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RECORD PLAYER WITH FEEDBACK TONE CONTROLS

VOLUME 13
NUMBER 8
MARCH
1960

The RADIO Constructor

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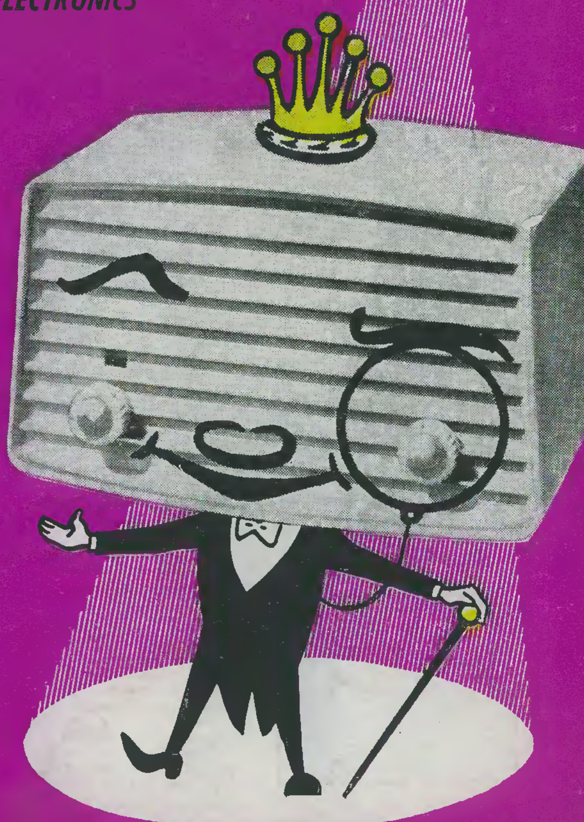

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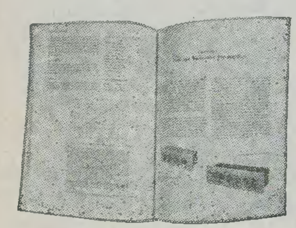

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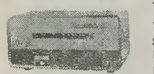

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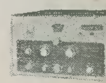

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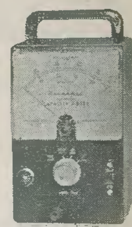

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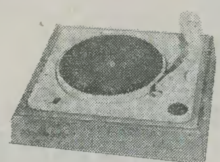

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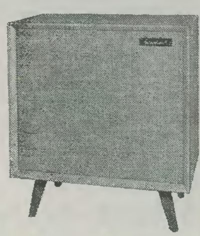

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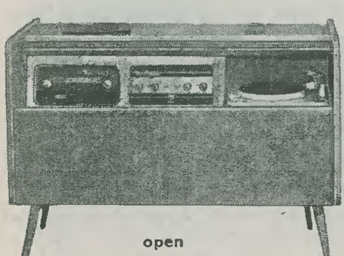

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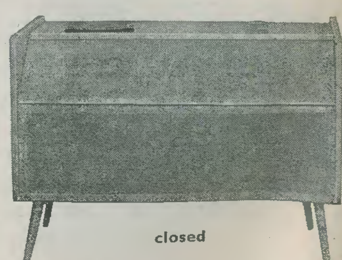

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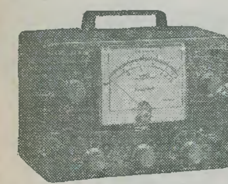

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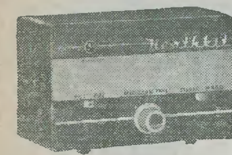

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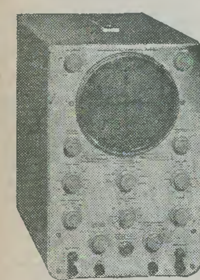

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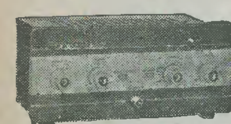

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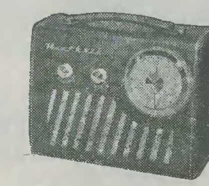

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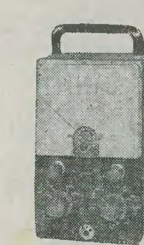
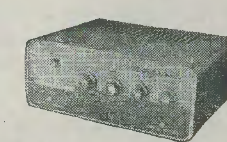


V-7A



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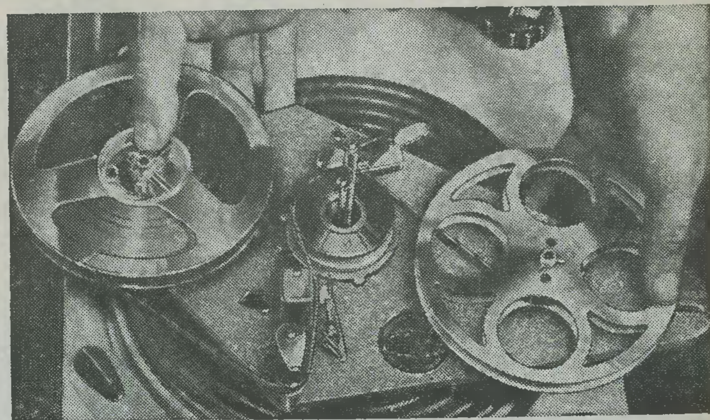

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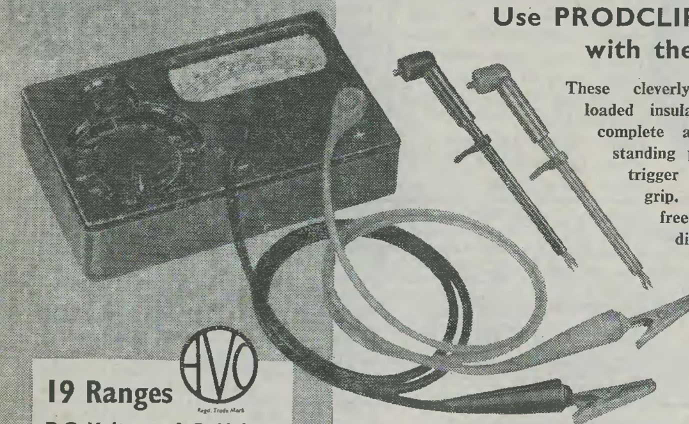

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No. 112 A Record Player with Feedback Bass and Treble Controls

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 data

EVERY NOW AND AGAIN THE WRITER devotes an article in this series to a complete a.f. amplifier circuit. To judge from the resultant correspondence it would seem that circuits of this type are very popular with readers, and so he has no qualms about introducing another amplifier in this particular contribution.

This month's circuit depicts a simple one-valve record player amplifier which, apart from being relatively inexpensive, has the feature of offering both bass and treble controls in a negative feedback arrangement.

The Circuit

The circuit of the amplifier accompanies this article. As may be seen, it employs a single valve, this consisting of a triode-pentode ECL83. The amplifier should be capable of providing an output of some two watts, and is intended especially for use in a record player cabinet where space is normally at a premium and where only a small loudspeaker may be fitted. The chassis of the amplifier is isolated from the mains, thereby enabling it to be bonded directly to the motorboard. The use of a mains transformer eliminates the risks of hum pick-up and shock which result from "live" chassis techniques.

Commencing at the input of the amplifier, the crystal pick-up connects, via the low-pass filter R_1, C_1, to the volume control R_2. The slider of R_2 connects to the grid of the voltage amplifier V_1(a) the anode of which then couples to the grid of V_1(b) via C_3. The anode of V_1(b) finally connects to the speaker transformer in normal fashion.

Between the anode of V_1(b) and the cathode of V_1(a) is connected the tone control feedback network. The functioning of this network may be readily understood when it is appreciated that, if the network offers a lower impedance to one particular frequency than it does to a second frequency, more feedback will be provided at the first frequency. The overall amplifier gain at the first frequency will, in consequence, be lower than that at the second.

Switch S_1 causes one of three series capacities to be inserted into the network. In the "Max" position, only the 500pF condenser, C_4, is connected into circuit. Due to the relatively low capacity of this condenser the feedback network offers a high impedance to the lower audio frequencies, and less feedback at such frequencies occurs. As a result the amplifier offers increased gain at these frequencies and a high degree of bass boost is obtained. In its central position, S_1 causes a capacity of 0.0055μF (C_5 in parallel with C_4) to be inserted into the network. As the series capacity is now increased, less bass boost is provided. In the "Min" position, S_1 connects the 0.05μF condenser, C_6, across C_4. The impedance to bass frequencies now becomes low, and the bass boost effect is almost negligible.

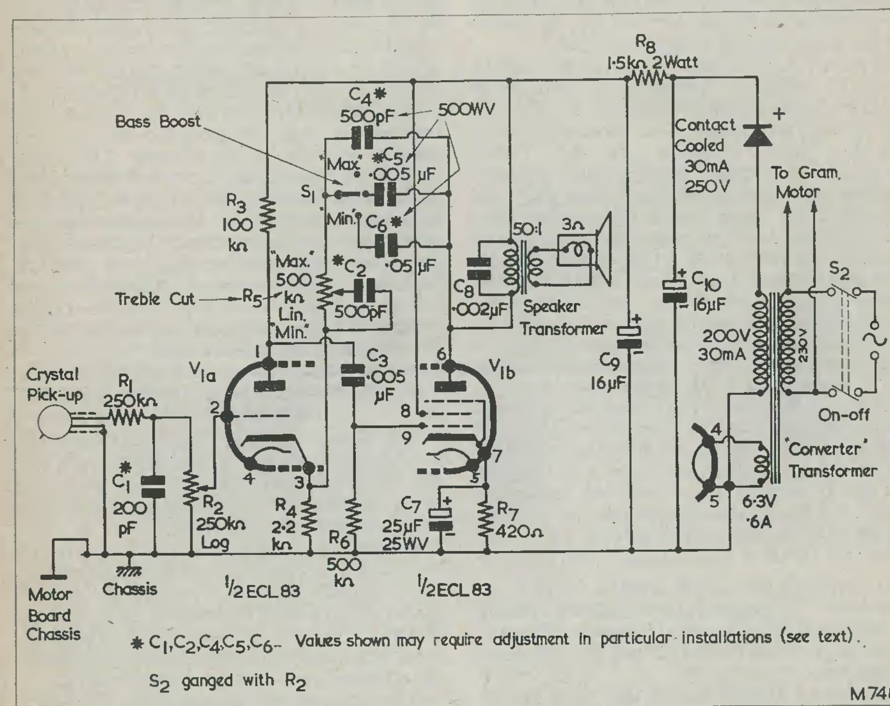
It will be noted that, whatever the position of switch S_1, C_4 is always in circuit. C_4 could, alternatively, have been connected to the blank contact at the "Max" position of S_1 without markedly affecting the operation of the bass boost circuits. This arrangement was not employed, however, as it would have resulted in no feedback at all being applied to the amplifier if the arm of S_1 became completely disconnected as it passed from one contact to the next. Such disconnection could cause a momentary high burst of amplification between contacts as S_1 was adjusted. Having C_4 permanently connected across S_1 ensures that some degree of feedback is present at all times.[1]

is at the lower end of its track, condenser C_2 is virtually short-circuited and has no effect on circuit operation. As the slider of R_5 travels towards the upper end of its track, C_2 has an increasing effect on the frequencies passed by the feedback network. C_2 provides a low impedance at the higher audio frequencies with the result that an increasingly lower impedance to these is offered by the network as the slider of R_5 moves upwards. When the slider of R_5 is at the top of its track feedback of the higher audio frequencies is at maximum. In consequence, this position of the slider corresponds to maximum treble cut.

Setting Up

A note appended to the circuit diagram states that the values of some of the condensers may require adjustment in particular installations. The reason for this is that the output from the amplifier will vary according to pick-up, loudspeaker, and loudspeaker enclosure. The values given in the diagram for the condensers in the feedback circuit should, however, cope for most instances where a small loudspeaker is fitted in an enclosure of the type offered by a record player cabinet, this being the application envisaged by the writer.

After the amplifier has been completed, it



The treble cut control R_5 enables the network to offer varying impedances to the higher audio frequencies. If the slider of R_5

[1] The present arrangement still has the slight disadvantage that momentarily increased bass boost may occur as S_1 is adjusted from the central to its "Min" position. A complete solution would be provided by a switch, which, when adjusted, caused the next contact to be made before the previous one was broken. The writer did not feel it justifiable to particularly specify such a switch in this instance, as the momentarily increased bass boost between the central and "Min" positions should not prove to be a significant disadvantage.

should be initially checked. S_1 should be set to its "Min" position and the slider of R_5 to the lower end of its track. Records of known performance should then be played at varying volume levels. The reproduction at this stage should show evidence of adequate, or even slightly excessive, "top", with reasonable (perhaps slightly attenuated) bass response. If there appears to be insufficient "top" the value of C_1 should be reduced. The effect of adjusting R_5 should next be ascertained. This control should give a smooth cut of treble as it is advanced. If treble cut is excessive at the "Max" end of the track, C_2 should be reduced in value. It is undesirable to *increase* the value of C_2 in order to obtain increased treble cut. If treble cut appears inadequate it would be preferable, instead, to increase the value of C_1, thereby reducing the level of the higher frequencies applied to the amplifier.

The effect of the bass boost control should next be checked. A significant increase in bass response should be noticed as S_1 is set to its central position, this increasing again at the "Max" position. In the "Max" position the amplifier gives a relatively high degree of bass boost, and this may be excessive for some tastes. Also, the bass-boost effect may be over-emphasised if the speaker cabinet tends to resonance at the lower frequencies. A slight increase in the value of C_4 will reduce the bass boost at the "Max" position, should this be desired.

It might appear from the above that experimental work is almost inevitable after the amplifier has been completed in order to obtain a satisfactory response. The writer would like to re-emphasise that such is not the case. In the majority of instances the amplifier will be satisfactory as it stands. If any adjustment is needed this will probably be satisfied, in most of the remaining cases, merely by adjusting the value of C_1 to ensure good "top" response, or C_4 to prevent excessive or resonant bass.

Practical Points

The amplifier should present few difficulties in construction due to the small number of components required. It would be advisable to mount the valve and its components close to the volume and tone controls. An ideal layout would consist of having the valve and its components mounted on a small chassis, together with the controls themselves. Mains wiring to the on-off switch should be kept well away from the wiring to V_1(a) grid.

The mains transformer and smoothing components may be mounted at any convenient position in the cabinet. The mains transformer secondary current will run close to the rated 30mA, and it would be advisable to ensure reasonable ventilation for this component in consequence. Ventilation for the smoothing resistor, R_8, will also be necessary. This component dissipates some 1.4 watts and it is essential that the resistor employed has a rating at least equal to the 2 watts specified in the circuit.

"THE MAGIC OF TRANSISTORS"

This is the title of a two-colour 8-page pamphlet produced by Associated Electrical Industries Ltd., which explains the transistor in very simple language A copy of this will be gladly sent to any interested reader on application to the Semiconductor Dept., Associated Electrical Industries Ltd., 155 Charing Cross Road, London, W.C.2.

CHANGE OF NAME AND ADDRESS

Direct TV Replacements are now trading as a limited company and it should be noted that the correct title is Direct TV Replacements Ltd.

It should also be noted that they are no longer at 134-136 Lewisham Way, London, S.E.14. The telephone number at 138 is Tideway 6666. Their manufacturing subsidiary company will continue to trade under the name of Direct TV Windings Ltd. and the head office address will be as above, and where orders are placed for Direct TV Windings Ltd., it is important that the goods are *delivered* direct to the factory at 5, 6, 7 Coopers Yard, Westow Hill, S.E.19, unless otherwise stated, and in all cases *invoices and correspondence* to 138 Lewisham Way, London, S.E.14.

ELECTRICAL ENGINEERS A.S.E.E. EXHIBITION

The ninth national Electrical Engineers Exhibition (Earls Court, 5th–9th April, 1960) will be opened by the President of the Board of Trade, the Rt. Hon. Reginald Maudling, M.P., at noon on 5th April.

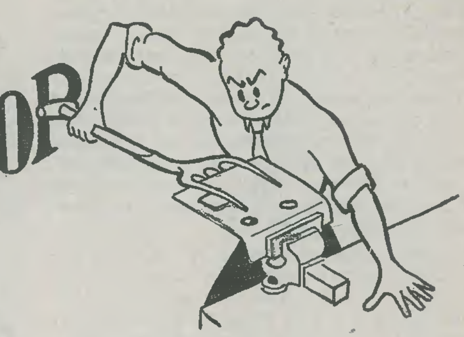
Part of the "Marine Electrics" feature will be devoted to electrical and electronic equipment from Britain's renowned aircraft carriers, H.M.S. *Victorious* and H.M.S. *Hermes*. Visitors will see much equipment never previously exhibited including control, navigational and communications devices.

Also featured will be equipment as used in the S.S. *Canberra*, the largest liner built in British shipyards since the war. Exhibits will include the latest navigational aids and radar, and radio communications equipment.

An electrolier, believed to be the world's largest, will be suspended from the 110ft-high roof of the Exhibition Hall. Its total loading will be around 18,500 watts.

To demonstrate the growing importance of floor-type heating, visitors will walk on the world's largest electrically heated carpet. Covering over 1,000 sq. ft, it will have a loading of more than 11,000 watts.

IN YOUR WORKSHOP



This month Smithy the Serviceman discusses, with his able assistant, Dick, some uncommon uses for domestic bits and pieces

"*Women!*"

Smithy had just thoughtfully filled in the last-but-one answer in his post-lunch crossword puzzle when his assistant burst in, threw a small package on his bench and despairingly gave vent to the single word which has been so often repeated in similar tones throughout the ages.

"Women!" repeated Dick explosively.

Smithy grinned to himself and returned to his crossword. He didn't know what mysterious errand it was which had caused Dick to leave the Workshop after lunch, but he was impressed by the fact that it had been very successful in puncturing even his dreadnought self-assurance. Smithy was curious about the errand also; but one glance at Dick's face, still as red as a midsummer sunset, made him realise that it would be better to forego any questioning till Dick's natural ebullience re-asserted itself. The Serviceman decided, therefore, to temporarily ignore his assistant's outburst.

Faults and Time

With a grunt of satisfaction Smithy filled in the last word in his puzzle and looked at the clock.

"It's time to get back to the grind", he called out.

Dick reluctantly took off his jacket and hung it on the peg behind the door. Slowly, he walked over to the rack holding the sets awaiting repair, and he carelessly selected a modern 110 degree television receiver. He then carried it over to his bench and plugged it into one of the row of assorted mains sockets at the rear.

He next switched the set on. The pilot lamp illuminating the tuner channel selector knob failed to glow. Realising that this lamp was almost certainly shunted by a resistor which would maintain continuity in the heater chain, Dick glanced through the perforations in the cabinet back to see whether the valve heaters were glowing. Even allowing for the delay caused by the series heater thermistor, however, it was quite evident that the valve heaters had no intention of warming up whatsoever.

"Blast", growled Dick irascibly. "I suppose I've now got to go through all the heaters to find out which one's gone open-circuit."

"Hey, wait a minute", said Smithy, who had been watching him. "You're jumping the gun a bit, aren't you?"

"I don't know", said Dick, belligerently, "The heaters don't light up, so I'm making the assumption that one of them's gone open."

"Come off it", protested Smithy. "I don't know what it is that upset you so much before you came in, but I don't see why you should take it out on me."

Dick's natural good humour slowly returned to the surface.

"I'm sorry, Smithy", he remarked contritely. "I've just had a traumatic experience which will, I'm quite certain, leave its scars on me for the rest of my life. Anyway, to return to the set, surely I'm not too far off the ball when I say that if the valves don't light up it's pretty certain that one of the heaters is open."

"You're not too well *on* the ball either", Smithy rejoined. "To begin with, the model you're checking is fitted with a mains supply fuse. Have you checked whether *that's* O.K.?"

Somewhat guiltily, Dick removed the back from the receiver and revealed the cartridge fuse-link referred to by Smithy. He unclipped it and checked it for continuity with his testmeter.

"Yes, it's quite definitely the fuse", said Dick confidently. He had now completely recovered his self-possession. So much so, indeed, that his tone of voice suggested that it was he, and not Smithy, who had thought of checking the fuse. "It's a lamp job. How are we off for spares?"

"That seems reasonable enough for a television set", commented Smithy. "Most t.v. sets have a number of fixed potentiometers between h.t. positive and chassis, and these would cause a lowish reading of that nature. Also, it would seem that the h.t. electrolytics are O.K. I would now suggest that you connect up your testmeter so that it reads h.t. voltage, pop in another fuse, and keep a careful watch inside the receiver to see what happens after you switch on."

"Okey-doke", replied his assistant.

Dick fitted another fuse, and proceeded to give a running commentary.

"I'm switching on," he said briskly, "*now!*

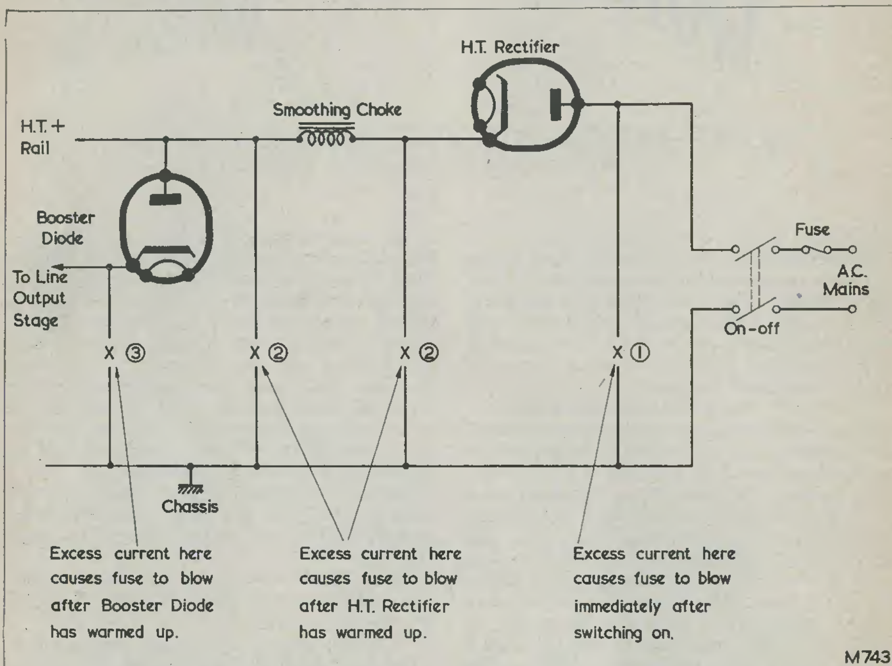


Fig. 1 When diagnosing the cause of blown fuses in a television receiver, it is helpful to remember that excess current in separate parts of the chassis cause the main fuse to blow at different intervals after switching on

"Not too well", admitted Smithy, just a little nettled at Dick's patronising manner. "So, before you fit a new fuse, it would be a good idea to check if there's an h.t. short to chassis, or something equally obvious."

