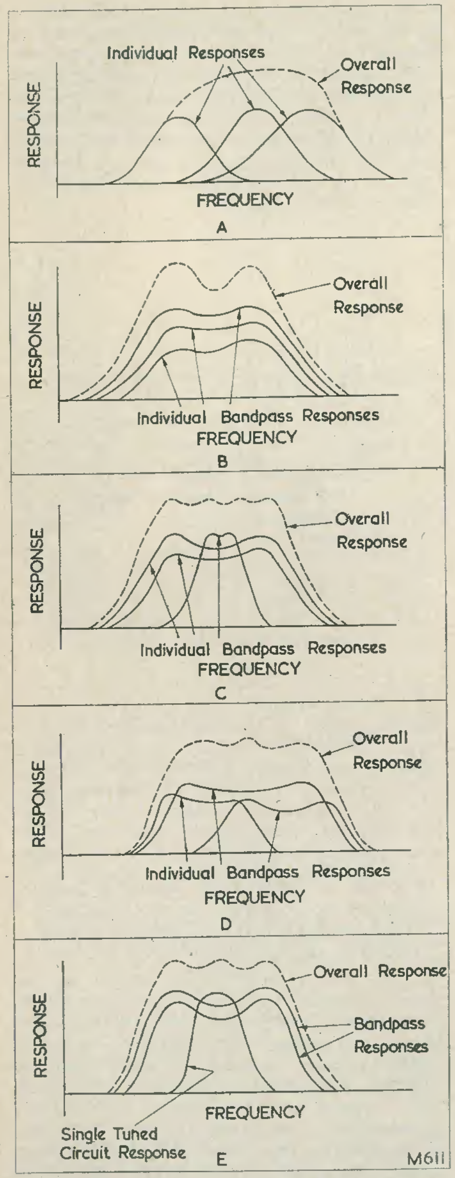


Fig. 85 (a) A relatively flat-topped composite response may be achieved by the combination of the responses of single tuned circuits resonating at different frequencies. (b) Here, a number of bandpass responses provide the composite response. (c) and (d) The tendency of response (b) to have an excessively deep trough may be alleviated by varying the bandwidths and/or centre frequencies of some of the bandpass responses. (e) A composite response may be obtained by the combination of bandpass and single tuned circuit responses

of tuned circuits may be combined so that a satisfactory overall response is obtained.

There are three basic methods of doing this. The first consists of employing a number of single tuned circuits, each adjusted to resonate at a different point within the band of frequencies it is intended to handle. This technique is described as "stagger tuning." A second system consists of employing bandpass coil pairs throughout the i.f. amplifier. The third method uses a combination of bandpass and single-tuned circuits.

Fig. 85 (*a*) shows how the individual responses of a number of stagger-tuned circuits may be combined together to provide a composite flat-topped response covering the desired band of frequencies. Fig. 85 (*b*) illustrates how bandpass coils may similarly be employed. Fig. 85 (*b*) also shows the fact that, if care is not taken, the individual double humped curves may result in a composite response which is, itself, excessively double humped. Such a tendency may be overcome, whilst still retaining bandpass circuits throughout, by such devices as are shown in Figs. 85 (*c*) and (*d*), wherein varying bandwidths and centre frequencies in the individual bandpass tuned circuits assist in raising the central trough of the composite curve.

Fig. 85 (*e*) illustrates a combination of bandpass and single-tuned circuits. This method of obtaining a composite curve is that which is most usually encountered in modern receivers.

It will be noted that all the composite response curves of Fig. 85 have "skirts" which fall slowly to zero level. Whilst the shape of either skirt in each response is acceptable for the lower frequency end of the i.f. response curve (see Fig. 82), it does not satisfy the requirement for a rapidly falling skirt at the high frequency end. In practice, the rapidly falling skirt is achieved by the addition of the sound rejector circuits.

Sound Rejector Circuits

We have already seen that it is necessary to employ special rejector circuits in the vision i.f. amplifier in order to ensure that the sound signal does not reach the video detector at sufficient strength to cause interference with the picture. We shall now examine the various types of rejector circuit which are employed in practical i.f. amplifiers.

One of the simplest types of sound rejector is that illustrated in Fig. 86 (*a*). The rejector tuned circuit in this diagram is adjusted to 38.15 Mc/s, whereupon it absorbs energy at that frequency from the i.f. coil to which it is coupled. There is no direct connection between the i.f. coil and the rejector coil, as the coupling is purely inductive. It is possible, by varying the spacing between the two coils, to make the circuit of Fig. 86 (*a*) provide varying degrees of rejection.

Another simple rejector circuit is illustrated in Fig. 86 (*b*). In this case the rejector circuit is inserted in the coupling connection between a pair of bandpass tuned circuits. Yet another simple rejector circuit is illustrated in Fig. 86 (*c*). In this instance, a series tuned circuit connects di ectly across one of the i.f. coils, and it absorbs energy at the frequency to which it is tuned. A further method of employing a single tuned circuit for rejector purposes is shown in Fig. 86 (*d*). Here, a parallel tuned circuit resonating at the rejection frequency is connected in series

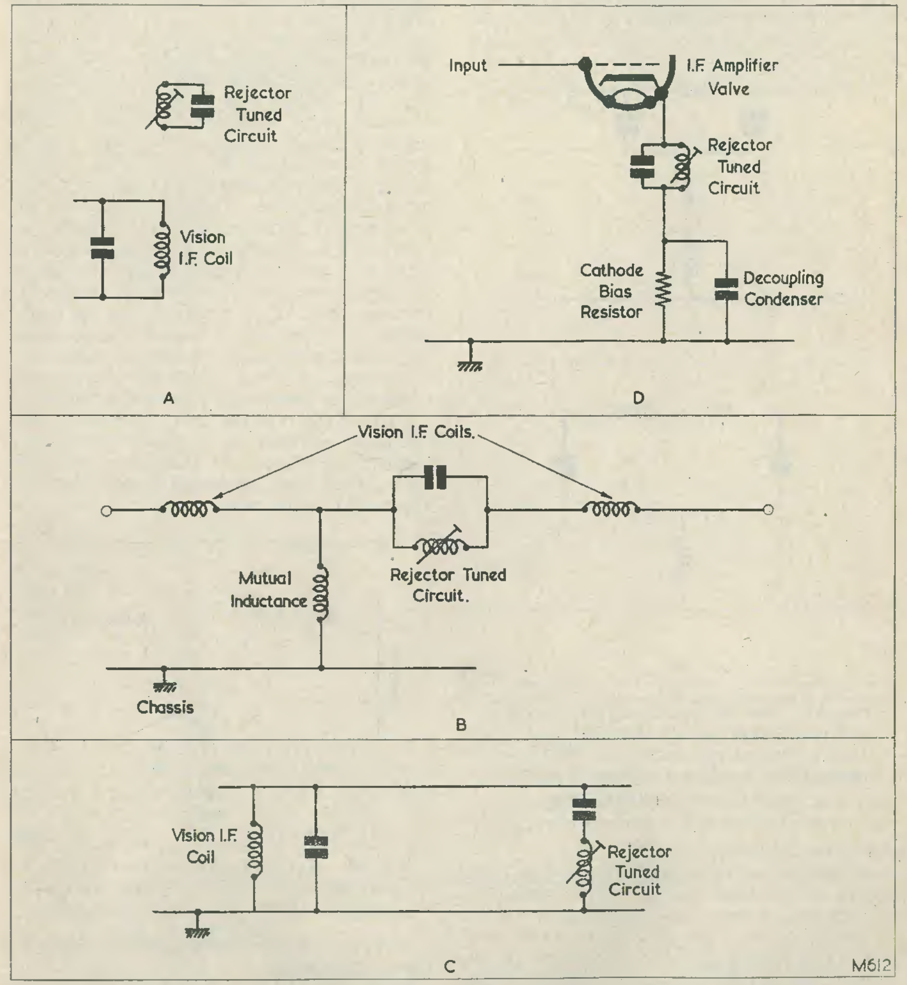


Fig. 86 (a) A simple absorption rejector circuit. The rejector coil is coupled inductively to the i.f. coil. (b) A bandpass network having a rejector tuned circuit inserted in the common connection between the two tuned coils. (c) Another absorption rejector circuit. (d) Attenuation at a fixed frequency may be obtained by inserting a parallel-tuned circuit in series with the cathode of an i.f. amplifier valve.

with the cathode of one of the i.f. amplifier valves. At frequencies removed from the rejection frequency this tuned circuit possesses a low impedance and has little effect on the functioning of the i.f. amplifier. At the rejection frequency the tuned circuit offers a high impedance, with the result that the valve functions in rather the same manner as it would if it had a high cathode bias. In consequence, it offers less amplification.

The circuits of Fig. 86 can all offer varying degrees of rejection according to the efficiency of the tuned circuits employed.

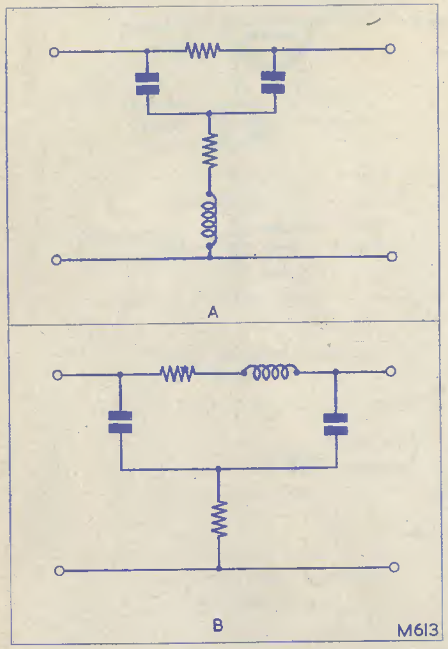


Fig. 87. Two bridged-T rejector circuits. The resistances shown in series with the coils represent the losses in these components and would not appear as physical items in practical networks

Adequate Rejection

In order to obtain complete freedom from sound interference on the picture presented by the cathode ray tube it is necessary for the sound i.f. to be some 40dB or more in level below the picture signal level.[5] None of the circuits of Fig. 86 are capable of providing this degree of rejection on their own, although sufficient rejection would be feasible if two or more were employed in successive stages. As a result, more complicated and more efficient rejector networks are employed in commercially manufactured receivers. The most popular of these is the *bridged-T circuit*. Figs. 87 (*a*) and (*b*) illustrate two popular bridged-T networks. When the correct values of resistance, capacity and inductance are employed in either of the circuits a considerable amount of rejection is obtained, and it is possible for one circuit of this type to provide all the rejection needed in a vision i.f. strip. Usually, however, a bridged-T network is employed in combination with one of the more simple types of circuit shown in Fig. 86.

The sound rejection in a number of modern televisors is so sharp that the effect on the overall response is similar to that shown in Fig. 88. When this type of response is obtained it is desirable to adjust the fine tuner of the associated receiver such that the sound intermediate frequency falls into the centre of the rejection trough, or "dip," and not to either side. Failure to do this may cause sound interference on the picture.

When adjacent channel rejector circuits are fitted to a receiver these usually take up one of the simple forms illustrated in Fig. 86, because there is no necessity for as high a degree of rejection at this frequency as is required in the sound rejector circuits.

Finally, a minor point of terminology needs to be mentioned. In British literature, circuits of the type we have just discussed are normally referred to as sound or adjacent channel rejectors. In American literature such circuits are frequently called sound, or adjacent channel *traps*.

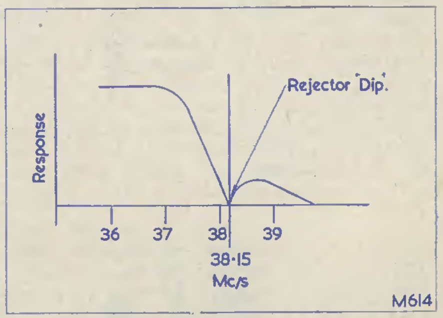


Fig. 88. If a network provides very sharp rejection, the overall i.f. response curve around 38.15 *Mc/s may take up the shape shown here*

Cross-Modulation

When two separate frequencies are handled by a single amplifier which introduces amplitude distortion,[6] each of the frequencies is liable to modulate the other. This process is described as *cross-modulation*.

Cross-modulation can be very troublesome in vision i.f. amplifiers because its existence may allow the vision intermediate frequency to be modulated by the sound intermediate frequency, with the result that there is sound interference on the picture. Cross-modulation is liable to be particularly troublesome in the early stages of a vision i.f. amplifier because the sound i.f. may not be fully rejected at such stages. At the same time later stages, which handle larger signals, are more prone, in themselves, to amplitude distortion and hence cross-modulation. However, the risk of cross-modulation is less severe in later stages because adequate sound rejection in the early stages will, in normal designs, have been provided.

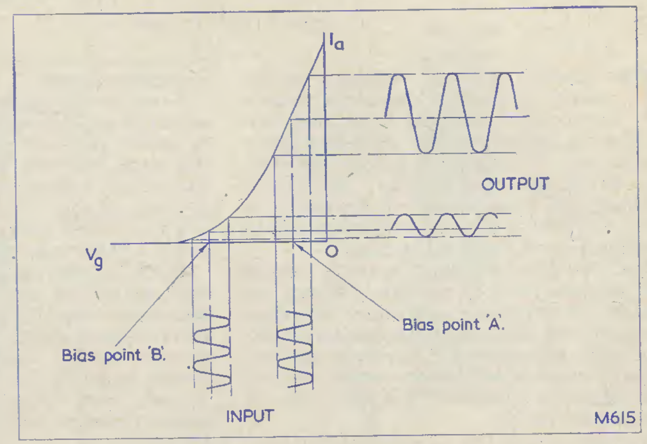


Fig. 89. The anode current-grid voltage curve of a typical i.f. amplifier valve. If the valve is biased at point A the input signal is applied to a relatively straight part of the curve, and the output waveform closely resembles the input. When the valve is biased at point B the input signal is applied to a noticeably non-linear part of the curve, with the result that the output waveform is a distorted copy of the input

Fig. 89 illustrates the I_aV_g curve of a typical i.f. amplifier valve. An input signal applied to the grid of the valve is reproduced by the anode in the form shown. The diagram should help to illustrate the fact that, if the input signal is applied to a straight, or "linear" portion of the I_aV_g curve, the anode signal will be similar in form to the input signal. If the signal is applied to a curved section of the I_aV_g curve, the anode signal will be a distorted version of the input signal.

In order to obviate cross-modulation, the valves of a visual i.f. amplifier are normally biased so that the input signal is applied to a reasonably linear portion of their I_aV_g curves. If the vision i.f. amplifier employs a.g.c., care is taken to ensure that at least the early valves of the amplifier do not receive bias voltages which would cause the input signal to be applied to badly curved sections of their I_aV_g curves.

Next Month

In next month's article we shall continue to discuss the i.f. section of the television receiver.

[5] 40dB corresponds to a voltage ratio of 1:100.

[6] Amplitude, or non-linear, distortion occurs if different signal amplitudes are amplified unequally.

CRYSTAL STABILISATION *for* MODEL CONTROL

by F. G. RAYER

THE SIMPLE TYPE OF TUNABLE MODEL control transmitter can easily operate outside the permitted band, and harmonics can cause television interference over a wide area. Though such transmitters have the advantage of simplicity, economical running, and small size, there are occasions when a crystal controlled transmitter can be employed instead with advantage.

Such equipment cannot operate outside the permitted band, as wrong adjustment will prevent the transmitter operating. For short range, enough output can readily be achieved. The signal may also be used for the accurate calibration of a wavemeter, which in turn will allow a tunable transmitter to be adjusted correctly.

Surplus crystals are easily obtainable, and a frequency which falls within the permitted band, when multiplied by 2, 3 or 4, should be chosen. For example, a 9 Mc/s crystal, with a multiplier stage, will provide 27 Mc/s. Crystals requiring very much multiplication are best avoided.

The crystal forms the resonant part of the grid circuit, as in Fig. 1, and the valve commences to oscillate when L_1 is tuned to the same frequency. A simple capacity coupled stage provides multiplication. For a 9 Mc/s crystal, L_1 can thus tune to 9 Mc/s, and L_2 to 27 Mc/s.

With an active crystal, or fairly large h.t. voltage, direct multiplication may be achieved by tuning L_1 to a multiple of the crystal frequency. However, with some crystals oscillation will only arise when L_1 is tuned to the crystal frequency, especially in view of the fairly small h.t. voltage which may be convenient. For this reason, it is as well to limit multiplication to the following stage.

Resonance Check

A meter should be included in the h.t. supply to L_1, or in series with the h.t. battery. A sudden drop in anode current, on tuning this stage, will then show that the valve has commenced to oscillate. A small power valve is most suitable. "All-dry" output tetrodes are satisfactory, and screen grid and anode may be wired together for triode operation.

The h.f. choke can often be omitted, but it increases output, and helps to assure oscillation with a small h.t. battery. Wiring should be reasonably short and direct. L_1 may be fixed, or can be wound upon a plug-in coil former, as in Fig. 4. For 9 Mc/s, 12 turns of 20 s.w.g. wire, occupying 1½in on a 1½in or similar diameter ribbed former, will be satisfactory.

L_2 will radiate sufficient r.f. to light a low-consumption bulb soldered to a 1-turn coil. After tuning L_1 for minimum h.t. current, it is thus only necessary to tune L_2 for maximum brightness of the bulb. An output on 27 Mc/s will then be obtained, provided L_2 and its associated condenser are so chosen that wrong multiples of the crystal frequency cannot be reached. Stray wiring, and the type of valve employed, exerts a fairly large influence on this stage, but 7 turns of 20 s.w.g. wire occupying 1in winding space on a 1in diameter ribbed former, as in Fig. 4, will usually be satisfactory.

If L_2 is not tuned correctly to 27 Mc/s, output drops, or ceases. With a 9 Mc/s crystal, no output would be obtained unless L_2 were tuned to 18 Mc/s or 36 Mc/s, instead of 27 Mc/s, and such a large error is extremely unlikely. This is quite unlike the results obtained with a self-energised tunable transmitter, which will radiate upon any frequency to which it is adjusted, so that operation just

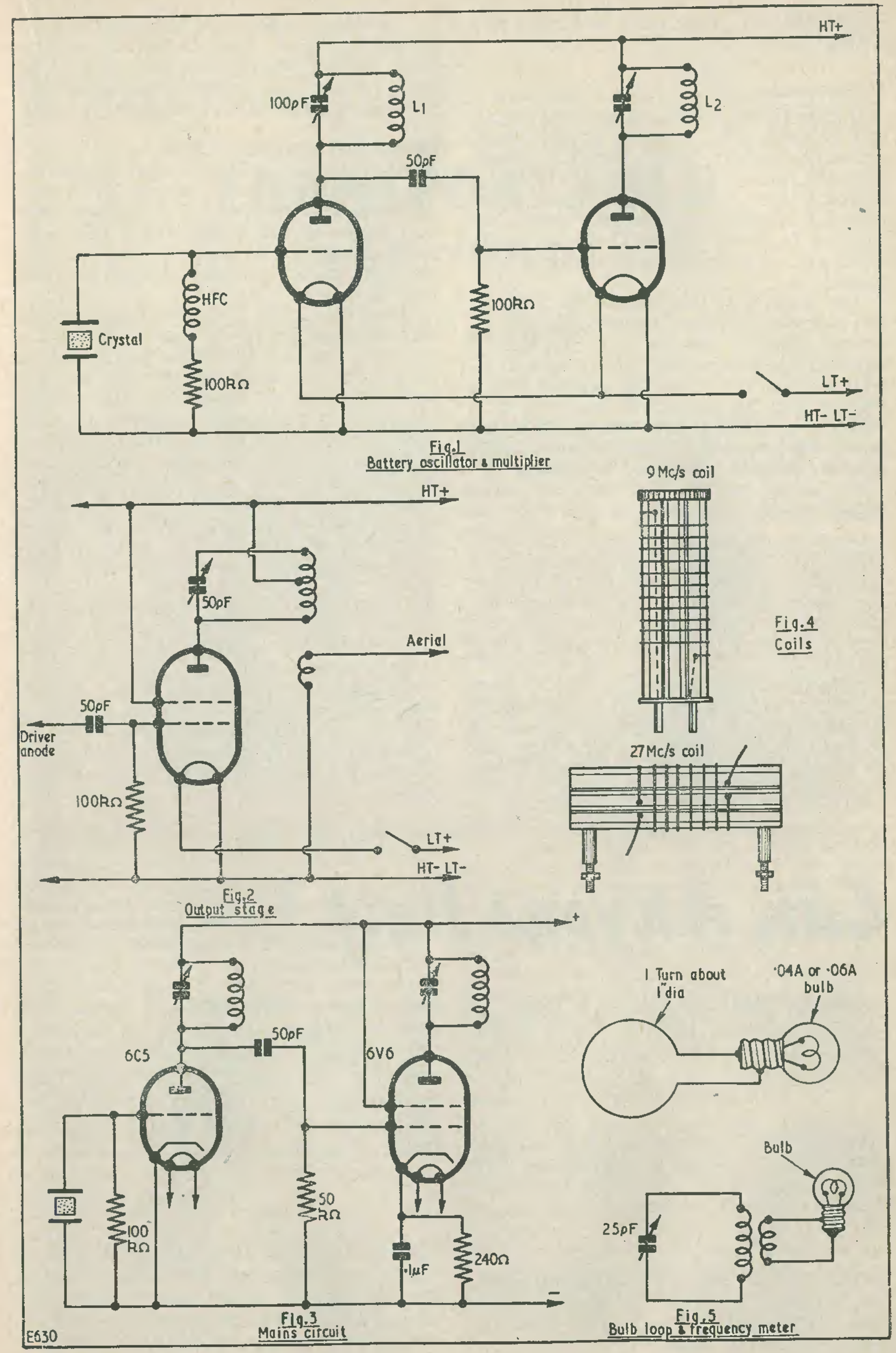


Fig.1 Battery oscillator & multiplier

Fig.2 Output stage

Fig.3 Mains circuit

Fig.4 Coils

Fig.5 Bulb loop & frequency meter

outside the 27 Mc/s band is likely, with wrong tuning.

Output Stage

If more power is required, a power tetrode can be used. Fig. 2 shows a very simple circuit of this kind. With a large h.t. voltage, neutralisation may be required to prevent self-oscillation in this stage. This can be achieved by adding an extremely small fixed capacity from the grid to tank coil, in the usual way. A neutralising condenser is most suitable.

