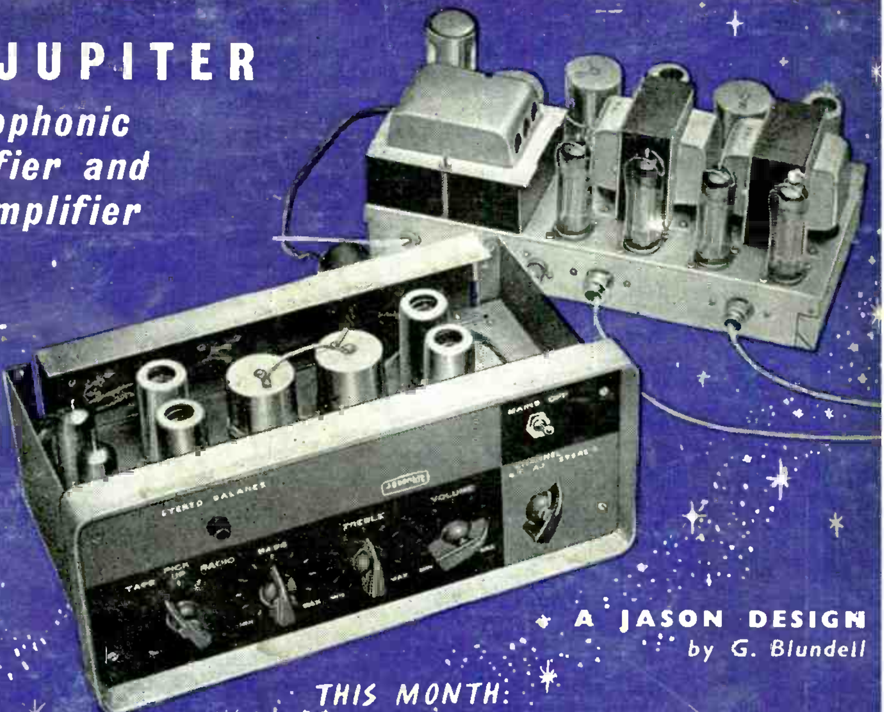
Radio Control Models: THE "WAVEMASTER" CABIN CRUISER

VOLUME 12
NUMBER 1
AUGUST
1958

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

The JUPITER Stereophonic Amplifier and Pre-amplifier



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THE MAIN AMPLIFIER

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TRANSISTORISED 3-CHANNEL RADIO CONTROL RECEIVER
21 Mc/s BANDSPREAD FOR HRO RECEIVER
TWO-VALVE KITCHEN RECEIVER
2-VALVE AMPLIFIER FOR R.E.P. 1-VALVE RECEIVER
THE "MINI-METER" FREQUENCY METER, Part 3

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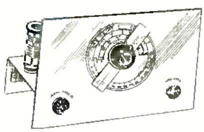

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This 1 valve S.W. receiver can be built for **35/-** from our list of components, which can be purchased separately. It includes valve and 1 coil covering 24–40 metres. Provision is made to increase to 2 or 3 valves if required, and all components are colour-coded so that the beginner can build this set quite easily.

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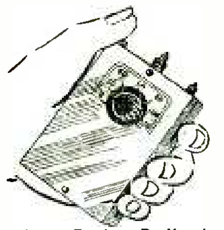

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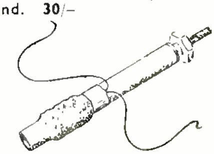

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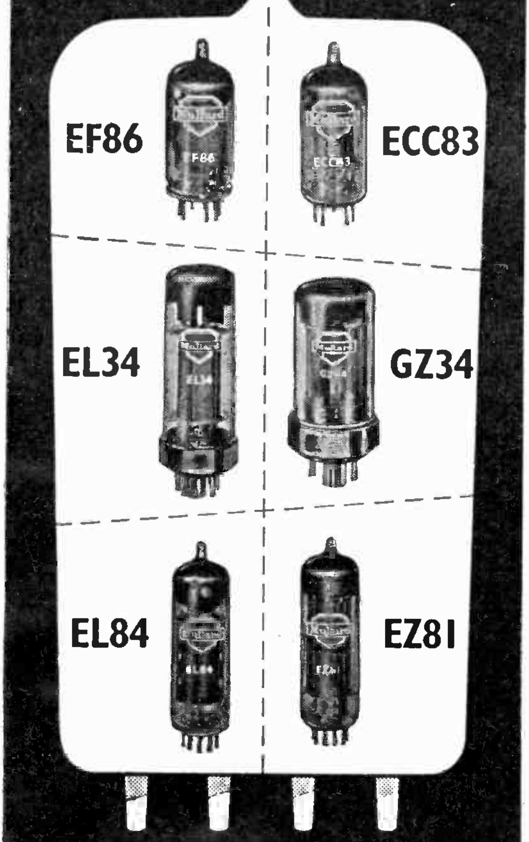

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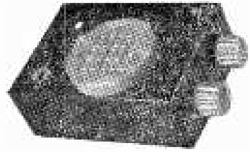

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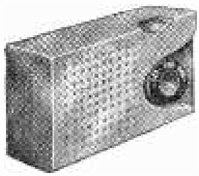

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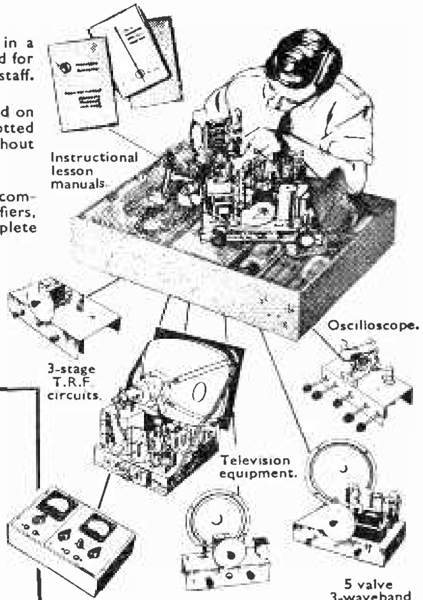

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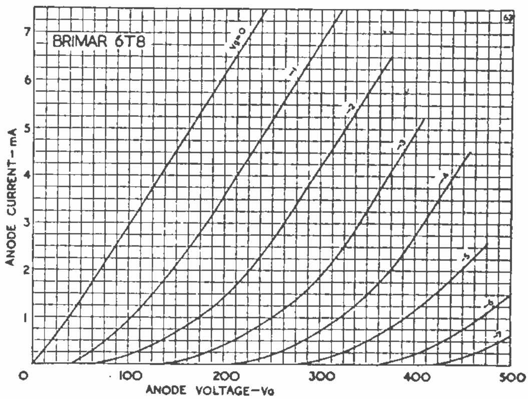

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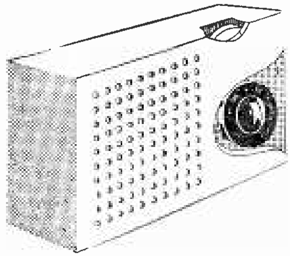

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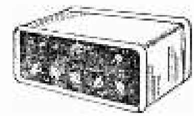

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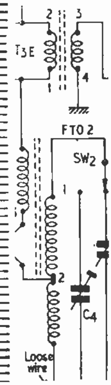
Suggested Circuits

No. 93 A 15-Way Remote Control System



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

IN SUGGESTED CIRCUITS No. 92 (PUBLISHED in last month's issue) the writer described a simple remote control system which enabled three local operations to be controlled from a remote point with the aid of only a single pair of interconnecting leads. Assuming a sufficiently low resistance between the two points, one of the interconnecting leads in the system described could be replaced by earth connections at either end. The local station employed two relays and, by means of suitably connected rectifiers, it was possible to energise either one of these relays, or both, from the remote position.

Since relay circuits almost invariably give rise to a high level of correspondence, thereby reflecting considerable reader interest, the writer decided that it would be worth while following up last month's simple circuit with a more complex arrangement in which four relays are employed. In this case three interconnecting leads are required between the local and remote station and, here again, one of these may be dispensed with if adequate earth connections are available at both ends. The relay energising circuits take advantage of the same principles which were employed last month, and no new methods of operation are introduced here. However, due to the fact that four relays are available, the number of controlled operations at the local station now becomes increased from three to no less than *fifteen*. This very large increase is due entirely to the number of different combinations offered by four relays, and the circuit is strikingly illustrative of the ability of simple relays to carry out complicated functions with the minimum of information-carrying links.

Relay Combinations

In the previous article a circuit employing two relays was used, and, disregarding the case where all controlled circuits were "off," was capable of completing one of three circuits. The fact that three circuits could be controlled was due to the fact that three relay combinations were available. Assuming that the relays were designated A and B respectively, these three combinations are: A energised, B energised, and A and B energised.

Far more combinations are feasible when four relays are used. Assuming that these relays are designated A, B, C and D respectively, and that reference is made to a relay only when it is in the energised state, these combinations are:

A; B; C; D; A+B; A+C; A+D; B+C; B+D; C+D; A+B+C; A+B+D; A+C+D; B+C+D; A+B+C+D.

As may be noted, this represents fifteen combinations, disregarding the condition where all relays are de-energised. It is possible, by logical circuit design, to take full advantage of these fifteen combinations, and this has been done in the circuit presented here.

Before proceeding with a description of the functioning of the circuit, it should be mentioned that the "detached" method of relay presentation has been adopted in the diagram in order that the circuit may be more easily followed. In the detached method of presentation, relay windings are depicted as rectangles having references which consist of a letter over a figure. The letter defines the relay, whilst the figure defines the number of contact sets which the relay employs. Thus, the reference C/4 qualifies the winding of relay C, and shows also that this relay has four sets of contacts.

In addition, with the detached presentation, relay contact sets are not shown close to their appropriate windings and may appear anywhere in the diagram. Unless otherwise stated contact sets are always shown in the position they take up when the appropriate relay is de-energised. The contact sets are given letter references followed by a figure. Thus, the four sets of contacts applicable to relay winding C/4 are marked C1, C2, C3 and C4.

Circuit Functioning

Having proceeded so far, we may now carry on to the functioning of the present circuit. It will be noted that, apart from the contact switching section, the local station merely doubles the number of relays and rectifiers which were employed in last month's arrangement. Three interconnecting leads couple the local to the remote station, that at foot of diagram being unnecessary if reliable earth connections at both stations are available. If we examine the remote station circuit we see that the two upper interconnecting leads connect to rectifiers W_5 to W_8, and to limiter resistors R_3 and R_4. To simplify tracing out the remote switching operations, the leads to the right of these rectifiers have been designated A, B, A+B, and so on. These letters refer to the relay or relays which are energised when the correspondingly marked lead is connected to the bottom interconnecting lead. Thus, if lead A is connected to the bottom lead, the rectifiers W_5 and W_1 in series enable half-wave rectified a.c. from the mains transformer secondary to be applied to the winding of relay A. Similarly, connecting lead B to the bottom lead causes rectifiers W_6 and W_2 to pass energising current to relay B. Connecting lead A+B to the bottom lead causes rectifiers W_1 and W_2 to pass energising current to both relays A and B, whereupon these both become energised. Since, to energise one relay or pair of relays it is merely necessary to connect the appropriately marked lead to the bottom interconnecting lead, the process of following the switching circuits becomes relatively uncomplicated.

Table 1

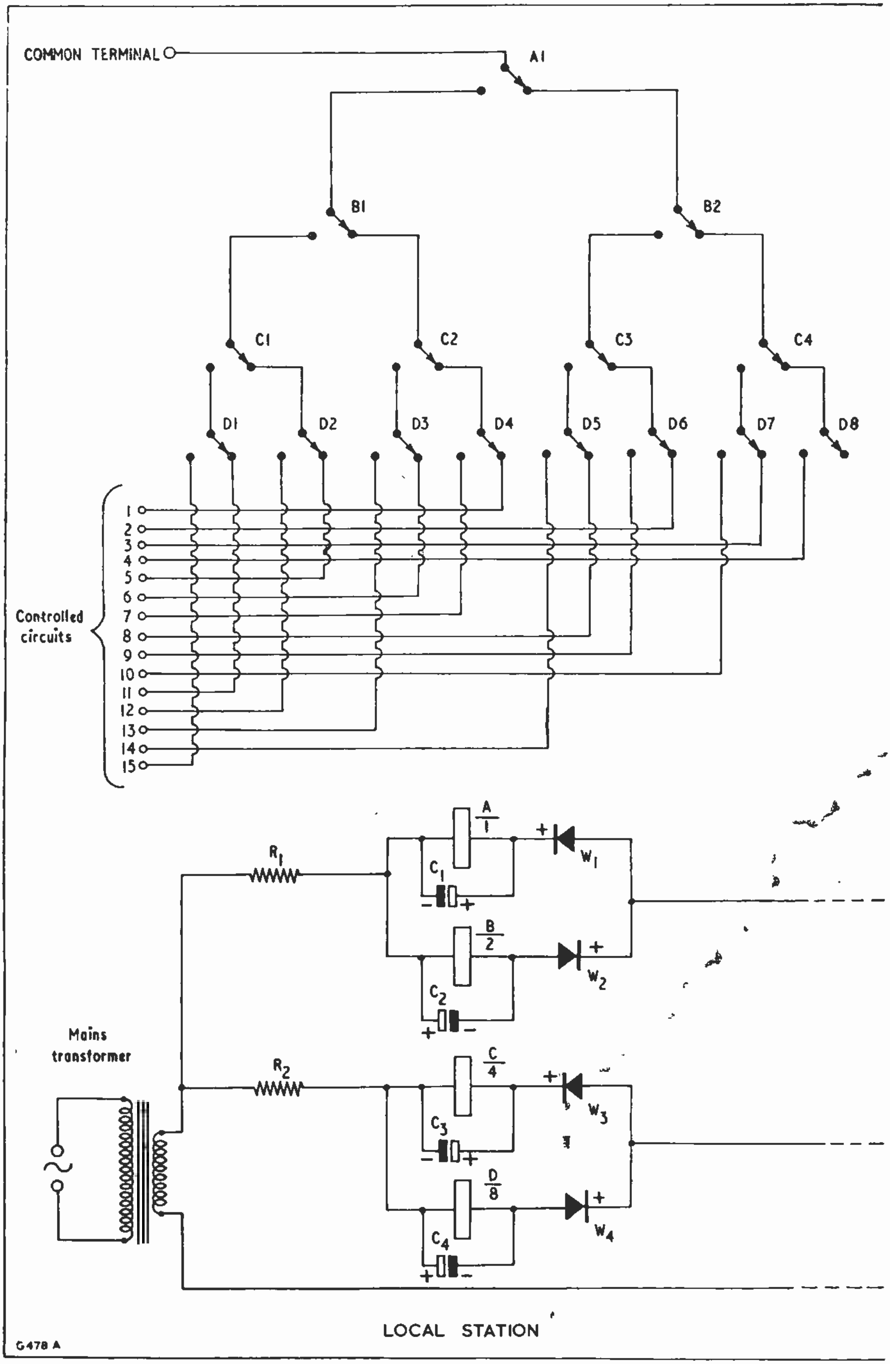
Switch Setting	*Relay Combination (Relays Energised)*
1	A
2	B
3	C
4	D
5	A+B
6	A+C
7	A+D
8	B+C
9	B+D
10	C+D
11	A+B+C
12	A+B+D
13	A+C+D
14	B+C+D
15	A+B+C+D

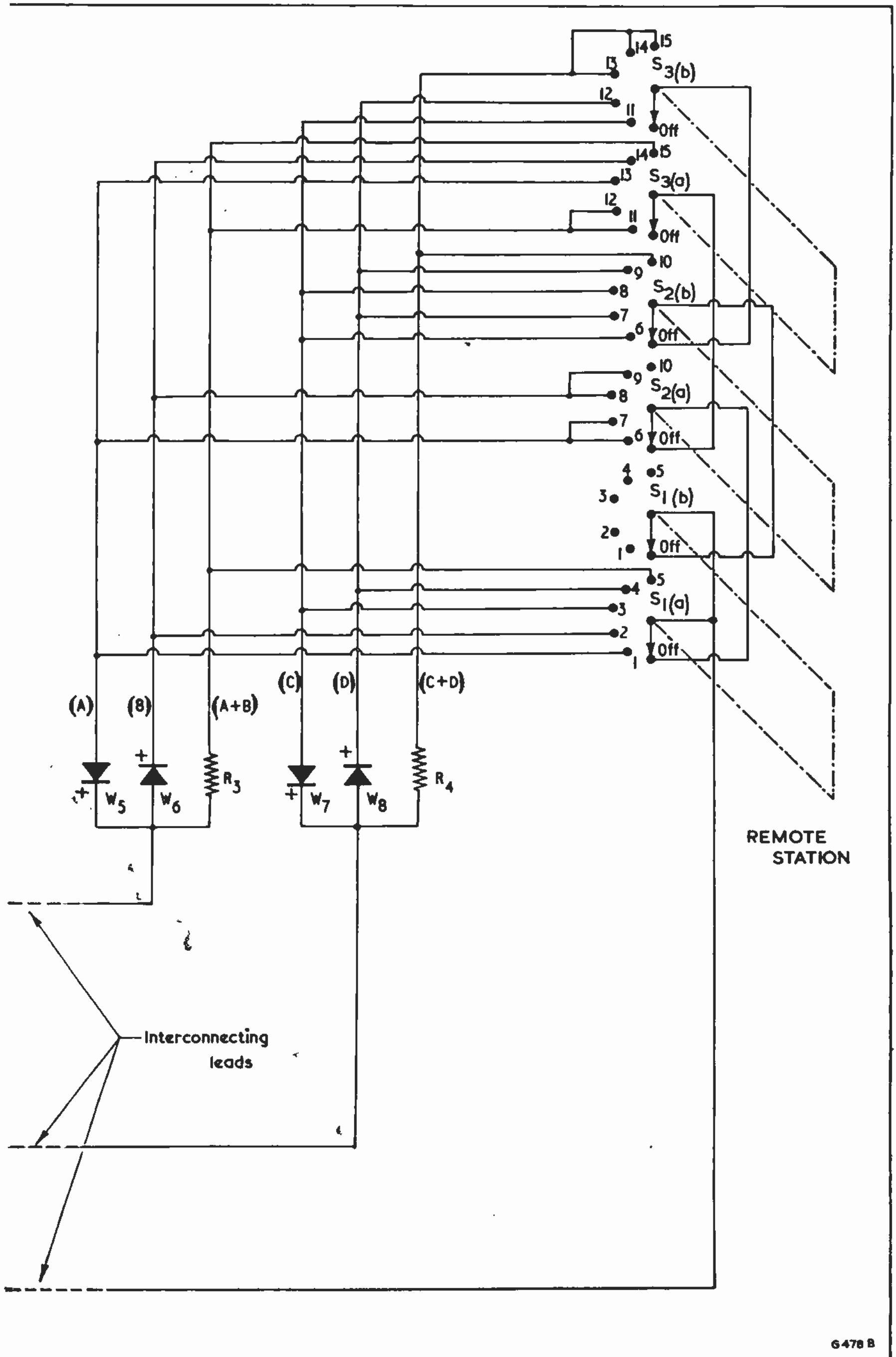
A simple method of relay combination selection consists of the use of rotary switches whose index settings are numbered in steps from 1 to 15. Ideally, a 2-pole 16-way rotary switch (one position being used for the "off" condition) is required here, but such switches are not readily available. On the other hand, 2-pole 6-way switches are easily obtained and three of these, S_1 to S_3, are employed in the circuit.

Commencing with switch S_1 it may be seen that, when this is set to positions 1, 2, 3 and 4, it connects the leads designated A, B, C and D respectively to the bottom interconnecting lead. In consequence switch position 1 causes relay A to energise, switch position 2 causes relay B to energise, and so on. After contact 4, the relay combinations are selected in the same order as was given above. (See, also, the table accompanying this article.) Thus, in position 5, switch S_1 causes relays A and B to energise.

In order to proceed to position 6, switch S_1 must be set to the "off" position, whereupon the bottom interconnecting lead is applied to the two arms of switch S_2. Switch positions 6, 7, 8, 9 and 10 then correspond to the energising of relays A+C, A+D, B+C, B+D and C+D respectively.

Setting S_2 to the "off" position applies the bottom inter-connecting lead to the two arms of S_3. This switch then becomes capable of being set to positions 11, 12, 13, 14 and 15, these corresponding to the energising of


COMMON TERMINAL
A1
B1
B2
C1
C2
C3
C4
D1
D2
D3
D4
D5
D6
D7
D8
Controlled circuits
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
A
1
B
2
C
4
D
8
R_1
R_2
C_1
C_2
C_3
C_4
W_1
W_2
W_3
W_4
Mains transformer
LOCAL STATION
G478 A



$S_3(b)$
Off
$S_3(a)$
Off
$S_2(b)$
Off
$S_2(a)$
Off
$S_1(b)$
Off
$S_1(a)$
Off
(A)
(B)
(A+B)
(C)
(D)
(C+D)
W_5
W_6
R_3
W_7
W_8
R_4
REMOTE STATION
Interconnecting leads
G 478 B

relays A+B+C, A+B+D, A+C+D, B+C+D and A+B+C+D.

It will be noted from the above that the switching circuit is capable of selecting any of 15 relay energising combinations, the only proviso being that "lower number" switches which are not in use should always be set to the "off" position. The existence of such a proviso is, of course, due to the interlock circuit provided by the "off" contacts of S_1 and S_2, this interlock circuit being provided to reduce the risk of incorrect selection if more than one switch is inadvertently operated. The interlock circuit is worthwhile also because, whilst bestowing an advantage, it does not have the disadvantage of requiring additional switching poles than are already given by readily available switches. It will be noted that, after switch S_1, the interlock circuit splits in two, coupling separately to the two arms of S_2 and S_3. This separation prevents the arms of any "higher number" switch from inadvertently paralleling two of the six control leads (those designated A, B, A+B, etc.) whilst a "lower number" switch is selecting a particular control.

