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DESIGN OF TAPE RECORDERS, Part 2

VOLUME 10
NUMBER 5
DECEMBER
1956

The RADIO Constructor

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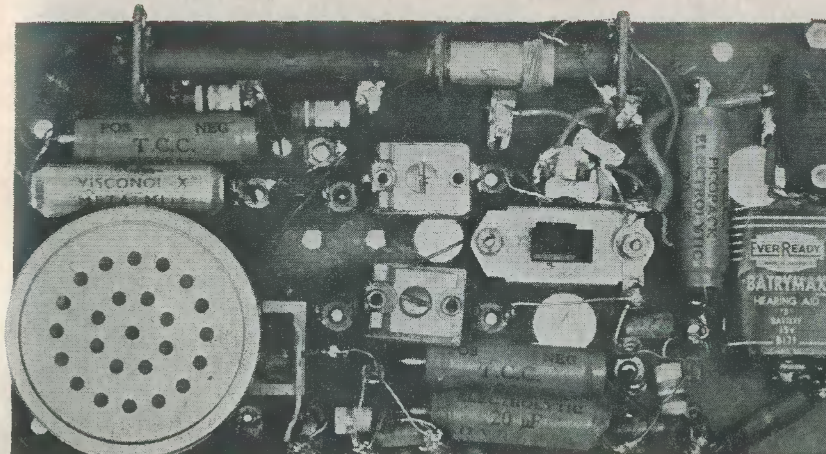

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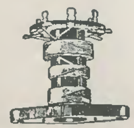

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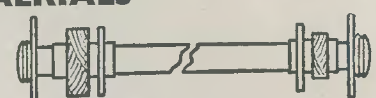

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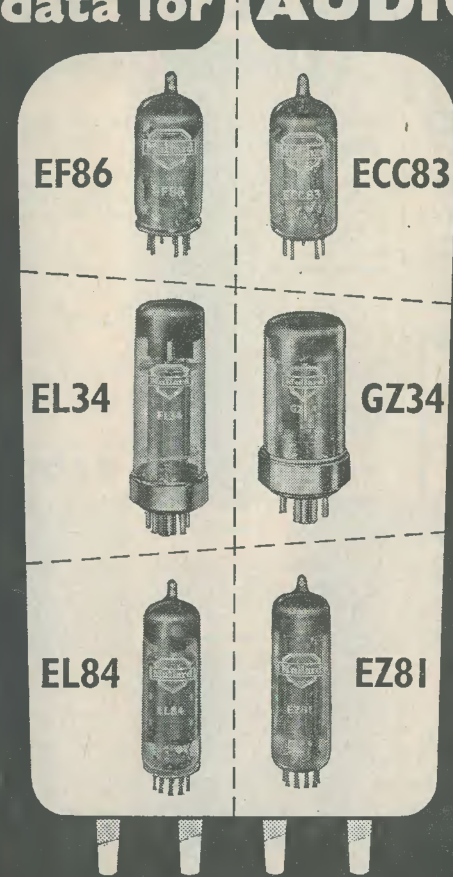

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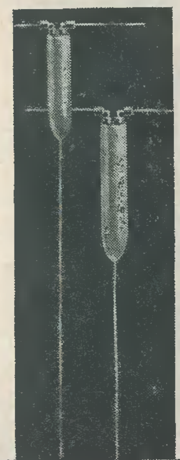

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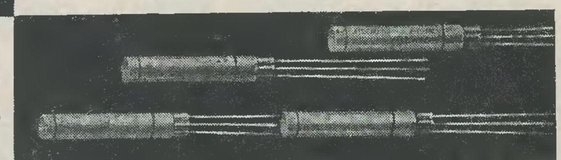

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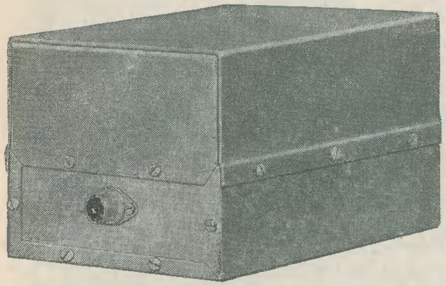

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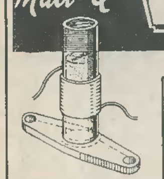

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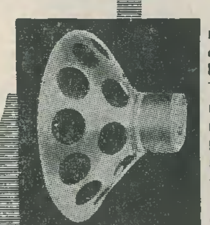

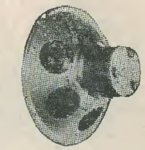

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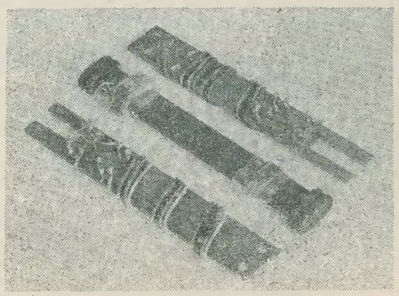

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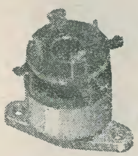

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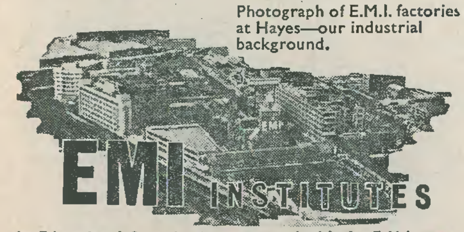

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The Radio Constructor

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DECEMBER 1956
ANNUAL SUBSCRIPTION 21/–

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CONTENTS FOR DECEMBER

NOTICES

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

All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

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

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

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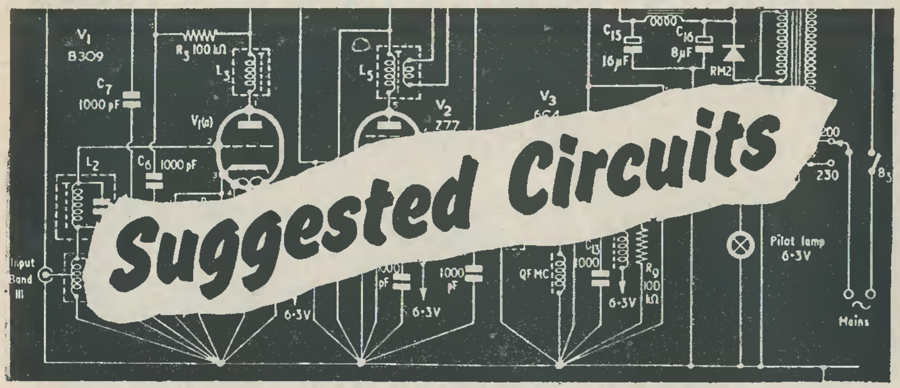

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No. 73. PHOTOTRANSISTOR CONTROL OF HEAVY CURRENTS

In last month's issue of *The Radio Constructor* we described, in *Suggested Circuit No.* 72, theoretical and practical arrangements whereby a relay could be controlled by the appearance or cessation of a ray of light. No amplifying valves were employed in the device described, the total complement of components consisting of a relay (whose coil was shunted by a crystal diode to prevent the formation of excessive back e.m.f.) and a Mullard phototransistor type OCP71. The circuit operated from a 12 volt d.c. source of supply. Last month's article also discussed practical methods of obtaining high sensitivity with the OCP71; and pointed out, in addition, the importance of correctly connecting the crystal diode to the relay coil, and of applying the power supply with correct polarity. The relay employed for checking the circuit was obtained from H. L. Smith, Edgware Road, and had the type No. RL5K/M. This relay has a 5,000 ohm coil, operates at less than 2mA, and has change-over contacts.

A Secondary Relay

As was pointed out in last month's article, the contacts of the relay controlled by the phototransistor are rather light, and they could not be employed for switching heavy currents. For this purpose a secondary relay is required. The use of a secondary relay brings about further incidental advantages, the most important being that it enables more complex switching operations to be obtained than can be provided by a single relay.

The secondary relay employed by the writer for his experiments was also obtained from H. L. Smith. The unit actually used was the ex-R.A.F. "Starter Type A" (Ref. No. 10F/7997), this consisting of a switching assembly which includes two relatively heavy relays and a starter resistor. The unit is recommended in this application owing to the heavy relay contacts and reliable action which it provides. Either of the relays in the Starter Unit should be capable of switching a.c. mains circuits up to several hundred watts quite comfortably. The two relays have single and double contacts respectively, the contacts making when the relays operate. The circuits shown this month have the relay with the single contact switched directly by the phototransistor relay. The contact of this relay then controls an external circuit directly, or switches in the double-contact relay of the Starter Unit.

Before carrying on to practical circuitry it becomes necessary to consider the fact that, as occurred with the phototransistor relay of last month's article, the back e.m.f. appearing across the coil of the secondary relay when its energising current is broken may cause damage to other components in the circuit. In this case the damage would occur at the contacts of the phototransistor relay, at which points the back e.m.f. would cause the appearance of a spark. This spark could soon burn out these contacts. In the previous article the back e.m.f. of the phototransistor relay coil was reduced to safe proportions by connecting a crystal diode rectifier across it. In the case of the larger relay under consideration this month a rectifier cannot be conveniently recommended, this being due mainly to the difficulty of specifying a suitable type which is available to the home constructor. Instead, therefore, a high-value condenser (actually 50μF, 12 W.V.) is connected across the secondary relay coil in the circuits which accompany this article. This condenser then effectively prevents the formation of excessive back e.m.f. To obviate a surge of current when the relay coil is energised (caused by the presence of the

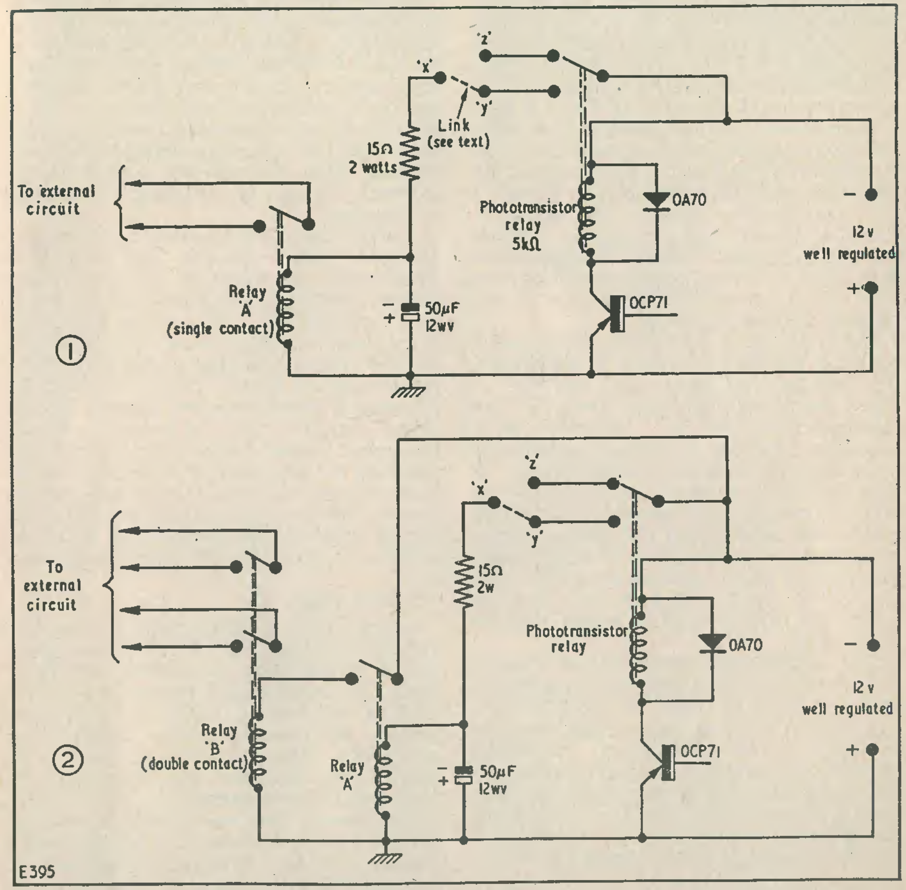


Fig. 1. *A simple practical switching circuit. Fig.* 2. *This circuit enables double-pole switching of the external circuit to be obtained.*

condenser) a limiting resistor of 15 ohms is also inserted in circuit. This combination of capacity and resistance is very effective in suppressing sparks at the phototransistor relay contacts and has caused no trouble in use.

It must be pointed out that this particular spark-suppression circuit has been tested only with the relay specified above. It may not necessarily be successful with other relays.

A Simple Circuit

Fig. 1 illustrates a simple manner in which the single-contact relay of the Starter Unit may be employed with the phototransistor. In this diagram the single-contact relay is designated "A." (In Figs. 2 and 3 the double-contact relay will be designated "B.") The operation of the circuit of Fig. 1 is quite straightforward. What occurs is that, when the phototransistor is illuminated, the phototransistor relay operates. The contacts of this relay then energise the coil of relay A via the 15 ohm limiting resistor just discussed. Relay A operates and its contacts complete the external circuit. When the illumination of the OCP71 ceases the phototransistor relay falls off, thereby de-energising relay A and opening the external circuit.

If it is desired to switch the external circuit *off* when the phototransistor is illuminated, the link between points "x" and "y" in Fig. 1 should be broken, and point "x" then reconnected to point "z." Under this set of conditions relay A is energised continually until the phototransistor is illuminated. It then switches the external circuit off. Another way of utilising this second arrangement would consist of having the phototransistor permanently illuminated. When the light beam to the phototransistor was interrupted, say, by the passage of a person's body or hand, the external circuit would then be switched *on*.

The linking arrangement between points "x" and "y" or "z" shown in the diagram is intended only to assist in describing the capabilities of the circuits, whilst using the minimum number of diagrams. In practice the linking arrangement could be replaced by an s.p.d.t. switch in cases where high versatility is required from the circuit; or, where the ultimate function is known beforehand, it can be replaced by permanent wiring.

Two-Pole Switching

In Fig. 2 it is assumed that a two-pole control of the external circuitry is required. In this diagram the double-contact relay of the Starter Unit, relay B, is pressed into service. This relay is energised by the contacts of relay A. When relay A operates, so also does relay B. This circuit is, of course, capable of all the functions offered by the circuit of Fig. 1, the only difference being provided by the addition of relay B.

It will be noted that no effort is made in Fig. 2 to suppress the back e.m.f. voltage appearing across the coil of relay B at the instant of de-energising. The reason for this is that the contacts of relay A are heavy, and do not in consequence require the same protection as do those of the phototransistor relay.

A Triggered Circuit

A triggered circuit is illustrated in Fig. 3. This circuit enables equipment to be switched on whenever the phototransistor is illuminated, or whenever its illumination is broken. Once the external circuit has been switched on, it stays in this condition regardless of the subsequent illumination, or otherwise, of the phototransistor, and it can only be switched off again by pressing the "re-set" button. Only a single-pole control of the external circuit is available with this arrangement.

In Fig. 3 relay A is energised by the phototransistor relay whenever the OCP71 is illuminated, or whenever its illumination ceases (according to the position of the link at "x," "y" and "z"). When relay A operates it energises relay B. Contact B1 then holds relay B closed, regardless of the state of the phototransistor relay or relay A. Contact B2 of relay B switches on the external circuit. When energised, relay B can only be de-energised by pressing the "re-set" button, this breaking the power supply to its coil. In the case of automatic operations, such as the opening of doors, etc., the "re-set" button can be replaced by a switch which opens the coil circuit on completion of the operation.

Practical Points

A few practical details require discussion before concluding this article. These apply mainly to the relays A and B in the Starter Unit. As manufactured, this unit is provided with its own internal wiring. *All* this wiring should be removed before commencing operations. The starter resistor fitted in the unit is not required, and may also be removed, if this is desired.

The Starter Unit was originally designed for use at aircraft voltages, but its insulation should stand up to mains voltages quite successfully. However, to improve the insulation position it might be desirable to unsolder the coil lead-out wires of both relays from the brass terminals into which they are fitted, as the insulation between these terminals and the yokes of the relays is rather of the low-voltage variety. The coil lead-out wires may then be extended by having additional wire soldered to them, the joints being covered by sleeving.

If it is found that relay A does not operate cleanly, due to the presence of the 15 ohm limiting resistor in series with its coil, reliable operation may be obtained by slightly reducing the armature spring tension by means of the adjusting screw provided on the relay.

The moving contact of the phototransistor relay specified is integral with its mounting assembly. Because of this it should not be mounted directly to chassis, but on an insulated bracket. (Alternatively, the chassis connection may be removed from the positive to the negative pole of the supply, if this is thought worth while. However, this method of connection incurs the slight disadvantage that both leads to the phototransistor are not at chassis potential.)

in the case of Fig. 1.) With all relays de-energised, the consumption is less than 0.5mA. For some applications this makes the use of even a 12-volt accumulator an attractive proposition.

If a mains operated supply is to be employed, this may consist of a conventional bridge rectifier connected to the low voltage winding of a suitable mains isolating transformer. The writer understands that a suitable 12 volt 1 amp transformer (Radiospares CRT Transformer) may be obtained from the suppliers of the relays. When a mains transformer supply is employed, reasonably effective smoothing might be desirable to prevent relay chatter, or the application of too high a voltage to the circuit during part of the rectifier cycle. Good regulation is advisable also, and this can be achieved by permanently loading the supply with a resistor consuming some 0.25 to 0.5 amps. The regulation of the power supply can easily be checked before finally completing construction by connecting a voltmeter across its output and applying this output to the relay circuit with the phototransistor omitted. The secondary relay or relays may then be energised by manipulating the contacts of the phototransistor relay, whereupon the supply voltage can be checked under all conditions of use. The polarity of the supply should next be confirmed as being correct. The phototransistor can then be finally connected into the circuit.

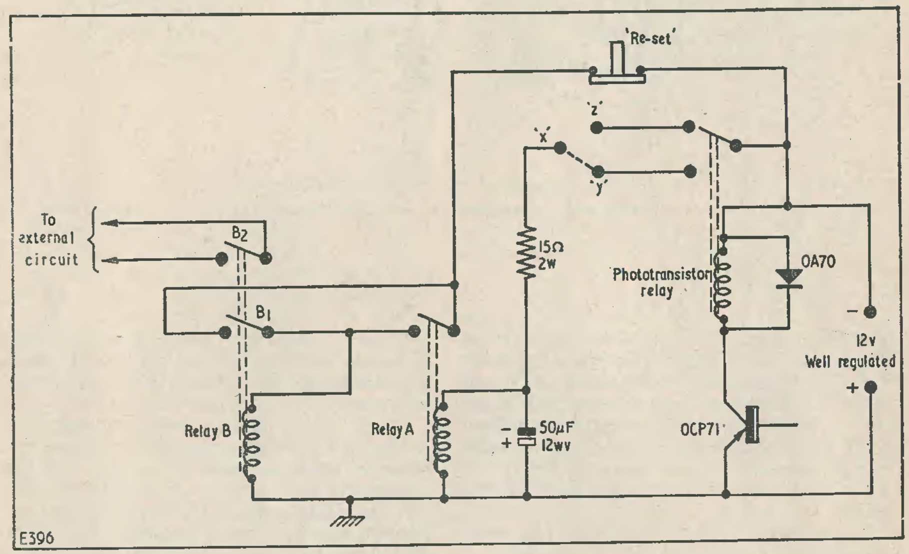


Fig. 3. A relay switching arrangement which provides triggered control

If it is intended that relay A or B will switch mains voltages it is advisable (and good practice) to connect the chassis of Figs. 1, 2 or 3 to a reliable earth. Such a precaution is even more to be recommended when the phototransistor wiring, or any other part of the circuit, is installed out of doors.

Power Supply

The power supply for the device should not involve any difficulties. The potential required is twelve volts, the relay circuit taking a maximum amount of approximately 0.5 amps when all relays are operated. (The current is approximately 0.2 amps maximum

At the request of readers Smithy the Serviceman continues to run the Workshop

SMITHY WAS HUMMING AWAY SOFTLY TO himself as Dick entered the workshop. Dick wandered quietly up to the bench and sat down: whereupon Smithy looked up and grunted a greeting over his shoulder. After a moment he left the job on which he was engaged and turned round to Dick.

"Would you like to do me a favour?" he asked.

"Certainly," replied Dick, "only too ready to help."

Donkey Work

"Fair enough," remarked Smithy, "but it's rather in the way of donkey work, I'm afraid. What's happened is that I have a television set in for repair which has poor interlace. I've carried out all the quick checks on the sync separator that I can do, without going into a really detailed search for the fault. That is to say, I've swopped valves and checked voltages for obvious snags, but I haven't been able to locate the trouble.

"Now, I know that the set is of a make and model which normally gives good interlace. Also the trouble has only occurred in the last few weeks. So there is a fair chance that some component has shifted slightly in the sync separator or, just possibly, the frame timebase."

"I see," said Dick, "in other words, what you want me to do is to make a routine check on resistor and condenser values in that part of the set."

"Yes, that's right," replied Smithy, "I should go for the most prevalent troubles first: such as resistors going high and coupling condensers going leaky. You will probably find that quite a lot of the resistors and condensers can be checked without having to disconnect them from the circuit. If there's a crystal diode in the circuit it should, of course, check high resistance with the ohmmeter leads connected to it one way, and low with the leads connected the other way.

"So there you are. Here's the set, and here's the circuit." Smithy left a service sheet on the bench and returned to his own task.

Quiet returned to the workshop for some time. Indeed, things stayed quiet for so long that Smithy looked around to see what was happening.

He saw Dick sitting unhappily at the bench, looking glumly at the service sheet.

"What's up?" asked Smithy.

Dick started, and went rather red in the face.

"Well, to tell you the truth," he said, a little confusedly, "I'm trying to find the sync separator in this circuit! I've located the frame and line output stages, but I'm not quite too sure which of the rest of the circuit is sync and which isn't!"

"Not to worry," remarked Smithy soothingly, "better brains than yours and mine have been foxed by circuit diagrams before now. Especially when they are drawn up by the type of draughtsman who is more interested in maintaining a certain density of lines to the square inch than in providing a clear, logical layout. Ah, this circuit is one of them! It's also one of those where the components don't have their values printed alongside them. You know, I often wonder how many man-hours are lost in this country by engineers having to turn the pages of a manual just to see whether a condenser is 0.01 or 0.001μF. To my mind, a circuit diagram without values is just adding extra time to the serviceman's job and extra money on his customer's bill.

"Anyway, let's get off my own particular hobby-horse and return to the problem in hand. Which is that we want to find the sync separator! Well, one thing that may help us is that the sync separator is almost always fed from the video output anode, and that the video output anode connects to the modulating electrode of the picture tube. Now here's the tube—can't miss that! Its grid goes to the brilliance pot, so it is cathode modulated. And the lead from the cathode goes back along here, over several stages, through a condenser and a peaking choke, and finally on to the video output anode. Also coming from this anode is a lead which travels down, along here, to the grid of V_{18}. So V_{18} is the sync separator in this circuit, and the components between it and the frame output stage are those you want to check."

"Thanks, Smithy," said Dick, "it's quite easy tracing through when you do it like that!"

"It's just another instance of the old, old story," returned Smithy. "When you're on unfamiliar ground, try and start from something you can recognise."

Checking Values

Smithy returned to his work again, and Dick commenced to check the components in the receiver. After five minutes or so his face took on an expression of gratification, and he searched eagerly in Smithy's spares cupboard. He replaced one of the resistors in the television chassis and switched it on. As the picture came up he looked at it anxiously, and then grinned with satisfaction.

"There you are, Smithy," he exclaimed proudly. "How's that?"

Smithy looked at the picture.

"Yes, that's perfectly OK. Which component was it?"

"It was a 68kΩ from the sync separator anode to h.t. It had gone up to somewhere around 250kΩ."

"Good show," remarked Smithy, "another job done! It doesn't take long when you settle down to it methodically, does it? I wish they were all as easy as that! Incidentally, I should check that the valve isn't passing too high an anode current before finally clearing the job—just in case there is another snag as well. It is doubtful, however, because resistors seem to go high in value much more readily when, like this one, they are passing pulse currents instead of steady currents."

"By the way," asked Dick, "how *do* you check for good interlace in a receiver?"

"You know, that's rather a difficult question to answer," replied Smithy thoughtfully. "I would say that it is experience mainly. In a set with good interlace the line structure seems to be *alive* and moving. A good plan consists of turning down the brilliance, preferably with a stationary pattern on the screen, until you can just see the brighter parts. If necessary you then readjust the focus, and examine these brighter parts. Under these conditions the lines usually show up very thin and fine, and you can see if they are equally spaced out or are approaching a state of pairing. A dodge which some engineers use is to have the set working normally, and then hold out a hand in front of the tube with the fingers outstretched horizontally. They then move the hand up at a steady, fairly slow speed. If you do this at a certain speed you get the impression that the top of the hand is moving in sympathy with the line structure. When the speed of the hand is slow for this effect the set should then be interlacing. Quite frankly I don't know how valuable such a test is scientifically, but I have found that it is difficult to get the effect—with the hand travelling slowly—on a set with poor interlace. It is possible that moving the hand in this manner assists the eye in examining the line structure as a fixed presentation."