Obediently, Dick looked inside the cabinet for an h.t. positive point and found one conveniently to hand on what was undoubtedly the smoothing choke.

"There's approximately 50kΩ between h.t. plus and chassis", he announced after he had applied his test prods.

Well, the pilot lamp is beginning to glow this time. Not much yet from the heaters, probably because the thermistor is holding things up a bit. Ah, here they come! Oh, yes, and there's a stir on the testmeter needle as well. H.T. is now reading ten volts, twenty volts, thirty volts, forty—phew, cor blimey! There's just been the father and mother of all flashes right before my very eyes. And, yes, the fuse has blown again."

Smithy nodded wisely.

"Where was the flash? Near the rectifier?"

"I couldn't place it exactly, but it was thereabouts."

"Fair enough", said Smithy. "Pop in a new h.t. rectifier and a new fuse and try again."

Dick did as he was bid and switched on again. This time the h.t. line achieved a full 200 volts without the fuse blowing. Shortly afterwards the line output stage came to life and the receiver produced a normal picture.

Smithy seemed satisfied.

"Well, that was easy enough", he remarked. "I'm afraid I was a bit long-winded with this particular snag but that was because I wanted to make certain of my facts. Whenever I get in for repair a t.v. whose main fuse has blown in the customer's house, I usually like to fit another and make *that* blow too as the first part of the diagnosis. The important thing to ascertain is *when* it blows. If it had blown immediately after switching on you could say straight away that there was a short in the wiring immediately after the switch, and start hunting accordingly. Some sets have an anti-mains-modulation condenser of 0.01 to 0.1μF wired across the mains just after the switch, and that would be a very likely suspect."

"Would you also suspect shorts to chassis in the heater chain?"

"Not normally", replied Smithy. "Such shorts, which are usually, incidentally, the result of heater-cathode breakdowns in the valves themselves, would more probably cause heater burn-outs higher up the chain rather than the blowing of the relatively heavier current fuse.

"Getting back to the time factor, if the fuse doesn't blow immediately, the excess current in the fuse will most likely only be apparent when the valves have reached full emitting temperature. That's the reason for keeping an eye on h.t. voltage. In your case the h.t. rose to some thirty-odd volts before the excess current flowed. The most likely suspect then, especially when you consider the flash you saw, is the h.t. rectifier itself—assuming that this is a valve type, of course. We knew beforehand that there was no *dead* short to chassis on the h.t. positive line, and it is unlikely that 30 volts of h.t. would cause anything else in the set to flash over like that."

"What would have happened if we'd reached full h.t. voltage without the fuse going?"

"We'd have left the set switched on", replied Smithy, "and waited for the booster diode to reach full emitting temperature. If the fuse had blown then we could have assumed that the line output stage was drawing excess current. This sketch (Fig. 1) may help to make things clearer. We have firstly the sort of snag which will cause the fuse to blow immediately after switching on; that is, shorts just after the switch. We next have snags which will blow the fuse only after the h.t. rectifier has started emission. These are shorts in the h.t. line or an internal short in the rectifier itself. Thirdly, we have the snags which will blow the fuse after the booster diode has reached emitting temperature, these consisting of shorts or excess current in the line output stage."

"Why did you plump on the h.t. rectifier so quickly?"

"Quite honestly", admitted Smithy, "I didn't plump on it quickly enough! If I hadn't been using this particular snag to demonstrate the various types of fuse-blowing faults that exist, the first thing I would have done with that set would have been to check the h.t. rectifier in the valve tester. This is because valve h.t. rectifiers are the most obvious suspect in a case of this type. Nevertheless, the procedure we followed is quite definitely a good one, and it certainly isolates the faulty component without doubt."

"What do you think is wrong with the rectifier?"

"Almost certainly it has a cathode-anode short. If you break the envelope open you will probably find a flake of cathode material which has broken away and is resting against the anode."

"Some sets", remarked Dick, "have two valve h.t. rectifiers in parallel. I suppose that an internal short in either could blow the fuse."

"That's right", confirmed Smithy. "The only difference here would be that you would have to isolate the bad one out of the two."

Metal Rectifiers

"I see", said Dick reflectively. "And what would we have done if the fuse just hadn't blown at all?"

"I would have let the set soak for a few hours. All fuses are liable to go open with time, and this is especially true with fuses which have to stand heavy switch-on surges as can occur when people switch off their t.v. sets, and switch them on again whilst the heaters are still warm. Of course, if the set has a metal h.t. rectifier you are liable to get a surge *every* time you switch on."

"I'd forgotten all about metal rectifiers", said Dick. "All you've discussed up to now are sets with valve h.t. rectifiers. How does your diagnosis work with sets which have metal rectifiers? Or, come to think of it, with sets fitted with those new teeny-weeny silicon rectifiers."

"In either case", said Smithy, "h.t. voltage appears as soon as you switch on. So your first two time-stages for fuse-blowing become one. I must add, incidentally, that it is theoretically possible for an internal short in a *valve* rectifier to blow the fuse immediately after switching on. In practice, however, I've never had it happen until the valve has started warming up."

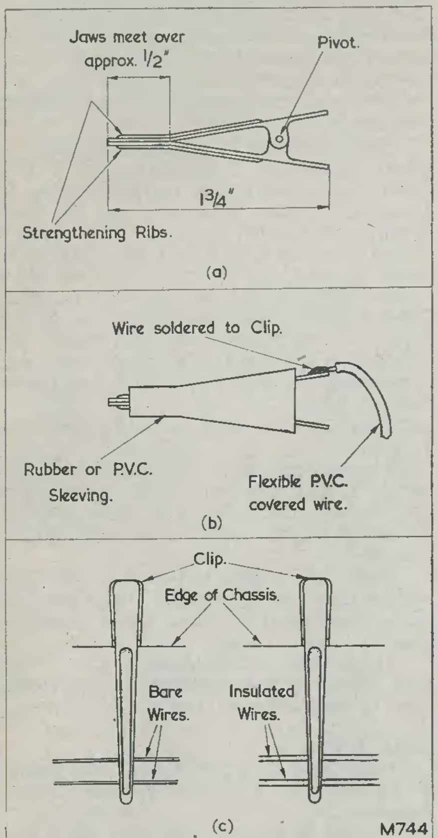


Fig. 2 (a) A curl clip, of the type purchased by Dick on his memorable shopping expedition. (b) The clip converted to a test clip. Due to its slimness it is capable of being applied to "awkward" test points. (c) The clip may also be used to hold either bare or insulated wires against the side of a chassis. Because its jaws have smooth surfaces, the clip will not damage insulation

"These new silicon h.t. rectifiers *are* very small, aren't they?" proceeded Dick, carrying on at a tangent. "How is it possible to replace a hefty thing like a metal rectifier with something as small as a silicon rectifier?"

"It's because of heat dissipation", replied Smithy. "The forward resistance of a silicon rectifier—that is, the resistance it offers when it conducts—is very much smaller than the forward resistance of a common-or-garden metal rectifier. So it drops less voltage when it conducts and, therefore, dissipates less heat. It's as simple as that."

"I'm with you", remarked Dick. "I can't think of any more questions for the time being", he added regretfully.

By now Dick was so very evidently his normal self that Smithy adjudged it was time to satisfy his own curiosity.

"Well, *I've* got a quick question to ask", he said. "What, if I'm not poking my nose in—and I know that I am—have you got in the mysterious package you threw on the bench just now?"

Dick's face went slightly pink.

"They're nothing that's of any use to the Workshop."

"How am I to know that till I see them?" persisted Smithy, catching quickly on to the plural.

"They're just *things*, that's all."

"What sort of things?" said the insatiable Serviceman.

Dick, realising that he would get no peace until Smithy had examined the contents of his package, offered this up silently.

"Ah", remarked Smithy, "let's see what we have here! There is, firstly, one gaily coloured card holding nine Esmeralda Stainless Curl Clips. Secondly, another card holding six Duchess Curl Foundations designed expressly for the Italian Hairstyle. Oh, yes, and a nice little bottle of Shocking Pink nail varnish. Is that all?"

"Is that all?" repeated Dick heatedly. "I'd like to see you go into the chemist's and buy a load of stuff like that!"

Smithy examined his nails, then solemnly patted his thinning hair.

"I've never really felt the need for such things myself", he remarked gravely.

"They aren't for *me*", said Dick aggrievedly. "My girl-friend, Ada May, asked me to get them for her."

"Ada May? Isn't she your steady?"

"Well, I suppose you *could* say that."

"She's a very sensible girl", said Smithy warmly. "I remember fixing her family's radio one day. She said the output valve was at fault because it didn't light up. She was perfectly right, too."

Smithy's judgment of female character tended to be based on standards peculiarly his own.

"And what, may I ask", continued the Serviceman, "is wrong with Ada May asking you to do a little shopping for her?"

"What's wrong with it", said Dick hotly, "is the fact that, when I got to the chemist's, it was chock-full of nattering women plus a crowd of giggling girl assistants behind the counter. As soon as I started to make what I considered to be a very reasonable purchase they started tittering all over the shop. Except, that is, for one old battle-axe. *She* kept talking about Teddy Boys all the time."

"Rather a peculiar reaction", commented Smithy.

"It got worse than that", continued Dick, his face becoming redder and redder. "All I asked for were curl clips, curl foundations and nail varnish, but the girl who served me wanted to make certain that I got *exactly* the right type. By the time she'd finished, the old dragon had left Teddy Boys and was on about re-introducing the birch. And all the rest were snickering fit to bust their corsets. Ye gods!"

The vision of that shopping expedition rose clearly before Dick's eyes.

"Do you know, Smithy", he ended, wearily, "there are something like ten different types of curl foundations and twenty different types of clip. I went through the *lot!*"

"Well, it's over now", soothed Smithy. "Let's have a look at them anyway."

Smithy removed one of the curl clips from its card.

"Why, this is useful", he exclaimed. "Just look at it. It's about $1\frac{3}{4}$ inches long, pivoted near one end, and the jaws meet over at least half an inch." (Fig. 2 (*a*).)

"What's so marvellous about that?"

"Why, it makes an ideal test clip!"

"Hey?"

"Surely. Look, it only needs to have a bit of rubber or p.v.c. sleeving put over its length and, because of its slenderness, you have a test clip which will get in anywhere. I've been looking for something like this for years!"

"Can you solder to it?" said Dick dispassionately.

"I think you could to this particular one", said Smithy. "It looks like nickel-plated mild steel to me."

He fastened the clip to a chassis nearby and experimented with a soldering iron.

"Perfect", he pronounced. "You need a little extra flux to get good initial wetting but, after that, it solders like a dream."

Despite himself, Dick began to be interested.

"Come to think of it", he remarked, "the ones I chose did seem to be shinier than the others. The others looked as though they were made of aluminium."

"That's no disadvantage these days", replied Smithy, "now that there's plenty of aluminium solder available."

Quickly, Smithy soldered lengths of p.v.c.-covered flexible wire to two of Dick's clips, converting them to test prods with leads. (Fig. 2 (*b*).)

"I must say they look impressive", commented Dick. "I think I'll knock up a pair of similar leads for myself."

Whilst Dick prepared his leads Smithy looked at the remaining curl clips on the card.

"You know, these would make very useful general purpose clips as well", he commented eventually. "They are ideal for clipping wires to chassis and things like that. (Fig. 2 (*c*).) If the wires were bare they would contact the chassis; and if they were insulated they would remain that way because the smooth finish of the clip jaws wouldn't cut the insulation. I honestly think, Dick, that your choice of clip was most commendable!"

"I have my moments", said Dick modestly, as he completed his test leads. He had by now completely forgotten the initial reason for buying the clips.

Residual Magnetism

Silence descended on the Workshop for some minutes as Smithy and his assistant resumed their duties. The Serviceman walked back to his bench whilst his assistant returned his television receiver to the "repaired" rack. Dick picked up another receiver at random and carried it to his bench. This done, he looked upon his choice with some disfavour, recognising it as a vintage sound receiver having a row of push-buttons for station selection at the top of its cabinet. Resignedly Dick prepared himself to tackle a repair job where most of the valves and special components would be obsolete. It was not long before a wail of despair reached Smithy's ears.

"Smithy", called out Dick. "How on earth do you clear a jamming relay?"

Submissively, Smithy turned away from the receiver he was examining, and his feet followed the well-worn path to his assistant's bench.

"It's this old sound receiver", complained Dick. "These buttons on the top cause a motor to turn the tuning condenser to whatever station is selected. Also, the buttons select long, medium or short wavebands, the necessary switching being achieved by the tuning motor in combination with a clutch arrangement operated by a separate relay gadget. It's the relay gadget that's jamming."

"I know the set very well", said Smithy, after a cursory examination. "It was one of the best sets made, in its time."

"Well, it isn't one of the best sets now", said Dick flatly, "because, when the relay energises, it *stays* energised! With the result that, despite valiant attempts on the part of the tuning condenser motor, the waveband selection cycle jams halfway through."

Smithy looked at the offending component.

"It's not *really* a relay, you know", he remarked, "its armature is meant merely to push the clutch mechanism over when it's energised. (Fig. 3 (*a*).) Anyway, the thing

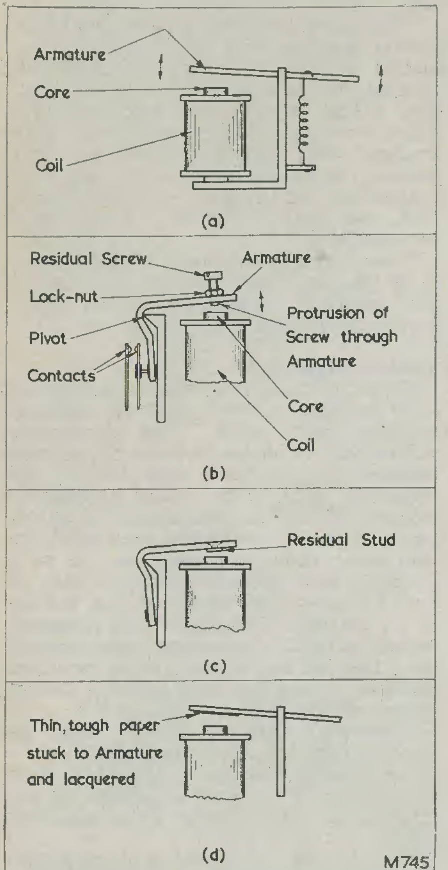


Fig. 3 (a) A simple and inexpensive electro-magnetic device of the type occasionally encountered in domestic receivers. (b) Higher-grade relays are fitted with non-ferrous residual screws to prevent the armature and core coming into intimate contact with each other. The armature is tapped to take the residual screw. (c) Frequently, instead of a residual screw, a non-ferrous residual "stud" is riveted to the armature. (d) A residual gap may be fitted to the simple device of (a) in the manner shown here

that's wrong with it is probably exactly the same thing that all these cheaper electro-magnetic devices suffer from eventually. Residual magnetism."

"Thank you very much", said Dick politely.

"Don't mention it."

"Perhaps you could further elucidate?"

"Certainly."

Smithy pressed a button experimentally and noticed that the armature of the device snapped down smartly on to the core of the coil. When the energising current ceased, however, the armature remained in place. Smithy pushed it gently with a screwdriver whereupon it returned immediately to the de-energised position, and the tuning operation selected by the button he had pressed was carried to its completion by the motor.

"There you are", said Dick triumphantly. "The relay keeps jamming, as I said."

Without a word, Smithy took a piece of paper, tore a strip from it and allowed it to lay flat between the armature and the core. He pressed another button. This time the armature snapped down on to the paper, after which it released itself in correct manner when de-energised. The tuning operation proceeded without a hitch. Smithy pressed several more buttons, with equally satisfactory results.

"I'm blessed", said Dick resignedly. "He puts in a bit of paper and clears the snag just like that. I should have realised something like that would happen when the fault is residual magnetism!"

"And so it is", said Smithy. "In a pukka relay of the type the G.P.O. uses you have a 'residual screw' fitted to the armature. This screw is made of brass or some similar non-magnetic material and its sole function is to prevent the armature and core coming into close contact with each other when the relay energises. (Fig. 3 (*b*).) The screw leaves what is sometimes called a 'residual gap'."

"What is the purpose of having a gap?"

"Well, if you didn't have a gap you would have a completed magnetic circuit whenever the armature touched the core. When the energising current is removed this magnetic circuit cannot collapse immediately, and the armature is liable to stay in the energised position for quite a long time before it springs off again."

"Oh, I see", commented Dick. "I presume that you adjust the residual screw so that the armature springs off nice and quickly when the relay is de-energised."

"That's about it", agreed Smithy. "If you're going the whole hog it's usual to set up the screw to give you so many 'thou' clearance, which you check with a feeler gauge. Some relays don't have any adjustment, being fitted with a residual 'stud' instead of a screw. (Fig. 3 (*c*).)

"In devices of the sort we've encountered here it's usual, for the sake of cheapness, not to have any residual screw or stud at all. Instead, the manufacturer relies mainly on the cadmium plating on the core and armature to prevent the actual ferrous metals from coming into contact with each other. After some years the plating gets worn at the points where the armature and core meet, and you finally get two smooth iron surfaces in intimate contact with each other. It is then that you find the device is slow to de-energise."

"What's the cure?"

"The easiest thing to do is to re-introduce a gap. I've met this snag several times in my career and what I've always done is to stick a bit of thin tough paper to the armature and give it a coating of lacquer. (Fig. 3 (*d*).) Nail varnish is as good as anything for the latter. You could carry out such a repair yourself quite easily."

a favourite complaint of his suddenly became apparent in his mind, "whether my friends don't expect me to call dressed in overalls, the way they drop these casual remarks. I'm certain that whatever social success I may have isn't because of my personality at all, but is due entirely to the fact that households these days are stuffed to bursting point with electrical and electronic gubbinses which are for ever going wrong . . ."

"The bell", Dick interrupted him, "and residual magnetism!"

"Oh, yes", said Smithy, as he brought his mind back to the immediate subject. "Well, anyway, I had a look at this bell and, blow me, if the striker wasn't stuck neatly to the gong! (Fig. 4 (*a*).) What had happened was that the striker arm, being coupled to the armature, had got gradually magnetised in use. Also, the fact that the striker had been bashing away at the gong for some consider-

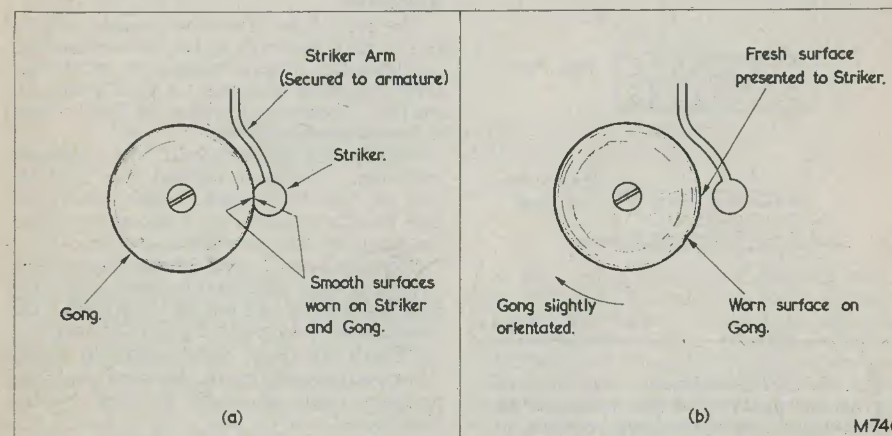


Fig. 4 The case of the defunct electric bell. Smithy found that smooth surfaces had formed at the points of contact on both striker and gong, causing two ferrous materials to come into intimate contact with each other, as in (a). Residual magnetism prevented the striker from leaving the gong. By slightly orientating the gong, as in (b), a new surface was presented to the striker, and the bell functioned correctly

The unsuspecting Dick quickly set himself to fitting a small piece of paper to the armature, liberally applying his girl-friend's nail varnish afterwards. As he and the Serviceman waited for the varnish to dry, Smithy continued to expand on the theme of residual magnetism.

"Funnily enough", he remarked, "it was only a few weeks ago that I came across another snag which lies in exactly the same category. I was calling on some friends when they dropped the casual remark that their front door bell had ceased to operate. I often wonder", continued Smithy aggrievedly, as

able time had resulted in the formation of two smooth ferrous surfaces. With the result that the striker remained held against the bell because of the intimate contact between the ferrous surfaces and its residual magnetism."

"How did you clear it?"

"All I did", said Smithy, "was loosen the centre screw of the gong and turn it round just a few degrees so that it presented a nice fresh surface of plating and grime to the striker. (Fig. 4 (*b*).) Whereupon, with the residual gap thus formed in position, the bell worked like one o'clock! I suppose the striker will wear *that* surface away in a few years' time and it will be necessary to turn the gong round once more. However, in the circs I think the repair I carried out was of a very creditable character."