Relay Contact Circuit

Having seen that the switching circuit is capable of selecting, in order, any of the combinations given above and in the table by being set to a number from 1 to 15, we may now examine the manner in which the local station relays translate the remote switch settings to similarly numbered control operations. To do this, we next turn our attention to the contact circuitry employed at the local station.

Let us commence by assuming that the remote switch is set to position 1, thereby causing relay A to be energised. At the local station, this at once causes a circuit to be completed from the common terminal to controlled circuit 1 via contact A1 (energised), B1 (de-energised), C2 (de-energised) and D4 (de-energised). When switch position 2 is selected relay B energises, causing a circuit to be made, via contact A1 (de-energised), B2 (energised), C3 (de-energised) and D6 (de-energised), to controlled circuit 2. Switch setting 3 (relay C energised) gives a circuit, via A1 (de-energised), B2 (de-energised), C4 (energised) and D7 (de-energised), to circuit 3. Switch setting 4 (relay D energised) gives a circuit, via A1 (de-energised), B2 (de-energised), C4 (de-energised) and D8 (energised), to controlled circuit 4.

By remembering that the switch number selected corresponds to a particular relay combination, all the remining control circuits may be similarly traced out. To take a typical example we could follow what happens when the remote switching circuit is set to position 12. This corresponds to the combination A + B + D whereupon we have a connection to circuit 12 via contacts A1 (energised), B1 (energised), C1 (de-energised) and D2 (energised).

As was mentioned earlier, a table listing the relay combinations and their corresponding numbers accompanies this article.

Final Points

Almost all of the practical questions which arise when a circuit of this type is utilised were dealt with last month, and almost the only point which requires any further amplification is that the mains transformer required in the present arrangement should be capable of energising four relays at one time instead of two. If it is found difficult to obtain a relay having eight sets of contacts for the D position, it should be possible to employ two relays, each having four sets of contacts, with their windings connected in series or in parallel.

In conclusion it might be stated, once more, that the circuit provides an excellent example of what may be given by the use of relays in simple logical circuits. To obtain an idea of the possibilities of circuit arrangements of this type it may be mentioned that, by adding another two relays, it becomes theoretically possible to control fifty-six operations with only four interconnecting leads between the local and the remote positions!

CONDENSER EQUIVALENT CHART

pF		μF	pF		μF	pF		μF
5	=	0.000005	200	=	0.0002	5,000	=	0.005
10	=	0.00001	250	=	0.00025	10,000	=	0.01
15	=	0.000015	300	=	0.0003	12,500	=	0.0125
20	=	0.00002	350	=	0.00035	15,000	=	0.015
25	=	0.000025	400	=	0.0004	20,000	=	0.02
30	=	0.00003	450	=	0.00045	30,000	=	0.03
45	=	0.000045	500	=	0.0005	40,000	=	0.04
50	=	0.00005	600	=	0.0006	50,000	=	0.05
75	=	0.000075	750	=	0.00075	100,000	=	0.1
100	=	0.0001	1,000	=	0.001	250,000	=	0.25
140	=	0.00014	2,000	=	0.002	500,000	=	0.5
150	=	0.00015	3,000	=	0.003	1,000,000	=	1.0

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

"WHAT AN EVENING, WHAT A REALLY smashing evening!"

Smithy's eyebrows shot up in astonishment as Dick exuberantly greeted him with these words. The Serviceman had only just opened the Workshop, and was entirely unprepared for his assistant's prolific good spirits at so early an hour of the day.

"This is an extremely unexpected change from usual," commented the Serviceman, as he gravely regarded his assistant. "Normally, it's as much as I can do to get even a peep out of you before ten o'clock. Whence the *joie de vivre*?"

"Ah, I had a specially good night last night."

"In company?"

"Of course."

"Don't say you've clicked at long last," said Smithy unkindly.

Dick looked hurt.

"You know very well," he stated, "that whilst I make no claims to being a ladies' man I still have no trouble in occasionally selecting a friend to while away the odd evening. After all, you can't be on your own all the time."

"No, of course not," agreed Smithy consolingly, "and, at the present moment, we have the company of the largest pile of chassis for repair I've seen for many a long day. We have work to do."

"O.K., O.K.," said Dick resignedly. "You can put the whip back in the cupboard, Smithy. I'm ready to begin when you are."

"Fair enough," replied Smithy, "I'll start you off on a nice easy job. It's this t.v. here, and it suffers from an absence of vision and sound."

Aerial Trouble

Dick soon settled down to the chassis Smithy had indicated, and commenced to trace its fault. First of all he took the back off the receiver and, without removing the cabinet, connected it to the mains and switched on. He first noticed that, as soon as the sound circuits warmed up, there was a lively background hiss at full volume. The line timebase then started running and a raster soon appeared on the tube face. The brilliance control seemed satisfactory, and Dick next connected a modulated signal generator to the aerial input socket. He swung the signal generator across the channel to which the receiver was switched and was rewarded by a faint modulation tone from the loudspeaker as the generator passed through the sound carrier frequency. Frowning slightly, Dick reduced the signal generator attenuation until the tone became reproduced at normal volume level. He then re-adjusted the signal generator to vision carrier frequency. A faint pattern of horizontal bars, given by the generator modulation, appeared on the screen, but their contrast level was low. The obvious conclusion was that, since the signal generator attenuation was now almost at zero, the chassis under test was extremely insensitive on both sound and vision and that it had, therefore, a fault common to both these sections.

Dick next proceeded to check the valves common to the sound and vision circuits.

Three valves were involved: the common i.f. pentode, the turret tuner cascode, and the turret tuner triode-pentode. Dick fitted "check" valves in these positions, but the performance of the chassis did not improve. Slowly, Dick replaced the original valves in their sockets.

"Smithy," he called out, "I think I've got a faulty turret here."

Smithy looked round with a frown.

"Are you sure?" he asked, as he walked over to Dick's bench.

"I'm fairly certain," said Dick, "and, as you know, you told me not to do too much prodding around inside turret tuners. Shall I get the chassis out of the cabinet for you?"

"Not yet," replied Smithy. "I want to hear what you've done first."

"Well," said Dick. "I began by making a quick check on the receiver with the signal generator. The timebases seemed to be O.K. and I could get both sound and vision through, but they were both very weak. That points to a fault in the common i.f. stage or the turret tuner. I've swapped the three valves concerned here, but they didn't do any good."

"Did you put the original valves back?" asked the Serviceman.

"Yes, I did that."

"That's good," said Smithy approvingly. "Apart from the fact that I don't see why our 'check' valves should find their way into customers' houses, it's always a good plan to put back the original ones if replacement effects no cure. This applies especially to turret tuners, where replacement valves are very liable to upset the tuning."

"But you, yourself, swap turret valves quite frequently," protested Dick.

"I know I do," admitted Smithy, "but only when I know that the replacement valve is really effecting a cure. Theoretically, a new valve in a turret tuner means that it should be re-aligned to accommodate any altered capacities; but, in practice, you can only presume that so long as the picture is good the turret alignment must be satisfactory. Which is, of course, all we're paid by the customer to do.

"Anyway, let's get back to the set under discussion. We've checked the three valves common to both vision and sound circuits and we know they're O.K. Now, before we unbox the chassis let's have a quick check for anything else which may fall within the category of obvious faults. We might, for instance, check the particular tuner coils in circuit by checking the channel next door to the one we're switched to.* This only takes a second or so and, whilst not checking the entire turret tuner, does at least show up faulty segments. Also, provided we stay in the same Band, we can swing the signal generator on to the next door channel quite easily."

Smithy quickly carried out his check, only to find that, on the next channel, the receiver was still very insensitive.

"Well, that doesn't throw any further light on the subject," he remarked reflectively. "You know, common sense tells me that I should get the cabinet off this chassis, yet I have an obstinate hunch that this isn't necessary. One reason for the hunch is the considerable liveliness of the set. As you can hear, there's quite a good background hiss from the speaker. Also, you may notice that quite a fair bit of 'noise' appears on the tube face when you turn the contrast up. I think, Dick, that I'll ask you to tell me what we should check next."

"All right," said Dick. "We know that the sound and vision circuits seem lively enough. I presume that the noise level would indicate that from the cascode input grid onwards the set is functioning correctly. That leaves the aerial input circuit."

"Well?"

"Well, there could be a turret fault here," continued Dick, "or it might be outside the turret. Now let's have a look. Ah, there's a piece of coax cable leaving the tuner which travels to the aerial socket board at the back of the cabinet. This board has the usual isolating condensers on it and I imagine that we should next check these."

"That's correct," said Smithy. "Now, this set employs the usual ceramic condensers you normally find in the isolating positions and, whilst condensers of this type do not normally go o/c, they may occasionally do so. Especially, of course, if they've been badly treated."

"Fair enough," replied Dick. "I'll give them a dig."

After disconnecting the receiver from the mains, Dick applied an exploratory finger to the isolating condensers. He soon found that one of these moved under gentle pressure, and a closer examination revealed that it was secured by one lead only, the other being broken off at the tag to which it had been connected.

"There you are," grinned Smithy triumphantly, as he watched Dick, "it couldn't have been simpler, after all, could it?"

"You're right there," replied Dick. "I'm afraid I've been jumping to conclusions again."

"It happens to the best of us at times," commiserated the Serviceman. "And I

* When carrying out this test, it should be remembered that some commercial turret tuners may not be supplied with a full complement of coil segments, and also that the segments may not be fitted in numerical order of channels.

suppose that many of us have a tendency to suspect turret tuners more often than we should. I expect it's the fact that the innards of turret tuners are liable to be rather difficult to get at, and that you can't normally swap a complete tuner like you can other units in a receiver. Perhaps there's a morbid pessimistic streak in we servicemen which makes us assume faults in the worst places."

Isolating Condensers

"You may be right there," said Dick, as he set about re-soldering the faulty isolating condenser. "I had a pretty morbid time last night myself."

"I thought you said you had a marvellous evening."

"I did."

"O.K., I'm hooked," said Smithy, abandoning further protest. "You've got me interested at last. Just exactly what did you do last night?"

"Well, first of all," said Dick, "we had a cup of steaming hot froth at 'El Mirabel' in the High Street."

" 'El *what*' in the High Street?"

"At 'El Mirabel'," replied Dick innocently. "Actually, it's Fred's Snack Bar, but he's just bought a new coffee machine. After that, we went to the flicks. To see 'Dracula'."

"A very pleasant choice for a young lady, I must say," Smithy remarked severely. "I'm surprised at you."

He paused for a moment.

"Any good?" he offered, casually.

"Oh, it was smashing," said Dick enthusiastically. "You ought to see the bit where Peter Cushing's bashing away with the old stake and hammer."

Smithy blanched.

"No thanks," he said primly. "I find your description just a little too graphic for my taste. Perhaps we'd better get back to work."

"Right you are," replied Dick. "I've re-soldered the condenser whilst we were talking. I haven't actually replaced it, incidentally, because it seems to be rather a peculiar type which we haven't got in stock. Fortunately, it had enough lead left for me to re-solder it to its tag."

"It seems a perfectly normal condenser to me," said Smithy, peering inside the cabinet. "What's peculiar about it?"

"Well, it's got a funny capacity for one thing. I would have expected something like a 0.01μF component in a low impedance aerial input circuit, but this condenser is only 470pF. Also, it's marked 'B.S. 415.' What does 'B.S. 415' mean, Smithy?"

"It means," said Smithy, "that the condenser meets the requirements of British Standard 415, the title of which, if I remember correctly, is 'Safety Requirements for Radio or other Electronic Apparatus.' B.S. 415 lays down safety requirements for domestic radio and television receivers, etc., one of these being that the maximum leakage current which can be allowed to flow to earth from the aerial terminal, or group of terminals, is 0.3mA. That means that your aerial isolation circuit must be such that, when the chassis is live, a meter connected between the aerial terminals and earth must not show a current greater than 0.3mA. It then becomes impossible for anyone who touches the aerial to pass a shock current greater than that particular figure. Actually, of course, due to body resistance, the shock current would be less than the short-circuit current."

"That doesn't seem to me to be a very heavy current," remarked Dick. "I mean, I've had quite a few belts from the mains and from h.t. supplies before now, and I'm certain that the current flowing through me was a lot greater than 0.3mA. And I'm still here."

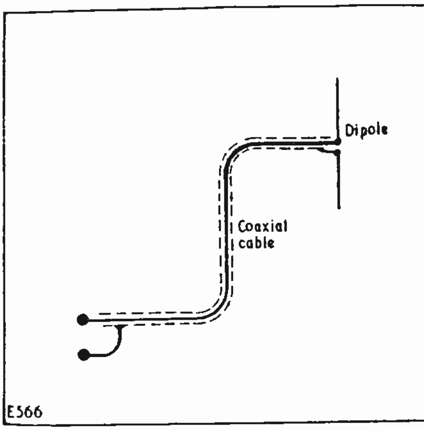


Fig. 1. A conventional dipole, with coaxial feeder, consists basically of two conductors insulated from each other

"Not entirely," remarked Smithy. "And I might add that—barring inevitable accidents—only mugs get shocks, especially from the mains. The mains is a killer, you know. Anyway, to return to the 0.3mA current which is the maximum permissible from a television aerial to earth, you must remember that a very likely recipient of shock from a t.v. aerial is someone who may be working on a roof, and who may be standing on wet slates or a metal ladder. Even a slight shock, when unexpected, may cause such a person to overbalance, whereupon the results could

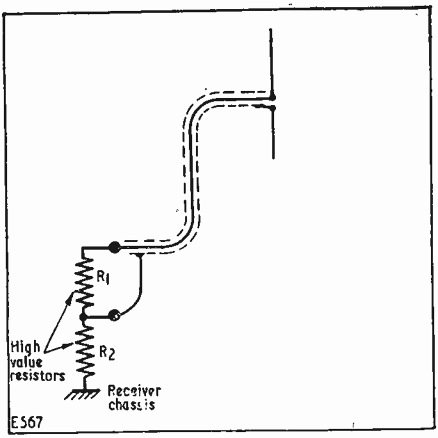


Fig.2. Static voltages cannot build up in the aerial system if high value discharge resistors are fitted

be very serious indeed. So I think that the maximum current provision in B.S.415 is extremely wise."

"O.K.," replied Dick, "I see your point. But that still doesn't quite explain the rather peculiar value of 470pF."

"The facts are these," said Smithy. "If a television aerial consists of a simple dipole, as very many do, you have two conductors which are insulated from each other and from earth. These conductors are the top element of the dipole and the centre wire of the coaxial cable, and the bottom element of the dipole and the outer braiding of the coax. (Fig. 1). It is unwise to have such conductors completely isolated as static charges may build up in them. In consequence, it becomes necessary to provide some form of discharge circuit and this can be best obtained with the aid of high value resistors. A suitable discharge circuit may consist of a resistor across the coaxial cable, and another between the outer braiding of the coax and earth. (Fig. 2.) So far as the prevention of static charge build-up is concerned, a satisfactory earth connection may be given by the television chassis, even if this should happen to be connected to the live side of the mains. To apply the signal to the receiver without a direct connection we need two equal-value condensers between the coaxial cable and the input terminals of the set. (Fig. 3.) Now as far as our 0.3mA current is concerned we can assume that we have an isolation circuit consisting of a condenser and a resistor in parallel, (Fig. 4), the condenser being, in practice, the two actual isolating condensers in parallel, and the resistor that between the outer braiding of the coax and earth.

"Let's now take a typical circuit combination and see what results we can obtain by calculation. The highest mains voltage liable to be applied to the chassis is 250 volts so, to meet safety requirements, the minimum impedance presented by the resistor and condenser in parallel must be 250 divided by 0.0003." Smithy scribbled on a piece of paper. "This comes to, let me see, 830,000 ohms."

"How do you get that?" asked Dick.

"Simple enough," replied the Serviceman. "It's just an example of Ohm's Law. Z=E/I where Z is impedance in ohms, E is e.m.f. in volts and I is current in amps. The 0.3mA becomes 0.0003 amps to fit it for the equation.

"Now let's have a look at the resistor in our isolation circuit. A sensible value for this component would be 2MΩ±20%—giving a minimum possible resistance of 1.8MΩ—whereupon we can get the capacity value from $Z=\frac{R}{\sqrt{1+\omega^2 R^2 C^2}}$, Z being our impedance of 830,000 ohms, R being 1.8MΩ, and ω being 2π times the mains frequency of 50 c/s."

Smithy busied himself with his sheet of paper.

"Well, I make the value of C approximately 1000pF," he said at length. "This means that the maximum permissible value for the two separate isolating condensers is approximately 500pF. A reasonable capacity to meet our requirements here would

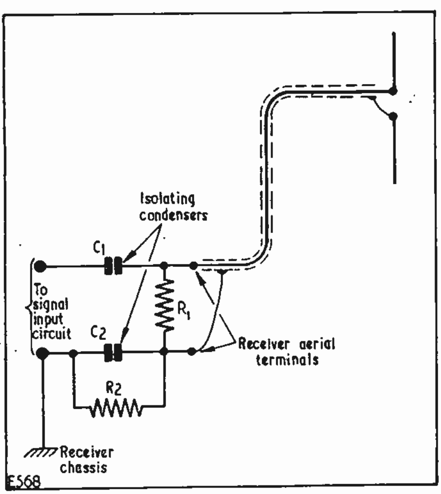


Fig. 3. Isolating condensers are needed if the aerial connects to a live television receiver chassis

then be the slightly lower preferred value of 470pF. Which, as we already know, is that fitted to the receiver you've been working on."

"Phew!" remarked Dick. "Don't simple things get complicated when you start examining them more closely? But you still haven't explained why it is necessary for the condensers to be marked 'B.S.415.' Wouldn't any 470pF condenser cope?"

"Ah, no," smiled Smithy. "There are, you see, quite a few other requirements laid down by the Standard which have to be met by the isolating condensers. If a series aerial condenser is marked 'B.S.415,' you know it meets those requirements."

"Well, you certainly seem to know all about it," remarked Dick. "If anyone ever deserved a certificate for knowledge, I think it should be you, Smithy. An 'X' certificate!"

"If," said Smithy, stiffly, "you're thinking of once more introducing the subject of that film you saw last night, I'm just not interested."

Dick remained silent.

"Nevertheless," continued the Serviceman, casually, "I seem to remember reading something in the papers about Dracula actually decomposing. Do you really see that?"

"Oh, definitely," returned Dick solemnly "But that only takes place later on. You see, what happens is that Dracula is chased back to his native castle—you know, of course, that vampires can only lie on their native ground—and is caught just before the sun rises. But vampires cannot stand the direct rays of the sun, so, after the fight . . ."

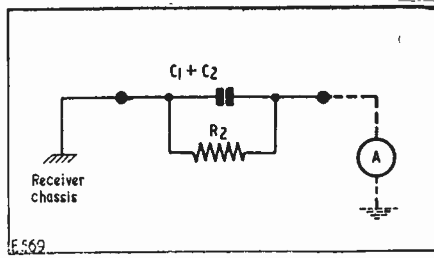


Fig. 4. In order to meet safety requirements, the leakage current flowing in the meter must not be greater than 0.3mA when the receiver chassis is connected to the live side of the mains

Reference: The full title of the publication referred to above is: British Standard 415: 1957, Safety Requirements for Radio or other Electronic Apparatus for Acoustical or Visual Reproduction (Electric-mains—supplied). It is published by British Standards Institution, 2 Park Street, London, W.1.

THE LABGEAR "DOUBLE DIAMOND" AERIAL

(Miniaturisation applied to Aerial Design)

The Labgear "Double Diamond" aerial represents a complete break away from orthodox multi-element Yagi design. As its name implies, it consists of two diamond shaped loops, parallel to one another, and it is uni-directional along an axis at right-angles to the planes of the loops. The larger of the two loops acts as a reflector and the feeder is connected to the smaller loop at an appropriate corner (top or bottom for horizontal polarisation or either side for vertical polarisation). The loops are dimensioned for resonance in Band III, the band width being about 10 Mc/s, i.e. suitable for two adjacent channels. Accordingly, models are available for channels 8/9 and 10/11 to cover present requirements.

The gain of the "Double Diamond" is quite exceptional for an aerial of its size. Many practical tests in a variety of locations have proved that it will outperform the average five or six-element Yagi and, in many instances, it has compared favourably with eight-element Yagis as far as signal pick-up is concerned, although in this latter case the acceptance angle of the "Double Diamond" (110°) is wider than that of the average eight-element Yagi (50°). Nevertheless, the front-to-back ratio of the new Labgear aerial (35dB) rivals that of the best Band III aerials commercially available.

The standard version of the "Double Diamond" (model 313/S) is intended as a Band III array, to be used in conjunction with an existing Band I aerial. However, there is a multi-channel version (model 313/M) which provides acceptable Band I pick-up without any deterioration of the Band III performance. A special stub is used on this model to raise the impedance on Band I which results in approximately 10dB improvement on all five channels. Model 313/M is particularly suitable for those many areas where a fairly strong Band I signal exists, the Band III signal being relatively weak. The frequency response of the aerial then tends to balance the two signals, minimising the usual effect noticed—namely, a grainy picture on Band III and "soot and whitewash" on Band I. Field trials have established that these conditions frequently exist in built-up areas, usually some 20–35 miles from the stations. It is in these localities where the correct application of the new Labgear Double Diamond Model 313/M, will play its major role in eliminating the need for large and aesthetically displeasing conventional arrays. According to local conditions, it may either be used in the loft space or attached by means of the special bracket provided to the gutter board of chimney stack. There is only one feeder connection for both Bands I and III and, moreover, the pick-up at v.h.f./f.m. frequencies is, generally speaking, adequate except in extremely hilly areas.