"Well, that's interesting," remarked Dick. He tried out the idea on the receiver he had just repaired, and after several attempts picked up the knack of it. "It certainly seems to work with this set, at any rate."

With which remark he set to work checking the anode current of the sync separator before finally returning the receiver to its cabinet. In the meanwhile, Smithy was engrossed again in his own job. A little bored with having nothing to do, Dick commenced to check the values of one or two components which were lying on the bench. After a while he gave an exclamation of surprise.

"What's happened?" grunted Smithy, from the other end of the bench.

"I've just found another component which is about double its marked value," chuckled Dick. "This must be my lucky morning!"

"Which component is that?"

"This disc ceramic I've got here," continued Dick. "Look, it's marked 1,000pF, but it's reading 1,800pF on the bridge. Come to think of it, that's the first time I've ever heard of a condenser going *high* capacity. Why would it do that, Smithy?"

Smithy laughed.

"It's meant to, Dick," he said. "Those 1,000pF disc ceramics are normally used for i.f. and r.f. decoupling in television sets where it doesn't much matter what capacity they have, within reason, so long as they're greater than a certain minimum amount. At most television i.f. and r.f. frequencies a minimum around 800pF represents a sufficiently low impedance to give adequate decoupling, and that is the value usually chosen. As a result, many of the 1,000pF disc ceramics you come across will probably have a tolerance range of something like −20 to +100%, i.e. from 800 to 2,000pF. Such a wide range doesn't prevent them functioning adequately in decoupling positions, although they might give trouble elsewhere."

"Is it easier to make condensers with such a large tolerance?" asked Dick.

"In this case I would say quite definitely, since it would be a relatively expensive process holding disc ceramics to tight tolerance values. There aren't many preferred values around 1,000pF, so when a wide tolerance can be accepted, there must be a corresponding reduction in manufacturing costs."

"What do you mean by preferred values?"

Smithy settled himself down comfortably as he answered this question.

"Preferred values are used for many components these days, including resistors especially. In the old days, resistors used to be made to the nearest round figure, and everyone spoke in terms of 1MΩ, 0.5MΩ, 0.25MΩ, and so on. Unfortunately, manufacturers found it difficult to make resistors to an exact value. So instead they made them as near to the required value as they could, and selected them afterwards. However, the old numbering system left a lot of gaps in some range of values, and created a large number of overlapping values in others. Thus a 1MΩ resistor of 20% tolerance could have a value between 800kΩ and 1.2MΩ; whilst the next common value down, 500kΩ would have a range of 400 to 600 kΩ when made to the same tolerance. This meant that, if a manufacturer made a batch of resistors which lay between 600 and 800 kΩ they would be outside tolerance on both the popular 500kΩ and 1MΩ values, and he might have difficulty in selling them.

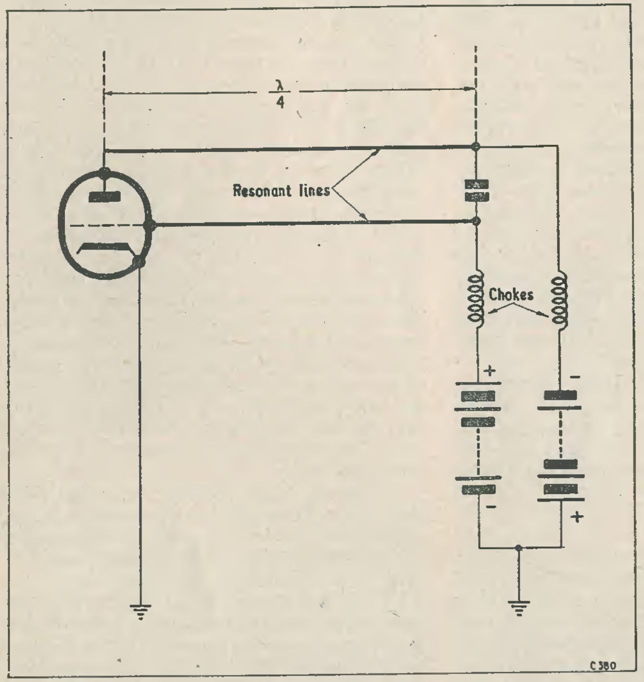


Fig. 1. *One of the basic forms of the Barkhausen - Kurtz oscillator*

With the preferred system, resistor values are not made to correspond to a round number, but to a number which lies a certain percentage away from its neighbours. If you decided to make ±20% resistors having the following values, 1Ω, 1.5Ω, 2.2Ω, 3.3Ω, 4.7Ω, 6.8Ω, 10Ω, and so on, you would be doing very well. This is because, if one particular resistor strayed out of its tolerance on one value, it would enter the tolerance of the next. For instance, a nominal 3.3Ω resistor which happened to be, say, 21% lower than that figure could still be sold, since it would then become a 2.2Ω± 20% resistor! The figures I've just given you are the preferred series for 20% tolerances. There is, actually, a slight overlap between the tolerance range of one figure and that of the next, but this is only because it is convenient to make the whole series lie between 1 and 10. The series can be carried on from 10 to 100, and so on up; or it can be taken down the same way: i.e. 0.1 to 1, 0.01 to 0.1, and so on. For a 10% series there are twice as many preferred values, the new figures being inserted between those existing in the 20% series.

"Nowadays, manufacturers can make resistors much more accurately than they could in the old days—although they may still have to select for close tolerances—and so the preferred system still represents a useful advantage. It now appears to be coming into favour with low value condensers also, and particularly with low value ceramic condensers."

"Well, that's something more I've picked up," remarked Dick. "Which reminds me about a remark you made some time ago about Barkhausen oscillations. Do you remember?"

The Barkhausen-Kurtz Oscillator

Smithy frowned a little.

"Yes, I do remember," he replied. "What I said was that I would discuss Barkhausen oscillations in television line output stages the next time we had a "gen session" together. In a way, though, I rather wish I hadn't introduced the subject to you."

"Why is that?" asked Dick.

"You may recall that, last time, we were talking about interference being radiated from line output stages due to corona, badly soldered joints, or Barkhausen oscillations. The difficulty with this last source of interference is that not all engineers seem to agree about its existence."

"This sounds interesting," remarked Dick; "almost as though there is a story behind it."

"Well, there is, in a way," replied Smithy. "You see, Barkhausen oscillations were first discovered as early as the 1920's. In those days, this mode of operation appeared in, to give it its correct name, the Barkhausen-Kurtz oscillator. This oscillator functioned by taking advantage of the regular movement of electrons inside a triode when the grid was made positive with respect to cathode, and the anode negative. As you may imagine, when potentials of this type are applied to a valve, the electrons emitted by the cathode are attracted to the positive grid. However, many of these electrons pass through the wires of the grid, whereupon their inertia carries them on towards the anode. As they approach the anode they become repelled, due to the negative charge on this electrode. In consequence they return to the positive grid again, and a proportion once more pass through its wires. When the electrons approach the cathode on their return journey they lose speed and are finally attracted back to the positive grid again. This causes them to commence another cycle of movement. As I have just mentioned, a proportion of the moving electrons hit the grid wires continually and cease to wander further. However, their numbers are constantly made up again by the emission from the cathode.

"It is possible to take advantage of this movement of electrons in the triode by coupling a tuned circuit to the valve in the manner shown here." Smithy scribbled some circuits on a piece of paper. "But, since the movement of electrons in the triode is so very fast, it is only possible to get results if the tuned circuit resonates at a very high frequency. When the Barkhausen-Kurtz oscillator was originally developed, the tuned circuits employed usually consisted of a pair of resonant lines, or Lecher lines, cut to a quarter of the wavelength required, and running parallel to each other. In this sketch (Fig. 1) the resonant lines are connected to the anode and grid; and in this (Fig. 2) to anode and cathode. The anode and cathode connection is the better because these two electrodes are more truly in antiphase so far as the movement of electrons in the valve is concerned. But the anode and grid arrangement was, so far as I remember, more popular in the days when the circuit was used, probably because of the difficulty at that time of keeping a cathode really efficiently isolated from earth potential at high frequencies.

"The frequency range of oscillation of a Barkhausen-Kurtz oscillator depends almost entirely upon the dimensions of the valve electrodes and the distances between them. Valves with cylindrical electrodes work best, because the electrode spacing then remains constant all round the cathode. It is impossible to make a valve oscillate in the Barkhausen-Kurtz mode unless the external tuned circuit approaches the natural frequency of the valve itself, or works, perhaps, at a harmonic of it. And I should also add that the oscillator is rather inefficient, this being due to the fact that electrons are emitted by the cathode all the time, and energy is lost in getting them to fall into step with those oscillating through the wires of the grid. The fact that there is a continual loss of electrons to the grid also causes reduced efficiency. Nevertheless, when the oscillator was introduced this low efficiency was outweighed by the considerable advantage that the device generated v.h.f. oscillations, a difficult operation in those days.

engineers in the U.S.A., a number of whom have claimed that they have cleared radiation troubles by mounting a permanent magnet close to the line output valve. The field from the magnet is considered to sufficiently distort the electron path inside the valve to prevent Barkhausen oscillations taking place."

"It seems a feasible enough theory to me," remarked Dick. "What do you think yourself?"

"I think that the Barkhausen theory is possibly quite correct," replied Smithy. "The difficulty is that there are so many other things which could cause periodic oscillations in the line output stage, or which could cause damped trains of oscillation to occur due to shock-excitation of tuned circuits made up of

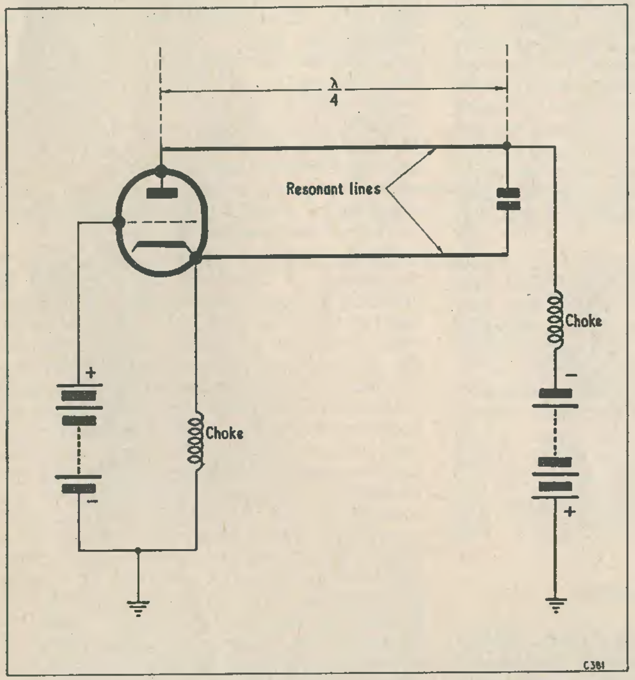


Fig. 2. Another form of the Barkhausen-Kurtz oscillator, in which the tuned circuit formed by the resonant lines is connected between anode and cathode of the triode

"Now when television commenced and entered its present state of design, one of the many snags which showed up was periodic radiation from the line output stage at line frequency. Since the line output valve may have its anode at a low potential and its grid positive with respect to cathode during part of the line cycle, many engineers declared that this radiation was caused by Barkhausen oscillations. The Barkhausen theory has gained considerable backing amongst service

stray capacities and inductance, that I just wouldn't like to hazard a guess."

"Seems that there is an interesting field of experiment here," remarked Dick. "In fact, I would like to have a look into it myself when I get the chance."

Smithy smiled. "First catch your radiation," he said.

"OK," replied Dick. "But don't be surprised if you see me with a pocket full of magnets from now on!"

TELEVISION for the HOME CONSTRUCTOR

PART 6.

by **S. WELBURN**

This month S. Welburn, our popular contributor on television topics, describes methods of checking signal strength at the aerial.

THE WRITER, IN COMPANY WITH THE Editor, has received several letters recently from readers asking for particulars of simple field strength meters. These have been required mainly for checking the efficiency of individual aerials and for providing a comparative measure of aerial sensitivity between one particular installation and another. A very interesting point was raised by one correspondent who remarked that a field strength meter could be especially useful for those who design and experiment with their own aerials, insofar that it would enable a direct measure to be made of the increased efficiency, or otherwise, provided by such things as variations of spacing in multi-element arrays and the like. This correspondent pointed out that, by taking advantage of a simple f.s. meter, the home-constructor would be able to make an aerial that was well-nigh as efficient as it possibly could be; this course being obviously preferable to that of constructing an array from approximate element length and spacing figures whilst keeping one's fingers crossed as to its final efficiency. The writer is in agreement with this argument.

Economy

In essence, a field strength meter is, of course, little more than a very reliable receiver which is fitted with an output meter plus a few extra controls. Unless one is contemplating making a laboratory-type instrument, the manufacture of a reasonably useful f.s. meter requires little more in the way of skill from the average home-constructor than that needed for any other sort of receiver construction. Unfortunately, whilst the difficulties of construction may not cause too many headaches, the question of cost can become quite significant. This is due to the fact that, being basically a receiver, a field strength meter will need at least as many components as would be required for the equivalent receiver, as well as the components that are needed for additional circuits. A typical basic requirement for the receiver section of an f.s. meter would include an r.f. stage, a mixer, say two i.f. stages, and a detector. An audio stage driving a speaker or headphones would also be very desirable, since this would enable signals received to be identified. A power supply of some type must be added to the list, as also must an output meter and some form of reliable attenuation.

It will be seen that the above could constitute quite an expensive outlay in cash, especially if most of the parts needed were bought new. However, on the credit side there is the fact that, apart from the r.f. and mixer stages, there is nothing at all "critical" in the circuit of a simple field strength meter of the type the writer has in mind for this particular context. For instance, the coils in the i.f. strip could be home-wound, and the i.f. valves could consist of any inexpensive war-surplus stock from VR53 or 65 vintage onwards. Pretty well any reasonable valves and components could cope in the a.f. stages, as these do not enter the field strength meter circuits proper. In consequence of these points it is possible that the constructor with a fairly well-stocked spares box would not find that a simple f.s. meter would cause too heavy a raid on his pocket after all.

The question of permissible cost is really governed by the frequency with which the instrument will be needed. A mobile television service engineer, or an aerial installation engineer, could find a simple f.s. meter of high value in his work, and its construction would almost certainly be more than worth his while economically. For the amateur who would use such a device infrequently the f.s. meter might, or might not, be an unjustified expense. However, the fact must always be borne in mind that, being basically a receiver, a simple field strength meter provides quite a number of useful facilities apart from that for which it was originally intended. The use of its i.f. strip for the design or alignment of television front-ends is only one example of these incidental advantages.

In this article, the writer will give general details of a simple field strength meter. For those who do not wish to construct such an instrument, he will also describe how some conventional television receivers may be pressed into service to give comparative field strength readings when these are required only occasionally.

The Basic F.S. Meter

One of the basic methods of measuring field strength employs the arrangement illustrated in Fig. 1 (*a*). In this diagram a non-a.v.c. controlled receiver connected to an output meter is switched to the aerial employed for the test, and is tuned in to the desired signal. Its gain control is adjusted to give a certain reading on the output meter. The receiver is then switched from the aerial and coupled into the output of the signal generator. This is set to the same frequency as the desired signal, and its attenuators adjusted until the receiver output meter gives the same indication as it did with the signal. The strength of the signal is then equal to that of the signal generator output, the latter being read off its attenuators. This process makes the reasonable assumption that the receiver does not drift in frequency or gain whilst being switched from the aerial to the signal generator. It is also assumed that the impedances of the receiver input, the signal generator output, and the aerial are all equal. This latter is a factor which is not always so easy to ensure as it may appear at first sight. However, the inaccuracies given by mismatching may usually be alleviated somewhat by inserting resistive pads between points where impedance is doubtful, and allowing for the attenuation given by these in final calculations.

The arrangement shown in Fig. 1 (*a*) gives reliable results; but individual readings take a little time to carry out. A slightly quicker method is illustrated in Fig. 1 (*b*). In this diagram a calibrated attenuator is fitted to the receiver (normally at its input, as shown in the diagram). The receiver is tuned to the desired signal, after which its input is transferred to the signal generator, this being set to give an output of standard amplitude. The receiver gain control is next adjusted so that a certain output reading is given when the attenuators are set to a reference figure of, say, zero db. The receiver is then returned to the aerial and the attenuator readjusted until the same level is shown by the output meter. The strength of the input signal (as compared with the standard output of the signal generator) can then be read off the receiver attenuators. The advantage of this second method of reading signal strength is that the signal generator has to be referred to only at the beginning of a series of readings on a single frequency.

In both the arrangements just mentioned, the receiver and output meter combination is always capable of indicating incremental increases in signal level without the need of reference to the signal generator or attenuators at all. If, for instance, we adjust the spacing of an element in the aerial and note that this increases the output level, then we know that our adjustment has obviously resulted in increased signal strength. Indeed, we could use the f.s. meter for a considerable amount of work on such things as the adjustment of aerial elements, or of aerial rotation, etc., etc., without bothering about the *absolute* increases in signal strength that we have obtained. Such absolute measurements could be made after we had finished our experiments.

In the writer's experience the field strength meter is very valuable, even when it is used only as a comparative signal strength meter in this manner.

Most commercial field strength meters employ the arrangement shown in Fig. 1 (*b*), in which the attenuators are integral with the receiver. A source of standard signal strength is also provided in the same cabinet, this sometimes being obtained from a noise generator, or similar device.

From the amateur point of view the provision of attenuators and a source of standard signal strength raise difficulties. Firstly, it is not easy to obtain reliable attenuators (reliable, incidentally, at Band III as well as Band I) which are calibrated in db's. Secondly, the provision of a source of constant signal cannot be constructed with any certainty without access to laboratory equipment. For this reason, the writer suggests that, from the home-constructor viewpoint, the arrangement shown basically in Fig. 1 (*c*) would provide quite a good compromise between cheapness and a high degree of absolute accuracy. If carefully made, the accuracy of the equipment shown in this diagram should not fall too far short of that given by much more expensive laboratory-type instruments. These, incidentally, would give no greater usefulness, so far as comparative readings were concerned, than does the simple device we are considering.

The Working-man's F.S. Meter

The idea behind the device shown in Fig. 1 (*c*) is that, when it is required for checking *absolute* values of signal strength, it is connected to the aerial and tuned in to the desired signal. With the i.f. gain control set to maximum, the r.f. gain control is next set to give a pre-arranged reading on the output meter. The signal strength is then read off the dial of the r.f. gain control, this having been previously calibrated. If the signal is so strong that it cannot be sufficiently attenuated

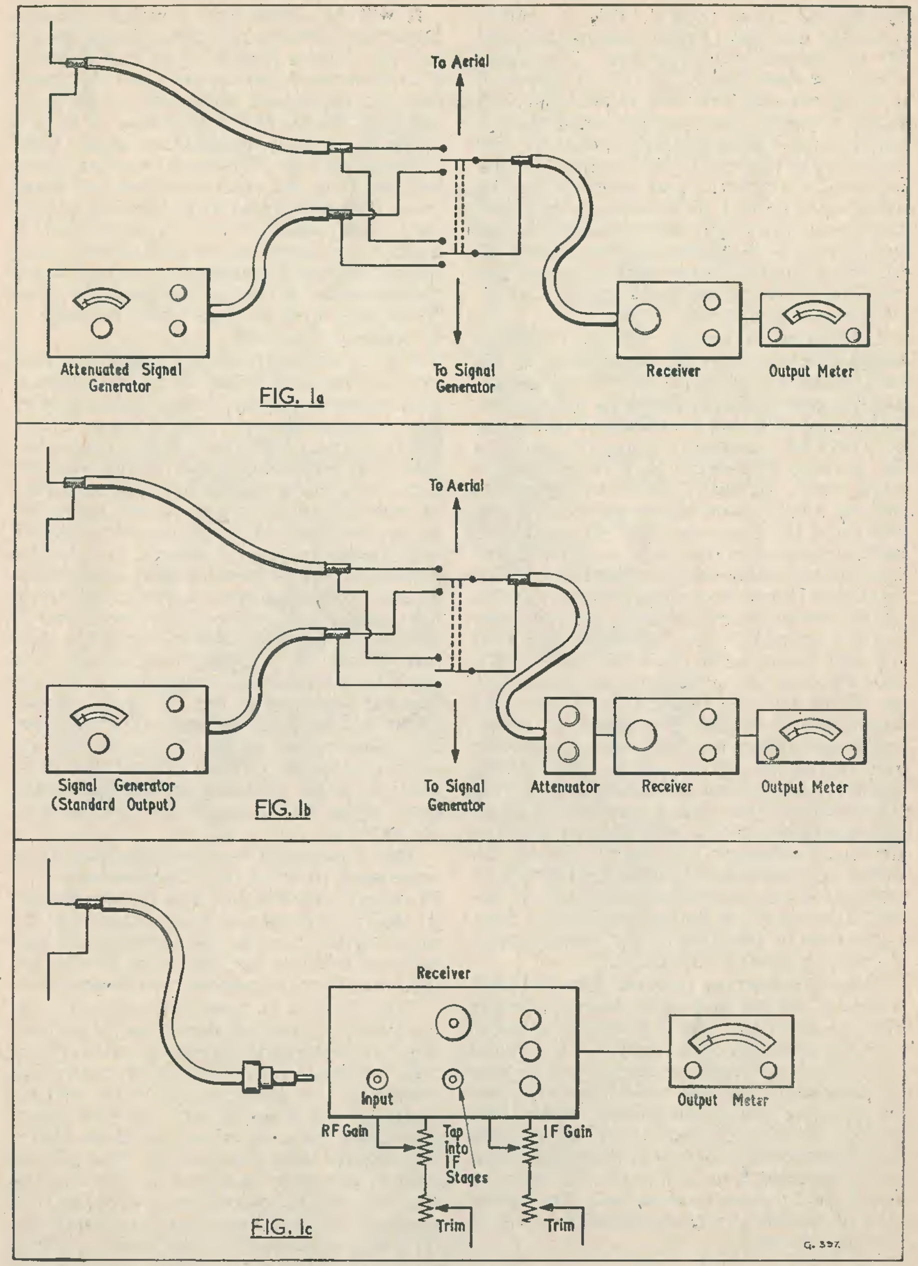


Fig. 1 (*a*). *A basic method of reading signal strength at an aerial.* (*b*) *An alternative method of measuring signal strength.* (*c*) *A simple field strength meter, suitable for home-construction, which is discussed in the text.*

by the r.f. gain control, this is left at minimum and the i.f. gain control adjusted for the desired output reading. The signal strength is then read off the i.f. gain control, it being assumed that this is used only for signal strength measurements when the r.f. gain control is in the minimum position. For comparative readings of incremental increase in signal strength the gain controls may be adjusted, as needed, for optimum conditions; alterations in strength being indicated by the output meter. A tap into the first stage of the i.f. strip is brought out to the front panel, this enabling the strip to be used separately, or for purposes of calibration.

Calibration is carried out by feeding a signal generator into the aerial input of the field strength meter and calibrating the r.f. and i.f. gain controls against its attenuators. Calibration will vary at different frequencies, so it will be necessary to repeat the process for as many frequencies as it is intended to work with. Normally, this will necessitate making a calibration run at one Band I and one Band III frequency only. If considered necessary, a calibration run at Band II, for f.m. signals, could also be carried out. (The frequency chosen here could be at the centre of the frequencies available for the particular district served.) Once calibrated, the field strength meter would then be available for use; the only further requirement being that its calibration was checked every now and again with the signal generator. In subsequent calibration runs any discrepancies in gain could be taken up by the "trim" potentiometers shown in the diagram. During the initial and later runs, a useful check of i.f. gain stability could be obtained by injecting the signal generator into the i.f. strip at the panel tap provided and noting the signal level needed for the reference output level. If discrepancies show up during later checks these could then be taken up by the potentiometer "trimming" the i.f. gain control.

Some constructors may not take too kind a view of the last paragraph, since it assumes that an attenuated signal generator is available for purposes of calibration. If a signal generator is not available, the r.f. and i.f. gain controls should be calibrated arbitrarily; say, by dividing the potentiometer scales into tenths. A little experience with the controls will then soon give an idea of the performance to be expected from any particular aerial to which the f.s. meter is connected. The usefulness of the meter for comparative checks is, of course, unaltered.

Circuit

Fig. 2 gives the basic circuit of a typical home-built f.s. meter using the ideas detailed above. There are several items here which need a little further explanation.

It will be noted that a resistive pad is connected between the aerial input socket and the receiver proper. This pad provides 6 db attenuation, and its purpose is to ensure that the impedance presented to the input signal by the f.s. meter is, as near as we can make it without losing too much gain, 75 ohms resistive. This is an important point because, first, the input impedance of whatever r.f. stage is employed in the receiver may vary quite widely from 75 ohms (due to design and production difficulties) and, second, because if we are going to check aerial performances we need to terminate the aerial feeder with an impedance which we *know* to be reasonably accurate.