Insulating Sleeves

By this time the nail varnish on Dick's armature had dried, and he was pleased to find that the tuning and waveband selector mechanisms in his receiver worked perfectly.

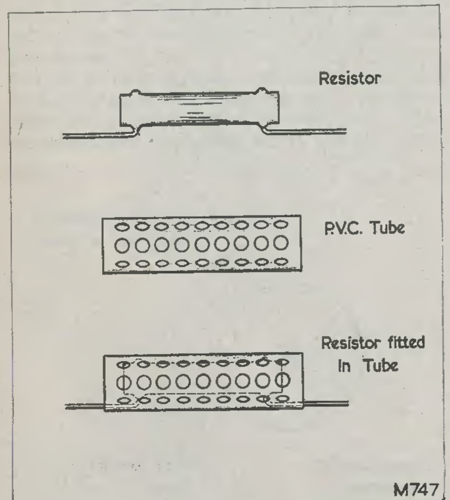


Fig. 5 Curl foundations, consisting of p.v.c. tubes with ventilating holes, may be conveniently fitted to large resistors to form insulating sleeves

"Good", said the crafty Smithy. "That's another job done. Now how about you giving *me* a bit of help? In the job I'm doing I've got a couple of two-watt resistors which are flapping around in the breeze rather. Have you any idea where I can get some insulating sleeves for them?"

Dick thought for a moment.

"I know", he said suddenly. "Why not use a couple of those curl foundations I bought? All they are, actually, are p.v.c. tubes two inches long with an inside diameter of about three-eighths of an inch. Also, they've got holes in them for ventilation. Here, I'll put them on for you."

Smithy showed Dick the two resistors in question, whereupon his assistant quickly fitted the p.v.c. tubes over them, holding them fast with dabs of nail varnish. (Fig. 5.)

"Just the thing", said Dick complacently. "Those resistors are now completely insulated, as well as being well-ventilated. It's a good thing *someone* in the Workshop has a bright idea now and again!"

Realisation

The rest of the afternoon passed uneventfully, and it was only as the Serviceman and his assistant were preparing to leave that Smithy noticed a change in Dick's outlook on life. There was growing, in Dick's face, a dawning sense of loss.

"Why, you rotten devil!" he exploded suddenly. "I've just realised I've used up half of Ada May's nail varnish, stuck two curl foundations into your chassis, and used up nearly all the curl clips as test prods!"

"Not to worry", said Smithy impassively. "Any personal expenses that you may have incurred will be met out of Petty Cash. On production of a receipted bill, of course."

"That's all very well", groaned Dick. "But *you* haven't got to go back and buy another load of stuff at that blasted chemist's!"

"If you *are* going to the chemist's", remarked Smithy unfeelingly, "you'd better get a move on before it closes. Incidentally, it gets pretty crowded just about now . . ."

But Dick was already leaving. As he passed through the door he turned his head and uttered one word very bitterly.

"*Servicemen!*"

Mullard Pocket Data Booklet 1959/60 Edition

The latest edition of this well-known booklet is now available from the Technical Service Dept., Mullard Ltd., Mullard House, Torrington Place, W.C.1. Readers interested should quote ref. 9333/C91/6 when applying for their copy.

Mathematics Course

We have received from Tutorial Mathematics, 200 Buchanan Street, Glasgow, two sample lessons of their radio mathematics course. Of these, one deals with algebra, this being simply introduced in terms understandable to all, such as the addition of apples, pears, etc. Progression is then made to algebraic addition, subtraction, division and multiplication, complete with worked examples and a set paper. The second sample lesson deals with Ohms Law, Measurement of Capacitance, Radian Measure, Alternating Current, the Time Base, etc., etc.

Getting Around

We were very interested to see illustrated on the cover of the Belgian electronics journal, *Evolution Electronique*, Jason's Stereophonic Amplifier. This is very favourably reviewed in their December issue, and Jason are to be congratulated on having obtained such Continental appraisal.

Radio Control Magazine

The proprietors of *Aero Modeller* and *Model Maker* announce that they propose bringing out a magazine devoted to radio control interests. It will be called *Radio Control Models and Electronics*, and issue No. 1 is scheduled to appear on Friday, 11th March.

UNDERSTANDING TELEVISION

PART 26

By **W. G. MORLEY**

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

In the article in this series which was published last month we discussed the frame output stage, dealing with its basic circuit arrangement and the methods employed for controlling linearity. We also considered the inductive "sawtooth-forming circuit", making the point that, when a voltage is applied across an inductance, the current flowing through that inductance increases at a slow rate.

We shall now carry on to the line output stage.

The Line Output Stage

The function of the line output stage is to cause a sawtooth current of adequate amplitude to flow through the line deflector coils. Because of the much higher frequency of the sawtooth waveform it handles, the line output stage operates in a manner which is completely different from that of the frame output stage. Whereas the frame output valve amplifies, with the introduction of little distortion, a relatively linear sawtooth applied to its grid, the line output valve functions more as a "switch" than as an amplifier. The line sawtooth waveform is then obtained from the inductive "sawtooth-forming circuit" given by the combined inductance of the line output transformer windings and the line deflector coils.

In the past a number of different basic types of line output stage have been employed in television receivers, of which the majority have employed circuit devices including "efficiency" or "booster" diodes to obviate ringing in the line output transformer after flyback and to prevent the dissipation of excess energy. Over at least the last five years, however, the booster diode arrangement is that which has been universally employed in conventional circuits, and there seems little reason to doubt that it will continue to be used in the foreseeable future. In consequence, we shall only consider the booster diode line output circuit here.

Fig. 146 illustrates a basic line output stage. A sawtooth waveform is applied to the grid of the *line output valve*, in whose anode circuit is connected the *line output transformer*. Also appearing in the diagram are the *booster diode* and the *boosted h.t. reservoir condenser*. The taps in the line output transformer anode winding are numbered in Fig. 146 to assist in the explanation of its operation.

Fig. 147 shows current and voltage waveforms appearing in the line output stage. It will be helpful to commence our examination of line output functioning at a point near the end of the scan period, it being assumed that the output stage has been running for some time. Such a point is indicated at A in Fig. 147. At point A the line output valve has zero grid voltage with respect to its cathode, and it is in consequence fully conductive. It thereby causes a continually increasing current to flow through the inductance provided by that part of the line output transformer winding which appears between the booster diode cathode and the line output valve anode; that is, between taps 2 and 1. The path followed by this continually increasing current is: chassis to line output valve anode through the line output valve; line output valve anode to booster diode cathode through taps 1 and 2 of the transformer winding; and tap 2 of the winding to the h.t. positive rail through the booster diode, which is now conducting.

with that in the deflector coils) collapses, with the result that the voltage on the anode goes violently positive. In consequence, tap 1 of the transformer winding now carries a high positive potential with respect to tap 3. Tap 2, connecting to the booster diode cathode, also goes positive, causing this diode to become non-conductive. At this time, the only stable potential with respect to chassis is that on tap 3, this tap being held at a constant potential by the reservoir condenser.

Due to the presence of unavoidable stray capacities in the line output transformer winding and the line deflection coil we next have a ringing effect, this occurring at the resonant frequency of the combined inductance and stray capacity. Thus, after the violent positive excursion at the anode end

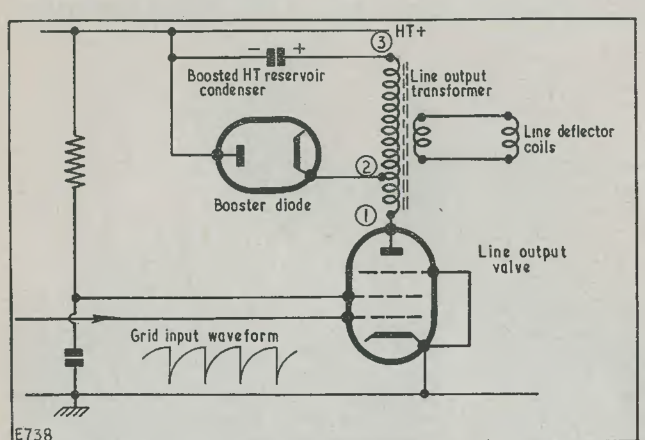


Fig. 146. The basic booster diode line output stage. The signs adjacent to the boosted h.t. reservoir condenser refer to the polarity of its charge and do not indicate an electrolytic component

At the same time as the line output valve draws current, another effect is taking place. Since the anode of the conductive line output valve is obviously negative of the booster diode cathode, it follows, due to normal transformer action, that the winding above the booster diode cathode is *positive* of that cathode. In consequence a positive voltage is applied to the right-hand plate of the boosted h.t. reservoir condenser from tap 3. During the first few cycles of operation (prior to our present examination) this positive voltage will have caused the reservoir condenser to become charged to the potential appearing across taps 2 and 3. It can be assumed that, at point A during our present examination, the condenser receives no further charge during this part of the cycle.

At point B of Fig. 147 the grid of the line output valve goes negative, thereby causing the valve to cut off. At once, the magnetic field in the line output transformer (together

of the winding, the field in the line output transformer and deflector coils collapses again, causing the anode to go negative, with respect to tap 3, once more. (In Fig. 147 the ringing effect is demonstrated by the fact that the current in the winding between points B and C changes direction.)

As the line output valve anode goes negative with respect to tap 3, so, also, by a lesser amount, does the cathode of the booster diode. When the potential across taps 3 and 2 becomes slightly greater than the potential across the reservoir condenser, the cathode of the booster diode becomes slightly negative of its anode, and the diode conducts. This conduction commences at point C of Fig. 147.

The low impedance path which is now provided by the conducting diode and the reservoir condenser prevents the voltage across the winding from increasing and the ringing effect ceases. Instead, the upper part

of the winding now behaves as though a short-circuit had been applied across it, and the current in it slowly decays, causing energy to be fed into the reservoir condenser. This process continues until we reach point D.

slightly. This drop in potential causes the booster diode cathode to go slightly more negative, whereupon it becomes fully conductive. Finally, the entire current is drawn through the booster diode and that part of

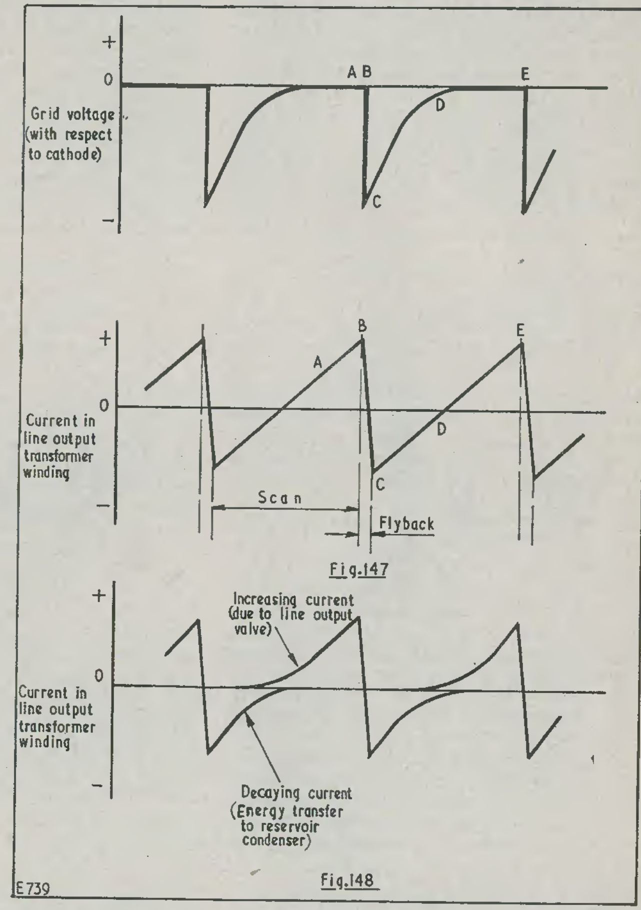


Fig. 147. Waveforms depicting the grid voltage input to the line output valve, and the current in the line output transformer winding. Fig. 148. The current flowing in the line output transformer winding near the centre of the scan period is composed of two separate currents, one decaying slowly and the other increasing slowly

At point D the current in the transformer winding has reached zero and, if the scan period is to continue, it becomes necessary to introduce a continually increasing current which flows in the opposite direction. Such a current is provided by the line output valve which, due to the voltage on its grid, has become conductive. The conductive line output valve now causes an increasing current to flow through the winding, bringing us to point E. Initially, this current is drawn mainly from the reservoir condenser, with the result that the potential across its plates drops

the winding between taps 2 and 1. We thus reach a state of affairs similar to that existing at point A in the previous cycle.

There are two factors in the above explanation of line output stage functioning which require a little further amplification. The first of these is a reiteration of the fact that it is possible for the voltage across an inductance to remain constant whilst the current flowing through it increases or decreases. Thus, when the line output valve conducts, its anode is liable to hold a sensibly steady potential during the time, in the second part of the scan period, that the current flowing through the transformer winding increases. Similarly, the potential across the upper part of the transformer winding between taps 2 and 3 may remain sensibly constant during the time, in the first part of the scan period, when its current decays. This effect is analogous to that which occurs when a direct voltage is applied to an inductance; whilst the voltage across the inductance remains constant, the current flowing through it increases. Re-emphasis of this particular point may assist especially in an understanding of why, during the current decay in the first part of the scan period, the potential across the reservoir condenser remains largely fixed.

each other, their composite curve being equivalent to that shown in Fig. 147.

It will now be helpful to sum up briefly the somewhat complex process we have just discussed. Before we begin our examination we assume that, due to the effect of previous cycles, the boosted h.t. reservoir condenser is charged to a voltage approximately equal to that appearing between taps 2 and 3 of the winding near the end of the scan period.

Commencing once more at point A of Fig. 147 we have the case where the line output valve is fully conductive and an increasing current passes through the valve, taps 1 and 2 of the winding, and the booster diode. The lower end of the winding is negative. At point B the line output valve

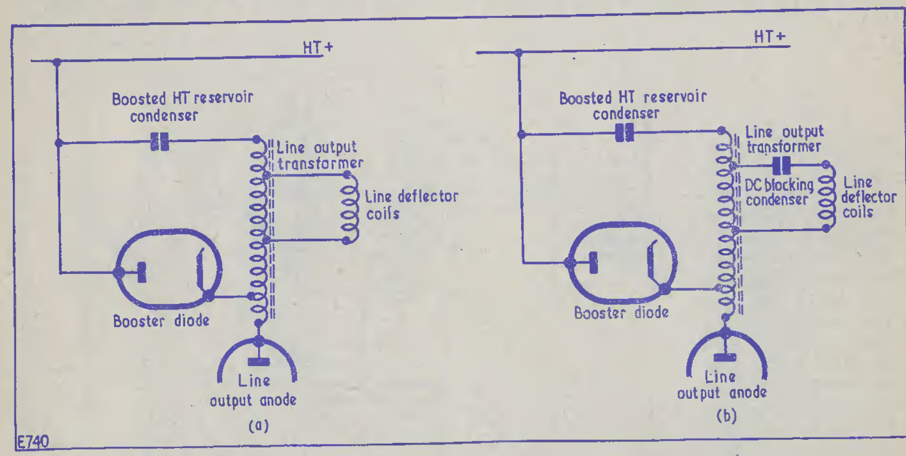


Fig. 149 (a) Because there is a change of direction of current in the line output transformer winding near the centre of the scan period, it is possible to dispense with a secondary for the line deflector coils and to tap these directly into the anode winding. (b) If the change-over in current direction in the anode winding is considered to be excessively displaced from the centre of the scan period, a d.c. blocking condenser may be inserted between the winding and the line deflector coils. This condenser allows only the a.c. component to be passed to the deflector coils. In practice, such a blocking condenser is used infrequently

The second point is that the changeover in current direction at point D of Fig. 147 is not quite as smooth as would at first sight appear from the diagram. What actually occurs is illustrated in more detail in Fig. 148. This diagram shows the decay in current given during the first part of the scan cycle, and it will be noted that the *rate* of decay decreases as the current approaches zero. At the same time the line output valve becomes conductive a little before the end of the current decay period, the current it causes to flow through the transformer winding becoming greater at a continually increasing rate until it has taken over altogether. As may be gathered from Fig. 148 the two current curves overlap

suddenly cuts off, whereupon the field in the line output transformer and deflector coils collapses, causing the lower end of the winding to go violently positive. Since the booster diode cathode now goes positive of its anode this cuts off also.

The line output transformer next commences to ring at the natural resonant frequency provided by its inductance and stray capacities, with the result that the lower end of the winding swings negative once more. However, as soon as the booster diode cathode tap goes slightly negative of its anode —which is the same as saying: as soon as the potential across taps 3 and 2 of the winding slightly exceeds the potential on the plates of

the reservoir condenser—the booster diode conducts. This prevents any further ringing and the field in the transformer and deflector coils begins to collapse, the collapse being slow because of the low impedance suddenly applied across the upper part of the winding. The collapse in magnetic field results in energy being fed to the reservoir condenser and a gradually decaying current in the upper part of the winding. As this current approaches zero the line output valve becomes conductive; and it draws current through the transformer winding in the reverse direction, first from the reservoir condenser and finally from the h.t. positive rail via the booster diode.

During the entire cycle the booster reservoir condenser retains approximately the same potential across its plates. It gains an additional charge during the first half of the scan period and loses this additional charge during the second half of the scan period.

Line Deflector Coil Current

As is indicated in Fig. 147, there is a reversal of current in the line output transformer winding approximately half-way through the scan period. In consequence, we do not have the same effect as occurred with the frame output transformer, where the current in the transformer anode winding flowed in one direction only during the scan period. With the frame output transformer it was necessary to use a separate secondary for the frame deflector coils to ensure that a reversal of frame deflecting current occurred half-way through the scan period. With the line output transformer such isolation is not necessary, because the reversal in current exists in the anode winding already. In consequence it becomes possible to dispense with a secondary winding, and to connect the line deflection coils direct to taps in the anode winding. A typical arrangement is illustrated in Fig. 149 (*a*).

In practice, the moment at which reversal of current occurs in the transformer winding is not exactly in the centre of the scan period and a d.c. blocking condenser, as in Fig. 149 (*b*), is sometimes fitted to ensure that only the a.c. component of the current flows through the deflection coils. Such a condenser is used infrequently as the displacement from centre caused by the direct connection is not normally sufficient to justify the expense of the additional component.[1]

[1] A series condenser to provide d.c. isolation of the frame deflection coils was not mentioned when the frame output stage was dealt with, because such a condenser is not used in conventional circuits. Due to the relatively low frequencies involved in the frame output stage, the condenser would require to have a very high capacity and would become expensive in consequence.

The Line Output Valve and Booster Diode

As we have just seen, high positive voltages appear on the anode of the line output valve during the flyback period. In practice such voltages are of the order of 4 to 5kV. Because of the presence of these high potentials the line output valve has to be provided with special insulation between the anode and the other electrodes. Also, the anode is brought out to a top-cap connection, well away from the pins at the base to which the other electrodes connect.

The line output valve must, in addition, be capable of passing high currents without excessive volts drop between anode and cathode during the period that it is conductive. The current passed at the end of the scan period may, for instance, be of the order of 180mA in a practical design.

Because of the requirements placed upon them, insofar as high voltages and high currents are concerned, the line output valves employed in modern television receivers are specially developed types intended for this function only.

High voltages, around 3 to 4 kV, also appear on the cathode of the booster diode during the flyback period. Again, inter-electrode insulation has to be capable of withstanding such voltages without the risk of breakdown. In the case of the booster diode adequate insulation must be provided not only between the cathode and the anode but also between the cathode and the heater. This last requirement poses a particularly difficult design problem. In British and European diodes, the requisite insulation between cathode and heater is achieved by providing a considerable degree of spacing between them. Such spacing results in a relatively long cathode warm-up time, and it is usually necessary to wait at least a minute after switching on the associated receiver for the booster diode to reach full emitting temperature. In America some booster diodes have been developed which have a considerably shorter warm-up time. Because of the insulation problem it is usual to bring the cathode connection of the booster diode out at a top-cap, rather than at a pin at the base.

The booster diode must also be capable of passing the same high currents, without excessive voltage drop, as are passed by the line output valve. Because of the requirements they have to meet, booster diodes are specially developed for their particular application.

The Boosted H.T. Supply

The point at which the booster diode cathode taps into the line output transformer winding regulates the potential held by the boosted h.t. reservoir condenser. It is usual to site the booster diode cathode tap approximately one quarter to one third of the way up the winding (from the line output valve anode end). If, to take an example, the tap is one quarter up the winding and some 120 volts are developed across the lower part of the winding when the line output valve is conductive, the boosted h.t. reservoir condenser will charge up to the 360 volts which appear across the upper part of the winding.

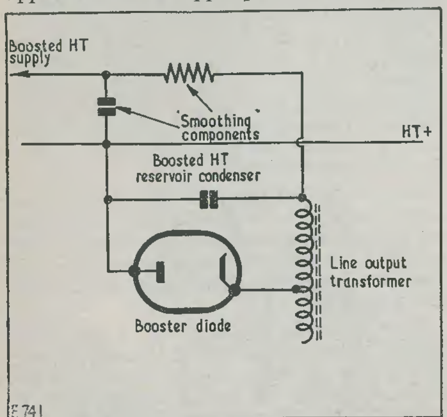


Fig. 150. The potential on the positive plate of the boosted h.t. reservoir condenser is well in excess of that on the h.t. positive rail and may be employed to supply other circuits in the receiver. Fairly typical values for the "smoothing" resistor and condenser would be 200kΩ and 0.01μF respectively

The negatively charged plate of the reservoir condenser connects to the h.t. positive rail of the receiver, with the result that the potential above chassis on the positive plate is equal to that across the condenser plus that of the h.t. supply potential. The potential on the positive plate of the condenser is designated the *boosted h.t.* potential, and it is always well in excess of the normal h.t. positive potential.[2]

The boosted h.t. potential, after "smoothing" with a resistor and condenser, is frequently employed to supply other circuits in the television receiver whose current requirements are small. See Fig. 150. A typical, and frequently encountered, application is given when it provides a supply for the frame sawtooth-forming circuit.[3] The boosted h.t. line may also be employed to provide high potentials for certain electrodes in the cathode ray tube.