One particularly outstanding feature of the "Double Diamond" is the way in which it can be folded flat. This enables the aerial to be contained in a shallow box, taking up very little storage space. When the aerial is to be erected it is withdrawn from the box, the two diamond shaped loops pivot on the spacer booms and take up their final position firmly secured by the "J" bolts on the cross-support arm. Erection is therefore extremely fast and, of course, the miniature nature of the aerial makes it extremely manoeuvrable.

Approximate overall dimensions are 17in x 17in x 12in and the aerial head weighs only ¾lb.

Models of the Double Diamond which will be available before the National Radio Show are:

	Retail Price
313/S. Band III only with straight arm and universal 1in–2in clamp	39/6
313/M. Multi-channel model with straight arm and swivel bracket	45/–
313/M-L. Multi-channel model with "L" arm and swivel bracket	45/–
313/M-LZ2. Multi-channel model with "L" arm and 6in chimney lashing set	62/6

The above models are suitable for vertical polarisation; models for horizontal polarisation will also be available.

UNDERSTANDING TELEVISION

PART 8

By W. G. MORLEY

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

IN THE LAST THREE ISSUES OF *The Radio Constructor* we have examined, in detail, some of the principles of operation of the cathode ray tube; and we have dealt especially with the processes of electrostatic and electromagnetic, or "magnetic" deflection, and of electrostatic and magnetic focusing. This month we shall conclude our study of the cathode ray tube, clearing up a number of smaller points which have not yet been discussed.

The Ion Trap

We have assumed to date that it is electrons only which are emitted by the cathode of the cathode ray tube when it is raised to emitting temperature by the heater. In practice, however, such an assumption is not entirely true, since a small proportion of particles other than electrons leave the cathode. These particles may consist of parts of molecules or atoms, and some of these may possess an electric charge.

When a molecule or atom acquires an electric charge it does so by virtue of the fact that it either loses or gains an electron. It is then referred to as an *ion*. If the molecule or atom loses an electron the resultant unbalance causes it to acquire an overall positive charge equal to that of the electron it has lost, and it is called a *positive ion*. If, on the other hand, a molecule or atom gains an electron, it acquires an overall negative charge equivalent to that of one electron, and it is known as a *negative ion*. Due to the fact that an ion contains a number of electrons and protons it is, in consequence, considerably heavier than a single electron; despite the fact that it possesses a charge which is equivalent to that held by the single electron.

In cathode ray tubes intended for television purposes positive ions emitted from the cathode do not normally cause any difficulties. Negative ions, on the other hand, may give rise to considerable trouble unless adequate precautions are taken. Because they hold a negative charge, negative ions are accelerated towards the screen by the final anode in just the same manner as are electrons. Unfortunately, due to their greater weight, negative ions are only partially deflected by the magnetic deflecting system employed with the tube, with the result that the points where they strike the screen become concentrated in a relatively small area only. If the electron gun of the tube were directed at the centre of the screen, the ions would bombard a relatively small area of the screen at this point. Whilst the fluorescent coating on the inside of the cathode ray tube screen may withstand continued bombardment by electrons,[1] it cannot similarly withstand

[1] Provided that these are not heavily concentrated over a very small area.

bombardment by the much heavier ions. Bombardment by the latter causes decomposition. Should bombardment by ions be allowed to continue for too long a period, that portion of the screen which is affected becomes discoloured and loses its fluorescent properties. This condition is described as an *ion burn*, the affected part of the screen being readily recognizable by its brown appearance. Ion burns normally show up as brown circles an inch or so in diameter, the discoloration being greatest at the centre of the burn.

purpose of this magnet is merely that of applying a uniform field across the tube neck, only a simple magnet assembly is required. A typical example of an ion trap magnet is shown in Fig. 41 (*a*). In this diagram we have a small permanent magnet which is mounted between two curved pole pieces. These pole pieces are magnetized by the permanent magnet, causing a magnetic field to appear across the tube neck over which the assembly is fitted. Two pieces of semi-flexible material, such as vulcanised fibre,

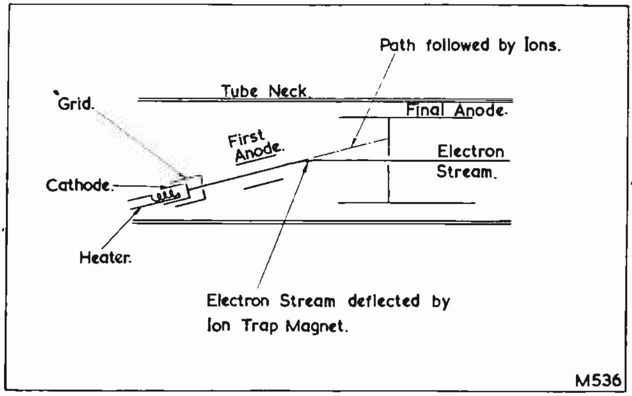


Fig. 40. Showing the principle of operation of an ion trap gun assembly. The cathode, grid and first anode are tilted so that electrons must be deflected by an external magnetic field before they can pass through the hole in the final anode diaphragm. Ions are not similarly deflected and do not pass beyond the diaphragm

In modern cathode ray tubes protection against ion burn is obtained by the simple process of mounting part of the electron gun assembly at an angle, and of applying across the tube neck a fixed magnetic field which causes electrons only to be deflected towards the screen. A typical example is illustrated in Fig. 40. In this diagram we have a gun assembly in which the cathode, grid and first anode are tilted. A magnetic field is applied across the assembly and this deflects electrons leaving the first anode in such a manner that they pass through a hole in the final anode structure. The heavier ions from the cathode are deflected only slightly by the fixed magnetic field and they cannot, in consequence, pass through the hole in the final anode. Instead, they strike this anode and travel no further.

When a cathode ray tube employs a tilted gun structure such as that shown in Fig. 40, it is described as incorporating an *ion trap*. The magnetic field which deflects the electron stream in the forward direction is provided by the *ion trap magnet*.

A discussion on the ion trap would be incomplete if a number of practical points were not examined. The first of these concerns the ion trap magnet itself. Since the secure the assembly to the neck, final tightening being achieved with a nut and bolt. In order to prevent static charges being built up in the magnet and pole pieces, it is common practice to earth these to the receiver chassis by means of a flexible wire.

An alternative form of ion trap magnet is illustrated in Fig. 41 (*b*). In this case the metal ring shown is, itself, the magnet; and it is magnetised across a diameter such that one end has a North pole and the other a South pole. The magnet ring is fitted with a simple semi-flexible mounting, this consisting often of a moulding of soft p.v.c. or a similar plastic. Ring magnets of the type shown in Fig. 41 (*b*) are not usually earthed to the televisor chassis. It will be noted that, with both the ion trap magnet assemblies just mentioned, care is taken to prevent any metal parts touching the glass of the tube neck. This precaution is necessary in order to obviate possible scratches on the glass.

The process of setting up an ion trap magnet is fairly simple provided it is borne in mind that initial adjustments may require considerable movement of the assembly and that final adjustments, once the correct position is approached, are fairly critical. The instructions provided by the manufacturers of the cathode ray tube should normally give full details of setting-up procedure. So far as this particular context is concerned it will probably be sufficient to state that the ion trap must be set to produce maximum cathode ray tube has a field strength which is correct for that tube. Some manufacturers cover this point by specifying a particular magnet make and type number for their tubes. As a general rule of thumb it is fairly

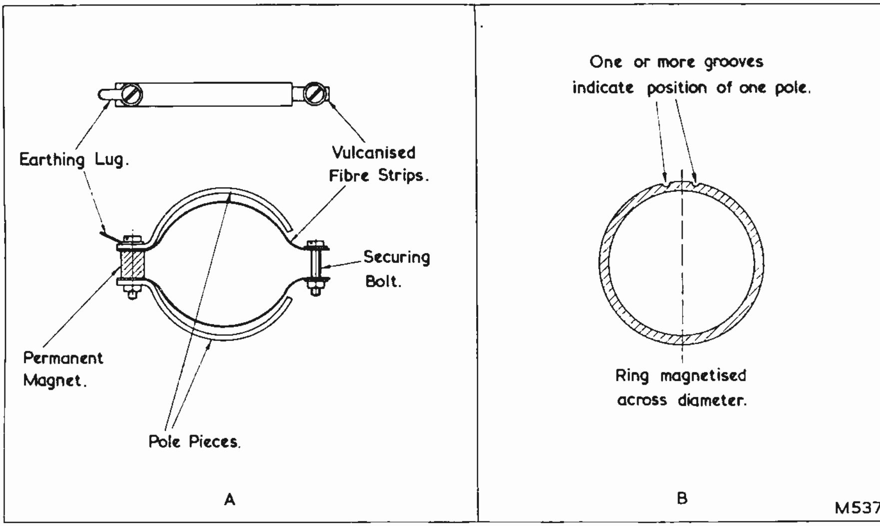


Fig. 41 (*a*). *A conventional ion trap magnet.* (*b*) *A ring magnet which, suitably mounted, may be employed as an ion trap magnet*

brightness of the picture, and that the adjustments required will be forwards and backwards as well as rotational. Where it is found that maximum brightness occurs over a fairly wide range of adjustment, the final setting of the magnet assembly should be mid-way between the points where maximum brightness occurs. If a cathode ray tube employs magnetic focusing or magnetic picture shift (to be discussed below) there may be interaction between the associated magnetic fields. If this occurs care should be taken to ensure that the ion trap magnet still provides a picture of maximum brightness after adjustments have been made elsewhere. Normally, by far the greatest interaction appears between picture shift and ion trap magnets. An important point is that an ion trap magnet should *never* be left in a position which does not correspond to maximum brightness. This is due to the fact that any loss of brightness resulting from maladjustment is caused by electrons striking the gun element through which they should otherwise pass, whereupon they can cause local overheating and reduced tube life. Although this point is not quite so important, some care should also be taken to ensure that the ion trap magnet used with a particular safe to state that the stronger the field strength of an ion trap magnet, the further back along the tube neck it has to be fitted for maximum brightness to be provided. If the magnet has to be fitted so far back along the neck that it is largely, or wholly, over the base of the tube, its field strength is probably too great for the tube with which it is used. When an ion trap magnet has too weak a field strength it is impossible to obtain a picture of adequate brightness Without specialised equipment, a weak magnet may only be reliably detected by substitution with one known to be good.

Picture Shift

In the last two articles we have considered the processes needed to deflect the electron beam inside the cathode ray tube so that it follows the scanning pattern required by the television system with which the cathode ray tube is to be used. We have not yet, however, considered the means whereby, having produced our picture, we may cause it to become accurately *centred* on the screen. By *centring* is meant the process of ensuring that the top and bottom of the picture fall on the top and bottom edges of the screen, and that the left and right hand sides of the picture similarly fall on the left and right hand edges of the screen.[2] Centring of the picture is necessary because it would be extremely difficult to generate deflection currents, and to manufacture deflection assemblies, which would provide correct centring. A much simpler solution consists of obtaining very approximate centring initially and of achieving final centring by additional circuitry or mechanical devices.

Without spending too much time on them, several methods of centring employed in early television receivers should be mentioned at this juncture. One of these methods consisted of passing controlled direct currents through the vertical and horizontal deflection coils. By means of suitable resistors and/or condensers the direct currents did not interfere unduly with those providing deflection. Control of centring was then achieved by varying the direct currents. An alternative method, when electromagnetic focusing was employed, consisted of tilting the focusing assembly in such a direction that the picture became centred satisfactorily. The range of adjustment provided by this second method was, normally, small.

[2] In practice, it is usual to slightly "overscan" the screen, the extreme outside edges of the picture falling outside the edge of the mask in front of the tube screen. (When a "push-through" presentation is employed, wherein all of the tube screen is visible, the extreme outside edges of the picture then fall outside the outside edges of the screen itself.)

Both these early methods of centring are somewhat clumsy, and later techniques employ much simpler devices. One of the more modern picture centring or "picture shift" devices is illustrated in Fig. 42, this being employed with permanent magnet focusing units. In Fig. 42 we have a permanent magnet focusing assembly, against one side of which is mounted a flat ring of mild steel. By means of a handle and a slotted mounting, the ring is capable of being adjusted such that it can move across the face of the magnet in any direction. Due to its proximity to the focusing magnet the ring itself becomes magnetised, providing a weak magnetic field of its own. Nevertheless, this field is still sufficiently strong to influence the path of the electron stream inside the neck of the tube with the result that, by adjustment of the position of the ring, it becomes possible to alter the direction of the stream. An alternative method of considering the action of this type of centring assembly is the assumption that, since the lines of force from the permanent magnet focusing magnet travel more freely through the ring than through the immediately adjacent air, the focusing field becomes modified in the region around the ring. This modified field may be moved by adjusting the position of the ring, thereby providing sufficient change in the overall focusing field for picture centring to be achieved. The flat ring shown in Fig. 42

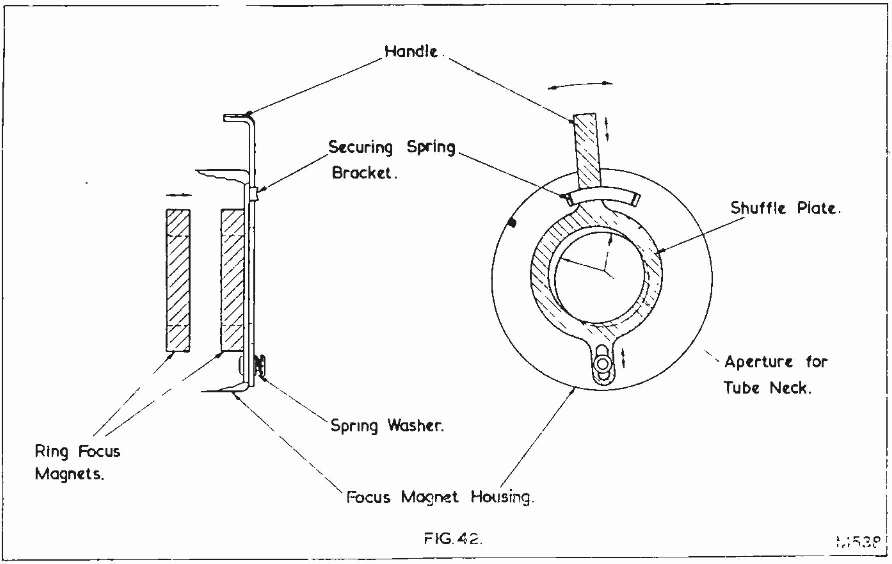


Fig. 42. A "shuffleplate" type of picture centring device, used in conjunction with a permanent magnet focusing unit

is sometimes referred to as a "shuffleplate."

Purely magnetic picture shift devices which are employed on their own are encountered in later receivers. A typical example is shown encountered with electrostatic cathode ray tubes, where the absence of a magnetic focusing assembly precludes the use of "shuffleplate" methods.

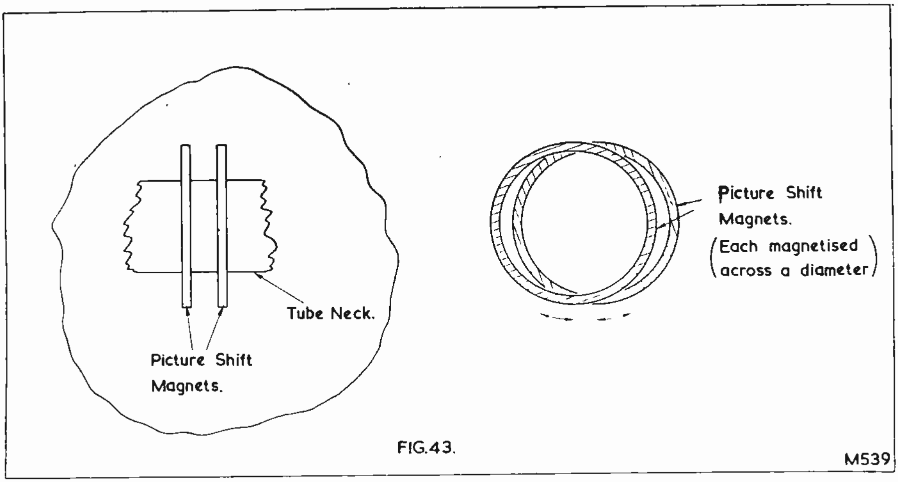


Fig. 43. Picture centring may also be obtained by individually rotating two magnetised rings fitted over the neck of the cathode ray tube (see inset). Mounting details are not given here

in Fig. 43 wherein two circular magnets, each being magnetised across a diameter in the same manner as was the ion trap magnet of Fig. 41 (*b*), are mounted so that they may be rotated independently of each other. By a suitable combination of magnet positions picture shift in any desired direction may be obtaieed. Yet another type of magnetic picture centring device is shown in Fig. 44. This arrangement is somewhat similar to the ion trap of Fig. 41 (*a*) with the exceptions that the pole pieces are usually sprung on to the tube neck instead of being secured with a nut and bolt, and that the magnet is circular and is free to revolve. The magnet is magnetised across a diameter. Movement of the electron stream in the required direction is then achieved by a combination of two adjustments: firstly, the magnet may be rotated, thereby controlling the strength and direction of the field appearing across the pole pieces and, secondly, the whole assembly may be rotated around the tube neck. (See Fig. 45.) Some flexible material, such as rubber, is fitted to the pole pieces to prevent scratching of the glass.

Where magnetic picture centring devices such as those shown in Figs. 43 and 44 are employed, the strength of the magnets used is low, as only a small amount of picture "shift" is normally required. These types are

Aluminising

An important advance in television cathode ray tube design which has taken place over the last ten years or so is incorporated in what are described as *aluminised* or *metal backed* tubes. In these tubes the phosphors which constitute the fluorescent screen are covered on the inside with a very thin film of metal, this metal normally being aluminium. The thin layer of metal is only several molecules thick, and it is applied during manufacture by such process as vaporising a slug of aluminium inside the cathode ray tube bulb whilst the latter is filled with an inert gas at reduced pressure.

Cathode ray tube aluminising provides a number of separate advantages which, when added together, cause performance to be notably superior to that of non-aluminised tubes. One of the more important advantages conferred by aluminising is that the metal layer behind the screen functions as a mirror. Since the screen of a cathode ray tube projects more light *backwards* than forwards, the addition of the metal backing, with its mirror-like action, causes a considerable amount of light energy which would otherwise be wasted to be reflected forward, towards the viewer. The result is a brighter picture. Also, since less light is radiated backwards in aluminised tubes and because of the opaque metal backing itself, there is much less risk of internal reflections from bright parts of a picture causing partial illumination of dark portions. As a result an increase in contrast level (i.e. the difference in light intensity between black and white) is conferred.

From the electrical point of view the aluminised tube offers further advantages. One of these is that the aluminising provides a partially conductive surface at the screen and there is less risk of picture distortion due to capacitive effects.[3] More important than this, however, is the fact that, due to the conductive nature of the aluminising, it becomes possible for the screen of an aluminised tube to acquire a potential of the same order as that held by the final anode. This obviates "sticking," a phenomenon occurring in non-aluminised tubes wherein secondary emission from the screen is not sufficient to allow the latter to reach the full potential of the final anode, causing, as a result, loss of brightness.[4]

In aluminised tubes it is necessary for the electron stream to pass through the metal backing if it is to reach, and excite, the phosphors of the screen. This fact does not raise any difficulties provided that the e.h.t. potential applied to the tube is sufficiently high. In practice, the e.h.t. potentials obtained in modern television receivers (of the order of 12 to 17kV) are more than adequate to ensure penetration.

A final point is that, whilst the metal backing does not prevent the passage of electrons, it does impede the passage of ions. Apart from ions emitted by the cathode a small proportion may be formed by electrons striking stray molecules of gas in the tube. Although their number may be small, the deleterious effect of such ions striking a screen unprotected by a metal backing may be significant over long periods of time. The protection against ion bombardment provided by the metal backing is not normally considered sufficiently good, however, for an ion trap to be dispensed with.

Safety Precautions

Any discussion on cathode ray tubes would be incomplete if a few words were not devoted to the safety precautions which should be observed when they are handled. The danger associated with cathode ray tubes is that resulting from accidental implosion. Whilst the domestic viewer is protected from the risks of cathode ray tube implosion by reason of the fact that the tube is housed in

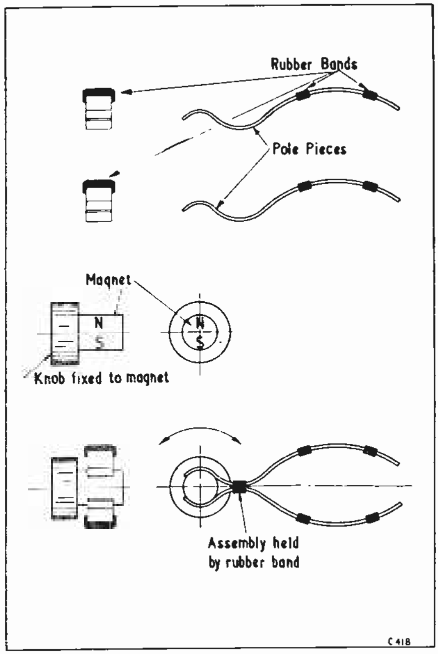


Fig. 44. An alternative type of magnetic picture centring device. The upper part of the diagram shows the component parts, the complete assembly being at the bottom

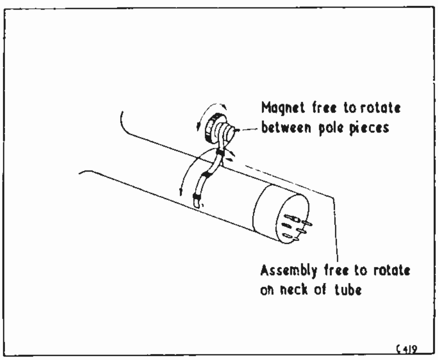


Fig. 45. The picture centring device of Fig. 44 has two modes of adjustment, as shown here

[3] Picture distortion of this type can be particularly noticeable when receivers with non-aluminised tubes are first switched on.