The r.f. and mixer stages in the instrument raise the major difficulty to be encountered. This is due to the fact that a high degree of gain is essential here. Fig. 2 shows a box labelled "tuner" for these stages, the author having in mind such a unit as the Valradio tuner, or a turret tuner. There are a number of manufacturers' surplus turrent tuners on the market these days, and provided that the unit chosen employs a cascode and triode-pentode circuit to give the gain needed, one of these might represent a profitable buy in this application. The tuner employed is almost certain to have the cathode bias resistor of the cascode brought out to a separate terminal for connection to a gain control; whereupon the r.f. gain control circuit of Fig. 2 may be used. The gain control values shown in Fig. 2 (R_4, R_5 and R_6) should, normally, enable sufficient gain to be obtained at the minimum setting without the input signal falling below the noise level of the mixer.

The i.f. output of the tuner should be at low impedance (that of the Valradio tuner is at 75 ohms), whereupon it may be brought out to the front panel and jumpered over to the input of the i.f. strip. This method of connection enables the i.f. strip to be fed separately, for the reasons mentioned above.

The i.f. strip is quite conventional. No component values are shown for the cathode bias or screen-grid dropping resistors, as these depend somewhat upon the valves employed. A glance at the valve maker's literature (or even at any reliable circuit employing the same valves) will show what is required for these components. The i.f. gain control components shown in the diagram (R_9, R_{10} and R_{11}) should cope with all valves encountered, and the cathode bias resistor for V_1 (R_8), should have the value normally employed when this resistor is returned directly to chassis. The decoupling condensers would normally require a value of some 1,000 pF or so.

The frequency at which the i.f. strip works depends rather upon the output frequency of

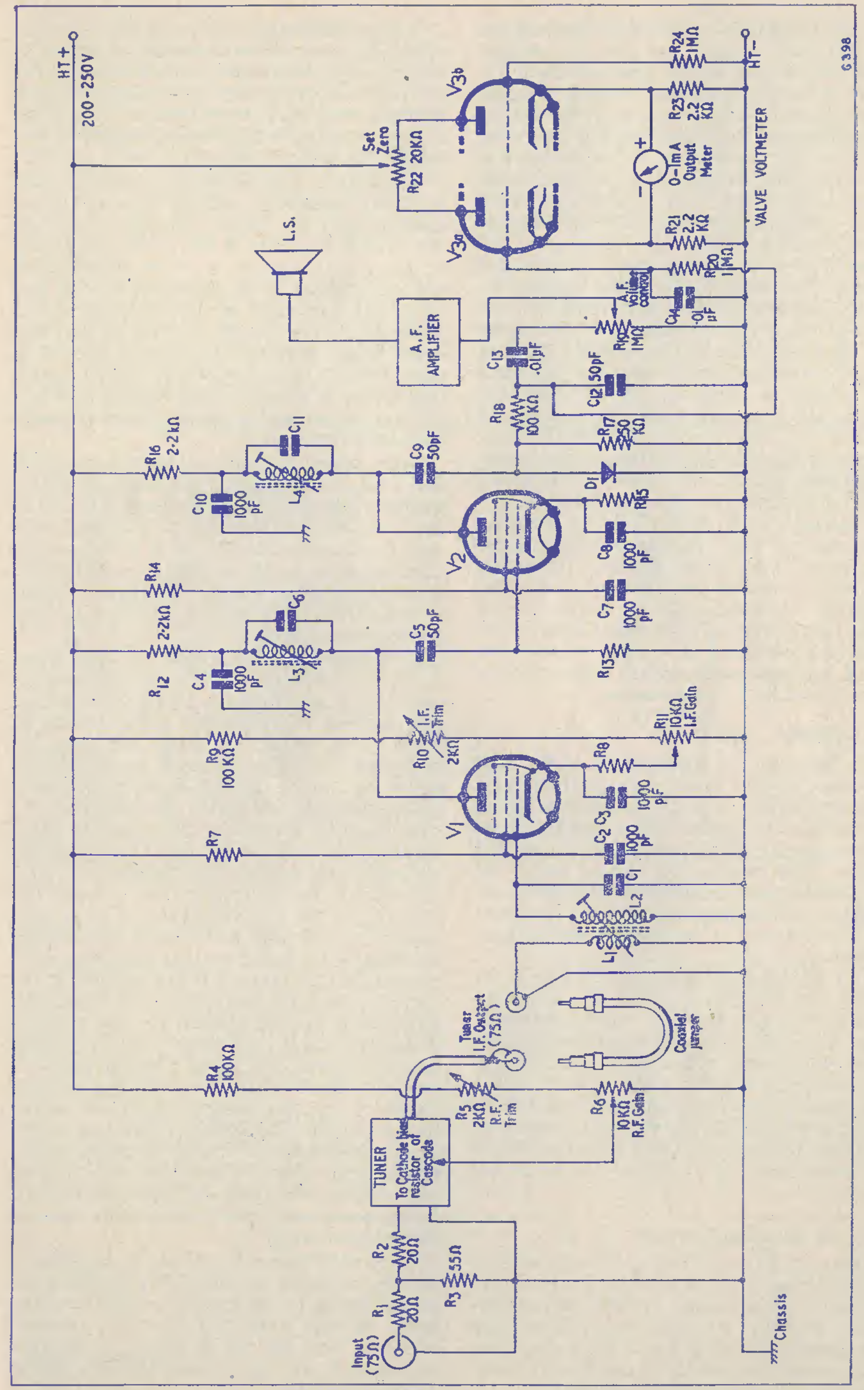


Fig. 2. A practical circuit for a home-built field strength meter.

the tuner employed. Any frequency between 15 and 35 Mc/s should give adequate results. The coils are very simple and can easily be wound at home. The classic method of winding on a few too many turns and then taking these off one by one until the slug can cover the frequency required without entering too far into the coil (where, at these frequencies, it may cause losses) will cope here. Fixed tuning condensers are shown in the diagram (C_1, C_6 and C_{11}) and these may have values below 30 pF or so, or may even be omitted if desired. The shunt-fed coupling between V_1 and V_2 may seem a little unconventional, but this will work quite adequately in practice. The input coil L_1 should be wound on top of L_2 near its earthy end, in order to provide a high degree of coupling. It will probably require about one-sixth of the number of turns in L_2, the number of turns finally selected being that which gives greatest transfer of energy from the tuner. This figure should not prove too critical in practice.

Constructors who do not feel up to tackling the winding of the coils may be able to press commercial coils into service; including, especialy, commercial coils intended for sound i.f. strips. Unfortunately, the writer cannot advise here owing to the fact that a particular i.f. is not specified. Screening between the two i.f. stages may be required if the coils are not mounted in screening cans.

The Detector

The detector is conventional, a high impedance crystal diode, such as the OA71, being employed. The d.c. appearing across the detector is applied to a double-triode valve-voltmeter, this functioning in normal fashion. The resistor R_{22} should be set for zero indication in the meter in the absence of a signal. A reading at half f.s.d. (0.5mA) may then be used as the check point for gain calibration.

The a.f. stage (or stages) is not shown in the diagram as this may be quite conventional. A single output pentode would probably prove adequate, although greater sensitivity would be provided by having a triode voltage amplifier preceding this pentode.

The power supply may also be conventional. Although a regulated h.t. voltage would be an attractive adjunct, the writer feels that this is not really worth the cost in this particular application.

Using an Existing Televisor

As was mentioned earlier, it is possible to employ an existing televisor for f.s. measurements in some instances. If absolute measurements of signal strength are required, the arrangement shown in Fig. 1 (*a*) should give quite reasonable results if the factors mentioned below are taken into account.

It is probable, however, that the televisor would be required for comparative measurements only, whereupon the problem boils down to that of obtaining a reading of signal strength from the receiver circuits. How the televisor is used for this purpose depends upon the circuits which it employs.

Assuming a conventional superhet, there are two places at which a comparative measurement of signal strength may be obtained. These are at the video detector or at the sound detector. For the purposes we are considering here, measurement at the sound i.f. detector is probably the more preferable. The reason for this is that the sound i.f. strip normally employs single-peak tuned circuits (whereupon it is easy to ensure that tuning is accurate) and because it is not difficult to connect a simple signal strength indicating device to it.

Many sound i.f. strips are a.v.c. controlled, the a.v.c. voltage being fed back to an i.f. amplifier valve from the detector. If this is the case, the signal strength indicating device may consist quite simply of a milliammeter inserted in the anode or cathode circuit of the a.v.c. controlled valve. Increased signal strength would then be indicated by a drop in milliammeter current.

If the sound i.f. strip is not a.v.c. controlled, a valve-voltmeter, or a simple home-constructed equivalent such as is shown in Fig. 2 could be connected across the diode load. The sound i.f. strip can then be employed for signal strength measurements either by tuning in the receiver normally (whereupon the indicating device shows the strength of the incoming sound carrier), or by adjusting the receiver oscillator such that the *vision* signal is injected into the *sound* i.f. strip (whereupon the indicating device shows the strength of the vision signal). The second method is preferable when aerial experiments on Band I are being carried out, because it ensures that the aerial is being adjusted at the correct operating frequency. At Band III, however, it might be found that the proportionately small difference in frequency between sound and vision carriers does not make it worth while detuning the receiver oscillator in this manner. (There is the further point, incidentally, that the sound carrier maintains a steady strength during programme hours, whilst the vision signal may vary considerably during such times, it being steady only whilst test cards, etc., are being transmitted).

In some receivers it will not be possible to detune the oscillator sufficiently to enable the vision signal to be injected into the sound strip. In such cases, and when it is intended to work with the vision signal, it becomes necessary to fit an indicating device to the vision i.f. strip.

If the strip is non-a.v.c. controlled, a valve voltmeter or, for that matter, a conventional voltmeter, may be connected across the diode load. A conventional voltmeter is permissible due to the low impedance of the load. Many televisors employ a video amplifier which is working close to cut-off or zero grid bias, and which is directly coupled to the diode load. A conventional voltmeter connected across the anode load of such a video stage will often give a good indication of signal level.

If the video i.f. strip is a.v.c. controlled, a milliammeter may be connected into the anode or cathode circuit of a controlled valve, as was mentioned above for the sound i.f. strip. Where gated a.v.c. systems are employed, comparison with a signal generator output level is not possible when using this system.

The main thing to guard against when using the video i.f. strip for signal strength measurements is that peaks in the i.f. response do not cause ambiguous readings of tuning positions. An ideal video i.f. strip should have a flat-topped response. In practice, however, and especially if the receiver has fallen out of alignment, peaks may occur, these changing in amplitude and, possibly, *frequency*, as a.v.c. voltages vary.

Finally, it should be mentioned that, when a television receiver is used for signal strength measurements, a resistive input pad, at the aerial socket, such as that given by R_1, R_2 and R_3 of Fig. 2, is a desirable adjunct in order to ensure accurate matching.

From our MAILBAG

DEAR SIR,

I feel I must make the following comments on the "Simple EF50 Tester" by "J.P.," described in the September issue.

1. The emission of a valve may be defined as the saturated current that may be drawn from the cathode. In a valve of the EF50 class this may be over one ampere, and the tester described cannot test the emission capabilities of any given sample by taking a few milliamps of current.

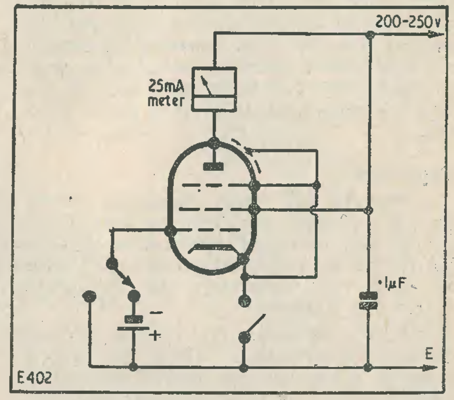
2. A glance at the valve data shows that at $V_a = 250V$, $V_{g2} = 200V$ and $V_{g1} = 0$, the currents will be $I_a = 20mA$, $I_{g2} = 5mA$; these values being consistent with the circuit constants. It will be seen that the anode dissipation will then be $\frac{250 \times 20}{1,000} = 5$ watts.

The makers' rating is 3 watts, so the valve would be heavily over-run and possibly damaged. It was found, however, that the circuit readily oscillated, the anode current then being less than 10mA and very variable.

3. The mutual conductance (g_m) is correctly defined as

$$\frac{\text{change in anode current}}{\text{change in grid voltage causing it,}}$$

all other parameters *remaining constant*. In the described test two big errors occur:



i The grid voltage change is less than 1.5 volts since grid current flows through R_1.

ii The screen voltage will change, due to the variation of screen current.

An improved circuit is as shown here. Readings on the same valve obtained in this and the original are tabulated below.

The readings under V_{g1} are voltages on the grid of the valve. At $V_{g1} = -1.5V$, the new gear runs the anode at a high but safe wattage; at $V_{g1} = 0$, however, it is over-run, and this test should be done quickly to prevent overheating.—R. W. WALDRON, B.SC.

	V_a	V_{g2}	V_{g1}	I_a	I_{g2}	I_{g1}	v_{g1}	g_m
Original	250 250	205 203	0 +1.5	16 16.5	4.5 4.7	0 3uA	0 +0.07	0.3
Improved circuit	250 250	250 250	−1.5 0	13.5 20.5	3.0 5.5	0 0	−1.5 0	4.6

IDENTIFYING AMERICAN COMPONENTS

by ALAN GUY

MOST OF US HAVE BY NOW BECOME familiar with British ex-Government radio equipment and are able to identify components on sight. However, some of the colour coding and serial numbers of American ex-Government parts are not quite so apparent. The following list, though it is by no means complete, will, I hope, serve to identify some of those parts lying in the junk box and enable them to be put to good use.

Capacitors

There are two main American colour codings for capacitors. They are the R.M.A. (Radio Manufacturers' Association) and the J.A.N. (Joint Army-Navy) codings. These all give the capacitance in Picofarads (micro-micro-farads).

R.M.A. 3-dot code. This code is for mica dielectric components. Have the arrows pointing to the right and read off the coding from the left. (This applies for all codes unless otherwise stated.) All capacitors in the 3-dot code have a voltage rating of 500 volts, and are of 20% tolerance. See Fig. 1.

R.M.A. 4-dot code. These are rated as above at 500 volts and are read the same. The dot above the value is the tolerance rating. See Fig. 2.

The R.M.A. 5-dot code. There are three variations of this code, which gives the value, working voltage and tolerance of the capacitor. The first will appear on first sight as a 3-dot coding, but on the back of the condenser are two further dots giving the tolerance and voltage rating. The second type has all five dots on the front, the top two being the tolerance and voltage. The last type looks like a 6-dot code, but one of the dots, usually the bottom centre, is left blank. See Fig. 3a, b, c and d.

R.M.A. 6-dot code. This is used for higher value components and makes use of three significant figures. It is also used for the lower values by leaving some dots blank. See Fig. 4.

R.M.A. code for Tubular Ceramics. The markings on tubular ceramics consist of three broad bands and three narrow bands. They do not follow the normal sequence, in that the first broad band indicates the third significant figure followed by the second and first, multiplier, tolerance and temperature coefficient. All these capacitors are 500 volt working. See Fig. 5.

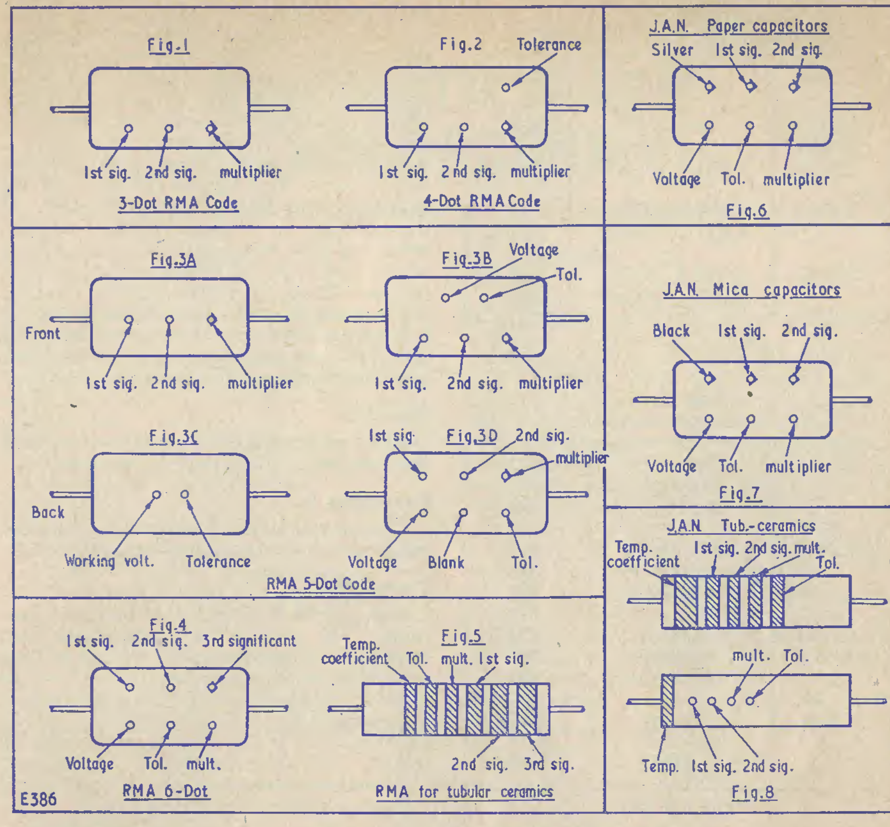
J.A.N. 6-dot code. There are two 6-dot codes in the J.A.N. classification. One is for paper condensers and the other for mica-dielectrics. The paper code is identifiable by the fact that the top left dot is always silver, while the mica code has always a black dot in this position. Otherwise the codings are identical. The top two dots are first and second significant figures, bottom right the multiplier. Voltage rating and tolerance are the other two. See Figs. 6 and 7.

J.A.N. Tubular Ceramics. These tubular capacitors can be coded in two ways. The sequence of the markings is the same in each case. In the banded type they are marked with a broad band followed by four narrow bands. The other is a narrow band followed by four dots. See Fig. 8. As in the case of R.M.A. tubulars, the working voltage is always 500 volts.

Resistors

There are only one or two differences between these and their British counterparts. The main one and the only one recorded here is the instance when there are four bands on the resistance, the fourth being other than a silver or gold band. When blank, the tolerance is 20%. Silver is 10% and Gold is 5%. The other colours in this position indicate intermediate tolerance values. They are as follows:

Brown	1%	Blue	6%
Red	2%	Violet	7%
Orange	3%	Grey	8%
Yellow	4%	White	9%
Green	5%		



Other Markings

Fixed and variable resistors and fixed capacitors under J.A.N. specifications may have a code number instead of a colour code. The value and other information can be found from these numbers by reading the following data:

Composition Resistors

A resistor may have a number as: RC 30 AE 474 M. The first four characters indicate the component and size. RC 30 is a fixed compositiion resistor of 1 watt rating. (See Table 4.) AE is the voltage working. The three figures indicate the resistance value as

TABLE 1

Colour	Significant figure	Multiplier R.M.A. mica and ceramic	Multiplier J.A.N. mica and paper	Multiplier J.A.N. ceramic	voltage
Black	0	1	1	1	
Brown	1	10	10	10	100
Red	2	100	100	100	200
Orange	3	1,000	1,000	1,000	300
Yellow	4	10,000			400
Green	5	100,000			500
Blue	6	1,000,000			600
Violet	7	10,000,000			700
Grey	8	100,000,000		0.01	800
White	9	1,000,000,000		0.1	900
Gold		0.1	0.1		1,000
Silver		0.01	0.01		2,000
No colour					500

TABLE 2
FIXED MICA AND CERAMICS

Case	Range	Volts wkg.
CM20	5–510pF	500
CM25	5–1,000pF	500
CM30	470–3,300pF	500
CM35	470–6,200pF	500
	6,800–10,000pF	500
CM40	3,300–8,200pF	500
	9,100–10,000pF	300

Prefix CM or CC.

TABLE 3
MOULDED PAPER

CN35	3,000pF	800
	6,000pF	600
	10,000pF	400
CN36	3,000pF	400
	6,000pF	400
	10,000pF	300
CN40	3,000pF	400
	6,000pF	300
	10,000pF	300
CN41	3,000pF	600
	6,000pF	600
	10,000pF	400

Prefix CN only.

TABLE 4
RESISTORS

Resistor	watts.
RC10, RC15, RC16 ..	$\frac{1}{4}$
RC20, RC21, RC25 ..	$\frac{1}{2}$
RC30, RC31, RC35, RC38	1
RC40, RC41, RC45 ..	2
RC65	4
RC75, RC76	5

Prefix RC and RA.

for colour codes. The example given above would read 470,000 ohms, the last figure being the multiplier. Variable-wire wound resistors have a similar number, e.g. RA 15 A 1 RH 103 A K. Where RA 15 indicates a w/w resistor of $\frac{1}{4}$ watt rating, A indicates that it has no switch. The figures 1, RH, A and K show torque, shaft, taper and tolerance respectively. The figures 103 indicate the resistance as in the case of fixed resistors. In the example the resistance would be 10,000 ohms. If there was a letter B instead of A it would indicate that there was a switch turned *on* at the start of a clockwise rotation.

The letter R may be substituted after the second figure of the resistance value. This would indicate a decimal point, but the figure after the point would be significant.

Rheostats

The above holds good for rheostats except that the prefix would be RP instead of RA.

Capacitors

There are serial numbers for mica, moulded paper and for ceramic tubular capacitors.

Fixed Mica

E.g. CM 20 B 511 K. CM indicates fixed mica. The number 20 indicates size and shape. B indicates working voltage but is a general figure as shown in table. 511 is the value in picofarads, and K is the tolerance The first two figures are the significant figures, and the third is the number of noughts to follow. 511 would be 500pF. See Table 2.

Working voltages of capacitors above CM40 are stamped on the case.

Moulded Paper

These follow the same system with the prefix CN. See table 3.

Ceramic Tubulars

The prefix for these capacitors is CC with similar following figures. All ceramics have a working voltage of 500 volts. The case figures are the same as for mica dielectrics.

These are only a few of the American notations, but it is hoped that the information will be of use to the many users, like myself, of surplus American equipment.

SCIENCE MUSEUM RADIO LECTURES

The Science Museum Radio Society is arranging a series of appropriate lectures for its monthly meetings at the Science Museum, South Kensington, commencing at 6 o'clock. Membership is open to all Civil Servants and visitors will be very welcome, but are requested to contact, in the first instance, Mr. Voller (G3JUL), Ken 6371, ext. 237. On 11th December there will be a lecture-demonstration entitled The Art and Science of Sound Reproduction by Mr. Hawes of the General Electric Company.

MAGNETIC TAPE RECORDERS

Some design considerations for the Home Constructor

PART 2 by A. BARTLETT STILL

IN OUR DISCUSSION LAST MONTH WE SET down certain basic requirements for the tape recorder we are to design. In order that these may be firmly established in our minds, we shall set them down again as a specification:

1. Frequency response 50–12,000 c/s $\pm$ 3 db.
2. Total record/replay third harmonic distortion not greater than 5%.
3. Noise level more than 50 db down on a fully modulated signal.
4. Input signal at full gain for full modulation to be not greater than 2 mV.
5. Equalising amplifier to deliver not less than 10V at full gain of a fully modulated signal.

It must be said here that not every deck is fitted with heads that will enable us to reach 12 kc/s. Later we will discuss such limitations with a view to obtaining the best response possible.

Looking now at our recording amplifier only, it would seem that we may safely disregard (5), assuming we shall record on the tape the maximum signal allowable. In practice also, if we have guarded against undue tape hiss by careful attention to the bias current used, we may ignore (3). It is proposed, therefore, while considering the recording amplifier alone, to be ruled by (1), (2) and (4), afterwards dealing with the bias oscillator and bias setting separately.

In last month's article we arrived at the record characteristic necessary to obtain the desired frequency response, and we may consider our job well done if we successfully reproduce all which that curve demands.

Unfortunately, as inspection of the curve

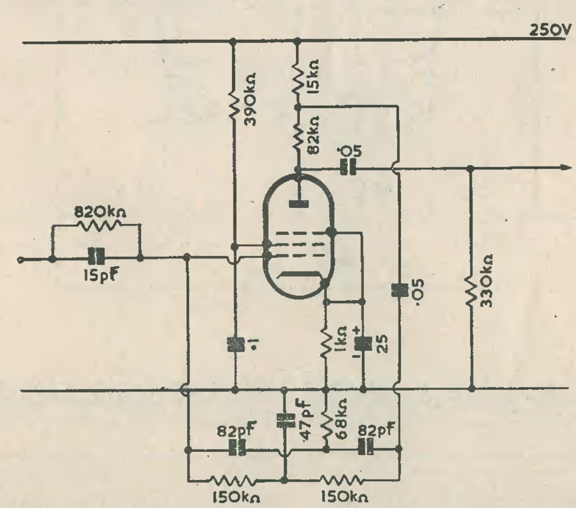


FIG 5. PRE-EMPHASIS CIRCUIT USING BRIDGED-TEE NETWORK.

will show, a conventional "treble lift" circuit will not completely fill the bill; if arranged to give the desired 19 db pre-emphasis at 12 kc/s, there will be rather too much around 7–8 kc/s, with a consequent "hump" at this point on playback. We must also bear in mind the desirability of being in a position, later, to increase the lift at 10–12 kc/s in order to compensate for head wear. What, then, is the answer? There are those who prefer the Bridged-Tee network, applied as a negative feedback chain about a single valve. A suitable circuit employing such an arrangement is shown in Fig. 5. Let us have a look at its performance and see whether it will, in fact, enable us to fulfil our specification. The valve used would be an EF86, Z729, or similar type, and would have a basic gain of 40–45 db. The gain at the point of resonance, in this instance 12.9 kc/s, would be about 26 db. With a gain at the limits well away from resonance of some 8 db we have a total lift of about 18 db, and the point at which we have 3 db of lift works out at about 5.7 kc/s, so it does seem to suit our needs. However, we are left with a high gain pentode giving us a gain at 1 kc/s of only about 2.5 times, but obviously that will have to be accepted. In the writer's submission, though, there are several disadvantages attached to this particular circuit. The "resonant frequency" works out very nicely on paper, but component tolerances being what they are, and not everyone having access to 1% or even 5% resistors and capacitors, the peak may well occur elsewhere. It cannot, either, readily be shifted.

