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THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagams 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.

ALL CORRESPONDENCE should be addressed to THE RADIO CONSTRUCTOR 57 Maidavale London W9.

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Suggested Circuits

No 88 A PERIODIC SWITCHING DEVICE

From time to time the writer receives requests from readers for periodic switching devices which are capable, without any attention, of continually turning equipment on and off at regular intervals. In most instances, the switching devices appear to be required for shop displays, or for ornamental lights, whereupon it is desired that the controlled circuits be continually switched on and off at cycles varying from some five to twenty seconds or so. Quite a proportion of the writer's correspondents have stressed their desire that, if a periodic switching device is described in these columns, it should be as simple as possible and have no more circuitry or components than is associated with an electronic timer.

This Month's Circuit

A practical relay switching circuit is illustrated in Fig. 1 and it is intended to answer these requests. As may be seen, it is extremely economical in components. Indeed, the writer feels that, if it were possible to make a periodic relay switch circuit any simpler than that shown in Fig. 1 he would be very interested to hear of it! The device consists of a relay having a fairly high resistance coil and two contact sets (one of which must break when the relay energises), an electrolytic condenser, and a resistor. A source of high voltage lying between, say, 100 and 250V, and capable of providing sufficient current to energise the relay, is also needed. Since current requirements are low, a normal h.t. supply of the type used in a mains receiver should be more than adequate for the device. If it is intended to provide the switching circuit with its own source of energising voltage, the simple arrangements shown in Fig. 2 or Fig. 3 will be suitable. It should be possible to obtain switching cycles up to twenty seconds and beyond with the circuit of Fig. 1, the cycle time required being provided by experimental selection of the value of the electrolytic condenser connected across the relay coil.

Operation

The operation of the device is as follows. Before the h.t. supply is connected to the series resistor and the relay coil, the voltage across the latter is zero and the relay is in the de-energised position. As soon as h.t. is applied, the voltage across the relay coil at once commences to rise. However, this rise in voltage is slow, it being controlled by the charging current of the electrolytic condenser. When the coil voltage has risen to a value sufficiently high to energise the relay, its contacts A open, and the connection between the coil and the condenser is broken.

The voltage across the relay coil now commences to drop. Again, a delay occurs, the same cause once more by the presence of the condenser across the relay coil. When the coil voltage has dropped sufficiently low for the relay to de-energise, its contacts A close once more. In consequence the voltage across the relay coil starts to rise again, and it enters a further switching cycle.

As may be seen from this description of circuit operation, the two factors which enable the device to switch on and off at regular intervals are, firstly, the condenser across the relay coil which causes voltage rise or fall to be delayed and, secondly, the fact that the coil voltage at which a relay de-energises is lower than that at which it energises. Whilst the relay contacts A enable the periodic switching operation to take place, a second set of contacts (B) are used for switching external circuits. Fig. 1 illustrates a set of "break" contacts, but any other type of contact—"make" or "changeover"—could be employed according to the desires of the constructor.

Practical Points

As was stated earlier, a relay having a fairly high resistance coil should be used for the device. Best results will probably be given by coils having resistances around 2,000 ohms. Post Office relays should function well in the circuit, and may prove more reliable than the less mechanically robust types employed for such functions as model control, etc. The relay should, preferably, be capable of energising at a current of 10mA or less. Relays requiring high energising currents need proportionally higher capacities in the parallel electrolytic condenser, such values becoming uneconomically large when long time cycles are required.

The value of the series resistor is determined empirically, it being slightly lower than that needed for reliable energising. (A value some 5 to 10% lower than that which just causes the relay to operate would represent a good practical choice.) The resistor and the relay are next connected into the circuit as shown in Fig. 1, different values of electrolytic condenser being connected experimentally across the coil until the required time cycle is obtained. It will probably be found that condensers around 200µF will give short timing cycles of some 4 seconds or so, whilst condensers around 1,000µF will give proportionately longer cycles, of the order of 20 seconds. (Large value electrolytic condensers are readily available as television spares, or from surplus equipment.) Unfortunately, it is impossible to specify any particular condenser value in this article, owing to the extremely large number of variables existing in the circuit. The working voltage of the condenser should, of course, be greater than that of the relay.
that needed by the relay to energise. Condensers having working voltages considerably higher than the relay coil energising voltage may be used without detriment to the operation of the circuit. When completed, the switching device should provide on and off periods which are approximately equal in length to each other. If it is found the relay tends to "stick" in the energised position, this will probably be due to too low a residual gap in the armature. (The residual gap prevents the armature from forming a closed magnetic circuit when the relay is in the energised position, and is adjustable with some relays.) If this still fails to "pick off" the energised position it might be found that the leakage current of the electrolytic condenser is excessive, in which case, a partial solution may be given by slightly reducing the value of the series resistor. Poor mechanical operation, or excess friction, in the relay will also, of course, affect reliability.

**Power Supply**

Although the device will function from any h.t. supply capable of offering the few milliamps required, the writer feels that some constructors may desire to provide it with its own power supply. In such an instance the circuit of Fig. 2 could be used.

Fig. 2 employs a series rectifier, thereby enabling half-wave rectified d.c. to be applied to the relay circuit. In most instances this should be all that is required, the electrolytic condenser across the relay coil preventing chattering due to the unsmeared output from the rectifier. When the simple arrangement of Fig. 2 is used, it will be necessary to connect a condenser of some 5 to 20uF across the relay coil to prevent chattering whilst the value for the series resistor is being initially found, remembering that such a condenser will cause a slight delay before full voltage appears across the relay coil.

It may, in some instances be found that the h.t. available from the circuit of Fig. 2 is inadequate, whereupon that shown in Fig. 3 should be used. Fig. 3 includes a reservoir condenser whose value should be 4uF or more. The circuit of Fig. 3 will cause a considerably higher d.c. voltage to be available than occurs with that of Fig. 2. There is also no necessity to shunt the relay coil with a condenser whilst initially finding the value of the series resistor. The limiting resistor included in Fig. 3 may be a half-watt component having a value lying between 200 and 400 ohms.

It must be emphasised that both the power supply circuits of Figs. 2 and 3 result in the relay circuit proper being connected directly to the mains supply. The insulation of the low-voltage variety, or if any part of the controlled circuit is capable of being touched, it is essential that an insulating transformer be connected between the a.c. input points indicated in Figs. 2 or 3 and the mains supply. An ordinary mains transformer having secondary tapping of offering 190 to 260 volts will prove adequate here. When such a mains transformer is used, the limiter resistor of Fig. 3 is not required.

**TWO NEW PHILIPS LOUDSPEAKERS**

Philips Electrical Limited have introduced two new models in their range of loudspeakers for use with indoor sound reproduction installations. Both are of modern styling with a smooth fruit cabinet finished in grey "Rezine" and beige "Vynair." They replace the existing ET301, ET304 and ET302. The two directional effect of the latter may be achieved by placing two ET3950 models back to back.

**Type ET3089**

This is a 7m moving coil speaker rated at 1W for disk or wall mounting. In the former position it stands on four small feet affixed to the broader end of the cabinet; when wall-mounted, the board is at an angle so that the sound is directed downwards. It is suitable for use in conjunction with any other type of amplifier where a 300W line is required. Dimensions: Height 9in., width 7in., depth at broad end 5in., depth at narrow end 3in. Price £4.50 (free of tax). A volume control costs £1 extra.

**Type ET3089**

This model is similar in style and shape to the ET3089. It has, however, an 8m speaker and the transformer is tapped for 1, 3 or 6W. Dimensions: Height 14in., width 12in., depth at broad end 6in., depth at narrow end 4in. Price £5.00 (free of tax). A common loudspeaker for portable receivers.

**NEW LOUDSPEAKERS FOR PORTABLE RECEIVERS**

The latest addition to the range of loudspeakers produced by the Philips Company Limited is a 3m shallow unit which has been specially developed for use in the smaller types of portable receivers. The overall depth and volume of the speaker have been reduced to the minimum proportions that are consistent with obtaining high sensitivity and maximum output. It can be supplied either with a circular chassis for mounting with a clamping strip and the most convenient position charge, or with a flat chassis which has four fixing holes.

Features of the speaker are the flat chassis and the window cut-outs, which are shaped to facilitate maximum output. An essential requirement was to provide a speaker for mounting other components. Overall depth of the standard model is 6in. and the flux density is 6,500 gauss. It also employs a magnet with a 9in. dia. pole. In instances where a greater depth can be employed a maximum of 10,000 gauss can be supplied. The standard voice coils are 3 or 5 ohm impedance, but high impedance coils up to 80 ohms may be fitted if required.

**THE RADIO CONSTRUCTOR**

**MARCH 1958**

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

_Although he, himself, would have indignantly denied such a charge, Smithy was essentially a man of habits._

Over the years, he had subconsciously worked out for himself the routine which he followed each day during the time he spent at the Workshop. His hat and macintosh, for instance, always found their way to the same familiar peg on the wall; his newspaper, projecting always from the same pocket of the macintosh, was always read carefully at lunchtime; and the solving of its crossword was always (or very nearly always) triumphantly completed some two minutes before it was time to start the afternoon’s work. Dick had once arrived early and had mischievously unscrewed Smithy’s peg and refitted it several feet away from its customary position, with the result that Smithy had nearly been tricked into hanging his hat and overcoat on a bare expanse of wall.

During the previous summer Smithy had, however, made a small change in his routine, consisting of discarding his heavy macintosh and replacing this with a rolled-up plastic raincoat. Smithy had marked this change in habit by carefully “miking up” the plastic material of the raincoat, and solemnly pronouncing its thickness to be 0.008 inches. This particular episode had greatly amused Dick until, after reflection, he had suddenly wondered if it was he, and not Smithy, who was having his leg pulled.

Whether they were assumed or not, some of Smithy’s customs had a seasonal long-term rhythm, wherein quite abrupt changes in routine were liable to occur at intervals of some six months or so. What was probably the most predictable of these evinced itself one cold February morning when Smithy’s arrival at the Workshop was not punctuated by his normal early-morning cough. Dick, who had preceded him, looked round and stared at the Serviceman’s unusually set and stern face. With a sigh Dick realised that Smithy had, once again, decided to Give Up Smoking.

Smithy greeted Dick a little curiously and immediately proceeded to the chassis which had been lying on his bench overnight. Dick, who was also half-way through a job he had started the previous day, similarly settled down to work.

**Feedthrough Condensers**

After a while, Smithy broke the silence and called Dick over to give him a hand. Reaching the Serviceman’s bench, Dick saw that Smithy had plugged two large soldering irons into the mains and that he was checking their temperature.

“This is just a quick job,” explained the Serviceman to Dick. “What has happened is that this chassis had a faulty 1,000pF feedthrough condenser; and one soldering iron just isn’t sufficient to melt the solder all around it so that I can get it free.”

Under Smithy’s instructions Dick held one of the large soldering irons against the chassis on one side of the feedthrough condenser.
while Smithy held the second iron on the other side (Fig. 1). With the concerted heat from the two irons the solder around the feedthrough condenser soon melted, whereupon Smithy was able to quickly pull it out of the chassis with a pair of pliers. Smithy next inserted a replacement condenser in the hole left by the faulty component and he and Dick re-applied their irons, together with a small amount of cold solder. The new condenser became reliably soldered into position in a matter of seconds.

"How exactly, are feedthroughs made?" asked Dick.