[4] See *Understanding Television*, part 5; May, 1958 issue; page 713.

a cabinet with a protective window, engineers who handle tubes directly are not so protected.

The dangers resulting from implosion may be underlined by the fact that some 500 foot pounds of mechanical energy are stored in a large cathode ray tube[5] due to the pressure on its surface, and that this energy is released if the tube implodes. During implosion violent disintegration of the tube may occur, with particles of glass being thrown over considerable distances. Such particles can, of course, cause injury, especially to the eyes. Also, since implosion is the result of air rushing into an evacuated space, it is possible for the hands of a person holding a tube to be drawn inwards, past jagged edges of glass.

Care should always be taken to avoid reducing the ability of a cathode ray tube to withstand implosion. The glass of a tube should never be scratched, as this may result in a weakening of the structure. It is for this reason that the metal parts of picture centring devices, ion trap magnets, and so on, are never allowed to come into direct contact with the glass. Tubes should always be handled with care to avoid putting excess strain on the glasswork.

A point which is sometimes overlooked is that cathode ray tubes painted on the inside and outside with Aquadag to form a reservoir e.h.t. condenser may frequently hold a high potential charge. If the final anode connector of such a tube is accidentally touched, the resultant shock may cause an involuntary movement with consequent dropping of the tube. Cathode ray tubes incorporating reservoir condensers should always have their condenser sections discharged before they are handled.

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[5] British Standard 415: 1957, *Safety Requirements for Radio or other Electronic Apparatus.*

Northwood Evening Institute, Potter Street, Northwood Hills, Middlesex.

Two courses will be held next session, one assuming no knowledge of radio and covering the whole Radio Amateurs' Examination syllabus, and the other a more advanced course including practical work, for students with knowledge of basic theory. Enrolments will take place between 6 and 8 p.m. on 15th, 16th and 17th September, and classes will commence on 23rd September. The instructor will be C. P. Anderson, A.M.I.E.E. (G2QY).

The following classes, organised by the **East London R.S.G.B. Group,** in conjunction with the Essex County Council, are available for all those interested in amateur radio, irrespective of whether they are members of any society or of the general public:

1. RADIO AMATEUR'S EXAMINATION COURSE. Wednesday, 7.15 p.m. to 9.15 p.m. 8-month course for those intending to take the examination.
2. MORSE AND CODES OF PRACTICE. Monday, 7.30 p.m. to 9.30 p.m. 6-month course for those who wish to learn Morse up to G.P.O. requirements for an amateur licence. Arrangements have been made with the G.P.O. for those who, in the opinion of the masters, have reached the required speed, to be tested at the College in the evening by a representative of the Post Office.

The venue for the above classes is: The Ilford Literary Institute, High School for Girls, Cranbrook Road, Ilford, Essex.

It is adjacent to Gants Hill Station on the Central London Tube and buses pass the door.

The fees for those living in the Essex County Council area are: 30s. for the R.A.E. course; 20s. for the Morse and Codes of Practice.

Students from other parts of London will be admitted as out-county students, provided the local authority is notified.

Enrolment nights—8th to 12th September, 7 to 8.30 p.m.

Classes commence the week commencing 22nd September, 1958. These classes have now been running for eleven years and over 165 students have passed the R.A.E. examinations. Those interested should, in the first instance, write to Mr. C. H. L. Edwards, G8TL, 28 Morgan Crescent, Theydon Bois, Epping, Essex.

Openshaw Technical College, Further Education Dept., Whitworth Street, Openshaw, Manchester 11.

C. & G. RADIO AMATEUR'S EXAMINATION COURSE.—The evenings will be: Tuesday—Theory. Thursday—Morse and Practical Work.

Enrolment will take place on Monday and Tuesday, 15th and 16th September, and the course will commence on Tuesday 23rd September, providing that a sufficient number of students enrol.

Further information can be obtained from the Registrar at the College or to Hon. Secretary, South Manchester Radio Club, "Greenways," 11 Cemetery Road, Denton, Manchester, Lancs.

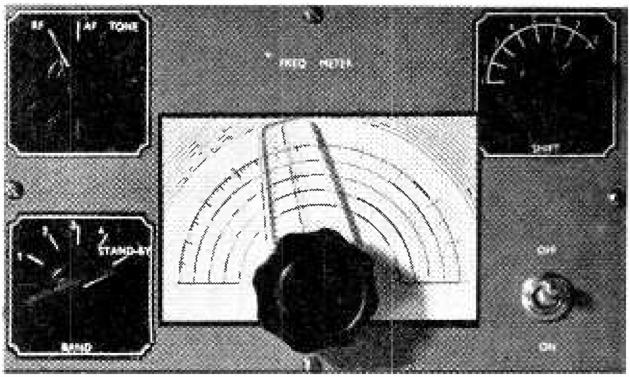
Courses already established at the College cover the C. & G. Radio Servicing courses for the Intermediate and Final Examinations, together with courses for Television Servicing.

THE Mini-Meter

A Frequency Meter for the Beginner

By JAMES S. KENT

Part 3



IN THE LAST ISSUE OF THE MAGAZINE WE HAD reached a point where the instrument had been completely wired, tested, and was in working order. The next step is to fix into position, on the panel face, the Panel-Signs as shown in the illustrations, and to provide the dial pointer.

These paint transfers are obtainable from Sets Nos. 1 and 2 and they are the cheapest method known to the writer of obtaining panel scales which are not only attractive to the eye, but also easy to apply and efficient into the bargain. Full details of how these may be applied are contained on the rear of every packet, and this will therefore not be discussed here.

The full vision graduated dial should be applied first, allowed to dry, and the thin backing paper removed after about four hours or so; any air bubbles should be pricked with a needle, in order to achieve a perfectly flat surface on which the frequencies may be marked with a mapping pen and indian ink. Following this, the other remaining panels should be applied and the same "drill" followed as for the dial. Next, the wording should be applied as shown on the photographs. Two of the smaller panels, as may be seen, have been modified somewhat. Originally they have twelve marked positions and, as we do not need all of these positions, the unwanted ones have been "blacked out" with indian ink.

Fig. 8 shows the clear Perspex marker drawn to full scale, so that it may be traced and the resultant drawing used as a template. Roughly cut from the Perspex sheet, the edges should be filed to size and a thin line scored directly down the centre. This line should then be filled in with indian ink, thus making a thin hair line cursor. It should then be drilled and screwed, by means of Parker-Kalon self threading screws, or, if not available, ordinary flat headed wood screws, to the rear of a suitable medium-sized fluted knob. The fixing holes will, of course, depend on the size and type of knob used. Once completed, the knob and pointer should be securely fixed to the condenser spindle with the vanes fully enmeshed and the cursor dial reading at 100 degrees.

The last constructional item is the output "aerial." This is simply a short length (total 9 inches) of thick copper wire soldered to the output plug. Whichever type of wire is used, it must be completely self-supporting and rigid, as movement will to some extent alter the frequency being radiated.

Calibrating the Meter

There are several methods of calibration. Probably the best and easiest way for the beginner is to take the unit along to a friendly amateur or to the local clubroom and have it calibrated there. The more usual method, however, is to calibrate it oneself. To do this satisfactorily, it is necessary either to possess a receiver with a calibrated dial, preferably a superhet, or alternatively, providing one has a receiver, even without a calibrated dial, to have access to a calibrated signal generator. For the beginner, however, probably equipped only with an uncalibrated S.W. t.r.f. receiver, the only answer is to request the help of a more experienced club member.

It *is* possible, however, for the beginner to calibrate the unit by first switching to the appropriate band on both the receiver and meter, setting the receiver to a known station, the frequency of which can be ascertained, and then tuning the meter to zero beat. The meter is then on the same frequency as that of the broadcasting station. Several points must be noted here, however, before serious operations are commenced. First, a strong signal is not normally required from the meter; this is governed by the output wire length and the distance of the meter from the receiver. Second, with a t.r.f. type receiver, in order to obtain a clear indication of resonance of the meter, the reaction control must be advanced so that the set is just oscillating. It is better to operate the meter some distance away from the receiver, while calibrating, so that the strongest signal received is the fundamental and not a harmonic.

WWV or MSF on 10Mc/s and zero beat the meter; carefully mark the dial. Tune the receiver to 20Mc/s when WWV will be heard; zero beat and mark the dial. We now have two known points on the meter dial, 10 and 20Mc/s. Now, tune the receiver to 5Mc/s and again find either the WWV or MSF transmission, tune the meter to zero beat and mark the dial. Tune the receiver to 15Mc/s WWV, zero beat meter and mark the dial.

We now have the following known frequencies marked on the scale—20, 15, 10 and 5Mc/s. A graph should now be drawn showing dial reading against frequency. These points should now be joined and, where possible, known broadcast station frequencies included. From this graph it is now possible to fairly accurately mark the remainder of the dial. It is stressed, however, that this is the method for those who have no other recourse than to carry out the work themselves with no outside aid or other test apparatus.

The actual limits of each band are, of course, affected by the setting of the iron dust cores of the coils. These should be so adjusted that the tops are level with the tag ring. The small variable condenser should be at half-mesh throughout the entire calibrating process.

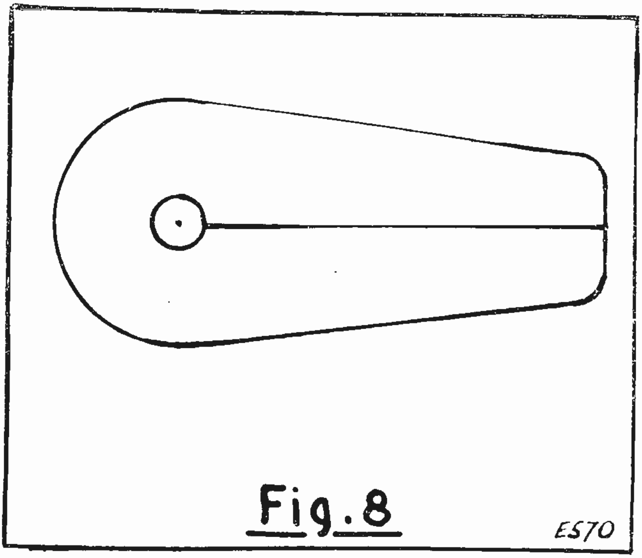


Fig. 8

Harmonics

For those who have access to outside help, it is only necessary to have Band 4 directly calibrated on fundamentals. From these frequencies, 400–100 kc/s, harmonic calibration is possible for the rest. Thus: 2nd harmonic range would be 800–200 kc/s; 4th 1,600–400 kc/s; 8th 3,200–800 kc/s; 16th 6,400–1,600 kc/s, etc.

The practice of calibrating a meter against known stations and frequencies, whilst a comparatively foolproof method, is a long process, i.e. possibly occupying several evenings.

With the prototype, one band only had been calibrated at the time the photographs were taken. This was done without the aid of a signal generator, and is the method recommended to beginners. Switch to range 1 (20,000 to 4,760kc/s), tune the receiver to

Conclusion

It is hoped that with this little frequency meter the beginner will not only have hours of fun calibrating and operating the unit, but will also derive much instruction from it. It is in reality, a small and weak transmitter, and for those who aspire to the amateur radio licence, a morse key inserted in the r.f. oscillator cathode lead would provide a means of perfecting one's c.w. sending by the only known method—continual practice.

A TWO-VALVE KITCHEN RECEIVER

by G. C. BOURNE

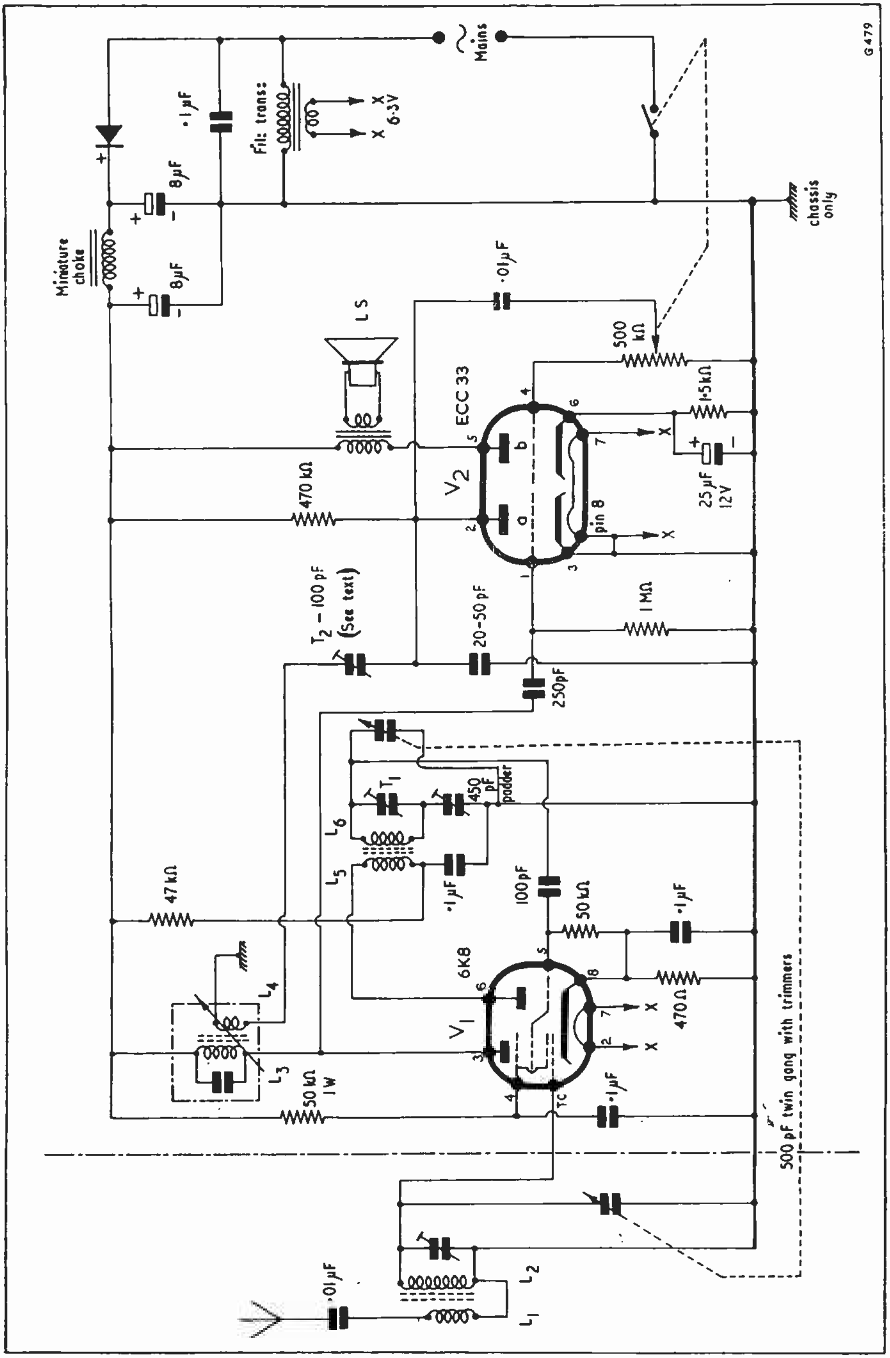
I WAS RECENTLY ASKED TO ADVISE ON THE repair of a home-built two-valve-plus-rectifier a.c./d.c. receiver. It was a straight leaky grid followed by a pentode output. A bad piece of wiring round the mains dropper had shorted, destroying all three heaters. My advice was to forget it, more so when I was told it only ever received one station. It was a nice looking little plastic cabinet with a five-inch speaker, so I made an offer of a few shillings for it, which was instantly accepted. I subsequently learned it had been bought in a sale for less than my offer!

Now our flat is over-full with radio equipment; our "wireless" is a two-valve tuner feeding a six-valve Hi-Fi amplifier. An excellent arrangement for a concert, but a couple of PX25s in push-pull is a bit of a waste just to get the time checks during breakfast! So I decided to build a little set in the newly acquired cabinet, just for the kitchen.

My first resolution was that there would be no mains dropper. I did not wish to use the thing for frying my egg on the top of the cabinet. My second resolution was that it would be a superhet. My third, that the chassis would have to do as it was, which would limit me to three valves at the most.

I bought a filament transformer of the miniature type with an output of 6 volts 1.5 amps max. and a contact-cooled rectifier 250 volt 80 milliamp rating (about the size of an Osborne biscuit); the rest of the works came from my odds and ends box. The two valves used are 6K8 and ECC33. The values of the other components were found to be correct with these two valves, and if some other types are used some of the resistors may have to be altered. The whole thing is quite stable and an increase of 25% in any of the resistors won't make much difference to the output. In fact, nothing seems to be very critical. The finished set has only two knobs, the volume control and switch being one, and the tuner which is put on the end of the tuning condenser without any gearing is the other. Only a few feet of aerial is needed in the London region, to get Home, Light and, in the evening, Luxembourg. It makes a very good set for the seasoned builder to make quickly, or for the newcomer who has never built a superhet before.

The circuit, to begin at the business end, is any available magnetic speaker, fed from a small speaker transformer. The fact that this is designed for use with a pentode won't matter in practice. The output is the second half of the double triode which has the volume control as its grid resistor. This is fed from the anode of the first half of the same valve working as a leaky grid detector. This anode voltage should be quite low, in the region of 20 to 50 volts. The tuning coil of this stage consists of part of an old i.f. transformer; the one I used was tuned to 1.5Mc/s but 465kc/s would do just as well. Remove about two-thirds of one winding, and the condenser from the same side, to make L_4, which is the reaction winding for the detector. Replace the transformer in its can. The grid condenser of V_{2a} forms the blocking condenser from the anode of V_1. The fact that the tuning coil is in the anode lead of V_1 instead of the grid to earth position of V_2 may look strange to a beginner but it is all the same to an r.f. current! It allows all frequencies except the wanted one to escape to earth via the smoothing condensers. V_1 is a conventional mixer, so there is no point in my describing its action here. The screening shown in the diagram to the left of the valve is easily obtained by putting L_1/L_2 on the top of the chassis and all the rest, except L_3/L_4 which is in a can, underneath. There are only two unconventional things about the circuit: firstly it has no i.f. amplifier, secondly it has a leaky grid second detector. The absence of the first is made up



G479
Mains
Fil: trans:
6·3V
·1µF
8µF
Miniature choke
chassis only
·01µF
LS
500 kΩ
ECC 33
V2
1·5kΩ
25µF 12V
pin 8
470 kΩ
T2 – 100 pF (See text)
20-50 pF
1 MΩ
250pF
T1
450 pF padder
L6
L5
100pF
50 kΩ
6K8
V1
47 kΩ
L4
L3
50 kΩ 1W
470 Ω
500 pF twin gang with trimmers
L2
L1

for by the sensitivity of the second. The layout doesn't matter very much provided all grid leads can be kept fairly short. The type of tuning coil doesn't matter either; mine consist of: L_2, 120 turns scramble-wound on a half-inch former with a slug; L_1, 20 turns wound on top of L_2; L_6, 50 turns on similar former; L_5, 20 turns wound ¼ in. away. Commercially wound coils should give better results.

As I have said, layout does not much matter. Wiring should be kept neat and the use of a tag-strip to provide the h.t. points is advisable. Start by wiring in the heaters, and note the earthing point is at pin 8 on the ECC33—this is to eliminate hum. Next wire the tuning coils and all the grid and anode connections to keep them short. Lastly, wire the feeds; it doesn't matter if these have to go round a few other components to get there.

The choice of a contact-cooled rectifier reduces a lot of heat troubles. It should be mounted somewhere against the flat chassis, such as against the upright back angle, where it can keep cool. It is running well inside its rating and will barely get warm. Choke smoothing is better than a resistor as a leaky grid detector is sensitive to hum. Quite a small choke would do. The power pack is quite straightforward. Since building, I have seen some miniature transformers on the market giving an output of 240 volts h.t. as well as 6V, 1.5amp. l.t.—one of these would do excellently to isolate the chassis from the mains.

No signal generator is needed to align the set, though a signal tracer in the form of a pair of headphones with a diode across them and a couple of condensers in the leads would be helpful. To line up, with the receiver disconnected from the mains, set the slug or tuning trimmer of L_3 to its mid-position. Put the signal tracer on the grid cap of the 6K8 and rotate the tuning condenser until the Home programme is heard (this should be possible if the signal tracer is any good), take away the tracer and without moving the tuner again switch on the set. When it has warmed up adjust the padder (starting from the unwound position) until the Home Service programme is heard in the speaker. Now switch off again, unplug, and replace the signal tracer. This time tune in the Light and repeat the process, but when switched-on bring in the sation in the speaker by adjusting the trimmer T_1. Final adjustments can then be made tuning in first the Home (or a station nearer the "long" end of dial if one can be picked up) to the best volume by slightly varying the padder P_1, and then tuning in the Light the same way using T_1.