Let us now consider the total gain required. With a medium impedance head, the full modulation audio current required will probably be of the order of 150–200 microamps at 1 kc/s. Due to the fact that the change of head impedance with frequency will tend to oppose our pre-emphasis, it is usual to series the head winding with a sufficiently high resistance to swamp the change. This resistor will serve the additional purpose of decoupling the bias from the amplifier and will generally be about 100kΩ, perhaps 200kΩ. We must then feed the head network with, say, 20 volts r.m.s. at 1 kc/s. This is, in fact, about the maximum if we are to obtain our lift at 12 kc/s without distortion, assuming a 250V h.t. rail. The total gain, then, must be about 10,000 times before pre-emphasis takes effect, resulting in a sensitivity figure of 2.0 millivolts, our specification. We have, therefore, to add on a stage or stages that will give gain of some 4,000 times, and the obvious combination would be a low noise pentode at the front end, with a medium impedance triode bringing up the

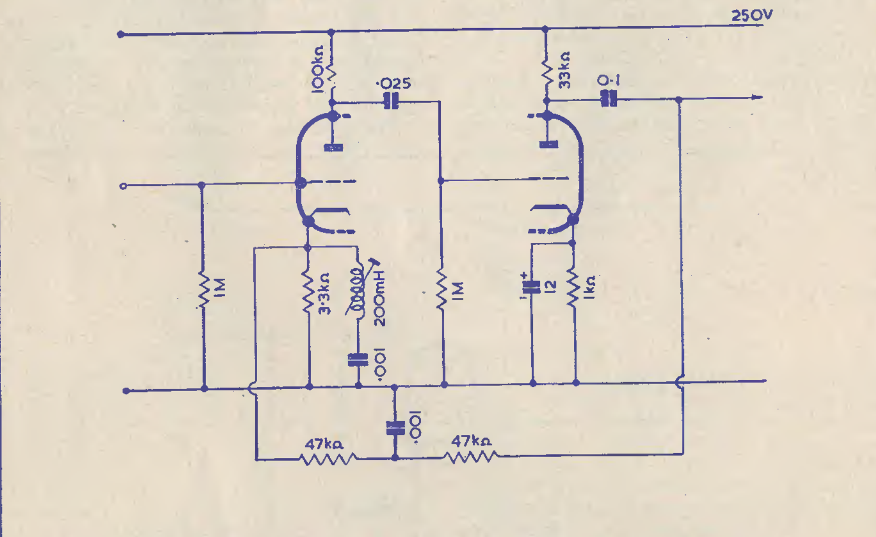


FIG. 6. DOUBLE TRIODE PRE-EMPHASIS CIRCUIT.

rear so to speak. Such an arrangement has, indeed, been used by the writer with moderate success, although the Bridged-Tee network circuit does not easily convert to produce the necessary response on playback, with the result that switching becomes a little complicated. Even less is it adaptable for two- or three-speed working.

Another arrangement is then looked for, and the reader is asked to bear with this discussion, remembering that once the Recording Amplifier has been designed, it must convert to our required replay conditions by the operation of as few switch contacts as possible.

The valve line-up recommended, and one that is used with success in at least one commercial model, consists of a pentode linear amplifier followed by a double-triode, connected in cascade. The necessary frequency correction is applied to the double-triode by means of negative feedback, bringing the normal gain of about 1,000 down to something of the order of 100 at the lower frequencies. In two envelopes only we have achieved the required gain and, what is more, we have used a pentode for small signals only. In consequence the third harmonic distortion introduced by the amplifier is kept very low indeed (*circa* 0.25%), allowing tape distortion to increase in proportion. Put another way, it means more signal on the tape for the same over-all distortion.

The problem we now have is to reproduce the required characteristic by means of a frequency selective negative feedback network. A suggested circuit to accomplish this is given in Fig. 6. It will be seen that treble lift is given basically by the feedback network with the required increase of slope with increase of frequency being provided by a series tuned cathode circuit resonated at 12 kc/s. Such an arrangement can, in fact, be adjusted to reproduce the necessary curve most faithfully. The basic circuit has two great advantages from the practical point of view. In order to change the record characteristic to suit a lower tape speed, parallel condensers may be added in the appropriate places, while to switch to playback a second feedback chain is selected. So far, the switching to be incorporated in our finished recorder has been kept to simple proportions.

A word now about coupling to the record head. It has already been mentioned that the signal is fed to the head through a high value of resistance. For a medium impedance recording head a single resistive chain of about 100–150kΩ suffices; but with a high impedance head that perhaps approaches that figure at the higher frequencies, it is advisable to shunt the resistor with a suitable con-

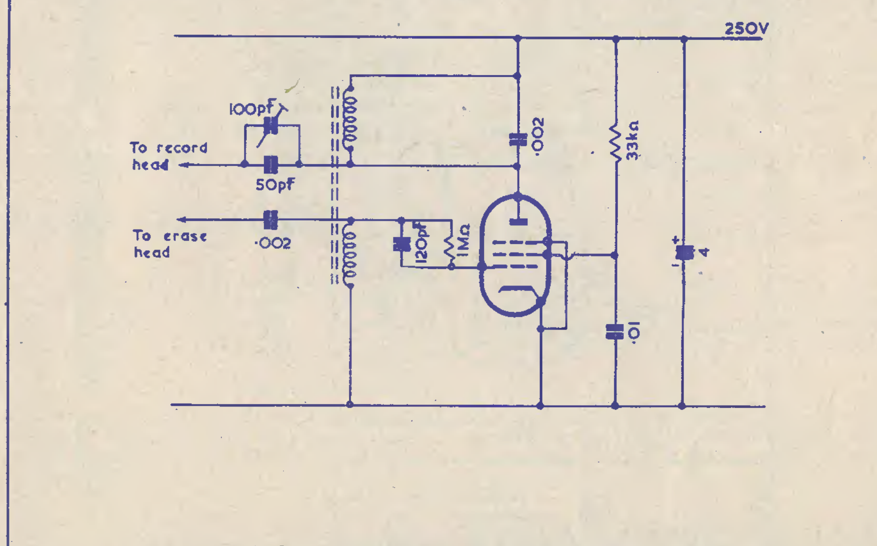


FIG. 7. A TYPICAL BIAS OSCILLATOR CIRCUIT.

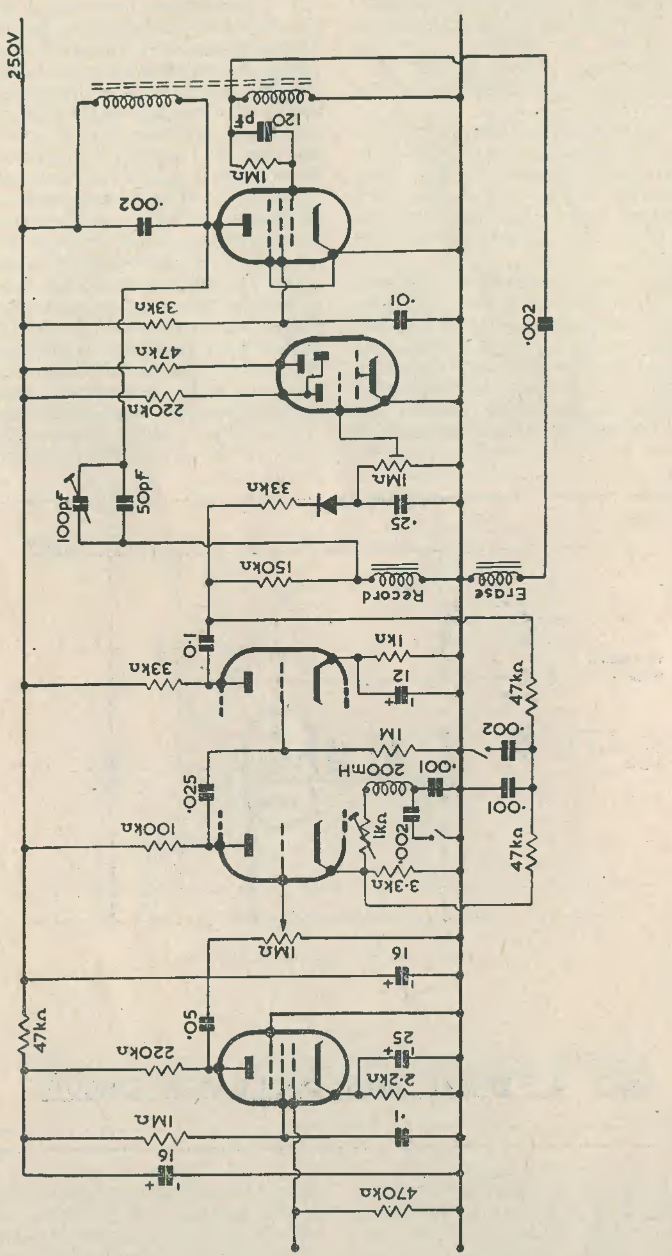


FIG. 8. BASIC RECORDING AMPLIFIER COMPLETE

denser to attempt to keep the total impedance, and consequently the audio current, constant except for the desired pre-emphasis.

The bias oscillator may be of almost any conventional type, though it is believed that the two circuits that have found most favour are the Hartley and the Tuned Anode, Grid Coupled. A suitable circuit of the latter type is shown in Fig. 7, and it will be seen that the bias is condenser coupled to the head directly from the valve anode, the variable component allowing us to adjust the bias to the correct level. A word of warning with regard to this coupling. Do ensure that the voltage and power rating of the condenser is adequate, since a breakdown will feed h.t. directly through the head, with expensive results. The erase head is capacitively coupled to the grid and presents no problem, provided sufficient power is available for full erasure. The efficiency of the erasing circuit may often be improved by tuning the erase head to the oscillator frequency. The correct value of the shunt condenser, however, will no doubt have to be found by experiment. Due to the fact that the correct setting of the recording bias cannot be obtained without the co-operation, so to speak, of the replay amplifier, this subject will be dealt with in the concluding article.

The double-triode valve, in addition to feeding the recording head, would normally be expected to drive the power amplifier. Whether this be a single output pentode, or something more complicated, it will probably be found that the signal level for a good recording is rather too high for comfort! Attenuation will, therefore, be required which may be fixed, and switched in on "Record," or some form of monitor volume control may be fitted.

One last item remains for our consideration in connection with the recording amplifier. The choice of recording level indicator is largely a matter of personal taste; those who believe in meters would never dream of using a magic eye, and vice versa. The writer, without wishing to enter into any arguments on this point (having heard a few!) would suggest, nevertheless, that a magic eye is usually cheaper, takes up less room, and, being inertialess, responds more quickly.

Fig. 8, therefore, is our complete recording amplifier. Note that no switching has been included such as would be required to convert for playback purposes. The frequency correction is as discussed earlier; but as in this case we are catering for 7½in/sec and also 3¾in/sec, close the switch contacts for the latter. A pre-set resistor has been included in series with the tuned circuit in order that the "lift" may be controlled.

Next month we will attempt the transformation into a replay amplifier of this valve line-up and basic circuit, and consider some of the pitfalls that may arise.

Can Anyone Help?

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

L. Cooper, 25 A.M.Q., Gatenby, near Northallerton, Yorks, requires information on an Emerson midget radio, valve line-up 12SF5, 12K7, 12J5, 50L6, 35Z5.

* * *

I. A. Williams, Hut A, Llangwyfan Hospital, Denbigh, wishes to buy, borrow or hire a circuit diagram for the MCR1 receiver and power pack.

* * *

P. J. Orchard, 98 Alberta Avenue, Cheam, Surrey, wonders if any reader has alignment data for the R.1155 communications receiver. He is willing to purchase, if necessary.

* * *

V. O'Connell, 28 Hillcrest Avenue, Queensbury, near Bradford, Yorks, is urgently in need of the valve line-up, manual, circuit or any data on the Eddystone B.34 (Naval) receiver. Would purchase. All letters answered.

R. Burgess, 82 Bressey Grove, South Woodford, London, E.18, wishes to borrow or purchase the Service Manual of a Murphy A4ORG receiver (not the circuit diagram).

* * *

R. G. Haseler, 30 Acheson Road, Birmingham 28, is in need of information on converting the ex-WD R.1584 unit to an F.M. Tuner.

* * *

G. V. Haylock, G2DHV, 63 Lewisham Hill, London, S.E.13, wishes to obtain a copy of the pre-war "Jones Handbook."

* * *

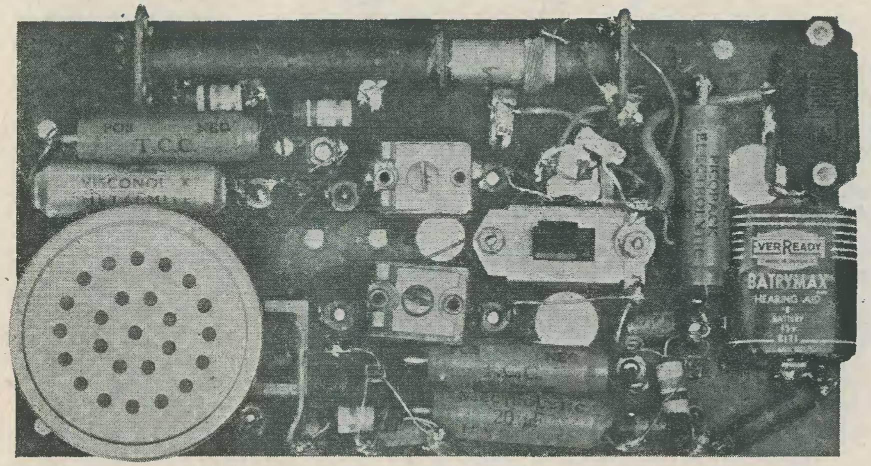
The Editor would like to purchase a copy of "CQ" containing modification data for the Pitch Prop Motor. Can anyone help?

* * *

L. Taylor, 60 Headley Park Avenue, Bristol 3, wishes to borrow any data available on the DST.100. Expenses paid.

The "EAVESDROPPER"

A miniature transistor receiver for local-station reception



PART 1

by **W. G. MORLEY**

SINCE TRANSISTORS FIRST BECAME AVAILABLE on the British home-constructor market, a great deal of interest has been shown by amateurs in building equipment which takes advantage of their unique properties. Perhaps the most attractive features of transistors are their small physical size, together with their modest power requirements; and these two factors make the construction of really miniature equipment a very profitable proposition.

This article is the first of two describing a simple receiver which employs three transistors, and which has been designed to have as compact a layout as is possible with readily-available components. Particular attention has been paid to achieving a layout that enables the set to be fitted into a small shallow cabinet, the outside dimensions of the chassis being only 6½ inches long by 3½ inches wide and 1 inch deep. The shallowness, incidentally, is perhaps the most useful feature of the layout, since it enables the complete receiver to be slipped comfortably into a pocket. As may be seen from the photographs accompanying this article, the flat layout has been achieved by mounting all components in a single plane on a sheet of Paxolin.

Two methods of tuning the receiver are possible. In the version illustrated pre-set tuning is employed, a miniature two-way switch selecting one of two stations. If desired, a conventional tuning condenser can be employed in place of the pre-set arrangement, but this has the disadvantage of requiring a knob which may protrude over the level of the surface of the receiver cabinet. The station selector switch employed in the pre-set version does not protrude in this fashion because, in company with the on-off switch, its control slide can be made to lie virtually flush with the cabinet surface.

The receiver employs a ferrite frame aerial which is capable of giving quite adequate sensitivity in districts where reasonable local station signal strength is available. If

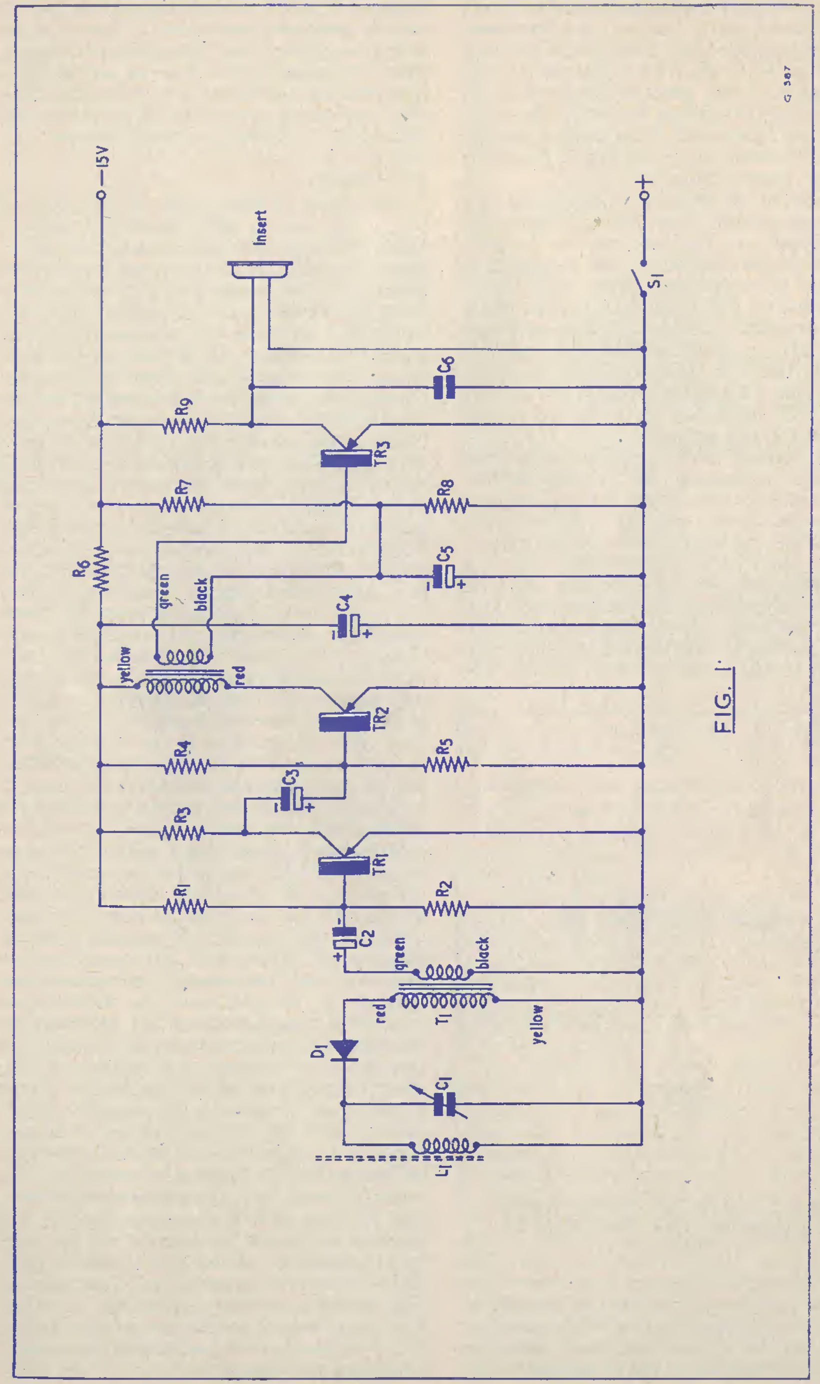


Fig. 1. The circuit of the "Eavesdropper"

desired, sensitivity may be increased by fitting a short aerial some four or five feet long. Should it be needed, this aerial could be made integral with a shoulder strap or similar accessory, and this point is discussed later. An aerial was not found necessary for reception of the Home and Light programmes in the London area, the ferrite frame providing sufficient signal pick-up.

The output of the receiver is applied to a crystal microphone insert which functions as a loudspeaker. The microphone is quite sensitive in this application and is capable of handling a surprisingly large amount of volume before any overloading takes place. Under domestic conditions the microphone should give an output adequate for normal listening; whilst in noisy localities the whole receiver may be held close to the ear, its light weight and small size incurring no fatigue when held in this manner.

It was decided, after a considerable amount of thought, to dispense with a volume control. The grounds for this omission were that such a component would take up valuable space, and that the projection of its spindle from the cabinet would be a disadvantage. The lack of a volume control does not incur any great difficulty in operation; if a received signal has too high an amplitude this may be reduced by simply turning the set so that less pick-up is given by the ferrite frame.

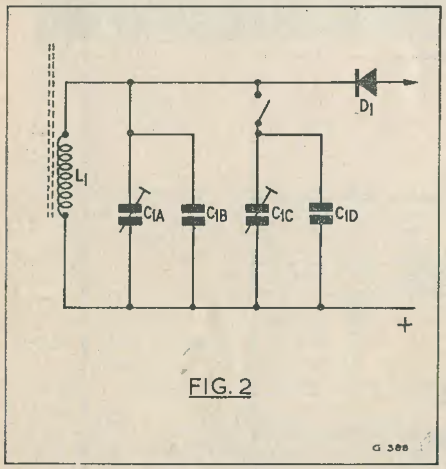


Fig. 2. The alternative tuning arrangement employed in the pre-set version

To sum up the main factors influencing its design, the "Eavesdropper" is a receiver which has been kept extremely small in physical size despite the use of standard parts (except for the two transformers), and which can be employed anywhere for local station reception. The name "Eavesdropper," itself, gives something of a clue to its adaptability. It was chosen after the prototype had been used on many occasions in an office for picking up the latest Test match scores!

The Circuit

The circuit of the receiver is illustrated in Fig. 1. As may be seen, this is fairly simple, although care has been taken to obtain maximum performance from the components employed. The ferrite frame L_1 is tuned, in this diagram, by the tuning condenser C_1. As was explained above, this method of tuning may be employed, if desired by the constructor, it suffering only from the fact that the requisite tuning knob protrudes from the cabinet. The alternative, pre-set, method of tuning is illustrated in Fig. 2. In this diagram $C_{1(a)}$ and $C_{1(b)}$ are permanently connected across the ferrite frame, the switch introducing extra capacity (hat of $C_{1(c)}$ and $C_{1(d)}$ in parallel) when it is closed. Condensers $C_{1(a)}$ and $C_{1(b)}$ are intended to be adjusted to tune the higher frequency station of the two transmitters desired, whilst $C_{1(c)}$ and $C_{1(d)}$ are then adjusted to tune the lower frequency transmitter. In the prototype $C_{1(a)}$ and $C_{1(c)}$ were 100pF (nominal) trimmers, whilst $C_{1(b)}$ and $C_{1(d)}$ were 40pF ceramic condensers. These values correspond to the capacities needed to receive the Home and Light programmes in the London area. In other parts of the country it may be necessary to vary the values of $C_{1(b)}$ and $C_{1(d)}$ in order to bring the desired stations within the range of the trimmers.

Referring back to Fig. 1 again, the ferrite frame is coupled via diode D_1 to the transformer T_1. D_1 is a high impedance crystal diode, and the tuned circuit damping introduced by this component, together with the primary of T_1, is small. It was found, in practice, that no marked advantage was obtained by tapping down the ferrite frame coil, or by using a coupling coil, to supply the diode circuit, and so the simpler arrangement shown in the diagram was employed. D_1 detects the signal picked up by the ferrite frame, and allows the consequent a.f. to appear across the primary of T_1. The self-capacity in this primary is sufficient to by-pass r.f. and no further filtering is required.

Transformer T_1 is a step-down component, and enables the high impedance of the detector circuit to be matched to the lower input impedance of the first transistor TR_1. The a.f. from the secondary of T_1 is passed to TR_1 via the condenser C_2, in order to enable bias to be applied to the base of this transistor. The two resistors R_1 and R_2 help in stabilising the bias current.

TR_1 is operated in the earthed-emitter mode, as are the other two transistors in the receiver. This method of working provides a high degree of amplification and has the further advantage of enabling h.t. and bias supplies to be obtained from a single battery. TR_1 couples directly into TR_2 via C_3, whilst TR_2 is connected to the primary of a further step-down transformer T_2. It will be noticed that the h.t. supply to TR_1 and TR_2 is decoupled by R_6 and C_4.

The output transistor feeds into a resistive load, R_9, across which the crystal microphone insert is connected. The capacitive loading presented by the microphone is not of great consequence at the low impedance at which the circuit operates and, within its response range, the microphone reproduces the audio voltages developed across the resistive load, R_9. As there is no direct connection through the microphone itself, it is possible to connect it in the manner shown in the diagram; i.e. between collector and h.t. positive. The a.f. circuit from R_9 to the microphone is then completed via the h.t. battery. Condenser C_6, connected across the microphone, applies a certain degree of tone-correction, helping to reduce also the slight background hiss given by the transistors.