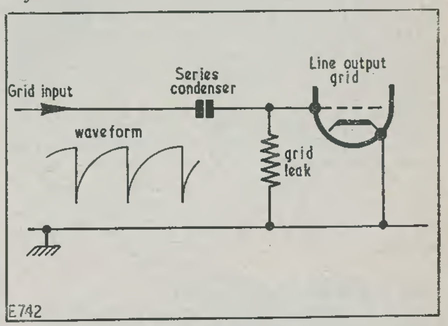


Fig. 151. The input waveform to the line output grid is supplied via a series condenser and grid leak circuit. The resulting leaky-grid action ensures that the most positive part of the waveform has a potential, on the grid, just slightly positive of cathode

Grid Waveform

As is shown in Fig. 147, the markedly non-linear waveform fed to the grid of the line output valve differs considerably from the waveform applied to the grid of the frame output valve. Since the line output valve functions more as a "switch" than as a linear amplifier it becomes necessary for this valve to become conductive approximately half-way through the scan period. This point is ensured by the typical input waveform which is illustrated in Fig. 147.

Another requirement of the grid waveform is that its negative excursion during flyback must be sufficiently large to keep the line

[2] Assuming a 200 volt h.t. rail, the boosted h.t. potential above chassis, in the case we have just considered, would be 200+360=560 volts.

[3] See "Understanding Television", Part 22, November 1959 issue, wherein it was shown that sawtooth linearity may be improved by increasing supply voltage. There is a further reason for running the frame sawtooth-forming circuit from the boosted h.t. line which will be considered in a later article.

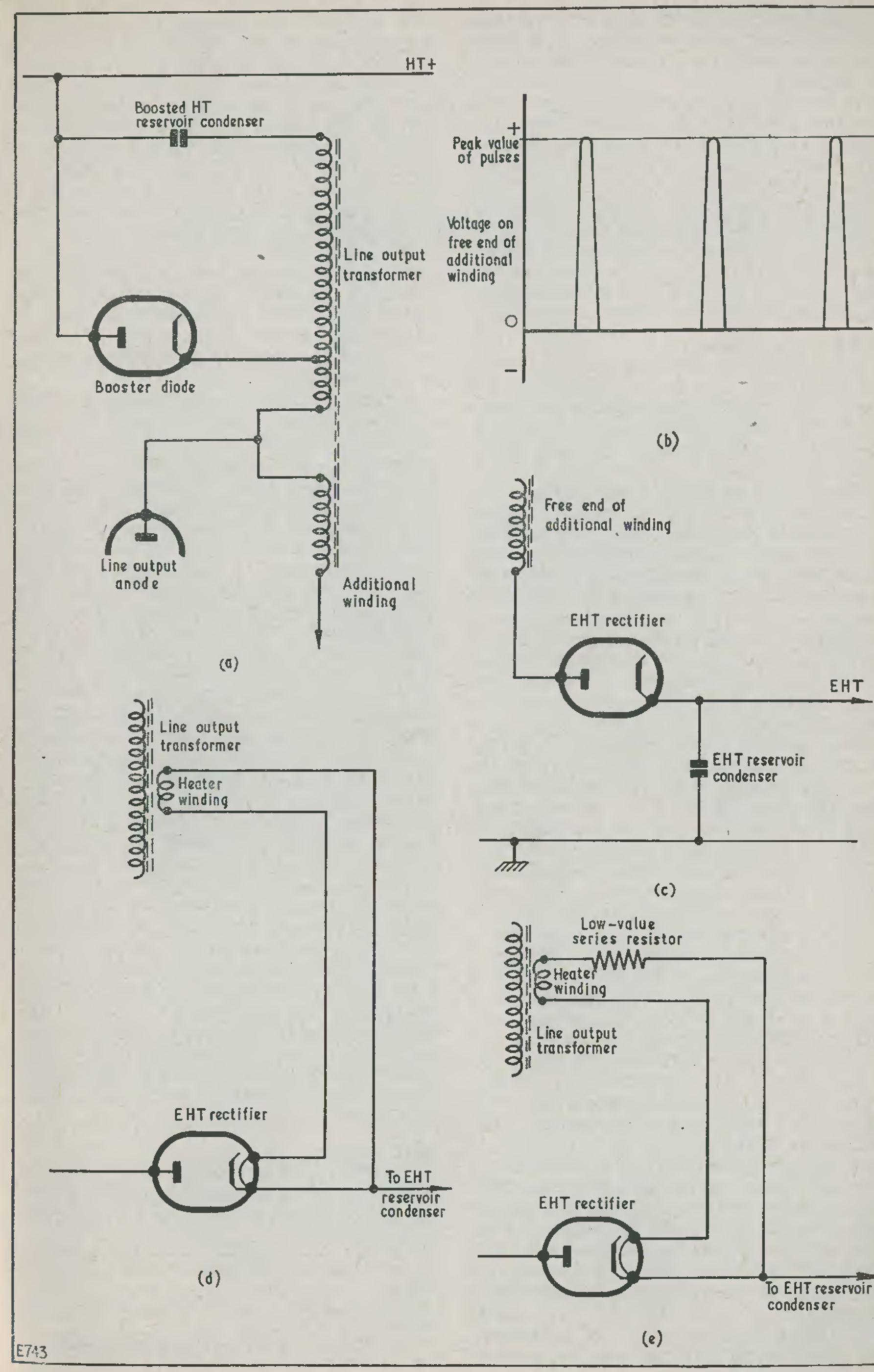


Fig. 152 (a) The line output transformer with an additional (e.h.t.) winding. (b) Positive pulses appear on the free-end of the additional winding during flyback. (c) If these positive pulses are applied to a rectifier and reservoir condenser, the latter charges up to their peak value. (d) The e.h.t. rectifier is heated by a special heater winding on the magnetic core of the line output transformer. Since the heater winding is at e.h.t. potential it has to be adequately insulated. (e) A low-value resistor is sometimes inserted in the heater circuit. This allows the heater winding to have a number of turns which is convenient for assembly purposes output valve fully cut-off despite the very high voltage appearing on the anode. In practice, this negative excursion is usually of the order of 100 volts.

In conventional receivers the input waveform is always applied to the line output valve grid by means of a series condenser and grid leak, the cathode of the valve connecting directly to chassis, as shown in Fig. 151. Bias is then provided by normal leaky-grid action, the most positive part of the waveform corresponding to a potential slightly positive of cathode. Typical values of grid condenser and leak (for the British line frequency of 10,125 c/s) are 0.01μF and 500kΩ respectively.

Extra High Tension

The fact that a high voltage appears across the line output transformer winding during the flyback period makes it possible to obtain a relatively inexpensive extra high tension (or e.h.t.) supply for the final anode of the cathode ray tube.

Fig. 152 (*a*) illustrates a line output transformer fitted with an additional winding connected in series with the main winding. In most instances this additional winding would have approximately 2 to $2\frac{1}{2}$ times the number of turns employed in the main winding. Since the additional winding is inductively coupled to the main winding, a voltage is induced in it during the flyback period, the magnitude of the voltage being approximately 2 to $2\frac{1}{2}$ (according to turns ratio) times that in the main winding. This voltage will add to that in the main winding, because of the series connection between the two, with the result that a potential which is normally some 14 to 15 kV above chassis appears at the free end of the additional winding. This potential consists of the sum of the voltage induced across the additional winding, that present across the main winding, *plus* the potential on the positive plate of the boosted h.t. reservoir condenser.

The voltage on the free end of the additional winding will appear in the form of positive pulses, as illustrated in Fig. 152 (*b*). It is possible to obtain a steady d.c. voltage from such pulses by connecting up a rectifier and reservoir condenser in the manner illustrated in Fig. 152 (*c*). Assuming that no current is drawn from it, the voltage appearing across the reservoir condenser will be equal to the peak value of the pulses. Such a voltage is suitable for application to the cathode ray tube final anode. In practice, a small current will normally be drawn by the final anode circuit, with the result that the average potential across the reservoir condenser will be slightly lower than the peak potential of the pulses. A reservoir capacity of 500pF is normally quite adequate, and provides a steady e.h.t. voltage which is sufficiently "smooth" for television purposes. In present-day receivers the reservoir condenser is an integral part of the cathode ray tube itself. The final anode (consisting of a graphite coating on the inside of the glass bulb) provides one plate, and a graphite coating on the outside of the bulb (connected to chassis by springs) provides the other. The glass of the bulb then becomes the dielectric.[4] The condenser thus formed normally has a value around 1,000pF, and it obviates the necessity for a separate component.

The additional winding of Fig. 152 (*a*) is usually described as the *e.h.t. winding*, the *secondary winding*,[5] or the *overwind*. The latter term stems from the fact that, in earlier line output transformers, the e.h.t. winding was frequently wave-wound on top of the main winding.

In modern receivers, thermionic rectifiers, in preference to metal components, are invariably employed as e.h.t. rectifiers. This is because of their cheapness and conveniently small size. The heaters (or filaments)[6] of such rectifiers are fed from a heater winding fitted to the line output transformer magnetic core, being inductively coupled thereby to the main winding. Fig. 152 (*d*) provides an illustration. In British and European television receivers the e.h.t. rectifiers most frequently employed have heater voltages of 6.3, this being supplied by a heater winding having some three to five turns. In American receivers e.h.t. rectifier heater voltages are often lower, and the appropriate heater winding may consist of a single turn only. Since the heater winding has to be at e.h.t. potential it is normally wound with wire having heavy polythene insulation. Despite its relative bulk, this heavily insulated wire takes up little space because of the few turns required.

Since it is difficult to obtain a heater potential exactly correct for the e.h.t. rectifier from a whole number of turns (when these are few in number), it is a fairly common British practice to insert a small-value resistor between the heater winding and the rectifier heater. See Fig. 152 (*e*). The heater winding is then made to have a whole number of turns in excess of that required for exactly correct heater voltage, the surplus voltage being dropped across the series resistor.

Next Month

In next month's issue we shall continue with the line output stage, commencing with a brief description of line output transformer assembly.

[4] See "Understanding Television", part 5, May 1958 issue.

[5] Whereupon the main winding is designated the *primary* winding.

[6] According to whether the rectifier has an indirectly heated cathode or not.

A "penny wise" SPEAKER ENCLOSURE

By A. G. BOURNE

A SUBJECT WHICH HAS ALWAYS FASCINATED the author is the speaker and the construction of its enclosure. Though many are content with the purchase of a complete commercial design and leave it at that, I am inclined to view these people as patrons to high quality rather than practical hobbyists.

Let us firstly reckon with the links in our chain. They will usually comprise (*a*) the source, which covers f.m. tuner, pick-up, etc., (*b*) the amplifier, and (*c*) the reproducer, namely speaker and enclosure. Each receive plaudits from enthusiasts, but without any undue outburst of criticism I think we can all agree that the reproducer appears to offer the most for our money in a listening sense.

For example, if we were to apportion our budget over all three links, assuming we start from scratch, the result is an average overall quality. Alternatively, of course, we could assemble with a view to improving our system as we go along by concentrating on one section at a time, often though with such rapid changes in the industry we are inclined to change our ideas midstream. If we were to invest in a truly magnificent pick-up to start with we would then run into difficulty perhaps on the next link, the amplifier; it would require sufficient gain and most likely have filters and several controls and we know full well that these are not cheap, even should we build one ourselves, and then added to this is the lack of test equipment to confirm the believed response or distortion factor.

Again, a really plush amplifier alone is lost on a compromise pick-up or speaker. However, by considering the speaker and its mounting as the basis of any system whether we intend to improve things later or not, we do at least hear the difference. The better this is the more marked our appreciation of high quality, and it is my contention—and I am not alone in this expression—that the speaker has the final say.

Remember that the enclosure plays a very important part in the whole. A small speaker of the domestic receiver variety housed in a reflex or horn design will perform in a manner which defies comparison with the usual baffle allotted to these types. I can recall a remarkable demonstration a few years back of a 4in communications receiver speaker in a Tractrix horn; it was impossible to believe it was the same speaker in use.

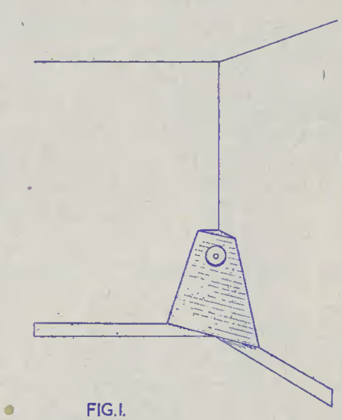


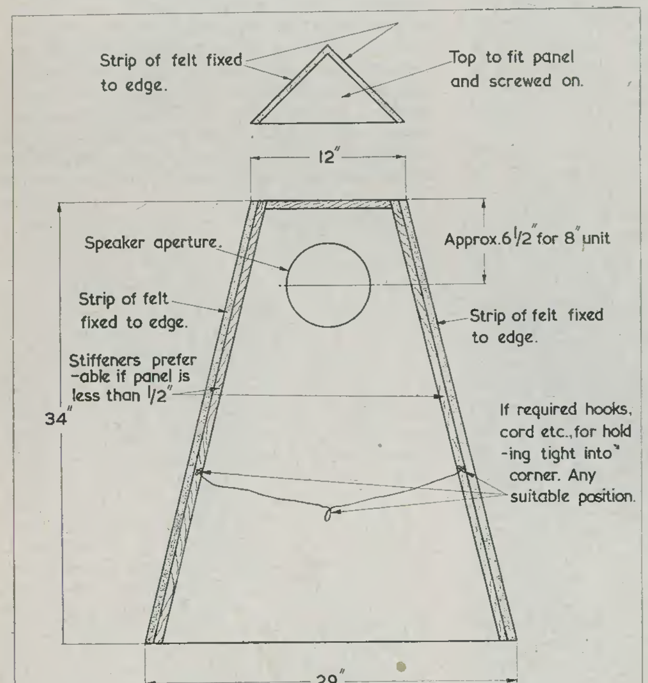
FIG. I.

Top is closed, bottom open.

M723

Many times recently I have heard similar units in good enclosures out-perform high fidelity units when the latter have been left to their own devices in boxes, radiograms and even in advertised housings which were entirely unsuited to their particular characteristics.

Referring to reports and data collected when using push-pull and single-ended amplifiers together with reflex cabinets, closed boxes and horns, it was revealed that we could safely economise on the amplifier and pick-up, selecting the reproducer as the major item. With a single-ended amplifier of the 3W ECL82 class, very enjoyable sound can be produced; in fact, apart from low power output, if we are to condemn it on that score, the performance with any suitable small speaker combination was practically indistinguishable in the home from high power equipments. A study was therefore made which led the author to standardise on a simple 3-watt amplifier, the most elementary type likely to be encountered, in conjunction with a small speaker mounted in horns, reflex boxes or closed baffles, to find the most suitable having regard to cost, space and performance.



REAR VIEW

FIG.2.

M724

Reflex cabinets are usually bulky and can be critical in port size. If we are to compare specifications of inexpensive receiver speakers and high fidelity types to be used, problems arise. Furthermore, the speaker is by necessity below the natural level of any performer; a psychological effect, but unrealistic. This was also true when the closed box was investigated, since it was found to be too large when using 6in units, but having cubic limitations for the higher class larger models. Admittedly cabinets can be semi-portable and sometimes conveniently arranged in a room. Looking into the horn "breed," we immediately think of Mr. Paul Voigt's celebrated corner horn. This remarkable reproducer has always impressed those who have been fortunate enough to hear it, but the front loading demands a great area and is not altogether favoured by the co-habitant, whether we economise by making it at home or not. Therefore we are left with a rear horn loaded device. The many excellent commercial versions are quite expensive, and a home constructed strict exponential rear path loading is still a large contraption; so would a compromise in length and flare have a serious effect upon results—an A.B comparison perhaps—but otherwise here was the line to follow, simplicity being uppermost in mind.

It is a panel (no claims are made for originality) utilising the corner of the room without padding, vents or obstructions of any kind. It gives a clean, superior performance and the range is dependent on the class of speaker selected. The proof of its encouraging response was readily noted when the Lowther PM6, an amazing horn drive unit well known to readers, was tried. Bass was adequate and unadulterated, the treble most impressive; as mentioned earlier, only an A.B comparison would detect any difference against a full-size horn. Sensitivity with any speaker is gratifying, a few hundred milliwatts ample and giving exact detail to the music and perfect balance which together provide an uncanny "liveness" to the reproduction. A pair in stereo will give endless satisfaction for what is practically the cost of just the two speakers.

This design will enhance any speaker used, but if we take into account the small outlay for the panels, a modest amplifier and a reasonable pick-up, more can be budgeted for the speaker. This panel occupies a floor area which does not interfere with any furniture arrangement. It has a slightly upward radiation with the rear horn formed by it and the two walls. (Fig. 2.) A small speaker suffices for intensities well above domestic listening levels, and transients are free from audible resonances. The height will result in more realistic reproduction since it is at ear level, and the sound front tends to become more broadly disposed in a room, this ensuring a proper fusing of the stereo sounds. The high frequencies are not obscured by furniture or other listeners, and easy listening is assured from anywhere in the room. It will be a pleasant surprise to any who give it a trial.

To sum up, by reducing the cost of the enclosure successfully and accepting the fact that geometric progression applies whenever we reflect on the performance and cost of a good domestic amplifier and that of a super, marginal something-extra, amplifier costing ten times the price, the class of speaker will make a noticeable difference; therefore it is right here that we should, if need be, invest in the finest obtainable and settle for music on a common-sense basis.

TRADE REVIEWS

Steadfast Ratchet Screwdriver

J. Stead & Co. Ltd., Manor Works, Cricket Inn Road, Sheffield 2, are the manufacturers of a unique ratchet screwdriver sent to us for test. The handle of this tool is shaped in a pistol grip fashion, thereby giving greater efficiency for turning power and speed. This type of grip makes the tool extremely comfortable to handle, and the great ease with which we drove home several types of screws—both into wood and metal—indicates that this screwdriver will be found a necessity both for the workshop and the garage. Made in transluscent amber plastic, the handle is insulated from the metal blade and ratchet mechanism and is virtually unbreakable. The blade is chromium plated and some 6in in length. The ratchet mechanism has been found both robust and positive in action. The screwdriver retails at 10s. 6d. and is available from most tool dealers and ironmongers.

Three-way Rolls Padsaw

This tool is, without any doubt, the most versatile padsaw that we have ever used. Sold at 7s. 6d. retail, it is supplied complete with one wood- and one metal-cutting blade. These blades may be fitted into the pistol grip handle in three differing ways: pistol grip for straight sawing; file handle grip for intricate cutting; and plane handle grip for cutting close to a wall or floor. The blade is double clamped for rigidity and may be set into the handle at any length, i.e. long or short. The padsaw handle has a blue hammered finish and consists of two halves pressure-diecast in light alloy and held together by two chromium plated screws. The slots in these screws are wide enough to accommodate a coin, thus enabling the padsaw positions to be readily interchanged without a screwdriver. Broken hacksaw blades can easily be put to further use in this padsaw handle. Obtainable from most tool dealers,. this padsaw is manufactured by Rolls Tools Ltd., 154 Blackfriars Road, London, S.E.1.

Multi-purpose Filament Valve Tester V.T.41

Manufactured by Eagle Products, 32a Coptic Street, London, W.C.1, this instrument has been designed to give instant filament tests to all current valves, both mains and battery types, fuses, pilot bulbs and for circuit continuity. Also included on the panel are B9 and B7 pin straighteners, together with provision for testing the internal batteries. Each component tested is instantly shown as "good" or "faulty" on a panel indicator. Housed in a grey hammer case with gold front panel, the V.T.41 measures only $5\frac{1}{2}$in x $3\frac{3}{4}$in x 1in, and is supplied complete with internal batteries and full instructions. The price is 30s.

Simple GRAM-AMPLIFIER/RADIO Unit

By J. G. RANSOME

With the comparatively recent growth in popularity of the 3- and 4-speed record-changer units and their consequent reduction in price, many home constructors have no doubt purchased these and incorporated them into a cabinet complete with a home-built amplifier. The present article describes a simple and efficient amplifier unit of one valve preceded by an equally simple detector circuit capable of adequate reception over the medium wave band. In this manner, and at a relatively inexpensive cost, the enjoyment of record playing may be alternated with that of listening to the Light, Home or Third programmes.

The circuit is shown in Fig. 1. From this, it will be seen that it employs two valves with two metal rectifiers in series. The prime requirement was that the receiver/amplifier had to be small in size, and for this reason a "straight" receiver was chosen in preference to a superhet design—the latter requiring at least four valves plus a rectifier—not to mention the increase in cost!

A small high-slope pentode, the 6AM6, was chosen for detection purposes, it having a very good slope and being reasonably small in size. Functioning here as an anode bend detector, the circuit has no attendant frills whatsoever. A pre-set type of reaction condenser, C_2, is adjusted for the maximum signal without introducing oscillation, and once so adjusted is left set in this position.

The tuning condenser C_3 is an air dielectric type, although there is no reason why this should not be one of the mica dielectric type where physical space is somewhat limited. The coil is a Teletron product, type DR, this having a separate reaction winding.

The output from the anode of the detector stage is taken, via a conventional R-C coupling, to the grid of the 6CH6 output stage. With the gram output being fed through the R-C coupling direct to the output valve grid, it is obviously desirable that an output valve with a very high slope is incorporated into the design. Were this not so, an additional valve pre-amplifying the a.f. signal would have to be included before the final stage. An EL41 was thought, at first, to be suitable but for various reasons was not included; although it could be tried by those readers with a valve of this type already to hand. The 6CH6, described by the manufacturers (Brimar) as a miniature video output pentode, is of course primarily intended for inclusion in the video output stages of a t.v. receiver. The writer has found, however, that it is very suitable for audio working. The output of this valve is about 3 to 4 watts with harmonics of around 8%, which is not very distressing. This compares very favourably with the more commonly used audio pentode 6BW6, this having an output of some 3.5 to 4.5 watts with 8% harmonics.