Components List

- 50kΩ 1 watt
- 50kΩ ½ watt
- 470kΩ ½ watt
- 47kΩ ½ watt
- 470Ω ½ watt
- 1MΩ ½ watt
- 1.5kΩ ½ watt
- 500kΩ pot with switch
- 0.1μF (4)
- 0.01μF (2)
- 100pF ceramic or mica
- 250pF ceramic or mica
- 20 or 50pF ceramic or mica
- 100pF trimmer
- 450pF trimmer
- 25μF, 12V
- 8μF, 300V (2)
- 500pF tuner (two-gang with trimmers)
- 1 pair superhet coils and matching i.f.t.
- 1 smoothing choke
- 1 filament transformer
- 1 contact cooled rectifier 250V, 80mA
- 1 speaker and transformer
- V_1, 6K8. V_2, ECC33

Up to this point T_2, which is a postage stamp type of trimmer, should be left in the unscrewed position. Now screw it up a little when the set is working. The station should get louder. If it gets softer reverse the connections on L_4. If it gets louder, screw it up until V_{2a} oscillates, then turn back a shade. A slight adjustment to the slug or trimmer of L_3 will now be found advantageous. If the reproduction becomes harsh and the oscillation rough, reduce the anode voltage on V_{2a}. If it oscillates all the time or when T_2 is almost all out, then increase the value of the 20–50 pF condenser between anode and chassis, or reduce L_4.

If everything has been done correctly, the output from the ECC33 will be ample for normal listening. My version supplies plus 16 dB on a B.B.C. announcer's voice, measured at the anode on an Elpico Microtester. (0dB=6mW.)

Warning: *Beginners should note that this receiver uses a.c./d.c. technique, and that the chassis is "live." It should not, therefore, be directly connected to earth, nor should any metalwork be handled whilst the mains are connected, even if switched off.*

The JUPITER

Stereo Main Amplifier

A Jason Design, by G. Blundell

THE JUPITER MAIN AMPLIFIER IS THE companion unit for the pre-amplifier described in last month's issue of this magazine, and it consists of two complete 10-watt amplifiers with a common power supply all built on one chassis.

The power output stage is of the ultra-linear type, and gives 10 watts output from each channel. A twin triode completes the output stage, the first half being an amplifier and the second a phase splitter. It can be seen from the circuit diagram that the cathode resistance of the phase splitter, R_8, is returned to the cathode of the amplifier, V_{1a}, giving about 5db of positive feedback.

This is very advantageous in giving extra gain at a low distortion point in the amplifier, and because of this extra gain the negative feedback can be increased to 20db without loss of input sensitivity. 20db is a reasonable compromise of negative feedback, giving good speaker damping and reduction of distortion. If more feedback were used, an extra stage would be needed in the main amplifier and the problems of stability would be increased. An extra stage would involve an extra low frequency phase shift in the form of a resistor and condenser in the extra stage, and thus increase the likelihood of low frequency oscillation or motor-boating. With more feedback the problems of unconditional stability in the presence of reactive loads is greater. The present amplifier is stable with any kind of load, as is shown in the diagram, Fig. 1. This is achieved by careful choice of the values of C_1/R_2, R_{18}/C_6, R_{19} and C_7, and the capacitor shunting the feedback resistor, C_8. Unconditional stability is a point of good design to be aimed at, so that whatever load the owner connects to the speaker terminals does not result in any instability. In practice, it means that long speaker leads may be used without danger of instability; this was not true until recently with one quite well known make of amplifier! Also, an electrostatic speaker may be used without the capacitive load proving troublesome.

The mains transformer is quite small for its rating, and this is achieved by the use of grain-oriented steel for the laminations of the transformer. The extra cost of such a transformer is not great, but the result of using these special laminations is a saving in weight of approximately one third and a reduction in the overall size of the transformer.

The mains transformer primary winding is split so that the halves may be connected in parallel for 110V operation and in series for 220V mains. The shorting plug joins socket pins 6 and 12 (wires violet and red) when the locating plug is in hole A, and this gives 250V operation. 220V operation is given by inserting the locator pin of the plug into hole B, thus joining socket pins 10 and 4 (wires green and white). For 110V operation the plug is connected as shown in the drawing; thus for 124V operation socket pins 11 and 12 are joined (red wire to mains) and also 5 and 6 (violet to mains). 115V operation is given by the plug in hole B joining socket pins 10 and 9, 3 and 4.

Building

Firstly, mount the valveholders and all components. The transformer wiring may then be completed, checking the colours very carefully. It will be noted that there are three black wires coming from the transformer, two of these being earth shields—these latter are knotted together. The third is the mains connection.

Because of the small size there is not room for conventional tag panels, and therefore the wiring should be tidy and leads short if the result is not to be the proverbial "birds nest." This method of point-to-point wiring does reduce the number of soldered joints and also the possibility of stray couplings causing unexpected instability effects.

Beware of scraping through the insulation of the high stability resistors and causing a short to a neighbouring tag.

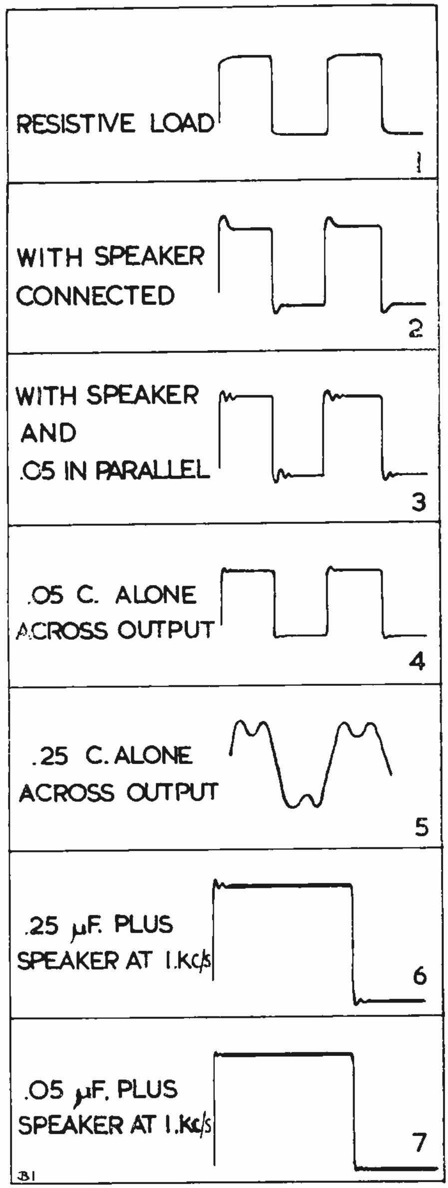
Power Response

Only the power response of the amplifier is given. The frequency response at one watt output is flat from 15 cycles to higher than 50kc/s. This, however, is not useful information; since if one tried to obtain the full output at 15 cycles, there would be severe distortion. The table, therefore, shows the most pessimistic result.

If this is compared with other amplifiers, be certain that it is the power response that is given and not the frequency response. Manufacturers are often wary of publishing these curves. In the case of one well-known amplifier the frequency response is flat from 20c/s to 20kc/s, but in fact the power response is only flat from 100 c/s to 6kc/s!

Switching On

First check the h.t. wiring very carefully, and check for shorts with a meter. Switch on and check the h.t. voltage at the rectifier. As soon as this reaches maximum, check immediately the voltage at the cathodes of the output stages. If this is not the correct voltage within 3 volts, switch off immediately and check for faults. Check other voltages when, if correct, a listening check may then be made.



Drawings 1 and 2 show in an exaggerated manner the effect of connecting resistive and loudspeaker loads. The frequency of the square wave is 10 kc/s and the shape indicates a good response to high harmonics, i.e. the fifth harmonic of 50 kc/s.

Drawings 3, 4 and 5 indicate the effect of capacitive loads, the effect being exaggerated in drawing 5 for clarity. For comparison purposes, the effect of capacity load only at 1 kc/s is shown in drawings 6 and 7

Table 1

POWER RESPONSE

Frequency	*Power*
10c/s	0.6W
15c/s	1.2W
20c/s	6W
25c/s to 10kc/s	10W
12kc/s	8W
15kc/s	7W
30kc/s	7W
50kc/s	10W

Table 2

TEST VOLTAGES

Test point	*Reading*
V_4 Rect, pin 8	335V
Junction R_{21}, R_{22}	318V
Junction R_{21}, C_{9a}	294V
Cathode V_2, V_3	12V
Junction R_9, C_4	195V
Junction C_3, R_8	64V
Junction R_5, C_2	130V
Cathode V_{1a}, pin 3	1.5V

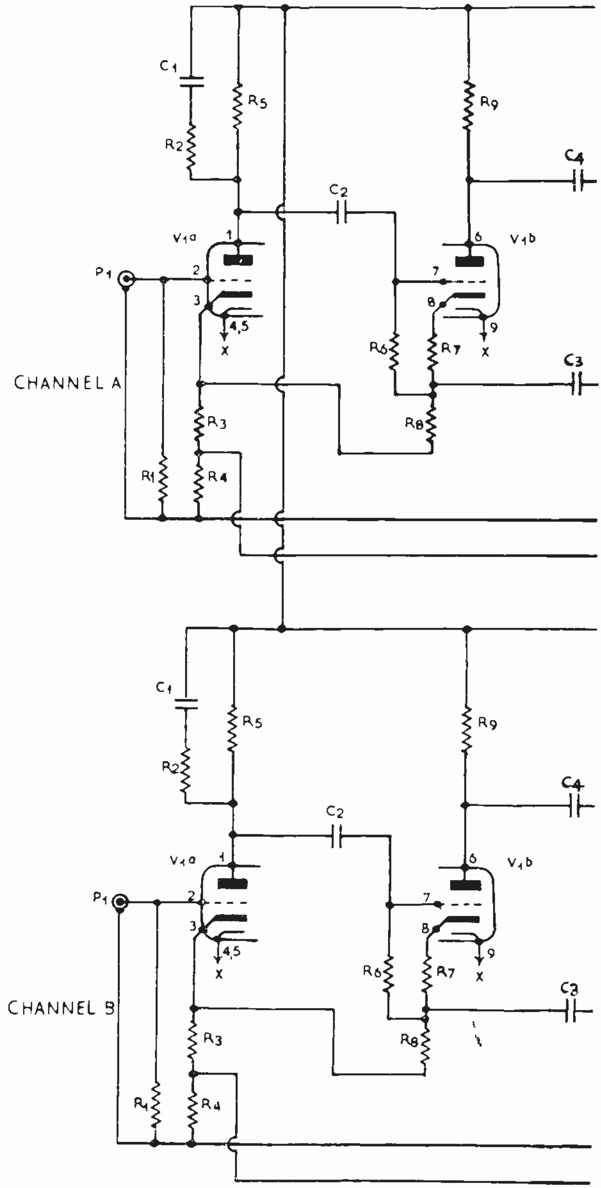
Table 3

IMPEDANCE TABLE

The feedback components R_{20}–C_8 on the circuit diagram, and the output transformer secondaries, are given for 15Ω loads. If other impedances are required, connect as follows:

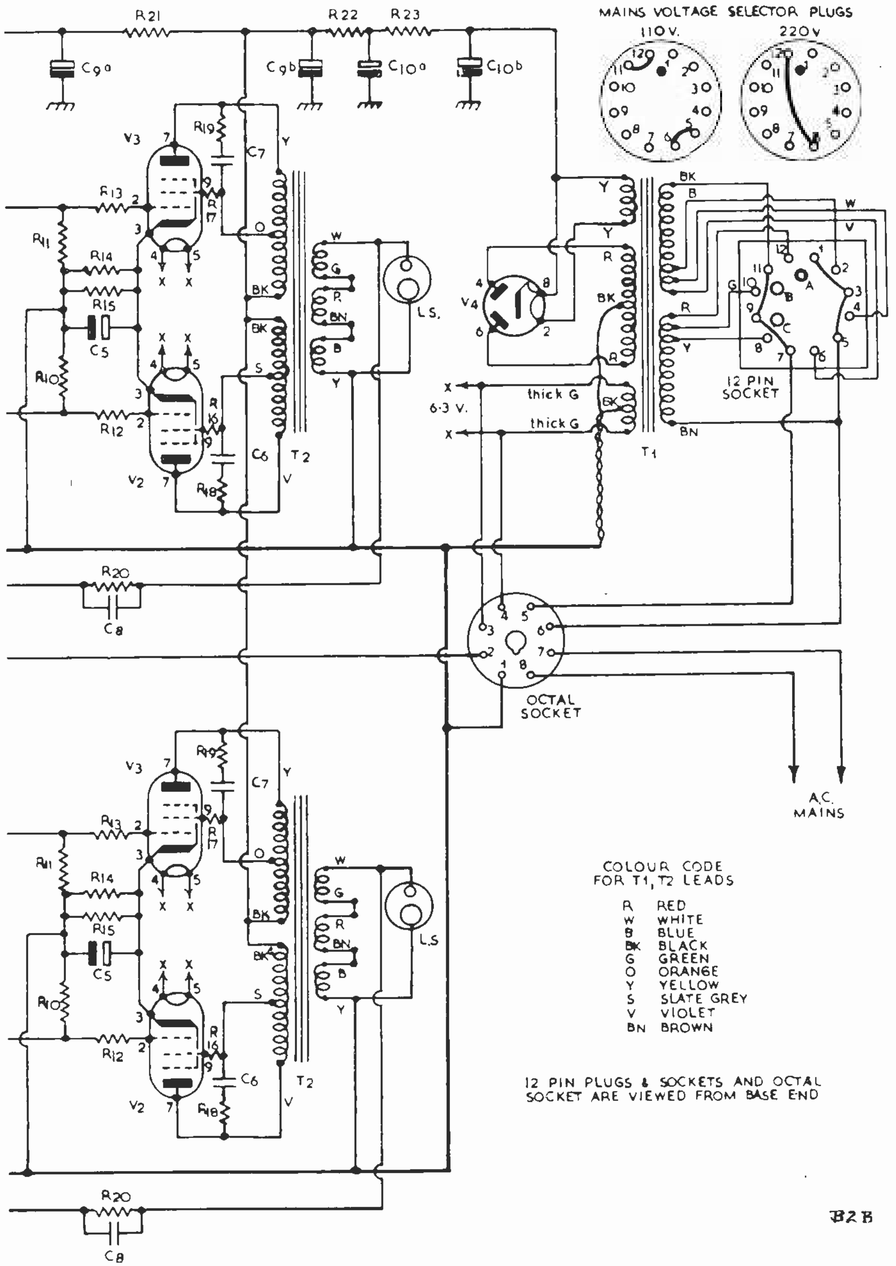
4Ω *Output Impedance*
Join Blue and Brown. Connect Yellow and Green to chassis. Join White and Red; this is the output connection to speaker. Alter feedback components to: R_{20}, 1.1kΩ and C_8, 100pF.

8Ω *Output Impedance*
Join Blue to Red and to Green. Join Brown to Yellow and to chassis. Join White to output socket. Alter feedback resistor R_{20} to 1.5kΩ and associated condenser C_8 to 68pF.



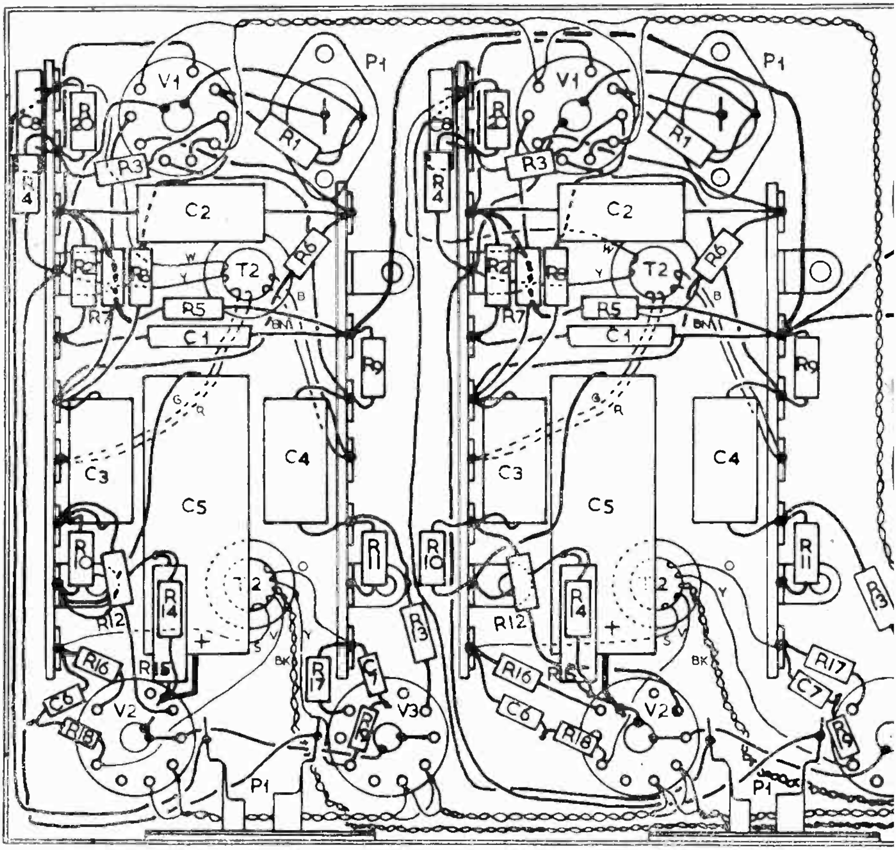
82A

Theoretical circuit



of the "Jupiter" stereo main amplifier

CHANNEL A CHANNEL B



B3

Under-chassis layout of the "Jupiter" stere

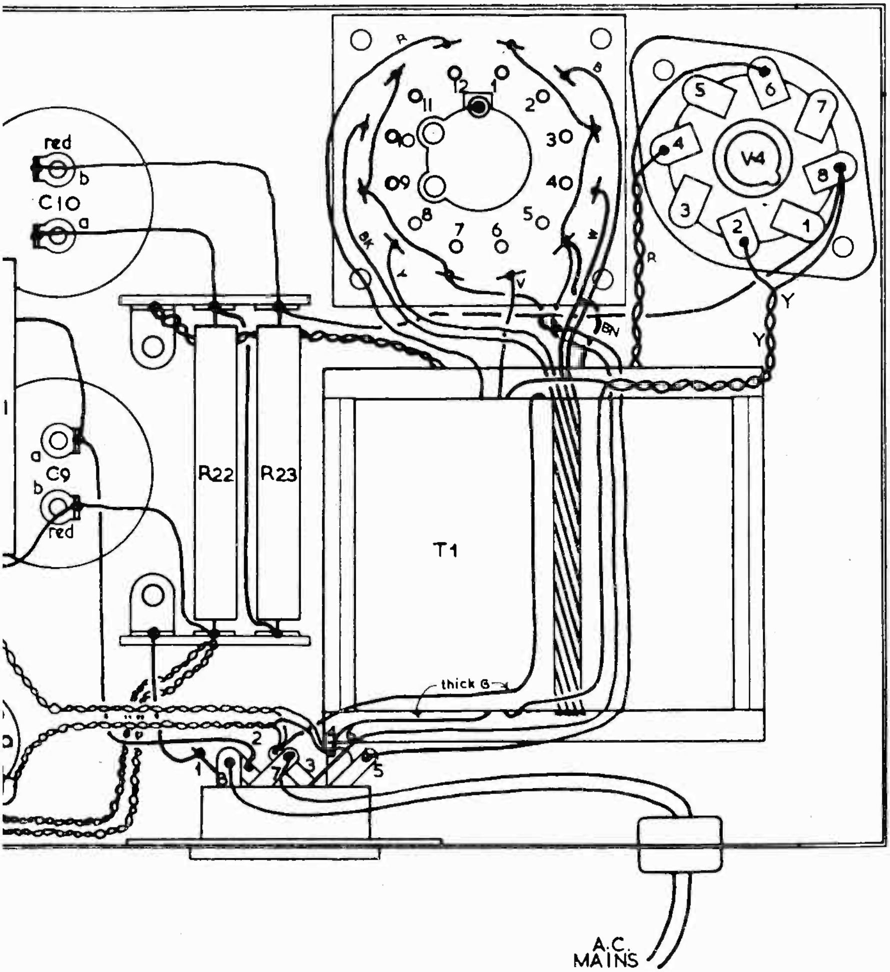
One off R_1 to R_{20} for each channel.
Resistors

R_1	1MΩ H.S. 10%
R_2	3.3kΩ carbon 20%
R_3	1.2kΩ H.S. 10%
R_4	100Ω H.S. 10%
R_5	220kΩ H.S. 10%
R_6	1MΩ H.S. 10%
R_7	2.2kΩ H.S. 10%
R_8	100kΩ H.S. 10%
R_9	100kΩ H.S. 10%
R_{10}	220kΩ carbon 20%
R_{11}	220kΩ carbon 20%
R_{12}	1kΩ carbon 20%
R_{13}	1kΩ carbon 20%
R_{14}	1kΩ carbon 20%
R_{15}	270Ω $\frac{3}{4}$W carbon 10%
R_{16}	270Ω carbon 20%
R_{17}	270Ω carbon 20%
R_{18}	4.7kΩ carbon 20%
R_{19}	4.7kΩ carbon 20%
R_{20}	2.2kΩ H.S. 5%

All above, except R_{15}, $\frac{1}{2}$W rating.

One each of the following resistors is required, these being common to both channels.

R_{21}	6.8kΩ $\frac{3}{4}$W carbon 20%
R_{22}	56Ω 1W carbon 20%
R_{23}	56Ω 1W carbon 20%



in amplifier (compare with photo overleaf)

Capacitors

One off C_1 to C_8 for each channel.