The aerial may be coupled by a 2-turn winding situated near the tank coil, or over-wound upon it near the h.t. tapping. If required, efficiency can be increased by adding an h.f. choke in series with the 100kΩ resistor, and this can also be done in Fig. 1. When two anode circuits are tuned to the same frequency, a careful layout is necessary, to avoid stray coupling and oscillation.

Mains Circuits

Good results can be obtained with mains valves, and a mains operated transmitter is convenient for testing model control receivers and equipment at home. Such a transmitter may also be run from a 6V accumulator, with h.t. derived from a small rotary transformer.

A 2-valve circuit is shown in Fig. 3, which operates as already described, but with much increased power. Although bias would be obtained by grid rectification, cathode bias is provided for the 6V6, to avoid heavy currents when adjusting the tuning.

Coils have already been described, and are shown in Fig. 4. Smooth formers can be used, but will usually require a turn or so less. For the 27 Mc/s coil, a self-supporting winding, of 16 s.w.g. wire, is easily arranged.

Output and Frequency Check

Fig. 5 shows a bulb loop, used to tune the transmitter for maximum output. With low-power battery equipment, the loop has to be near the anode coil, in line with it. But with mains equipment, or higher power, the loop must not be too near the coil, or the bulb may blow.

When the crystal controlled transmitter is correctly tuned, it can be used to calibrate a frequency meter. The coil for this should have turns cemented in position, so that calibration is not lost, and the tuning condenser is fitted with a pointer or dial. Two turns of thin insulated wire, overwound upon the tuned winding, and also cemented in place, are taken to the bulb. Soldered connections are preferable to a bulb holder, as changing the bulb can slightly upset exact calibration. A 6V 0.3A bulb can be used for mains equipment, but a low consumption bulb is better for battery equipment.

The frequency meter is approached to the 27 Mc/s anode coil, and the meter tuning knob rotated for maximum glow. The exact resonant point is more accurately seen if the meter is kept at a sufficient distance, so that the bulb only just lights when tuning is correct. This calibration point may be used to adjust a tunable transmitter, in this case transmitter tuning being set for maximum glow.

Can Anyone Help?

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

Hallicrafter S38C Receiver.—P. J. Darke, of 5 Whalley Lane, Uplyme, Lyme Regis, Dorset, requires servicing data—all expenses paid.

* * *

"Hambander" Receiver.—J. Hibbard, of "Rose Cottage," Cat and Fiddle Lane, West Hallam, Nr. Derby, requires the circuit diagram or service sheet.

* * *

R1392 (95/155 Mc/s ex-Service Receiver).—P. Wright, of 111 Yew Tree Road, Birchencliffe, Huddersfield, W. Yorks, wishes to obtain the service manual.

Trans/Receiver RT34/APS-13.—J. Baldwin, of "The Dingle," Habberley Road, Bewdley, Worcestershire, asks for information in particular for details of the 7-pin plug connections. Any circuits lent will be returned and any expenses defrayed. Alternatively willing to purchase.

* * *

"Jason" Variable Tuned FM/VHF Tuner.—R. G. Hassler, of 30 Acheson Road, Birmingham 28, would be glad of any information that would enable him to fit a "Magic Eye" tuning indicator.

A Core-Tuned TRANSPORTABLE

by **A. S. CARPENTER**

An unusual receiver, small in size and semi-portable

It is not usual, in receivers covering the normal broadcast bands, to tune by means of a variable inductance tuner, but with the introduction of the Teletron FX25, self-tuned, dual-wave inductor (which made its debut in a transistorised circuit) such a method becomes possible. Experiments reveal that the unit can give an excellent performance when associated with valves, and the practical arrangement described here results in an efficient little receiver which is not expensive to construct.

Whilst aerial/earth sockets are provided it should not be thought that they are essential; in a great many locations the receiver will function admirably without either, as the inductor has been carefully positioned in order to obtain maximum self-pickup.

Care has been taken, too, to eliminate any possibility of the chassis becoming "live," and a negative bus-bar, to which the chassis is connected via a high voltage capacitor, makes it possible to ground the chassis in the usual way. No on/off switch is fitted to the prototype, in order to ensure that at all times when not in use the receiver is disconnected from the mains supply. In many cases this precaution might be considered unnecessary and a switch may be included, either in the flex input leads or incorporated in the regeneration/gain control. A switch of the double-pole variety must be used, however, whichever method is adopted.

As a slim construction was desired, the prototype chassis was made to order: bending one's own is not always a practical proposition when a perfectly symmetrical end-product is required!

The Circuit is shown in Fig. 1, where it can be seen that only two valves are employed, the first being used as a leaky-grid demodulator plus low frequency amplifier. Controlled regeneration assists the tuned circuit and greatly improves sensitivity, the particular mode of control being extremely docile in operation. Feedback is obtained from the screen of V_1 and not from the anode.

Switching of the tuned circuit is ridiculously simple, the long-wave winding merely being shorted when medium-wave transmissions are required.

When the inductor is purchased a capacitor of 500pF will be found connected from tag 4 to tag 6, its purpose being to roughly tune both bands. In some cases it may be left *in situ* and will occupy the position C_4 occupies in the circuit diagram, so that the C_3 shown will not be required. The slight modification shown was made in order to obtain optimum results at the high frequency end of the medium-wave band as it was discovered that by cunning variations in the values of C_3, C_4, the output could be made to discriminate in favour of a particular section of either band.

The output stage and the power supply arrangements are conventional, the field winding of an energised type speaker being used as a smoothing choke. A permanent-magnet type may be used instead if desired, but a choke will then be needed.

Construction is not difficult, but to assist beginners both chassis drilling and point-to-point wiring diagrams are given (see Figs. 2, 3, 4, 7, 8). A simple L-shaped bracket needs to be made to hold the inductor and this is illustrated in Fig. 5—16 s.w.g. aluminium will be found suitable.

Once the chassis has been drilled the various components can be mounted, and to secure the speaker, a sheet of metal or plywood 6in square is recommended, the speaker being bolted to it after first cutting an aperture. The assembly may be bolted to the front flange of the chassis and held off by ½in spacers to avoid having to make a cut-out in the chassis itself.

All controls are placed at the side, and provided a cabinet not less than 9½in wide

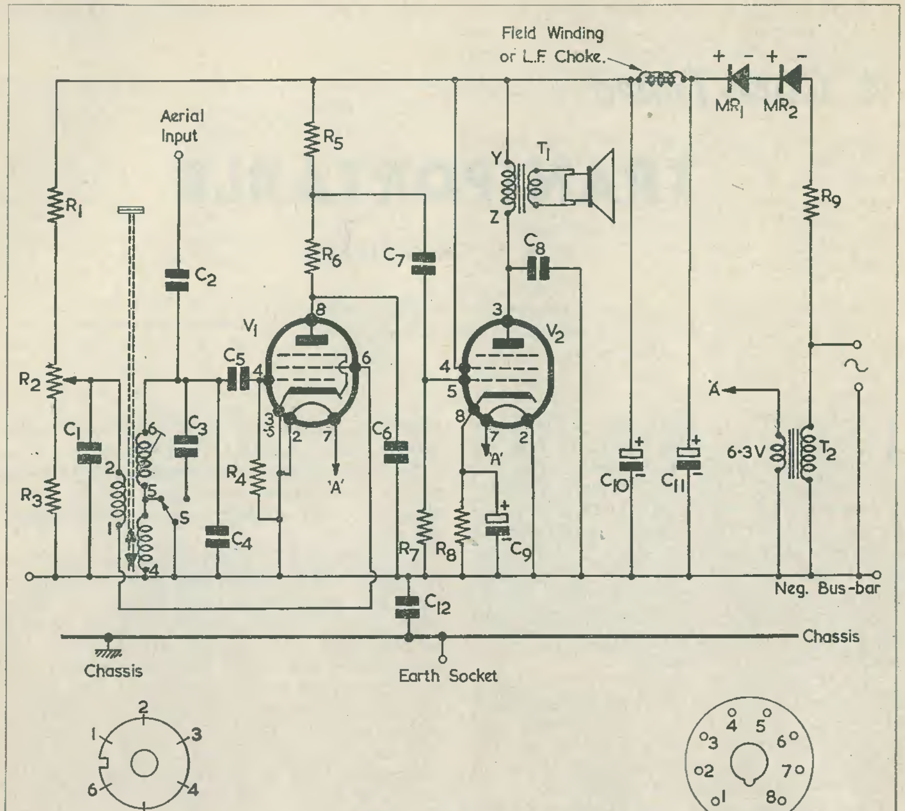


FIG. 1.
Circuit Diagram of the 'Core-Tuned Transportable' Receiver

Capacitors
- C_1, C_7 0.01μF
- C_2 75pF
- C_3 500pF (fitted to FX25—see text)
- C_4, C_5, C_6 150pF
- C_8 2,000pF
- C_9, C_{10}, C_{11} 12+12+12μF electrolytic 350V

Resistors
- R_1, R_6 47kΩ, 1-watt
- R_2 10kΩ wirewound potentiometer (see text)
- R_3 15kΩ, 1-watt
- R_4 3.3MΩ
- R_5, R_7 470kΩ
- R_8 470Ω, 1-watt
- R_9 100Ω, ¼-watt

Valves
- V_1 6SH7
- V_2 6V6GT

Rectifiers MR_{1-2}
RM2 (2) or DRM2B (1) Brimar

Output Transformer
8,500Ω–3Ω

Inductor
Teletron, FX25

Speaker
5in energised (or see text)

Heater Transformer
230V input, 6.3V output at 1.5 amps.

Switch
Single pole, two-way

Chassis
8½in x 4¼in x 1¾in—Oliver & Randall Ltd., 53 Perry Hill, S.E.6

Miscellaneous
Aerial/earth socket, wire, solder tags, tagstrip—(6+1 earth), 3 control knobs, nuts, bolts, mains lead and 3-pin plug, bracket (see text), etc.

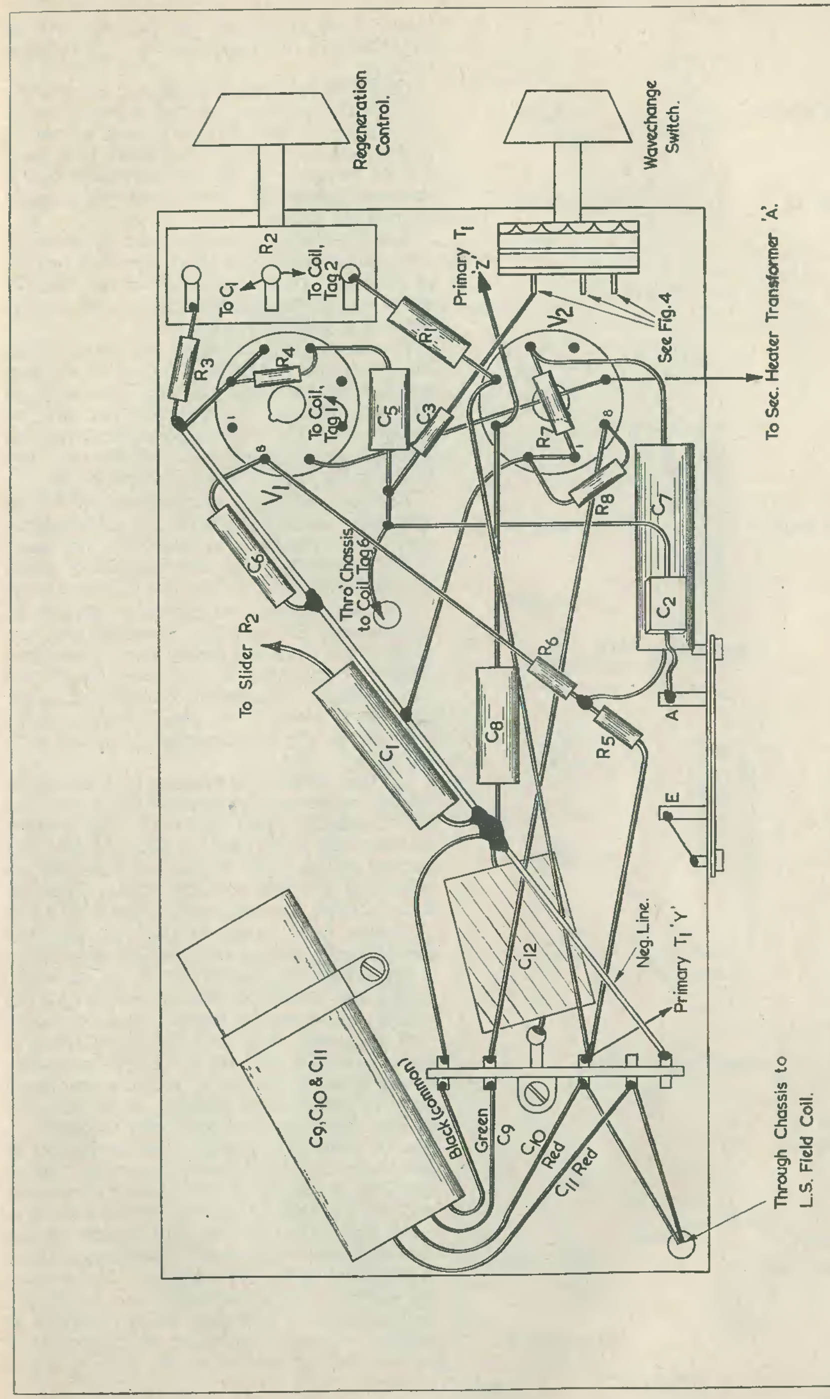


FIG. 2.
Point-to-Point Wiring.

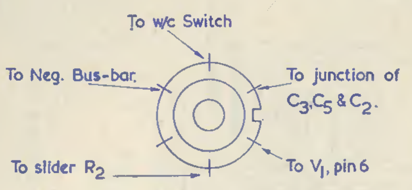


FIG.3
Coil Connections.

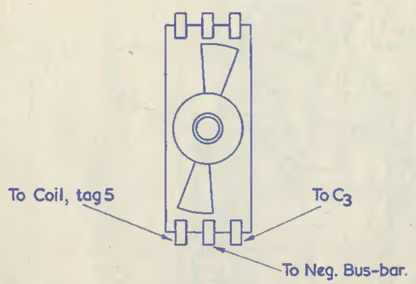


FIG.4.
Switch Connections

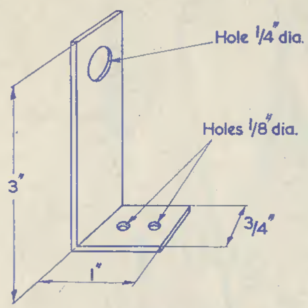


FIG.5.
Inductor Support Bracket.

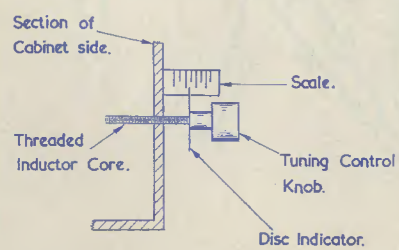


FIG.6.

M605

internally is employed, no difficulty will be experienced in inserting the completed chassis.

Only one tag strip is used, and from a tag on this the negative bus-bar is run clear of the chassis in bare 22 s.w.g. wire across to pins 2 and 3, V_1 (pin 1 on this valve must not be included in the connection as this is the metallising pin). To this wire all negative returns are taken.

The electrolytic capacitors are all included in a single cardboard tube type but in case of difficulty, or for convenience, C_9 may be made a separate component, ample chassis mounting space being available.

Particular care should be taken when mounting the aerial/earth socket to see that no short-circuit exists between the aerial pin and the chassis. It is important, too, to ensure that C_2 is included, otherwise an external aerial plugged in will become live to the mains when the set is switched on.

Detailed wiring instructions are not necessary as the diagrams are self-explanatory: it is, however, advisable to use leads with differently coloured insulation when wiring the inductor to facilitate final checking.

On completion, no difficulty should be experienced in locating transmissions on either band when the tuning knob is manipulated. By adjusting R_2, optimum results will be obtained. Reception should be crisp, clear and "beefy." R_2 *should not* be of the type where the spindle makes contact with the slider.

All that remains to be done is to house the chassis in the most attractive cabinet that one can construct, and as only the speaker occupies the front panel, a sheet of gold fret backed by plywood may cover this area, so achieving a contemporary style. Approximate internal dimensions are: $9\frac{1}{2}$in x 5in x 6in.

Tuning scale. Due to the fact that the tuning knob spindle (with which is supplied a brass bush to enable fitting to be made with a $\frac{1}{4}$in knob aperture) screws in and out of the inductor, the normal type of tuning dial is useless. The total length of travel is approximately 1in, and a suitable indicating device is shown in Fig. 6, where a graduated strip of celluloid or perspex is let into the cabinet side close to the control knob. A disc of white card glued to the inside edge of the knob acts as a rotating pointer. Alternatively, a length of $\frac{3}{8}$in diameter, wooden rod can be fixed to the end of the iron dust core and extended the full width of the cabinet so that it projects $1\frac{1}{4}$in through a hole drilled for it in the opposite side. The projecting end may be painted white and graduated, the principle of operation being the same as before, viz, that its marked position relative to the cabinet indicates the desired transmission.

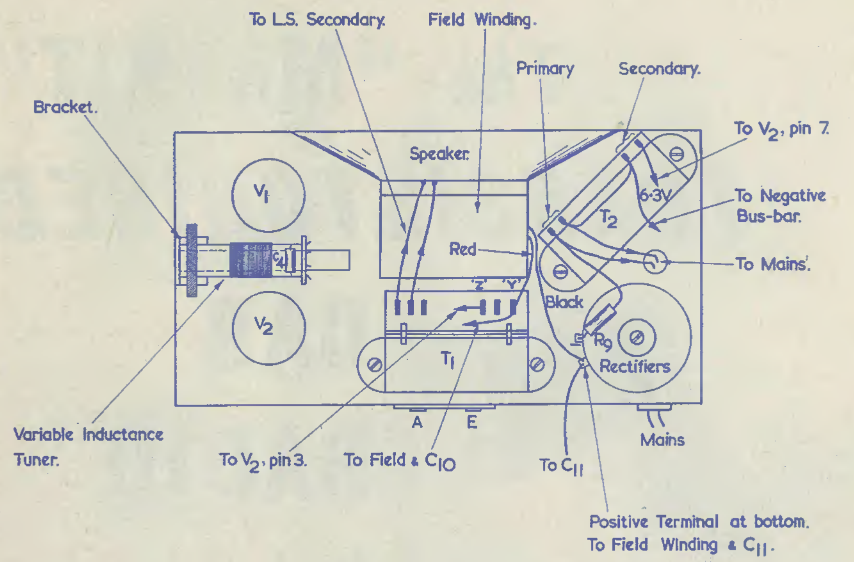


FIG.7.
Above Chassis Layout and Wiring Details

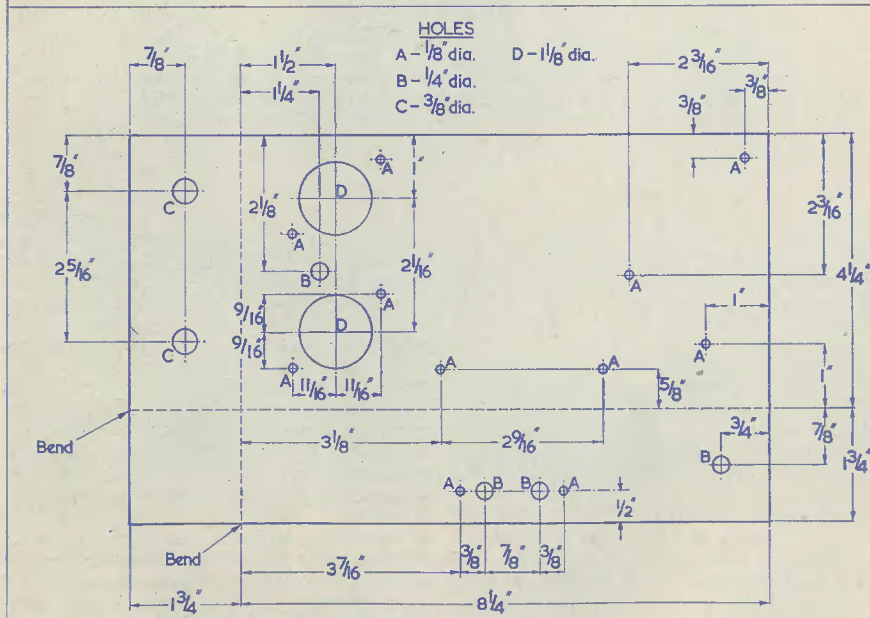
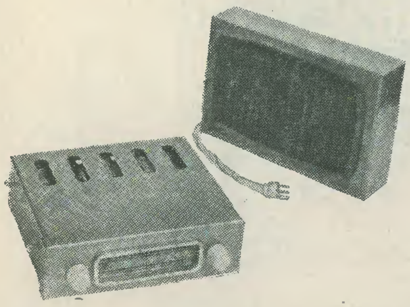


FIG.8.
Chassis drilling details.
(Two sides are shown flattened out.)

M606

The "MAYKIT" TRANSISTORISED CAR RADIO



Part 1

by Richard Myers

This series describes fully a modern car radio design which may be built by any motorist—with or without experience of radio work—from the receipt of the components to the testing of the unit. Suggestions for car installation are included. The printed circuit and condensers are by T.C.C.

Test Report

Power supply voltage 14.4V d.c., gain control set to give an output of between 1 and 2 watts under strong signal conditions.

1. A.G.C. delay corresponds to 300mW.
2. With a.g.c. operative, a change of 40dB at the input gives a change of 3dB at the output.
3. Sensitivity figures at 640 kc/s, 2.5 microvolts for 100mW. At 1.43 Mc/s, 2.2 microvolts, 100mW.
4. *Signal-to-noise:* With a sensitivity of 2.7 microvolts at 640 kc/s, signal-to-noise is 20dB. At 1.43 Mc/s, sensitivity is 0.7 microvolts, signal-to-noise 20dB.
5. *Rejection:* At 640 kc/s, image rejection at 1.6 Mc/s is 60dB. At 1.43 Mc/s, image rejection at 2.4 Mc/s, 51dB.
6. *I.F. Rejection:* 200 kc/s is 39dB; at 640 kc/s, 10dB; at 1 Mc/s 38dB; and at 1.43 Mc/s 51dB.
7. *I.F. Sensitivity:* Input of 120 microvolts, 100mW out.
8. *Bandwidth:* 8.6 kc/s at 3dB points.