"If you break one open," replied Smithy, "you can usually get an excellent idea of their construction. They consist basically of a ceramic tube, the inside and outside surfaces of which are silvered (Fig. 2). The connector, which passes down inside the hole, is soldered to the inside silvering, whilst the skirt is soldered to the outside silvering. So far as I know, the solder used in the assembly is very similar to the 60:40 tin: lead mixture that we use ourselves, plus the addition of a small silver content, with the result that you are quite likely to momentarily melt the solder holding the skirt to the outer silvering whenever you fit the condenser to a chassis. If you overheat the condenser seriously, not only is the solder joint to the skirt liable to become unreliable, but you may also find that the silvering blackens up. When that happens, your condenser has well-nigh had it. In any case, there's something wrong with your methods if you treat feedthroughs as badly as that. Normally, the necessity for quick soldering of the feedthrough is the prevention of capacity shift, which, as I mentioned earlier, this being possible well before the condenser, as such, becomes physically damaged."

"Well, that didn't take long," commented Dick.

"It rarely does, when you use two irons," replied Smithy. "Although I must point out that you can usually solder a feedthrough condenser into a chassis fairly easily with one iron, because it isn't entirely necessary for the solder around it to melt all at once. On the other hand, and especially if you have a chassis made of fairly heavy gauge metal, it can often be the very devil to get one out with only one iron. The difficulty of removal becomes all the harder if the feedthrough has a circular skirt around its body instead of two lugs on either side.

"Returning to the question of fitting new feedthroughs, I often think it's worthwhile using two irons for this operation because this cuts down the amount of time during which the condenser is subjected to a high temperature. I've known feedthroughs shift as much as 50 per cent from their nominal capacity when they have been overheated, and this is something which should never be allowed to occur."

"What are the advantages of feedthroughs?" asked Dick.

Smithy settled himself down comfortably on his chair and felt absent-mindedly in his pocket, only to realise that he was now undergoing a period of self-imposed self-denial. A frown crossed his face and he had visibly to collect his thoughts before he was ready to answer Dick's question.

"Well, the main advantage of feedthroughs," he commenced, a little distractedly, "is that they are ideal for connecting together circuits in separate screening compartments whilst automatically providing decoupling (Fig. 3(d)). However, this is by no means the entire answer because, due to the way in which feedthroughs are made and are soldered to their associated chassis, they also provide a decoupling path whose inductance is very low indeed. One of the second factor you find feedthroughs employed in decoupling circuits where all the connections to them are made at one end only. In such an instance, it is almost certainly the low inductance feature of the feedthrough which is being exploited. An ordinary tubular or disc feed coupling condenser has noticeably more inductance than a feedthrough, this being almost entirely due to the fact that such condensers have essentially to be connected into circuit by means of their lead-out wires. These lead-out wires, usually very thick, are the main contributors to the extra inductance. Incidentally, the inductance of a straight piece of wire increases as it becomes thinner. When a feedthrough goes open-circuit you can quite often effect a quick repair by soldering an ordinary condenser across it (Fig. 3(b)). However, you may not always get away with this sort of repair, especially if the feedthrough was intended to decouple a v.h.f. circuit or is completing a tuned circuit.

"When I talked just now about the inductance of a straight piece of wire you might have thought that I was painting rather too exaggerated a picture, but quite honestly this is not the case. At frequencies around Band II and Band III, component lead-out inductance becomes extremely important. In fact, you will find in some turret tuners that feedthroughs which are used for completing tuned circuits are mounted in positions where they are not soldered to the chassis at all. Instead, their outside silvering is soldered direct to valveholder or component tags, their bodies being 'in mid-air.' In practice, the use of a feedthrough in this slightly unconventional manner has a great deal to commend it. Not only does the feedthrough present a low inductance to the circuit in which it is inserted, but it also presents a constant inductance. In such mass-production things as turret tuners, constant wiring inductances, from turret to turret, are quite essential."

"I certainly didn't think things were as critical as that," remarked Dick. "Still, I suppose that the higher we go in frequency, the more attention we have to pay to 'hidden' inductances, and points like that."

"Believe it or not," commented Smithy, "but things that dead easy right now. When Band IV and V open up, then t.v. design and servicing will become really interesting!"

**Modulation Hum**

Smithy ended the conversation somewhat abruptly at this stage and turned to his bench,
whereupon he moody surveyed the chassis whose feedthrough condenser he had just changed. Dick decided to leave him to his thoughts and walked back to his own work. Smithy was already beginning to exhibit marked signs of grumpiness, and Dick wondered how long it would be before the Serviceman finally gave up his struggle. Dick made a private bet with himself that a cigarette would be burning away on Smithy’s bench before the day was over.

To prove his point, Smithy turned the tuning knob of the receiver. Between stations the background noise was of a similar kind and of average quality, but when a station was tuned in a loud hum became evident.

"The annoying thing," continued Smithy, "is that this modulation hum may only be present on the mains supply and not also on the chassis. I bet that, if I were to try it out in the customer’s home, the trouble would not occur at all." Dick regarded the Serviceman with sympathy, marveling at the fact that the great man was so distracted that he was now defeated even by modulation hum. Gently he pulled the mains plug of the receiver from the bench socket and reinserted it experimentally the other way round. All trace of the modulation hum cleared.

Smithy looked round, started out of his apathy.

"Ye gods and little fishes, am I slipping," he exclaimed. "Perhaps I’ll feel better after a cup of tea." A cup of tea soon cheered up the distraught Serviceman and, before long, he had almost retrieved his normal confident and competent outlook on life.

"Well, Dick, you certainly showed me up there," he chuckled. "Fancy me forgetting to do a simple thing like that!"

"Mains modulation doesn’t seem to be a very frequent fault these days," Dick volunteered.

"You’re perfectly right there," replied Smithy. "I suppose that the main reason for its relative rarity is that sound receiver power supplies are so simple and straightforward now that there is little risk of the stray coupling that existed in some of the more fancy circuits employed before. Also, almost all manufacturers employ the simple device of connecting a condenser of 0.01 μF (or thereabouts) between one side of the mains input and chassis (Fig. 4(b)). Sometimes you have two condensers (Fig. 4(b)) or, in an a.c./d.c. set, a condenser straight across the supply (Fig. 4(c)). Either of these arrangements is usually sufficient to kill mains modulation altogether. T.V. receivers also employ a condenser across the mains supply, but the value in these sets may be notably higher, up to 0.1 μF or so. It is therefore, if ever you replace a condenser in an a.m. mains modulation position you should always try to use one having an a.c. working voltage rating which is higher than the mains voltage. Such a condenser is not then liable to break down in use. In point of fact, the question of anti-mains modulation condensers breaking down is really quite important, this being due to safety considerations. The situation isn’t too bad in a.c./d.c. sets because, if the condenser breaks down, it merely blows the house fuse. With sets employing isolating mains transformers, however, the state of affairs is much more dangerous due to the chassis becoming live as a result of the breakdown. This may mean that the external cabinet metal work of the set may also become live, as well as the aerial lead. Quite a hazardous condition."

"Quite enough modulation hum usually sufficient to clear modulation hum?" asked Dick.

"Normally they are," replied Smithy, "but there are not always. After all, modulation hum can sometimes be very tricky to tackle. We saw just now that, by merely reversing the receiver mains plug, the modulation hum cleared up in that set on the bench. As a matter of fact, assuming an a.c. mains supply, reversing the mains plug is usually the first thing you should try. With some of the older receivers. modulation hum might be extremely strong in one house and completely absent in another. An old dodge used to consist of adding 0.01 μF condensers between either one side and the other side of the receiver and chassis. I have heard a number of claims for success with this idea but, quite frankly, it has never worked for me."

"Is the aerial input circuit liable to contribute to modulation hum?" asked Dick.

Smithy did not answer immediately, and Dick saw that his eyes were focused on a point behind him. He turned round and poured out a second cup of tea for the Serviceman. Under Dick’s ministration, Smithy slowly returned to the world. Dick revised his previous estimate and gave Smithy no more than two hours at the outside before cigarette smoke once more filled the Workshop.

"What was that?" said Smithy. Dick repeated his question.

"Oh yes," responded Smithy. "The aerial circuit! Ah, now, that can have quite an effect on modulation hum. Let us assume that you have an a.c./d.c. receiver whose chassis is connected to one side of an a.c. mains supply. We then connect an aerial to its aerial terminals. Like this (Fig. 4(a)). I’ve assumed in my sketch that there is a condenser C1 in series with the aerial which is connected to the chassis. Now the a.c. input to the receiver is connected to earth which we could reproduce in a simple equivalent circuit (Fig. 5(b)) as CA. We could also state that the impedance of the receiver, Z, exists inside the receiver between the aerial socket and chassis. So far so good! Now, let’s see what happens when a 50 c/s voltage exists between the chassis of the set and earth. At once (Fig. 5(c)) we have the case where we can represent this voltage by an a.c. generator. The voltage from the a.c. generator, of course, being very high—approximately equal to the mains voltage itself—so the chassis is connected to the live side of the mains."

"If there can’t be any more point will be," interrupted Dick. "What happens now is that you apply a 50 c/s a.c. voltage via Ca and C1 to the input impedance of the receiver. It then becomes possible for a proportion of the a.c. to be built up across this input impedance, thereby giving you modulation hum."

"Exactly," Smithy replied. "And we now come to the all-important question of the input impedance, Z, itself. If this input impedance is that presented by a tuned circuit with a coupling winding (Fig. 4(d)), the impedance presented to 50 c/s a.c. by Z will be only that of a small number of turns of wire. This impedance would be so low compared with that given by Cl and CA in series that only a negligible amount of 50 c/s a.c. would appear across it. An input coil of this type would not allow modulation hum via the aerial circuit to appear. As I really wish to talk more about bottom-end coupled input circuits, I want to make the quick statement just now that a 50 c/s voltage across the primary coil of a tuned circuit to reach the grid of the first valve via the mutual inductance between this primary and the tuned coil. The relatively low value of this mutual inductance will further help to eradicate mains modulation."

"A bottom-end aerial coupling circuit, which is still used fairly frequently in present-day receivers, gives a very different picture. In its simplest state, a bottom-end coupled circuit would take the form of a condenser at the bottom of a tuned coil (Fig. 5(e)), whereupon our input impedance Z becomes the reactance of this condenser. Such a reactance may easily be comparable with that of Cl and CA, in which case the result that quite a considerable amount of 50 c/s a.c. may be built up across it and be applied to the grid of the first valve. In practice, bottom-end coupled circuits employing a simple condenser are rarely, if ever, used mainly because they give rise to—guess what?"

"Modulation hum?" queried Dick.

"Precisely," replied Smithy. "So it is usual to use an input circuit for bottom-end coupled receivers wherein a low value resistor effectively reduces the input impedance so far as the 50 c/s a.c. is concerned. Then, we could reproduce in a simple equivalent circuit (Fig. 5(f)) as CA. Values for this resistor, which is connected in parallel with the bottom-end condenser, lie normally between 2 and 10 kΩ. Unfortunately, even the presence of this low..."
value resistor does not entirely eradicate the trouble, and circuits of this type are still liable to suffer from modulation hum in 'awkward' localities.'

"Are there any cures for the trouble?" asked Dick.

"Well, it's fairly easy to reduce the hum if the aerial input circuit is causing the trouble," replied Smithy. "One method consists of reducing the series aerial condenser, and this can usually be done by simply inserting a low-value series condenser—say 50 pF or so—between the aerial and the receiver input socket. There is no need, in this instance, even to take the back off the receiver. Inserting the low-value condenser is equivalent to reducing the value of C_A and C_l in series. Alternatively, you can try reducing the value of the resistor across the bottom-end condenser; but, as you are liable to lose gain seriously if you go below 1 kΩ here, this course does not give you much scope. Often, quite a considerable improvement can be made by adding a simple R-C filter (Fig. 5(g)) between the bottom-end condenser and the aerial input socket. A value of 5 kΩ for the resistor and of 20 to 100 pF for the condenser would be typical, and there wouldn't be too much loss in gain. The 5 kΩ resistor then presents a low impedance to 50 c/s a.c., whilst the 50 to 100 pF series condenser gives a high impedance, thereby causing less a.c. to appear.
across the bottom-end condenser itself. If you have a real 'toughie' you could try an r.f. choke in place of the additional resistor (Fig. 5(b)), the very low impedance of this choke to 50 c.a. clearing modulation hum out of the aerial circuit altogether.