- C_1 150pF S.M. 10%
- C_2 0.05μF 400VW d.c. paper
- C_3 0.05μF 400VW d.c. paper
- C_4 0.05μF 400VW d.c. paper
- C_5 100μF 25VW
- C_6 500pF 20% ceramic
- C_7 500pF 20% ceramic
- C_8 50pF 10% silver mica

One each of the following capacitors

- C_9 32+32μF 350VW
- C_{10} 32+32μF 350VW

2 Output transformers, type OT10, Jason
1 Mains transformer, type MTS, Jason

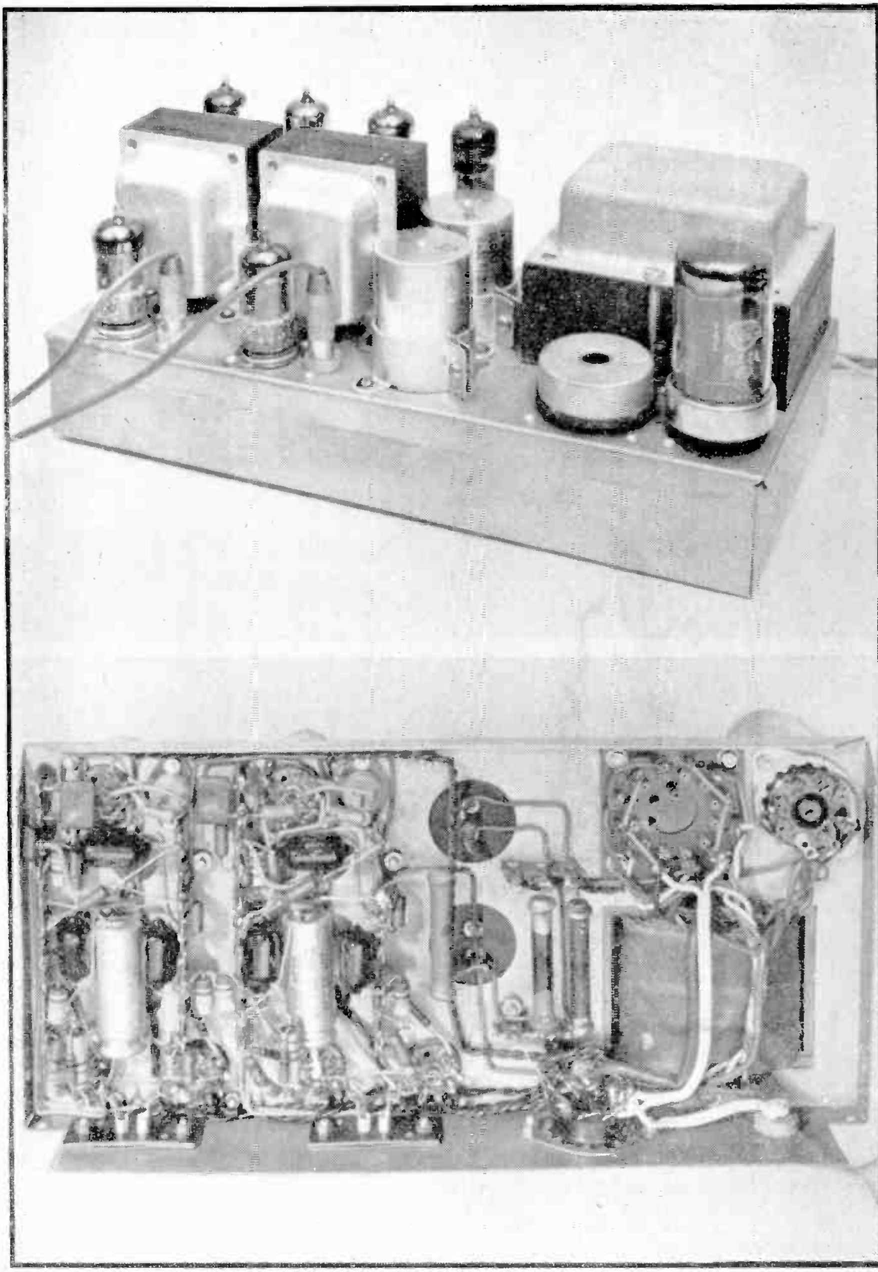
Valves required

1 GZ34
4 EL34
2 ECC81

Other Components

1 Mains adjustment panel and plug, Jason
2 Coax input sockets and plugs
2 Speaker output sockets
6 B9A Valveholders
2 I. Octal holders
1 Grommet ⅜in
6 Tag strips
1 Chassis, ready punched, and base, Jason
4 Rubber feet, Jason

continued on page 42



Top: Above-chassis layout of "Jupiter" main amplifier

Bottom: Under-chassis layout—compare with diagram on previous page

A TRANSISTORISED 3-CHANNEL RADIO CONTROL RECEIVER

By C. M. PEARSON, B.Sc., G3IUQ

SINCE A LOW VOLTAGE BATTERY IS GENERrally used for powering radio controlled models, it was thought that there might be some interest in the transistorised three-channel radio control receiver described below. It is designed to be fed from a standard super-regenerative detector, the input to the receiver being connected in place of the sensitive relay normally used for single channel control. For close range work, however, it should operate quite well from a simple crystal detector as the sensitivity is extremely high. When correctly adjusted, a minimum input signal of the order of 1/10th of a microwatt will give reliable control.

Three-channel control is achieved here by modulating the transmitter at any of three fixed audio frequencies in the range 300–500 c/s. The received signal is detected, amplified and used to energise a tuned reed relay, which has three reeds tuned to the audio modulating frequencies and carrying contacts. Output is obtained from each reed only when energised at its resonant frequency, so that three individual control circuits may be operated from the receiver.

The relay consists of three strips of Stalloy, carrying contacts, mounted over an electromagnet so that when the coil is energised with a current at the resonant frequency of one of the reeds, that reed will vibrate strongly and make a pulsating connection with a fixed contact. If the three reeds are of different lengths they will resonate at different frequencies. A diagram to illustrate the construction of the relay is given in Fig. 1.

The reeds were made from a mains transformer lamination which was first cleaned with emery cloth and then tinned using flux and a hot soldering iron. Three strips about $\frac{1}{16}$in wide were guillotined off the lamination and cut to lengths of 1in, $1\frac{1}{8}$in and $1\frac{1}{4}$in. The reeds were then soldered parallel and close to one another on a strip of 24 s.w.g. brass $\frac{3}{16}$in x $\frac{5}{8}$in and contacts removed from a small relay were soldered on as shown in Fig. 1 (*a*).

Three contact strips from a change-over relay, one straight and two angled, were assembled between two pieces of $\frac{3}{32}$in thick Paxolin $\frac{3}{16}$in x $\frac{5}{8}$in with "Araldite" adhesive as shown in Fig. 1 (*b*). The sandwich was then assembled with "Araldite" to the brass strip and the whole clamped loosely in a toolmakers' clamp. After aligning the contact strips to the reed contacts the clamp was tightened up as much as possible and the whole put in an oven at Regulo 1 for $\frac{3}{4}$ hour in order to cure the adhesive. "Araldite" is used as it gives an extremely strong joint between metal and Paxolin providing the parts are clean and dry.

A supporting frame was made from 20 s.w.g. brass with two holes for fixing the electromagnet and three 10BA tapped holes for the contact adjusting screws, as shown in Fig. 1 (*c*). The electromagnet was removed from a Siemens high speed relay and has two coils giving a total resistance of 290Ω.

The contact assembly was painted with "Araldite," clamped to the bracket and heated in the oven at Regulo $\frac{1}{2}$ for 1 hour. Before adding the coil, fine wires were soldered to the three contact strips and to the brass plate bearing the reeds. A slip of paper was fixed on each contact strip to insulate it from its adjusting screw. The completed relay is shown in Fig. 1 (*d*). Finally, the adjusting screws were screwed down to give about 5 or 10 thou. contact clearance, and locked. The electromagnet may be packed up with washers to give about 20 thou. clearance with the reeds.

The relay was tested by connecting it to the output of an audio frequency signal generator, connected as shown in Fig. 2 (*a*) or (*b*) since it is necessary to polarise the relay with direct current to give correct operation. With a signal of 3V r.m.s. across

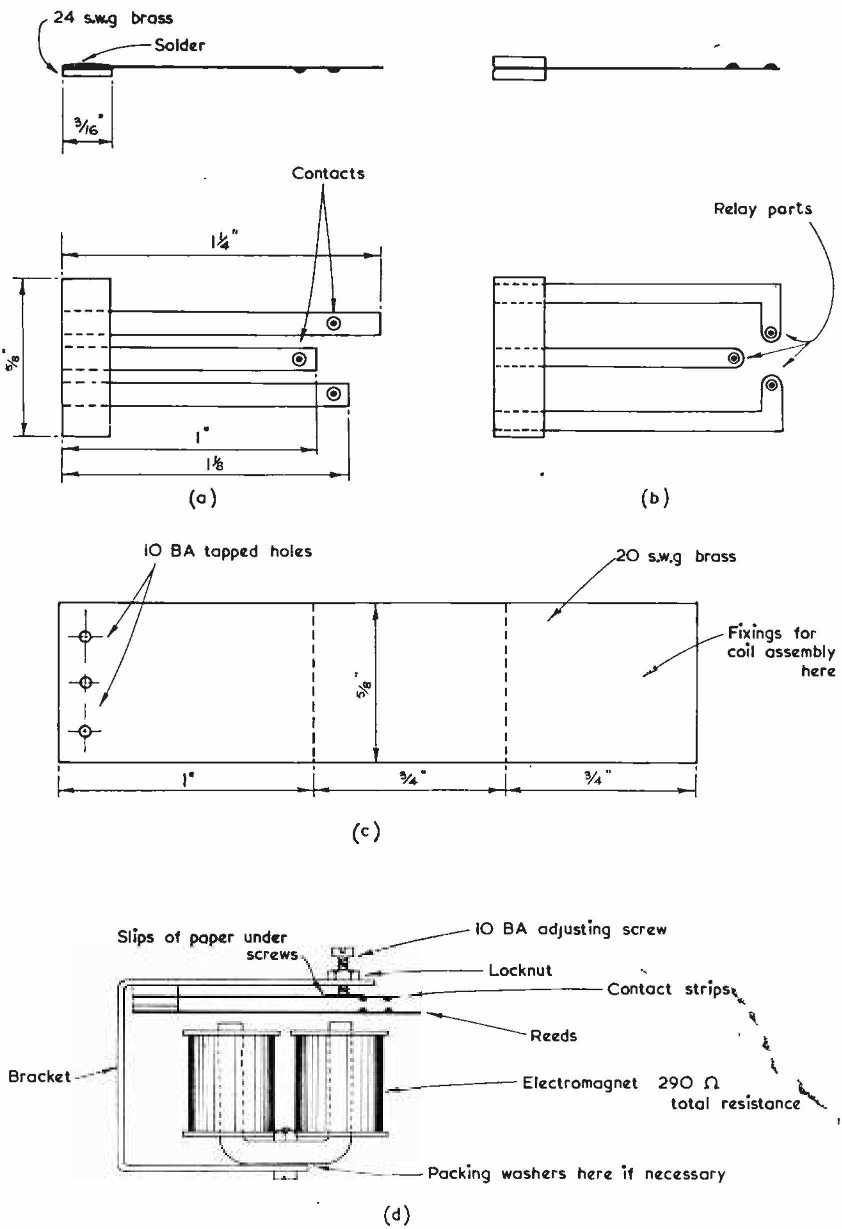


FIG. 1. TUNED REED RELAY CONSTRUCTION

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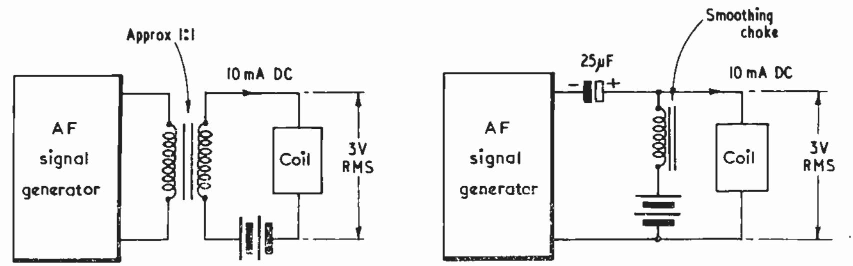


FIG. 2. RELAY TEST CIRCUITS

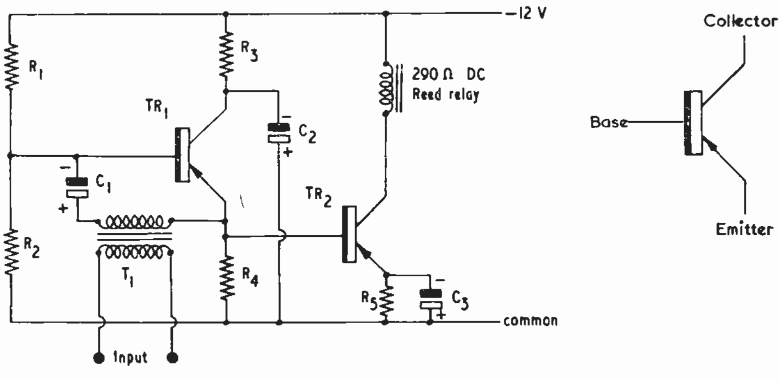


FIG. 3. REED RELAY AMPLIFIER

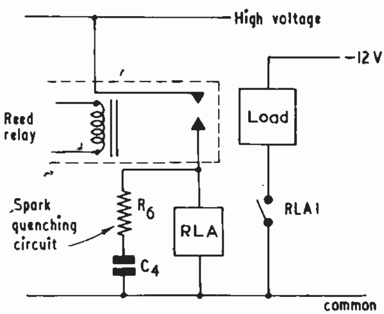


FIG. 4 (a)

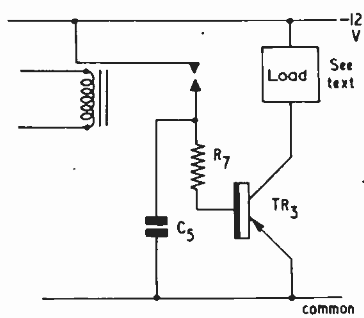


FIG. 4 (b)

G477

the coil the reeds should vibrate against the contacts at frequencies of the order of 300, 400 and 500 c/s one at a time as the signal generator frequency is changed. It is, however, most important that the shortest reed does not resonate at the second harmonic of the resonant frequency of the longest reed, as this may give a spurious response when connected in the receiver. If necessary, to avoid this, it is quite easy to lower a reed frequency by loading it with a little solder applied with an iron.

In the absence of a signal generator the relay can be connected to the output of a receiver adjusted for C.W. reception of a steady signal, the beat frequency oscillator being varied to change the pitch of the beat note.

The circuit of the transistor amplifier used to drive the tuned reed relay is shown in Fig. 3. It is basically a two-stage amplifier, but the circuit configuration is somewhat novel, having been designed to use the minimum number of components consistent with high gain and stable performance. The operation of the amplifier is as follows:

The input signal applied to the primary of T_1, connected as a voltage step-down transformer, is amplified in TR_1 which operates as a grounded collector stage. Normally, degenerative feedback makes the voltage gain of a grounded collector stage less than unity, but here one side of the secondary of T_1 is connected to the emitter so that there is no feedback and there will be appreciable current and voltage gain. The emitter of TR_1 is direct-coupled to the base of TR_2 which operates as a conventional grounded emitter stage, with the reed relay coil as the collector load.

The d.c. potential at the base of TR_2 is approximately equal to the base potential of TR_1, this being determined by the bias potentiometer R_1, R_2. This therefore controls the emitter potential of TR_2 and hence the collector current. The collector current of TR_2 polarises the electromagnet and gives correct operation of the reed relay.

The contacts on the vibrating reeds cannot be used directly for the control of heavy current circuits as they only make contact instantaneously once per cycle, so they are normally used to energise sensitive relays, which then switch the heavy current circuits as shown in Fig. 4 (*a*). If, however, the power requirements of the load circuits are sufficiently low, as may well be the case with actuators, the switching can be carried out with transistors as shown in Fig. 4 (*b*) and the relays may be dispensed with, giving a considerable saving in weight.

Using a TJ3 transistor in the circuit of Fig. 4 (*b*), the load circuit should be designed for a working voltage of 10V and a current of less than 65 mA, which means that the d.c. resistance of the load must be greater than 150Ω. The OC72 transistor, although having a lower collector dissipation than the TJ3, has a much lower bottoming potential and will switch a load of 100mA at 12V, or almost twice the power, in this circuit. The resistance of the actuator should not be less than 120Ω for the OC72.

The complete amplifier, tuned reed relay and three switching transistors was constructed on a piece of $\frac{1}{16}$in Paxolin $3\frac{5}{8}$in x $2\frac{1}{8}$in. Small holes were drilled in the board and component wires passed through. The wiring was carried out on the back of the panel with 26 s.w.g. tinned copper wire, a heat shunt being used when soldering connections to the transistors and other components. The transistors were fastened down to the panel with twine passed through holes in the board and tied at the back. The completed assembly weighed approximately $3\frac{1}{2}$ ounces. It was tested on the output of an audio frequency signal generator and functioned consistently at 3μA r.m.s. current input. Performance was unaffected by an increase in signal strength of 50 dB which is greater than the overload signal likely to be encountered in practice.

The transmitter circuits used will depend on the type of control required. If more than one reed must be operated at once, then more than one audio oscillator will be required to modulate the transmitter. If only one reed is operated at a time, only one modulating oscillator will be necessary as its frequency may be switched from one channel to another. Transistors may be used for the audio oscillators and modulators, but at the present there are no commercially available transistors which will operate as oscillators on the 27 Mc/s band.

Component List

R_1	220kΩ 1/10th watt
R_2	180kΩ 1/10th watt
R_3	10kΩ 1/10th watt
R_4	10kΩ 1/10th watt
R_5	330Ω 1/10th watt
R_6	220Ω 1/10th watt
R_7	3.3kΩ 1/10th watt
C_1	5μF 12.5V
C_2	16μF 12.5V
C_3	16μF 12.5V
C_4	5μF 12.5V
RLA	sensitive relay
T_1	2 : 1 step down transformer (Repanco TT4)
TR_1	OC71
TR_2	TJ3
TR_3	TJ3 or OC72 (see text)

Radio Miscellany

LAST MONTH I FELT IT NECESSARY TO apologise for giving over much of the column to gramophones and records. Apparently I need not have worried. Rarely has the postbag been so full. Many readers wrote asking for the catalogue number of the *Popular Science* magazine Test Disc which I mentioned was now available in the U.K. Fortunately I was able to find time to reply to them all, but for the benefit of others who might have wondered it is simply known as Test Disc No. 1 and is issued by Allied Records Ltd. (London). I was surprised that so many record dealers did not seem to know of the existence of this record—apparently they only sell them and would seem to have but little interest in the contents.

Thinking of record dealers reminds me of their being by-passed as the result of the direct sale of records in a similar manner to that popularised by the various Book Clubs. I have had quite a few requests for my opinion on the quality of the recording of various "Club Records"—some of which sell for little more than a third of the price of records sold through the normal channels. As the choice of titles selected are those which would chiefly appeal to the serious music listener, the question of recording quality is obviously of considerable importance. I have heard one which sells for under 15s. but as it was played on very indifferent equipment I must reserve judgment. The quality, however, was about the same as that of standard records played under the same conditions. I hope soon to have an opportunity of making a comparative check on real hi-fi equipment. I would put the emphasis on the word "real" —lately I seem to have been running into much stuff which is hi-fi in name only! In the meantime the views of any readers who have made comparative tests will be welcome.

The only "Club Record" I have heard played on a truly hi-fi system was one (of a set of ten with monthly additions) sponsored by a record manufacturer. These 12in long plays cost a little over a pound, and the one I checked on seemed equal in all respects to the better standard recordings.

I have also heard a brief demonstration of the first stereo disc records (double sound track), recently issued by Pye. Properly used, they certainly give 3-D sound. By the phrase "properly used" I don't simply mean with the special equipment—that is obviously necessary. There is, however, an additional control, to give a balance between the two speakers. This and other incorrect adjustments can quickly falsify musical values, and I hate to think of what sort of sound people with more money than musical taste might adjust them to give. Apart from this danger, it represents a considerable technical advance and will keep the keen constructor on his toes as soon as he realises his present hi-fi may soon be considered old-fashioned.

A Job for Idle Hands

Among the letters received this month was one from a Luton reader. I rarely quote the nice things that readers, on occasions, say about this column; but this one is a little unusual inasmuch as it was written by a non-regular. He writes: "Like yourself, I have had a longish spell in hospital, and while there a friend brought me a bundle of old *Radio Contructors* to read. I haven't done any radio for years, although at one time I was a keen experimenter. The magazines certainly re-vitalised my former interest. I went more or less straight through the bundle reading all your Radio Miscellany articles which I enjoyed—especially the parts about Old Timers. I think it must have been the revival of old memories and a certain hint you dropped that rekindled my old enthusiasm.

"In one of your earlier articles you wrote at some length on rebuilding and modernising old receivers. Like most other families we had an old broadcast set at home, stuck away in the attic. So in the long weeks of posthospitalisation at home I got busy with a new all-wave coil pack, miniature valves, a new dial and sundry modern components, all bought by post. I completely rebuilt the set, trying to keep it as much as possible like an exhibition piece. It works perfectly and I have now started to modernise another—a long-discarded portable.

"I am convinced the idea which came about as the result of reading your articles materially assisted me in speeding up my recovery and made the long weeks of enforced idleness a pleasure instead of a period of boredom. Thank you for both the enjoyment and the idea I derived from your column, and I hope that you are now, like myself, fully recovered."