The resistance R_4 is included as a normal gain control whilst R_5 has been incorporated to somewhat reduce the gain as the output valve is extremely sensitive. This latter resistor should be short-circuited when the gram input is connected and in use. Should the reader reside in a locality noted for poor reception, then R_5 should be omitted from the circuit.

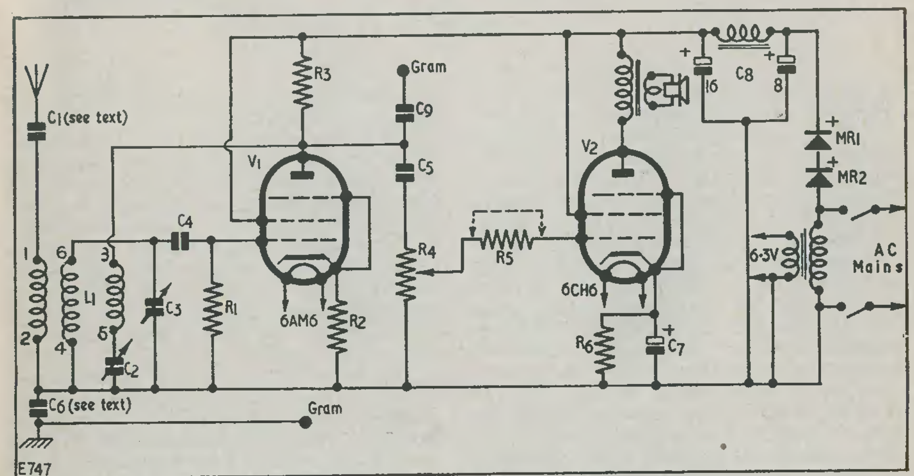
The gram input is connected between "X" and true earth, i.e. not the chassis.

It should be noted here that the unit, under certain conditions, can be alive to earth. This being so, access to the chassis should be made impossible by housing the whole assembly in a cabinet. That in use by the writer has been housed in a gramophone cabinet with the chassis of the unit isolated from the motor board in order to protect the pick-up. It should also be noted that the aerial should be isolated from the mains by inserting a 500pF condenser (C_1) between the aerial and L_1. The true earth connection should also be isolated from the chassis by an 0.1μF condenser having a working voltage rating of 1,000 volts, or at least 750 volts minimum.

The speaker used is an ordinary 3 ohms impedance type, the output transformer being of the 45 : 1 variety commonly available at any radio retail shop.

The power supply consists simply of a 6.3V heater transformer (T_1) with two metal rectifiers MR_1 and MR_2 in series, these being the Brimar type RM1. Smoothing is taken care of by the inclusion of a 60mA, 10H choke in conjunction with C_8, an 8+16μF electrolytic component.

This little unit will be found ideal by those who require a simple and inexpensive radio/amplifier for the newly purchased record-player unit.



Components List

Resistors

R_1	2.2MΩ $\frac{1}{4}$ watt
R_2	150Ω $\frac{1}{4}$ watt
R_3	820kΩ $\frac{1}{4}$ watt
R_4	500kΩ potentiometer with switch
R_5	500kΩ (see text)
R_6	100Ω 1 watt

Miscellaneous

V_1	Brimar 6AM6
V_2	Brimar 6CH6
MR_1	Brimar RM1
MR_2	Brimar RM1
Chassis, valveholders, etc.	

Condensers

C_1	500pF, 1,000V wkg.
C_2	500pF, variable
C_3	500pF, variable
C_4	200pF, silver mica
C_5	0.1μF, tubular
C_6	0.1μF, 1,000V wkg.
C_7	50μF, 12V wkg., electrolytic
C_8	8+16μF, electrolytic, 450V wkg.
C_9	0.1μF, 1,000V wkg.
T_1	6.3V heater transformer
T_2	O/P transformer, 45 : 1 (3Ω matching)
L_1	Type DR (Teletron Co. Ltd.)

24-HOUR SERVICE FOR ELECTROLUBE BRAND LUBRICANT USERS

In order to keep abreast of the ever-increasing demand for Electrolube brand lubricants, specially prepared for the electrical trade, the manufacturers have installed the new Ansafone device on their telephone Hyde Park 0501. This enables telephone calls to be received and recorded at the sales office, Slough Estates House, 16 Berkeley Street, London, W.1, at any time of the day or night. Electrolube Ltd. will supply an instruction card upon request.

The BARONETTE

A Midget A.C. T.R.F. Receiver for Long & Medium Waves

Described by **P. VERNON**

Most radio enthusiasts, especially those with growing sons and daughters, are sooner or later plagued with many pleas for more and more personal radios with which to furnish the various rooms of the household. As time passes, each plea tends to become more plaintive than the last, with each junior member of the homestead verbally jostling for the position of "first supply". Apart from the problem of cost—and this can be quite a worry—one has to consider the availability of components, ease of construction, and the necessity of exact duplication—where more than one receiver has to be supplied. The receiver about to be described is, in the writer's opinion, a very good answer to the above problems. Small and compact, supplied in kit form if required, modern in design—both in circuit form and with respect to the cream plastic cabinet—it is ideal for the juniors' room and as a secondary set for the household.

Circuit

The circuit uses modern double-purpose valves, thus enabling a high efficiency to be obtained and, at the same time, allowing the physical dimensions to be very small indeed. The first valve, V_1, an EBF89 double diode pentode, is utilised both as an r.f. stage and as a detector. The variable-mu pentode section is an entirely conventional r.f. stage, tuned by C_3 (being one-half of the variable two-gang condenser) and the trimmer C_2, in conjunction with the coil L_1. The primary winding of the coil L_2 acts as an r.f. choke, the selected and amplified signal being induced into the secondary winding, this being tuned by the second half of the two-gang variable condenser C_8, with C_7, the trimmer, in parallel. The signal then passes, via C_9, to the diode, where rectification takes place. R_3 and R_4 form the diode load, the rectified signal arriving at the grid of the second stage via the condenser C_{10}. R_2 and C_5 form the required cathode bias components for the r.f. stage.

The second stage is constructed around the ECL80 triode pentode (V_2) used here as an RC coupled voltage amplifier. R_5 is the grid leak resistor and R_6 the anode load of the first section. Via the coupling condenser C_{11}, the signal then passes to the volume control R_7, and thence to the grid of the second half of the valve, this acting as a normal pentode output stage. The resultant output is fed, via the speaker transformer, into a 5-in. speaker.

The power supply uses a heater transformer and a contact cooled Westinghouse rectifier. The output of the rectifier is smoothed by a 32+32μF condenser, $C_{14, 15}$, and a 1.2kΩ resistor, R_{10}. It should be noted here, of course, that the chassis is alive to one side of the mains and must therefore *NOT be connected to earth.* When completed, the receiver is completely enclosed and safe, with a compressed board backing and, of course, the plastic cabinet. Once the knobs have been fitted, the screws fit well down into them; a little wax dropped into these holes will doubly ensure safety.

Assembly

The various components should be mounted in the following order: bolt the valveholders to the underside of the chassis, with the blank position, between pins 1 and 9, facing the rear edge of the chassis. These pins are numbered from 1 to 9, clockwise from the gap, viewing the valveholder from the underside.

Mount into position the heater transformer (see photograph for orientation) using two 6BA screws and nuts, and two small brass washers under the nuts. Next, secure the two-gang variable condenser with three 6BA screws and nuts with washers ensuring that (*a*) the condenser is fitted into a final position as near to the centre of the chassis as possible, this to allow the correct dial position at a later stage; and (*b*), under that 6BA nut fitted at the right rear edge of the chassis—looking at the rear of the set—fit one of the 60pF trimmers in such a manner that the screw adjustment is facing outwards towards the open end of the chassis.

The volume control should next be fitted so that the three top tags are positioned at the bottom of the chassis—see photograph. Following this, fit the wavechange switch into position so that the ball-bearing is downwards at the bottom of the chassis. It should be noted here that the spindle must be cut so that approximately only half an inch of actual spindle is left. This may either be done before mounting, or after, according to individual preference.

The next item is the metal rectifier. This

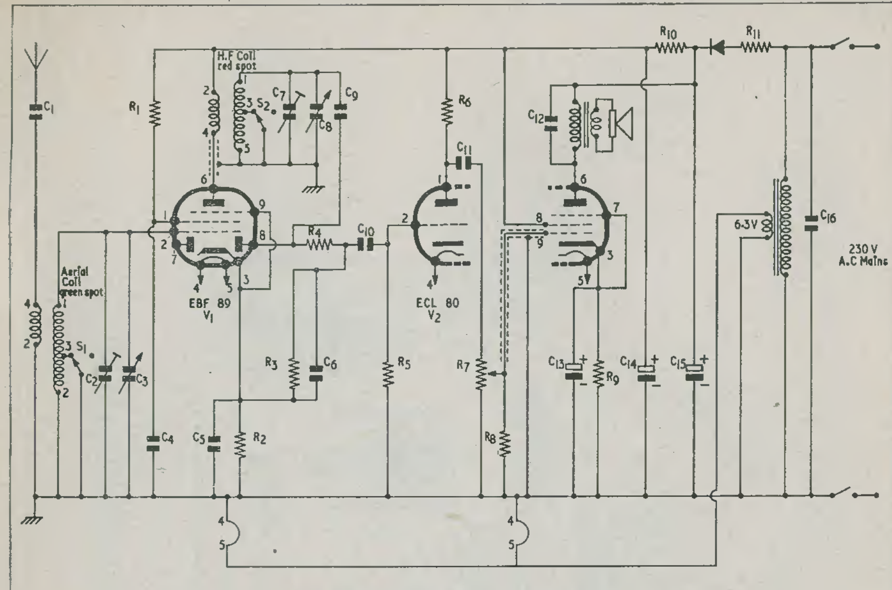


FIG. 1, THEORETICAL CIRCUIT OF THE BARONETTE RECEIVER

G 591

Components List

Resistors

- R_1 68kΩ ½ watt
- R_2 330Ω ½ watt
- R_3 470kΩ ½ watt
- R_4 68kΩ ½ watt
- R_5 470kΩ ½ watt
- R_6 470kΩ ½ watt
- R_7 500kΩ pot with D.P. switch
- R_8 1MΩ ½ watt
- R_9 330Ω ½ watt
- R_{10} 1.2kΩ ½ watt
- R_{11} 220Ω ½ watt

Valves

- V_1 EBF89
- V_2 ECL80

Speaker

5in P.M.

Chassis, Cabinet, Heater and Output Trans.

Lasky's Radio Ltd.

Condensers

- C_1 0.001μF, tubular
- C_2, C_7 60pF trimmers
- C_3, C_8 500pF variable 2-gang
- C_4 0.05μF, tubular
- C_5 0.05μF, tubular
- C_6 300pF
- C_9 60pF
- C_{10} 0.001μF
- C_{11} 0.001μF
- C_{12} 0.001μF
- C_{13} 25μF, 25V wkg.
- C_{14}, C_{15} 32+32μF, 275V wkg.
- C_{16} 0.01μF tubular

Metal Rectifier

Westinghouse type 18/RA/1/1/16/1

Drive Spindle, Drum, Cord, Screws and Nuts, etc.

Lasky's Radio Ltd.

G 592

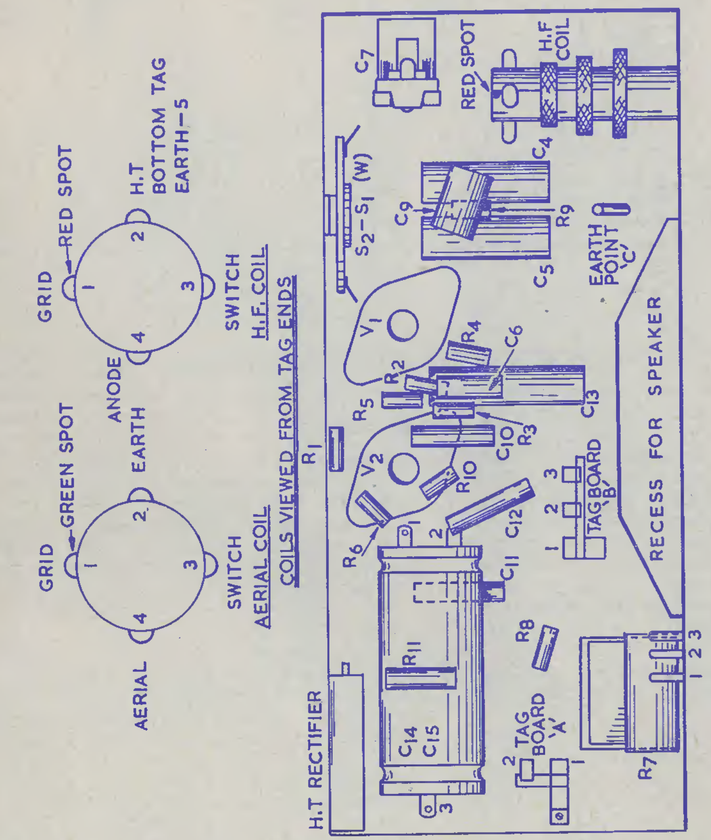


FIG.2. UNDERSIDE OF CHASSIS SHOWING COMPONENT LAYOUT

G 593

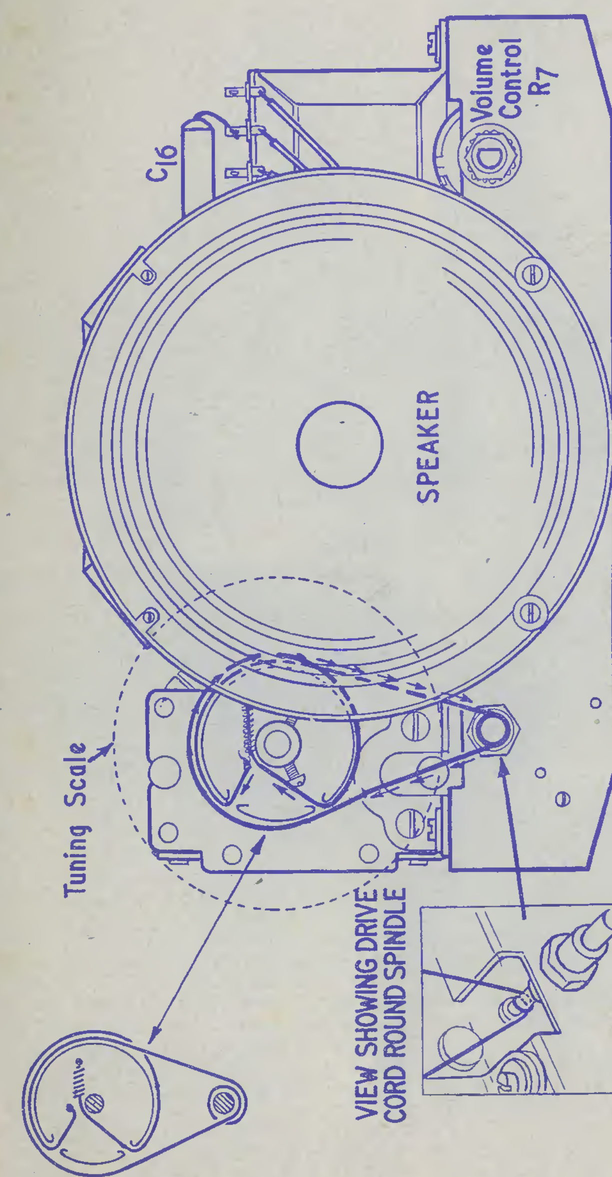


FIG. 3. FRONT VIEW

should be fitted so that its metal face lies against the chassis edge in order that the heat may be conducted away to chassis. Secure into position with a 6BA screw, nut and washer.

Dealing next with the tagboards and solder tags, fit tagboard "A" (see Fig. 2) and tagboard "B" into position, exactly as shown. Between the wavechange switch and the speaker cut-out will be seen a hole for fitting a 6BA screw; this should be fitted with a solder tag both above, and below, the chassis. (solder point "C" of Fig. 2.)

The red spot coil should next be secured into position, by means of the small brass fitment being passed through the slots in the coil and a 6BA screw through this from the front of the chassis. Ensure that the red spot is downwards towards the bottom of the chassis.

Fit the drive drum to the variable condenser spindle as close to the condenser body as possible, with the open end of the drum towards the front. Secure into position the drive spindle to the front of the chassis. Now fit the drive cord and spring as shown in Fig. 3. When fitted, the cord should be under tension from the spring. In the model supplied, it was found that the spring was over long and had to be cut to length so that eight complete metal spirals were left. Ensure that, when completed, the drive spindle rotates the condenser vanes through the 180° of its "swing".

Dealing next with the speaker, fit to that half having the soldering tags uppermost, the small metal sub-assembly; but before doing so, secure to this metal strutting the output transformer and the green spot coil—with the green spot uppermost. (See photograph.) Secure the speaker and its assembly to the chassis by means of two 4BA screws, nuts and washers.

This completes the assembly of the main components.

Wiring the Circuit

All of the small components are shown, in Fig. 2, in their approximate positions, and these should be adhered to as closely as possible. An electric iron with a small bit and a good quality flux-cored solder are required for wiring and soldering the circuit. All connecting leads should be kept as short as possible.

Using a small bare length of wire, solder the central metal spigot of V_1 to pin 4 of the same valve and from there to the solder tag at solder point "C".

Similarly, solder a length of bare, tinned copper wire to the central metal spigot of V_2 and from there to pin 4 of the same valve —continuing this wire to tag 1 of tagboard "B".

Resistors

All resistors should have their connecting wires cut to length and tinned before soldering into position. Care should be taken that these wires do not come into contact with any other point than those specified. Systoflex does not need to be fitted except where stated. Dealing firstly with R_1, solder one end to pin 8 of V_2 and the other end to pin 1 of V_1; these wire ends should be fitted with systoflex. From pin 3 of V_3 to pin 4 of V_2, solder R_2. Dealing next with R_3, solder one end to tag 3 of tagboard "B" and the other end to pin 9 of V_1. Connect R_4 between tag 3 of tagboard "B" and pin 8 of V_1. From pin 2 of V_2, to pin 4 of V_2, connect R_5. With R_6, cover each wire end with systoflex and connect one end to pin 1 of V_2 and the other end to pin 8 of V_2.

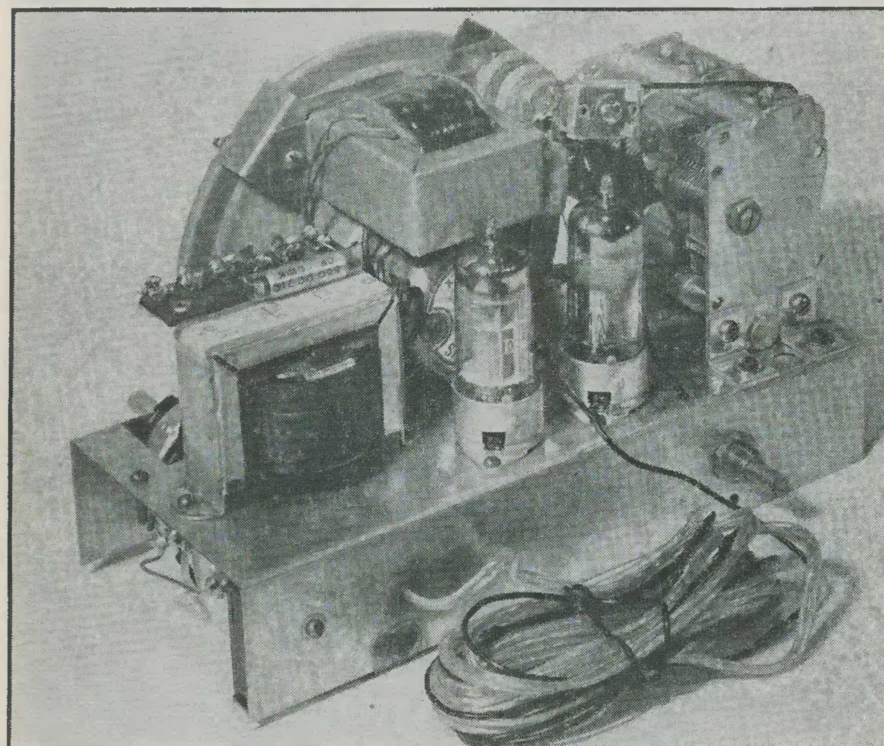
Next, the resistor R_8 should be soldered at one end to tag 1 of tagboard "A", the remaining end being left until we deal with R_7, the volume control. Connect one end of R_9 to the solder tag "C" (see Fig. 2) and the other end to pin 3 of V_1. Solder one end of R_{10} to tag 2 of tagboard "B" and leave the other end free for the time being. Solder one end of R_{11} to tag 2 of tagboard "A", leaving the other end free for connection at a later stage.

Condensers

Solder one end of C_1 to tag 4 of the green spot coil mounted with the speaker. The other end of this condenser has an aerial wire soldered to it just before lining-up the receiver. About 5 to 8 feet of aerial wire —ordinary p.v.c. covered tinned copper wire was used with the prototype—is sufficient. C_2, the trimmer condenser we have already mounted on the underside of the chassis, should now have its remaining tag joined to tag 1 of the red spot coil. Dealing now with the two-gang variable condenser C_3, $_8$, with a short length of p.v.c. covered wire, solder one end to tag 1 of the red spot coil, feed through the aperture nearest the front of the chassis and solder the other end of this wire to the solder tag at the bottom end of C_3 (that portion nearest the front of the chassis.) Deal similarly with C_8, connecting the wire at the other end to pin 2 of V_1. Solder one end of C_4 to solder point "C" and the other end to pin 1 of V_1. Dealing with C_5, solder into circuit between solder point "C" and pin 3 of V_1. To tag 3 of tagboard "B" connect one end of C_6, the other end to pin 9 of V_1.