Many present-day car owners, whether brand new cars or not so new, aspire to the ownership of one of those "extras" so glibly advertised by the second-hand car marts! The "extra" referred to here is probably, after a heater-demister installation, the most important of the additional features among the whole bewildering host of extras currently being offered to the motorist.

The advantages of a car radio to the regular, or even the week-end motorist, are many—the most important being, apart from pride of ownership, the ability at will to keep in touch with events while on the road. Newscasts, sports events and results are among those which come readily to mind. Additionally, of course, the entertainment value—particularly to the passengers on that long journey—often appears to cut many miles off the route! Jocularly, even the most rabid "back-seat driver" is silenced by the lilting melodies often to be heard from the Continental stations!

Illustration showing Car Radio components as received. Top, left to right, speaker and output stage chassis with main chassis; power filter chassis, and front panel with outer receiver casing. Tuner unit, transformers and wires. Pre-packaged components for the various stages of assembly, etc. Valves, dial and printed circuit panel

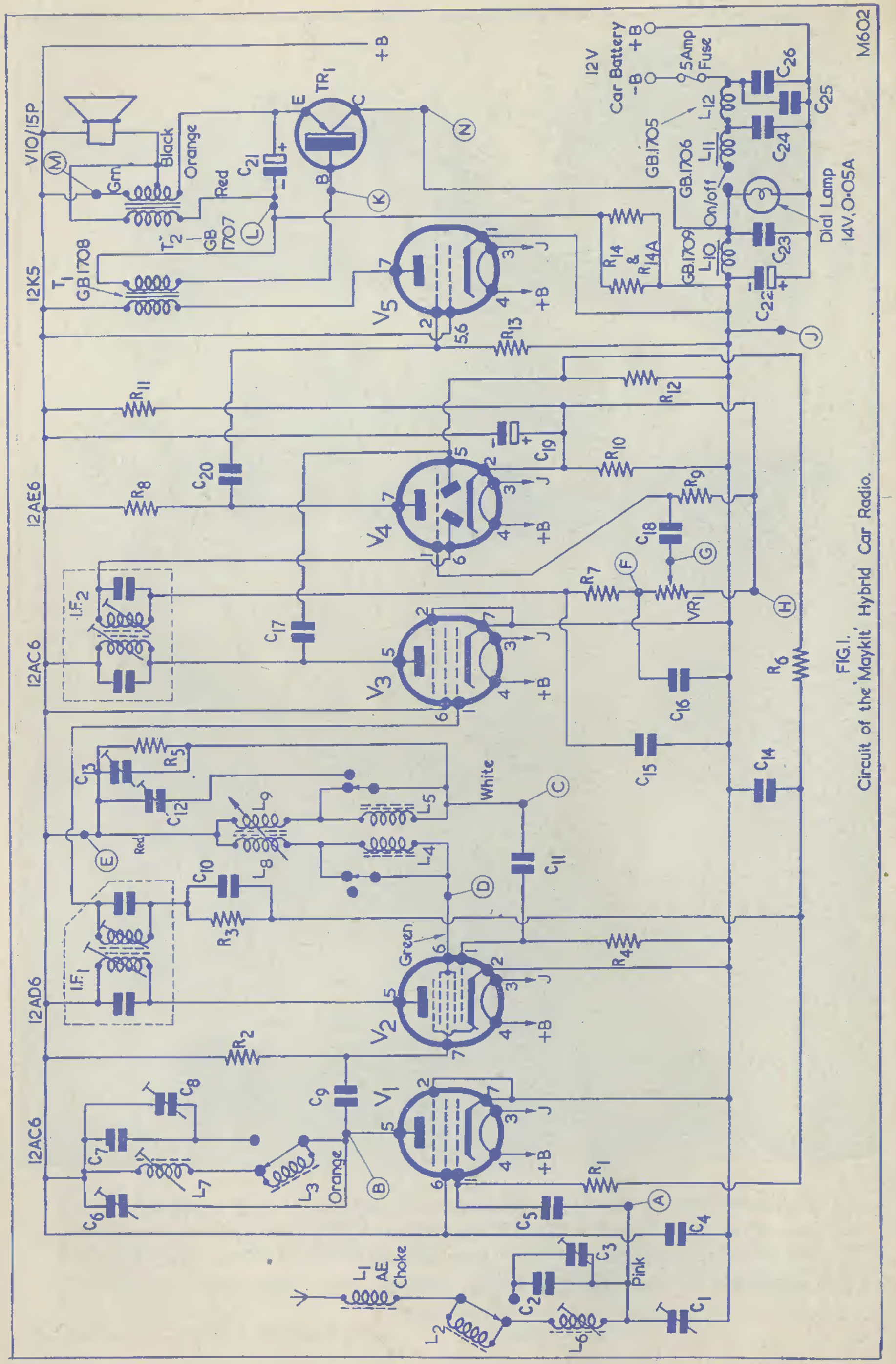


FIG. 1. Circuit of the 'Maykit' Hybrid Car Radio.

To construct the car radio about to be described, no special skill or equipment is required other than a small electric soldering iron, a medium and a small-sized screwdriver, a pair of cutters and pliers and a razor blade. The inclusion of a printed circuit ensures that assembly is kept at a minimum, and wiring errors hardly likely which, consequently, enables the results obtained to be very largely standardised from one receiver to another. The tuner unit is complete and pre-aligned, as are the i.f. transformers.

The new hybrid design uses five Brimar valves with transistor output, and the inclusion of an r.f. stage—not often found in car radios—ensures adequate volume level under all conditions. The receiver is for use with a 12 volt battery, with a consumption of only 1.5A. It is regretted that no 6 volt models are available. Two-knob control is a feature of the receiver, that shown on the left-hand side being on/off and volume, that on the right being both the wavechange and the manual tuning control. The wavechange (Long and Medium Wave), is effected by a pull-out mechanism. The radio outer metal case is of grey hammered steel, fully louvred for ventilation purposes, this having a standard size of 8in x 7in x 2¼in to fit all modern cars.

The case itself contains the printed circuit and associated components, valves, tuner unit, and power supply filter box. The speaker and the transistor output stage are contained on a separate chassis, this stage being cable-connected to the receiver. Thus, the speaker unit is capable of being mounted, assembled as shown, at any suitable position at the front of the car according to the make and type or to the individual preference of the owner. Alternatively, of course, the actual output transistor, chassis, and associated components could be mounted in the front, i.e. under or behind the dashboard, and the speaker only, with a suitable metal grille or mesh, fitted at the rear of the car behind the back seat and under the rear window. In this latter instance, only the two speaker wires would have to be connected from the output transformer to the speaker —thus avoiding an unduly long inter-unit connecting cable.

As received, the components, any of which may be purchased separately, are as shown in the illustrations *except for the speaker cabinet*. In many types of cars this will not be required, it being shown here as an example for those who do require such a cabinet. The car radio supplier will, however, supply a very similar cabinet as an extra. A

COMPONENT LIST

Set out for easy reference to Fig. 1

Resistors
- R_1 2.2MΩ
- R_2 2.2MΩ
- R_3 2.2MΩ
- R_4 33kΩ
- *R_5 4.7kΩ (see text)
- R_6 3.3MΩ
- R_7 56kΩ
- R_8 330kΩ
- R_9 2.2MΩ
- R_{10} 10kΩ
- R_{11} 100kΩ
- R_{12} 2.2MΩ
- R_{13} 2.2MΩ
- R_{14} 470Ω
- R_{14a} 470Ω

Condensers
- *C_1 80pF trimmer
- *C_2 400pF
- *C_3 140pF trimmer
- C_4 0.05μF
- C_5 27pF
- *C_6 80pF trimmer
- *C_7 500pF
- *C_8 140pF trimmer
- C_9 220pF
- C_{10} 0.01μF
- C_{11} 27pF
- *C_{12} 140pF trimmer
- *C_{13} 80pF trimmer
- C_{14} 0.01μF
- C_{15} 100pF
- C_{16} 100pF
- C_{17} 30pF
- C_{18} 1,000pF
- C_{19} 25μF electrolytic
- C_{20} 10,000pF
- C_{21} 250μF electrolytic
- C_{22} 250μF electrolytic
- C_{23} 0.5μF
- C_{24} 0.5μF
- C_{25} 0.5μF
- C_{26} 3,300pF

Valves
- V_1 12AC6 Brimar
- V_2 12AD6 Brimar
- V_3 12AC6 Brimar
- V_4 12AE6 Brimar
- V_5 12K5 Brimar

Transistor
- TR_1 Newmarket V10/15P

Transformers and Chokes
- T_1 Driver trans: 80/30Ω type GB1708
- T_2 Output trans: 30/3Ω, type GB1707
- L_{10} L.F. choke, type GB1709
- L_{11} R.F. choke, type GB1706
- L_{12} R.F. choke, type GB1705 (Mayra Electronics Ltd.)

I.F. Transformers

Weyrad, type P40/1 (480 kc/s)

*NOTE: Components marked * are part of the tuner unit.*

Tuning Unit

MW/LW Car Radio (Mayra Electronics Ltd.)

Metalwork

Outer case, receiver chassis, filter box chassis, output stage chassis, front panel, chromium bezel, dial and drive assembly, etc. (Mayra Electronics Ltd.)

suitable car aerial, heavily chromed and in three pull-out sections, complete with input co-ax lead, will also be supplied as an extra.

Circuit

The theoretical circuit of the car radio is shown in Fig. 1. From this it will be seen that it consists of five 12-volt valves, in cascade, coupled into an output transistor. The valves used in this hybrid design are: V_1—12AC6 tuned r.f. stage; V_2—12AD6 mixer/oscillator stage; V_3—12AC6 i.f. stage; V_4—12AE6 detector, a.v.c. and first audio stage and V_5—12K5 audio amplifier and driver stage. These valves are followed by the output transistor—this being coupled via the output transformer to the speaker.

A technical specification of the receiver, under test conditions, is given later in this article.

The 12AC6 r.f. stage is both grid and anode tuned (t.p.t.g.), this being effected by two dust-cored inductors, L_6 and L_7, in the grid and anode circuits respectively. The stage is prevented from oscillating by reason of the low h.t. voltage employed. On the Medium wave position (as shown in the circuit diagram), L_2 and L_3, the additional Long wave inductances, are short-circuited by the switch wavechange mechanism. On the Long wave position, both of these latter inductors are brought into circuit, they then being in series with the Medium wave windings. At the same time, the trimming condensers C_2 and C_3 (grid), together with C_7 and C_8 (anode), are all brought into circuit in parallel with the combined inductances. With the mechanism necessary for changing the wavelength is also combined that required for varying the two inductances, in step, thus tuning both the grid and the anode of this stage over the wavelength selected. The r.f. stage has a.g.c. (automatic gain control) applied via R_1, C_5 being the isolating condenser. The a.g.c. line is decoupled by the components R_6 and C_{14}. The tuned output from the r.f. stage is taken via the coupling condenser C_9. The Medium wave trimming condensers are C_6 (anode), and C_1 (grid). Those for the Long wave are C_8, C_7 (anode), and C_3, C_2 (grid).

In the 12AD6 mixer/oscillator stage, L_8 and L_9 are the oscillator variable inductors in the Medium wave position—both L_4 and L_5 being short-circuited by the switching mechanism; these latter inductances are those required for the Long wave position. In this latter position both L_4 and L_8 are connected, in series, with the oscillator anode; while both L_5 and L_9 are also in series, the trimming condenser C_{12} being in parallel across both windings. These two inductors (L_5 and L_9) are condenser-coupled to the oscillator grid by C_{11}, R_4 being the grid-leak. The Medium wave trimmer is C_{13}, C_{12} being that for the Long wave position.

The output from the mixer/oscillator stage is passed, via the tuned coupling of IFT_1, into the grid of the next stage.

The 12AC6 i.f. stage is conventional, its function being to provide additional selectivity and gain, at the intermediate frequency of 480 kc/s, and to pass the amplified signal to the following stage. A.G.C. for the i.f. stage is obtained via the components R_3 and C_{10}. The amplified i.f. signal from the 12AC6 appearing across the tuned windings of IFT_2 are then rectified by the demodulator diode and taken, via the secondary winding, to the volume control VR_1. R.F. decoupling is provided here by C_{15}, R_7 and C_{16}, bypassing to chassis any residual r.f. that may still be a component of the signal at this point. The input for the triode section of the 12AE6, V_4, is tapped off the volume control and passed, via C_{18}, to the control grid.

The second diode of the detector is coupled to the anode of the i.f. stage via C_{17}, and provides the necessary a.g.c. voltage. The a.g.c. voltage appearing across the load resistor R_{12} is taken, via R_6, to the r.f. stage and via a further resistor R_3 to the i.f. stage. A delay voltage to prevent the a.g.c. operating on weak signals is obtained via the cathode components R_{10} decoupled by C_{19}. The amplified output from the anode of V_4 is then taken to the grid of the second a.f. stage, V_5, via the condenser C_{20}.

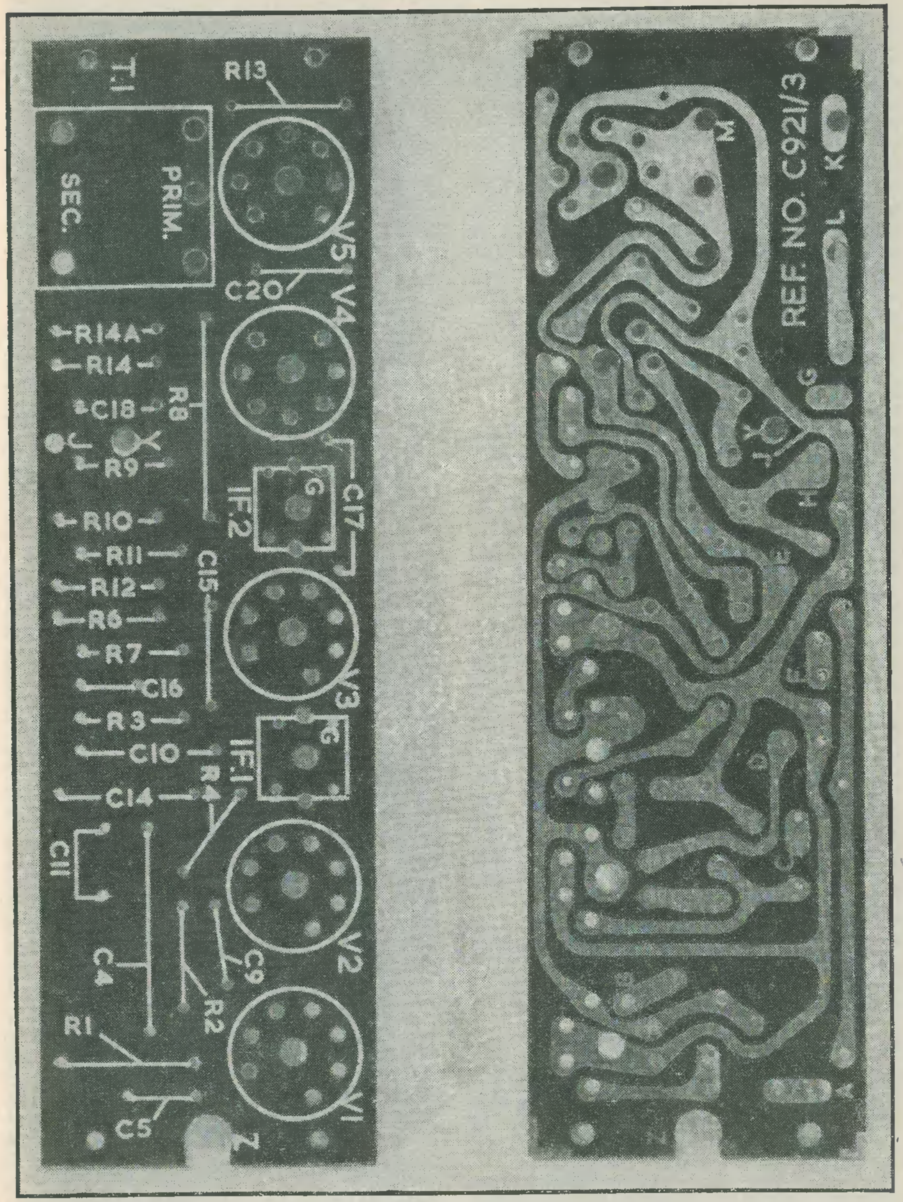
The amplified audio signal is now applied to the primary winding of the driver transformer T_1 from the anode of V_5 (12K5). Being induced into the secondary winding, the signal is now applied to the base of the output transistor, this being operated in the earthed collector mode. Bias is applied to the base from the junction of the resistors R_{14} and R_{14a} (these being parallel-connected in order to obtain the required correct bias voltage) and part of T_2 connected, in series, across the supply. The output is taken from the emitter and thence via the output transformer to the speaker.

The power input is subject to a thorough filtering process by means of the three chokes and five condensers shown in the input supply. A 5-amp fuse is provided for protection purposes.

The ringed letters shown on Fig. 1 correspond to points similarly marked on the printed circuit panel.

Assembly and Construction

As received, the kit is mostly contained in seven polythene packets. Of these, five contain the various components necessary for the completion of each stage, as described, while the remaining two contain the printed circuit and dial assembly, etc. In addition



Both sides of the pre-fluxed printed circuit panel are shown above. Components are mounted on the non-copper side in the positions clearly indicated and are soldered on the reverse side

to these will be found the speaker and tuner unit respectively, in small cartons, and the output transistor in a small envelope. The main chassis, together with the power filter sub-chassis, chromium bezel, and the required wire and solder, etc., will be found contained within the main receiver metal casing.

The intending constructor will be wise to adopt the method of assembly and construction described here, otherwise difficulty may be encountered at a later stage. The order and method has been carefully planned by the designers to ensure that no mistakes are made, no omissions possible, and no trouble experienced with the assembly and wiring. In addition to the foregoing, it is advisable for the constructor to open only those packets as stated in the order described. The remainder should be left sealed until they are required. In this manner, the motorist with no previous experience of radio will not tend to become confused with the various components required for each stage. Do not throw away the polythene packets, as some will be required later.

Step No. 1

Locate the *printed circuit panel*. Open *packet No.* 1 and identify the following components: R_1, R_2, R_3, R_9, R_{12}, R_{13}. All these have a value of 2.2MΩ (red, red, green). R_4—33kΩ (orange, orange, orange). R_6—3.3MΩ (orange, orange, green). R_7—56kΩ (green, blue, orange). R_8—330kΩ (orange, orange, yellow). R_{10}—10kΩ (brown, black, orange). R_{11}—100kΩ (brown, black, yellow). R_{14} and R_{14a}—470Ω (yellow, violet, brown). Each individual resistor is marked with its appropriate circuit designation, i.e. R_1, R_2, etc. Two i.f. transformers (small metal cans marked "reg'd Design No. 884154"). One length of solder. Place these components on one side, open *packet No.* 2, and identify the following components: C_4, marked TCC 0.05μF type 346; C_5 and C_{11}, small white bodies marked 27±20%; C_9, small brown body marked 220; C_{10}, marked TCC 0.01μF type T383; C14, marked TCC 0.01μF type T383; C_{15}, C_{16}, small white bodies marked 100 ±20%; C_{17}, small flat type marked 101 SMP 30pF ±20%; C_{18}, small white body marked 1000; C_{20}, lozenge shaped and marked TCC 10000pF CC1545. Five valveholders, four self-tapping screws and one transformer T_1 marked GB 1708.

Step No. 2

With the two packets now opened and the components identified, we now proceed to solder in position the components on the printed circuit panel, the copper connections of which are pre-fluxed.

Mount the valveholders into position first, and do this by pushing them firmly into position so that the tags are protruding through on the side with the shiny copper markings. Note here that any valveholder will fit into any of the five positions; it does not matter which one is fitted into any particular position.

Solder each valveholder into position on the circuit board in the order 1 to 5 and do not forget to solder the central metal spigot. *The soldering should be done with a hot iron which must not be held on the printed circuit any longer than is necessary to make a good joint.*

Step No. 3

With each valveholder now fitted, proceed to solder into position each individual resistor. The positions for these are plainly marked on the circuit panel (see illustration). The best method of mounting the resistors, in order that no mistakes are made, is to first deal with R_1, R_2, R_3, R_9, R_{12} and R_{13}, these all being 2.2 MΩ. The wires should be straightened, and then bent at right-angles to the resistor body, the wires then being inserted through the panel and soldered by the holes. With this completed, the surplus wire should then be removed with a pair of cutters. When soldering R_8 into position, note that the end wires, in this single instance, will have to be bent at right-angles at a greater distance from the component owing to the greater length of wire required to fit the resistor to the panel.

Again, when dealing with the remaining resistors, commence soldering the individual resistors in numerical order, i.e. from R_4 to R_{14a}. The missing resistor R_5 in the above sequence is to be found in packet No. 3, and will be dealt with at a later stage. Having dealt with the resistors, we now proceed to deal with the contents of packet No. 2, setting aside for the moment the i.f. transformers.

Step No. 4

Proceed to solder into position, in numerical order, the condensers contained in packet No. 2, commencing with C_4, which should be so positioned that the end marked with a black line is nearest to R_1. C_5, C_9, and C_{11} may be mounted either way round. C_{10} and C_{14} should both be so positioned that the black mark is nearest to the space allocated to the first i.f. transformer (IFT_1 of Fig. 1). C_{15} and C_{16} may be mounted either way round, but note that C_{15} does not make contact with the valveholder in any way. *Do NOT mount C_{17} at this stage* but proceed to C_{18}, any way round, and C_{20}—but particularly note that the latter component must be mounted vertically.

Step No. 5

Having mounted all the condensers, except for C_{17}, proceed next to correctly position the i.f. transformers on the printed circuit panel. Note that either transformer will fit into the positions shown—it is not important which one is fitted to either position. Mount them so that the leads protrude through to the copper-plated side

of the printed panel, ensuring that the green spot on the base of the can is in the same corner as "G" shown on the panel. Bend over the two metal tags of the outer can and solder the i.f. leads into position, finally cutting off the surplus wire. With this completed, we can now solder into position the condenser C_{17}, this being so positioned that it is mounted vertically and *NOT* touching the metal casing of the i.f. transformer.