Thank you too, J.S., for a most encouraging letter received just as I was about to again put my nose to the grindstone. Come to think of it, redesigning old sets must be an ideal way of pursuing constructional interests for armchair-ridden enthusiasts. No chassis bashing, octal-sized valveholder holes blanked off with miniature adaptors, doubtful components stripped out and modern parts fitted. No heavy benchwork, and it can all be completed with a few simple tools and a soldering iron—plus a couple of cushions in the back of the armchair to prop you up! I gladly pass the suggestion on for other readers to try out on their convalescent friends.

Centre Tap talks about items of general interest

For Those With Ideas

Among the other interesting letters received this month is one from Mr. C. W. Ward, who adds to my recent comments on Lossev's experiments with oscillating crystals. He still has his notebooks (*circa* 1924) containing a summary of Lossev's original articles from several publications, dealing with experiments with natural and synthetic zincite used with steel catswhiskers. For those with a taste for experimental work with transistors he recommends a collection of papers "Some Conducting Materials" (Henisch 1951) published by Butterworth, which includes one on "Crystal Triode Action In Natural Lead Sulphide." It seems that galena can produce the transistor effect almost, but not quite, as well as germanium —the natural being somewhat superior to the synthetic in this respect. Since galena is cheap and easily obtainable in quantity, there would appear to be considerable scope in this field for those with a taste for original research. He would be greatly interested to hear of any experimental work done by readers in this connection, also of any further references. His address is 43 Woodlands Road, Bexleyheath, Kent.

It is by no means unusual for important and original ideas to spring from this kind of experiment. Frequently discoveries only remotely related to the work on hand are made. The history of invention is studded with examples of major discoveries being made by people with infinite enthusiasm for following up a specialised interest and when concentrating on some significant (and often unexpected) result, suddenly perceiving a new use to which it can be put. However, more of this later. Since I wrote about ideas for automatic ventilation control I have had quite a bit of correspondence on the matter and it's too big a subject to deal with in detail in the space available.

Old Wives' Tales

Contrary to a widespread belief, *all* modern inventions are not the work of teams of professionals working for big organisations. A steady proportion are purely amateur, particularly those of everyday devices rather than abstract ideas. The safety razor was just such an invention, and Kodachrome was initiated by two amateurs. Nearer at home, Bakelite—so widely used in radio—at least started off with independent backing.

Inventors, too, appear to be born rather than made. Once a man has invented something he is eagerly snapped up for institutionalised research. Here he gets a chance to show his paces with big financial backing. Perhaps for this reason (the spreading of a wide filter for all sorts of ideas still untried) institutional research pays off dividends and is so widely thought to be responsible for the introduction of *all* new inventions.

Usually, whenever I get a lot of correspondence on a particular point, and especially when the writers seem a little hazy on a subject, I try it out on my circle of friends and acquaintances. . . . It invariably provides a useful clue to what people popularly suppose and what they really know. I did just this on the topic of inventions, and to my astonishment I found quite a lot who were firmly convinced that "big businesses" buy up and suppress inventions so as not to ruin their existing market. This, of course, is just nonsense; in Britain, at any rate. If a patent is not worked for three years after the grant, any bona fide applicant can apply for the issue of a compulsory licence to do so.

Old wives' tales die hard. One or two friends I spoke to obviously still harboured a suspicion that there was a catch in it somewhere, even after I tried to disillusion them. Perhaps there is something in the romantic fiction that bright ideas are regularly bought up and "killed" that makes them prefer to believe it's true!

My Punctured Vanity

When I sat down to prepare this month's column I had before me a number of letters I have not found time to acknowledge and hoped to find space to touch on regarding their particular points of interest. Apologies, therefore, to C.K. (Saxmundham), J.L. (Parkstone), "Mr. Fox" (Balham, S.W.12), H.R.N. (Harrow) and M.S. (Steckford, Birmingham 33). I have just "gossiped on" and left myself no space this month. At least *Radio Miscellany* was described as a "gossip column" in the May R.S.G.B. Bulletin—in a friendly sort of way, of course.

Funnily enough, although I have been a member for almost enough years to win a round of applause in a Wilfred Pickles show, and I have contributed at some time to almost every British radio journal past and present, I've never written anything for the "Bull." Still, they sometimes put in nice little bits about me, either as an amateur or about my "gossip." We are thus the best of friends, and who am I to quibble over a word?

Down the years I have written numerous technical, theoretical and constructional articles. Never did I find any one of them as hard to write as a page of "gossip"—and I often marvel that after writing hundreds of them I still go on without re-hashing. To keep up a regular commentary which must please both beginners and old hands alike demands qualities I haven't really got. Prime requisites are a prolonged association with the hobby, an up-to-date knowledge of the many subjects related to radio, the time and opportunity to keep in touch with everything cooking in the radio world, an inexhaustible fund of experiences and anecdotes, sufficient imagination to guess what many people might like to read—and a sense of humour.

On reflecting how lacking I am in most of these qualities, I am even more painfully conscious of my shortcomings. When added to this my cherished commentary is described as "gossip" I am almost tempted to write up some choice bit of tittle-tattle about the writer of that editorial—only I don't know any!

Can Anyone Help?

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

D. Fynn, 46 Conway Crescent, Perivale, Middlesex, wishes to obtain the circuit diagram, and/or service sheet, for the Pilot 5-valve "Little Maestro" a.c./d.c. 200-250V receiver.

* * *

R. P. Jones, 92 Hurst Road, Twyford, Herts, requires a circuit of a Philco car radio receiver No. K628S, and also a circuit of the American receiver BC.348.L. He will be only too pleased to purchase either or both.

* * *

F/Lt. W. C. Brown, Pendref, Caersws, Montgomeryshire, wishes to obtain a circuit diagram for, and details of using, a BC.624.C receiver on the 144 Mc/s Amateur Band.

* * *

W. McCarthy, 45 Tintern Street, Liverpool 4, wonders if any reader can help him with the circuit of a radiogram which nobody locally seems to have heard of! The make is "Gamma," and it uses four valves including the rectifier. It was purchased in 1949.

G. Gallamore, 34 Hardwick Road, Partington, Urmston, Manchester, wishes to buy *The Radio Constructor* for August 1955—cost no object!

* * *

D. A. D. Coates, 12b High Street, Sutton, Surrey, wishes to purchase or borrow a circuit or manual of the Air Ministry oscilloscope "Monitor 28."

* * *

A. Jameson, 75 Poplar Avenue, Pemberton, Wigan, Lancs, would like to purchase the circuit of the Collins TCS.12 receiver which covers 40, 60, 80 and 160 metres.

* * *

E. M. E. Decottignies, 58 Leighcliff Road, Leigh-on-Sea, Essex, reports that his request for information on the CV1501, published in the June issue, has brought an overwhelming response. Would readers who enclosed an S.A.E. therefore bear patiently with him, and would others please accept this notice as an intimation of thanks.

Technical Forum

A Sound-operated Switch

A SENSITIVE SOUND-OPERATED SWITCH HAS many applications; some are useful and others may be classified as amusing. Before describing the device, certain of its uses will be mentioned and, in so doing, the reader's imagination may be fired into suggesting some other work for the switch. Basically, as its name implies, the device is employed to open or close an electrical circuit upon receipt of a signal which may be supplied by an amplifier, radio set or similar piece of equipment. The switch is most commonly used in conjunction with a tape recorder, where it is arranged to start the mechanism upon receipt of a signal and stop it some few seconds after its termination. The delay at the end is required to ensure that the recorder is not inadvertently stopped during a short pause in either speech or music. Provision can be made for adjusting the delay, which is usually required to be in the region of 5 to 10 seconds. The switch is fitted with a sensitivity control which is particularly useful when tape recordings are being made of selected items in a conversation, as it may be set so that operation is only obtained when words are being spoken directly into the microphone and not on the general background noise. If the recorder is being used as a dictating machine it may be advantageous to reduce the delay time at the end of the signal to about two to four seconds. This will permit the tape transporting mechanism to stop during the longer pauses in the dictation, such as occur when a point is being checked or new material obtained.

Another possible application for the switch will be found with automatic record changers, which may be stacked with records and arranged to be switched off at the end of each, and then restarted as required by whistling or speaking into a microphone. Under these conditions the switch is held in by taking a signal from a microphone which is picking up the sound from the player. The delay timing can be set so that the gramophone motor is stopped when the pick-up has been returned to its rest.

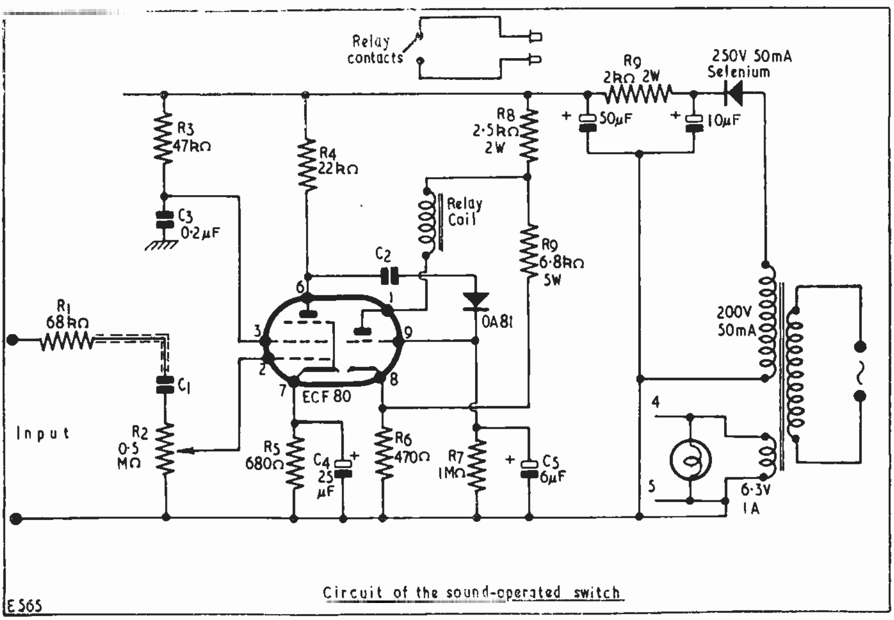
The Circuit

Largely with a view to economy consistent with sensitive operation, the circuit has been designed around a single valve, the triode pentode type ECF80. The pentode section functions as a resistance-capacity coupled a.f. amplifier, and its output is rectified by a semi-conductor diode to provide a positive-going voltage. This voltage is, in turn, fed to the grid of the triode half of the valve, in the anode circuit of which is the coil of the relay. This sounds relatively straightforward, but there is a special requirement of a sound operated switch which complicates the design. It is important that the relay contacts should close as soon as possible after receipt of the audio control signal, and that they should remain closed for a predetermined time after the cessation of the signal. These two requirements are to some extent incompatible, as the first calls for a short time constant and the second a long one. In the circuit shown, a compromise has been achieved by the use of a combination of components which gives a short charging time to a high value capacitor which is arranged to have a long discharge time. The capacitor in question is the electrolytic C_5.

This is charged by the rectified signal from the anode of the pentode, and the charge is built up quickly by virtue of the low value anode load resistor plus a reasonably high anode current. The capacitor cannot, however, discharge by this path because the rectifier does not conduct in that direction, so that the delay is obtained via R_7 which provides for the discharge. The value of R_7 should not be made larger than 1MΩ as it must be low when compared with the leakage resistance of the shunt electrolytic. Thus if it is necessary to increase the delay, a larger value capacitor should be used; whereas a reduction in timing may be obtained by reducing either the "R" or the "C."

A practical point is well worthy of mention in connection with the use of electrolytic capacitors in circuits which are required to have a specific time constant. An electrolytic will always possess some small leakage current which in circuit gives the same effect as a shunt resistor. The resistance added in the circuit across the capacitor should always be low by comparison with the leakage resistance. Should a capacitor have been out of service for some time its leakage current will have risen; this may also apply to a new component which has been on the shelf for some time. In such cases the leakage can be restored to its original low value by ageing the capacitor by connecting it with the correct polarity across a d.c. source having an output approximately equal to the working voltage. A run of about 15 minutes should prove adequate.

R_8 and R_9. The anode is also tapped into the potentiometer to hold its voltage to about 100V, in the relay open condition. This is done to keep the cathode bias required for cut-off as low as possible and thus maintain a high order of sensitivity. The circuit will accommodate quite a wide tolerance in the relay coil, but a component should be selected with a pull-in current between 1 and 5mA and a resistance not in excess of 20kΩ. With some combinations of valves and relays it may be necessary to adjust the bias on the valve to reduce the anode current to less than 0.25mA in the no-signal condition; this should be done by minor adjustment of R_6. The switching contacts on the relay should include a single-pole pair insulated to take the 250V a.c. mains at currents up to at least 1 amp. The power supply for the circuit is quite straightforward and calls for little comment. Resistance-capacity smoothing has been employed to save the price and weight of a choke. Values listed for the smoothing capacitors are not critical, but components having values within 50% of those recommended should be used. The h.t. supply voltage will be in the region of 180V at a no-signal current of about 25mA. When the relay pulls in, this consumption will



Circuit of the sound-operated switch

To return to the circuit analysis, the triode section of the valve is biased very close to the current cut-off point by the 10 volts fed to the cathode from the dividing network R_6,

rise by the amount passing through the coil.

One last point concerning the circuit diagram—a resistor R_1 has been included in

continued on page 55

21 Mc/s Bandspread Conversion for the National HRO Receiver

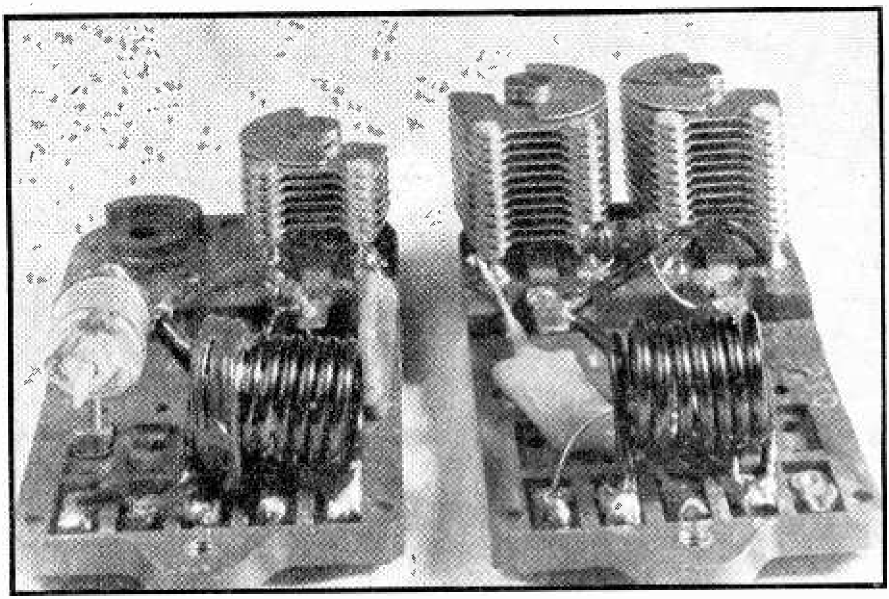
By **E. H. TROWELL, G2HKU** to a design by **G2ATV**

LIKE MOST SURPLUS RECEIVERS, THE ubiquitous wartime HRO does not have provision for bandspreading the post-war 21 Mc/s band. This article describes how a cheap and very efficient conversion may be carried out without using or converting an otherwise costly h.f. coil set as other writers have done.

The coil set used for the conversion may be any one of the following: Type J, 50–100 kc/s; Type H, 100–200 kc/s; Type G, 180–430 kc/s; Type F, 480–960 kc/s; Type E, 900–2050 kc/s. The Type J was used by the authors.

Construction

Whichever coil it is decided to use, the screening cans should first be numbered 1 to 4 and removed from the mounting plate. Each coil should be withdrawn from its screen and lettered in accordance with its screen number. The coils themselves should then be removed from their mountings together with any other components *except* the trimmer condensers C_1 ($T_{2, 4, 6}$) on the two r.f. and mixer coil plates and C_1, C_2 ($T_{7, 8}$) on the oscillator coil plate. These are shown in position on the coil plates in the



Shown on the left is an R.F. or mixer section, and on the right the H.F. oscillator section

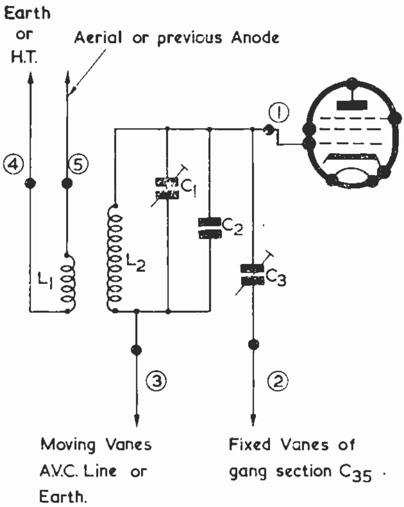


FIG. 1.
Bandspread R.F. Stage (or Mixer).
21Mc/s.

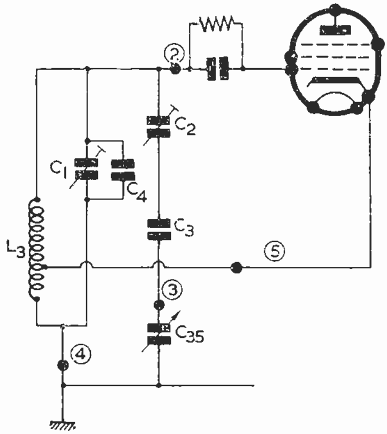
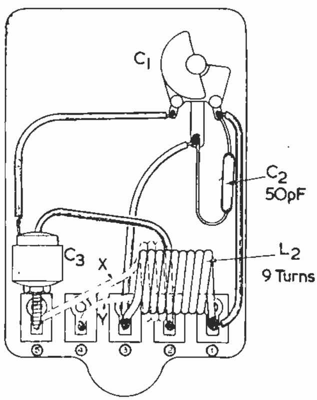


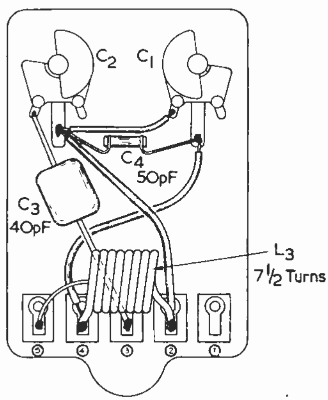
FIG. 3.
Bandspread Osc. Stage.
21Mc/s.



XY = 3 turns overwound at earthy end of L_2.

X = Anode end is nearest end to Tag 3

FIG. 2.
Practical Version of FIG. 1.



Tag 5 tapped 2½ turns up from Tag 4

FIG. 4.
Practical Version of FIG. 3.

M533

photograph, the r.f. or mixer unit on the left and the oscillator unit on the right. The position of the Philips trimmer should also be noted.

with the coil connections, and in the left-hand hole is fixed a 6BA screw as shown in the photograph. A wire gripping type of solder tag is used to hold the trimmer in position,

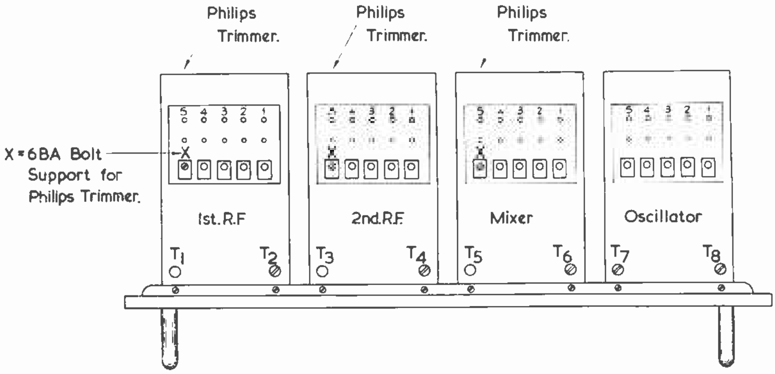


FIG. 6
HRO Coil Unit showing position of Trimmers & Supports.

The larger coils should be wound to the specifications given in Table 1 and mounted on their connections as in Figs. 2 and 4, corresponding to the circuits in Figs 1 and 3. No difficulty should be experienced in mounting, the coils being soldered directly to the connections provided and the smaller coils XY overwound and fixed in position with Polystyrene cement.

and the joint soldered. Using a one-inch screw should bring the adjustable end of the trimmer in line with the hole already provided for trimming in the rear of the coil screen. This provides a firm fixing; although constructors may like to try their own method of mounting, it is in any case important that there must be no play in the mounting of the trimmer.

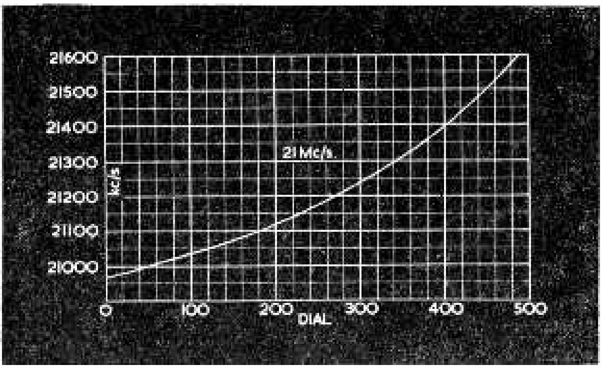


Fig. 5. This graph may be cut out and inserted behind coil box panel in place of existing one

The next step is mounting the Philips trimmers and their supports on the two r.f. and mixer coil bases. An examination of the coil base will reveal a row of holes parallel

Wiring of each coil base may then be carried out and the coil unit now assembled for testing. A word of warning here which may save time and temper. Place a ruler or straight edge across the coil contacts after assembly on their base plate to ascertain that each row of coil contacts is level with the next as, if one coil is low, it may not make contact with the contact strip when inserted in the HRO receiver.