"What don't we understand," commented Dick, "is why you go to all this bother to clear modulation hum from the aerial circuit when it seems that this trouble is only liable to be really serious when the chassis is at live potential. Couldn't the hum be cleared merely by reversing the mains plug? This would then cause the a.c. generator in your circuit to supply only the small a.c. voltage, if any, which exists between the neutral line and earth." "That's a good point," agreed Smyth, "and I'm afraid that, in trying to show the importance of the aerial input impedance, I have somewhat over-simplified the problem. In practice, reversing the mains plug only reduces and does not entirely clear obstinate cases of mains modulation. The reason for this is that, apart from the fact that there may be a small voltage between the neutral line and earth, there may also be a certain amount of capacitive coupling between the aerial and any unscreened mains wiring inside and outside the house. Thereby, you still get a capacitive coupling between the aerial and a high voltage mains point."

Oscillator H.T. Ripple

"This raises another point," said Dick. "A friend of mine has a short-wave receiver which exhibits modulation hum, but only when the set is tuned slightly off the station. What would be the reason for that, Smyth?"

However, Smyth was not listening and had reverted, instead, to staring past Dick's shoulder. Suddenly Dick realised that the Serviceman had his eyes fixed on the valve cupboard behind him. With a somnambulistic motion the Serviceman finally rose from his chair and, walking stiffly, reached the cupboard. After some moments he turned round again, a cigarette in his mouth, a cloud of smoke above his head, and a gleam in his eye.

"I thought I'd left a packet in there," Smyth remarked triumphantly.

He returned to his bench and inhaled luxuriously.

"Now, what's all this?" he said briskly to Dick. "Hum on a short-wave set when you're slightly off-tune? That's almost certainly not modulation hum at all, my boy. Instead, it's very probably ripple on the h.t. line causing the oscillator to be frequency modulated at the ripple frequency. When you're off-tune the f.m. becomes a.m. on the skirts of the i.f. response, and you then hear it from the speaker. Remedy? Check your smoothing. And now let's get down to the grind!"

With which comment Smyth ended discussion for the morning and, coughing happily, sent the protesting Dick scurrying back to his work.

THE TELEVISION SOCIETY ANNUAL EXHIBITION

The 15th annual exhibition of the Television Society is being held at the Royal Hotel, Woburn Place, London, W.1, as follows: Tuesday, 4th March, 11.30 a.m. - 8 p.m.; Wednesday, 5th March, 12 noon - 8 p.m.; Thursday, 6th March, 12 noon - 7 p.m. A wide range of equipment and new apparatus will be demonstrated, including colour television receivers. The exhibition covers many facets of the television field and is the only one dealing specifically with this subject.


Admission is by ticket only, available free from the Secretary, the Television Society, 166 Shaftesbury Avenue, London, W.C.2, or from any exhibitor.

PHILIPS TAPE RECORDERS

A New Accessory

A programme indicator (three-digital revolution counter) designed to clip on to the edge of the carrying case of the AG 8109 tape recorder is a new accessory now being marketed by Philips Electrical Limited. It can also be used by clipping to the carrying handle of the case, with models AG 8105 and AG 8107. A programme indicator is already available for model AG 8106. Known as Type EL 1979/77, it is the new indicator is finished in grey plastic to match the AG 8109, and the digits are in white. There is a plastic cap at the end of the drive cable, and this is pushed over the top of the spool spindle. The accessory can, therefore, be very quickly and easily fitted and removed as required. It sells at £3.7.6 (free of tax).

IN THE SECOND ARTICLE IN THIS SERIES, published in last month's Radio Constructor, we dealt in very general terms with the nature of the transmitted television signal. This month and next we shall carry on to discuss the television signal in greater detail, paying especial attention to its constituent parts when considered in terms of frequency and time.

We shall not, however, concern ourselves with examining the British 405 line system only, but will also pay attention to the American 525 line system, the "C.C.I.R. 625 line" system employed on the continent and in Australia, and the French 819 line system. The writer feels that, even at this early stage, it is worthwhile examining television from the viewpoint of the major systems employed throughout the world instead of merely working in the narrow field of our own 405 line standard. Much development and design work is in progress with all the systems currently employed, and too great a pre-occupation with a standard which does not conform with the best that modern television can provide is liable to give a somewhat limited horizon.

The 405 line System

The British 405 line system employs the waveform shown in Fig. 13. This diagram illustrates the appearance of the waveform around the frame synchronising pulses for the even and odd frames, the remainder of the signal consisting of the picture information and line sync pulses which occur in the frames themselves. Commencing with the first waveform ("Even") we encounter several lines of picture or video information. (Video qualifies picture signals in the same way as audio qualifies sound signals.) We have the irregular line normally employed to denote the picture signal provided during the scan period, this being followed by the line sync pulse which was discussed last month. At the end of the last line in the frame (No. 405) we enter into the frame blanking period. The first part of this period is devoted to frame synchronising pulses, these occupying a time equal to four complete lines. It should be noted that, although the shape of the frame sync pulses is considerably different from that of the line sync pulses, we still have downward-going pulse edges which are spaced out at intervals equal to one line. Since these downward-going pulse edges are equivalent to the leading edges of line sync pulses, they initiate the line flyback at the requisite instant in just the same manner as occurred before we entered the frame blanking period. As a result, the line deflection circuits in the receiver still keep running at correct, synchronised frequency during the frame blanking period. The diagram shows twice as
many downward-going pulse edges as are 
needed for line synchronisation, the receiver 
line synchronising circuits being such that 
they respond only to the first, third, fifth, 
seventh and ninth pulse edges, those in 
between being ignored.

At the end of the frame synchronising 
signal section, we enter into the remainder of 
the frame blanking period. Over this 
remaining part, the transmitted signal 
remains at a blanking level, downward-going 
pulse edges continuing to be transmitted at 
intervals of one line. The overall length of 
the frame blanking period is $14 \pm 1$ lines, 
with the result that the second part, the 
"post synchronising frame signal blanking 
period" occupies $10 \pm 1$ lines.

The last downward-going pulse edge in the 
frame suppression period could be considered 
as being the leading edge of the first line sync 
pulse of that part of the frame which follows, 
since it is succeeded by the familiar line sync 
shape pulse and a back porch. After the back 
porch we have the commencement of video 
information in the first active line of the 
frame (i.e. the first line containing picture 
information), whereupon the waveform pro- 
cedes, down the frame, in normal position.

The second waveform shown in Fig. 13 is 
that applicable to the odd frame blanking 
period, and it differs slightly from that for the 
even frame blanking period. As before, we 
start off with several lines of video informa-
tion, together with their now-familiar line sync pulses, but, this time, we enter the frame 
blanking period after only half of the last 
active line of the frame (No. 205). The frame 
sync pulse section of the frame blanking 
period now occupies the same time as 
four lines, but this time the downward-going 
pulse edges, which keep the receiver line 
circuits in synchronism, are the second, 
fourth, sixth and eighth. After the frame 
sync signal section the waveform enters the 
same "post synchronising frame signal blanking period," as occurred with the even frame. It will be observed, however, that the first part of this period at blanking level is 
equal in length to only half a line, this 
offering its first downward-going pulse edge 
to follow, after the correct time of one line, 
the eighth downward-going pulse edge in the 
frame sync signal period.

The odd frame suppression period con- 
tinues until we reach the ultimate downward-
ging pulse edge, after which we have a half-
line at blanking level before picture informa-
tion commences. Following the first half-line 
of picture information (half of line 217) a 
normal line sync pulse appears and the next 
line, and those subsequent to it, are trans-
mitted in the usual fashion. 

It will be obvious from the waveforms 
illustrated that at no time does the signal rise 
above blanking level during the entire frame 
blanking period, with the result that, 
theoretically, the screen of the television 
receiver should remain blanked out during 
this period. A minor point of interest is 
the existence of the half-lines of picture informa-
tion commencing and ending at the odd 
frame blanking period. It is possible to see 
these half-lines very readily at the top and 
bottom of the picture on any television 
receiver having a black and white interface and focus.

In Fig. 13 part of the picture information 
section before the frame blanking period is 
shown shaded. This shaded section can either 
consist of the picture signal, as shown, or of a 
signal whose amplitude is at blanking level.
length of time taken up by each constituent part of the waveform, and the units we use are, as is to be expected, units of time.

We know that, in the 405 line system, we have 25 pictures per second, each consisting of 405 lines (including the "line" which occurs during the frame blanking period). It follows from this that the line frequency of the 405 line system must be 25 multiplied by 405 cycles per second; that is, 10,125 cycles per second. Since there are 10,125 cycles per second, it follows again that the length of each line cycle must be 

\[ \frac{1}{10,125} \text{ seconds; viz. 98.7 microseconds. (One microsecond—or } \mu\text{s—is one-millionth of a second.)} \]

The length of each complete line cycle shown in Fig. 13 is, therefore, 98.7 \mu s.

![Diagram](image-url)

**Fig. 15.** The line sync waveform of the 405 line system. This signal is shown in its video form, before it modulates the transmitter. The modulated carrier signal has synchronising signal level at 0.3% and blanking level at 30 ± 3% of peak carrier amplitude (white level). Pulse durations are measured at half-amplitude points on a white level signal. (Rise time of leading and trailing edges of sync pulse—10% to 90% amplitude—is not less than 0.25 \mu s. Rise time of leading and trailing edges of blanking pulse—10% to 90% of its amplitude—is between 0.25 and 0.5 \mu s)

Of the line cycle, part of the 98.7 \mu s is taken up by the line sync pulse, together with its front and back porches. The total time occupied by this part of the waveform, allowing for tolerances in the transmitter, lies between 17.5 and 19 \mu s (as Fig. 15); and we could assume a mean of approximately 18 \mu s in the average transmission. This means that the average time devoted to black signal plus a white signal) of the 1 Mc/s vertical bars is 1 \mu s. Similarly, each cycle of the 2Mc/s bars has a length of 0.5 \mu s, and each cycle of the 3Mc/s bars is 0.23 \mu s. The frequencies and cycle times of all the Test Card C gratings are shown in Fig. 14.

In Fig. 15 is shown a detail illustrating the shape taken up by the 405 line sync pulse, together with its front and back porches. It will be seen in this diagram that the sync pulse does not have the idealised shape assumed in Fig. 13. A slight delay occurs when the amplitude of the signal changes, and the outlines of the pulse become somewhat sloping and rounded in consequence. Fig. 15 also illustrates the requirement of the term "blanking level." The blanking level in the 405 line waveform is 5% of full amplitude below the level and encountered only during synchronisation periods.

Fig. 15 gives information on the various proportions of the waveform together with their times. It may first of all be noted that peak white corresponds to 100% waveform amplitude. This is, of course, due to the fact that the 405 line system employs positive modulation, wherein maximum transmitter output is given when the television camera scans a peak white part of a scene. All other amplitudes are then quoted as a percentage of peak white. Also, tolerances are given for the amplitude of the blank and blanking levels. Tolerances are necessary here because it is impossible to hold these amplitudes to an exact percentage. No tolerance is given for line period time of 98.7 \mu s, as this figure represents the length of a cycle whose frequency is closely controlled. However, fairly wide tolerances are given to the lengths of time taken up by the front porch, back porch and sync pulse. Such tolerances are necessitated in practice by the nature of the transmitting equipment.