Step No. 6

The last component to mount on the panel is the transformer T_1 (marked GB 1708), from packet No. 2. It is only possible to position this component the correct way round, there being three tags on one side and only two on the other, each corresponding to similar cut-outs on the printed panel. This transformer should be mounted on the same side of the panel as the other components.

Step No. 7

Bare both ends of three lengths of black p.v.c. wire, each about 1½in long (it is only necessary to bare about ⅛in at each end), and solder one wire end to point K on the printed panel; the second wire end to point L and the third end to point M. The three free ends will be dealt with at a later stage.

(*To be continued*)

Book Reviews

RADIO TUBE VADE-MECUM (14th Edition). By P. H. Brans. 464 pages. Published by P. H. Brans Ltd., Antwerp. Distributed in England by Bailey Bros. & Swinfen Ltd., Hyde House, West Central Street, London, W.C.1. Price 32s.

There are hundreds of receiving and transmitting valves listed in the pages of this comprehensive data book. Valves made by most of the manufacturers in the world are to be found in the listings.

The various types are shown with those prefixed by figures first, in numerical order. Then follow types prefixed by letters, in alphabetical order. The data is presented over two pages at a time so that all details can be seen at a single opening of the book. The type number is followed by the name of the maker, the classification, then characteristics. A column then follows in which is given in abbreviated form the applications to which the valve can be put, together with some dynamic characteristics for those particular functions. The last column in the data gives a reference number for base details, which are separately tabulated at the end of the book.

A preface has been translated into eight languages. In this the use of the book is explained. Much of the information presented in the body of the data sheets is in abbreviated form. A very useful and convenient means of interpreting these conventions into understandable language is the book mark, which has printed on both sides all the abbreviations and their meanings. It is therefore possible to place this list at any opening of the book being studied, where it can be consulted immediately and without the inconvenience of having continually to turn to another page to interpret symbols.

Wherever possible direct equivalents for certain valve types are indicated in the tables. These identities refer to the similarities of electrical characteristics and operational data; where certain differences exist, these are indicated in the Addenda column. Large figures or letters on the page margins assist considerably in locating a particular valve quickly. In some instances this reference shows the first and last type listed on the page, and it is thought that this system could be used throughout the book to some advantage.

A GUIDE TO AMATEUR RADIO (7th Edition). Edited by Pat Hawker, G3VA. 72 pages, about 100 diagrams, tables and illustrations. Published by The Radio Society of Great Britain, New Ruskin House, 28/30 Little Russell Street, London, W.C.2. Price 3s. 6d., postage 6d.

This handbook should find considerable appeal among those seeking to learn the basic principles of amateur radio equipment, its operation and use, and the procedure adopted by amateur operators. Even while the writer had the review copy in his hands for scrutiny, a younger relative purloined it and is now in hot pursuit of the necessary qualifications to acquire a transmitting licence!

The Introduction sets out pretty nearly all the questions posed by those who ask what all this amateur radio business is concerned with, and gives lucid and informative answers. The chapter in Getting Started gives simple yet concise information on basic circuits for apparatus, characteristics of the amateur frequency bands, and station layout. A third chapter deals with the principles, design and operation of communications receivers, while the fourth chapter discusses the various parts of amateur transmitting equipment in some detail. Both these chapters have several sections dealing with particular aspects of the equipments being considered.

In the fifth chapter there is useful information concerning the Amateur (Sound) Licence, the conditions with which an applicant has to comply in order to obtain one, and suggestions on how he can study for the Radio Amateurs' Examination. The Syllabus for this examination is given, together with a typical examination paper set by the City and Guilds of London Institute.

The sixth chapter contains information useful to amateurs in operating their stations, such as the Q code, abbreviations commonly used in morse code communications, country prefixes, and some hints and tips on DX operating. Finally, the seventh chapter tells of facilities and advantages in membership of the R.S.G.B. This handbook has been compiled by experienced amateurs and forms an excellent primer for the newcomer, who is sure to find in it much to interest him and whet his appetite for more knowledge and experience.

R.S.G.B. AMATEUR RADIO CALL BOOK (1959 Edition). Edited by John Clarricoats, O.B.E., G6CL. 72 pages. Published by The Radio Society of Great Britain, New Ruskin House, 28/30 Little Russell Street, London, W.C.2. Price 3s. 6d., postage 6d.

About 4,000 call-signs, names and addresses of amateur transmitting station operators in the British Isles are listed in the 57 pages forming the directory. The information contained therein is up-to-date at the time of going to press, and the publishers are provided with details of the Call Sign Records maintained by the G.P.O. to enable them to compile the published calls.

The book lists some 700 new call signs issued since the previous edition in 1957, in addition to which some 400 re-issued call signs have been included. Nearly 900 changes of address have been recorded and some 350 call signs cancelled. The /M (i.e. Sound (Mobile) licences) are no longer shown separately owing to the ever-increasing number of licensees availing themselves of this facility. The book also contains information concerning the aims and objects of the R.S.G.B., and full details of the QSL Bureau facilities available to members free of charge. An amateur transmitting station is hardly complete without a copy of this book on the operating desk, and one imagines that many short-wave listener stations would be similarly undressed in the absence of a copy.

W. E. Thompson

radio miscellany

IT HAS COME AS QUITE A SURPRISE TO ME IN recent weeks to learn just how many of our fellow-hobbyists are garden-shedders. Well, at least they have the advantage of being able to work undisturbed and to be able to return next evening and find things just as they left them, even if there are difficulties about a garden shed which have to be ironed out. Previously, I have always thought that the styling of our particular dens as "shacks" was due to our self-effacing modesty, but that obviously wrong idea has now been somewhat revised. It is indeed often a pukka shack tucked away in an odd corner of the garden not wanted for anything else. Hence letters have continued to come in arising out of our earlier discussion on the subject of condensation. A reader has been good enough to send along a few tips on rust prevention and removal, gleaned from a recent article in the *Model Engineer*. The easiest way, apparently, to remove patches of rust from components and tools is to use one part of phosphoric acid to three parts of water. Application is best made by brushing, but care must be exercised not to get it on one's clothing. On the fingers no burns will result if they are rinsed in water soon after contact. The phosphoric acid, of a specific gravity 1.75, costs about two shillings a pint.

Incidentally, phosphoric acid is generally used industrially for de-rusting before painting, usually with a wetting agent. This treatment is widely adopted for the very excellent reason that there is little likelihood of rust re-forming on the metal underneath. Nor are the residues corrosive. For the protection of surfaces of tools, metal parts, etc., after cleaning, a solution of lanoline 30% to 70% by weight to white spirits is recommended. An adequate quantity for most purposes can be made up with 6 oz. anhydrous lanoline (costing about 1s. 3d.) added to one pint of turps substitute (white spirit). Dip the metal to be protected for about half a minute and allow to drain. The excess solvent will evaporate in a couple of hours leaving behind a protective film of lanoline.

Economy Corner

On the same subject, J.S. (Sidcup) says that his bedroom became so overcrowded with gear and tools he had to do something about an outside workshop as he had no further space to expand. So he sent for details to a firm who extensively advertise portable buildings. In due course he received a magnificent coloured catalogue and a book on greenhouse methods which he didn't want. The price list was on a little slip of paper in the bottom of the envelope—the whole lot costing 8d. postage. He says the catalogue was printed on super art paper and must have cost several shillings to print. When he studied the slip of paper containing the prices he nearly passed out, and decided it would be just about as cheap to move to a bigger house where he could have an indoor shack.

To cut a long story short, he eventually decided to build his own shed, although he had no previous experience of that sort of thing. He bought the timber and roofing felt from a big firm who delivered it to his doorstep, at a cost barely one-quarter of its prefabricated equivalent.

"And," he adds, "I have the door and windows just where *I* want them; not where somebody else decides to put them." He finishes up with a tip to others who might follow his example. "I made only one mistake which I might well mention for the benefit of others. Don't putty the glass in until you have finished painting the frames. I did, and all the putty fell off. It just doesn't cling to bare wood. It was a good job I used a few tacks, otherwise the glazing bill might have been doubled."

Another Tip

A further nice letter from our old friend L.H.B. (Abingdon, Berks) who, you will remember, has a daughter with ideas on escape routes for t.v. interference. By the way, many thanks, O.M., for Harwell House Magazine copies, safely received. He writes: "It is not generally realised by constructors that a metal woodworkers' vice is often much more useful for radio work than the more usual engineers' vice. A 6-in carpenters' vice costs only 22s. 6d., and easily opens up to 5in, but one of the engineers' pattern with a comparable jaw capacity is a much more expensive item." He is right, too, although I cannot recall anybody drawing attention to it before. Worth bearing in mind by those newly starting off, or re-designing their workshops.

Incidentally, I recently added to my range of workshop "furniture." Treated myself to a ball-based vice which tilts to any angle up to 30 degrees in any direction. Can't say I have found any special use for it yet, but it's a nice sort of thing to have. Impresses visitors, too. Everybody who has come so far has played with it and adjusted it to all sorts of improbable angles. Then they ask the price and say "H'm." Next time I do the rounds I must see how many have bought one like it.

Hard Lines

In writing about the possible uses to which the vacant t.v. channels might be put, I mentioned a number of alternatives. One was to start 625-line transmissions to ease an export problem and at the same time enable an inexpensive (for viewers) gradual change-over as existing receivers become obsolete. J. A. C. (Gilda Crescent, Polegate) takes me to task over this, but I rather imagine his real idea is to provoke discussion. He says he recalls many technical writers advocating sticking to our 405 line system so convincingly that he has been won over to their way of thinking. He is satisfied, too, that B.B.C. transmission quality is good enough even for exhibition photographers, and hints that those who complain ought to look to their receivers!

I am afraid it is a bit too late to start an argument now, J.A.C. Since receiving your letter it seems that the Television Advisory Committee (set up to advise the Government on such points) suggest that we change over from our "old-fashioned" 405-line system to the international 625-line. They recommend that transmissions at the present standards should be kept going for ten years. By that time our present sets will be so outdated that even the most parsimonious will have no cause for complaint.

Better Late than Never

Some years ago I wrote at length on what I thought to be a strange omission in all the American technical books I checked on—the absence of any mention of Oliver Heaviside. Within the Empire we perpetuate his memory by naming one of the ionized layers above the earth's atmosphere after him, in the same way we speak of the lower layer by calling it after Sir Edward Appleton. In the United States it is spoken of simply as an upper ionized layer and no credit is given to Heaviside.

Oliver Heaviside died at the age of 75 some 34 years ago, embittered and practically penniless, much of his work unpublished—and unpublicised. Recently, as the result of a close examination of many of his scribbled papers and formulae found long after his death, he has been proved to be an even greater original scientific thinker than previously believed. Perhaps with the full unravelling of his scientific notes he will receive greater recognition here, and, at least, acknowledgment abroad.

How often in the history of scientific discovery have men with ideas a generation before their time been snubbed by their more orthodox contemporaries! Maybe today our attitude isn't always much more enlightened towards modern Heavisides.

I recall that when I wrote of the failure of American technicians to connect him in any way with the layer we name after him in the rest of the English-speaking world, I asked if any reader had found mention of the Heaviside Layer as such in an American work. No replies were received.

A good publicity agent seems to be a greater asset than a brilliant brain.

Unkind

Quote, from an amateur film critic: "Third rate? I'll say it was. Not even good enough for television."

Anyway, viewers, you will have to wait at least another twenty years before you see it.

Centre Tap talks about items of general interest

JINGLEBELLS

AMATEUR RADIOTELETYPE

Part 2

By JIM HEPBURN, VE7KX

TO RECEIVE AN F.S.K. RADIOTELETYPE signal the receiver's beat frequency oscillator is turned on, the same as for C.W., and the receiver tuning adjusted to produce two audio tones from the RTTY signal representing the "space" and "mark" signals being transmitted alternately from the sending station. This has converted the F.S.K. signal to A.F.S.K., and in order to be compatible with audio frequencies adopted for amateur A.F.S.K. signals the receiver should be adjusted to give an audio signal of 2,975 c/s for the "space" frequency and 2,125 c/s for the "mark" frequency.

This two-toned audio signal must now be converted into d.c. pulses to operate the selector magnet in the teletype printer, and this is accomplished by the "converter" unit shown on the accompanying diagram, Fig. 2. In this converter the two audio signals are separated by tuned filters and rectified so that the 2,975 c/s signal applies a negative voltage and the 2,125 c/s audio a positive voltage to the grid of a d.c. amplifier stage, V_2, which in turn drives the keyer stage V_3. The input transformer T_1 is a midget 500 ohms line-to-voice coil transformer; this can be eliminated if it is desired to run the converter directly from the receiver speaker voice coil circuit, but as it will be necessary to make use of test equipment, audio oscillators and bandpass filters, etc., it is desirable to keep all station audio lines at 500 ohms impedance.

The transformers T_2 and T_3 are made up from high "Q" 88 millihenry toroids. These toroids are known locally (in Canada) as "load pot toroids" and are employed in vast quantities for telephone cable loading or "Pupin Coils." They are also available on the surplus market as the C-114 line loading coil having been used for army (U.S.) field telephone lines. These latter are encased in a small cast metal case and need to be depotted for this application. These coils have two windings which are connected in series to give the 88 mH inductance. On each toroid a small link winding of six or four turns of small hook-up wire is added and these links are connected in series across the secondary winding of the input transformer T_1. Link coupling is used in preference to capacity coupling to avoid stray capacities and possible resonances which might affect the tuning of these extremely high "Q" toroids. If these toroids are not available, small audio chokes of fractional henry inductance or the 500 ohms winding of midget speaker transformers may be substituted. However, these are very low "Q" inductances and it will be necessary to use several tuned stages in cascade, with probably additional amplification to achieve the selectivity of this simple toroid circuit.

The rectifier stage V_1 consists of a 12AU7 with the grid and anode of each section connected together to form diodes. A double diode such as the 6AL5 could also be used, but the 12AU7 was chosen to keep valve types to a minimum. The d.c. amplifier stage V_2 is one section of a 12AU7 and its anode supply is stabilised by an 8μF 150V condenser and two small neon bulbs in series. Condenser coupling is employed between the amplifier and keyer stages; this 0.5μF condenser should be of good quality and low leakage. The 6V6GT keyer stage V_3 has its screen voltage regulated at 60 volts by the 47kΩ screen resistor and another small neon bulb. The printer selector magnet is connected in series with the keyer tube anode and this coil is shunted with a 10kΩ 1-watt resistor to absorb transient surges created in the printer magnet coil. The keyer valve is normally conducting and the current through the printer magnet coil is adjusted to the required value (usually 30mA) by the adjustable 10kΩ 10-watt resistor. Should the printer be one that requires a 60mA coil current it will be necessary to add a second keyer valve in parallel and adjust resistor values and power supply requirements accordingly. The cathode of the keyer valve is connected through the teletype machine keyboard contacts to ground. These contacts are normally closed and remain so during reception. The keyer valve is conducting during no-signal and space signal conditions; the positive mark pulse from the filter-rectifier stage is inverted by the d.c. amplifier and applied as a negative pulse to the grid of the keyer valve, cutting off the keyer valve and releasing the printer selector magnet.

Operation of the keyboard opens the cathode of the keyer valve, thus operating the printer for "local copy" from the keyboard.

valve and is subjected to full power supply voltage to ground. Should there be any doubt as to the insulation of the magnet windings, the magnet coil can be connected between the cathode and the keyboard contacts. However, this causes degenerative feedback into the grid of the keyer valve and pulse-shape distortion. If this circuit connection is used, the spare section of V_2 should be connected as a clamper diode between grid and ground of the keyer valve.

The only critical adjustment required to get this converter into operation is the tuning of the toroid filters. This requires a calibrated

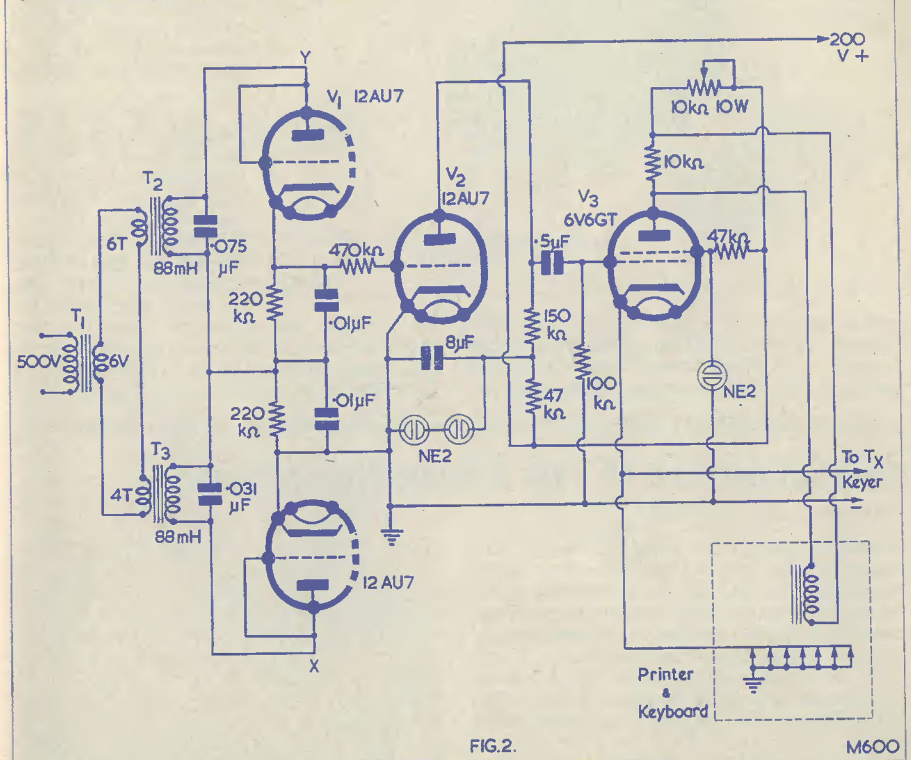


FIG.2.

The 60 volts regulated screen voltage appears across the keyboard contacts during this operation and a lead is brought out from the keyer valve cathode so that this keyed voltage can be used to control an RTTY radio transmitter. The receiver must be shut off or disconnected from the converter during transmission so that key clicks and noise will not feed through the converter and cause garbling.

In this circuit the printer magnet coil is connected in the anode circuit of the keyer audio signal generator and either an oscilloscope or a valve voltmeter. Feeding the audio signal into the converter input and reading the d.c. voltage generated at the grid of V_2, different values of condensers are connected across the tuned circuit until the frequency-voltage curve resembles that shown in Fig. 3. The ideal condition is when the positive and negative curves are the same height and cover equal areas, when random noise signals are balanced out and do not affect the keying. It may be necessary to adjust the number of link turns and/or add shunt resistors to the tuned circuits to achieve a perfect balance. This detail is only required for weak signal work. On strong signals a five to one unbalance will still print perfect copy. An oscilloscope makes an ideal indicator for tuning RTTY signals. Connect the horizontal input to the "space" or bottom anode of V_1 and the vertical input of the scope to the other anode of V_1. A properly tuned space signal will show as a clean horizontal line and a mark signal as a clean vertical line, and a properly transmitted and tuned RTTY signal as a perfect right-angled cross. Any distortion, improper shift or incorrect tuning can be read off the scope pattern.

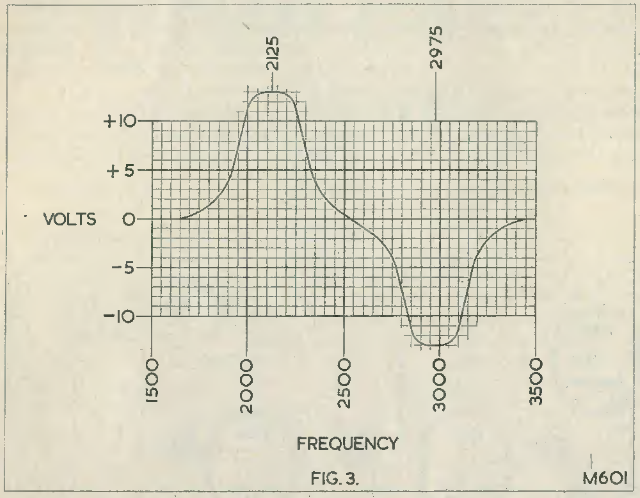


FIG. 3.

Power supply requirements for this converter are 50mA at 200 volts. Filtering and regulation are not critical; but this power supply should not be used for any other equipment, as the sharp massive pulses of the keyer output will affect any other gear drastically.

Very accurate audio frequencies can be obtained from a BC-221 frequency meter by beating its low frequency band against a 125 kc/s oscillator. On this band the BC-221 has a bandspread of forty dial divisions per thousand c/s. These dial divisions can be read to a tenth of a division, thus any audio frequency can be set up to an accuracy within three cycles.

An Explanation of Low Power Ultrasonics

—continued from page 626

tioned, and that is the successful use of ultrasonic soldering. Being able to solder aluminium in this way is extremely useful when it comes to repairing castings, and the aluminium speech coil wires of loudspeakers are also soldered by ultrasonics.

Before concluding, it might be as well to classify the generators available today. This is usually done by means of a small classified table.

As far as "Do-it-yourself" or home construction goes, it is inadvisable to think of building one's own equipment. A considerable amount of research has gone into achieving the present high standard of commercial equipment, and there is every indication that the prospects of being successful with a home-built equipment are remote. In the first place, a rather ambitious generator is necessary, giving 50–60 watts output as the minimum requirement. It is true that some public address amplifiers provide such an output quite easily and could be adapted to amplify the waves generated from an oscillatory circuit. Provision can be made fairly easily for the polarising voltage for the transducer, but the story does not end there because one would have to consider the provision of the transducer for drilling which must be mounted on a suitable stand, or alternatively, a cleaning bath. It would be an interesting proposition which would open up a number of possibilities for the man with engineering and electrical instincts, and perhaps the day will come when some enterprising manufacturer will turn his thoughts to designing something in the nature of a kit partly assembled which will enable the average handyman to obtain the benefits of ultrasonic cleaning and drilling for jobs about the home or for his hobby.