Return now to the variable condenser C_3, C_8, above the chassis. To the two earthing tags fitted to the body of the component, solder a single length of bare wire, firstly to the front tag and thence to the rear tag. Continue this length of wire, now covered with systoflex material, down to the solder tag mounted above the chassis at solder point "C". Ensure next that this wire does not foul the condenser plates as they are meshed and unmeshed. Solder one end of a suitable p.v.c. covered length of wire to the top tag of C_8 (that nearest the rear of the chassis) the other end now being connected to tag 1 of the green spot coil. Solder tag 2 of the green spot coil to that solder tag mounted on the condenser body, using a small length of bare wire for the purpose. Obtain the trimmer C_2 and solder one tag of this to tag 1 of the green spot coil and the other tag to the solder point on the condenser frame, ensuring that the screw adjustment of the trimmer is set outwards to the rear of the chassis.

Place into position the smoothing condenser C_{14}, C_{15}. The single solder tag at the metalised end (tag 3—see Fig. 2) should now be "sprung", tinned, and connected, via a short length of 18 s.w.g. tinned copper wire, to tag 1 of tagboard "A". This stout wire will effectively hold the component in position. Solder the free end of C_{12}, covered with systoflex, to tag 1 on C_{14}, C_{15}. Dealing now with C_{13}, solder the negative end to tag 1 of tagboard "B" and the positive end to pin 3 of V_2. Returning now to C_{14}, C_{15}, with a length of covered wire connect tag 1 to the positive tag of the metal rectifier. With two lengths of p.v.c. covered wire, connect tag 2 of C_{14}, C_{15}, to pin 8 of V_2 and to tag 2 of tagboard "B". Connect one end



Three-quarter rear view of the "Baronette" chassis

Solder one end of C_9 to pin 8 of V_1, this end being covered with systoflex. The remaining end will be dealt with later. Connect one end of C_{10} to tag 3 of tagboard "B", cover the remaining end with systoflex and solder to pin 2 of V_2. Suitably covered with systoflex, solder one end of C_{11} to pin 1 of V_2. With C_{12}, cover end end with systoflex and solder one end to pin 6 of V_2.

of C_{16} to tag 1, and the other end to tag 3 of the heater transformer. (*NOTE:* The heater transformer shown in the prototype herewith is NOT that supplied with the kits. Those now supplied have four tags only, numbered from 1 to 4, 1 being that nearest the edge of the chassis. The instructions given here are for the heater transformer currently being supplied.)

Wavechange Switch

See Fig. 4. W1 has no connection. W2 is now connected to tag 3 of the green spot coil by means of a suitable length of p.v.c. covered wire taken through the chassis. (See Fig. 2 for coil connections.) W3 is next soldered to pin 4 of V_1. Tag W4 is next connected to the central metal spigot of V_1. Tag W5 is now connected to tag 3 of the red spot coil. The tag W6 has no connection.

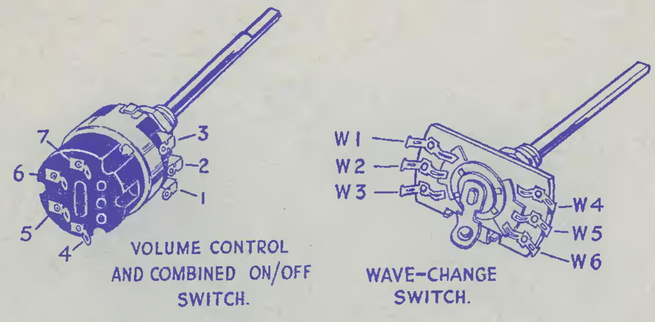


FIG. 4

G 594

Volume Control R_7

See Fig. 4. Solder tag 1 to the free end of C_{11}, ensuring that this condenser wire is covered with p.v.c. material. To tag 2, solder the free end of R_8 and, by means of the centre wire of a length of screened lead to pin 9 of V_2. To tag 3, solder the outer metal braiding of the wire used on tag 2. Solder the other end of this braiding to the central metal spigot of V_2—ensuring that this braiding does not come into contact with any other metal point.

To tag 4, solder one half of the mains input lead. Tag 5, connect to tag 2 on tagboard "A" and also to tag 1 of the heater transformer. With tag 6, connect to tag 1 on tagboard "A" and also to tag 3 of the volume control. Lastly, to tag 7, solder the other lead of the mains input wire. Feed the mains input wire over the smoothing condenser and thence through a rubber grometted hole, having first tied a small knot in the lead itself.

Coils

The connections to the green spot coil have already been completed but the red spot coil must now be dealt with as follows. Connect the free end of C_9 to tag 1 of the coil, covering the condenser wire with systoflex material. Solder a length of covered wire to tag 2 of the coil and the other end of this wire to tag 2 of tagboard "B". Tag 3 of the coil has already been dealt with, and tag 4 should now be connected to pin 6 of V_1—using the centre wire of a length of screened lead. The outer screen of this lead should now be soldered to the centre spigot of V_1. Tag 5 of the coil should now be connected to solder point "C" via a suitable length of wire.

Output Transformer

Bring the two thin red leads down under the chassis and solder one of these (it does not matter which one) to pin 6 of V_2 and the other to tag 1 of the smoothing condenser C_{14}, C_{15}. Of the remaining three wires, two black and one yellow, one black wire (it does not matter which) is left insulated and tucked away. The remaining black wire should now be soldered to the speaker solder tag (any one will do), having firstly scraped the outer enamelling from the wire. Deal similarly with the yellow wire.

Heater Transformer

We have already dealt with tag 1 of this component. Connect tag 2 of the transformer to tag 1 of tagboard "A", tag 3 to tag 1 of tagboard "B", and tag 4 of the transformer to pin 5 of V_2.

Metal Rectifier

Of the two tags involved here, the positive one has already been connected into circuit.

To the remaining tag (negative), solder the free end of R_{11}—ensuring that this component wire is covered with systoflex.

Junction Connections

Before the actual wiring is completed, there are several wiring junctions to be made. With a short length of p.v.c. covered wire, join together pins 3 and 7 of V_2. Similarly join together pins 3 and 9 of V_1. Using a length of covered wire, join together pin 5 of V_1 to pin 5 of V_2.

This completes the wiring of the receiver.

Calibration

The dial should now be fitted to the spindle of the tuning condenser. With the vanes fully in mesh, the 550m red mark of the dial should be roughly at the bottom of the scale.

Having checked the wiring and ascertained that all is well, connect the receiver to the mains, after plugging the valves into position and temporarily fitting the knobs. The receiver is designed to operate on a.c. mains only, 200 to 250V.

Calibration should be carried out before fitting the receiver into the cabinet by adjusting the trimmers C_2 and C_7. Switch to the Medium Wave position. Rotate the tuning condenser until the dial indicates the wavelength of your particular local station. Select, if possible, a station towards the lower wavelengths. The actual position of the scale reading is at the bottom centre of the scale (see cabinet for aperture). Adjust the two trimmers for correct scale reading and the maximum output, at the same time reducing the volume control in order that the speaker will not be overloaded. The receiver is now aligned and no adjustment will be necessary on the Long Wave position.

The mains plug should be reversed and tried for the position of minimum hum. *WARNING:* We repeat—do not earth the chassis.

Fitting the Cabinet

For fitting the receiver into the cabinet, four special spring steel clips are supplied. When pushed over the ridges moulded into the inside of the cabinet, they will provide the necessary holes to which the compressed cardboard back should be affixed. These clips cannot, once in position, be removed from the cabinet without damage to the plastic ridges.

Place the chassis inside the cabinet and secure into position by passing through the underside of the cabinet, and into the chassis lugs, the two screws provided. Pass the mains lead and the aerial wire through the holes provided in the cabinet rear cover and screw this cover into position. Place into position and secure the three knobs to their respective spindles. The receiver is now complete.

Can Anyone Help?

Requests for data are inserted free of charge. Enquirers undertake to answer all correspondence and defray all expenses

A.M. Monitor Type 33.—R. A. Richards, 41 High Street, Eastleigh, Hants, would like to buy or borrow circuit details or manual for this unit.

* * *

Pen.DD.61.—D. Sandiforth, 47 Court Crescent, Chessington, Surrey, wishes to obtain details of characteristics and pin connections.

* * *

R.A.F. Receiver 1448, 10D/1170, 400B.—R. G. Baker, G6QN, 1 Boundary Road, Colliers Wood, London, S.W.19, would like to obtain circuit, manual or other data on this set, which is not, but has the appearance of, the Eddystone 358X receiver. He can reciprocate with gen on the 358X, HRO or RL85 and also with many copies of *The Radio Constructor*, *Radio Amateur* and *Short Wave News.*

U.18 Civilian A.C. Receiver.—B. D. Farrelly is modifying this to cover the 1.8 and 3.5 Mc/s bands, and would like the circuit and/or manual, on loan or to buy, also details from anyone who has carried out this conversion.

* * *

R.F.26 Unit.—G. Foster, 4 Thompson Avenue, Ormskirk, Lancs, wishes to convert to 21 and 28 Mc/s to feed into an R.1155. Can anyone help by supplying details of necessary modifications?

* * *

Troubador 2-valve A.C./D.C. Receiver.—H. Barker, 9 Regent Road, Leyland, Lancs, needs valve data, circuit information, or other gen on this American receiver.

continued on page 607

IT'S THAT MAN AGAIN!

(We are pleased to report that our old friend Centre-Tap is making progress, and he feels he simply must say a few words of thanks to those kindly pen-friends who remembered him at Christmas.)

During the many years in which I contributed regularly to *R.C.*, I have been pleasantly surprised at the number of readers who sent cards and words of friendly greeting at Christmas. To me it further exemplified the wonderful spirit of friendship that exists among radio hobbyists. During 1959 I was driven into temporary retirement by ill-health, and over the Christmas period I was deeply touched at the number of Greetings Cards and Get-well-soon messages.

Nor were they all from Old Timers. One, indeed, was from A.J.A.L. of Aberdeen Grammar School, who is only 14. He sent one of his school's Christmas cards with a cheery message which made me feel really good. Another regular, L.H.B. of Harwell, also thought of me with a nice card and a copy of *Harlequin*.

My anonymous joker friend, who annually sends a card to which he adds drawings of his own, didn't forget me. Readers may recall my mentioning his 1958 card which had a picture of "Centre Tap Villa" and "Ye Olde Village Inn" to which he added a row of footprints in the snow leading from the former to the latter. This year he sent a similar card—but decided that I am still not yet fit enough to walk it, so he sketched in a neat little drawing of me being pushed along the same route in a Bath-chair! Inside was written, "I hope you are soon on your feet again". Many thanks, unknown reader, it gave me a far merrier chuckle than anything in the Christmas t.v. programmes.

Wot! No Mains?

Another Old Timer, E.T., also writes, "Since last year I have retired down here in remote North Cornwall where we are still without electricity supply. It's almost like the good old days, except that modern dry batteries are reasonably reliable and present-day valves are so economical in their current demands."

Ninety-five per cent of the real Old Timers will well remember being without mains. They were still a great rarity in private houses at the conclusion of World War I—and for a good few years after. We had only bright emitters taking 4 or 6 volts at not less than one amp. apiece, and you can guess what they did to the clumsy and crude accumulators of that period. It was not the chief worry that they lasted only one evening or so between charging. The worst problem was hauling them to the nearest charging station, and these were few and far between. Some of the more enterprising motor garages had a "Charging Board", and it made a real hole in my limited pocket-money—which I found equally as hurtful as having to haul the darn things backwards and forwards. Radio enthusiasts were easily identifiable by the acid burns on their jackets and, indeed, when one went to visit friends one invariably looked around to see how many more holes had been burned in their living-room carpet. Distracted housewives spent much time and ingenuity searching out matching rugs, etc., to cover the gaping scars.

For myself, I had to haul my batteries nearly a mile to get them recharged, and although still only a schoolboy the waste of time and energy irked me sorely. The avoidance of tiresome jobs always stimulates my imagination, so I invented what was many years later to re-appear as the wheeled shopping-stick. This consisted of a stout walking cane, two 6in pram wheels and a box platform designed to keep the battery upright when held at the transit angle. Perhaps in those more leisurely days most groceries, etc., were delivered. Anyway, nobody copied my "invention" for shopping purposes.

However, twenty-five years later, when I came back from World War II and everyone had to fetch and carry, I found half the housewives in the country busily tripping each other up with their wheeled shopping-sticks. I never received a scrap of credit, so it is just as well I am putting this on record before I forget another of my contributions to modern life—although sure enough someone will claim he used the same idea before World War I!

Down Our Way

Then electric mains came right to the end of the road in the select South London suburb in which we then lived. It was the real stuff, too. 200 volts a.c. Adjacent districts which had been wired some years earlier were of supposedly "safe" voltages of 35 or 50 volts d.c., or some other queer figure. I was so excited that I shot round to the Electric Company's office without even asking my parents' permission. Oh, yes, they would bring it to our front door for a mere £35, after which we would have to get an approved contractor to wire the house. I used all my schoolboy eloquence on Dad and Mum to take advantage of this modern blessing. I even argued that we should not wait for the neighbours to have it first. Let the Jones's keep up with us! Whether that argument carried any weight I don't know, but at last Dad decided to have it laid on to the ground floor only, "to start with".

While no one had yet seriously considered mains-operated sets I had long since dreamed of battery charging; and to my joy, in addition to having it installed on the ground floor, we also had a lighting point put in our rather large cellar. There were, of course, no metal rectifiers available at that time; and as the mains were a.c. I got busy collecting jam jars, chemicals and bits of metal to try my hand at chemical charging. I couldn't find out much about it, and it seemed that nobody else knew much either, but I didn't let such minor considerations deter me.

Two or three days later I had everything in readiness, and the big moment to switch on arrived. No explosions—just a few gentle bubbles, and off I went to school. Now, I had never known Mother to go in that cellar before, but for some extraordinary reason she decided to go down there that very morning. She was horror-stricken at the sight of my jam jars bubbling away merrily. Indeed, according to her version they were boiling and seething like a witch's cauldron, and she was convinced the house would be going sky-high at any moment.

She rushed off to fetch Dad, and by the time she got there she also claimed she saw sparks dancing up and down the wires. So convincing was her story that apparently he dared not go too near it, and finally contented himself with switching off at the mains.

Of course, there was a terrible row and I was most strictly forbidden to carry out any more experiments with chemical charging, hence I have had less experience of this than any other branch of old-time radio activity. I might add that I spent several more years sadly trundling my wheeled stick backwards and forwards—a most humiliating experience for a bright, proud youth whose family actually had their own electricity supply right to the house!

Can Anyone Help?

continued from page 605

Data Book 4, *Inexpensive Television.*—A. MacLean, The Caravan Site, Upper Cottown, Kintore, Aberdeenshire, urgently wishes to purchase a copy of this publication, which is now out of print.

* * *

U.S.A. Receiver 1585.—23534874 A/T Mercer, "D" Coy., A.A.S., Harrogate, Yorks, wishes to obtain information on the pin numbers and their uses on front panel and rear of this set.

* * *

Admiralty Pattern W.2508 Signal Generator including Wavemeter G73 Crystal Calibrator G42.—A. Leadbeater, 145 Doncaster Road, Rotherham, Yorks, would welcome circuit details or other data, on sale or loan.

R.1155.B Receiver.—L. Duncan, 3 Lindsays Wynd, Oakley-by-Dunfermline, Fife, circuit diagram and data on modifying the MW range to cover 100–200m.

* * *

1392 Receiver.—S. L. Parton, 295 Werrington Road, Werrington, Stoke-on-Trent, Staffs, requests information on operation, waveband coverage, connections, etc. Willing to pay any expenses.

* * *

Baird T.4860 TV Receiver.—Allen, 41 Edith Street, West Bromwich, Staffs, wishes to borrow or purchase a service sheet for this televisor.

Getting Started on RTTY

by Arthur C. Gee, G2UK
Hon. Sec., British Amateur Radio Teleprinter Group

Part 5

Last month we showed how the f.s.k. method of radio transmission functioned and how the "intelligence" was conveyed by shifting the carrier frequency a few hundred cycles in accordance with the particular code being sent; it could be the Morse code or one or other of the teleprinter codes or, again, the impulses created in picture transmission. This month we will consider how this frequency shift is converted back in the receiver into usable electric impulses.

Generally speaking, there are two methods in use for the reception of f.s.k. signals. In the first, the incoming signal is made to beat with the b.f.o. of the receiver in the same way as for normal Morse c.w. reception. However, two tones are thus produced instead of the one produced in "on-off" c.w. reception, due to the shift in frequency of the incoming signal. These two tones can be separated from each other by means of audio filters, so designed that they pass only one or other of the two tones produced by the b.f.o. The output from each filter can then be rectified separately and the resulting d.c. current used to work a relay, which in turn works a Morse tape recorder or teleprinter.

The success of this system depends on really good frequency stability, not only in the transmitter, but also of the receiver oscillators, both for the frequency changer stage and for the b.f.o.

Automatic frequency control can be applied to the receiving part of the system. One method is to take part of the audio frequency signal from the output of the receiver and feed it into a second pair of audio filters. From these two filters the signals are combined in a unit called a discriminator. This unit produces a d.c. voltage proportional to the difference between the frequency to which the receiver is tuned and the actual frequency of the incoming signal. Thus, as differences occur due to receiver drift, so a corresponding d.c. voltage is built up in the discriminator. This voltage is then applied to one of the oscillators, usually the b.f.o., so that the change is corrected.

The system has its defects. A deep fade, for instance, may cause it to lose control, and strong interference from an adjacent signal may make the a.f.c. lock on to itself instead of to the required signal. These defects can be overcome by using a small electronically controlled electric motor to rotate a variable capacitor by means of which the oscillator frequency can be varied—but this is a complication unlikely to be met with in amateur installations!

The other method for the reception of f.s.k. signals makes use of a discriminator circuit. We shall leave detailed consideration of this type of f.s.k. reception until later on in this series.

The type of audio filter reception described above lends itself readily to amateur RTTY practice, and the rest of this article will be devoted to a description of the audio filter unit used by the author.

The circuit is shown in Fig. 1. It is a modified version of that described by W2PAT in the "RTTY Handbook", the chief modifications being the omission of the crystal diode limiting network and the use of a small transformer for signal input. This enables the unit to be used directly connected to the loudspeaker terminals of the receiver. In the author's experience, the limiting network appears to be a great user of audio power and, if included in the circuit, may require the use of an additional audio amplifier stage between the receiver and the terminal unit, particularly if receivers of the BC348 type are used, which in the author's

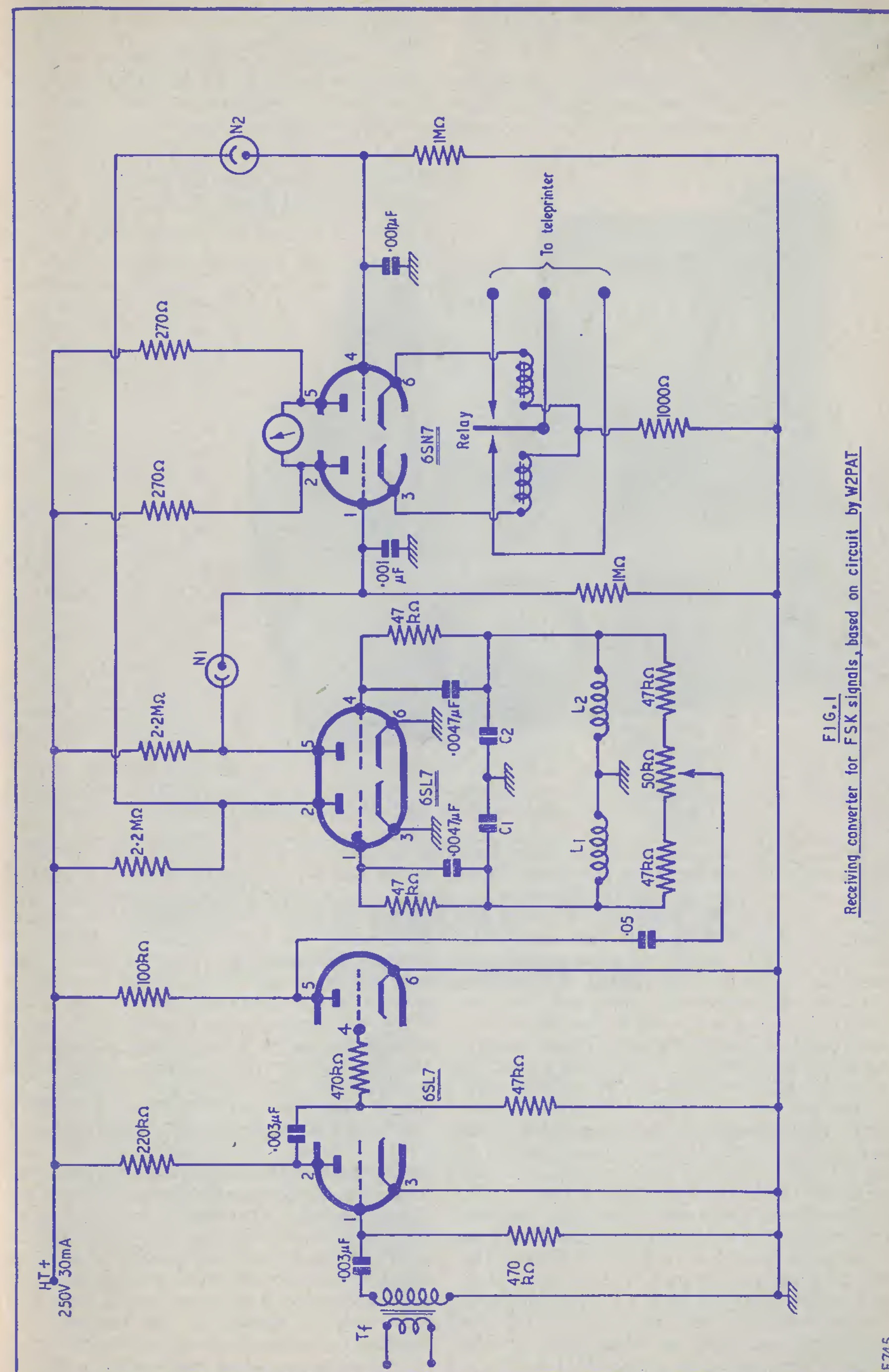
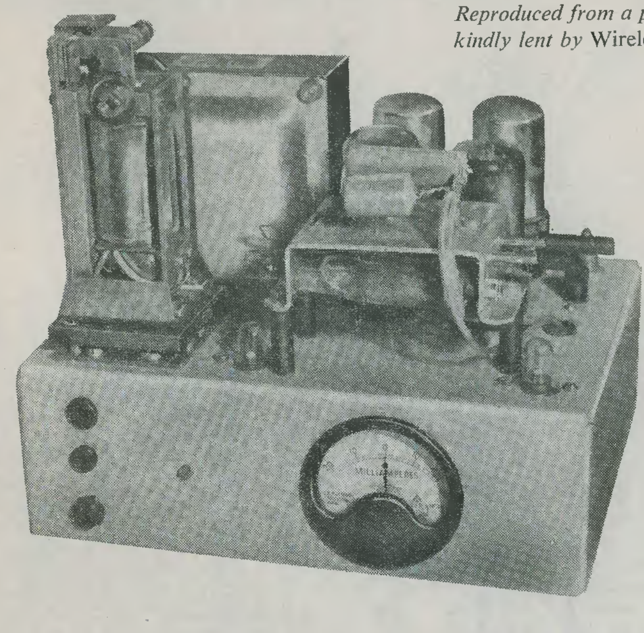


FIG. 1 Receiving converter for FSK signals, based on circuit by W2PAT

experience are ideal for amateur RTTY as their frequency stability and a.v.c. characteristics are so good.