**Picture Elements**

In the previous article it was stated that horizontal detail of the same standard as that given in the vertical sense is given by the 405 line system when this has a limiting picture information frequency of 3 Mc/s. With such a limiting frequency it would be theoretically possible to transmit a chequerboard pattern, the sides of whose squares would be equal to the width of one scanning line. We are now in a position to examine this point in greater detail.

A term which is frequently used when referring to television reproduction is picture element. Fig. 16 shows part of the chequerboard pattern we have just referred to. Each black square, and each white square, in this pattern could be described as a picture element. The waveform given by a camera scanning along line XY of the chequerboard would be that shown below the pattern. We know that each cycle of picture information corresponds to two picture elements; or in other words that, if a cycle commences at a point where a black square changes to a white square, it ends at the point where the next black square changes to a white square. A second term employed to describe a television picture is its aspect ratio. The aspect ratio of a picture is the ratio of its width to its height and, in the 405 line system, is 4 : 3. Thus the width of the television picture is 4\frac{1}{3} times its height.

The number of active horizontal lines in a 405 line is 405 minus the number lost in the frame blanking period. An average of 28 lines (each of the two frame periods are equal to 14:2 lines) are lost here so the number of active lines left in the picture is 377, each of which is capable of reproducing in the vertical sense, one picture element; i.e., a white square of the chequerboard appears on one line, a black square on the line above, and so on.

![Diagram](image-url)

**Fig. 16.** The "chequerboard" concept employed for evaluating horizontal versus vertical resolution.

Let us now work from the assumption that 3Mc/s represents our top picture information frequency. Each cycle of this frequency will occupy 1/3 \mu s of time with the result that, in our average line of 80.7 \mu s picture information time (see above) we may reproduce 3 \times 80.7 \mu s; that is, 242. Each cycle contains two picture elements, so we may say picture-Mc/s corresponds to 484 picture elements in each line of the picture. However,

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1 This assumes a mains supply frequency, to which the transmitted frame frequency is tied, of 50 c/s.

2 This figure is equivalent to the aspect ratio of commercial moving picture film. Or war, in the pre-Cinemascope days. (continued on page 592)
The
AJAX
Crystal Receiver

Described by P. VERNON

Crystal receivers are always in the news and several have been described within the pages of The Radio Constructor in recent years. Despite this, however, the demand for these relatively simple and inexpensive receivers continues unabated among our younger readers. As an introduction to the hobby, and to radio construction in general, they are ideal for the enthusiast. The receiver about to be described offers nothing new in the way of either circuit or technique—but it does bring within the reach of the “out-of-town” constructor the means by which all the components can be purchased from several of the advertisers in this issue all in one parcel. A further advantage is that a well-designed casing of attractive appearance, together with a suitable tag board, is available. The cream plastic case, together with the red figured dial and white pointer knob, makes an attractive ensemble and has considerable eye appeal. The lid of the case is robustly fixed to the casing body by means of a metal hinge.

Circuit
This is shown in Fig. 1, from which it will be seen that it is a perfectly straightforward crystal detector circuit. Although the quality of a crystal detector is excellent, there usually remains the great disadvantage of lack of selectivity, the greatest cause of this being the dampening load across the tuned circuit caused by the detector itself. In the circuit shown, the selectivity problem has been largely overcome by using a triple-wound coil. This particular coil (Teletron type HAX/M/MW) has been specially designed by the manufacturer for use with germanium crystal diodes. The maximum selectivity, together with a high signal output, has been achieved through the minimum damping of the tuned circuit achieved by the inclusion of a separate winding for the crystal diode. The employment of these new miniature type diodes largely removes the main problem associated with crystal receiver design and construction.

Alongside the circuit is shown the point-to-point wiring diagram, both being simplicity itself and requiring little explanation. The tuning condenser is of the variable mica dielectric type—these being more compact that the normal air-spaced types and thus being admirably for crystal sets which are usually required to be of small physical dimensions.

No particular germanium diode is specified, the reader being free to choose any that he may prefer. Types such as the Brimar GD4 or the Mullard OA71, or others such as the GEX34, GEX44, GEX55, GEC45, IN34, or the BTHCG1 will perform equally well in this circuit. All of these crystal diode types have a very low forward resistance, being of a few hundred ohms only, while their reverse resistance is very high.

The headphones used should be of the high impedance type—4,000Ω if possible.

Construction
Assuming that the reader has purchased the complete kit as offered by an advertiser, the method of construction is very simple indeed. For the benefit of the beginner readers, these instructions are set out below.

First, mount the Teletron type HAX/M/MW coil on the paxolin chassis by means of the long screws provided. It will be noted from the photograph shown here that this coil is positioned so that the slot in the tag ring is towards the bottom end of the case. Three holes are already drilled in the paxolin chassis, and the two lowest should be used for mounting the miniature coil. The remaining hole at the top is for use with the standard type HAX coil—this being somewhat larger than that shown here. Should this standard type coil be used, the two outer holes will, of course, be used for mounting the coil—in which case the coil connecting tags will require to be carefully bent downwards in order to permit the casing lid to be fully closed.

Having mounted the coil, the wiring should now be carried out with the chassis outside the case. First, solder the crystal diode into position, using a pair of pliers as a heat shunt, i.e., gripping the lead between the joint and the glass. The red, or positive, end of the diode should be soldered to tag 3 of the coil situated at the top right of the tag ring (see photograph and Fig. 1). The black, or negative, end of the diode should next be soldered to the bottom right-hand socket looking at the chassis from the front, this tag being one of the ‘phone output sockets. The eventual position of the diode may be seen from the illustrations. Next, with a suitable length of bare wire, solder together the top left hand socket (earth connection), to the bottom left hand socket (remaining ‘phone output socket), and from there to coil tag 1 at the bottom left-hand of the tag ring. From this latter tag ring, also solder one end of a small length of p.v.c. wire of sufficient length to reach the tuning condenser when mounted.

Component List

| Headphones 4000Ω Impedance.          |
| 500pF Variable Condenser (Mica Dielectric). |
| Crystal Diode (see text).            |
| Pointer knob.                        |
| Screws, nuts, connecting wire.       |
| From tag 2 of the coil at the top left of the tag ring, solder one end of a length of p.v.c. wire, the other end of which should now be secured to the top right hand socket of the chassis (this being the aerial input terminal). Having completed the above, fix the chassis into the case by means of the two small screws and nuts provided. |
The next item to place in position is the tuning condenser. Mount this, by means of the nut and threaded spindle, into the case lid. Secure the pointer to the spindle in such a manner that the pointer fully covers the dial readings in conformity with the condenser “swing.”

at the bottom left of the tag ring, is connected to the larger of the solder tags on the tuning condenser (this tag being secured to the condenser spindle by a large nut).

This completes the wiring and assembly of the crystal receiver. Connection of an aerial, earth and headphones will enable the con-

The completed receiver with lid opened to show wiring

The final connections are those to the tuning condenser and these are best carried out by approximately half closing the lid (see photograph for this position) and then soldering the respective connections. Connect by means of a suitable length of p.v.c. wire tag 4 of the coil (lower right hand of the tag ring) to the smaller of the condenser solder tags. The remaining length of p.v.c. wire, that we have previously soldered to tag 1, to tune in most of the local stations; but it should be pointed out that a really good aerial and earth system are required to enable the receiver to perform with its maximum efficiency.

This little crystal receiver is not only ideal for the beginner but would also make an attractive present for the junior members of the family.

ERRATA: In the circuit diagram of the Virtuoso Amplifier on page 488, last issue, R10 was inadvertently omitted. It should be connected between R4, R5, C1 and C2.

A similar error occurred in Suggested Circuits No. 87, where in Fig. 1, page 463, R12 (between R13 and h.t. +) was indicated but not shown.

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THE RADIO CONSTRUCTOR

A VERSATILE 2-VALVE

PRE-AMPLIFIER

By R. HAYES

A T THE NATIONAL RADIO SHOW LAST YEAR, the writer was looking for a pre-amplifier design which would enable him to obtain all the facilities provided by the better-class commercially made "Hi-Fi" amplifier equipments at which one is inclined to look so longingly. An extremely interesting array of items on the Mullard stand, who devote a special section to cater for the needs of the amateur constructor each year, attracted my attention and subsequently ended my search. Having discussed the question of pre-amps with an enthusiastic Mullard attendant there, I was shown a prototype version of an extremely useful and flexible 2-valve pre-amp which would give me the required facilities, all provided by the operation of a single rotary switch. Originally this piece of equipment was designed for constructors who had built the Mullard “5-10” 10-watt High Quality Amplifier and who wished to alter its form to accept a number of varying inputs. The addition of this pre-amp to that amplifier can be carried out quite easily by removing the existing input circuit of the “5-10” in “one lump,” as it were, and substituting the new pre-amp. This would seem a worthwhile addition to make to the original “5-10” as by so doing the following inputs can be accepted, and provides the link by which the main amplifier can be put to many uses and which would form the basis of a very classy complete “Hi-Fi” outfit. Such an equipment could compare favourably with the best money can buy, provided that care is taken in selecting the ancillary equipment such as loudspeaker, tape-deck, i.m. tuner, pick-up, etc.

The writer now has such an outfit and felt that, in view of the fact that the Mullard leaflet issued so far on the pre-amp only gives the circuit, description and component list, the constructional details should be of interest to the many constructors who have built the main amplifier and merely use it for gramophone reproduction or in conjunction with an i.m. tuner.

Description

The circuit (Fig. 1) used here gives the output connections to the Mullard “5-10” (from the junction of R2 and R3). The full output can be taken, if required, directly from the anode of the second valve via the usual condenser, from which it is true to say that the pre-amp will serve admirably in front of many other well-known amplifiers, including the Mullard “20 watt.”

Mullard Ltd. state that the original and only leaflet issued (their ref. TP331 Aug. 1957) is now being revised so that the circuit details and component numbering used in this article are as will appear on a forthcoming publication by them.

Before describing the construction of this amplifier, let us look over the specification quoting from the above-mentioned leaflet.

Mullard EF86 high gain pentode valves are
used in each of the two stages, all equalisation being achieved in the first stage by means of frequency-selective feedback applied from anode to grid of V1. The second stage embodies no feedback, but arrangements are made to determine the sensitivity of the amplifier by altering the ratio of R3 and R4. An alternative method consists of adjusting each input channel individually by altering the series grid resistors of V1 (R1 to R4). You will see, therefore, that either the overall sensitivity can be set at maximum or minimum, and either of these conditions can be maintained whilst individual input channel sensitivity and impedance can be adjusted as required. The input impedance of any one channel is the sum of the series grid resistor and the effective grid impedance, which latter can be taken at 20kΩ.

Switch Position Summary

1. Auxiliary Position
   This position can be used for Mullard Tape amplifier insertion or high-output crystal pick-ups. If required for low-output crystal pick-ups, R4 can be cut down to 1MΩ. Otherwise it is identical with the radio input channel. As it is shown, input impedance is 2MΩ, sensitivity 250mV.

2. Radio Position
   With the impedance and sensitivity as for "Auxiliary" position (these values being most suitable for normal requirements) any alteration to the circuit can be achieved by varying the feedback resistor R3 and series resistor R4. For example, if the input impedance is too high it can be decreased by a resistor of the requisite value from the input end of R3 to chassis.

3. Tape Playback Position
   Intended for the replaying of pre-recorded tapes using high impedance heads, the input impedance is arranged to be 80kΩ as shown—but if more sensitivity is required, R4 can be decreased until a satisfactory level is reached.