As will be seen from the above, the circuit of the "Eavesdropper" is not at all complicated, and it should, therefore, not cause any great difficulties when it is put into practical form.

Construction

Due to the inherent stability given by the circuit of this receiver, the question of layout does not become as critical as it might be with more complicated equipment. Nevertheless, layout is still of importance, if only to ensure that components are positioned such that a compact assembly results. It is also, of course, necessary to ensure that instability does not result due to injudicious placing of input and output components in relation to each other.

The layout employed for the prototype of this receiver is recommended for those who wish to construct it because, to the writer's mind, it represents a good approach to a shallow single-plane chassis. It employs several techniques which may be a little unfamiliar to the amateur who is used to working with metal chassis, but these do not entail any extra degree of skill on his part. The major differences encountered are the fact that the chassis is formed by a single sheet of Paxolin, that the transistors and transformers are recessed in this material, and that solder tags are mounted on the chassis at the points where they offer greatest convenience to the circuit. It is, in fact, true to say that the chassis design employed for the

Components List

Resistors

R_1	47 kΩ } will saturate Tr1 !
R_2	30kΩ
R_3	6.8kΩ *
R_4	220kΩ
R_5	30kΩ
R_6	10kΩ
R_7	220kΩ
R_8	10kΩ
R_9	5kΩ

Condensers

C_2, C_3, C_4, C_5	20μF 12 WV
T.C.C.	"Picopack"; or 25μF
12WV	Daly H2–11/2
C_6	0.05μF T.C.C. "Metalmite"
Continuous tuning version:	
C_1	500pF variable, solid dielectric
Pre-set tuning version:	
$C_{1(a)}$, $C_{1(c)}$	100pF Trimmer
$C_{1(b)}$, $C_{1(d)}$	see text

Other components

L_1	FRM (MW) Ferrite rod Aerial, Teletron Co. Ltd.
TR_1, TR_2, TR_3	P.N.P. Junction transistors, Red Spot, Henrys Radio.
T_1, T_2	5 : 1 Interstage transistor transformers, Henrys Radio
Microphone	Insert Acos type 6–12, or similar
D_1	Crystal diode type OA71, Mullard
Battery	15 Volt, type B121, Ever Ready
Switches	Henrys Radio, or Bulgin S.591

"Eavesdropper" is similar to that used for commercial transistor receivers. It represents, therefore, an example of modern commercial design.

The basic element of the chassis is the Paxolin sheet from which it is constructed. This is illustrated in Fig. 3, in which diagram the positions of the various holes required are illustrated. The Paxolin sheet employed needs to be fairly thick, in order to provide sufficient strength. A thickness of $\frac{1}{16}$ to $\frac{1}{8}$ inch is recommended.

The holes in Fig. 3 have been given letter designations. The holes marked "A" are intended for mounting solder tags. It is anticipated that most constructors will wish to employ 6-BA tags here, these being held by 6-BA nuts and screws. If this is the case it would be advisable for all holes marked "A" to be drilled out 6-BA clearance (No. 32 drill). Some constructors, however, may prefer to employ eyelet tags, these being eyeletted to the chassis and giving a more "professional" finish. In such an instance, the holes drilled should have the diameter applicable to the particular eyelet tags used. As will be shown later, some of the tags will

* See March 1957 p557 where R1 = 220kΩ and R3 = 2.2kΩ but this will still saturate Tr1!! R2 should also be changed to about 3kΩ. JBS 1.X.10

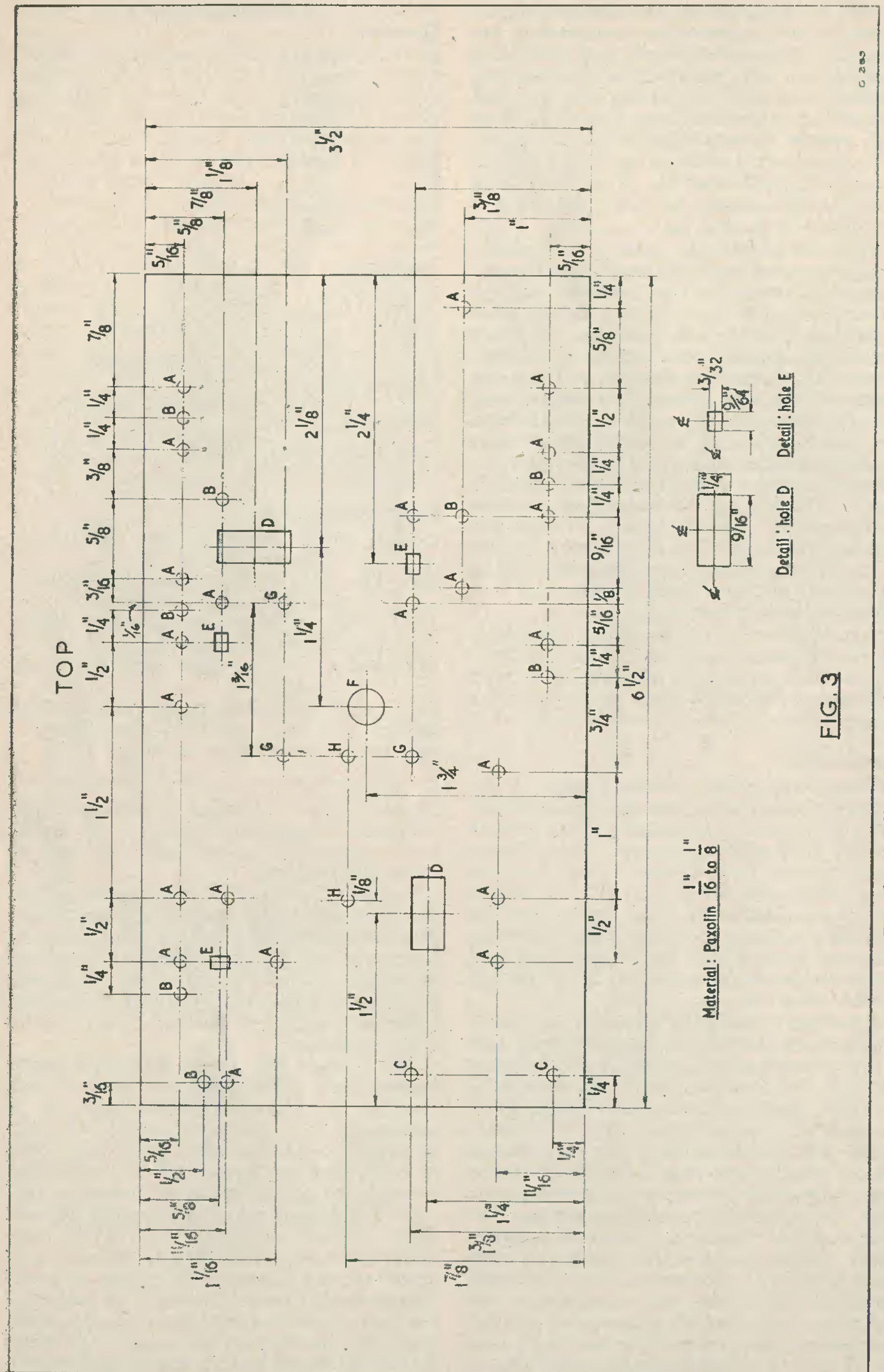


Fig. 3. Drilling layout for the "Eavesdropper" chassis

need to be double, and some single, types. This should cause no difficulty so far as the 6-BA tags are concerned, as, if necessary, two single tags may be held under one bolt head to form a double tag; or double tags can be cut down to single types where required. The latter remark applies also to double eyelet tags.

The holes marked "B" in Fig. 3 are used to allow the passage of wires through the chassis. A hole diameter of approximately 3/32 in. should cope comfortably here. These holes will not be required if eyelet tags are employed as the appropriate wires may pass through the eyelets themselves. In the wiring diagrams which follow in the second article, it will be assumed that the leads pass through the holes "B"; the appropriate changes incurred by passing them through the eyelets being obvious.

The two holes marked "C" are employed for holding the on-off switch, and should be drilled out 6-BA clearance.

There are two rectangular holes in the chassis marked "D." They are intended to take the transformers T_1 and T_2, these being mounted in the manner shown in Fig. 4. The holes should be filed out such that the transformers can be fitted in comfortably without the use of any force which may result in damage. If made carefully, the holes will enable the transformers to be held quite securely without any other means of mounting being needed at all. The transformers could be sealed in position finally with a little adhesive, if this is desired.

The holes marked "E" apply to the transistors. These are fitted in the manner shown in Fig. 5. The transistors should be a sliding fit in the holes, as their lead-out wires keep them in position. The transistor holes are 3/32 × 9/64in. but, due to the difficulty of working to dimensions of this size, it may be found easier merely to increase the size of the initial hole until the appropriate transistor fits comfortably. In the two right hand holes of Fig. 3, the longer dimensions are horizontal (i.e. parallel with the longer side of the chassis). In the left hand hole the longer dimension is vertical.

The hole marked "F" is required only if a tuning condenser, as shown in the circuit of Fig. 1, is to be employed. The hole takes the tuning condenser bush, and should, for normal components, have a diameter of 3/8 inch. If the tuning condenser is to be employed, holes "G" and "H" should *not* be drilled out.

On the other hand, if the receiver will be employing pre-set tuning (as in Fig. 2) it is hole "F" which should not be drilled. Holes "G" take three further solder tags and may be either 6-BA clearance, or capable of taking eyelet tags, as desired. Holes "H" will be used for mounting the station selector switch, and should be 6-BA clearance.

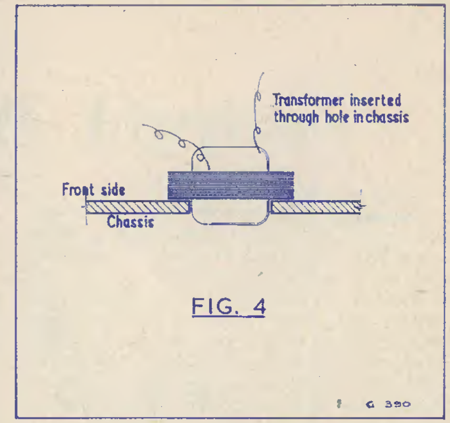


Fig. 4. The method of mounting the interstage transformers

Mounting the Tags

After all the holes have been drilled or cut out, the next step consists of mounting the tags. These are fitted as shown in Fig. 6, their type (i.e. single or double) and their orientation being clearly shown in this diagram. The tags should stand up vertically from the surface of the chassis. When 6-BA tags are employed, the screw heads should be on the front side of the chassis (i.e. the side on which the tags appear), the nuts being underneath. Short screws should be employed so that they do not project to any great distance outside the level of the nuts.

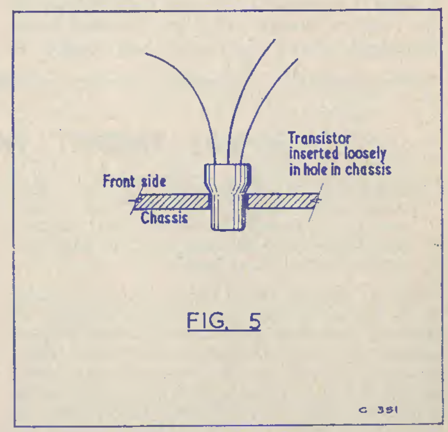


Fig. 5. Illustrating how the transistors are fitted

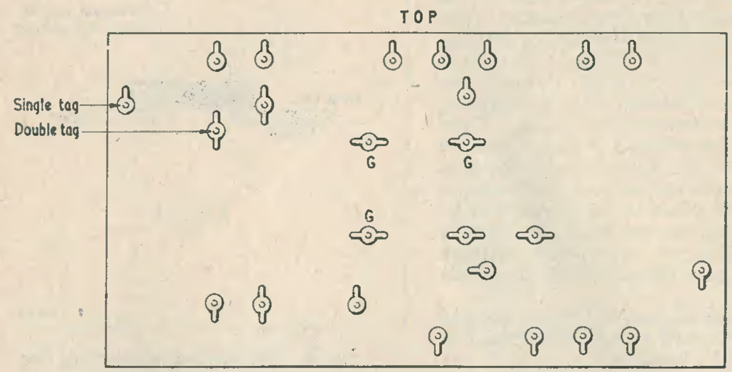


FIG. 6

G 392

Fig. 6. The solder tags fitted to the chassis take up the positions shown here

It is important to ensure that all tags are fastened down tightly. The three tags marked "G" are those which are fitted to the similarly-lettered holes of Fig. 3. They are not, of course, needed when a tuning condenser is employed.

The Switches

Note that the switches used in the prototype are Henry's Radio types, and employ 1½-in mounting centres on the chassis shown in Fig. 3. An almost exact alternative is the Bulgin type S.591. This employs the same chassis mounting holes, but requires a simple bracket to enable it to be fitted into the receiver layout. This bracket will be described in the next article.

Next month

In next month's issue we shall carry on to the process of assembling and wiring this little receiver.

For the SHORT WAVE ENTHUSIAST

CERTIFICATES AND AWARDS. 40 pages. Published by the Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1. Price 2s. 6d., post 4d. (50 cents, post free in U.S.A. and Canada.)

This is claimed to be the first handbook of its kind in the world. It contains full details of about 80 operating certificates and awards issued by member-societies of the International Amateur Radio Union, and by certain journals. For those who are looking for other fields to conquer this book is invaluable, and it should also provide the incentive for those who have not yet gained a DX award of some sort. For these latter in particular, the useful notes headed as a Guide to DX Operating will be of value. A survey of the many awards and certificates listed leaves one with the impression that a study of the book and a check through QSL cards ought to be the means of many operators obtaining wallpaper for the shack.

AUSTRALIAN RADIO AMATEUR CALL BOOK —1956. 152 pages. Compiled and published by the Wireless Institute of Australia, Victorian Division, C.O.R. House, 191 Queen Street, Melbourne, C.1, Australia. Price, A4s. 6d.

Not unlike the R.S.G.B. call-book in some respects, this is chiefly a listing of the VK amateur stations. The reproduction of licensing conditions is useful information. There is a list of countries, prefixes and zones; a list of QSL bureaux; and a list of DX awards obtainable from various parts of the world.

Technical Forum

A Method of Modifying a Standard Audio Amplifier for use with a Tape Deck—Part II

IN THE LAST ISSUE WE DISCUSSED THE additional items necessary to convert an existing audio amplifier to function with a tape deck. This month some practical details of the connection of the recording head and the level indicator will be given. These two items are kept together as they are fed from the same point in the amplifier. The advantage of this is that by simply adjusting a single series resistor and using the level indicator as a guide, the correct operating conditions for the recording head are readily obtained.

The Recording Head

Most of the popular tape decks on the market at present are fitted with high impedance heads. By this is meant a head which has an impedance of 40kΩ at a frequency of 10 kc/s. Such a head would draw a signal current of about 200μA at the optimum recording level. To ensure that this current is maintained at a reasonably constant amplitude regardless of the signal frequency, the head is fed from a high impedance source. This condition is obtained by the use of an R–C network in the feed line to the head which also serves to prevent the bias voltage from reaching the level indicator and upsetting the reading. The circuit of the indicator, oscillator and head switching arrangement is shown in Fig. 1. The feed to the head is taken from the anode of the output valve in the main amplifier; in the case of a push-pull amplifier the anode of either output valve may be used. The only minor modification required to this part of the amplifier is to arrange for a speaker muting switch S_{1a} to isolate the speaker during recording. The switch must have contacts of the "make-before-break" type and is used to select either the speaker or a dummy load resistor. The resistor has a value equal to the speaker impedance (3 or 15 ohms) and a wattage of about half the rated output of the amplifier.

The single switch shown in the circuit diagram is of the 6-pole 3-way type, but if necessary a 6-pole 2-way unit could be employed by dispensing with the "erase" position. This is a small refinement which many constructors might feel is unnecessary, and its removal may enable the switch unit provided with some tape decks to be employed without modification.

A word of warning regarding the hum level should be added at this stage. In some audio amplifiers the anode of the output valve is fed from the first reservoir capacitor in the h.t. smoothing filter, and in certain cases the hum level at the anode can be rather high. If this trouble is encountered it may be possible to feed the recording head from the anode of the previous stage, but if the signal available here is inadequate additional h.t. smoothing should be added to reduce the hum at the output valve. This is achieved by including a 10H smoothing choke in series with the smoothing resistor in the h.t. filter. Some adjustment of this resistor may then be necessary to return the h.t. voltage to its original value.

The Oscillator

The oscillator is of conventional design and is intended to operate at a frequency of about 60 kc/s. It performs the dual function of erase and bias, supplying about 2 watts of power to the erase head and around 1mW for bias. The erase head is in use during the whole of the recording time to ensure that the tape is "cleaned" before use. A capacitor C_1 is included across the h.t. supply to the oscillator to allow the oscillation to die away gradually when switch S_{1b} is opened. Any sudden cessation of oscillation might leave the heads permanently magnetised, with a consequent loss of performance.

The circuit as shown in Fig. 1 is suitable for use with oscillator coils made by either Collaro or Brenell, and will match the erase heads found on the tape decks made by these two companies. Minor modifications are required for the coils made by Lane or Truvox, and these are shown in Fig. 2. It is important that the correct oscillator coil for the tape deck is employed.

If these precautions are observed the correct erase level will be obtained, but should it be necessary to check it the current in the head should be measured. This current will be in the region of 1mA if all is well, but because of its high frequency direct measurement is not easy. Perhaps the best indication is obtained by connecting a 100 ohm resistor in the earthy lead to the coil and measuring the voltage across it with a suitable voltmeter, one capable of reading 0.1V at 60 kc/s being required.

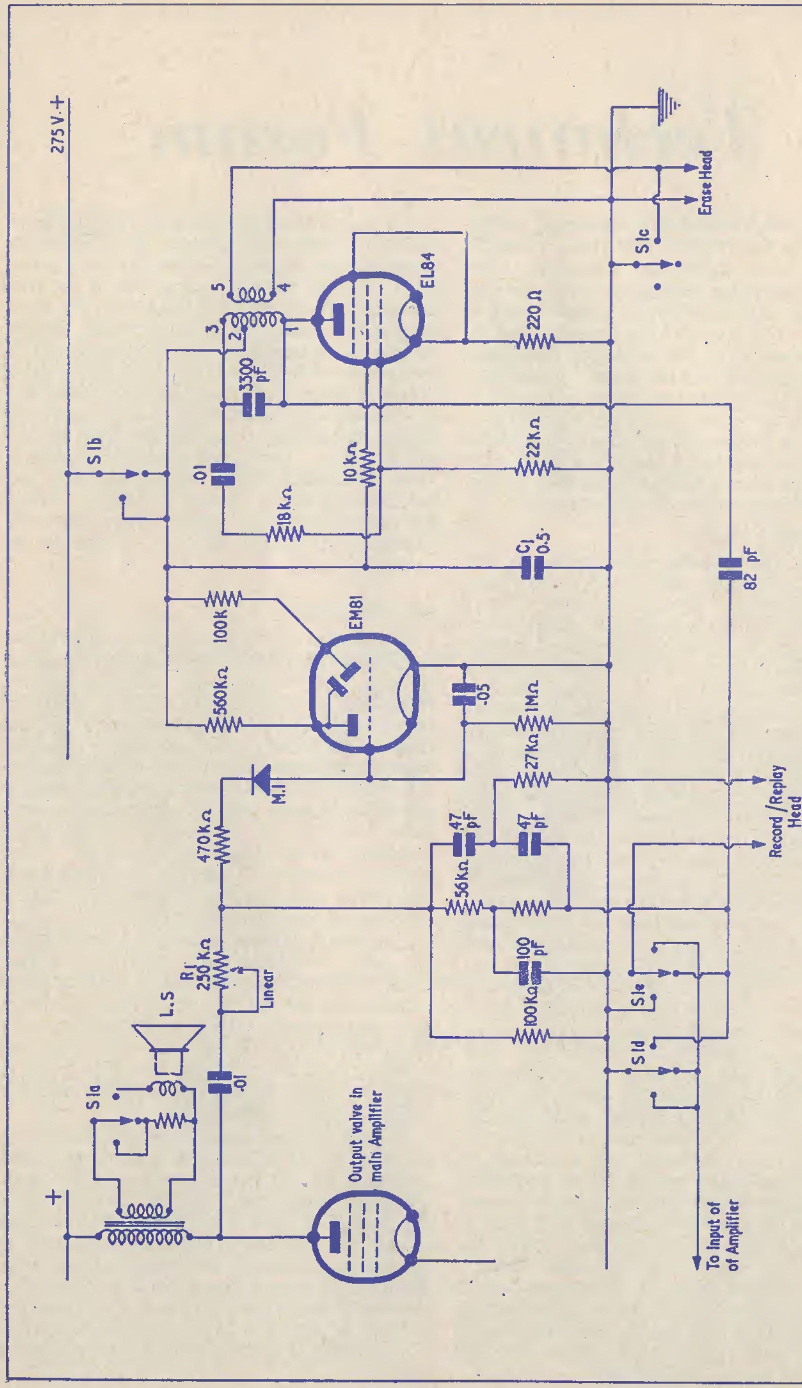


FIG. 1 Connections for the heads, indicator and oscillator. Switch shown in record position. M.1 is a miniature 50V selenium rectifier or germanium diode type 0A71

Level Indicator

A conventional type of tuning indicator is employed for indicating the recording level. A small selenium rectifier is used to rectify the recording signal so that it may be fed as d.c. to the control grid of the indicator. A resistor is included in series with the rectifier to eliminate any damping which the rectifier would otherwise impose upon the signal circuit. As the indicator is connected directly to the filter feeding the recording head, it is possible to use it when initially setting-up the pre-set resistor R_1. The procedure adopted in setting this resistor is as follows: Turn the gain control on the main amplifier up about 30% and feed a typical signal into the amplifier. Then adjust

The indicator is fed from the same switched h.t. line as the erase oscillator so that it is extinguished when S_1 is in the play-back position. This provides a ready indication of the position of S_1.

The circuit as shown in Fig. 1 is complete but for the input equalising amplifier which will be described next month. This additional amplifier stage goes between the play-back head and the input to the main amplifier, and its function is to correct for recording characteristics as explained in the last issue. The output from the head when used for replay is in the region of 1mV, and if the main amplifier has adequate sensitivity tolerably good results will be obtained without the equalising stage.

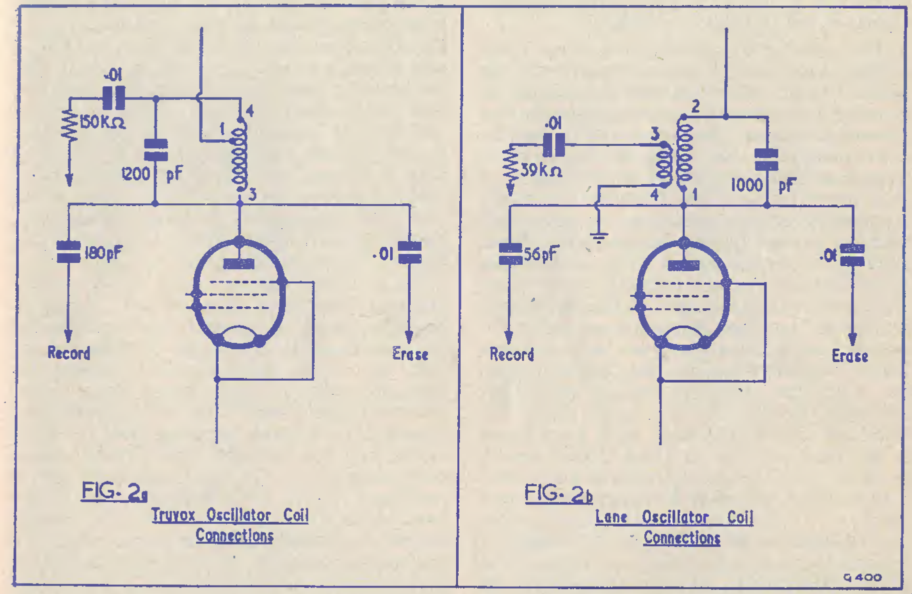


FIG. 2a Truvox Oscillator Coil Connections

FIG. 2b Lane Oscillator Coil Connections

R_1 until the petals of the indicator just close on the higher sound peaks. Under these conditions the recording level should be set to optimum, a condition which occurs with 20 volts of signal on the output side of R_1.

To keep the noise level as low as possible, the lead to the input of the amplifier should be screened and the contacts forming S_{1d}, S_{1e}, and S_{1f} included on one wafer which should be screened from the remainder of the switch. S_{1f} will be shown on next month's diagrams.

New Bulgin Catalogue

We have received a copy of the latest 140-page Bulgin catalogue of Electronic Components, list No. 196. Straightaway we solved a problem of where to obtain a certain component, and have no hesitation in suggesting that all our readers would do well to send for a copy. Several hundred components are listed and illustrated, and dimensions are given. The price is 1s. post free, and the address is A. F. Bulgin & Co. Ltd., Bye-Pass Road, Barking, Essex.