The circuit is straightforward enough, except for the filters L_1/C_1 and L_2/C_2. The becomes difficult to tune in and hold the signals.

The second T.U. built by the author—the one shown at the Radio Hobbies Exhibition and the one illustrated herewith—uses two



Reproduced from a photograph kindly lent by Wireless World

The F.S.K. receiving converter built by A. C. GEE, G2UK

experimentally-minded will no doubt have their own views on suitable components for these. Of the two Terminal Units so far built by the author, the first used two Murphy V.200 series t.v. line amplitude controls. Some experimenting was needed to get the right values of capacitors to tune them, but tuning to the audio frequencies was not found to be too critical. There are two types of these chokes. One is designated by a yellow patch of paint on the terminal strip —this is Type No. 57010. The other has a green spot on it and is Type No. 56443. The yellow spot one needs a 0.1μF capacitor across it, i.e. for C_1. The green spot one requires 0.15μF of capacitance across it (C_2). These two will then tune to the audio frequencies required. They will be quite "flat" in tuning, but work well enough. If desired, the effect of putting an iron core in each or in one or the other can be tried. This sharpens up the tuning a bit, but this has its disadvantages as well as advantages; if the "sharpening" process is carried too far, it width control chokes made from a Plessey unit used in a number of t.v. receivers. The author is indebted to Mr. Don Smith, G3LIS, for the information on these. He writes: "This choke is mounted side by side with the linear control and the line output transformer is mounted above. They can often be obtained for nothing from radio service depots as the whole unit has been thrown out due to a faulty line output transformer. The following t.v. receivers are fitted with this unit: RGD.6014.T, 6017, 7017 and C54; Defiant 1453, 1753, 1754, 1454, 1755, 1456 and 1456C; Regentone 17.T and 14.T; Marconi VT.63; Decca D.17, 222 and 333. The choke required is the one with the two leads only. Two such units are required, the linear control choke being removed, the width control from the second unit being fitted in its place." These chokes are fitted with adjustable iron cores, which help very materially in tuning to the required frequency.

The relay used by the writer is of the polarised type in which the tongue is "centre stable"—i.e. at rest, it stays midway between the two magnets. The type shown in the photo is available on the surplus market and comes out of a unit called a Teleprinter Repeater Unit—often coded Type TC18. These relays are designed for teleprinter use and are coded D164816. They have a special nine pin base and sockets are available for them. If difficulty is experienced in obtaining them, a limited number are held by BARTG.

A chassis, drilled and cut out to take valveholders—four—including one for the power supply rectifier, mains transformer (Woden Type RMS 10A), a centre-zero milliammeter and the relay socket is available from Phillpots Metalworks of Loughborough, who have the drawings of the one they made for the author. A suitable 20–0–20 centre zero milliammeter can be obtained from BARTG if difficulty is encountered getting it elsewhere.

The input transformer Tf is a small personal portable type of output audio transformer, with the higher resistance winding connected into the grid circuit of the first valve and its loud speaker winding connected to the low resistance output terminals of the receiver.

The neons, N_1 and N_2, are Radiospares Neon Bulbs, M.E.S. Suitable bases can be obtained for them from most electrical and many chain stores.

Power supplies for the unit are approximately 250V at 30mA h.t. and the appropriate heater voltages depending on the rectifier valve used. The unit shown has its own power supply built on to the chassis, but this is not always necessary; as the h.t. requirements are not heavy, they may possibly be obtained from the receiver.

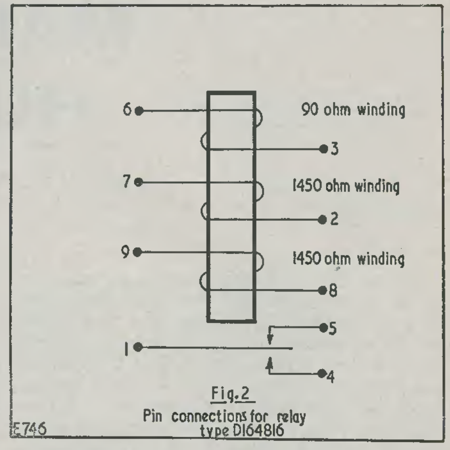


Fig.2
Pin connections for relay type D164816

The unit should work straight away. The potentiometer should be set to give zero reading on the meter, with no signal. On applying the signal and varying the b.f.o., first one and then the other neon should light up temporarily. By getting the setting of the b.f.o. right, the neons should then flash in step with the f.s.k. signal and the relay should follow in step.

NEW MOULDED TRACK POTENTIOMETER

The well-tried range of moulded track potentiometers produced by The Plessey Company Ltd. has been augmented by a new hermetically sealed type, the XP5.

Designed to operate within the temperature range −40°C to 70°C, the new potentiometer conforms with the inter-Service Standards for radio components. It will withstand severe bumping, vibration and tropical exposure.

The XP5 is entirely moisture-proof. The spindle is sealed with neoprene rings which, seated in channels and lubricated with anti-freeze grease, give a smooth action free of bearing slop. The silver-plated terminals are integrally connected to the resistance element and protrude through sealed ceramic insulators. A neoprene washer fitted to the mounting face provides the panel seal essential for use in sealed equipment.

Resistance extends from 500 ohms to 2.5 megohms (linear or logarithmic). Maximum working voltage across resistance is 500 volts d.c. subject to power rating limitations.

PREVENTING MAINS HUM

By H. C. PARR, M.A.

Conclusion

It is when such a unit takes its power from the main amplifier that the difficulties arise, for the screen of the connecting cable must not be allowed to carry any heater current. The simplest solution is to feed the heaters in the tuner or pre-amplifier by twin wiring, which is connected to chassis only in the main amplifier, for then the preceding paragraph can still be applied. If the heaters are, in fact, wired on the earth return principle and it is not feasible to rewire them, or if to do so would be to risk instability as in the case of v.h.f. units, then the first line of attack must be to join the two chassis by a very heavy cable firmly bolted at both ends, remembering that the whole heater current must flow through this without its resistance being sufficient to generate enough voltage difference to introduce hum. If this proves unsuccessful, the only alternative left is to feed the signal via a suitable transformer, with the primary earthed to the first chassis and the secondary earthed to the other.

Fortunately it is possible to employ this transformer method in many radio tuners without the trouble and expense of a separate transformer, but using the last i.f. transformer. Fig. 6 shows the connections for an a.m. superhet tuner with a conventional detector circuit, and it will be noticed that none of the components associated with the secondary of the last i.f. transformer is earthed in the tuner, but all the earthing is done to the chassis of the main amplifier through the screen of the connecting cable. The same circuit can be used if a valve rectifier is used in place of the crystal diode of Fig. 6, and similar principles can be applied to an f.m. tuner provided the output comes straight from the demodulator, without the interposition of an a.f. stage.

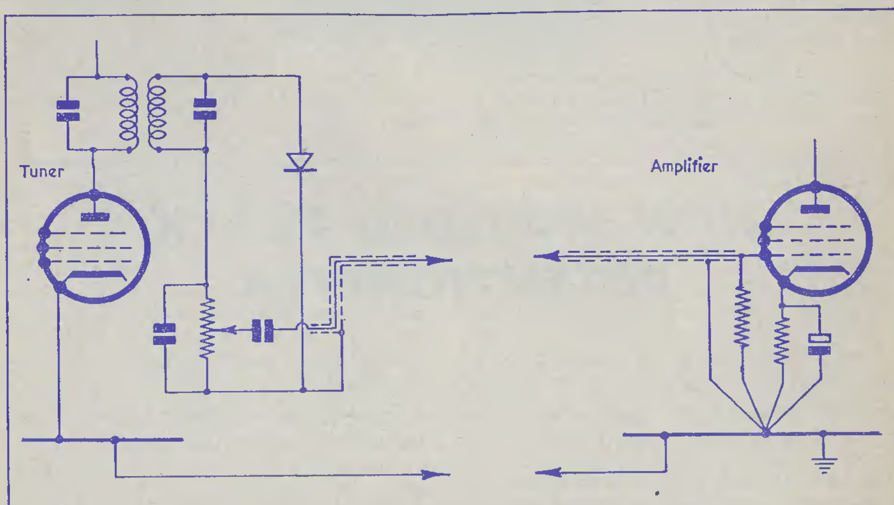


FIG. 6.

There is, however, one further complication when this method is used with a short wave or v.h.f. tuner. The screen of the connecting cable in Fig. 6 will prove to be an efficient radiator of the i.f. and its harmonics, and if these find their way to the aerial some most mysterious effects can occur. To prevent this, the condenser which bypasses the i.f. should be earthed *in the tuner*, all the other earth connections being as before. Fig. 7 shows this applied to an f.m. tuner.

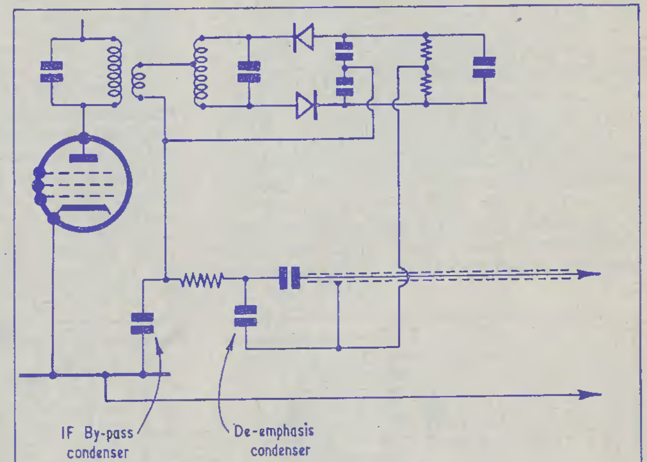


FIG. 7.

Detecting Sources of Hum

If all the above principles have been applied, it should be possible to turn the gain control of an amplifier to the highest setting ever likely to be needed without hum being audible from a normal listening position. A faint sound will probably be noticeable if the ear is placed close to the speaker, but this is of no consequence.

If one has not been completely successful and the hum level is higher than this, it is easy to determine which stage of amplification is responsible by shorting in turn the grid of each valve to earth until the sound ceases. With a little experience it is also often possible to tell from the actual sound which species of hum is present. Electrostatic hum, unless it is subject to a high degree of bass boost as in a tape playback amplifier, is characterised by the predominance of the higher harmonics of the mains frequency, so that its sound is best described as a "buzz". Magnetic hum, on the other hand, consists largely of the 50 c/s fundamental, and produces a deep "boom" from a good speaker. Hum originating in the power pack or from faulty smoothing is recognisable by the absence of the fundamental and its odd harmonics, and so gives a note an octave higher than the other types. Faulty earthing can produce any of these effects, and that is one reason why it is often more difficult to trace and deal with.

In conclusion, it is interesting to note that almost all the factors in amplifier design which reduce hum also reduce the risks of instability, so that careful attention to the points mentioned in this article will not only eliminate the hum bugbear, but should also greatly lessen the likelihood of unwanted oscillation.

CHANGE OF TITLE

The Patent Department of Western Electric Co. have informed the Hon. Sec. of the British Amateur Radio Teletype Group, that the word "Teletype" is a Registered Trade Mark and may not in consequence be used in the title of this Group. Its name has, therefore, been changed to the **British Amateur Radio Teleprinter Group.** The word "Teletype" should apparently only be used to indicate equipment manufactured by the Teletype Corporation, which is a subsidiary of Western Electric Company, Inc.

AN ELECTRONIC MUSIC STUDIO

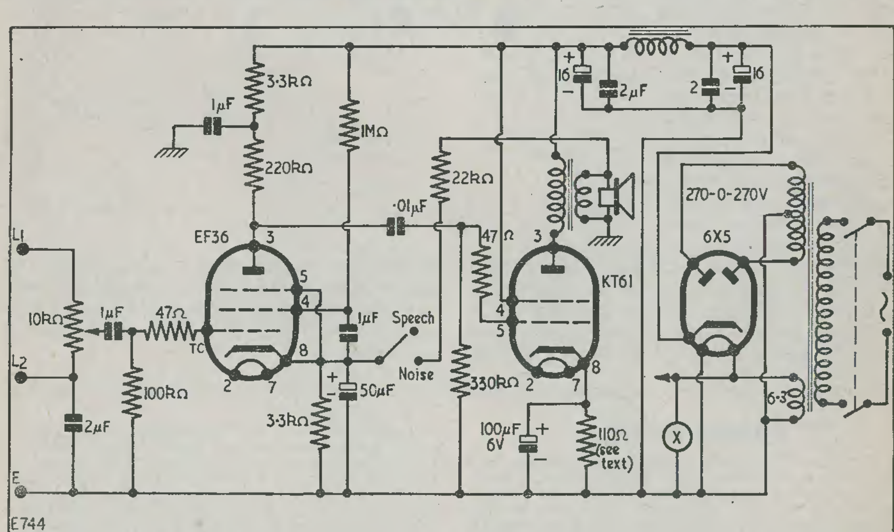
A special correspondent of *The Times* recently described a studio, established by Miss Daphne Oram of Fairseat, Kent, for the composition of music created solely by electronic means. Such music is produced from pure tones generated electronically as sine waves, which are mixed and blended according to the dictates of the composer, and recorded on magnetic tape. Miss Oram's venture has already found commercial outlets. She has composed music for several t.v. advertisements and also as background music for some documentary films. Her main interest, however, is in research into the possibilities of this method of creating music, which she considers may offer even more scope than the conventional musical instruments. Interest in this subject is apparently increasing rapidly amongst musicians, so much so that week-end courses are to be arranged at Miss Oram's studio. She hopes, too, to have a selection of magnetic tape and disc recordings on sale in the shops before long.

An Electrical Guitar Amplifier

by K. E. MARCUS

FROM TIME TO TIME A LITTLE PIECE OF Army equipment (the *Amplifier Monitoring*, No. 10 (ZA 33405)) appears on the surplus market which can easily be modified to an electrical guitar amplifier.

It consists of a straight pentode as a pre-amplifier and an EF50, operated as a triode, as the output valve working into a small built-in loudspeaker. In its unmodified state the output is, on full volume, just about as loud as the guitar. But when the output valve is replaced by a KT61, which is easily obtainable on the surplus market, the volume increases about five times. The explanation of this is that the KT61 needs only about 4 volts input for full output, while the EF50 as triode requires about 18 volts.



Modification Details

The necessary modifications can be carried out in less than a couple of hours. The diagram gives the circuit *after* modification, together with a list of the components required.

(i) Unsolder the connections to the EF50 and remove both valve and valveholder. In place of the latter fix an international octal holder with long screws and distance pieces, so that it stands about 1 inch below deck. This is necessary as the KT61 is taller than the EF50.

(ii) Resolder the grey wire (originally on pin 6) to pin 8 (Cathode); resolder the red wire (originally on pin 3) to pin 3 (Anode); resolder the heater wire (originally on pin 1) to pin 7; resolder the resistor (originally on pin 7) to pin 5 (Grid). Then solder a new wire from the h.t. side of the output transformer to pin 4 (Screen Grid), and connect pin 2 by a small piece of wire to the adjacent earthing tag.

(iii) Replace the 330Ω resistor (cathode resistor of the EF50) on the tagboard to the right of the new octal base by two resistors 220Ω in parallel, and bridge these by the electrolytic capacitor 100µF 6V wkg, noting the correct polarity (cathode is positive).

(iv) Undo at the switch the blue lead connecting a 50µF 12V electrolytic near the front panel, and transfer it to the (grey) cathode-side of the 3.3kΩ resistor in the cathode of the pre-amplifier. Then unsolder the lead connecting the feedback resistor 22kΩ to the switch from its switch-tag and resolder it to the point from which the blue lead was removed before. Both these resistors are on the same tagboard as the electrolytic.

(v) Since the amplification is now fairly high, the hum level is now a bit too high. It is therefore recommended to parallel the reservoir and smoothing condensers (only 2µF each) with electrolytic capacitors 16+16µF 450V. In the prototype a rather bulky metal-cased unit was fitted near the choke and clamped down below deck by a band clip.

(vi) It is advisable to replace the input terminals by a jack for easy operation.

Performance

As already mentioned, the little unit on full volume is at least five times as loud as the guitar itself. Though the quality cannot be described as "pukkha hi-fi", it is very reasonable in the switch position "NOISE", mainly due to negative feedback. A rough check with an audio generator (B.F.O.) showed a fairly level amplification from 100 to 6,000 c/s.

In the switch position "SPEECH" the sound is even louder, though a little harsh; this, however, only increases the "readability" of speech if used with a dynamic microphone.

New Components Required

1 Valveholder, International Octal Amphenol
1 Valve, Osram KT61
2 Resistors, ¼-Watt, 220Ω±20%
1 Capacitor, electrolytic, 100µF 6V
1 Capacitor, electrolytic, 16+16µF 450V
1 Jack, suitable for plug on guitar pick-up lead

BOOK REVIEWS

A FIRST COURSE IN TELEVISION. By "Decibel". 149 pages, 106 diagrams. Published by Sir Isaac Pitman & Sons Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 15s.

It is not easy to describe in simple terms how television works, as anyone can find out for himself by trying to explain for his favourite aunt how the picture is produced on her set. Although it is not expected this book will be read by very many favourite aunts, it is more than likely that considerable numbers of the favourite nephews could acquire from it much to enlighten themselves.

If those who read this book have only a rudimentary knowledge of radio, they should be able to follow, and benefit from, the easy manner in which the author presents his subject. They will not be called upon to understand anything more than simple arithmetic in the few places in which calculations appear.

To start with, the television signal is compared with ordinary radio signals; from this basis an understanding of television principles is developed, from scanning systems, cameras, and the complete television signal. Basic circuits associated with transmission and reception are discussed, with chapters on v.f. amplifiers, waveform generators, picture tubes and associated circuitry, power supplies and so on. The causes and effects of distortion are also mentioned. Others chapters deal with aerials, miscellaneous apparatus, and an insight into colour television.

MAGNETIC RECORDING TECHNIQUES. By W. Earl Stewart. 272 pages, 165 diagrams. Published by McGraw-Hill Publishing Co. Ltd., McGraw-Hill House, 95 Farringdon Street, London, E.C.4. Price 66s.

This text is intended for engineers and research workers rather than those who have "amusement" interest in the techniques of tape recording. The established standards of equipment and accessories are discussed in full detail; several chapters are devoted to the theory of ferromagnetism, recording mechanisms, and recording and reproducing processes.

Much of the explanation is achieved without a great deal of mathematics; nevertheless the author imparts considerable knowledge by the judicious use of diagrams, sketches, graphs and tables of data. Each chapter has a useful list of references appended to it from which particular subjects can be further investigated.

The work is sufficiently up to date to give more than passing mention to transistor circuitry, t.v. recording, and the use of tape recording techniques in computor and automation equipment.

HI-FI YEAR BOOK, 1959. Edited by Miles Henslow. 240 pages, 480 diagrams and illustrations. Published by Miles Henslow Publications Ltd., 99 Mortimer Street, London, W.1. Price 10s. 6d.

It is evident from this fourth edition of the *Hi-Fi Year Book* that the choice of equipment available has considerably increased. The book is profusely illustrated with transcription motor units, pick-ups, speakers, cabinets, amplifiers, microphones, tape recorders, test equipment, radio tuners and control units.

For each item of apparatus or equipment listed in the guide, brief technical specifications are given, together with the price at the time of going to press.

Each section is devoted to particular items of equipment, and is preceded by a short article on the general use of such apparatus. Several pages contain a list of hi-fi dealers in the larger towns throughout the country. Nearly one-third of the pages contain advertisements, though many of these give information that is not contained in the main text.

It is to be noted that as soon as this edition was off the press, material for the next edition was being compiled, to those who need to keep abreast of market expansion and production developments are obviously in the mind of the publishers. This present edition makes a speciality of tape recorders.