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Sensitivity as shown is 3mV and the C.C.I.R. characteristic is followed down to 100 c/s; below this frequency less boost is evident.

4. **Microphone Position**

High impedance microphone equipment is catered for on this channel, the usual crystal, or magnetic type with matching transformer, being the two forms usually encountered. With an input impedance of 1MΩ the sensitivity is 6mV.

5. **Magnetic Pick-up Position**

This position is ideal for those fortunate enough to possess a variable-reluctance type kind ly to this loading, or its output is too high, you can use the auxiliary switch position as described, when the exact loading required can be provided. In comparison to Position 5 the sensitivity of this channel, as given, is 50mV at 1 kc/s for L.P. and 150mV for the 78 r.p.m. position, and you can compare this with the figures given for the auxiliary position.

*N.B.*—Regarding Switch Positions 5 and 6, it is essential that these two input sockets do not have the magnetic and crystal pick-ups plugged in together.

Illustration of a prototype showing appearance of completed pre-amplifier, with cover plates removed

Other points of interest to note are that the equalisation for the pick-up positions conforms to the latest R.I.A.A. characteristics which are in use by most of the well-known recording companies, whilst the tape playback characteristic is suitable for replaying pre-recorded tapes at 7½ inches per sec.

It will be noted that low impedance tone controls covering a wide frequency range are used, making the pre-amplifier give sufficient control for most applications today, and making it possible to use reasonable lengths of co-axial input cables without their attendant capacity effects.

With regard to the h.t. supply, the current drawn by the unit is 3mA. The smoothing circuit shown in dotted inset should be included in the main amplifier chassis, a good
place usually being to attach it to the supply socket provided. With 320V available from the main amplifier supply it is quite easy to calculate that R_33 should be volts to be dropped by current drawn.

The value of the resistor is therefore 30kΩ 1½ watts, which is a suitable one to insert in the above case, and can be made up from two 15kΩ ½ watts in series. This value should be within ±10%, and alteration can be made to suit a particular h.t. supply. The capacitor should be a 16μF electrolytic.

Construction
A ready-punched chassis can be obtained from a number of retailers, details of which will be found among the advertisements in this issue. The usual "box" type of chassis is not employed, it being felt that the home constructor would best be served by a unit construction type of assembly.

Figure 2 shows the chassis with component parts in position. This photograph in conjunction with the layout diagram (Fig. 3) will enable the constructor to get a start at assembling. It was found advisable to solder the resistors and capacitors on to the two group boards before fixing their supporting bracket on to the main chassis. With these in position and the two group boards bolted on, there is very little difficulty in following out a wiring sequence which becomes obvious if a start is made at the output socket, tackling the valveholder connections to the group board assembly first. Certain of the wiring to the control panel components is best accomplished with the front panel detached, and the channel selection switch is best left until last.

One very important point concerns the earthing arrangements. It is important that the "earth rail" system be used which only makes contact with the chassis at one point and one point only. Fix a soldering tag at a convenient point in the middle of the six input sockets, and use this as the terminal point of the "earth rail". It will be found that, starting at the earth tag, a lead can be run along to spigot (V1), on to spigot (V2) across to the joint of C_19, R_34, and thence to the joint of C_6, R_7, C_9. The following can then be "hooked on" to the "earth rail" where convenient: R_7, R_16, R_20, C_12, C_8, C_9.

The h.t. line is best secured to the end of R_33 which comes nearer the front panel. A hole to which a rubber grommet should be fitted is provided, through which the supply cables are run. Some form of retention should be made on the cable inside the box to prevent undue strain on the soldered joints. This can be achieved either by a whipping, tied to the chassis, or by means of a cable cleat which can be placed in the space on the bracket carrying the group boards. The heater pair should be separately twisted along themselves, and for neatness the h.t. positive and the twisted heater pair again twisted together. The writer understands that a suitably engraved panel is being prepared for sale through dealers. This is necessary in order to present an acceptable exterior when fitted into your cabinet.

In conclusion, no difficulty should be encountered in the construction; and there is no reason why, with reasonable care and attention, your various pieces of equipment are correctly plugged into the requisite input socket, you should not enjoy immediately the very great advantages of being able to switch over from gramophone to tape or F.M. or microphone, and so on, by the operation of a single switch.

Films for Electrical Trades
A number of 16mm films which are of interest to the electrical, radio and allied trades have been added to the G.B. Film Library's hire list of industrial subjects. They include Project Tinkertoy from America, which demonstrates the application of machine assembly methods to the production of electronic components.

Others are Water Power (describes methods of utilizing water for generating electricity); The Steam Turbine (showing its development from Hero of Alexandria to Parsons); Electro-Magnetic Induction (principles demonstrated by animated diagrams); Cathode Ray Oscillograph (construction and application); The Microphone (explanation of carbon and ribbon types); A Switch in Time (illustrates the principle of motion study in the assembly of a light switch); Elements of Electric Circuits (the concept of electric currents and flow electrons); Series and Parallel (the relationship between resistance, current and pressure in series and parallel circuits); How Television Works (explains how a television camera analyses a picture into electrical impulses for broadcasting); and Primary Cell (a study of dry cell operation in terms of electron action).

In addition to these, further titles are available on free loan. They are Power Tools in Industry (covers the building operations by various trades from the foundations to the completion of a house); Golden Minutes (illustrates creative electrical tool selling with special emphasis on good display); Modern Motor Manufacture (describes the manufacture of the Ferranti single-phase type F.M. meter); and Opportunity Knocks (demonstrates effective sales approaches for salesmen of power tools).
The

HI-GAIN BAND III
PRE-AMPLIFIER

By DEREK WINTERS

The “Hi-Gain” pre-amplifier is intended for insertion between the aerial and 75 ohm input circuit of any television receiver capable of reception on Channels 8, 9 or 10. Low noise performance, a gain of 17 dB or more, and simplicity of trimming adjustments make this pre-amplifier a very attractive item for the home constructor.

Design Progress

The writer feels that it would be of interest to readers if the steps involved in the design and manufacture of the prototype Band III pre-amplifier were detailed here in more or less “chronological” order, because such a procedure not only assists in giving an insight into the technical functioning of the pre-amplifier but also enables the constructor to understand the necessity for arriving at certain decisions concerning the overall design.

It was considered from the outset that the pre-amplifier should be completely self-contained, it consisting of a unit having a 75 ohm input socket, a 75 ohm output socket, and a mains supply lead. No on-off switch would be fitted, as the constructor would probably prefer to connect the mains input of the pre-amplifier to the mains circuit of the associated television in such a manner that...
The circuit design of the pre-amplifier proper was next considered, and it was felt that a single cascode valve should provide enough gain for normal requirements provided that care was taken with its operating potentials and that best use was made of the tuned coils in its input and output circuits. This last requirement raised what was probably the greatest design problem of all. The difficulty here was due to the almost certain fact that the average home-constructor building the pre-amplifier would be without access to a wobbulator and oscilloscope capable of displaying a response at Band III frequencies, whereupon alignment would have to be carried out on received signals only. The response curve of the pre-amplifier would, in consequence, have to be fairly flat if tuning on received signals was to be undertaken, incurring thereby a possible loss in gain. In practice, the conflicting requirements of a flat response and good amplification are, however, met quite successfully in the Hi-Gain unit. The overall response of the prototype dropped some 1 to 1.5 dB at 2 Mc/s on either side of centre frequency and the overall gain is of the order of 17 to 18 dB (input and output loads being 75 ohms respectively.

The final decision which had to be made during initial design concerned the chassis on which the pre-amplifier was to be built, and it was found that the Teletron Converter chassis, already available at a reasonable price, lent itself excellently for the purpose. It is necessary to drill about half a dozen holes in the Teletron Converter chassis to fit it for its new role, but this means far less work than would be required if the pre-amplifier chassis had to be made entirely from scratch. In order to ease drill requirements, satisfactory results can be obtained if all the extra holes are drilled 6BA clearance only. There is the further advantage that the use of an already-tooled chassis ensures that the all-important layout of the r.f. section of the pre-amplifier is copied exactly by the constructor.

Having proceeded thus far, work commenced on the prototype, with the result that the circuit shown in Fig. 1 was evolved.

**The Circuit**

The circuit of Fig. 1 illustrates a fairly conventional cascode amplifier plus a small power pack. In the diagram the Band III aerial is applied, via the input socket, to the coupling winding L1 of the input tuned circuit L1 C1. The turns ratio of L1 to L2 is that which was found to offer greatest transference of energy from a 75 ohm input source. So far as can be determined the standing wave ratio on a feeder connected to the pre-amplifier input circuit is low, the feeder being ’dead,’ whatever its length, to hand-capacity and similar effects whilst the response of the pre-amplifier is displayed by a wobbulator and oscilloscope. It is important to maintain a low standing wave ratio in the input circuit of a Band III pre-amplifier, not only to prevent losses and ghosting but also to avoid feedback between input and output feeders. During tests, the pre-amplifier output was connected to the aerial sockets of several commercial sets and no instability or shift in response was evident when the aerial feeder was held close to the pre-amplifier output feeder.

Instead of relying entirely on tuning by valve and stray capacities, a small fixed condenser, C1, connects across the input tuned coil, L2. This condenser is fitted for a number of reasons. Firstly, the use of a condenser of this type assists in achieving the response characteristic desired from the pre-amplifier. Secondly, despite its low capacity of 2 pF, C1 helps in swamping the capacities which are presented to the coil by the input capacity of the cascode, its valveholder, and the immediate wiring. Such capacities are liable to vary rather widely from unit to unit when the equipment is of the home-constructor variety. Thirdly, the use of the condenser assists in easing the very tight inductance tolerances which have to be met by L5, thereby enabling this coil, if produced commercially, to meet the requisite frequency range more reliably. When it is considered that a very large number of Band III coils used in commercial tuners are adjusted to their shape after they have been fitted into their immediate circuits, the difficulties of producing reliable coils for home-constructor apparatus may be more readily appreciated.

The tuned circuit, L2 C2, connects to the first triode V1b of the cascode via a conventional neutralising arrangement. Neutralising is provided by C5 and C6, and functions by reason of the fact that the triode anode...
voltage is fed to the condenser potentiometer given by C3 and C5 in series, the end of the coil remote from V1(0) grid connecting to the tap between these two condensers. Although not obvious at first sight, coil L2 is effectively paralleled by two capacities in series, their junction being at chassis potential. These two capacities are provided mainly by the C4 and C6 of V1(0) (plus stray) and they have the same effect as do the "hidden" capacities across the coil of a conventional Colpitts v.h.f. oscillator. In the case of L2 the presence of the "hidden" capacities provides the coil with an effective earthy tap between its two ends, and enables the neutralising feedback voltage to be applied in the correct phase. The neutralising network in the "Hi-Gain" unit gives a very satisfactory performance and this, combined with the double screening between input and output coils, enables extremely stable overall operation to be achieved.

The peaking choke L3 couples together the two triodes of the cascade, its function being to operate as the inductive element of a pi filter, the two capacities to chassis on either side being provided by the output and input capacities of the triodes. By taking advantage of the stability given in the "Hi-Gain" circuit, and by keeping its Q to a fairly low value, the choke L3 is made to resonate at the centre of the band of frequencies the preamplifier is intended to cover. This is mainly because of the fact that the unit is able to provide its relatively high amplification figure whilst still retaining a broad response characteristic. It must be pointed out that, due to the function it carries out in this particular circuit, L3 becomes rather a "critical" component. In practice, the choke needs to be handled carefully in order to prevent displacement of its turns. It should also be carefully soldered to the appropriate valve pins in the manner described in the assembly instructions.