In the meantime, there are efficient commercial equipments available to industry which are proving their worth every day in tackling problems which before use was made of ultrasonic waves were difficult, laborious, costly or even impossible.

The AMPLIFONE

by

I. F. Gregory

A neat and functional device which enables telephone conversations to be amplified and reproduced over a loudspeaker

IT IS A FUNDAMENTAL AXIOM OF MODERN living that, whilst the telephone has introduced many advantages and has resulted in considerable savings in time and energy, it has also been guilty of causing probably more general frustration and inconvenience than has any other electrical or electronic instrument. When it occurs, frustration is almost always due more to the human element than to the mechanics of the telephone itself, and it is probably at its worst when the telephone is employed for purposes of trade. A subscriber rings up a particular person at his place of business, only to be told by an impersonal operator that he must hang on until the required person has been found. After this initial contact, the process of hanging on may last for a few seconds only or it may extend to as long as ten minutes, during which time the caller is tied to his own telephone and is unable to take the receiver away from his ear in case he misses the person called up. Under these conditions it is impossible to concentrate fully on any other work. In addition, the vexations of hanging on frequently make themselves evident outside the realms of business, as many subscribers who have attempted to reach particular departments in large stores or other organisations will bear out. A typical instance occurs when the enquiry offices of some of the London railway stations are rung up, the state of affairs here having been sufficiently bad in the past to cause letters of complaint to appear in such newspapers as *The Sunday Times*.

The inconvenience given by the telephone becomes very apparent when long conversations take place. The necessity of keeping the receiver held to one's ear means that a single hand only is free for purposes of making any notes that may be required.

The "Amplifone" overcomes these disadvantages at one step, this being due to the fact that it enables telephone conversations to be reproduced at loudspeaker level. In consequence, any subscriber who is told to hang on has merely to switch on his "Amplifone," whereupon he can place his receiver down on the table and concentrate on any other jobs he wishes to handle. As soon as the required person is found, the caller will be advised over the "Amplifone" loudspeaker. Similarly, when long conversations take place, it is necessary merely to turn on the "Amplifone" whereupon all information may be heard at comfortable level, both of the subscriber's hands being free for any action that may be desired. With the aid of the "Amplifone" it is in many cases possible to hold two-way conversations without the necessity of handling the handset at all. The telephone microphone is sensitive enough to pick up speech when it is quite some way away from the speaker's mouth and it may be kept in this position for, at least, local calls.

The "Amplifone" Circuit

An amplifying device of the type we are concerned with here has, apart from such obvious features as those of providing adequate volume and acceptable fidelity, to meet two special requirements. The first of these is that it must be capable of being brought into use at a moment's notice. This point makes it undesirable to employ an amplifier having mains valves because of the necessity of waiting for these to warm up after the amplifier has been switched on. A possible solution, that of keeping the mains valve heaters supplied all the time and switching on h.t. only when the amplifier is required, is rather clumsy and wasteful of power. A battery-powered amplifier provides a much more attractive possibility; and battery costs can be kept to a very low level by the use of transistors. The "Amplifone" employs four readily obtainable transistors, these being powered by a 6-volt battery.

The second requirement of a telephone amplifying device is that no connections must be made directly to G.P.O. lines. This point is met in the "Amplifone" by the aid of a

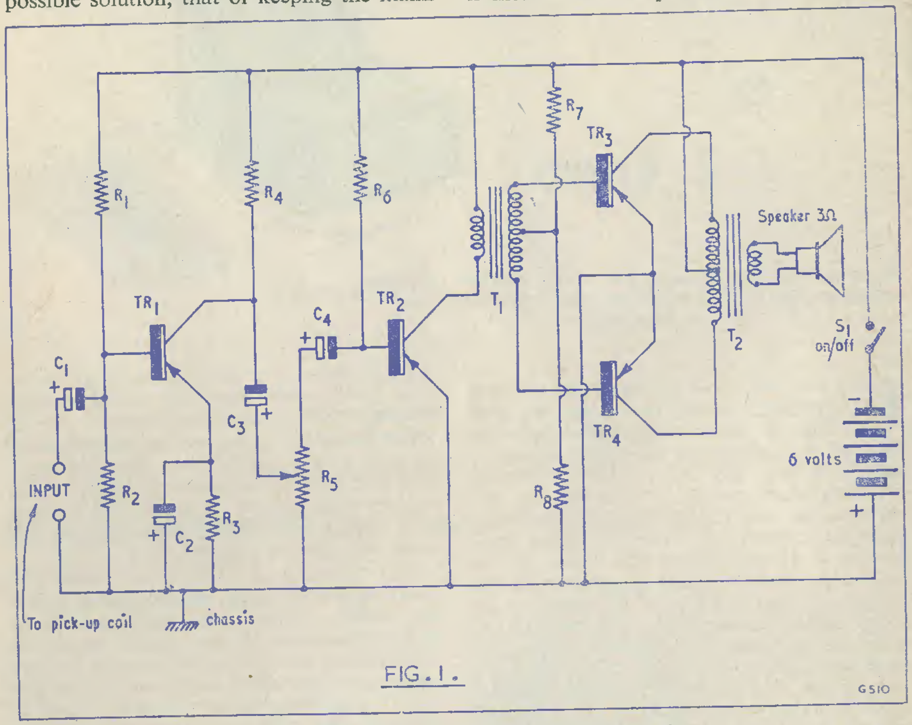


Fig. 1. The circuit of the "Amplifone" amplifier

Components List

Resistors
- R_1 47kΩ
- R_2 10kΩ
- R_3 470Ω
- R_4 2.7kΩ
- R_5 5 or 10kΩ potentiometer
- R_6 22kΩ
- R_7 4.5kΩ
- R_8 180Ω

Condensers
- $C_{1, 2, 3, 4, 5}$ 8μF 6 w.v. electrolytic

Transistors
- $TR_{1, 2, 3, 4}$ "Red Spot," p-n-p, junction transistors

Transformers
- T_1 Ardente, type T131
- T_2 Ardente, type T132

Switches
- S_1 On-Off, s.p.s.t. (May be combined with R_5, if desired.)

Speaker
- Impedance 3Ω

Battery
- 6V Type to suit individual amplifier cabinet layout.

Pick-Up Coil
- As described in the text

special pick-up coil which is held close to the base of the telephone instrument, an inductive coupling being obtained with the transformer which is fitted therein.

The circuit of the "Amplifone" amplifier appears in Fig. 1. As may be seen, this consists of a conventional four-transistor amplifier whose input terminals are fed by the pick-up coil, and whose output connects to a 3 ohm loudspeaker. The first two transistors, TR_1 and TR_2, operate in earthed emitter stages, a volume control, R_5, being inserted between them. According to individual choice, R_5 may be combined with the on-off switch S_1, or it may be separate. The first alternative is worth consideration insofar that it allows a single panel control to be fitted; whilst the second gives the advantage that, once the volume control has been set to the level required by the user, it does not need to be adjusted further. Whether or not the volume control is combined with the on-off switch is left to the choice of the individual constructor.

Transistor TR_2 drives the two output transistors in a normal push-pull stage, adequate volume being provided for normal purposes. The two transformers T_1 and T_2 are miniature components and they are specified in the parts list by manufacturer and type number.

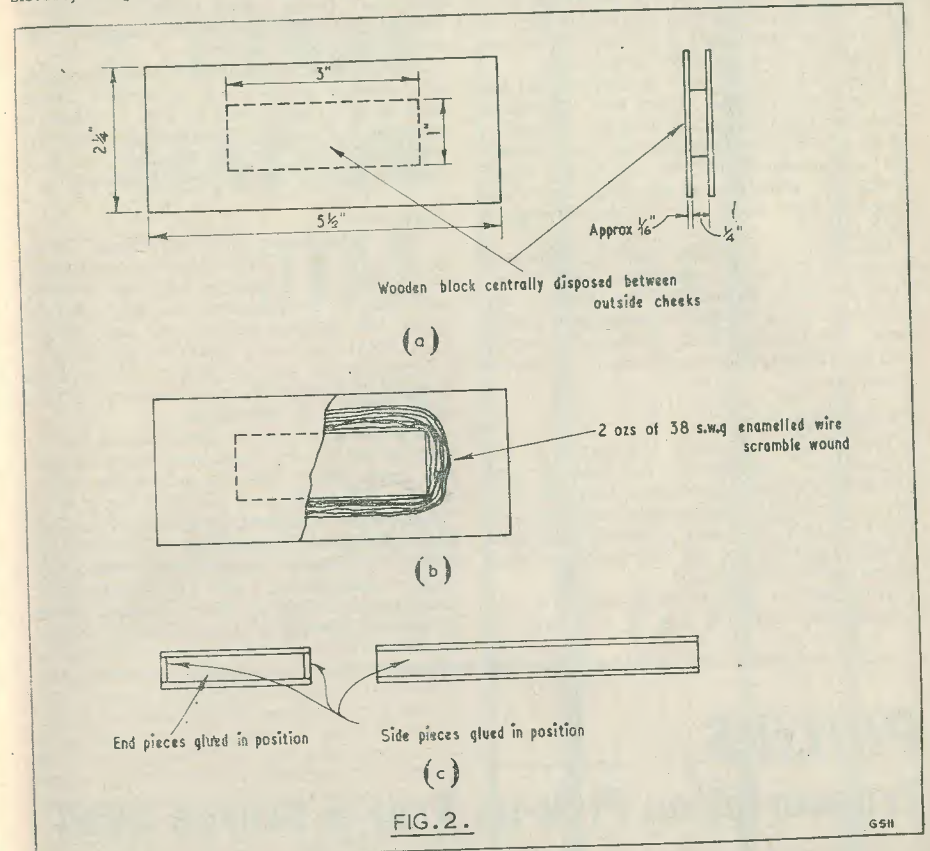


Fig. 2. The assembly of the pick-up coil. This consists basically of a 3 x 1 x ½in wooden block to which are fixed two rectangular cheeks (a) The coil is then wound on the central wooden block (b) after which two end pieces and two side pieces are glued into position (c)

The remaining part of the amplifier circuit proper consists of the speaker and battery. The pick-up coil does not form part of the amplifier unit, it being connected externally via a length of flexible two-way cable.

Due to the few components required in the amplifier section, together with their small size, it is possible to make this part of the "Amplifone" very neat and compact. A photograph of the housing employed by the designer accompanies this article and gives an idea of the dimensions required. It should be pointed out that the amplifier fitted in this particular housing was laid out very comfortably with no emphasis on saving space, and that a significantly smaller cabinet could be used, should this be desired. The speaker employed in the designer's prototype is a 2½in unit, and the power is provided by four U.16 "pen-type" cells connected in series-parallel to give a potential of 6 volts.

From the point of view of construction and layout, the amplifier offers few difficulties. The first transistor stage should, preferably, be mounted at the opposite end of the chassis (or component board) to the output stage. If the two transformers are fitted very close together they should be at right-angles to each other.

The pick-up coil can, most conveniently, be connected to the amplifier via a socket fitted to one of the walls of the cabinet. The designer used a miniature hearing-aid socket here. The length of lead between the pick-up coil and the amplifier may be left to individual preference.

The Pick-Up Coil

Due to the low input impedance of the "Amplifone" amplifier, the pick-up coil differs somewhat from the type of coil encountered with tape recorders and the like. The coil may be made at home with little trouble as there are no very critical points which have to be satisfied.

The pick-up coil is constructed in the manner illustrated in Fig. 2. As will be noted, it consists basically of a wooden block to which are fitted two side cheeks. The latter should have a thickness of approximately $\frac{1}{16}$in and may consist of wood or any suitable insulating material such as Perspex or Paxolin. The coil is wound on the central wooden block, after which side and end pieces are glued into position as shown in the diagram, giving a final "solid" effect. A hole may be made at one end of the assembly to take the lead-out cable, connections to the coil ends being made inside. The outer surface of the assembled coil unit may then be cleaned up as required.

The coil itself is simple to wind, it consisting of 2 ounces of 38 s.w.g. enamelled copper wire fitted as illustrated in Fig. 2. There is no need to count the number of turns provided that the correct weight of wire is employed. The coil is scramble-wound.

Operation

After completion, the "Amplifone" needs to be fitted up to the telephone instrument with which it is to be used. All that is necessary here is to switch on the amplifier and apply the pick-up coil to the base of the instrument, leaving it finally at the position which provides greatest pick-up of telephone speech. Coil positioning is liable to vary for different types of telephone.

It is possible in some cases that, at the full volume setting, feedback may occur between the loudspeaker and the telephone microphone. This will most probably occur if the "Amplifone" loudspeaker is directed towards the telephone microphone. The solution consists of orientating the loudspeaker. The final volume setting for the "Amplifone" amplifier is that which gives adequate output at normal telephone speech levels.

PHILIPS

Transcription Pick-up Arm & Stereo Head

Philips Electrical Ltd. have introduced a Transcription Pick-up Arm (Type NG5400/S) fitted with a pick-up head (Type AG3060) which is designed for reproduction of stereophonic as well as monaural long-playing records. Arm and head complete sell at 15½ gns. (List £11 15s. plus P.T. £4 10s. 6d.).

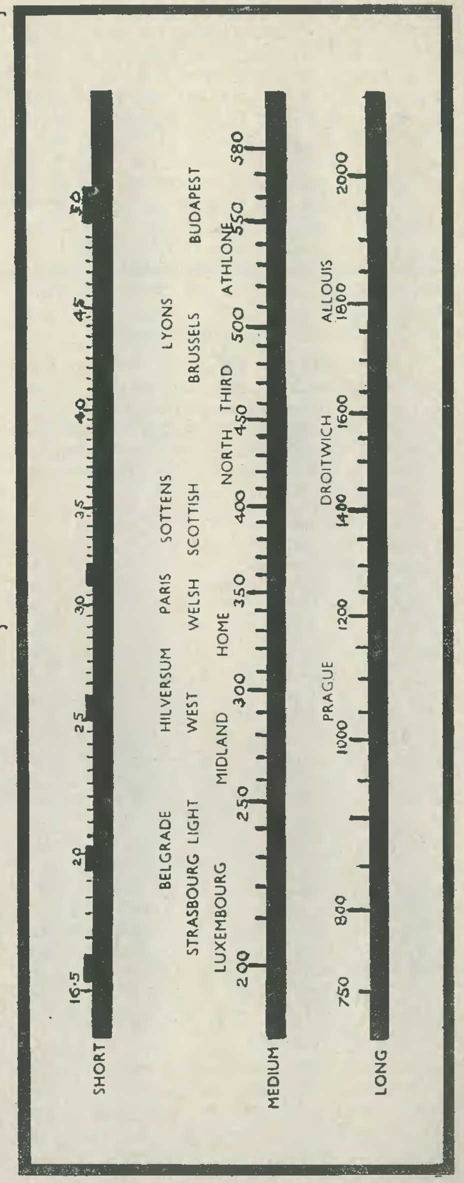
The precision-engineered arm, well known for its association with the Philips magnetodynamic pick-up head, is professional in appearance, with a durable satin chrome finish. It is equipped with a micrometer playing weight adjustment, and the arm pedestal and rest are adjustable in height so that the pick-up can be used with any separate turntable.

Close attention has been paid to the matter of minimising resonance and friction.

The crystal pick-up head has a diamond stylus and a frequency response of 30–12,000 c.p.s. The recommended load resistance for each channel is 500kΩ, and the output is approximately 0.5 volt for each channel. Suggested playing weight is 4–6 grams.

MAKING A GLASS STATION DIAL

by B. B. Rafter



Most readers will be familiar with the Panel-Signs sets of transfers issued by the publishers of this magazine and designed to give a professional finish to the visible parts of home-constructed equipment. Many may not yet have realised the value of the fairly recent additions to Sets 3 and 4, the lists of names of the main Long, Medium and Short Wave stations to be found on the average dial plate. Indeed, the writer himself had not seen their possibilities until a friendly hint from the Editor in response to a desperate appeal got him out of a very awkward situation indeed.

It was the usual story; not leaving well alone. Some very extensive repairs had been carried out to modernise an "old-timer" for an elderly lady who couldn't bear to part with what had been her wedding present, an H.M.V. Model 486. As the rehabilitated watts poured over the bench, it seemed a good time to remove some of the dust and stains of the years from the glass station-dial, which had never been touched since the day it was fitted. Out it came, and into a bowl of tepid suds, just to ease the pain. Time for a few adjustments to the set, then out of the suds with the dial, a quick rub with a clean cloth and . . . large swathes of the pre-Copenhagen names and wavelengths came away on the cloth! Disaster!!

There was no returning the set to the owner with its dial in that condition. The makers, when approached, had, of course, run out of spares before Hitler ran into Austria, where the original plates were made, being a sort of transfer on glass, station names in black on a white frosted background, with slots at the appropriate places for viewing the pointer. Restoration of the original in anything like its previous form seemed impossible, as did various other solutions that sprang to mind for either finding a three-wavelength glass dial of the same size ($12\frac{1}{4}$in x $3\frac{1}{2}$in) with a pointer travel of exactly $8\frac{1}{4}$in, which nobody seemed to stock; or for changing the pointer travel to fit a substitute of reduced dimensions. The latter would have got us inextricably trapped in the higher maths, since the early H.M.V. lines used a sturdy gearbox on their reduction drives and it was not a question of just changing one drive drum for another.

Near-despair was finally relieved by the above-mentioned friendly hint by the Editor, who once, it seems, hand-painted his way out of a jam like this by the use of a technique known to the limners of mediaeval manuscripts! But that was before the days of Panel-Signs!!

A few experiments with some of the titles from Set No. 4 showed that admirable prints of bold black lettering about $\frac{3}{32}$in high could be made on glass, to show up extremely well against a background of white paper lit from behind. The following method was then adopted to produce a substitute for the wrecked scale. A piece of picture glass was cut to the same size as the original, together with a piece of good quality, translucent writing paper, same dimensions. In this paper were then cut, with a razor blade, three slots $\frac{1}{8}$in wide by $8\frac{1}{4}$in long, one above the other, spaced as in the original, to provide the wavelength scale behind which the pointer would be seen to travel along. Fortunately there was enough detail left along the original slots to enable it to be used as a template, so the paper mask was laid over it, slots coinciding, and the wavelength scale was marked in indian ink along the edge of each slot, Short Wave at the top, Medium below and Long at the bottom. The more neatly this was done, of course, the better the final job would look.

The next stage was to fix the paper wave scale behind the glass. A first attempt was made to do this merely by sticking it at the ends with Sellotape. Pasting or glueing to the glass was not possible, since the scale was to be lit from the back and perfect translucency would be spoiled. Owing, however, to varying conditions of humidity, it was found that the Sellotape was not sufficient to maintain a tension which would keep the paper scale flat against the glass at all times, so another identical sheet of picture glass was cut and the paper scale fixed dead flat by sandwiching between the two glass plates bound together by Sellotape.

It remained to start printing the station names in neat groupings on the top of the glass above the appropriate wave scales. There were no Short Wave stations named on the original, thank the powers, so there remained the Long, which it was decided to cut down to three (Prague, Droitwich, Allouis) and the Medium band. Here, as no attempt was to be made to cut tiny slots under each name, as in the original, the names had to be placed with their centres corresponding approximately to the reading in metres on the scale below. A list was made of all the principal British Medium Wave stations, with wavelengths from Third (463) to Light (247) and a choice of the four best for this area (Third, North, Home, Midland) was made, these names to be placed lowest, that is just above the wave scale, for ease of reference.

The actual process of printing these transfers was incredibly simple, with results the writer would never have believed possible. The backing paper was removed from the complete sheet and each name cut out from the transparency as required, trailed across the surface of a saucer of clean water with a pair of stamp tweezers and placed in position on the glass above the proper section of the wave scale. Linearity was checked with a ruler after positioning, the tissue gently padded with a piece of blotting paper and left to dry. After this other names were added at each end of the bottom line (Athlone, at the right, Luxembourg at the left, then another line was begun, above the first and slightly staggered to the right (Brussels, Welsh, West, Light) and finally, above these a row of foreigners (Lyons, Sottens, Paris, Hilversum, Belgrade). This set of fifteen names very conveniently filled the space available and gave a useful choice and neat display, completed by the words Short, Medium and Long at the left-hand end of the wave-scale slots.

When all the transfers were dry, the tissue was slightly damped with a cloth and peeled off with tweezers, to reveal a most satisfactory print. A little cleaning away of surplus gum and, when all was bone dry, a coat of transfer fixing varnish over the names completed the job, which, when fitted into the set, gave a smart, clean dial, perfectly adequate for all normal domestic requirements.

This method of making a station dial could be adapted to almost any home-constructed set, with most pleasing results.

A Battery Power Unit

by J. HILLMAN

THIS UNIT WILL SUPPLY BOTH L.T. AND H.T. for most battery sets, and provides a convenient source of supply for servicing these sets. It consists of two units, the main unit having the controls on it, and a plug-in unit with a flexible lead having various sockets on it to suit the different types of battery plugs. The off-load voltages are: L.T., variable from 0 to 7.5V.; $H.T._1$, variable from 0V to 250V; $H.T._2$, variable from 110V to 250V. With controls at maximum, on-load voltages are L.T. 3V at 1 amp; 7V at 100mA; $H.T._1$ and $H.T._2$ 250V at 80mA. The $H.T._2$ variable control is rated at 3 watts and up to 15mA can be safely taken through it, whilst the $H.T._1$ variable control is rated at 1 watt and up to 5mA can pass through it. For test purposes these figures can be exceeded, but not if the unit is to be kept on for very long.

Construction

First mark out the chassis in aluminium as Fig. 1 and bend the $\frac{1}{2}$in edges up at right-angles to form a shallow box. Drill $\frac{1}{8}$in holes at corners and secure with 6BA nuts and screws. Next cut out the panel as in Fig. 2 and bend up the $\frac{1}{2}$in edges at right-angles, then drill holes as marked out in Fig. 4. Now fix the panel to the chassis as in Fig. 5 and assemble components as in Figs. 7 and 8. Next fit components to switch block as in Fig. 10. For the wander plug sockets use plain sockets and drill $\frac{7}{32}$in holes; for the 0BA terminals drill $\frac{15}{64}$in holes, and for the flexible lead drill a $\frac{3}{8}$in hole.