Radio Miscellany

ANOTHER YEAR HAS SIMPLY FLOWN BY—perhaps the absence of a summer made it seem shorter!—and once again it is my pleasure to wish you the Season's Greetings. May all your constructional efforts in 1957 be 100% successful.

The passing of another year marks the twentieth since my *nom-de-plume* first saw the light of print. The fact that it has kept on running has to me been a constantly recurring cause for wonder. It started with a monthly commentary in the original *Short Wave Magazine* under the eloquent persuasion of that lively Editor, Basil Wardman, G5GQ. I agreed to tackle it until someone who could make a "proper job of it" came along. Since then it has grown on me. Up to that time I had written, at odd intervals, only a few constructional articles, etc. A regular feature, which had to have entertainment value for both expert and beginner, seemed a very tall order. In fact I tore my first few efforts up for fear that someone should see them! However, G5GQ, and to a lesser degree the late Stan Clark, G2AMW, must have found a lot more promise in them than I could, because with their encouragement and a little arm-twisting, I kept at it for another month or two. To my greater amazement quite a few readers seemed to like it! A couple of months later I was sure there was nothing else left to write about. Yet something more was expected of me, so I decided to note what the chaps at the local clubs chatted about when they got together.

That Second Hobby

With this line of thought I tried to recall just what they did talk about. As far as I could recollect it seemed to be almost every subject under the sun—sometimes even radio!

What do *you* chat about when you have a get-together with your fellow hobbyists? Unless you are very much off the average, my guess is that it's about the "fringe" subjects, especially the points where radio overlaps into other hobbies.

My first radio club, which, incidentally, flourished under the title of a "society," I joined as a youngster in the early days of broadcasting. Receivers of that period were extremely simple, with home-wound coils in solenoid form and everything well within the scope of the tyro handyman. They not only made sets for themselves, but for all their relatives and most of their neighbours. At that time commercially made sets were few—and expensive—and a royalty of 7s. 6d. per valveholder was due. Hence, few listeners had factory-built receivers. Their sets were "unofficially" made for them on the promise that if anyone asked they were to say they built it themselves! Quite who would have believed that so many dear old maiden aunts had built those queer looking contraptions was beyond my imagination. Fortunately, as far as I know, nobody asked.

Thus at the "society" there was a weekly attendance of some 80 to a 100, of whom perhaps barely a quarter had technically progressive ideas. As might be expected, in such a mixed gathering one tended to gravitate into the little group with tastes nearest to one's own. I found my little niche amongst the keenest, but even there the conversation tended to turn upon motor-bikes or photography. The same experience seems invariable today. Even the keenest among us has a second hobby, or at least a lively interest in one, especially if it is in any way related to radio or electronics. The amateur cabinet-maker designs his own cases, radiograms and extension speakers, or even bass reflex cabinets. The model-maker and lathe-worker makes many of his own components, and the gadgeteer is in his element.

When I felt that I was no longer limited to strictly radio, things seemed much easier. So much so, that at one time I was managing three columns a month. In any case, a periodical limited to only constructional and theoretical articles would grow awfully monotonous.

Specialisation

In post-war years the radio amateur has come down to the hard core. The building of even comparatively simple receivers requires familiarity with (and often construction of) test gear outside the limits of handymanship.

Just as radio often leads to an interest in other hobbies, the "fringe" hobbies frequently serve as a recruiting means for new enthusiasts. Nor must it be forgotten that our numerical strength has an important bearing on the availability of components, etc. It is not economic for manufacturers to try to cater for a too insignificant market, and already there are too few retail shops serving amateur needs. Personally, I have to go quite a few miles whenever I want an odd-sized resistor or capacitor—and that often means waiting until the next Saturday! I always regard it as something in the way of a tragedy whenever any part of our hobby fails through lack of support. It undermines the confidence of both the manufacturing and retail side of the industry.

Reverting back to the friends I made in those early club days, two of them followed out-of-the-usual other interests. One of them was a keen amateur meteorologist who, when I last heard of him, was still doing long period weather forecasts for his local paper. He first dabbled with radio because he found it helpful in collecting weather news, and it was generally believed at that time that there was a direct relationship between the weather and propagation conditions. Perhaps a relic of this is to be found in QSL cards, many of which still reserve a little space marked WX........................ His garden was a miniature Air Ministry roof with amateur versions of every known meteorological device, and his special line of study at that particular time was the winds.

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

The other was an amateur astronomer who started off by building an outsize telescope. He eventually got such high magnification that he had to make a concrete emplacement to hold it steady. When I visited him I found his bedroom ceiling was covered with a network of cotton strands upon which hung little globes representing all the major stars. He made a nightly ritual of changing their relative positions. At first I thought it was because he could then lie in bed and look at them, but I later found out that that was the only ceiling his mother would allow him to use for the purpose. Like myself, he later turned to amateur transmitting; but he has never completely deserted his stars, just as few of those early club friends have never deserted radio even if they do have occasional off seasons. Apparently once the virus gets into your system you always come back. It is surprising how often correspondents mention they have dabbled with radio on and off since the crystal set days, and that they are once again busy trying to catch up with the latest developments.

In Hand—But Nearly Out of It

Having mused upon the past, what of the present? As the season of Good Resolutions is nearly upon us, I am resolving never to start another job before the current one is complete. My little den is overflowing with half-finished equipment. The QRO modulator is down for overhaul—and this is a priority job. An all-transistor receiver is on the stocks. Two T.V.s, one an early Pye and the other home-built *à la* Viewmaster (both t.r.f. upper sideband circuits), are being subjected to experimental treatment to eliminate traces of sound breakthrough on vision and *vice versa*.

On top of this I am being harassed about furniture rearrangement following experiments with stereophonic sound. Since all the major cinemas are equipped for "3-D" sound film system, my ideas for domestic reproduction have been re-orientated. Fortunately (for those with plenty of money) magnetic tapes with dual tracks and suitable replay equipment are now available. Those, like myself, without much money but possessing lots of cheerful optimism, can enjoy our experiments on these lines. Despite the fact that it is a lot of fun, it also consumes a big proportion of one's spare time.

As if these activities were not enough, I have started on a Jason F.M. Tuner—largely because the Editorial staff of *The Radio Constructor* are so enthusiastic about the ones they have built. Oddly enough it is the first time in my life I have used a kit of parts and strictly followed someone else's design. However, it is such a neat and sturdy chassis, with an excellently planned lay-out, that I found it irresistible. These points are, of course, of the highest importance. If you haven't tackled v.h.f. before, don't—unless you follow a successful design or are prepared to put in evenings of planning and patient experiment. A mere quarter of an inch in the wiring can put you megacycles away from the required frequency. I remember when the 144 Mc/s band was handed out for amateur use—but I had better not start that now. It would run to another couple of columns.

I hope to discuss points of interest arising from these items in future issues.

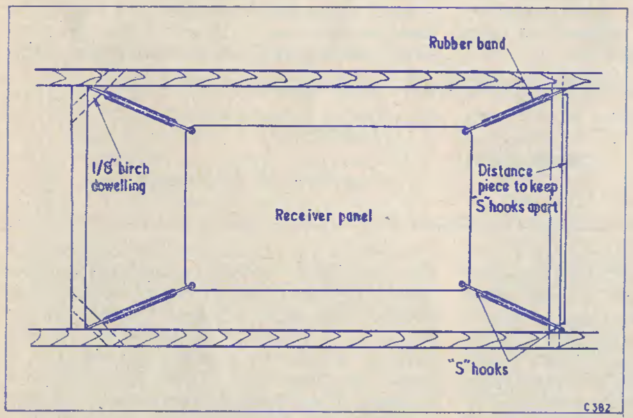
(*continued on page 353*)

Radio Control of MODEL AIRCRAFT

PART 3 RECEIVER MOUNTINGS

by "QUENCH COIL"

THE SIMPLEST WAY OF MOUNTING THE receiver within the fuselage is by slinging it between rubber bands from small "S" hooks fitted to each corner of the panel to take the rubber bands, which in turn are held by "S" hooks fastened to dowels passed through the air-frame. The rubber bands need to be fairly strong and tight enough to prevent the receiver from banging against the sides of the model. At the same time they should be springy enough to stop engine vibration reaching the relay. The bands behind the receiver need to be stronger than those in front to take the extra strain when landing, as the receiver tends to shoot forward should the landing be abrupt (see Fig. 12).



Very good mountings can be made up from sorbo rubber, some ideas being shown in Fig. 13. In sketch A the receiver is mounted on sorbo rubber fillets glued to balsa fillets on the airframe sides. Sketch B shows a mounting for a heavier receiver in which mounting bolts are passed up through a sorbo foundation. Another similar and even better sprung mounting can be made by soldering bolts to a thin metal top plate and gluing this to the surface of the sorbo mounting. This type of mounting is well shown in the photo Fig. 10.

In sketch C a combination of rubber band suspension and sorbo protection is shown, pads of sorbo being glued on to the sides of the fuselage to prevent damage should the rubber band suspension be unable to control any violent movement of the receiver.

Battery Boxes and Fittings

Whilst the same type of batteries can be used for aircraft as for boats, more attention must be paid to their fitting in model aircraft. It is surprising the amount of damage which can be done should one of the batteries become dislodged from its mounting during a rough landing. A small "Pen-cell" has been known to almost penetrate the side of a model, so one can well imagine the damage which could be done in this way to the receiver or its valves.

The size of the model naturally governs the type of batteries used, but one of the best methods is to make the required battery capacity up from small cells into what one might term a "battery pack," by strapping them together with transparent adhesive tape. This battery pack can then be held in a shallow tray by means of rubber bands. This is so mounted that it can be slid fore and aft along runners to adjust the trim of the model. Once adjusted, the tray can be fixed by cementing on to the runners (see Fig. 14).

Electrical connections to the flexible leads are made by soldering the male parts of small dress fasteners to the battery outputs and the female parts to the leads.

The battery construction suggested above, whilst being quite reliable and satisfactory in operation, suffers from the disadvantage that a falling h.t., l.t., or actuator battery section

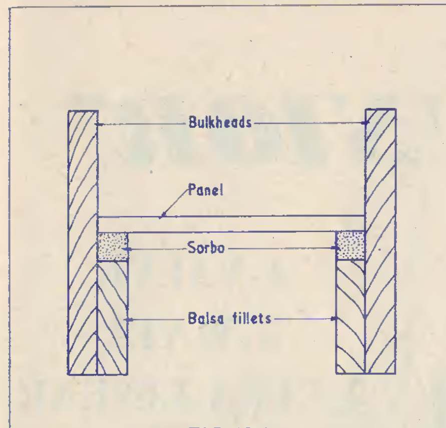


FIG. 13A.

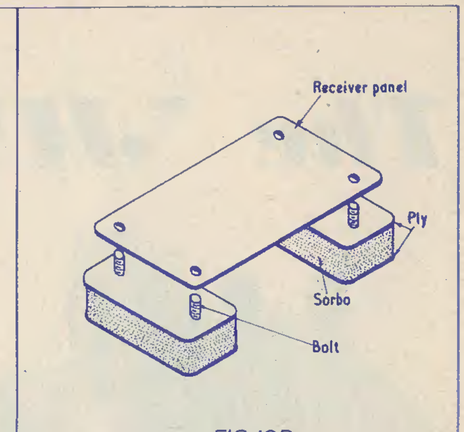


FIG. 13B

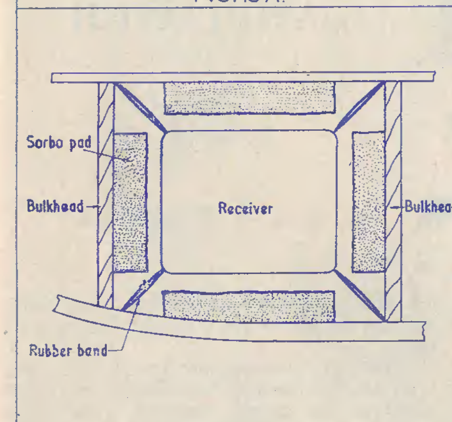


FIG. 13C.

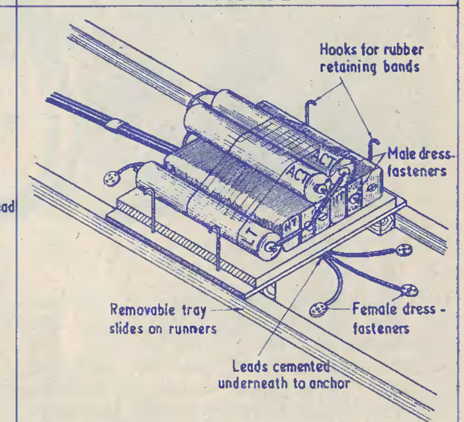


FIG. 14.

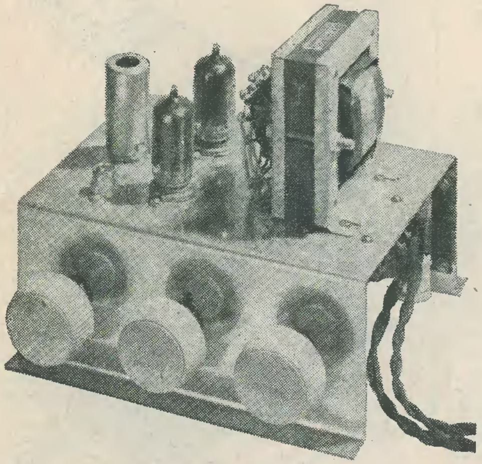
requires the block to be broken into pieces for replacement of failing elements. This can be overcome by mounting the batteries individually in a box type structure, using spring contacts in place of soldered fasteners. This method has proved quite successful in practice, except that the tension of the spring contacts needs continual adjustment to maintain reliable contact, although the removal and replacement of the batteries is quick and most convenient.

From the writer's experience, the h.t. batteries can be expected to last about half the flying season; actuator batteries about a quarter. L.t. batteries should be renewed fairly frequently, as the sensitivity and reliability of the XFG1 receiver is reduced considerably by run-down l.t. batteries.

MERRY XMAS MERRY XMAS MERRY XMAS MERRY XMAS MERRY

The Editor and Staff send
Christmas and New Year Greetings
to all Readers throughout the world

The "JUNIOR"



4-VALVE 5-WATT ULTRA-LINEAR AMPLIFIER

PART 2

by G. R. WOODVILLE*

The two chassis Fig. 5 are of identical size for ease of manufacture and their dimensions are 7in × 5in × 3in. The point-to-point wiring is shown in Figs. 6 and 7. Fig. 7, the power supply, is straightforward and no difficulty should be experienced in its assembly. A suitable mains tapping strip is fixed to one of the vertical chassis walls and the connections from the transformer primary taken to it; some transformers have four primary connections, 1)0 2)200/216 3)220/230 4)240/250 and others have five, 1)10 2)0 3)200/210 4)220/230 5)240/250. The additional ten volt tapping enables a more accurate voltage setting to be made. The transformer actually used in the amplifier was of this type, but this feature is not essential, and the more usual four connection type is equally suitable. A fuse of 500 mA rating is connected between the transformer secondary centre tap and chassis to protect the rectifier and the transformer in case of excessive current. A point worth mentioning here applies to those constructors who wish to use a transformer which they already own but which has a higher secondary voltage than 250–0–250. A resistance may be connected in series with the fuse to reduce the d.c. voltage, a 300 ohm 3 watts rating being suitable if a 300–0–300 volt transformer is on hand.

Although a duel-section capacitor C_{15}, C_{16} is shown, two separate ones are suitable. The choke is not critical, adequate space being available for a larger one should it be handy.

The amplifier chassis comprises more components, but the assembly is assisted by a tag board containing most of the resistors and capacitors. This should be made up before being mounted on the chassis as some of the wiring, shown in broken lines, is done at the back for neatness, but this is not essential and it could be done on top of the tag-board.

The three controls are mounted on the opposite side to the tag-board. This form of assembly leaves plenty of room on the chassis deck and makes it easy to check the wiring.

A six-way connector is fixed at the end of the chassis remote from the first valve, and to this are connected the 250 volt supply, the 12.6 volt heater supply and the two loudspeaker connections. The output transformer is provided by the makers with four connections, and the instructions provided with it should be followed to cater for either 15 or 3 to 4 ohm speakers. The resistor R_{21} should not be connected until the amplifier is known to be working properly. This resistor con-

* The M.O. Valve Co. Ltd.

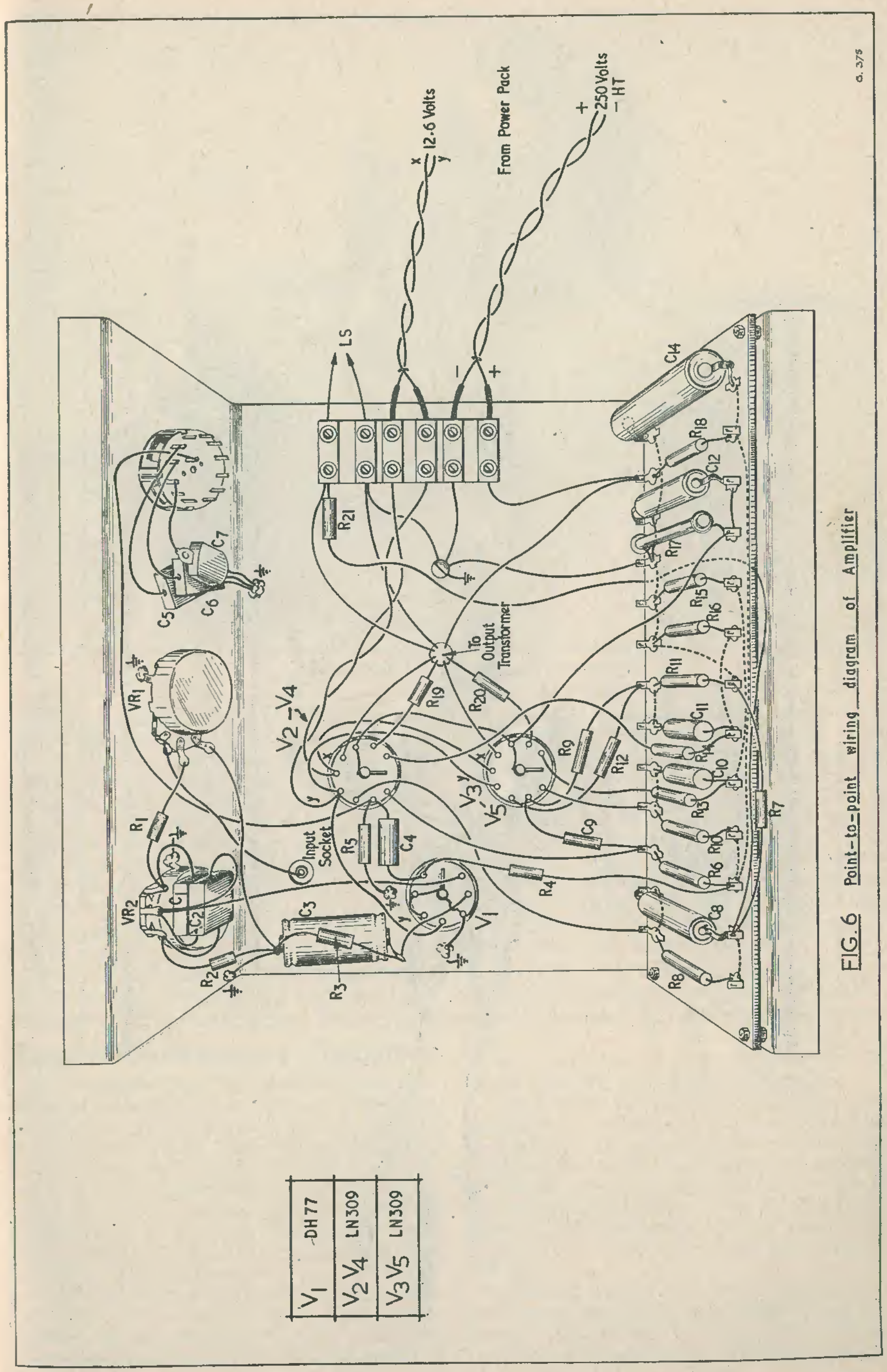


FIG. 6 Point-to-point wiring diagram of Amplifier

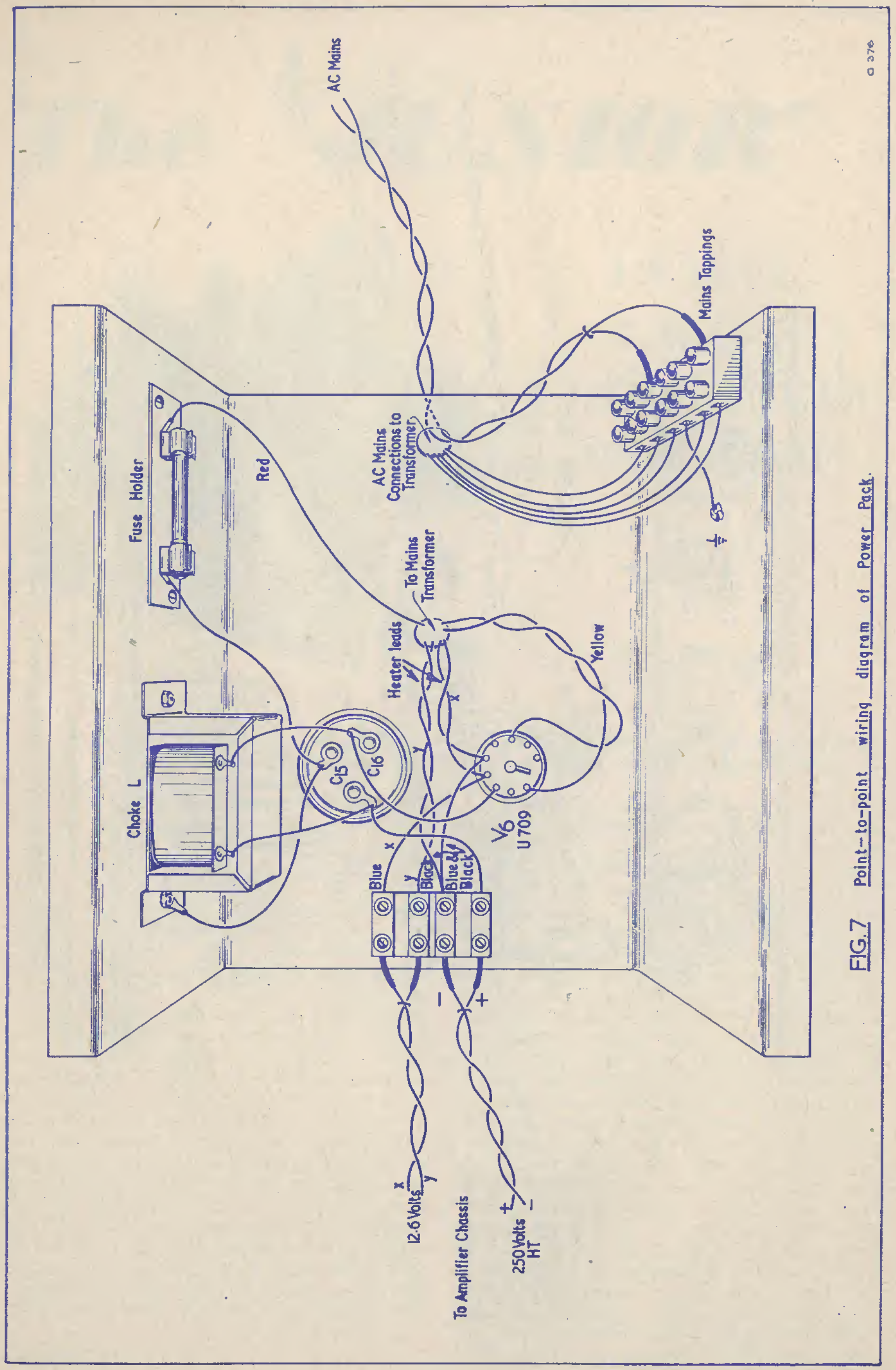
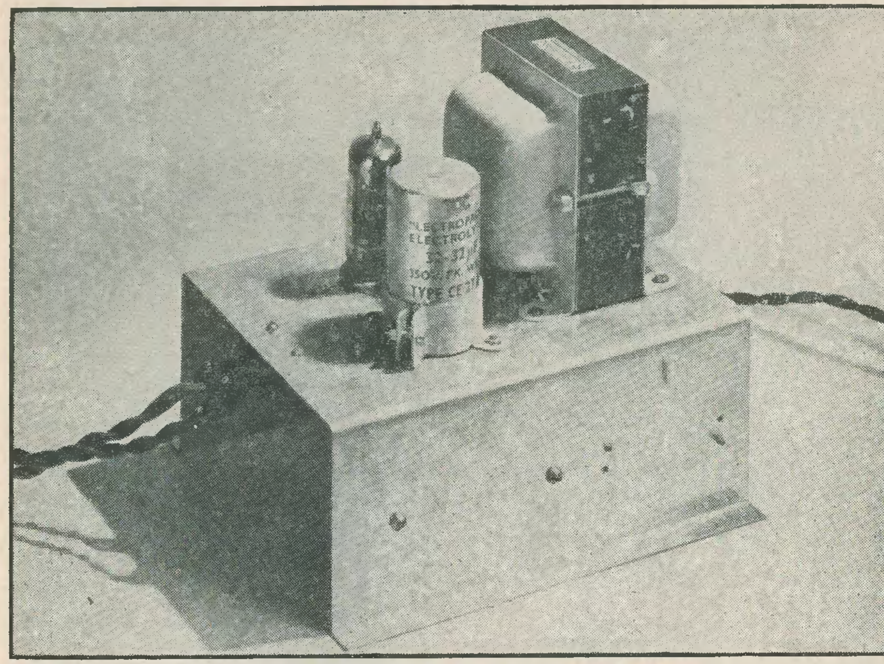


FIG.7 Point-to-point wiring diagram of Power Pack.