Two important components in the cascade circuit are R3 and R4. These two resistors regulate the h.t. voltage applied to the grid of the second triode, and their ratio was determined empirically under working conditions. The fact that both resistors possess the same value is incidental. The condenser C5 is also of importance, since it decouples the grid of the third triode, this being usually the "hottest" point in a cascade amplifier. It is essential to use a good quality condenser in the C5 position, and to connect it correctly. The bias resistor R2 also has an important bearing on cascade performance. In the prototype, the value shown for this resistor resulted in a cathode current of 14 mA, this being comparable with the figures given by commercial applications and comfortably within the manufacturers’ limiting value of 18 mA.

The anode of the cascade second triode connects to the output tuned circuit L4 C8. Here again, a 27°C condenser is parallel across the coil, this being fitted for the same reasons as were discussed earlier for the presence of C1. The coupling coil L5 provides an output at 78 ohms impedance for connection to the subsequent receiver.

The power pack circuit requires little comment. The rectifier, W1, is a small contact-cooled component and is bolted to the side of the chassis. The thermal contact between the rectifier and the chassis then enables any heat which is dissipated to be conducted away. The resistor R6 is a ripple-limiting component, and at the low h.t. currents involved here, causes little loss in h.t. voltage. Since the small mains transformer specified has a fairly high internal resistance, R5 is not entirely essential. However, its presence provides an increased safety factor and it is worth including if only for that single purpose.

Performance

After work on the prototype was completed, a number of performance checks were carried out. The gain provided at channels 8 and 9 was 18 dB; and that at channel 10, 17 dB. These figures were taken with resistive input and output impedances of 75 ohms, and may vary somewhat (up or down) when impedances other than 75 ohms are applied to the input or output sockets.

Checks with several commercial receivers and an aerial fed via attenuators to reduce input level gave promising results, and the writer’s aim, that of providing a picture of entertainment value where no picture previously existed, seemed to be satisfied. The pre-amplifier was then checked on a fringe site where it resulted in a very considerable improvement in picture level. (So much so, indeed, that the set-owner was very loath to part with it for tests elsewhere!). Further checks on other sites also gave good results. So far as noise level was concerned, the prototype gave a good account of itself, and it compared favourably with the noise level given by a number of commercial tuners.

Construction

The construction of the amplifier is fairly simple to carry out, and the only point to which especial attention must be given is the necessity of ensuring that layout of r.f. components conforms accurately to that given in the wiring diagrams.

It is first of all necessary to drill the extra holes required by the pre-amplifier circuit in the Teletron Converter chassis. The postitions of these holes are indicated in Fig. 2. Many constructors will drill the extra holes after carrying out the normal workshop practice of marking out their centres, but others may wish to follow the somewhat less accurate (but still practicable enough) process of using the components themselves as ‘templates.’ If this latter course is followed, be quite satisfactory if a smaller drill is not available. The contact-cooled rectifier is mounted by 6BA nuts and screws situated at the points marked “D.” These holes correspond to the particular rectifier employed in the prototype. If an alternative rectifier is used the position of holes “D” may vary, but the general siting of the alternative rectifier should still be the same as is indicated in Fig. 2. The mains transformer is bolted to the holes marked “E.” These should, preferably, be 4BA clearance, although 6BA clearance would cope if washers were fitted under the bolt heads. The final hole “F” is intended for mounting the 3-way tagstrip, and should preferably be 4BA clearance although—once more—6BA clearance will cope. As may be seen from this paragraph,
all the extra holes required in the chassis could be made with a single 6BA clearance drill, this point being of possible advantage to those constructors who do not have extensive metalworking facilities.

The main components may now be mounted, those taking up the positions illustrated in Fig. 3. This diagram does not show the mains transformer, which is mounted above the chassis. The position of the mains transformer is, however, readily evident from the photographs accompanying this article. The electrolytic condenser, C6-C9, is mounted on its side, being held in place with

of C4-C6 which connects to the junction of R3 and R6.

The 470 ohm resistor R6 connects to that tag of the rectifier which is marked with a positive sign. Connections from the coils to the coaxial input and output sockets are also made at this stage. Where it is necessary to shorten the insulated leads from the coils this should be done carefully, taking care not to exert too much tension during stripping. These leads from the mains transformer travel through the large hole immediately under this component and connect to components below the chassis. One lead connects to the same

![Diagram of the circuit setup](image)

**Fig. 3.** The positions taken up by the main components, together with the initial stage in wiring. The three leads from the mains transformer are discussed in the text.

the clip with which it should be provided. The clip is secured to one of the clips already punched in the chassis. It will be noted that five solder tags are held under component mounting nuts, and it is important to ensure that these are held down very securely, as intermittent operation at v.h.f. can easily result from poor chassis connections. The screws, or screws and nuts, securing the two coils should not be tightened excessively, as damage to the plastic former bases may result.

Fig. 3 also illustrates the power supply wiring, plus the first stage of r.f. wiring. It should be noted that it is the 16 µF section chassis tag which provides the earth connection for the electrolytic condenser case. This lead connects, above the chassis, to one side of the heater secondary and one side of the h.t. secondary. The second lead passing through the large hole connects, above chassis, to the remaining h.t. secondary tag and, below chassis, to the rectifier. The third lead connects the remaining tag of the heater secondary to pin 4 of the valveholder. There is no mains wiring below the chassis. All points marked "X" in Fig. 3 should be left until the stage, as further connections are made to them later.

**Fig. 4.** The second stage in wiring. C9 should be mounted close to the turns of L4, L5, using short connections. **Fig. 5.** The final wiring stage. C5 should be connected via very short leads, and L3 should be positioned at the angle shown here.

The final process consists of connecting the mains lead to the mains transformer. This is carried out above the chassis at the appropriate transformer tags. If so desired, the mains lead may be anchored to the chassis by means of a suitable clip secured under one of the transformer mounting screws.

**Alignment**

The pre-amplifier is now complete, and is ready for testing and alignment. Before it is coupled to the television with which it is to be used, the latter should be set up to receive the Band III channel desired, and its fine channel tuned for optimum sound (or for any other indication of optimum tuning which may be advised by the manufacturers). The Band III aerial is then disconnected from the receiver and inserted into the input socket of the pre-amplifier. A further length of coxial cable then couples the output socket of the pre-amplifier to the aerial socket of the television. It would be worthwhile mentioning at this stage the somewhat obvious fact that the output socket of the pre-amplifier is close to the tags of the mains transformer and that, in order to prevent shock, the pre-amplifier should be disconnected from the mains when plugs are being fitted to, or removed from, this socket.

The pre-amplifier is next connected to the mains and the ECC84 allowed to warm up.

Assuming that everything is well, all that is then required is to align the cores of the pre-amplifier coils, these being adjusted for maximum signal strength. It will very probably be found that adjustment of the cores may give an improvement of flatness of tuning. The main reason for such an impression is that the cores do not cause a large change in inductance in the particular coils which are employed in the pre-amplifier. (Incidentally, it should be pointed out that the cores still have an effect on inductance when they are some way out of their formers, and it may be necessary for them to be so positioned when alignment is carried out on Channel 10.) A second reason for the
impression of flatness of tuning is due to the fact that indications of signal strength will be obtained by observing the received picture, this method is not normally giving so positive an effect as would be given by, say, increases in volume in a sound signal. If necessary, it may be found easiest to set the pre-amplifier cores to a position mid-way between the points where the picture level obviously becomes degraded. The impression of flatness of tuning will be very apparent in receivers employing vision a.g.c. and/or a.c. couplings to the tube.

Before concluding, it would be advantageous to deal with one or two points concerning the pre-amplifier installation. Although the pre-amplifier should be inherently stable, it is inadvisable to run the coaxial lead from its output socket very close to its input feeder. As was mentioned earlier in the article, no instability or detuning occurred when this was done with the set in operation. Nevertheless, such troubles could occur if either the Band III aerial or the input circuit of the television set is not shielded properly. No input modification at the aerial inspector will affect the signal to the extent of avoiding such a risk. Bad input matching at the aerial inspector socket the aerial inspector socket may also cause difficulties due to the consequent appearance of standing waves on the feeder between this inspector and the pre-amplifier input; and the output points may be necessary to avoid lengths of coaxial cable between the two sockets which are odd multiples of a quarter-wavelength of the signal being received. This situation is complicated if a further length of coaxial cable inside the receiver cabinet couples its aerial socket to the tuner inside the cabinet. In poor results are obtained on first installing the pre-amplifier it might be worthwhile experimentally shortening (or extending) the length of feeder between the two units in one or two successive steps of six inches.

Acknowledgments

Before concluding, the writer would like to express acknowledgments to the Teletron Co. Ltd., for assistance with coil design.

Can Anyone Help?

R. J. DEAS, 108 Woodland Way, Winchmore Hill, London, N.21, requires technical, servicing and aligning instructions for the ex-Govt. receiver R.1132A. He has the circuit diagram fitted in the case, but more detailed information is needed, particularly on the aerial feeders and b.f.o. units.

CAPT. G. A. DAWE, 19 Coy R.A.S.C. (Tt. Tp.), Ranby Camp, Retford, Notts., wishes to obtain information on the battery mains portable receiver TEKADE, type GBW.167, No. 096784. Valve line-up DF91, DK92, DF91, DF91AF, DL94 (or equivalent). In particular he would be grateful for details of the coil pack, and is willing to pay for information, service sheets, etc.

J. AYRES, G3DQT, 7 Berrylands Road, Surbiton, Surrey, wishes to buy or borrow the circuit of the Army R.209 receiver.

E. M. STEVENS, "Foxwood," 14 Trowce Gardens, Sherwood, Nottingham, would like to buy or borrow a copy of Bernards No. 1 Amplifier Manual (now out of print).

L. WOODLEY, "Nokomis," Great Stambridge, Rochford, Essex, wishes to borrow or purchase the circuit of the Marconiphone model 392 a/c.d/c. 4-valve superhet radioboom.

C. McCHESSNEY, c/o 10 Ella Street, Hull, Yorks., requires the back numbers of The Radio Constructor or any other journal describing the conversion of the Indicator Unit 182A to a 'scope, on sale or loan.

M. BUTTON, 7 Upper Flowerfield, Nunney, near Frome, Somerset, requires details for converting the R.1132 receiver for use on 144 Mc/s, and is willing to pay for any circuits, etc.

W. PHILLIPS, 130 Hillbury Road, Warrington, Liverpool, would like to buy or borrow the manual and/or operating instructions for the type 52A Signal Generator, ref. no. 1058/087.

J. HILL, 177 Hillyfields, Loughton, Essex, would like to borrow or buy a service manual for the Eddystone 350 or 356X receiver.

J. A. MORAN, La Cotte Cottage, Route Orange, St. Brelade, Jersey, Channel Islands, is anxious to obtain data, service sheets, circuits, etc., on the 8-valve receivers made by R.A.P. (England) Ltd. up to about 1952, when they went out of business. Valve line-up is 6K7G, 6K6G, 6K7G, 6Q7G, p.p. 6V6G's, 6G5 and 5Z4. Speaker 10in Rola enemised.
For the information of more advanced constructors, the original amplifier uses a U7F6 and a pair of UCL92s. The circuit arrangement and components values were based on those used in a 7-watt high-quality amplifier designed for a Federal Service Dept. of Mullards. A 4-page folder giving full details (TP325), circuit and layout was published by them in August last year and, I believe, is still available.