Wiring

Wire up as in Fig. 9, using stranded wire to cut down voltage drop in leads. For the flexible lead use 4ft lengths of 23/36 single rubber flex; five lengths are required, and after connecting them to the various sockets on the switch block twist them together one by one to get a smooth cable, and finish off with a turn of insulating tape, finally soldering them to the valve plug as in Fig. 10.

Meter

The meter used had an F.S.D. of 500μA, with a resistance of 500 ohms; and the values of series resistors are as shown in Fig. 9. A 1mA meter may be used, but in that case the series resistors will be different and for a 100 ohm resistance meter the values will be: 3V range, 2,900 ohms; 15V range, 14,900 ohms (a 15kΩ will do); 150V range, 150kΩ; 300V range, 300kΩ. Meters having a greater full-scale deflection than 1mA may be used but will increase the consumption of the unit and will therefore lower the voltages which the unit will supply. The meter should be checked against a standard one if possible, as its accuracy is important to ensure that the sets are not over-run, especially on the l.t. ranges. If no meter is available to check against, then the meter can be checked against a freshly charged accumulator which has been allowed to stand off charge for several hours and which should read 2.2V.

The meter resistors are made up from standard 10% tolerance ones; the 5.17kΩ being made up of 4.7kΩ and 470Ω in series; the 278.2kΩ one is made up of 270kΩ and 8.2kΩ in series; whilst the 526kΩ one is made up of 470kΩ and 56kΩ in series.

The flexible lead plug is made from an old 5-pin valve. Wrap a cloth around the valve and break it with a hammer, remove all the broken glass and scrape out the old cement with a knife, and then apply a hot soldering iron to the tip of one pin and pull out the old wire from inside with a pair of pliers. The new lead can be threaded down inside

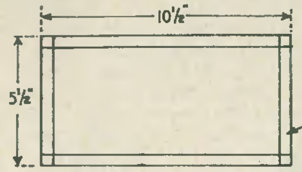


FIG. 1

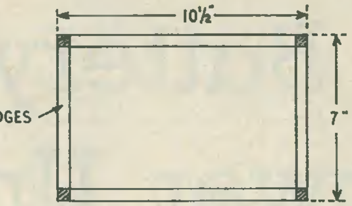


FIG. 2

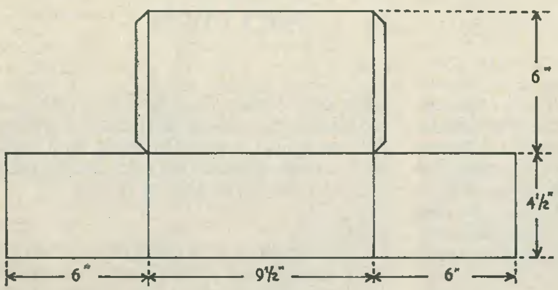


FIG. 3

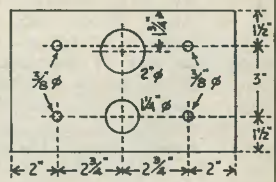


FIG. 4

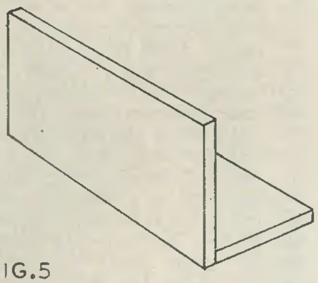


FIG. 5

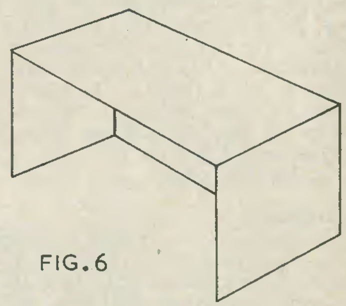


FIG. 6

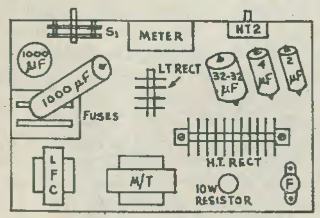


FIG. 7

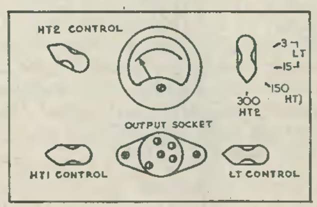


FIG. 8

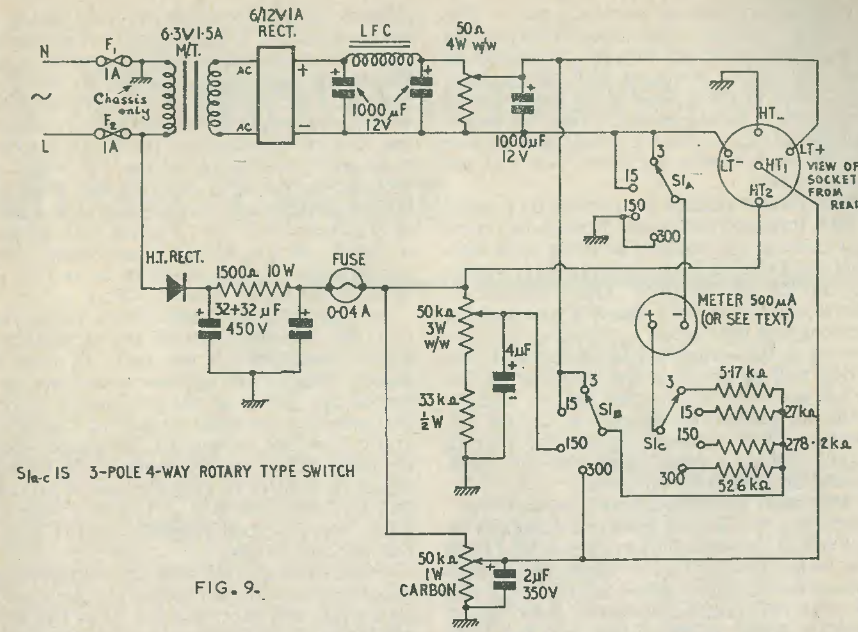
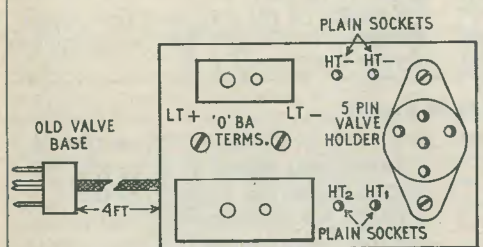
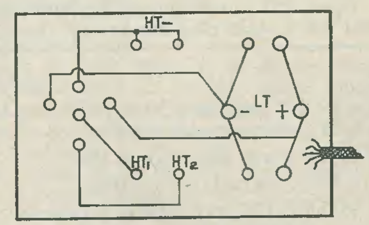


FIG. 9.



WOOD SWITCH BLOCK 6"x 3"x 1"

FIG. 10



WIRING OF SWITCH BLOCK

FIG. 11

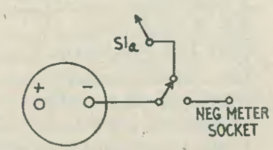


FIG. 12

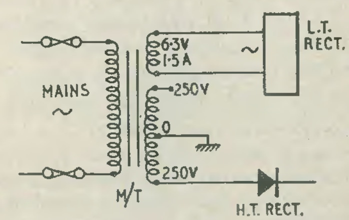


FIG. 13

the pin and resoldered at the tip again. The l.f. choke was one that came from an old battery converter, but any l.f. choke will do provided that it is wound with heavy gauge wire, 16 or 18 s.w.g., so that the voltage drop across the winding is negligible. Failing a suitable l.f. choke, then a heater transformer can be used; ignore the mains side and use the l.t. side.

The 10-watt resistor is mounted by passing a 4BA threaded rod down through its centre and through the chassis, securing with 4BA nuts and bolts, and using a large plain washer on top of the resistor. There should, of course, be no contact between the resistor element and the fittings or chassis. The h.t. fuse is a 0.04-amp M.E.S. bulb, and this rating will ensure that the majority of the valves are protected in case the h.t. and l.t. leads are plugged in wrongly at the set. If, however, it is intended to use the unit to supply 80mA current, then the fuse bulb should be altered to 0.1 amp.

The meter can be used as a separate voltmeter but in this case it will be necessary to fit a S.P.D.T. switch in the negative lead from the meter to S_{1c} and a separate negative socket on the front panel as Fig. 12. The 3V and 15V positive socket is then the l.t. positive socket of the output and the 150V socket is the H.T.$_1$, whilst the 300V socket is H.T.$_2$.

When first connecting up the power supply lead use a 3-pin plug top so that the correct polarity is observed, the live lead going to the lead marked L and the neutral lead going to the lead marked N. These markings are usually on the plug top when its cover is removed, but if there are no markings then with the large pin uppermost and looking at the back of the plug top, the L pin is to the right and the N pin to the left. If it is required to keep the unit isolated from the mains, then a mains transformer giving 250V at 80mA and 6.3V at 1.5 amps may be used in place of the heater transformer. The connections are then modified as in Fig. 13. (This is the better method.—Ed.)

In operating the unit always make sure that the variable controls are at minimum before switching on the unit, so that no excess voltages are applied to any set connected up. Bring up the l.t. control, having first switched the meter to the "l.t." position, and adjust the voltage to its correct value on load. Then switch meter to H.T.$_1$ and adjust its control to give the correct voltage, and similarly with H.T.$_2$. Use H.T.$_1$ for the lower voltages, including 90V, and H.T.$_2$ for the highest voltages.

When using the unit with sets incorporating automatic bias, do not plug in an earth to the set as this will short out the bias; this does not apply if an isolating mains transformer is used in the unit.

To finish off the unit, mark out a panel of aluminium as in Fig. 3, then cut out and bend to form a cover as Fig. 6.

List of Parts Required

- 1 6.3V 1.5 amp, or 250–0–250V 80mA and 6.3V 1.5 amp mains transformer
- 1 6/12V 1-amp full-wave rectifier
- 1 L.F. choke or l.t. transformer
- 3 1,000μF 12V wkg tubular condensers
- 1 250V 80mA half-wave rectifier
- 2 1¼in 1-amp fuses
- 1 twin fuseholder, baseboard mounting
- 1 32+32μF 450V wkg tubular condenser
- 1 1,500Ω 10-watt wire-wound resistor
- 1 M.E.S. 0.04-amp bulb, any voltage
- 1 M.E.S. holder, baseboard mounting
- 1 3-pole 4-way rotary switch
- 1 meter, 0.5mA or 1 mA
- 1 50Ω 4-watt wire-wound potentiometer
- 1 50kΩ 3-watt wire-wound potentiometer
- 1 50kΩ 1-watt carbon potentiometer
- 1 33kΩ ½-watt resistor 10%
- 1 4.7kΩ ½-watt resistor 10%, see text
- 1 470Ω ½-watt resistor 10%, see text
- 1 27kΩ ½-watt resistor 10%, see text
- 1 270kΩ ½-watt resistor 10%, see text
- 1 8.2kΩ ½-watt resistor 10%, see text
- 1 470kΩ ½-watt resistor 10%, see text
- 1 56kΩ ½-watt resistor 10%, see text
- 1 4μF 350V or 500V wkg tubular condenser
- 1 2μF 350V or 500V wkg tubular condenser
- 2 British 5-pin valveholders
- 4 plain metal wander plug sockets
- 2 0–BA terminals
- 1 M.2 all-dry battery socket
- 1 S.2 all-dry battery socket
- 20ft 23/36 single rubber flex
- 1 6in x 3in x 1in wood switch block
- 1 sheet aluminium 10½in x 12½in
- 1 sheet aluminium 10½in x 21½in
- Panel signs transfers, Set No. 4

LONDON AUDIO DEMONSTRATION

Heathkits (Daystrom Ltd.) have made arrangements to display and demonstrate their audio and other equipment at the Royal Hotel, Russell Square, W.C.1, from 2nd to 5th April, inclusive. The model S-88 Hi-Fi stereo amplifier and the SS-1 Hi-Fi speaker will be particularly featured.

A Comprehensive Mixer-Fader

by J. G. RANSOME

This unit was originally designed for a friend who was suffering from "the tape bug." His requirements were for a two-channel high-gain mixer for two microphone inputs, the output of which could be mixed with the output from a gramophone. The actual circuit designed was for an amplifier-mixer for four channels, two high gain and two low gain, each channel of which could be mixed with any other or use made of all channels at once. The prototype has been in use for some time now and is giving quite pleasing results.

In order to keep the cost within reasonable limits, the circuitry has been devised for equipment which, to a certain degree, might be found in the "spares box" (modern euphemism). The high-gain channels are designed around the EF37A, but there is no reason for not employing valves of the EF40 type or EF86 variety; no circuit changes will be required. The EF37A is used in conventional circuitry and really needs no comment save for the fact that the decoupling provided by R_3–C_2, R_5–C_4 is essential, to prevent cross-talk on the channels. The wiring to V_1 and V_2 must be as short as possible to avoid hum pick-up; mixing four sets of hum in a circuit like this is rather aimless! R_9 controls channel 1 gain, whilst R_{10} controls the gain of channel 2. The two load resistors marked R_L are to suit the impedance of the microphone being used; the original circuit used, rather wastefully, two 5 MegΩ potentiometers here, and these were adjusted for best quality. The outputs from the two amplifiers are taken through R_{11} and R_{12} and thence via C_{14} to the channels 1 and 2 master control R_{25}, which controls the mixed level output from the microphone pre-amplifiers and passes it on to the master mixer.

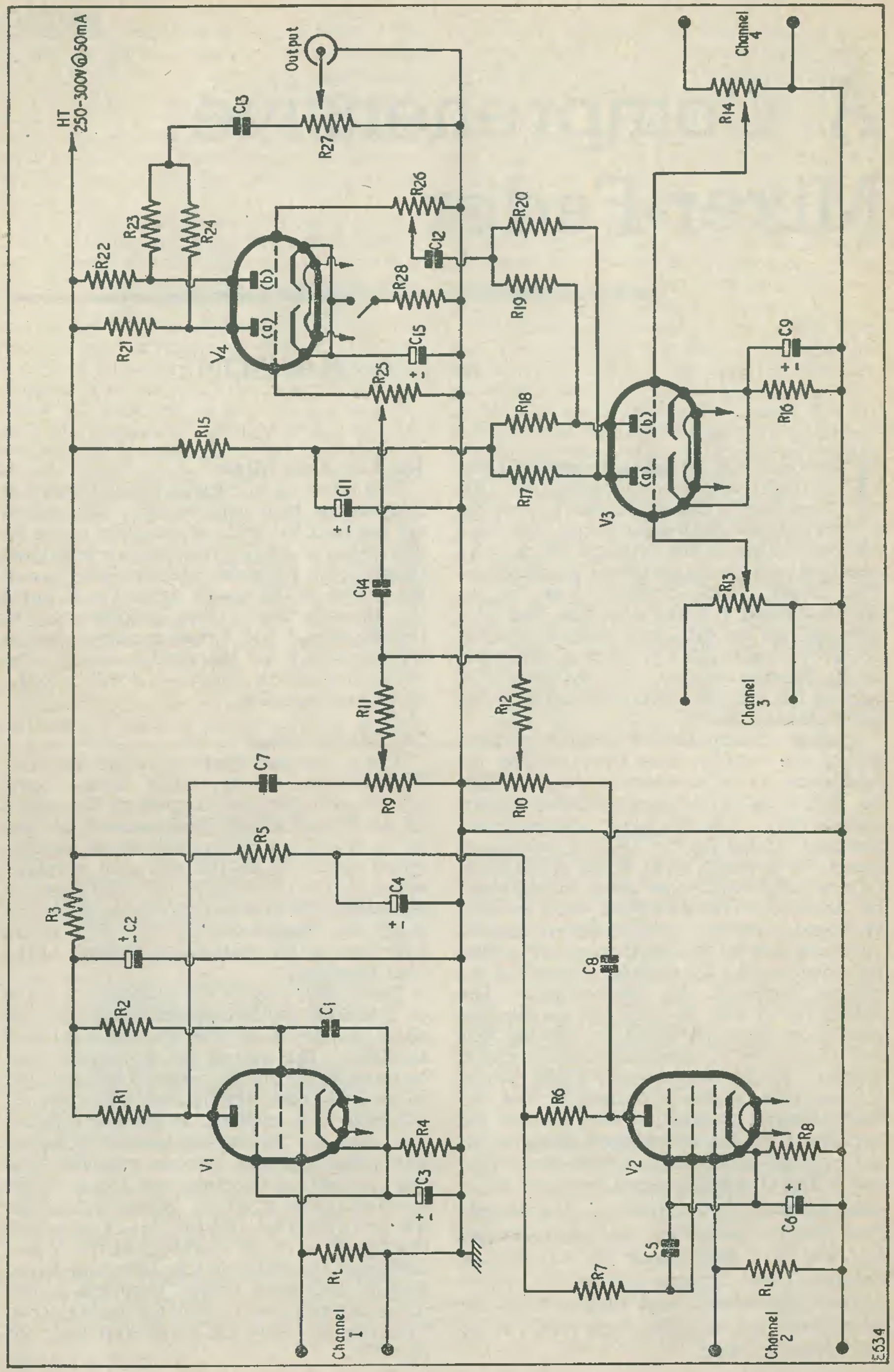
The Low Gain Mixer

This mixer is, in effect, a triode version of the pentode high gain section. The signals are fed into the grids of the twin triode by way of R_{13} and R_{14}, which provide individual channel gain controls. The amplified signals are passed in the anode circuit via R_{19} and R_{20} through the coupling condenser C_{12} to the channels 3 and 4 master control and to the other side of the master mixer. The decoupling afforded by R_{15}–C_{11} will be found to be indispensable.

The Master Mixer

This is the unit where all of the incoming signals have a final mixing before being passed on to the main amplifier. The mixed signals from the high gain channels are put on to grid 1 (*a*) of the twin triode and the mixed signals from the low gain amplifier mixer are put on to grid 1 (*b*). The resultant signals are mixed in the anode circuits of this valve and passed via C_{13} and R_{27}, which latter acts as the master gain control, to the final amplifier.

The overall gain of the system is 16 x 150 or 2,400 for the microphone channels, and about 16 x 16 or 256 for the low level amplifier. The output for the system may be too high for the amplifier to be used, and if this is so, some simple attenuation circuits will have to be evolved. A cathode follower was used for feeding the output from the mixer into the tape recorder amplifier and this method of coupling was found to be excellent. For a simple fading system, for the lazy, the bias resistor R_{28} is switched; this by virtue of the discharge of the bypass condenser C_{15} which is very large and consequently discharges slowly, produces a slow fade—this being very useful for the busy chap who has probably his hands full with the recorder.



It may be inferred from the circuit diagram that the unit is riddled with lurking potentiometers, and in order to clear up any difficulty the use of each will now be given:

R_9 channel 1 gain control, R_{10} channel 2 gain, R_{13} channel 3 gain control, R_{14} channel 4 gain, R_{25} channels 1 and 2 master control, R_{26} channels 3 and 4 master control, R_{27} overall master control.

Each potentiometer may be labelled as to its function for easy reference.

Main Components List

Resistors

$R_{1, 6, 11, 12, 17, 18, 19, 20, 21, 22, 23, 24}$ 220kΩ

$R_{9, 10, 13, 14, 25, 26, 27}$ 500kΩ pot.

$R_{3, 5, 16, 28}$ 3.3 kΩ

$R_{2, 7}$ 1mΩ

$R_{4, 8}$ 2.2kΩ

R_{15} 47kΩ 1W

Condensers

$C_{7, 8, 12, 13, 14}$ 0.05μF 350V

$C_{2, 4, 11}$ 8μF, 350V electrolytic

$C_{3, 6, 9}$ 25μF 25V electrolytic

$C_{1, 5}$ 0.25μF 350V

C_{15} 1,000μF 6V

Valves

V_1 EF37A

V_2 EF37A

V_3 6SN7

V_4 6SN7

MISCELLANEOUS

An Explanation of LOW POWER ULTRASONICS

By **R. WEBB,** M.I.P.R.E.

If the bible is to be believed (and far be it from me to discredit it), the principle of ultrasonics was used by the attacking hosts who, by raising a great sound, caused the premature collapse of the walls of Jericho. Seriously, though, it was towards the end of the 19th century that it was first shown that fine particles could be agglomerated at the nodal or "no-movement" point of a sound-wave, and thus in a sense rendered visible. It had been realised for some time that vibratory waves did not cease at the upper limit of hearing, but continued to be propagated at much higher frequencies, and whistles and tuning forks capable of producing high frequency sound-waves had been constructed. The sound energy produced by these means was of extremely small magnitude, but interest in the subject increased with the discovery of piezo-electricity, for it was soon seen that a crystal element was capable of providing large power outputs when driven by a suitable alternating supply source of energy. The application of magneto-strictive materials for the same purpose soon followed, and present-day research has been almost entirely built up around these sources of ultrasonic energy.

Wartime requirements—that is the 1914-18 war—showed a useful application of ultrasonics, in that under-water detection was developed when it became necessary to find out the whereabouts of enemy submarines and mines. The period 1919–1939 showed the first real effort being made to investigate the physical effects of high intensity sound, until today there is quite an army of interested research engineers progressing the subject, and it is the intention of this article to cover some of the various applications, together with certain basic methods of generation.

In the first place, let us be quite clear what the term ultrasonics means. The term is used to describe a vibratory wave of a frequency above that of the upper frequency limit of the human ear. Therefore, we are thinking of all frequencies above 16 kc/s. For a time the word "supersonic" was wrongly applied, and this term has now rightly taken its place as meaning "above the speed of sound."

As far as we are concerned, the frequency is only limited for our requirements by the type of transducer employed. The thing that decides the type of transducer is very largely the medium into which the waves are to be propagated, and the various frequencies conveniently allocate themselves to various applications. At the lower end of the ultrasonic band we find a suitable frequency for a transducer which can undertake drilling and soldering, this being of the order of 20 kc/s. For submarine detection, 30 kc/s transducers are suitable, whilst for flaw detection in metals and glass—for example—we move up to a maximum of 10–12 megacycles. A certain amount of heat is generated in the materials into which the waves pass. Making use of this property it is possible to scramble an egg without removing the shell, and plastics may be welded by this means. Again, an ice cube subjected to ultrasonic waves for a short time will break into small fragments when squeezed in just the same way as the sun will melt it—in other words, liquefaction has occurred. Similarly, if a block of wax is placed in the path of the wave it will melt in a pattern that shows the conical focusing of the beam inside the block.