A COMPACT square wave generator

BY B. GILBERT

THE SQUARE WAVE GENERATOR HAS MANY uses in the shack, too numerous to mention thoroughly. However, many have the disadvantage of having a fixed mark/space ratio, usually 1 : 1. (The mark/space ratio is the ratio of the length of the positive pulse as compared to the length of the base voltage.) This ratio undoubtedly has many uses alone, but a distinct advantage would be a generator in which this ratio could be varied. The testing of sync separator circuits in t.v., for instance, necessitates a mark/space ratio of $-10:1$ or $+10:1$, according to the circuit. This designation will be explained later.

Now methods of achieving this are quite complex; e.g. one method involves the differentiation of a 1 : 1 MSR square wave, the clipping of a voltage out, and amplifying this—being rather involved. (See Fig. 2.) Another disadvantage of conventional generators is the limited frequency range at which the output is truly square. Normally, at the lower frequencies it becomes peaky, while at the higher frequencies, 100 kc/s and up, the wave rounds off at the edges.

The generator to be described overcomes all these difficulties, giving a perfect square wave output from 10 c/s right up to 100 kc/s at any mark/space ratio from $-15:1$ (when the positive pulse is 15 times as short as the base voltage), through 1 : 1 (when the positive pulse is equal to the base voltage in time) to $+15:1$ (when the negative pulse is 15 times as short as the positive pulse). (See Fig. 3.)

The equipment uses only three valves plus a metal rectifier, the whole being very compact and contained on a chassis measuring some 9in x 6in x 2in, this being secured to an aluminium panel 6¾in high. The equipment was designed having in view a low initial cost and a low mains consumption.

The first requirement was met by using surplus valves and components wherever possible, and the second by keeping the heater and h.t. currents at a low value. The total consumption of the unit is approximately 30 watts.

Fig. 1 shows the action of the unit in schematic form. The sawtooth voltage source is V_1, the range being 10 c/s to 100 kc/s. This is directly coupled to the anode of a diode V_{2a}, which clips off part of the sawtooth as shown. This resultant voltage is then fed to the second half of the 6H6, another diode, which clips off a further portion of the sawtooth, thus leaving a very low voltage square wave. At first sight, it would appear that this "square wave" has a very slow rising and falling time but, for two reasons, this is not in fact the case. It is apparent from the diagram that as the original voltage is negative, the rise time is a fraction of the flyback time which is in itself very short. How small a fraction depends on the ratio of the voltage clipped out of the original voltage. If the latter were 100 volts and the former 0.25 volts, then the percentage rise time would be 0.25% of the flyback time at all frequencies. This rise time is then very short; at 100 c/s it would be about 0.1μ sec., somewhat better than may be obtained by more conventional generators. The fall time of the wave is only some 0.25% of the rise time of the sawtooth voltage, which again, at 100 c/s is only some 0.25μ sec.—more than adequate for the average home constructor! Thus, it will be realised that without a complicated equipment a perfect square wave may be obtained from 10 c/s to 100 kc/s with any MSR from $\pm 15:1$ to 1 : 1!

The circuit of the square wave generator is shown in Fig. 4. It will be seen that V_1 is an EF36, this valve being chosen for three reasons: (1) it is easy to obtain on the surplus market, (2) it is a very good type for sawtooth oscillators and will oscillate right up to 500 kc/s readily, and (3) the current consumption in both h.t. and l.t. is rather low. Possible alternatives, however, are: EF39, EF50 or 6J7, these being capable of inclusion without much difference in operation. An SP61 is definitely not recommended in the circuit shown; a simply awful waveform is the result!

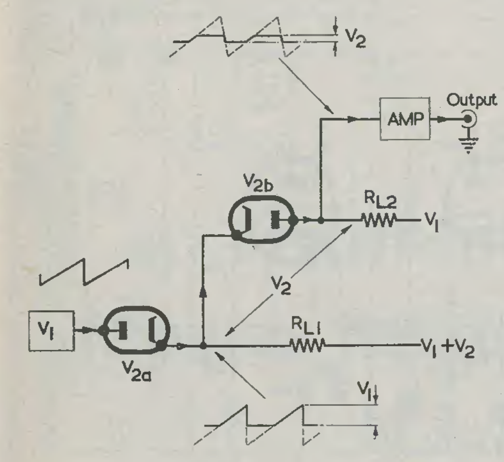


FIG.1.

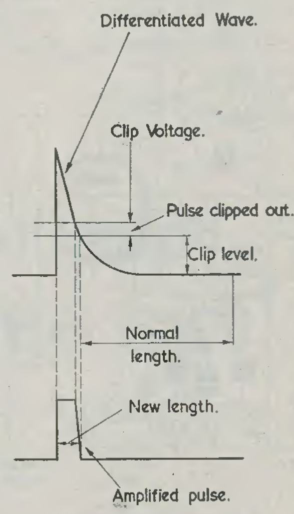


FIG.2.

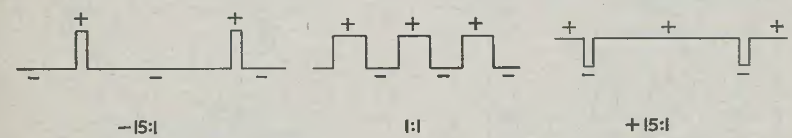


FIG.3.

M741

The following stage, V_2, is the well-known 6H6 double diode. No other valve is recommended here unless it has similar characteristics, these being a high anode current and low internal capacities. A type having a fairly high heater/cathode breakdown voltage would be advantageous as the cathode is some hundred volts above earth.

The output stage is constructed around an EC52, this being chosen for its high anode current and low input capacity. If the input capacity were high, then the leading edge of the square wave would be affected and deteriorate. The EC52 is capable of providing an output of 10 volts, which is considered by the writer as adequate for most purposes. Whilst on the subject of output, this is made variable by the calibrated potentiometer VR_4, this being fed into two co-ax sockets (3 and 4 on the diagram) one of which is blocked to d.c. by a 0.25μF condenser. Also available is a 10 volt sawtooth voltage, this being available from socket 2. This output is very handy for modulating test oscillators—a series 47kΩ and a parallel 0.01μF condenser will provide an almost sine waveform. The resistors not only drop the sawtooth voltage but lessen any shifting of the calibration which would occur if it were coupled direct to the anode. Sync can be applied if needed by another co-ax socket (1 on the diagram) connected to the suppressor of V_1.

The oscillator coverage is in four ranges, i.e. 10–250 c/s; 100–2,000 c/s; 1.5 kc/s–25 kc/s; and 20 kc/s–100 kc/s, these being switched by S_1, a 2-pole 4-way yaxley-type switch.

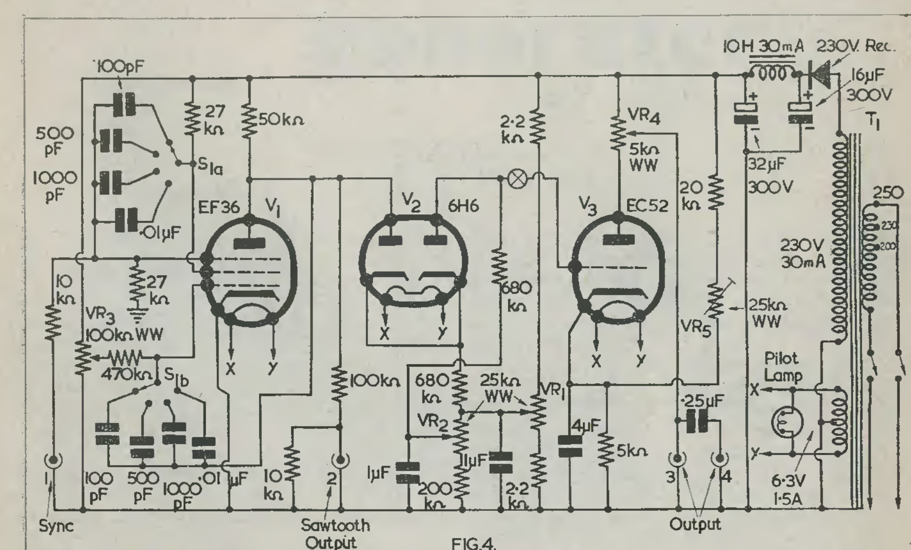


FIG.4.
Circuit Diagram

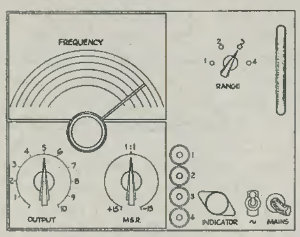


FIG.5
Panel Layout

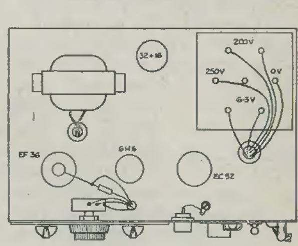


FIG.6
Chassis Layout

M742

The panel layout is shown in Fig. 5 and the chassis layout in Fig. 6. The main frequency control, VR_3, is driven via a 10 : 1 slow-motion drive. An accurately calibrated scale is made on cartridge paper using indian ink for the purpose and using an oscilloscope for calibration purposes. Later this scale is covered with a perspex sheet. The use of a set of Panel-Signs No. 2 would be of advantage here.

The other main controls are the mark/space ratio control and the output volts control. Both these potentiometers should be of the wirewound type—as, indeed, is VR_3. The use of these types ensures lasting accuracy. As before, a calibrated scale is made for both with the aid of an oscilloscope. To calibrate the mark/space ratio control, the simple expedient of measuring the lengths of the positive and base voltages on the screen is taken. These two controls are also finished off with a perspex sheet and, finally, two 2in pointer knobs are secured into position.

Little need be said about the chassis layout; the connecting wires must, of course, be short and avoiding any possibility of interaction. Whilst that given is only a suggested layout, the writer advises intending constructors to adhere as closely as possible to this, the original, in order to obtain the highest possible efficiency.

The power pack follows convention and can easily be altered without any change in performance. However, the 16+32μF condenser should be retained in the design as it is necessary to eliminate any hum—this being more important here than in a radio receiver.

The wiring is carried out using 22 s.w.g. tinned copper wire covered with 1mm. sleeving. After completion, VR_5 is set so that the cathode of V_3 is Eg volts above the voltage on the slider of VR_2. If it is felt that d.c. coupling is undesirable, a 0.25μF condenser can be inserted at "X" and a 220kΩ resistor wired to earth with VR_5 and the 20kΩ resistor omitted. This arrangement works perfectly so long as the low frequencies are not often needed. D.C. coupling was inserted merely to help the low frequency coupling. VR_2 is set so that the difference of voltage between cathode one and two and anode two is 0.25V. This can be increased (with a deterioration of rise and fall time) to a maximum value of 0.75V.

MISCELLANEOUS

A Transistorised Morse Practice Set

By **L. BAKER**

A GREAT DEAL OF ENTERTAINMENT CAN BE obtained these days by listening on the amateur bands. Not all amateur stations, however, are on voice transmission; quite a few use continuous wave transmission and communicate by means of the Morse Code. Most amateurs when they come on the air for the first time use C.W. for preference, because a C.W. transmitter using Morse as a means of communication is the simplest rig one can put on the air on the amateur bands. Apart from the amateur bands, however, there is all sorts of interesting stuff to be picked up on short wave and trawler bands. The shipping and airplane bands, for instance, are excellent examples of these.

In order to be able to understand and read all these interesting transmissions, though, it is, of course, necessary for the listener to be able to read the Morse Code, and the best way to learn the code is by the use of a practice set. A buzzer can be used with great success for this, but the Morse Practice Set to be described gives more realistic results and also has a variety of other uses in the workshop, as will be described later. The set is simple to make, uses a single transistor, and can, if desired, be built into a very small plastic case.

Regarding the case, no particular dimensions need be strictly adhered to, and the choice is left to the intending constructor who will be able to press into service whatever small box or cabinet is to hand. A suggested layout for the parts is given in Fig. 2; the spacing of these is not critical, however, and any more convenient way which may suggest itself can be employed just as well. The circuit diagram is given in Fig. 1.

No specialised parts are used. If one is interested in making the unit as small as absolutely possible, miniature parts such as transformer, jacks, resistors, etc., are now easily obtainable from the various firms advertising in *The Radio Constructor*.

The power supply in the original model was an Ever Ready type P.P.3 battery. It was found that the set would operate on a lower voltage battery than the P.P.3, but after testing, the 9 volts supply was found to be best.

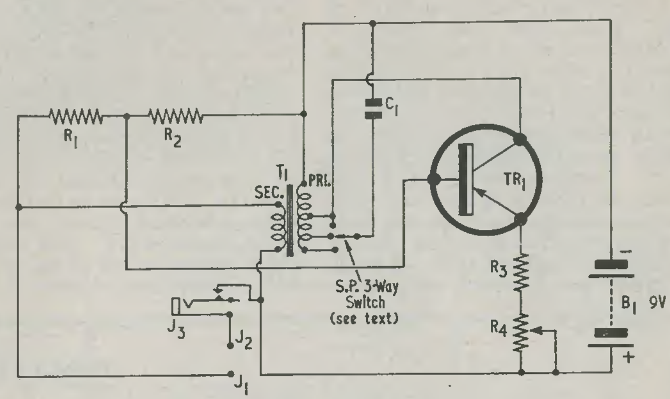


FIG.1. MORSE PRACTICE SET

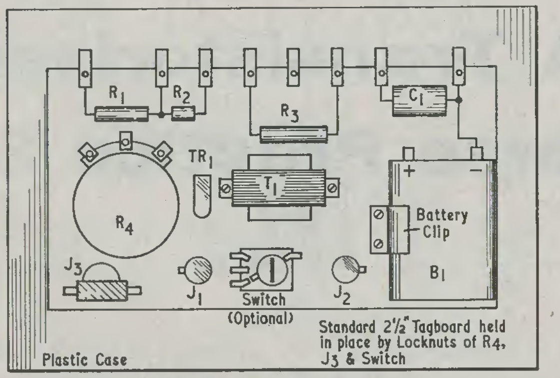


FIG.2. MORSE PRACTICE SET BACK

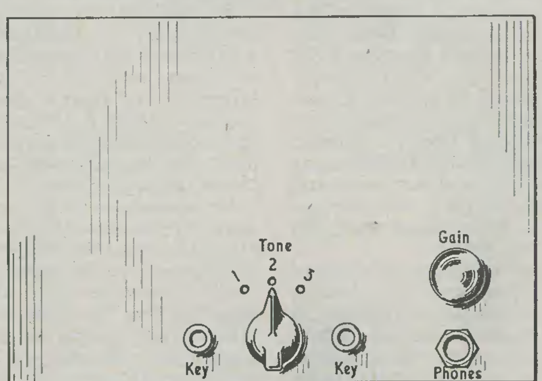


FIG.3. MORSE PRACTICE SET FRONT

G 590

The switch selecting various tappings of the primary of the "output" transformer T_1 is an "optional extra" and is included to give three separate tones from the unit by selecting any one of the three positions. If this feature is not required, the switch may be omitted and the condenser C_1 may be wired direct to the tapping on the transformer which gives the most desirable tone. Alternatively, a "single ratio" type of transformer could be used for T_1, omitting the switch altogether. If the three tones are required intermittently the switch could be omitted and C_1 could be terminated in a crocodile type clip for connection to the various tappings of T_1.

The jack J_3 has a single-pole switch which is closed when the phone plug is inserted, thus starting the unit. The other two jacks, J_1–J_2, are for the key connections and are of the ordinary "single socket" type. If required, an on-off switch ganged with R_4 could be used instead of the switch on the jack J_3. R_4 serves as a volume control and it also controls the pitch of the note to some extent. $R_{1,\,2,\,3}$ are ordinary 5% half-watt type carbon resistors. C_1 is a 0.003µF capacity tubular paper type.

Several transistors were tried in the unit, the OC71 and TS3 types giving excellent results. The surplus "red spot" types or any of the general-purpose small types of transistor will all be found to be satisfactory provided they are in known good condition.

The construction of the unit is simplicity itself. In the interests of neatness it is suggested that the "tagboard" type of assembly shown in the drawings should be used. The writer used a small plastic case obtained from a multiple store to house the finished instrument; many types of plastic cases are available at these stores, and for the sake of appearance one of these should be used.

Use short, direct connections where possible when wiring. The use of thin plastic flexible wire makes for neatness in the finished unit. The resistors and condenser may be mounted between tags as shown. It is advisable to use a heat shunt when soldering the smaller components; this applies especially to the transistor as this delicate part could be easily ruined by excessive heat. The same applies to a lesser extent to the miniature resistors if these are used. Leave the battery connections until last.

Having completed the wiring, it is advisable to re-check the wiring and connections against the circuit diagram, making sure that there are no errors. It is essential that the leads to the battery are free from shorts and that the correct polarity is observed. This also applies when connecting the battery finally. The battery *must* be connected with the polarity as shown in the circuit diagram Fig. 1, or the transistor TR_1 could be ruined.

To test the unit, plug in the Morse key to J_1–J_2. Short-circuit the key by screwing down the arm. Next plug in phones, which switches on the unit (switch on if a separate on-off switch is used). Rotate R_4 from minimum towards maximum. The tone should now be heard in the phones (which should be of the high impedance type). Select whichever tone is required, and finally adjust R_4 again to suit personal requirements. If no tone is heard after switching on, oscillation is not taking place and the outer and inner extremes of the primary winding of T_1 should be interchanged. The primary of T_1 is tuned by C_1, and if no tone is heard C_1 could also be suspect.

Having completed the preliminary adjustments as described, the key may now be released and the unit is ready for use.

The set can be keyed at any speed, even by a high speed automatic tape-actuated mechanism, and the speed of keying in no way affects the quality of the output tone in the phones.

Other uses for this unit include the testing of audio amplifiers, tape recorders, gramophone equipment, etc. To use it as such, all that is necessary is to short-circuit the key terminals (as in the preliminary setting up) and inject the tone from J_1 to the input of the equipment under test. The unit could also be employed as the signal source for a test bridge or continuity tester.

Components List

J_1, J_2	Wander plug sockets
J_3	Jack socket with S.P. switch
T_1	Multi-ratio output transformer
TR_1	OC71 or similar
C_1	0.003µF tubular paper
B_1	Ever Ready type P.P.3
R_1	1kΩ ½W
R_2	100kΩ ½W
R_3	1kΩ ½W
R_4	5kΩ variable

Phones, cabinet, tagboard, wire, etc.

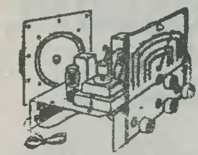
AMATEUR TELEVISION CONVENTION

The fifth Amateur Television Convention, arranged by the British Amateur Television Club, will be held on Saturday 10th September, 1960, in the Conway Hall, London, W.C.1.

BRITISH SOUND RECORDING ASSOCIATION

The British Sound Recording Association is holding a Convention on Saturday 23rd April at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, in conjunction with the London Audio Fair.

SUPER CHASSIS 79/6



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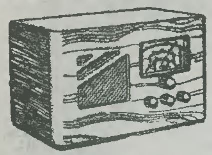
Home Radio 79/6



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112 sq. in.	**6/–**	240 sq. in.	**10/–**	368 sq. in.	**14/–**
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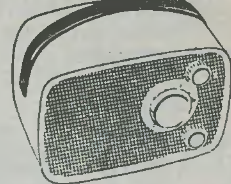

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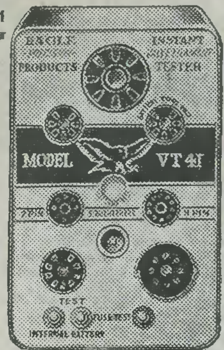

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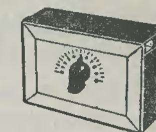

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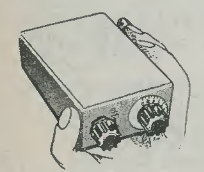

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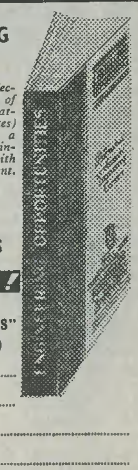

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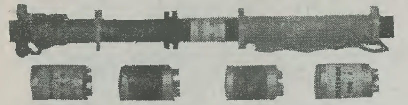

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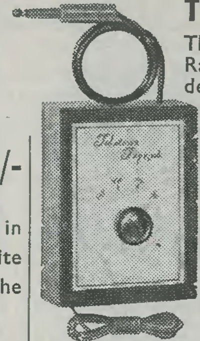

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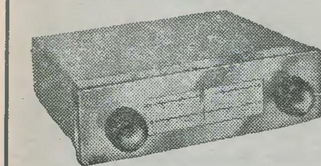

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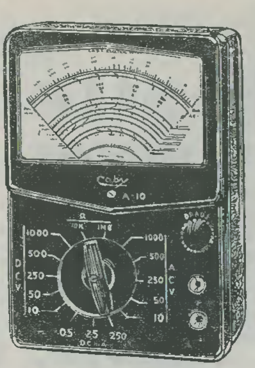

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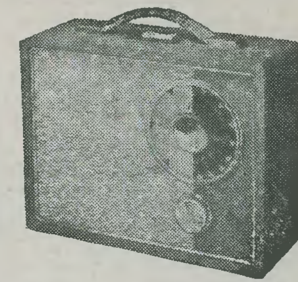
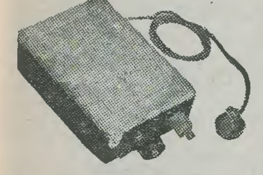


Size 9½" x 7" x 3½" Weight 4lb

MAJOR–3 *(3-Transistor Radio)*



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continued on page 639

L. F. HANNEY

77 LOWER BRISTOL ROAD BATH

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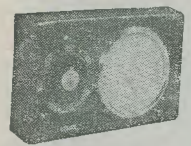

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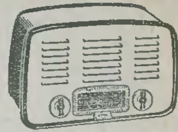

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TRADE—*continued*

continued from page 637

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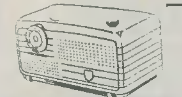

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