Blow—or Suck?
Almost every other week one reads of educationalists and others urging young women and girls to seriously take up technical and scientific careers. Perhaps I may be old-fashioned, but somehow I feel the prospect of large numbers of female engineers and scientists rather frightening. It is rather alarming to think that in a couple of generations some poor chap will have to look after the children and pavements while his wife, as Director of an Atomic Pile, dashes off to catch the 8.10. Encouraged by these constant appeals for brains among women, there may come a time when even the most important job, even the amateur movement might be overemphasized by a feminine invasion, and the poor husband will find himself doing the cooking and putting the kids to bed while his wife is out in her workshop bending and drilling a chassis for their new t.v.

Already a few women do take radio seriously. Even this column, on the odd occasion, has been honoured by a letter from a YL reader. I have never discovered whether the liking for the hobby is natural or the result of the exuberance of a persuasive science mistress.

A newcomer to the fold is Miss Nola Brophy (Finley Barry Road, Age 93) years. She has applied herself to the problem of t.v. interference—especially lighting. Her system uses a "Sterroscope" (costing 10/-) attached to the rear of the set. She explains "All the interference is reflected off to the sterroscope while the machine switches itself on and off because of the interference to get stuck through the sterroscope and out of the back down the wire that leads to the aerial. This wire has wire-netting over the funny pipes, and the interference goes along the wire in and out through the funny pipes on the aerial."

Centre Tap talks about Items of General Interest

A Lot of Bricks
In our January issue I mentioned an obviously worded circular letter from ex-DLICU who, as a result of a private war against higher authority, became the subject of diplomatic exchanges and forfeit his premises. Now I have received an interesting letter from a British "exiled" Gerald Lander (G.392, DL1952) which fills in many of the details. It was only after reading Gerald's letter I already knew something of ex-DLICU's past exploits and reputation as an indefatigable fighter against officialdom. On this occasion, apparently exhausted by the unwillingness in official circles to take action about broadcast intrusion in exclusive amateur bands, he organised a protest. The protest took the form of employing as many DL amateurs as possible to put on their 40-metre transmitters one Sunday morning. The result was the resignation of DLICU's interference, but in view of his reputation for coming back fighting, quite a lot of people feel that may have continued on page 592.

This receiver has been designed to provide what the writer believes is an entirely new valve line-up for this type of set.

Circuit Description
As will be noted from the circuit diagram, the receiver is a 4-valve superhet receiver using all B7G-based valves and in a half-wave rectifier for h.f. supply. Vs is a Brimar 6B6E pentode operating as frequency changer with electro coupling. The input to this valve is from a short throw-out aerial via Osmon aerial coils type QA8 and QA9 for medium and long waveband operation, or as an alternative Osmon medium and long waveband ferrite rod aerial type XFR 2.

As noted the oscillator section is somewhat different from the usual type of superhet receiver in that the feedback winding of the oscillator coil is in the cathode circuit of the valve. This type of operation is ideal for the type of valve in use and gives a very good performance. It is advisable that only the type of coil specified be used as this coil has a very tight coupling between primary and secondary windings, a factor which contributes to the performance of the receiver.

Vs is a Brimar 6B6E variable-mu h.f. pentode operating as i.f. amplifier in conjunction with the two i.f. transformers tuned to 485 kHz.

Vp is a Brimar 6B6E h.f. pentode which is used as 1st a.f. amplifier. As this valve has no signal diode, a Brimar GD3 germanium diode is used for signal rectification and a.c. voltage. It will be found that with this combination of valve and separate signal diode, a very high gain is available with the added advantage of hum free operation. This is very noticeable when searching for a station with the volume control at maximum.

Vs is a Brimar 6AK6 output pentode feeding the 5m. loudspeaker via the output transformer.

A GENERAL PURPOSE SUPERHET

By S. E. ADDIS

THE RADIO КONSTRUCTOR

MARCH 1958

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Components List—set out for easy reference to above diagram

Condensers

- C1 100pF Silver Mica
- C2 100pF Silver Mica
- C3 470pF Silver Mica
- C4 300pF Silver Mica
- C5 0.01µF 250 VDC
- C6 0.01µF 250 VDC
- C7 100pF Silver Mica
- C8 0.01µF 250 VDC
- C9 0.01µF 250 VDC
- C10 0.01µF 250 VDC
- C11 0.01µF 350 VDC
- C12 13 32 + 32 µF 250 VDC Electrolytic
- C13 25µF 25V Electrolytic
- C14 0.01µF 250 VDC

Cabinet and Chassis,

5in. Loudspeaker with output transformer.

Resistors

- R1 1 MΩ 1W
- R2 27kΩ 1W
- R3 18kΩ 1W
- R4 500kΩ Volume Control with Switch
- R5 10 MΩ 1W
- R6 2.2 MΩ 1W
- R7 470kΩ 1W
- R8 470kΩ 1W
- R9 1.2kΩ 1W
- R10 470 Ω 1W
- R11 2.2 MΩ 1W

4-pole 2-way Wavechange Switch,

50kΩ Volume Control and Switch.

Valves

- Brimar 6BE6 (V1)
- 6J6 (V2)
- 6J6G (V3)
- 6AK6 (V4)

GD3 or GD5 Germanium Diode (D1)

Trimmers

- 2 50pF M/W (TC1, TC2)
- 2 100pF L/W (TC3, TC4)

Osmor Coils QA8 and QA9 or Ferrite Rod

Aerial type QFR 2.

Osmor Coil QQ8.

Metal Rectifier H.T. type 250V 30mA (MR).

Mains Transformer, mains input to 200V, 25 mA, 6.3V, 1A.

Midget Osmor 465 kc/s i.f. Transformers (2).

H.T. voltage is obtained from the mains transformer and a small metal rectifier.

Construction

The receiver is constructed on a double chassis and the transformers are mounted on the back. The transformers and the i.f. transformers are mounted at right-
If the receiver is fitted with the aerial coils, attach a short length of wire to the aerial socket. Carefully rotate the tuning condenser until the local station is heard. Now carefully adjust the core of the i.f. transformers for maximum volume. If no signal can be received when using the ferrite rod aerial, a short length of wire may be attached to the input grid of V1 to assist in signal pick-up.

Switch receiver to the long waveband and set the dial at 1500 metres. Slowly adjust the oscillator coil core until the Light Programme is heard at maximum volume. Now switch to the medium waveband and locate a station between 200 and 215 metres. Adjust the medium waveband aerial and oscillator trimmers for maximum volume and correct calibration.

Tune to a station near to 460 metres and adjust oscillator core for correct calibration and medium waveband aerial coil core for maximum volume. Return to 200 to 215 metres and repeat the operation until no further improvement can be made. Again switch to the long waveband and correct the calibration of the Light Programme by use of the long waveband oscillator trimmer. Trim for maximum volume with the long waveband aerial trimmer. If this trimmer will not peak, slightly re-adjust the core of the long waveband aerial coil.

If the ferrite rod aerial is being used, the coils will have to be moved on the rod instead of aerial core adjustment. Moving the coils towards the centre of the rod will increase the inductance.

In the construction of this receiver special note should be given to the connections to the Q08 output coil. It will be found that the normal earthy end of the secondary or reaction winding is connected to the cathode of the valve and that the “hot” end of the winding is earthed to chassis. This is quite normal for this type of circuit. Regarding the 100pF trimmer and 300pF silver mica condenser for parallel trimming on the long waveband, the exact values will depend on the type of tuning condenser and the tuning scale used. If good calibration cannot be obtained, the value of C4 can be increased or decreased over the range 220 to 330pF.

It should be noted that if a ferrite rod aerial is used there will be no primary windings on the aerial coils and the wave change switch may, therefore, be a double-pole change-over unit.

**ELECTRONICS**

**Power Transistors**

*By E. G. BULLEY*

These transistors are now becoming more readily available upon the commercial market and it is to be hoped that before long, the amateur and constructor will be able to evolve around them many circuits and equipments for their own purposes. Such transistors are used mainly for large power applications such as audio amplifiers. Their physical size is much larger than their counterparts in portable radio receivers. Nevertheless, they are much smaller than the conventional valve and have the advantage that associated components are much smaller and lighter in weight, thus equipment suitable for amateur use will be produced which is portable and lighter in weight.

Power transistors are used in what is termed a heat sink. This sink comprises a flat piece of copper or aluminium and to this is secured the transistor. The heat generated by the transistor is dissipated from the heat sink. The sink must be insulated from the chassis by mica or similar material. The transistor is incorporated into the electronics to measure an unknown current. Power transistors are also used in the way into d.c. voltage amplifiers wherein two power transistors oscillate and set up an a.c. voltage across the primary of a transformer. The output from the transformer secondary is naturally determined by the turns ratio and by the voltage applied to the transistors.

The reader must take due precautions when using or installing power transistors such as he would take when using the conventional types. Such precautions have, however, already been dealt with in this journal and it is not, therefore, necessary to repeat them.

**Surge Limiting**

The majority of readers would, we feel, agree with the statement that good radio components are expensive, and it follows that they require careful operation in order that a long period of use may be obtained. We know, in fact, from correspondence that when a constructor is not following a well-designed circuit he will make careless measurements to ensure that components are not being over-run. These tests are usually made to determine the maximum dissipation of resistors, the working voltage of capacitors and the current and voltage operating conditions of valves. Sometimes, in spite of such care, the failure rate of one particular component is high. Obviously either the component itself has been badly designed or some aspect of its working conditions which can cause early failure has been overlooked. Usually it is the operation which is at fault, and here we would make a plea on behalf of the constructor; all too often components are sold over the counter with insufficient technical details being made available to the purchaser. Should the buyer be aware of possible pitfalls he can request further details about the item being purchased, even if this may mean contacting the manufacturers. The best assurance against short component life is, therefore, a good general knowledge of the special operation conditions to which certain parts may be subjected. The special conditions usually arise due to high supply voltage or current values appearing on the component. The measurement of these voltages and currents requires special care and at least a calibrated oscilloscope, and as such may well be outside the scope of many constructors. However, measurement is not necessarily essential so long as certain precautions are taken. It will be useful at this stage to list some of the components of a radio or t.v. receiver where peak operating conditions can cause trouble.

(a) Line output transformer
(b) Line output valve
(c) Boost diode valve
(d) E.H.T. rectifier
(e) Frame output valve

![Surge Limiting Circuit Diagram](image)

The operation of these components is almost entirely a function of the way in which they are designed. It follows that providing reputable makes are purchased and that the recommended circuit and values are closely followed the working conditions of all parts will be correct if the h.t. supply voltage is correct. This latter point is most important and is a measurement which can easily be made.

(f) Blocking oscillator valves
(g) Blocking oscillator transistors

Most suitable triode valves will stand a peak grid or anode voltage of 500V. Where this figure or the peak voltage rating...
of the blocking transformer is exceeded, a reduction may be obtained by connecting a damping resistor (about 56kΩ) across one winding of the transformer.

(6) H.T. rectifier valves
(7) H.T. reservoir capacitors.

This list can be extended quite considerably, but we have commenced by including only the most important items and those which have given trouble in the past. Let us confine our attention now to the mains rectifier circuit.

SWITCHING SURGES

The use of a metal rectifier working within its voltage rating is dependent largely upon the temperature at which it operates, and this in turn is governed largely by the output current and is independent of peak current. The use of a surge limiting resistor with a metal rectifier is not always essential for rectifier safety, but another difficulty may exist. At the instant the mains switch is closed the reservoir capacitor will be discharged, and the peak current may easily be in the region of 5 amps. If the immediate peak at the output filter has a current of 250 mA, which is at a different part of the waveform, it is possible for the peak current at the turnon due to the inductive component of the transformer to cause the transformer to saturate.

To overcome this difficulty, a large inductance is sometimes used to limit the current, and a capacitor is inserted in series with the rectifier to provide a short time delay for the current.