Measurement of these ultrasonic frequencies is made by absorption type wavemeter for over 100 kc/s and by direct-reading frequency meter of the counting or integrating type for the range below 100 kc/s.

Generation

As far as the means by which the required ultrasonic wave is produced, we can break these up into four various types or methods, viz:

Piezo-electric
Magneto-strictive
Jet and
Electromagnetic.

I will describe each briefly.

The first one—piezo-electric or crystals—will be familiar to us; the main point in using this method is to remember that the crystal will present a mainly resistive load to its power supply equivalent to anything between 10 and 250 thousand ohms shunted by a capacitance of up to 100 pico-Farads. As mechanical energy generated by the crystal is primarily a function of voltage, it must be borne in mind that very close impedance matching to the supply will be necessary to develop a high voltage across the crystal. This impedance refers, of course, to quartz crystals; but as a matter of fact the most usually used material is a ceramic, barium titanate, which looks at something like 15 ohms plus 18,000pF but, of course, it is dependent on size, loading and frequency. Quartz is usually used for the higher ultrasonic frequencies (in the 5–10 Mc/s range) whilst barium titanate is used for normal industrial frequencies up to 1 megacycle. The quartz does present some insulating difficulties for high power work.

Magnetostriction occurs when ferro-magnetic materials are subjected to a magnetic field, and a change in physical dimensions takes place. This physical change brings about a change in the magnetic properties of the material and is called magneto-striction. Nickel is such a material, and is used as a transducer for low and high power application such as drilling, cleaning, processing, etc. Ferroxcube is another material which is electrically suitable, but mechanically weak for our purpose, though it can be used in special circumstances. If a nickel rod is brought into a magnetic field, it is shortened. It will be seen that if the rod is not previously magnetised, it will vibrate with double the frequency of the alternating field, whereas if suitably pre-magnetised, the mechanical change in length will be in step with the applied alternating frequency. If there is resonance between the natural elastic period of the rod and the frequency of the alternating current, the amplitude of the oscillation will then be at its maximum, and sound waves of the same frequency will be sent out from the end of the rod.

With various materials the frequency varies with the length, e.g. a rod of nickel 12.5 cm long vibrates at a natural frequency of 20.4 kc/s, whilst the highest frequency obtainable is of the order of 60 kc/s for a piece about 4 cms long. In such a rod or tube, set in longitudinal oscillation by magnetostriction, we find sound waves are only emitted from the ends of the rod. This would be useless for such things as submarine work, and so a means of radiating in all directions in one plane must be found. The answer lies in using a circular ring set by magnetostriction into elastic oscillation in such a way that the ring forms a circle with a periodically changing radius, the sections of the ring only moving radially. Waves are then radiated from the outer edge in a radial direction. A ring of this sort may be excited by a toroidal winding through which an alternating current is sent.

Under the heading of jet can be grouped sonic and ultrasonic generators employing high velocity liquid or gas streams, such as resonant cavity whistles, pulsed liquid jets and gas and liquid operated sirens. One main advantage of jet generators is the simplicity of the power source, this being either a compressor pump or a high speed rotary movement. An example of this type of generator that comes to mind is the Galton dog whistle—a whistle which we cannot hear but to which dogs respond from quite astonishing distances.

The electromagnetic method of converting electrical energy to acoustic energy by the movement of a coil carrying a varying voltage in a magnetic field of constant intensity is well known; a loudspeaker or earphone is, of course, an everyday example. With slight modification to the moving coil system, it is possible to use it for ultrasonic frequency generation. In such a device the efficiency falls off considerably as the frequency increases and the system is rarely used, so that the application is really restricted to fatigue and vibration study at l.f.

Now, whilst all these various methods and applications are all very interesting, they cover a very wide field. It seems advisable, therefore, to concentrate on a particularly useful section of ultrasonics, viz. drilling, cleaning and cutting by low power generation (approx. 50 watts). Let us take drilling first. The chief advantage of ultrasonics for drilling is that materials which are too brittle to drill by ordinary means can be handled satisfactorily. It is, in fact, the only practical method of producing shaped holes in brittle material, and for round holes under ⅛in it is claimed to be the best method. The same small portable equipment can be used for cleaning and cutting, and has a number of biological applications which will be described later. Coming back to drilling, there is a saying which can be loosely applied to this effect: "If you can shatter it, you can drill it," thus indicating the suitability of the ultrasonic drill for materials such as ceramics, glass, tungsten carbide, germanium, synthetic gems, and similar materials which have previously presented difficulty when drilling has to be performed. An ultrasonic drill is used for drilling diamond dies for tungsten wire drawing where the wire has to be drawn down to something like 10–12 microns thickness. For this purpose, an ordinary sewing needle may be used, and how it is possible to use this needle for this process will become apparent when the principle of the drill is explained.

Explanation of Ultrasonic Drill Principles

In the drill-head, there is a laminated nickel stack, the clamp being secured at the nodal, or "no-movement" point. By setting up an alternating field round a nickel element the nickel tends to contract at approximately a frequency of 20 kc/s, this being the natural or resonant frequency of this transducer. (The frequency range of the generator is 16–25 kc/s.) Nickel is ideal for this particular purpose as it has a very high fatigue strength. The stack, or transducer, movement up and down is 3/10 thou. at 20,000 c/s. Now 3/10 will be insufficient movement for our purpose, so the problem arises as to how to increase this movement from 3/10 thou. to something of the order of 2 to 3 thou. The answer is to fit what is called a *stub*, or velocity transformer made of aly. bronze. The stack is drilled and tapped and this stub is screwed in tightly. Now if you visualise something the shape of a Rawlplug tool, you can realise the shape of one of the original types of these stubs. There is a mathematical law which the design of the stub follows which is rather outside the scope of this article. The material decides the length of the stub, and if you wish to have a size reducing to ¼in we start off with the part of the stub which screws into the stack at ¾in diameter, thereby giving a step up of amplitude of physical movement. This increase in amplitude is determined by the ratio of the square of the end diameters. There is a limit to this step up in amplitude and materials generally will not tolerate without fatigue or crack-up more than a 9:1 increase. To keep within this limit on this low power equipment the size of the working tip diameter cannot go below ¼in, this giving a 9:1 increase of amplitude, that is from 3/10 thou. to 2.7 thou. The working end of the stub is drilled and tapped to take any tool shape required. The user of the drill makes his own tools to screw into the stub, as they are quite simple to make and need only be of some tough material which is abrasive-proof. There is a law here that the diameter of the tool must never exceed the diameter of the working tip, in this case ¼in, by more than 1/10in, but they can be less than the diameter of this working tip. It is interesting to note whilst on this subject that a 6 thou. hole in soda glass has been achieved.

Materials

Pure nickel and various nickel alloys give good results, e.g.:

(1) An alloy of 36% nickel–64% iron called "invar."

(2) 68% nickel and 28% copper with small amounts of iron silicon, manganese and carbon called "monel."

The natural frequency of a nickel tube can be changed by filling with, say, lead. A proprietory brand of this is known as "Permaloy."

A word about the tools. As already stated, these can be of some tough material, such as tool or silver steel, and it is important to remember that it is not the tool which does the cutting. This is done by an abrasive carborundum powder suspended in water, known in the trade as slurry. The principle to remember is that the tool guides the slurry only. A further point is that it is usual to trepan the holes. This, in itself, is useful because if, for example, one is drilling glass, the piece removed may be required as a lens. As the user makes his own tools, he can lay on a quantity of one particular shape if he has a large scale production job to do, although the wear on the tools depends entirely, of course, on the material one is drilling or cutting.

It is possible to obtain a depth of cut up to $\frac{1}{2}$in in difficult materials at low powers only. If one attempts to drill any deeper, there arises a difficulty in feeding the slurry into the hole and, at the same time, cleaning out the chips of material which have been removed. You can, of course, drill from both sides at once. If you look into the tool kit of anyone habitually using one of these drills, you will find that an essential part of their equipment is a stick of plasticine. This is used on occasion to form a little cup round the drilling operation if the job has to be carried out horizontally, for example, drilling in a cornice.

How long does it take to drill a hole by this means? Examples of time required are as follows:

- a hole in glass $\frac{1}{16}$in x $\frac{1}{16}$in x 2mm. deep —20 seconds.
- a hole in silica $\frac{1}{8}$in x $1\frac{1}{2}$mm. deep—12 seconds
- a hole in tungsten carbide $\frac{1}{8}$in dia. x $\frac{3}{16}$in deep—38 minutes.

One should note here in this connection that the coarser the abrasive or slurry the quicker the result. A finer slurry will be slower, but will give a better finish: as an example, a slurry mixture of what is called 800 mech can achieve an accuracy of 2/10 thou. provided the mechanical design of transducer and stand is adequate for these accuracies.

It was mentioned that a 50 watt generator equipment can be used for cleaning. A point here is that the stub provided for this purpose is undrilled and untapped. Briefly, when the energy in an ultrasonic wave is sufficient to set up peak alternating pressures in the liquid greater than 1 atmosphere, a phenomenon known as cavitation takes place. During negative pressure cycles we expand the microscopic bubbles present in all liquids and during the positive pressure cycle we collapse this bubble and the high local pressures set up at the point of collapse, which speeds up our cleaning action. Fairly obviously, certain materials require certain cleaning agents and as an example a diamond ring would require hot caustic soda, whilst for quartz crystal cleaning distilled water is used. Incidentally, the cavitation zone has an area similar to the diameter of the probe used.

As regards biological applications, a rat's liver in water put through an emulsifying process becomes just like a table jelly. Apart from emulsifying things like that, there are a number of instances where ultrasonics is materially helping research. For instance, disruption of bacterias, i.e. examination of cholera and whooping cough bacteria where the final break-up of the bacteria is achieved by subjecting them to ultrasonic waves. In the case of smallpox and chickenpox, after the virus has been successfully cultured or propagated from an infection in the blood stream the anti-gens are isolated so that a pure vaccine can be obtained and used for curative purposes.

We can classify dentistry under medical applications. You have, no doubt, heard of the ultrasonic dental drill which permits painless dentistry in respect of drilling teeth. Apart from being painless, there is another advantage in that the drill automatically ceases to drill when it has penetrated the hard outer shell of the tooth and does not plough into the soft centre which, with ordinary drilling, the dentist goes to no little trouble and uses his skill to preserve. As far as can be ascertained, it can be said that it is known that the dental drill cuts satisfactorily. It is as quick as existing dental engines, although they are now drilling mechanically at 150,000 revs per minute, a ball-race having been developed which appears to cope satisfactorily with this extraordinary speed. There does exist, of course, a very great danger in that control of such a mechanical drill can only be entrusted to a dentist well qualified to use it; one slip, of course, causing great damage in the mouth.

It is proved that the ultrasonic method is definitely painless, the frequency, as with hearing, being above the threshold; in this case, the pain threshold.

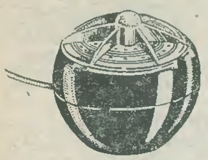
Slurry is a problem, the lower jaw being easier as one is drilling downwards and it is not difficult to accumulate and maintain the slurry in this position. At the moment, drilling upwards is not possible on account of this difficulty in accommodating the slurry, but experiments are going on to find a method of suspending the slurry medium for upper jaw drilling, although some humorist will no doubt immediately suggest that the patient stand on his head to overcome the difficulty! All this can be performed with a 50 watt generator with a water-cooled transducer. An interesting use of the dentist drill is that it can be used for engraving—for fine freehand work.

A further use of the ultrasonic drill is that it can be used for diesinking. As an example, if the rear of a sheet of glass is embossed by drilling half way through and then the back silvered, the effect when viewed from the front is quite pleasing.

There is another use of these low power generators which must, of course, be men-

continued on page 610

HOME RADIO OF MITCHAM



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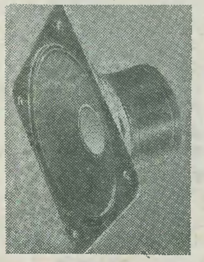

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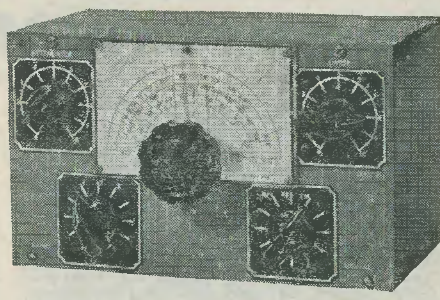

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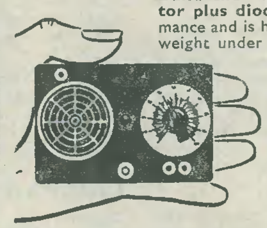

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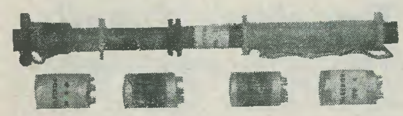

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144 sq. in.	**7/–**	272 sq. in.	**11/–**	and pro rata	
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(*Length plus twice depth x width plus twice depth)

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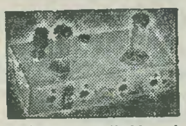

Suitable Wales, London, Midlands, North Scotland, etc. All the parts including 2 EF80 valves, coils, fine tuner, contrast control, condensers and resistors. (Metal case available as an extra.) Price only **27/6**, plus 2/6 post and insurance. Data free with parts or available separately, 1/6. *Please send two more kits, the one you sent last week is performing magnificently.* We receive this sort of letter every day of the week, so if you have hesitated because you thought our kits too cheap you need hesitate no longer.

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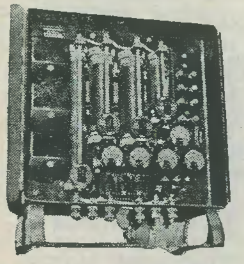

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The unit 3515 less valves and i.f. strip. This contains components valued at least £10 as follows:

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Plus hundreds of miscellaneous items, nuts, bolts, washers, tag strips, i.f. sockets, etc. All for **6/6**, plus 5/– carriage up to 250 miles.

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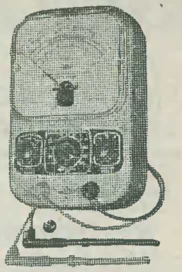

Undoubtedly a most useful instrument by a firm long famous for fine instruments. Entirely re-designed, it has a square movement with diacon plastic cover; this makes for a brighter, more readable scale, extra scale length and wider angle of vision. With the test set is included a pair of combined test prods and crocodile clips also a stand for inclining the meter at the best reading position. Ranges: a.c. volts: 0-10, 0-25, 0-100, 0-250, 0-500, 0-1,000; ditto d.c. A.C. current: 0-100mA; d.c. current: 0-2.5, 0-10, 0-100, 0-500 mA. Resistance: 0-1M and 0-10kΩ. **Price £12.7.6** plus 5/– carr. and ins., or £1 deposit and 24 fortnightly payments of **10/–**. **FREE GIFT.**—All purchasers this month will receive a Series 100 range extender scale and data, which adds capacity 0-0.1μF in two ranges, inductance, e.h.t., and many others.

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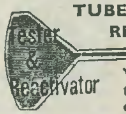
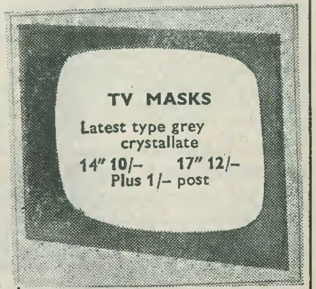


We can supply all the main components for making this unit which will not only test Cathode Ray Tubes but will also re-activate them. Supplied complete with full instructions. Price **£3**, plus 2/6 post and ins.



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2-pole, 4-way	**2/–**
4-pole, 4-way	**2/9**
4-pole, 5-way	**2/6**
2-pole, 5-way	**2/6**
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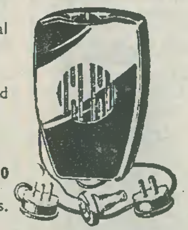

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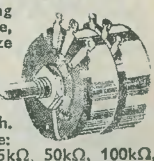

Single and 2-gang types available, standard size with good length spindle, all new and boxed. Single types **1/–** each. Values available: 5kΩ, 10kΩ, 25kΩ, 50kΩ, **100kΩ**, 250kΩ, 1MΩ, 2MΩ. Gang type, 3/– each. Values available: 5kΩ+5kΩ, 100kΩ+100kΩ, 500kΩ+500kΩ, 2MΩ+2MΩ.

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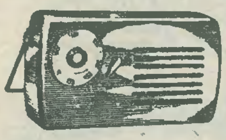

An attractive receiver employing 6 selected transistors and covering Medium and Long wavebands. Housed in smart blue, pink or cream plastic case, size 5¾″ x 3¼″ x 1½″, with gilt table stand and control knobs. All necessary components for construction of this beautiful receiver are available at a special inclusive price of **£9.19.6** *plus* 2/6 P. & P., including comprehensive, easy-to-follow instructions (*available separately price* 2/6 *post free*).

Equipment to build yourself

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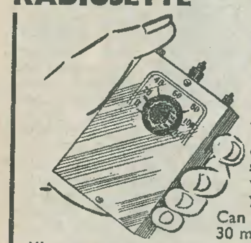


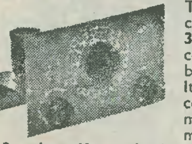
The ideal low cost transistor pocket radio for the beginner. The circuit utilises the new R.C.S. VARILOOP-STICK transistor coil. A specially designed miniature .0004 tuning condenser permits the set to be in a case which fits the palm of your hand.

Can be built in 30 minutes **30/-**

All components are sold separately, full construction data including plan of parts, 2/–

ALL-WAVE RADIO 35/-

Ideal for the beginner or for those requiring a simple stand-by receiver



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RESISTORS. Pref. values 10 ohms 10 megohms, 20% tol., ¼W, **3d.**; ½W, **5d.**; 1W, **6d.**; 2W, **9d.**; 10% h-stab., ¼W, **5d.**; ½W, **7d.**; 5% tol., ½W, **9d.**; 1% h-stab., ½W, **1/6**
PRE-SET W/W POTS. TV knurled slotted knob type. 25 ohms to 30,000 ohms, **3/–**; 50,000 ohms, **4/–**; 50,000 ohms to 2 Megohms (carbon), **3/–**

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Log. or lin. ratios, 10,000 ohms–2 Megohms. Long spindles. 1 year guarantee. Midget Ediswan type, 1⅛″ dia. No sw. **3/–**, d.p. sw. **4/9**

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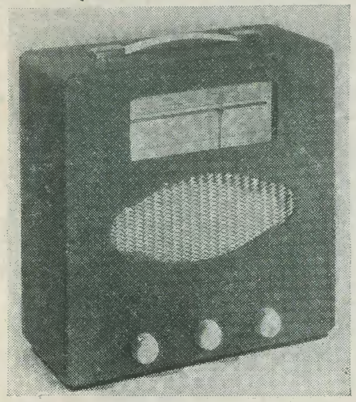

Chassis size 10" x 10" x 4"

AC/DC portable radio—a well-known manufacturer's product, fully guaranteed and tested.

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- ★ 7" x 4" elliptical speaker
- ★ Slow motion tuning
- ★ Two models available
  - Med., long, short and gram.
  - Med., short, short and gram.
- ★ Gramophone pick-up sockets
- ★ A complete and working unit
- ★ Ideal radiogram

ONLY **£7.12.6** pos 5/-

Portable polished wood cabinet ... ... 27/6 extra
Super rexine portable cabinet ... ... 37/6 extra
(As illustrated)

A REAL BARGAIN !

CRYSTAL MIC. INSERTS

¾" square ... ... 3/6 1½" round (Acos) ... 7/6
¾" round (Acos) ... 5/- 2" round (Acos) ... 12/6
Suitable moulded plastic hand mic. case, only 2/6 P.P. 9d.

NEW BARGAIN CORNER

Perdio style Cabinet size 5¼" x 3½" x 1¼", with fully screened 208+176pF ganged condenser, 3 ohm 2½" speaker to fit; single ended 20:1 output transformer; 5-transistor printed circuit and complete circuit diagram.

ALL FOR ONLY 55/- P.P 2/6

Ideal **BASIS** for a 5-transistor radio

AC/DC 200/250V PORTABLE-GRAM AMPLIFIER

Completely assembled on baffle board size 12½" x 4½", depth 3". Containing two Mullard valves type UL84 and UY85. Elac 7" x 4" elliptical speaker, volume control, tone control. Nothing else to buy, just plug in to mains and connect your pick-up to amplifier.

Absolute bargain 67/6 Carr. 2/6

RECORD PLAYERS

Collaro Conquest. The latest 4-speed autochanger with lightweight turnover crystal pick-up. Brand new and guaranteed **£7.19.6** P.P. 4/6

Garrard 4-speed single player with latest turnover crystal pick-up. Brand new and guaranteed. **£6.19.6** P.P. 3/6

B.S.R. Monarch. The latest version of this well-known 4-speed autochanger with turnover crystal pick-up **£6.19.6** P.P. 4/-

VIBRATOR PACKS. Input 6V d.c. Output approx. 100V d.c. at 30mA, fully smoothed and r.f. filtered. Size 6½" x 5" x 2". Fitted with Mallory 629C vibrator. BRAND NEW. Boxed. **12/6**

PACKARD-BELL PRE-AMP. Complete in screened case with 6SL7GT; 28D7 relay; leads, jack plug, etc. Handbook. Sealed in carton ONLY **12/6** P.P. 2/-

RF UNITS

TYPE 25 Switched. Tuning 30 to 40 Mc/s. includes 3 SP61s Carriage 2/6 **10/-**
TYPE 26. Variable tuning, 50 to 65 Mc/s. including 2 EF54s and EC52. Carr. 2/6 **25/-**
(Circuits in stock for both types 9d.)

373 MINIATURE I.F. STRIPS 9.72 MC/S

The ideal f.m. conversion unit as described in *P.W.*, April/May 1957. Complete with 6 valves, three EF91s, two EF92s and one EB91. I.F.T.s, etc., in absolutely new condition. With circuit and conversion data.