Above-chassis layout of power supply

trols the feedback, but if it is wrongly connected the distortion will be increased. Once the amplifier is operating properly, and it is known that no wrong connections have been made, R_{21} may be connected whilst listening to some music. If the volume *decreases* the resistor R_{21} is connected correctly. If, however, the volume *increases* the connections to the secondary of the transformer should be reversed.

The Output Transformer

The output transformer is provided with two secondary windings which may be connected in series or in parallel to cater for 15 or 3.5 ohm loudspeakers. The appropriate ratios are 24 : 1 and 48 : 1, but other ratios could be chosen, e.g. if two 3.5 ohm speakers are to be used the ratios should be made 32 : 1 and 64 : 1 which would give a satisfactory match with the 64 : 1 ratio to either one or two speakers. A series connection would provide 32 : 1 giving an equivalent anode-to-anode load of 15,300 ohms with one 15 ohm speaker. A reference to Fig. 4 will show that only a slight fall in output will result due to the use of a high load impedance.

Errata. C6 should have been given as 0.001μF in the components list in last month's issue.

Plessey Sub-Miniature Capacitors

A complete range of all-aluminium sub-miniature electrolytic capacitors, which includes the smallest type in existence, has just been introduced by The Plessey Co. Ltd.

The new components are expected to achieve wide application in transistorised circuits, such as hearing aids, where small physical size is essential, the smallest capacitor being only 0.1in in diameter and $\frac{7}{16}$in in length, including spigots.

Resulting from considerable research and development work, they have been made possible by the application of a new type of etched foil construction. A new method of securing the wire terminations to the anode riser has also been incorporated.

The Plessey sub-miniature capacitors are available in a range of capacitances from 1 to 50μF and for operation at peak working voltages from 1.5 to 70. They can be supplied in four case sizes and are suitable for use in the temperature range $-15°$C. to $+60°$C., at working voltages up to 40V d.c., and from $-30°$ C. to $+60°$ C. at higher working voltages.

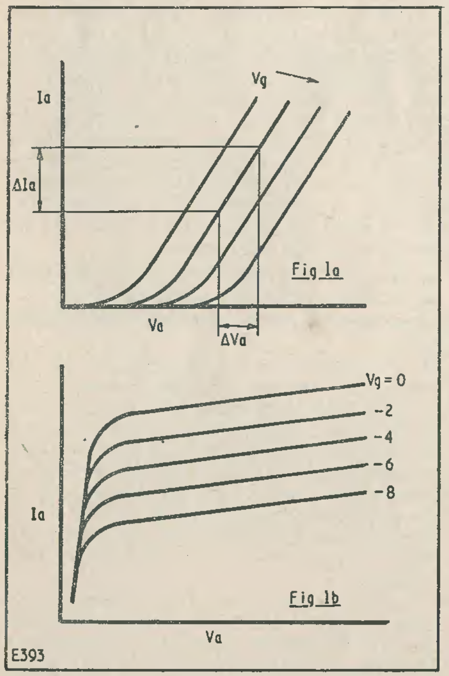
Technical advice on the application of these components may be obtained from The Plessey Company Limited, Components Division, Kembrey Street, Swindon, Wilts.

RIGHT—*From the Start*

PART 10 PENTODES

by **A. P. BLACKBURN**

FROM LAST MONTH'S RATHER THEORETICAL treatment of valves, we graduate now to more practical matters. Before leaving this aspect of valves, however, it would be as well to take a closer look at an important type —the pentode. Last month we dealt entirely with triodes. The curves and so on are rather different from those of a pentode, and the characteristics of the two types vary considerably, as well.



Characteristics

As with the triode, the pentode is judged by three characteristics: amplification factor μ, mutual conductance g_m, and anode impedance R_a. You may recall that R_a and g_m were the slopes of two of the characteristic curves of the valve. The g_m curve, i.e. grid voltage plotted against anode current, of a pentode is of the same shape as that of the triode, so we will not reproduce it again. There is one slight difference in the definition of all the parameters of pentodes, however; take g_m for example. It was defined before as the change of anode current for a given change in grid voltage, when the anode voltage is kept constant. The pentode, however, has two more electrodes, the screen grid and the suppressor grid. The latter is normally connected to cathode, but the screen grid usually has a positive potential of 100 volts or more impressed upon it. The definition of g_m will then have to be slightly modified to "the change in anode current, etc., when the anode and screen voltages are retained constant."

The same thing must be applied to the definition of μ and R_a—the screen voltage is always held constant.

The shape of the anode characteristic is certainly rather different to that of a triode. Fig. 1*a* shows some typical triode anode curves and Fig. 1*b* some pentode curves. Now if R_a is the change of anode voltage to produce given change in anode current, i.e.

$R_a = \frac{\Delta V_a}{\Delta I_a}$, we can see from Fig. 1*b* that the change in I_a is smaller for a given change of V_a in the pentode case than in the triode case. For example, if the triode anode voltage change were 50 volts and the current change 10mA, then R_a would be 5kΩ.

The pentode anode current may only change 1mA for an anode voltage change of 50 volts, therefore the R_a would be 50kΩ. So the smaller ΔI_a, the higher the R_a.

So far we have not mentioned the amplification factor μ. This was defined as the change in anode voltage for a given change in grid voltage with the anode current held constant (and in the pentode case, of course, the screen voltage constant also). It is related to g_m and R_a by the simple formula.

$$\mu = g_m R_a \quad \text{..........} \quad (1)$$

Now we have already seen that the R_a of a pentode may be higher than that of a triode, and the g_m may be of a similar magnitude. The expression (1) for μ shows, then, that μ for a pentode may also be much higher than for a triode. For example, if the g_m of a particular triode is the same as for a particular pentode, but the R_a of the latter is ten times higher than that of the triode, then the μ will be ten times higher also. This suggests that the pentode is capable of higher gains than the triode.

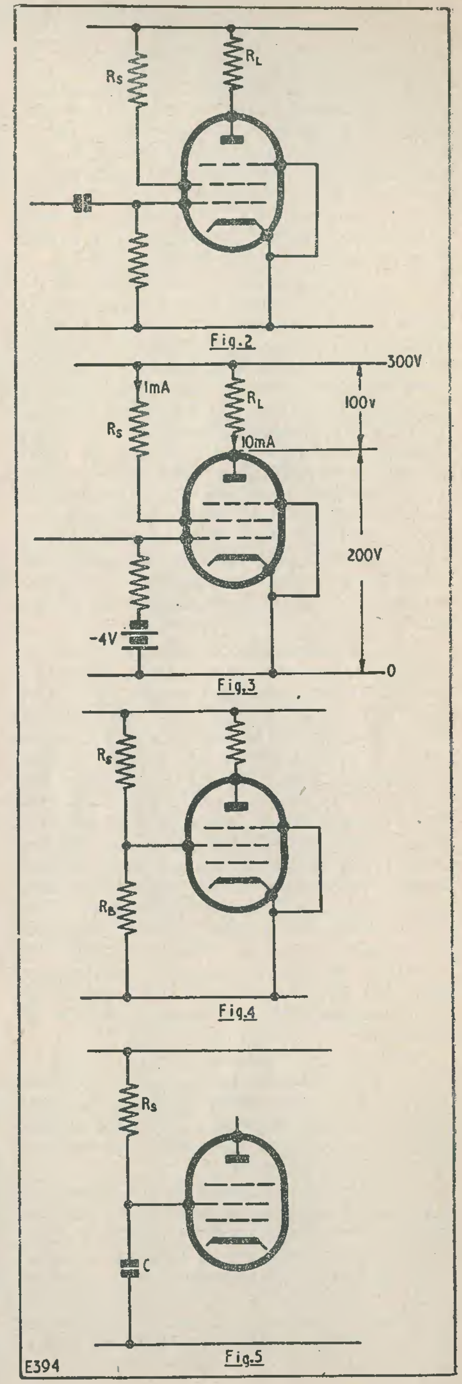
We saw in the last article that if the anode load is high enough, we can approach a gain of μ times, and no more. The high μ of the pentode does really mean that the pentode can produce a higher gain. This is true of many pentodes, but some are intended for high power output and do not have particularly high voltage gain possibilities.

A very simple formula for calculating the gain of a pentode is Gain A $\doteqdot g_m R_L$ where R_L is the anode load resistance.

For example, if the g_m is 10mA/volt and R_L is 20kΩ, the gain will be approximately 200 times. The "approximately" is inserted to remind one that the expression above is only true when the anode load resistance is considerably smaller than the R_a. If in the case given the R_a had been 200kΩ, then our answer of 200 is pretty nearly true. If, however, the R_a had been only 10kΩ, then the gain would have been approximately 66 times only. So it is important to remember that R_a must be large (say 4 or 5 times larger at least) compared to R_L if the result is to be reasonably accurate.

The Screen Grid

The difficulty in operating pentodes effectively is very often what to do with the screen. All the characteristics mentioned above assume the screen grid at a constant potential. A typical circuit may be as shown in Fig. 2. Imagine that the grid were to be made slightly more positive. The current in the valve would increase; both screen and anode current. Due to the resistors R_s and R_L the screen potential and the anode potential would drop. Because the screen voltage has dropped the conditions in the valve have changed, resulting in less current reaching the anode than if the screen potential had remained unchanged. The final result is



less gain from the stage than we would have expected. One way of looking at the action is that the screen grid is acting as a sort of auxiliary control grid, but acting automatically in partial opposition to the proper control grid. The problem is how to overcome this effect. One solution would be to use a separate battery just to supply the screen, but economics obviously make this undesirable. Another, which is often convenient, is to use an h.t. voltage which is low enough to connect to the screen direct, thus avoiding R_s. This point is worth amplifying slightly. Fig. 3 shows a stage working from 300V h.t. With the −4V bias shown, the valve current is 10mA and the voltage drop across the 10kΩ anode load is 100 volts; the anode to cathode voltage is therefore 200 volts. Now it may be recommended by the valve manufacturers that the screen be operated at 200 volts, or alternatively the screen dissipation (i.e. the wattage dissipated by the screen in heat) should not exceed, say, 2 watts. If the screen is drawing 1mA as shown, then connecting it direct to 300 volts will dissipate 300 volts × 1mA = 3 watts. Note that the anode is only at 200 volts, because we wish the anode voltage to be as "mobile" as possible, and the load resistance R_L is desirable in the case of the anode.

There are two methods commonly used to hold the screen voltage constant. One is to provide a "low resistance supply." This is shown in Fig. 4. All that has been added is the resistor R_B. The principle of operation is that R_s and R_B are chosen so that a current flows through them from h.t.+ to earth which is many times greater than the screen current. If the screen current should change due to a signal at the control grid, then this change being small compared to the total current flowing through R_s and R_B will only produce a small change of voltage at the screen. The disadvantage of this system is the current that is virtually wasted in flowing through the resistors. In a battery operated receiver, for example, an extra drain of 10mA would be most undesirable from the point of view of battery life.

Another very common system is shown in Fig. 5. This depends for its action upon the ability of a capacitor to store an electrical charge. In the diagram, C is called a "by-pass" capacitor and there are two ways of envisaging its operation.

In the absence of this capacitor the screen voltage will change pretty well instantaneously if the grid voltage were to change instantaneously also. So let us imagine the grid suddenly has a large negative voltage applied to it. The current in the valve will suddenly cease and the screen voltage will rise just as suddenly to h.t. + because there is no longer any current in R_s. Now let us return the grid to its original condition and connect C. The sudden application of the negative grid voltage will once again cut off the current in the valve, but the screen grid cannot change immediately, because C now has to be charged or discharged if its voltage is to change. If the negative grid voltage is maintained C will slowly charge until the full h.t. voltage is across it, and the screen will be at h.t. + as well. If, however, the grid voltage had been restored to normal shortly after application of the negative potential, the capacitor C would not have had time to charge very much, and the screen voltage would have remained virtually constant during the period of the grid "signal." We can see, then, that effectiveness of C in keeping the screen grid voltage constant is dependent upon the rapidity of the fluctuations at the grid. Or, in other words, its effectiveness depends upon the frequency of the signal. The higher the frequency the more constant will the screen voltage be, and conversely the lower the frequency the less constant. So far we have not mentioned what sort of value C should have.

The rate at which a capacitor will charge and discharge depends upon the capacity and the resistance through which its charge is flowing. In Fig. 5 the screen dropping resistor is chosen to drop the voltage from h.t. to the desired screen voltage. R is fixed by these considerations and we have to make C as large as possible. In audio amplifiers it may be as large as 8μF.

The ultimate effect of the variation of the screen voltage is, as we saw earlier, a loss of gain. We have also seen that the screen voltage will vary most at low frequencies. Combining these two facts shows that the loss of gain will occur at low frequencies. C should be made large enough to hold the gain, at the lowest frequency likely to be encountered, at the same value as the gain at higher frequencies.

Another way of looking at the action of C is to consider that it bypasses to earth the signal appearing at the screen grid. The reactance of a capacitor increases as the frequency decreases, so once again the effectiveness of C decreases as the frequency decreases. For this reason C is often called the screen bypass capacitor, or sometimes the screen decoupling capacitor.

The choice of C is very much influenced by the circuit conditions. For example, if the anode is decoupled, whether the cathode bias resistor is decoupled, and so on. It is not possible to give a hard and fast rule, therefore.

Apart from the obvious advantage of high gain, pentodes have other advantages too. In this article the audio amplifier application only has been mentioned, but in r.f. amplifiers they are virtually indispensable.

BOOK REVIEWS

HI-FI FROM MICROPHONE TO EAR. By G. Slot. 180 pages, 118 diagrams and illustrations. Published by the Philips Technical Library. Obtainable in England from Cleaver-Hume Press Ltd., 31 Wright's Lane, Kensington, London, W.8. Price 17s. 6d.

The twelve chapters in this small but informative paper-covered book provide a deceptively large amount of material on sound reproducing methods and equipment. A short history is included which traces the art from its beginnings in acoustical reproducing methods to the present-day electrical recordings.

The manufacture of disc records is described in good detail, and there is useful information on the care of records and styli. The operating principles and electrical characteristics of pick-ups, record players, amplifiers, speakers and tape records are discussed and described authoritatively, forming the major part of the text.

Other matters dealt with include acoustical problems, the use of multi-speaker systems, and the characteristics of rooms used for reproduction and listening. Although the field covered is fairly wide, the subjects have not been skimmed over. This is a good survey of modern techniques and equipment.

HI-FI LOUDSPEAKERS AND ENCLOSURES. By Abraham B. Cohen. 360 pages, 160 diagrams and illustrations. Published by Chapman & Hall Ltd., 37 Essex Street, Strand, London, W.C.2. Price 37s. 6d.

The American origin of this book should not deter one from obtaining what is really an excellent survey of the last link in the reproduction chain. Written by the Engineering Manager of University Loudspeakers Inc., the work is based on actual experience in design and manufacture of high-quality speakers.

There are eighteen chapters in the three separate sections which cover speakers, enclosures and room acoustics. The first section of seven chapters deals with the mechanical and electrical characteristics of speaker units, resonances, damping, impedance, etc., multi-speaker systems and divider networks. Too much reliance should not be placed in the abac of Fig. 7-17 on page 154 since it is not accurate at one end, as can be verified from use of the formula from which the chart is derived.

The second section, again of seven chapters, discusses baffles, cabinets, reflex enclosures and horn type enclosures. The last four chapters in the book, forming the third section, deal with the acoustics of rooms, and means of adjusting the reproducing system to suit the room conditions and the ear.

In all these chapters no effort has been spared to describe everything from first principles in a way that is easy to understand.

The Appendix is worthy of special mention, containing as it does drawings in full detail for eighteen speaker enclosures of various types, suitable for speakers ranging in size from 8in up to 15in diameter. Some excellent designs for multi-speaker enclosures are to be found here. A good index is in keeping with an equally good book.

MAKING ELECTRONIC EQUIPMENT FOR THE LABORATORY. 20 pages, 22 diagrams. Published by Kendall & Mousley Ltd., 18 Melville Road, Edgbaston, Birmingham 16. Price 2s. 6d., post 4d.

An ideal handbook for those seeking guidance in setting up a collection of simple and easily-made test gear. Brief, but essential and factual information is given on four simple resistance measuring circuits covering values from thousands of ohms down to a fraction of an ohm. A mains-operated multi-vibrator serves as a signal source generating high-order harmonics for rapid testing and fault finding, while a somewhat similar "noise source" does much the same thing using transistors. Three useful stabilised power units are described, one with four separate outputs in multiples of 70 volts using either an STV.280/40 or an STV.280/80 multi-gap neon regulator, another capable of delivering up to 250mA at voltages from 250V to 400V, and a third unit giving up to 125mA over a voltage range of 250-400V. A basic resistance-capacitance bridge and a very simple oscilloscope should also form useful basic test instruments.

All the devices can be made from readily available parts and should provide interest and education for many who are looking for just this sort of thing to start them off in an absorbing hobby.

DIRECT-COUPLED PUSH-PULL AMPLIFIERS. 24 pages, 18 diagrams. Published by Kendall & Mousley Ltd., 18 Melville Road, Edgbaston, Birmingham 16. Price 2s. 6d., post 4d.

High-quality amplifiers need not of necessity be expensive, nor is it imperative that large quantities of components are required for large outputs. The original circuits given in this book are not only novel; they are practical and technically of interest.

A 10-watt push-pull amplifier is described which requires nothing more than four valves (including rectifier), two transformers, 12 resistors, a potentiometer, and 6 capacitors as the basic items. A 20-watt version demands only a few more parts and larger valves. The absence of a.c. couplings removes the difficulties caused by phase shifts, and improves frequency response.

A pre-amplifier suitable for use with either of the two amplifiers is equally simple to make. A short chapter on the correct operation of speakers, with notes on divider networks, adds useful relative information.

NOTES ON SOLDERING. By W. R. Lewis, B.SC. (LOND.). 88 pages, 47 diagrams and illustrations, 16 tables. Published by the Tin Research Institute, Fraser Road, Perivale, Greenford, Middlesex.

This, an extremely interesting book devoted to the many aspects of soft and hard soldering techniques and the properties of solders, has more to say about an everyday subject than many might imagine could be possible. It describes meticulously the essential requirements of good fusion of metal to solder, the various methods necessary in different industries for their particular purposes, and the properties of solders and fluxes.

Although this book is issued without charge by the Tin Research Institute it is intended to reach those who have some definite interest in soldering techniques. Readers of this journal could perhaps obtain a copy if they state their qualifications for a particular interest in tin and tin-lead alloys.

Approved industries and businesses can also obtain the quarterly journal, "Tin and its Uses," issued free by the Institute.

FREQUENCY-MODULATED RADIO. By K. R. Sturley, PH.D., M.I.E.E., SEN.M.I.R.E. 120 pages, 105 illustrations. Published by George Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 15s.

Although about a half of the text is devoted to the general principles of FM, and the methods of producing this form of transmission, the very clear explanations given enable the reader to understand fully the underlying principles of the receiving circuits described in the latter part of the book. A realistic and practical approach has been made by Dr. Sturley, and throughout the book one senses the deliberate avoidance of deep technicalities. Concise factual information so essential for the layman's comprehension of the subject is obviously uppermost in the author's mind.

The various methods of aligning tuning circuits and obtaining the correct response characteristics with a minimum of testing apparatus are described in a way that must surely remove many difficulties for those with limited experience or facilities. There are no frills or fancies to distract the reader anywhere. Surprisingly little use is made of mathematics to expound a technique which usually abounds with them.

W. E. THOMPSON

A Sensitive BABY ALARM

by O. J. RUSSELL, *B.Sc.*, G3BHJ

Many makeshift and unsatisfactory ideas are used for the purpose of providing an electronic baby alarm. After carefully considering these ideas, certain design fundamentals were assessed for providing a really satisfactory baby alarm. Firstly, it was obvious that really high sensitivity is necessary, so that not only the cries of the infant may be heard, but also the sound of normal or abnormal breathing. However, high sensitivity does not mean an excessive volume of output; as otherwise, when the gain is turned up so that the "normal" breathing sounds can be heard, a real cry would blast the listening eardrums. Therefore some form or a.v.c. or overload action is needed to limit the full output, while still giving high sensitivity. Moreover, one or two remote listening posts, apart from the central one, are a good idea. Further, while the unit is often operated in the bedroom, with only speaker leads going to the listening points, an amplifier capable of being used with long microphone leads is also sometimes desirable.

Accordingly the circuit of Fig. 1 was evolved, and proved very satisfactory. To obtain high gain, no fewer than four cascaded amplifier stages are used, giving an overall maximum gain of over 90 db from input grid to final anode. Despite this high gain, internal noise is negligible. By using double triodes only two miniature valves provide the cascaded stages. A 12AX7 miniature valve gives the two high gain initial stages, with the 12AU7 following acting as a further amplifier and output stage combined. The output half of the 12AU7 gives adequate volume to operate two extension loudspeakers simultaneously; and sufficient on cries to over-ride local noise, while, however, limiting smoothly so as not to be deafening. Such an arrangement is extremely economical of space, and also has a very moderate current consumption, enabling a small mains transformer to be used. The first R-C coupling is designed with a short time constant, so as to attenuate the lower frequencies (eliminating l.f. rumble noises common with some baby alarm amplifiers), and also serves to attenuate hum. Low hum level and stability are assured by the three stage decoupling in the feed to the earlier stages; and with this, R-C smoothing is entirely satisfactory for the main h.t. line.

It was found possible to assemble all the components comfortably on a 7-in by 5-in chassis, with a 2½-in depth. To reduce overall height, the rectifier socket was sunk 1½ inches below the deck level. A small metal rectifier could be used here, however, as the total h.t. current consumption does not exceed 25 mA. A tagboard was used to accommodate the amplifier wiring and the second 8μF of the h.t. smoothing line. The 3,000Ω smoothing resistor was slung between the tagboard and the rectifier, and the input 8μF was also wired directly at the rectifier socket. One or two minor resistors were wired directly to the valve socket, but the majority are accommodated on an 18-tag "Radio Spares" tagboard, the layout and wiring of which are shown in Fig. 2 as a guide to those who prefer to use a tagboard layout. The amplifier, after initial tests, was finally enclosed in a metal cabinet sprayed cream, with an engraved strip in black Traffolite covering the control positions.