BIOÓS O scillator

ONE OF THE MOST IMPORTANT REQUIREMENTS OF A CLASS-1 TAPE RECORDER IS A bias generator producing a pure waveform. Where the sine-wave contains parasitics, second and third harmonics, or is seriously non-symmetrical, poor results are inevitable. Agitation of the signal and the ferrous particles on the tape will occur. Distortion, particularly to the high frequency end of the spectrum, will arise and objectionable hiss and hum round noise may, completely ruin a recording.

With all recorders, a periodical check should be made to appraise the general noise level. This is easily done by using a virgin tape and running part of it through the recorder in the Record position but with no signal input. Play back, noting the difference when the tape runs on to the untouched virgin tape again. Little difference in noise level should be noticed. If possible before this test, all heads should be demagnetized.

SINGLE-ENDED OSCILLATORS

Some very good designs have been in use, but these are seldom free from one disadvantage or another, and to be really successful an elaborate filter system is normally necessary.

Coupling to the heads requires special care to block d.c. that might otherwise burn out a head winding or, at the least, cause complete demagnetization.

Push-Pull

It has been found that push-pull circuits are a great improvement and they are often to be found in commercial or high priced recording equipment. A range of coils for push-pull oscillators and to cover most combinations of Ernig and Record heads, is now available from The Teletraon Co. Ltd.

THE CIRCUIT

It will be seen that these coils are wound transformer fashion. No d.c. is present on the secondary, and possible risks of magnetizing the heads are eliminated.

Direct coupling may be effected to the Erase head, and a simple type of capacitor fed to the Record head may be confidently employed. At the same time, due to the tapped secondary, a closer impedance matching is achieved for differing combinations of Erase and Record heads.

A conventional flip-flop type of circuit is employed.

Frequency is determined by the total capacity, but tests have been carried out, and the following table indicates the approximate frequency to be expected when the capacitor C1 (750pF) is altered:

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Capacity in pF</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 kc/s</td>
<td>1600</td>
</tr>
<tr>
<td>50</td>
<td>1000</td>
</tr>
<tr>
<td>60</td>
<td>700</td>
</tr>
<tr>
<td>62</td>
<td>660</td>
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<td>520</td>
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<td>80</td>
<td>400</td>
</tr>
<tr>
<td>90</td>
<td>300</td>
</tr>
<tr>
<td>100</td>
<td>250</td>
</tr>
</tbody>
</table>

It must be noted, however, that with an excessive increase of frequency a progressive reduction of bias current will occur. Thus, for example, more power is available at 40,000 cycles per second than at 100,000 cycles. Similarly the output voltage will be affected by the h.t. voltage. Unfortunately, it is not possible to give a useful formula for this circuit in which the output power is considered individually and each set of heads brought to optimum performance.

The circuit as shown produces a most excellent waveform, but some further improvement can be achieved in symmetry by balancing the two resistors R1 - R2 (68 kΩ).

It is not very likely that the two sections of a circuit were so similar as this will have identical characteristics.

Obviously, an oscilloscope is the best method to observe a waveform. These con-
It is very clear, then, that the playback characteristics of a recorder could be quite easily spoiled by incorrect bias voltage. Obviously, where the recorder has been properly equalized the optimum performance can be found reasonably quickly.

Adjacent Channel Interference

The core of the coil is normally left as supplied, but where "whistling" is heard when recording a radio programme, slightly adjust the core.

Bias Rejection

Most recorders can be improved by installing a bias rejector circuit. This greatly reduces the possibility of bias appearing in the output circuit. A typical arrangement is shown.

The version as printed has been thoroughly tested and approved by Standard Telephones and Cables, Ltd.

Telcotron Coil Types

T010 For high or low impedance heads, tapped at 25 kV for Erase Head.

Ferron Type.

T010/1 High or low impedance heads tapped approximately 60-70 V for Erase Head (Ferron Type).

T010/2 High impedance heads only, approximately 3 watts output.

BR10 Bias rejector coil.

Valve

12BH7, Brimar.

MARCH 1958

THE RADIO CONSTRUCTOR

Introduction

THE CONVENTIONAL METHOD OF TESTING AN audio frequency amplifier employs an audio oscillator, an output meter—which may be an oscilloscope—and some method of indicating the distortion.

This method is capable of giving good results, but it does not tell the whole story, and will not always disclose defects capable of giving rise to a distorted output under certain conditions. Furthermore, it may be difficult to obtain a distortion measuring equipment covering a wide frequency range. Some very useful additional tests may be made with a square wave generator, which supplies the amplifier under test a signal having a waveform shown in Fig. 1, instead of the sine wave shown in Fig. 2. Square wave generators are available commercially from manufacturers of test gear, but later in this article a description will be given of a simple device capable of providing a close approximation to a square wave from an audio oscillator.

The square waveform has the property of "triggering off," as it were, defects in an amplifier which may otherwise remain unsuspected and be responsible for an imperfect reproduction of the input signal. This is particularly true of output transformers which, if inferior in design, are incapable of reproducing a square waveform.

Equipment Required

In addition to the square wave generator a cathode ray oscilloscope will be required, together with a resistance having a value to match the output of the amplifier. The oscilloscope should have a level response to 250 kHz, or preferably more. The equipment should be set up as in the block diagram Fig. 3, the square wave generator being connected to the amplifier so that for the initial tests no tone controls are in circuit. The oscillograph gain control should be set to give an adequate deflection at the full sine wave output of the amplifier, and a note made of the trace deflection amplitude since all square wave measurements will be made inside this deflection; usually 75% is convenient.

Method of Test

It is preferable to examine first the higher audio frequency behaviour of the amplifier, so the generator should be set to give a square wave output of 2,500-10,000 c/s, and its output increased until the trace seen on the c.r.o. attains a peak-to-peak amplitude approximately three-quarters of that given with a sine wave at full output.

According to the excellence, or otherwise, of the amplifier, the output waveform will not reproduce exactly the input waveform, which will have the form shown in Fig. 1. Typical oscillograms to be expected are shown in Fig. 4 and 5. Fig. 4 being obtained with a first-class modern output transformer (No. 1), with two triode-connected K.166, and Fig. 5 with an older transformer (No. 2) and pentode-connected valves. It will be noticed that Fig. 4 departs very little from Fig. 1, the initial rate of rise (a) being rather slower, but the top (b) is almost flat. On the other hand, that in Fig. 5 shows considerable overshoot (c) and oscillation ("ringing") (d) at a frequency higher than that of the input signal. The ringing frequency can be estimated by counting the number of complete oscillations occurring during the (half) square wave, the duration of which is, of course, known from the generator calibration.

The lower the amplitude of the overshoot, and the higher the frequency of the oscillation, the better the transformer may be classed as far as the higher frequencies are concerned. In Fig. 4 the overshoot is approximately 5% and the ringing frequency is above 150 kHz, whereas in Fig. 5 the overshoot is 30% and the ringing frequency is considerably lower at 30 kHz. The combination of pentodes and transformer No. 2 would be unlikely to give a satisfactory performance; and, furthermore, if an attempt were made to add
A square wave generator is probably the most satisfactory method of examining the square wave output of the transformer. In the worst cases, self-induction of the circuit is a critical factor with regard to the output transformer. The transformer will have a low ratio of transformer to primary. The transformer should be connected across the two primary terminals and the slope of the square wave at 20 to 240 volts should be the same as that of the square wave at 20 to 240 volts. The square wave output should be compared with that of another transformer. When the wave height is increased to 20 to 240 volts, the square wave will become distorted. The slope of the square wave will be flat. A transformer with a higher frequency response should be used. When the frequency response is increased to 20 to 240 volts, the square wave will become distorted. When the frequency response is increased to 20 to 240 volts, the square wave will become distorted.

The transformer No. 2 is shown in Fig. 8 when the high frequency response is increased to 20 to 240 volts. The square wave at this point is shown in Fig. 8. When the frequency response is increased to 20 to 240 volts, the square wave will become distorted. The slope of the square wave at 20 to 240 volts should be the same as that of the square wave at 20 to 240 volts. The square wave output should be compared with that of another transformer. When the wave height is increased to 20 to 240 volts, the square wave will become distorted. The slope of the square wave will be flat. A transformer with a higher frequency response should be used. When the frequency response is increased to 20 to 240 volts, the square wave will become distorted. When the frequency response is increased to 20 to 240 volts, the square wave will become distorted.

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ing the high grade output transformer with one having an inadequate primary inductance.

Square Wave Generator

In Fig. 12 is shown the circuit of a clipper which, when inserted between the output of an audio oscillator and the amplifier under test, will produce a close approximation to a square waveform. An output of about three-quarters of a volt peak-to-peak is obtained.

The resistor shown across the output of the audio oscillator is not necessary if a d.c. path exists internally. The other values are not critical.

The oscillator should deliver to the diode 25 volts r.m.s. or more, and a check should be made by connecting the c.r.o. to the 5,000 ohm output control to ensure that a satisfactory square waveform is being produced and that the c.r.o. is capable of reproducing it. A table showing the equivalent pulse duration for various square frequencies is given in Fig. 13.

The double diode D77 has its heater connected to a pair of flying leads, which may be clipped to the heater supply of the amplifier under test.

Conclusion

In conclusion, a few oscillograms obtained from the 5 watt “JUNIOR” amplifier designed by the writer and described in the November and December 1956 issues of this magazine are reproduced.

Book Reviews


The author of this book is well versed in the subject of f.m. receivers, and is no mean exponent of writing clearly on his knowledge. He has produced a very useful book which is of value to service engineers and home enthusiasts alike.

The first two chapters describe the nature of the f.m. signal, and the advantages to be gained from its use. These two chapters are thought to be particularly well written, for they make the understanding of a complex subject quite easy.

Other chapters are concerned with various stages in f.m. receivers, namely r.f., i.f., frequency-changer and detector arrangements. Following these are discussions on combined a.m./f.m. receivers, i.f. adaptors, v.h.f. aerials, and the audio section of the receiver. Two chapters are given over entirely to servicing and aligning f.m. receivers, though in the other chapters there is further information concerning the particular circuits under discussion.

The diagrams and photographs are very clear, and the book as a whole is well produced. The text is up to date, liberal use being made of the most recent circuits and receiver designs.

In the chapter on frequency-changers, mention is made of precautions necessary to prevent radiation of oscillator harmonics. It is thought that more could have been said about spurious radiation that can occur with f.m. receivers, for several manufacturers have, in the past, produced service modifications to overcome troubles of this sort.

THE BOYS’ BOOK OF RADIO, TELEVISION AND RADAR. 143 pages, 130 diagrams and illustrations. Published by Burke Publishing Company Ltd., 51 Briton Street, Clerkenwell Road, London, E.C.1. Price 9s. 6d.

The application of electronics to science and industry is now so wide that it has become almost part of our lives. The boys of today start life in an age of electronics, and it is understandable that many of them seek to learn how use is made of the simple concepts of electron theory in the many examples of complex apparatus in general use.

This book sets out to describe such matters in simple terms. It does so in a commendable manner, for not only is the text informative and instructive, but the diagrams and illustrations add much to the clarity of the discussions.

The earlier chapters deal with the principles of electronics, wave motion and radio communication, introducing thermal valves and cathode ray tubes in a way that should make their principles of operation easily understood.

Other chapters describe the use of television in underwater applications, and for industrial purposes. A good idea can be gained of the principles of radar, and navigational aids for aircraft. The final chapter deals briefly with electron microscopes.

This latest edition of a popular boys’ book has been revised, and serves a useful purpose in enlightening the younger generation in a way they should enjoy reading.

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