12/6 (less valves) **37/6** (with valves)
Postage and packing 2/6 (either type)

426 CONTROL UNIT

Includes 4 EF50; 2 SP61, EB34; multibank switches; pots; transformer, etc. ONLY **30/-** P.P. 5/-

SIX-TRANSISTOR POCKET-SUPERHET

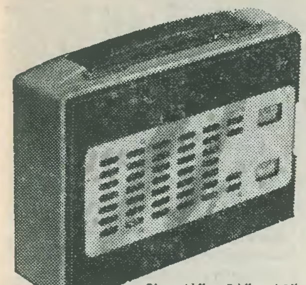
- ★ Medium and Long wave
- ★ 6 selected transistors
- ★ Printed circuit
- ★ Internal ferrite aerial
- ★ 30 ohms speaker
- ★ Instruction booklet
- ★ Low consumption
- ★ Attractive plastic cabinet (red, blue and white colours)
- ★ 9V P.P.4 battery
- ★ Easy to build

All items supplied special inclusive price of **£9.19.6** P.P. 2/6

All components sold separately
Send for lists

SEND 3d. STAMP FOR NEW TRANSISTOR COMPONENTS LIST; QUARTZ CRYSTAL LIST; VALVE LIST; TRANSISTOR RECEIVER CIRCUITS, ETC.

HENRY'S RADIO LTD · 5 HARROW ROAD · LONDON W2
Opposite Edgware Road Tube Station (DEPT. RCM) *Telephone* **PADdington 1008/9**



Size 4½" x 3½" x 1⅜"
Weight only 14 oz.

Special Offer! POCKET TRANSISTOR RADIO

- ★ 6-transistor Superhet
- ★ Medium and long wavebands
- ★ Push-pull output
- ★ Built-in ferrite aerial
- ★ Attractive moulded cabinet with gold trimmings
- ★ Printed circuit
- ★ Fully guaranteed

The product of a well-known British manufacturer: a receiver of the latest design using Mullard and Ediswan transistors.

List price 17 gns. **OFFERED AT ONLY £10.10.0** *incl. batteries* P.P. 2/6

NOT A DO-IT-YOURSELF—BUT A FULLY WORKING POCKET RADIO

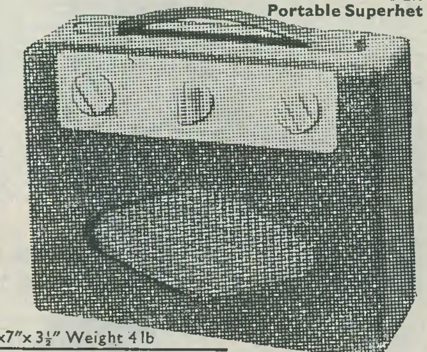
"THE TRANSISTOR—8" Push-Pull Portable Superhet

This Portable 8-Transistor Superhet is tunable for both Medium and Long Waves and is comparable in performance to any equivalent commercial Transistor Set.

- ★ 8 **EDISWAN** Transistors
- ★ 250 Milliwatts output push-pull
- ★ All components identified
- ★ Medium and Long waves
- ★ Internal ferrite rod aerial
- ★ 7" x 4" elliptical speaker
- ★ Drilled chassis 8½" x 2½"
- ★ Point-to-point wiring and practical layout
- ★ Economical. Powered by 7½V battery
- ★ Highly sensitive
- ★ Attractive lightweight contemporary case.

COMBINED PORTABLE/CAR RADIO
Two sets for the price of one

We can supply all these items including cabinet for **£11.10.0**, P.P. 2/6. All parts sold separately. Circuit diagrams and shopping list free.



Size 9"x7"x 3½" Weight 4 lb

Car Radio Conversion Components, **8/-** extra
A.V.C., **4/3** extra. 325mW version, **40/-** extra

NEW! Special 2 watt Power Stage usable with **Any** Battery Portable having an output Transformer

NEW! SOLAR-THREE

- ★ No BATTERIES!
- ★ No running costs! Uses light cells
- ★ Three transistors
- ★ Built-in Ferrite aerial
- ★ No aerial or earth

Send for free components list

A pocket transistor receiver working from daylight!

MAJOR—2

(Two-transistor pocket receiver)

- ★ 4-stage reflex circuit
- ★ Variable tuning over medium waves
- ★ Highly sensitive
- ★ No aerial or earth
- ★ Economical
- ★ Drilled and mounted chassis
- ★ Size 4½" x 3" x 1¼"
- ★ Internal ferrite aerial
- ★ Weight less than 4 oz
- ★ Complete layout diagram

All items can be supplied, including **EDISWAN** transistors, battery, case and personal phone, etc., for **72/6**, post free. All components sold separately. Circuit and shopping list FREE. **Call and Hear Demonstration Model.**

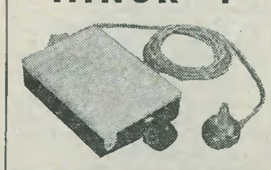
LATEST TRANSISTORS
JUNCTION TYPE P.N.P.

EDISWAN XA104 6 Mc/s osc./mixer, r.f. amplifier	18/-
EDISWAN XA103 4 Mc/s i.f. and r.f. amplifier ...	15/-
EDISWAN XB104 1 Mc/s audio output and driver	10/-
(A pair in push-pull will give up to 250mW audio output)	
Continental OC44 12 Mc/s osc./mixer, r.f. amp. ...	30/-
Continental OC45 6 Mc/s i.f. and r.f. amp. ...	25/-
Continental OC72 325mW in push-pull	20/-
Red Spot 800 kc/s audio amplifier	7/6
White Spot 2 to 5 Mc/s r.f. and i.f. amp.	12/6
Green/Yellow 600 kc/s audio amplifier	7/6
Red/Yellow 1.5 to 8 Mc/s r.f. and i.f. amp. ...	15/-

NEWMARKET POWER TRANSISTORS IN STOCK

Large range of sub-miniature transistor components in stock. Send for new free list

MINOR—I



- ★ Variable tuning on medium waves
- ★ 3-stage reflex circuit
- ★ Highly sensitive
- ★ Internal ferrite aerial
- ★ Drilled chassis
- ★ Long-life battery
- ★ Complete constructional details
- ★ Size 3" x 2" x ¾"

Total cost, including transistor, personal miniature phone, case, battery and complete circuit and layout diagrams, 52/6 post free. All components sold separately. Circuit and shopping list FREE.

HENRY'S RADIO LTD · 5 HARROW ROAD · LONDON W2
At junction of Edgware Road and Harrow Road (DEPT. RCM) *Telephone* **PADdington 1008/9**

The TRANSIDYNE RECEIVER

(*Page* 119 *Sept.* '58)

Complete Kit **£11.19.6**
or less transistors **£8.15.6**

FREE—Special printed circuit solder with each kit

Only genuine Teletron parts

Full details and price list **1/–** post free

Heavy duty 500pF differential condensers 3/–. Small solid dielectric variables, 0.0001µF **3/–**; 0.0003 µF **3/9**; 0.0005µF **4/–. Resistors** from **3d.** each. Asstd. carbon (many 5%) 25 for **3/11,** 50 for **7/6.** Hi-Stabs 10% ½ watt **6d.**; 10% 1 watt **9d.**; 1% ½ watt **2/–.** Many odd values available at lower prices. Send requirements for quotation. **Ajax Crystal Set** complete, **14/6**; L.W. **15/–.** Case and chassis **5/9. Teletron HAX coil 3/–. REP Dual Wave Xtal Coil 2/6 Headphones,** lightweight, **14/–** and **16/– Nuts, bolts, washers, tags.** Well assorted: 25 **1/–,** 72 **2/9.** 144 **5/–. Miniature Neons 1/10.**

TRANSMITTING KEYS

Heavy duty with 27 ins twin rubber cable, fitted robust jack plug. Ideal also for Morse practice. The plug alone is worth the price! **Limited number at 1/6 each**

Sensitive Transistor Receiver

NEW LOW PRICE

(*Page* 298 *Nov.* '58)

All parts now available for this excellent receiver.

Complete Kit (less spkr.) **£4-18-9** or less speaker and transistors **£3.10.0**

(S.A.E. for price list)

7" x 4" Speakers **22/6**

(Others available)

TRANSISTOR ITEMS. **Electrolytics** 8µF 6V, 16µF 12.5V, 32µF 3V, 5µF 12.5V, 5µF 40V, 2.5µF 40V, 1.6µF 6V, 25µF 6V. **All 3/– each**; 100µF 6V 3/–; Paper 0.01, 0.001. 0.002, 0.005µF, **all 8d. each. Transistor Holders 1/–** each, 6 for **5/9, 11/–** doz. **Ardente T.1065** transformers (page 911—July), **12/–. Subminiature Speakers 1¾"** round, **27/–**; 2" x 3" elliptical, **33/–. Sub-miniature Output Transformers,** single-ended or p/p, **12/6. Volume Controls,** button type (totally enclosed), 47k and 1MΩ, **2/6**; preset skeleton type 5k, **2/6**; spindle type, ½M, 1M, 2M, **4/3** (page 705—'*R.C.*' May) **Ardente Deaf Aid Earpieces** E.R.100, with cord and plug. Limited number at **13/9. Ardente Catalogue 6d. Transistors:** Yellow/Red **15/–**; White Spot **14/–**; Yellow/Green **7/6**; Red Spot **7/–**

Multicore Solder 4d. yd, 19 ft reel **2/6, 1lb reel 14/9. Fine gauge** for printed circuits, 40 ft reel **2/6. Switches,** s/p from **2/3,** d/p from **3/6. Ferrite Rods 8" x ¼"** diam., **2/–. Mains neon indicators** with built-in resistor. Domed top, chrome bezel, 1" long ½" diam. Opal, red, amber, **3/10**; green **4/7**

We recommend the 'LITESOLD' soldering iron for all work and especially printed circuits. Mains or battery. **21/6** complete (*state mains voltage*)

CONNECTING WIRE p.v.c. 50ft coil, 5 colours, **1/9. Sleeving,** 15 ft, asstd. colours and thicknesses, **8d. Tinned Copper Wire** 24 s.w.g., 15ft **8d. Combined pack** (3 above items) **2/9**

NEW EDISWAN TRANSISTORS

Now in stock

XA104 R.F. (4 Mc/s) 18/–
XA103 I.F. (2 Mc/s) 15/–
XB104 A.F. 10/–

Also a full range of **PYE 'GOLTOP' r.f., a.f. and power transistors.**

Enquiries welcomed

QUOTATIONS gladly given (S.A.E. please)

R. FAGELSTON (MAIL ORDER)

Please add Postage to above prices

46 HARDWICKE ROAD · LONDON N13

★ VALVES NEW TESTED AND GUARANTEED

1R5	7/6	6X4	7/6	DK91	7/6	EF92	5/6
1S5	7/6	6X5G	6/–	DK92	9/–	EL41	10/–
1T4	6/–	12AH8	9/6	DK96	9/–	EL84	9/–
3S4	7/6	12AT7	7/6	DL92	7/6	EL91	7/6
3V4	8/–	12AU7	7/6	DL94	8/–	EY51	10/6
5U4G	6/–	12AX7	9/–	DL96	9/–	EZ35	8/–
5Z4G	9/–	12K8GT	13/6	EB91	5/6	EZ40	8/–
6AM6	6/9	12K7GT	8/6	EBC41	8/–	EZ80	8/–
6AL5	5/6	12Q7GT	7/–	EBF80	9/6	EZ81	8/6
6AT6	7/6	25A6G	10/6	ECC81	7/6	KT33C	9/6
6BA6	8/6	25L6GT	7/6	ECC82	7/6	PCF82	11/–
6BE6	7/6	35Z4GT	8/6	ECC83	7/6	PL82	10/6
6BR7	10/6	35L6GT	9/6	ECC84	8/6	PY81	8/–
6BW6	8/6	53KU	11/6	ECF82	11/–	PCC84	9/–
6J5G	5/6	807	6/9	ECH81	10/6	PCF80	9/6
6J7GT	8/6	5763	10/6	ECH42	10/–	U76	8/6
6K7G	2/6	DAF91	7/6	ECL80	12/6	UBC41	10/–
6K8G	7/6	DAF96	9/–	EF36	7/6	UCH42	9/–
6Q7GT	8/6	DF91	7/6	EF39	5/6	UF41	10/–
6SL7GT	8/–	DG96	9/–	EF41	9/–	UL41	9/6
6SN7GT	8/6	DH76	8/6	EF80	8/–	UY41	8/–
6V6G	7/6	DH77	7/6	EF91	6/9	W76	8/6

Matched Pairs. EL84, **23/–**; 6V6G, **17/–**; 6BW6, **18/–**; KT33C, **19/6**; KT66, **27/6**; 807 **14/6** pair

1R5, 1S5, 1T4, 3S4, 3V4, DAF91, DF91, DK91. DK92, DL92, DL94. any four, **27/6** per set

P.P. Op. Transformers. MR 3-15 ohms for EL84, 6V6, 6BW6, etc., **18/6**; Op. Pen. 50mA, **5/6**; 30mA, **4/6**

Volume Controls. All values, long spindle. L/S **3/–,** s.p. **4/–,** d.p. **4/9,** ext. spkr. control **3/–**

W.W. Pots. Pre-set **3/–**; 3W long spindle **5/6,** s.p. **6/6**

P.M. Speakers. 3 ohm. 5" **16/6,** 6½" **17/6,** 8" **21/–,** 10" **25/–,** 12" **30/–,** Bakers 12" 15 ohm 15W, **90/–**

Coaxial Cable. 75 ohm ¼" stranded, **8d.** yd; semi-air spaced, **9d.** yd; screen cable single and twin, **9d.** yd

Coaxial Plugs 1/– each; **Sockets 1/–** each

C.R.T. Isolation Transformers with nil, 25% and 50% boost, low capacity a.c. mains 200/250V for 2V 4V. 6.3V and 13V tubes. All **10/6** each

Valveholders. 4, 5, 7 pin English and U.S.A. B7G, B9A, 1.0 Mc. B8G, **9d.** each; B7G, B9A with screening can, **1/6**; B12A, **1/3** Aladdin formers ¼" with core, **8d.** each

Scotch Boy Recording Tape, 1,200ft reels, **27/–**

Jack Plugs, miniature standard, **3/–**; **Sockets 3/–**

2-Gang Condensers, 0 0005 small size, **7/6**

I.F. Transformers, 465 kc/s, small size, **7/6** pair

Capacitors, small mica, 5% 1pF to 100pF, **8d.**; 120pF to 1,000pF, **9d.**; 1,000V wkg. .01, .0015, .0025, .004, .005, **1/–** each

Crystal Diodes, G.E.C., **1/6** each

Headphones, lightweight, 4,000 ohm, **16/6** pair

Ceramic Capacitors, close tol. 500V for V.H F., **9d.**

Paper Capacitors, tubular, .01, 1,000V, **1/–**; 0.1 to 0.5 500V, **10d.**

Paper Blocks, 4µF, 1,000 wkg., **3/6**

Rectifiers, contact cooled, 250V 50mA, **7/6**; 85mA, **9/6**

Reaction Condensers, .0001, .0003, .0005, **4/6** each

Heater Trans. 200/240V, 6.3V, 1.5A, **7/6**

Resistors, ¼ and ½W, insulated, **4d.** and **6d.**; 1W, **8d.** 6W W.W., **1/–**; 10W, **2/–**

Electrolytics. Wire ends. 25/25V, **1/6**; 50/50V, **2/–**; 12/50V, **9d.**; 8/450V, **2/–**; 16/450V, **2/9**; 16/500V, **3/6**; 32/450V, **4/–**; 8+8/450V, **4/6**; 8+16/450V, **4/6**; can types: 16/450V, **3/6**; 16+16/500V, **6/–**; 32/500V, **6/6**; 32/450V, **6/6**; 20+20/450V, **4/6**; 64+120/275V, **7/6**

Wavechange Switches, midget: 1p 12W, 2p 6W, 3p 4W, 4p 3W, 4p 2W, long spindles. **4/6**

Toggle Switches. QMB, s.p.s.t., **2/–**; s.p.d.t., **3/3**; d.p.s.t., **3/6**; d.p.d.t., **4/–**

Chokes, 80mA, 15H, **8/6**; 100mA 10H, **10/6**; 150mA 10H, **14/6**

★ **Solder, Multicore, 4d.** yd; Sleeving 2mm, **3d.** yd

P. and P 9d. to £1; 1/6 to £2; over £2 post free. C.O.D. 2/6

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CROYDON 9186

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FOR SALE. New ex-Government multi-range testmeter, normally 35s. each, £15 for crate of 22, carriage 35s. Box No. E.197.

FOR SALE. Expensive Decca trolley gram cabinet, walnut, £4, with autochanger £8. Photo available. Ferranti 18 gns. a.c. transportable radio, half price. Classical L.P. records, mint 21s. each. S.A.E.—9 Brenda Crescent, Thornton, Liverpool 23.

FOR SALE. Aspden tape deck, 7in reel of tape, amplifier, speaker and microphone, £12, o.n.o. 9in TV, not repairable but good tube and 15 valves, 10s.—Ring BOW 9846 after 6 p.m.

FOR SALE. Handbooks 19 Set Mk. 2. Circuit, R.C. values. Full details. P. & P. 6s. H. Lewis, 16 Belle View, Belgrave Road, Birmingham, 12.

FOR SALE. Transistorised 3-channel radio control receiver, prototype described in August 1958 *Radio Constructor*, complete with 5 transistors, £5. Canadian Marconi crystal calibrator, generating 1 Mc/s, 100 kc/s and 10 kc/s markers, £2 10s. 0d. 160/80/40 metres phone or c.w. transmitter/receiver, for portable or field use, a.c. mains or 12V battery, fully self-contained, £12.—Pearson, 37 Vale Road, Bushey, Herts.

FOR SALE. *Wireless World* 1954, 1956 and 1958, 1s. each plus postage.—Hawkins, 86 Alphington Road, Exeter.

SONOMAG adaptatape tape recorder (Mark IV Collaro deck), new, unused, in maker's carton, £37 o.n.o.—222 Carshalton Road, Sutton, Surrey.

MURPHY V150 12in working tube U/S £4. White-Ibbotson wall projector, 4ft x 3ft picture, 12-channel tuner, complete working, requires attention, circuit supplied but no cabinet, £10. Pre-amplifiers, new, with EF54 valve made by Cossor 7s. 6d., postage 2s. 6d. New 4ft fluorescent batten fitting, 27s. 6d., carriage 3s. 6d.—381 Staines Road, Hounslow, Middlesex.

AMATEUR DISPOSING surplus stock, large quantity valves, etc. Send s.a.e. for list.—66 St. Anthony's Drive, Chelmsford, Essex.

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WHAT OFFERS? "Mini-7," long and medium waves, carrying case, hearing aid phone.—Box No. E.198.

WANTED. 3H tapped choke, Bulgin LF43 or Varley DB18.—McLeod, "Rosedene," Forres, Morayshire, Scotland.

WANTED. Philco BP413 receiver.—Prouse, 5 Tresluggan Road, Plymouth.

FOR SALE. Portable top band Tx/Rx. Tx: EF40, EL91, EL41 mod., with carbon mic., EL41 co/pa. Rx: EF91, EF92, EL91, TRF. In black crackle cabinet 12in high, 8in wide, 7in back to front. Chrome handle on top. Rotary converter power supply, 12V input. With key, phones, 2 xtals, and whip antenna. Smart little unit, £12.—Box No. E.199.

continued on page 639

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1A3	2/–	6Q7G	7/6	803	20/–	EY51	12/6
1L4	5/–	6Q7GT	9/6	830B	15/–	EY86	12/6
1R5	7/6	6SA7M	7/6	866A	15/–	EZ40	8/–
1S5	7/–	6SG7M	7/6	959	5/–	EZ80	8/–
1T4	6/–	6SH7M	5/–	1616	5/–	EZ81	8/–
2A3	8/6	6SJ7M	7/6	1629	4/–	GT1C	8/6
2X2	3/6	6SK7M	6/6	5763	10/6	GZ32	12/6
3A4	4/6	6SL7GT	7/6	EA50	1/6	HK24G	25/–
3Q4	7/6	6SN7GT	5/6	EABC80	10/–	KT33C	9/6
3S4	8/6	6SQ7M	7/6	EAC91	4/6	PCC84	10/6
5R4GY	12/6	6V6G	7/6	EAF42	9/–	PCF80	12/6
5Y3G	8/6	6V6GT	8/6	EB34	2/–	PCF82	10/–
5Y4G	6/6	6X4	6/–	EB91	4/6	PCL82	12/6
6AC7M	5/–	6X5GT	6/6	EBC33	7/6	PL81	14/6
6AG5	3/6	7B7	8/–	EBC41	8/6	PL82	9/6
6AK5	5/–	7C5	8/–	EBF80	9/–	PL83	10/6
6AL5	4/6	7C6	8/–	EBF89	9/6	PY80	8/–
6AM6	5/–	7S7	9/6	ECC82	8/6	PY81	8/6
6AQ5	8/6	7Y4	8/–	ECC83	9/–	PY82	9/6
6AT6	7/6	12A6M	6/6	ECC84	10/6	PY83	8/6
6AU6	7/6	12AT6	8/–	ECC85	9/–	R19	12/6
6B8G	3/6	12AT7	8/6	ECF80	12/6	TT11	4/–
6BA6	8/6	12AU7	8/6	ECF82	11/6	UAF42	9/–
6BE6	7/6	12AX7	9/–	ECH42	9/–	UBC41	9/6
6BH6	7/6	12AU6	9/–	ECH81	10/–	UBF89	9/6
6BJ6	7/6	12BE6	8/6	ECL80	12/6	UCC85	9/6
6BR7	11/6	12C8M	7/6	ECL82	12/6	UCH42	9/6
6BW6	9/–	12K7GT	6/6	EF36	4/–	UCH81	9/6
6C4	4/6	12Q7GT	6/6	EF39	5/–	UF41	9/6
6C5M	5/6	12SC7M	2/6	EF41	9/6	UF89	9/6
6F6M	5/6	12SJ7M	5/–	EF50	2/6	UL41	9/6
6J5GT	5/–	12SK7M	5/–	EF50(S)	4/–	UY41	8/–
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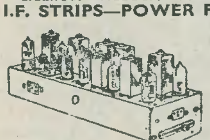

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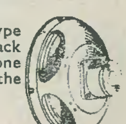

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