On test the unit proved stable even at maximum gain, provided the speaker leads were connected to earth at the amplifier chassis; and to assist stability, a small 47pF mica condenser was shunted directly across the speaker primary winding. The maximum gain was far too great for use with an Acos 33–1 crystal microphone, and the gain control was turned well down in these tests. Tiny noises could be distinctly heard with good clarity due to the bass roll-off incorporated; while normal noises, conversation, footsteps, etc., could be heard well over 50 feet from the microphone. Some 50 to 100 feet of mike cable (coaxial cable should be used, *not* screened flex) could be used without requiring more than a fraction of the full amplifier gain. In fact, a small loudspeaker connected to the input without any step-up transformer is perfectly adequate as a microphone, and a

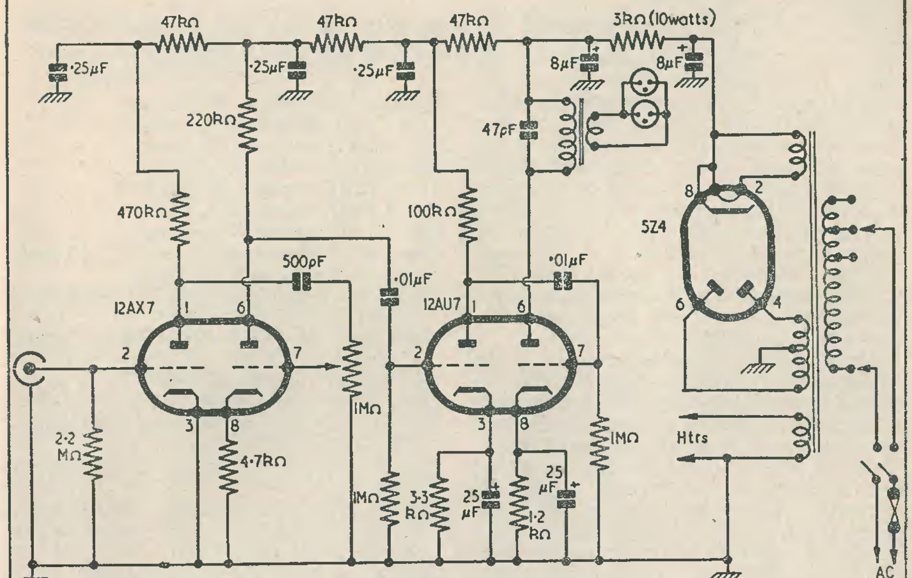


FIG. 1
A sensitive baby alarm

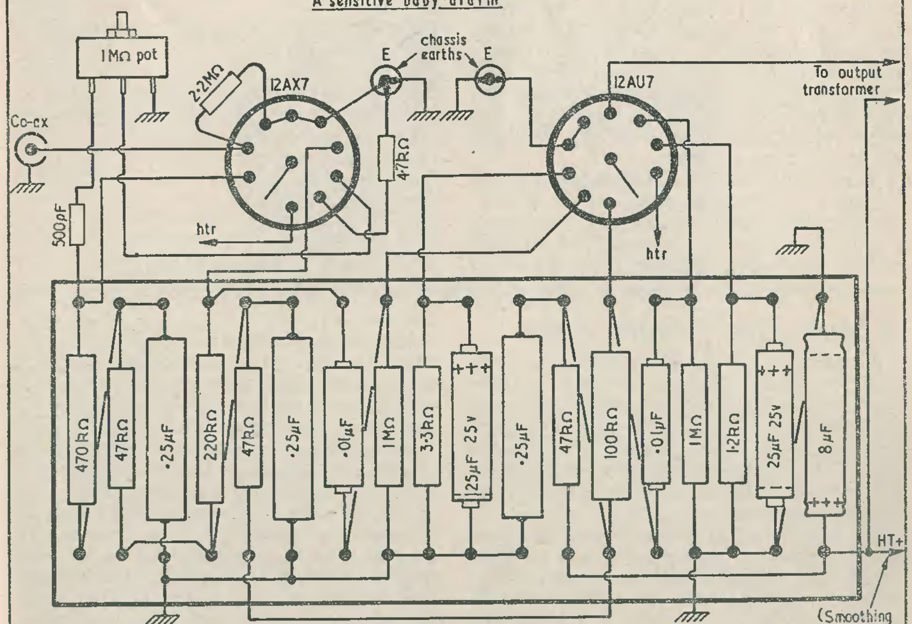


FIG. 2
Tagboard layout

E403

telephone earpiece is also usable as a microphone. However, the Acos 33–1 can be conveniently positioned and is unobtrusive as a "baby alarm" microphone.

With the gain full up, hum is only just audible, and there is a slight gentle hiss corresponding to the thermal noise of the first stage. Possibly cracked carbon resistors for the input grid and first anode resistors might reduce this slight hiss, but from the gain figure of over 90 db the residual noise at full gain represents about that expected on theoretical grounds. At operating gain there is no discernible amplifier noise at all, and a ticking watch or clock might be needed to give a signal when testing in a very quiet location. However, the noise output of a standard resting baby is very adequate as a test source, even without employing more than a fraction of the available gain!

The amplifier outputs are brought to the miniature three-pin Bulgin plugs, enabling two speakers for two listening stations to be used. A switch on the speaker mounts enables them to be turned on or off at the remote points. If desired, with a crystal microphone, a long coaxial mike lead may be used, so that the amplifier itself may be located at one of the listening points. Moreover, of course, there is no need to provide more than one listening point if one will serve. The amplifier could, of course, be modified into an "intercom" telephone of the loudspeaking type by switching the near and remote speakers in and out as microphones, but this would probably need a further speaker transformer used "backwards" as a microphone transformer, and also the switching at the front end would need shielding so that electronic feedback could not cause oscillation.

The amplifier is now in full-time use for its designed purpose, so that no "intercom" modifications have actually been attempted. It should be noted, by the way, that although only a short lead is taken from the input coaxial socket to the input grid tag, this is run in coaxial cable, as with the high gain available no chances of feedback should be taken.

PARTS LIST USED IN PROTOTYPE

(All composition resistors by Erie, except where otherwise stated.)

One 2.2 MΩ resistor 20% ½ watt
Two 1 MΩ resistors 20% ½ watt
One 470 kΩ resistor 20%, 1 watt
One 220 kΩ resistor 20%, 1 watt
Three 47 kΩ resistors 20%, 1 watt
One 4.7 kΩ resistor 20%, 1 watt
One 3.3 kΩ resistor 20%, 1 watt
One 3 kΩ Wirewound resistor 20%, 10 watts
One 1.2 kΩ resistor 20%, 1 watt
One 1 MΩ logarithmic track volume control (LAB)
Three 0.25 μF tubular condensers (Hunts, HW 1)
Two 0.01 μF tubulars (Hunts)
One 500 pF mica condenser
Two 25 μF 25 volt working electrolytics (TCC type CE30)
Two 8 μF 450 volt working electrolytics (Plessey)
One mains transformer 250–0–250 secondary at 60 mA 6.3 volts and 5 volts heater windings (Ellison MT162)
One coaxial input socket (Belling Lee)
Two miniature three-pin plugs and sockets (Bulgin)
One fuseholder and ½-amp fuse (Belling Lee)
One pointer knob
One dial light and bulb
One 18-position tagboard (Radio Spares)
Two "Noval" (B9A) valveholders (McMurdo)
One octal valveholder (McMurdo)
One crystal microphone (Acos 33–1)
One chassis 7in by 6in
One 12AX7 Brimar
One 12AU7 Brimar
One 5Z4 Brimar
Wire, sleeving, nuts and bolts, etc.

A New Flat Picture Tube

Speaking to the Television Society on 25th October on the design of his new flat television tube, Dr. Denis Gabor, F.R.S., said that the idea came to him four years ago and that it had been worked out with the aid of the National Research Development Corporation in the Electronics Laboratory at Imperial College.

By 1952 it had appeared certain that tube manufacturers would soon be faced with the problem of a reliable and inexpensive colour television tube and the flat tube seemed to be the solution of the tube problem. The tube itself has the shape of a rectangular glass box having a total depth of only 4½in for a 21in screen. It is divided into two halves by a metal tray which carries the whole electron optical system and which also acts as a magnetic screen for the beam. By an ingenious system of electron lenses the beam is curved to run parallel with the glass faces of the tube and is finally deflected towards the screen by a series of conductors which run parallel to the screen itself.

The flat tube can be made safer than the conventional television tube because the glass is specially toughened, as in car windscreens. These tubes might therefore dispense with the safety screen in front. They would not be damaged by accidental scratching.

In Reference: This tube is protected by British Patent No. 739496, 1953 (U.S. Serial No. 309677) and others.

INSULATION TESTING

by A. W. WOOD, *B.Sc.*

It is often necessary to test the insulation of condensers, especially ex-Government paper tubular types, before putting them into service; but this sets a problem to many experimenters who think that somewhat elaborate apparatus is necessary. This is far from being the case, as with a high resistance voltmeter, which many experimenters possess, the insulation of any condenser can be accurately measured. There is only one provision; the current consumption of the instrument corresponding to any voltage must be known, i.e. if a home-constructed voltmeter with a full-scale deflection of 1mA is set to the 500 volt range, 300 volts will represent 0.6mA, 250 volts represents 0.5mA, and so on. The only doubt may arise in the case of commercial multi-range meters, but the actual current can be easily found by including a 0–2mA meter in series with the instrument, when set to a voltage range.

Operation

As shown in Fig. 1, a two-way single-pole switch is used to isolate the supply while the condenser is secured to the test terminals, and for convenience in testing. The best way of illustrating the method is to give a typical case. Suppose we wish to test a 0.1μF 350V working condenser for insulation. The switch is set in the "off" position and the condenser is secured to the test terminals. 350V d.c. are obtained from any suitable source, i.e. broadcast receiver or any power pack, by means of flying leads. A suitable meter (not more than 1mA f.s.d. and preferably less) is set to cover the output voltage of the power supply and jacked into the sockets of the unit. The switch is now set to "Read" and the voltage of the supply (V_s) is shown on the meter. This is noted, and the switch turned to "Test." This places the condenser in series with the meter across the d.c. supply, and the voltage on the meter (V_m) is again noted together with the current (I) passing through the meter.

Then the resistance of the condenser is given by:

R ohms $= \frac{V_s - V_m}{I}$ where V is in volts and I in amps; or $R = \frac{(V_s - V_m)\,1{,}000}{I}$ where R is in kilohms and I in microamps; or $R = \frac{V_s - V_m}{I}$ where R is in Megohms and I in microamps.

Thus if the d.c. supply is 350 volts, and the meter is 500μA f.s.d. and set to the 500 volt range, and the test reading is 100V (this corresponding to 100μA), then:

$$R = \frac{350-100}{100} = \frac{250}{100} = 2.5\text{M}\Omega$$

This means that the condenser should be dropped into the dustbin forthwith. The above formula is a combination of Ohms Law and common sense. Referring to Fig. 3:

$V_x = V_s - V_m$ (V_x = volts developed across condenser)
(V_m = volts developed across meter)
(V_s = supply voltage)

By Ohms law, $V_x = IR_x$

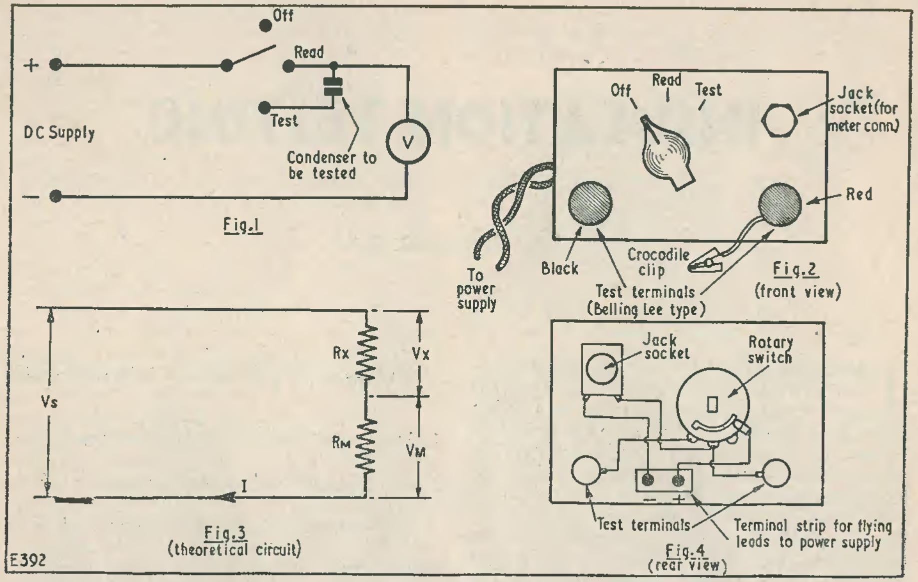
$$IR_x = V_s - V_m$$

$$R_x = \frac{V_s - V_m}{I}$$

The insulation resistance of a first class paper condenser should be 50MΩ per microfarad. Thus the resistance of a 0.1μF condenser should be at least 5MΩ. Mica types should be at least 100MΩ per μF. Any condensers which are not up to standard should be thrown away. If they are built into a circuit they will only cause harm sooner or later.

Electrolytic Condensers

As these condensers depend upon a flow of current through them for their action, the writer felt that this method might not



be applicable, so decided to give it a test. The meter was 500μA f.s.d., and was set to the 500V d.c. range. The condenser was an 8μF Dubilier electrolytic, and the voltage applied was 230V d.c. When first the switch was turned to the test position, the needle flicked right over to read 230V and then, very slowly and steadily, fell back until it finally read only 10μA. Another read 80μA and was considered to be satisfactory. A third proved to be almost shorted and was discarded.

Therefore this test can be used to check electrolytics and also gives some idea of the condition of the condenser. For instance, if the needle does not swing far and then drops back, then the capacity is low; and if the needle does not move at all, or only a minute distance, the condenser is open-circuited.

Resistance Measurement

Obviously resistors can be measured in the same way, and the only point to be considered is the voltage to be used. The best way is to use two grid bias batteries in series and to tap off the voltage until a suitable deflection is obtained. (9V with a 500μA meter set to the 10V range will enable resistors of up to 250kΩ to be measured). Thus a simple and effective ohmmeter is formed. Fig. 4 shows the rear view of the unit.

To sum up, the method is simple and effective; and the more sensitive the meter the higher are the values of insulation resistance which can be measured. Any convenient meter can be jacked in, and there is no danger to the movement provided it is set to the correct voltage range.

Radio and Electronic Component Show

Recognised as one of the most important technical displays of the year in Great Britain, the 14th annual exhibition, organised by the Radio and Electronic Component Manufacturers' Federation, is to be held at Grosvenor House and Park Lane House, Park Lane, London, W.1, from Monday 8th April to Thursday 11th April, 1957.

Formerly known as the Radio Component Show, the title has now been changed to Radio and Electronic Component Show to be more descriptive of its scope, covering as it does components for the radio, television, telecommunications and electronic industries in their widest aspects.

The exhibition has grown from year to year—next year 160 manufacturers are expected to exhibit—and this has necessitated holding it in two sections which, however, are close together and will be organised and operated as a single exhibition.

For overseas visitors and other special guests a preview is being held from 10 a.m. to 2 p.m. on the first day, 8th April. Admission is by ticket obtainable from the Secretary, R.E.C.M.F., 21 Tothill Street, Westminster, London, S.W.1.

CRYSTAL RECEIVERS AND AMPLIFIER/RECORDER FEEDER UNITS

by JAMES S. KENT

For those who have constructed or purchased a magnetic tape recorder, the problem of providing a "front end" suitable for quality reception of radio programmes soon arises. Apart from the question of quality, other considerations are of paramount importance. Among these are the necessary considerations of light weight and portability where these are desired. For a static arrangement, the cost of a radio tuner unit, together with the power supply problem with the possible introduction of hum, leaves much to be desired.

For the truly portable recording enthusiast the most obvious solution to the problem is the simple crystal receiver feeding into the recorder input circuit. Here, however, certain considerations must be borne in mind before embarking on the building of such a unit. Although the quality of a crystal receiver is excellent and the presence of a power supply and, therefore, hum non-existent, there still remains the great disadvantage of lack of selectivity. This is mostly occasioned by the dampening load across the tuned circuit caused by the crystal detector. In the circuits about to be described the selectivity problem has been largely overcome by using a triple-wound coil (see diagrams). This particular coil has been designed by the manufacturer especially for use with germanium crystal diodes. Maximum selectivity together with a high signal output has been achieved by minimum dampening of the tuned circuit—achieved by the use of a separate winding for the crystal diode. Thus the inclusion of these coils largely removes the main stumbling block in crystal receiver or feeder unit construction. With these points in mind, the following paragraphs deal with the design and construction of a simple crystal receiver and follow through to the conversion of this into an amplifier or recorder feeder unit.

The Crystal Receiver

Fig. 1 shows a standard simple crystal set in two forms. The circuit, shown alongside the point-to-point wiring diagram, is simplicity itself and requires but little explanation. The tuning condenser should be of the variable mica dielectric type, these being more compact than the normal air-spaced types, and serving admirably in crystal sets. The germanium diode specified is the Brimar GD4 but others, such as the OA70, OA71, GEX44, GEX55, GEC45, IN34, BTHCG1, or the Westinghouse WG7A, B or C, serve equally as well. It is merely a matter of preference as to which is actually used. All of these types have a very low forward resistance, a few hundred ohms only, while their reverse resistance is high. The headphones should be of the high impedance type—4,000Ω if possible. The whole unit could easily be included in a small metal box where connection to an aerial of about 25 feet in length and an efficient earth would produce stations with comparative ease. A two-ounce tobacco tin is ideal for this purpose.

In Fig. 2 is shown a slight variation of the first arrangement, in that selection of the Light and Home programmes is made possible by the substitution of two 100pF trimmers of the postage stamp variety for the variable condenser. A toggle switch for this purpose is shown, but this could be a Yaxley type switch if preferred, with the addition of other trimmers pre-tuned to differing frequencies. This would, of course, largely depend on the actual location of the individual user and the various signal strengths at that location.

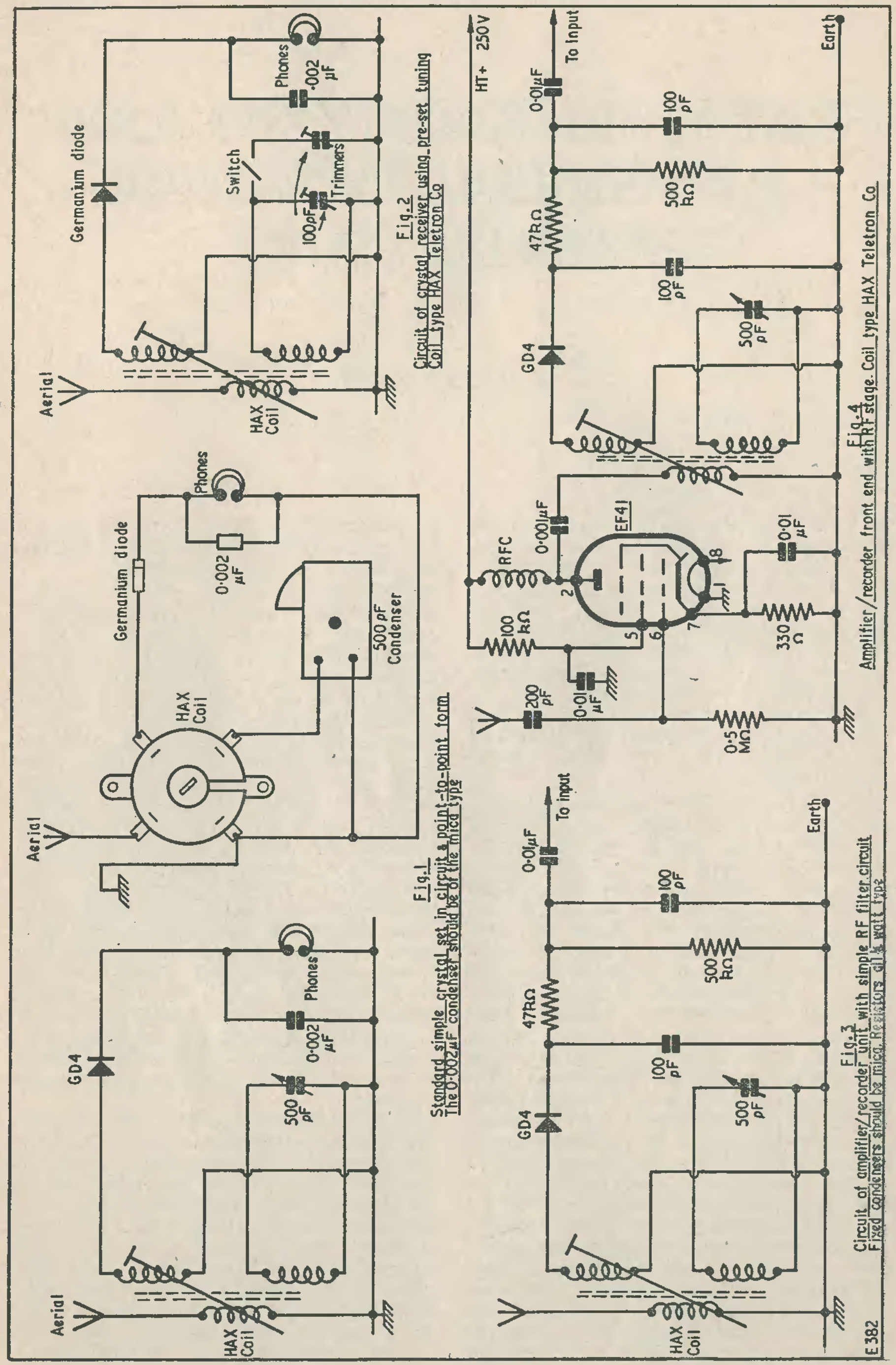


Fig.1 Standard simple crystal set in circuit & point-to-point form. The 0·002μF condenser should be of the mica type

Fig.2 Circuit of crystal receiver using pre-set tuning. Coil type HAX Teletron Co

Fig.3 Circuit of amplifier/recorder unit with simple RF filter circuit. Fixed condensers should be mica. Resistors all ½ watt type

Fig.4 Amplifier/recorder front end with RF stage. Coil type HAX Teletron Co

The Amplifier/Recorder Unit

The first of these is shown in Fig. 3, where it will be noted that it closely follows the previous circuits and is merely a derivative of these except for the inclusion of a simple r.f. filter network, load resistor, and blocking condenser, from which the filtered audio is fed into the required input circuit. Component values are shown, and with these selectivity and sensitivity are of an order suitable for the purpose in mind.

From the circuit of Fig. 3 we derive that of Fig. 4, where the inclusion of an r.f. stage provides some additional gain. This is a compromise between a full-blown radio feeder unit and that of a simple crystal receiver. As with most compromises it has advantages and disadvantages—the latter being the power supply needed. The valve itself consumes very little current and this, in itself, is no problem. The trouble arises from the purely physical problem of tapping the power requirements from the existing recorder or amplifier. Provided the enthusiast is easily able to overcome this, the advantages outweigh the disadvantages.

The r.f. stage is untuned, thereby obviating the need for any ganging of tuned circuits and the inclusion of a further coil. The valve used is the Mullard EF41—a B8A base r.f.-i.f. pentode. All the component values are shown. There is approximately a stage gain of 10 from this untuned r.f. amplifier; the resultant amplified r.f. is fed into the aerial winding of the feeder unit via the 0.001μF mica condenser. The gain may be considerably increased overall by the simple expedient of feeding the r.f. output from the valve, via the condenser, directly to the tuned winding of the coil. This will, however, depend on whether the selectivity is acceptable at the particular location at which the unit is used. Cut and try would provide the answer here.

As an alternative to Fig. 4, with its variable condenser, the switched version of Fig. 2 may, of course, be preferred; in which case there is no reason why it should not be used.

Conclusion

It is hoped that the circuits presented here will provide home constructors with some alternatives when considering methods of constructing "Front Ends" for the purposes discussed. Also those requiring simple crystal receivers, for whatever purpose, have several circuits from which to choose. Various mains or battery pentodes, consuming very little current, are available on the market and could easily be adapted for use in the circuit of Fig. 4. It now remains for the individual constructor to choose that circuit most suited to his needs.

Radio Miscellany

continued from page 335

On the Roof of the World

While a certain amount of noise in reception is attributable to atmospheric disturbances, thermal agitation in the valves, etc., by far the greater part of it is caused by man-made static. Those who live, or spend a holiday, in the remoter districts enjoy a nearly noise-free reception. On numerous occasions readers have commented on this, and I was again reminded of it when reading Heinrich Harrer's "Seven Years in Tibet." Writing of Lhasa, some 12,000 feet up, he says: "It gave one a feeling of unreality to get such clear reception . . ." He had to remind himself that there were no electric drills, hairdressers, tramways, or other electrically powered apparatus to disturb the peaceful ether. It might have led the uninitiated to suppose that it was the clear mountain air that made such reception possible!

Incidentally, he also mentions Reg Fox and Bob Ford, both of whom for a time operated amateur stations in Tibet—the latter from Chamdo. For months they were the most sought after stations in the world, and were inundated with shoals of letters, QSL cards, listeners' reports and presents. Ford was captured by the Chinese Communist Forces when they invaded Tibet and wild charges of "espionage" were brought against him because of his amateur activities. I believe his own station log and the incoming cards were used as evidence against him. He was imprisoned for five years and subjected to the terrible processes of "brain-washing."

Harrer also mentions that he met him later in London, where he planned, after a long rest, to write of his experiences. I should be interested to learn if any reader knows whether these have appeared. Reg Fox, incidentally, died in Kalimpong in 1953, following a complication of illnesses.

This Month's Tailpiece

From a reliable source comes the story of an incident which took place at the R.S.G.B. Group meeting at Norwood. The occasion was a talk by "Dicky" Bird, G4ZU, on the "Minibeam" of which he was the designer. The address was to be illustrated by lantern slides, but apparently some practical joker "got at" the slide box before the meeting began. Instead of illustrations of the "Minibeam" installations being flashed on the screen, the audience (not 100% male) were regaled by glorious technicolour pictures of Paris Beauties in the nude. Happily the darkness concealed a few red faces!

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continued on page 359)

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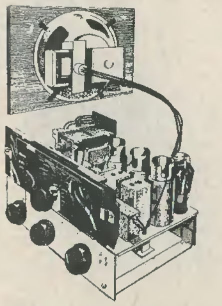

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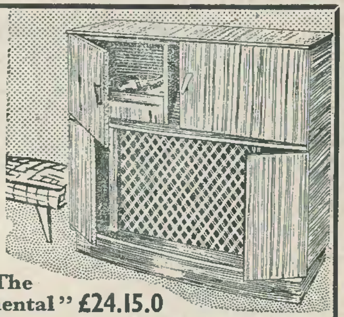

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continued on page 360

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(continued from page 359)

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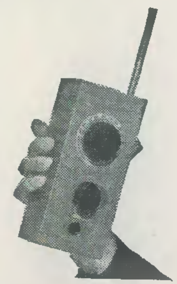

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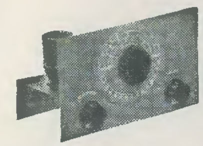

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