Alignment

A source of 21Mc/s signal is required either from a transmitter or signal generator, preferably the latter, which should be set to 21,000 kc/s and the HRO dial to 50. C_1 in the oscillator section (T_8 in HRO Manual) should be adjusted until the signal is heard. Turn the receiver dial to 425, set the signal generator to 21,450 kc/s and adjust C_2 (T_7) until the signal is heard. By adjustment of C_1 bandsetting and C_2 band spreading it should be possible to spread the band as shown in Fig. 5, which is the graph of the coil modified by G2HKU and is reproduced here in a size suitable for insertion on the front of the coil box.

The r.f. and mixer stages should be aligned by adjustment of C_1 ($T_{2, 4, 6}$) for maximum background noise as described in the HRO Manual. Check that this noise is fairly constant throughout the tuning range and, if not, adjust the Philips trimmers until the sensitivity is constant from 50 to 425 on the HRO dial.

A check that the oscillator is operating 912 kc/s higher than the r.f. stages should be made. This is not as easy as it seems, for the "regular" HRO coils can be checked on general coverage and then changed to bandspread, whereas our coils do not cover 912 kc/s. However, this is overcome by setting the signal generator to 21,000 kc/s and the receiver dial to 50 and noting the strength of the signal either by S meter reading or by ear. Then tune the generator to 21,912 kc/s; if all is well the signal should be very much weaker.

The Editor G2ATV and G2HKU both working independently modified their coils as described above and each worked perfectly at the first trial. The credit for the design goes to G2ATV.

TABLE 1

L_1	3 turns 22 s.w.g. insulated overwound at earthy end of L_2
L_2	9 turns 14 s.w.g. enam., $\frac{7}{16}$in. inside dia.
L_3	$7\frac{1}{2}$ turns 14 s.w.g. enam., $\frac{7}{16}$in inside dia., tap at $2\frac{1}{2}$ turns from tag 4.
C_1	R.F. or mixer coil box is original trimmer.
C_2	R.F. or mixer coil box is 50pF silver mica.
C_3	R.F. or mixer coil box is Philips trimmer 3/30pF.
C_1	Oscillator coil box is original trimmer.
C_2	Oscillator coil box is original trimmer.
C_3	Oscillator coil box is 40pF silver mica.
C_4	Oscillator coil box is 50pF silver mica.

Also required, three 6BA bolts 1 inch long and nuts with shakeproof washers.

Bibliography

* "Some HRO Modifications." Ward VQ4FB, *Short Wave Magazine*, December, 1954.

* "Bandspread on 21 Mc's for the HRO," Mason GM6MS, *RSGB Bulletin*, February, 1953.

TECHNICAL FORUM

continued from page 51

the input lead at the remote end of the input screened cable. The purpose of this resistor is to prevent the capacity of the cable from shunting the amplifier to which the switch may be connected, thus eliminating the possibility of a loss in the top note response.

Sensitivity

The sensitivity of the switch is adjustable by means of the potentiometer R_2. In the maximum position a signal of about 100mV (0.1 volt) will be required to operate the relay.

Construction

The layout is quite non-critical, but lead lengths should be kept reasonably short, particularly those associated with the input circuit. The whole unit may be housed in a small metal box with a co-axial socket for the input and a flying mains lead. An indicating lamp is necessary to show when the unit is functioning, and a second lamp is an asset to indicate when the relay pulls in. Most relays have more than one set of contacts, and the additional pair may be used to switch on the 6V lamp when the relay is energised.

FOURTH AMATEUR TELEVISION CONVENTION

The British Amateur Television Club will be holding its fourth Amateur Television Convention on Saturday 6th September, from 10 a.m. to 7 p.m., in the Conway Hall, Red Lion Square, Holborn, London, W.C.1. There will be displays of amateur built television equipment in operation, and among the many attractions will be pictures received from the club's outside broadcast van, as well as demonstrations of amateur colour television. Both members and non-members will be very welcome. The charges for non-members are as follows: all day, 5s.; admission after 2 p.m., 2s. 6d.

Further particulars and tickets can be obtained from any of the following: D. S. Reid, 27 Rose Valley, Brentwood, Essex; J. E. Tanner, 16 Norfolk Drive, Chelmsford, Essex; or D. W. E. Wheele, G3AKJ, 56 Burlington Gardens, Chadwell Heath, Romford, Essex. Tickets will also be on sale at the door, on 6th September.

MODELS FOR RADIO CONTROL

THE "WAVEMASTER" *KIT*

Part I

by Raymond F. Stock

An ambitious radio-controlled model can represent the highest degree of amateur craftsmanship, since it may require ability in both design and construction of not only the radio equipment, but the model itself and its power plant. The range of skill needed (and the workshop facilities) may be very wide; seldom, however, is a comprehensive design of this type seen. Most enthusiasts are primarily modellers, to whom a minimum knowledge of radio gear is a means to an end, or they may be radio amateurs whose basic interest is in the control gear and whose model may represent little more than a test vehicle.

The purpose of this article is to discuss the construction of a model from the point of view of the radio enthusiast who has never previously built a model but who is, like most enthusiasts, able to carry out the normal range of workshop operations with hand tools.

Most readers of this magazine would build a radio-controlled model primarily to exploit the electronic equipment; in general, model aircraft are the least suitable for this purpose since they impose severe weight restrictions and require a certain minimum knowledge of aerodynamics to operate successfully.

Land vehicles are a better proposition in these respects, but usually necessitate a workshop equipped with machine tools to permit the fabrication of the transmission and similar parts. Moreover, the control problems are greater in a vehicle, which needs to be very precisely steered to be acceptable.

It commonly happens, therefore, that the choice of the newcomer to radio control falls on marine models. A first-class ship model can present as many problems as any aircraft or land vehicle, plus a considerable amount of work in connection with external detail; but if the type of craft is correctly chosen, a perfectly acceptable model can be built at the cost of little time and effort, and without needing the use of special tools.

Types of Models

Before considering a specific design, it may be as well to review the types of craft generally copied in model form.

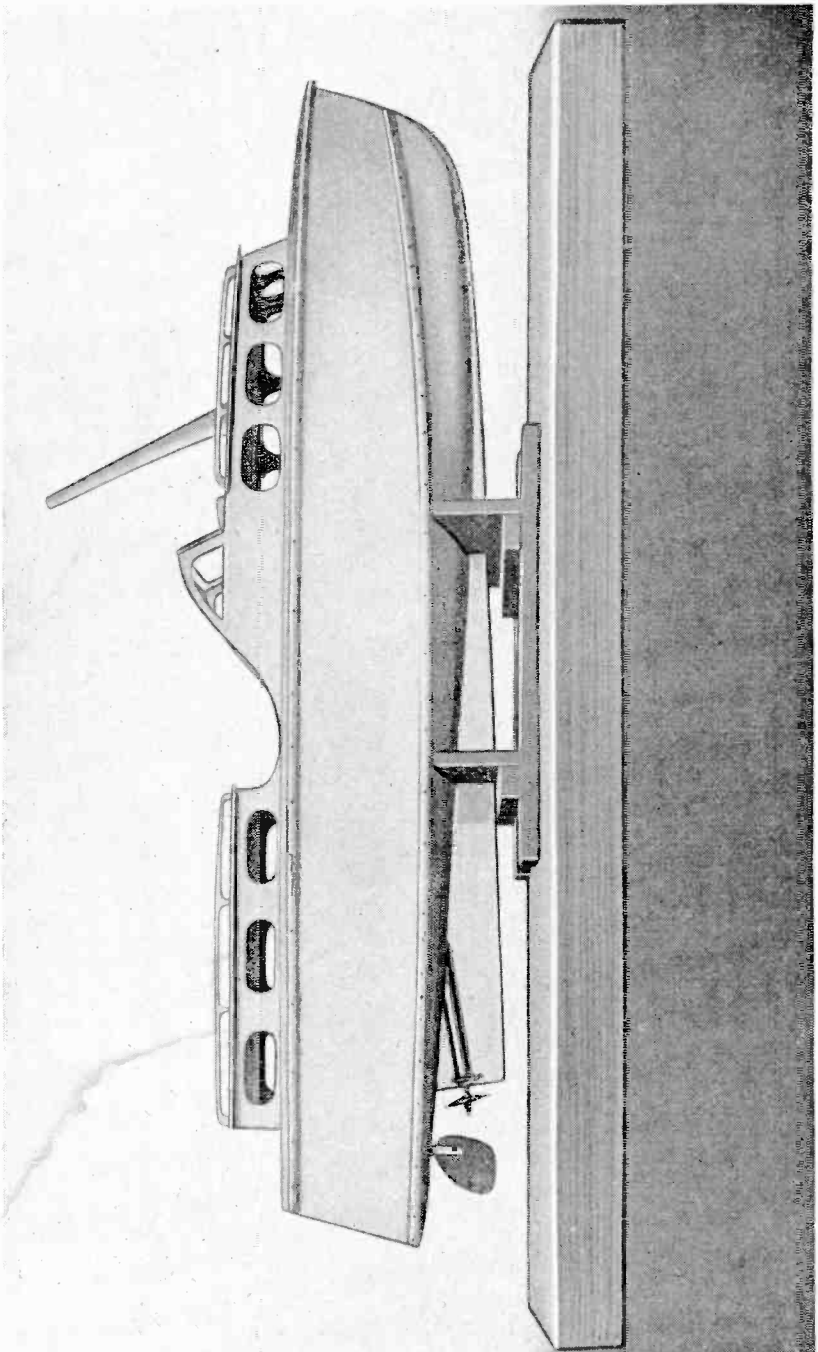
Warships, from corvettes and destroyers up to battleships and aircraft carriers, make most impressive models, but are generally tackled only by the most enthusiastic ship modellers, since the amount of external detail needed is very great, and can seldom be faithfully represented without a genuine feeling for the subject.

Passenger and cargo vessels are subject to similar considerations, though their greater relative displacement is useful for accommodating a considerable weight of control gear. All these types of ship mentioned have a round bilge cross-section, which again is not the simplest type of hull to construct, since it involves double-radius curves which generally need to be carved to shape in a wooden hull.

Open boats, from a 6-foot dinghy to a motor launch perhaps ten times that size, are seldom modelled, since the lack of a deck prevents the control and propulsion gear from being hidden. The commonest kinds of craft modelled tend, therefore, to be medium-sized boats between the two extremes mentioned, and in this category may be included motor gunboats, motor torpedo boats, air-sea rescue launches and a variety of civilian cabin cruisers.

It will be appreciated that the smaller the craft being copied, the less will be the amount of detail work which need be added to maintain a reasonable appearance. Further as the scale increases, the size of the detail necessary makes for a stronger, less vulnerable model.

Other things being equal, civilian craft are simpler than Service craft; as a final result of the foregoing considerations, the most popular type of model by far is the cabin cruiser.



The "Wavemaster" cabin cruiser, the construction of which is described in this series

Hard Chine Hulls

The various types of small craft, mentioned above, have another virtue: they all employ a hard chine hull. This is shown in Fig. 1. While the proportions of beam to length can vary widely, the basic shape remains; and it can be seen that this is made up from four fairly simply curved surfaces. From the modeller's point of view this means that each surface may be made from a single sheet of thin plywood, thus simplifying construction.

The popularity of the hard chine cabin crusier type is confirmed by manufacturers, who have chosen this type almost exclusively for kits. Since much of the hard work is already done when the kit is packed, most constructors will prefer this approach.

The Wavemaster

One of the best kits for the newcomer to radio control is the "Wavemaster," produced by Hammersmith Model Makers Limited.

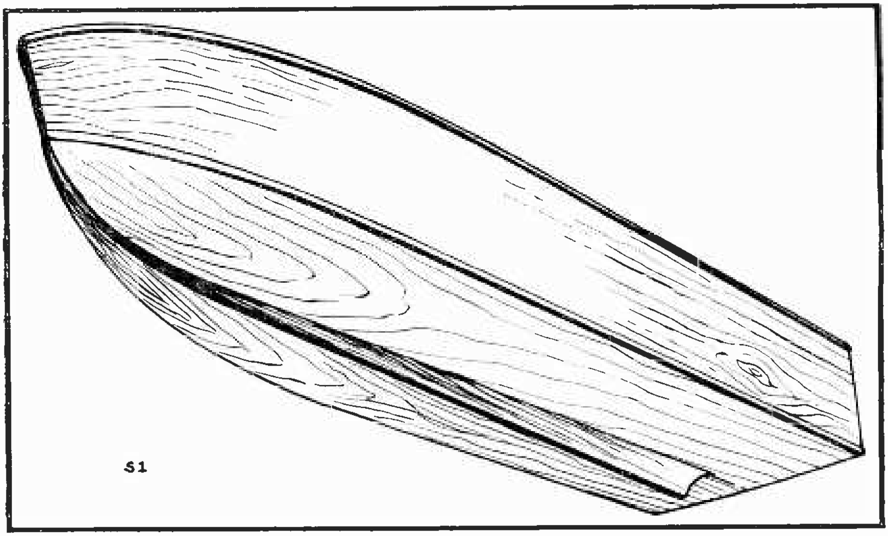


Fig. 1. A typical hard chine hull

This type of hull generally has a very wide beam and is thus eminently suitable for containing a large amount of control gear. Motor cruisers vary widely, from the slow type of river boat (used on the Broads, for example) to fast sea-going types capable of perhaps 25 knots. It is thus quite logical to power a model with anything from a small electric motor to a large internal combustion engine. The "scale" speed of a model, incidentally, is calculated from the formula $v = \frac{V}{\sqrt{S}}$ where v is the speed of the model, V is the speed of the full size craft and S equals the linear scale.

This is very strong, easily built and of a suitable size to contain quite comprehensive control gear. The length is 34in and the beam is 11in. The model was designed for radio control, and a suggested installation is, in fact, shown in the included instructions. The gear referred to is of the simplest type, but the hull is eminently suitable for more advanced equipment, and the writer knows of several "Wavemasters" fitted with control gear weighing over six pounds.

The price of the kit is very modest and it employs a simple form of construction enabling it to be built without previous experience.

To be continued

ERRATA

Transistorised Microphone Pre-amplifiers, p. 911, July 1958.—At the foot of the diagram, T_1 was stated as being an Ardente T1075 transformer—this should have read T1065.

The "Jupiter" Stereo Pre-amplifier, p. 884, July 1958.—In Fig. 5, the sliding contact of S_{1b} should be shown making with that contact connected to R_9, and the designations "Radio" and "Tape" should be reversed.

An Add-on Baby Alarm Unit

By F. G. WILSON

Introduction

THIS ARTICLE DESCRIBES A SIMPLE UNIT that can be added to any domestic a.c. receiver or hi-fi system to enable it to be used as a baby alarm in addition to its normal function. There is no audible difference in the quality of the reproduction, provided that the input from the baby alarm circuit is kept reasonably high. A single control knob provides either the normal programme, the baby alarm facility on its own, or the baby alarm superimposed on the normal programme to any desired degree. In this condition, irrespective of the setting of the volume control the ratio of baby alarm signal to programme remains substantially constant, i.e. the volume control can be altered from time to time to suit domestic requirements without any compensating adjustment being necessary on the unit. A paragraph at the end of the article describes the modifications necessary to the usual domestic a.c. receiver when it is desired to use it with this unit. *It is not recommended that universal or d.c. sets should be modified unless stringent precautions are taken to ensure that the mains voltage does not appear on the external wiring or screening.*

Circuit (See Fig. 1)

The output of the microphone is fed to T_1, which is of suitable turns ratio to match the microphone to a load of between 500kΩ and 1MΩ. The programme input is from the feeder unit or playing desk of the main equipment. It may be necessary to include R_X in the circuit, particularly when a crystal pick-up is used. This is to ensure that the pick-up is adequately loaded to provide its correct response. The value of R_X should be chosen so that it, plus the portion of R_1 usually in circuit, is the load recommended by the pick-up manufacturer. The output of the unit is fed to the main amplifier input.

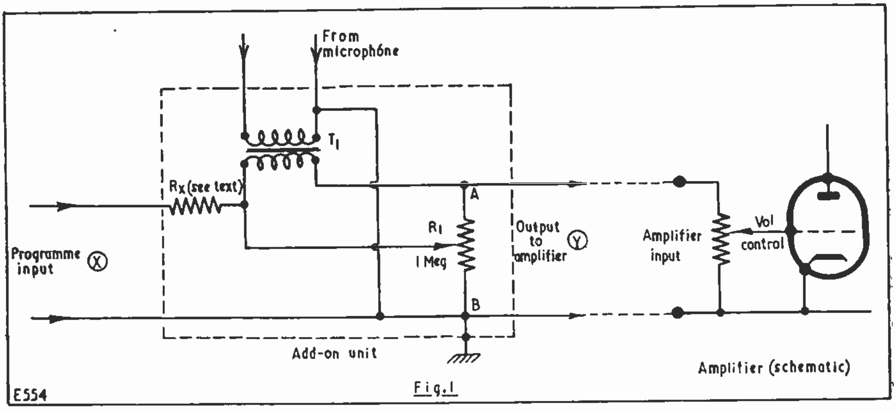


Fig. 1

R_1 is the mixing control and in conjunction with the volume control of the main amplifier forms a potentiometer chain across both of the inputs to the unit. The nature and magnitude of the input appearing across the volume control of the amplifier is therefore dependent on the setting of R_1. When the slider of R_1 is at point 'A' (see Fig. 1) the whole of the programme input and none of the microphone input appears across the volume control. When the slider of R_1 is at point 'B', the whole of the microphone input and none of the programme input appears across the volume control. It will be seen then that this single control will provide either input independently or a mixture of the inputs in any desired ratio.

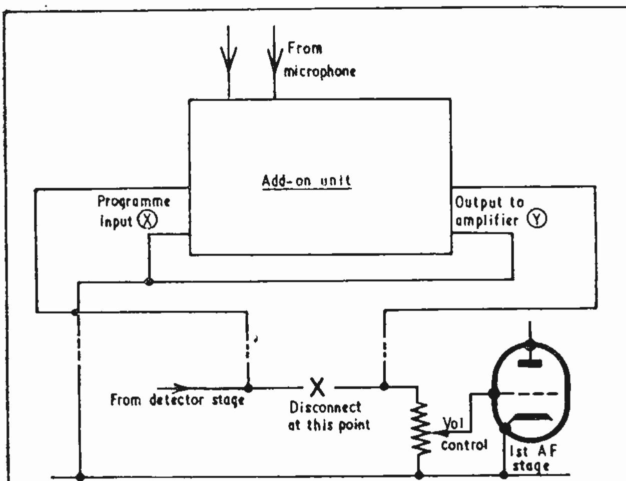


Fig.2
Domestic receiver (schematic)

with most amplifiers having an input impedance of 500kΩ to 1MΩ.

If the input impedance is much less than this, R_1 should be reduced accordingly. Hum can be a problem, but to minimise this the unit should be housed in a metal box and the box connected to the chassis of the amplifier. All leads to and from the main equipment and all leads on the unit should be screened and the screening connected to the chassis (the leads from the microphone to the unit need not be screened). Screened leads to and from the amplifier should be kept as short as practicable as they are effectively shunt capacitances across the amplifier input and as such will reduce the top response of the equipment. If lengths of over 18in are necessary it is worth considering the use of t.v. type coaxial feeder, although even this often has a self-capacitance of 25 to 30pF per foot. Care should be taken in positioning the unit to ensure that it does not pick up hum from mains leads or transformers. As stated earlier, the leads from the microphone to the unit need not be screened and twin plastic flex of small diameter is suitable. This can be conveniently fixed to picture rails, etc., with drawing pins. It is unwise to run these leads parallel to existing extension speaker leads or mains leads. The siting of the microphone should be such that it picks up maximum sound from the baby and the minimum sound from other sources (i.e. open windows). It is particularly essential to keep the input high as this enables the slider of R_1 to be positioned (under average operating conditions) so that the secondary inductance of T_2 is shunted by a fairly small resistance and its effect on the input circuit of the amplifier is kept to a minimum. If a high gain amplifier system is used in a small house, acoustic feedback may occur particularly when doors are opened. This can be overcome by careful siting of the microphone. It is generally better to have the microphone suspended from the wall rather than standing on a table. In very bad cases plastic foam may have to be used to insulate the microphone from the shell of the house, through which considerable acoustic energy is normally transmitted.

General Constructional and Installation Details

A small loudspeaker is an excellent microphone but any low impedance microphone is suitable. T_1 is not critical, but an adequate turns ratio should be chosen to give good voltage step-up. Generally speaking, physically small transformers are preferable to larger types as they are less liable to hum pick-up. A standard loudspeaker output transformer can be used. The primary is connected to the add-on unit and the secondary is connected to the microphone. R_1 is a standard 1MΩ volume control. A straight characteristic would be preferable, but the more usual logarithmic type can be used successfully. It is worth while experimenting with reversal of the end connections to obtain the smoothest mixing under operating conditions. The value of 1MΩ chosen is suitable

Operation

Set R_1 to position 'A' (Fig. 1). Set all other controls on the main equipment so that a programme is received at the usual listening level. Adjust R_1 until the signal from the microphone input just about equals the programme level. (A ticking clock placed near the microphone is a useful source of signal for test purposes and may, if desired, be used under normal operating conditions to provide continuous monitoring of the system.) The main equipment volume control can now be used to provide any listening level. The baby alarm signal will be present and at a level comparable with the programme. After a few weeks use the optimum setting for R_1 can be obtained and marked. If the baby alarm facility only is required, R_1 is set to end 'B' (Fig. 1) of the potentiometer and, conversely, if programme only is required R_1 is set to end 'A'.

Conversion of Domestic Receiver

To use the unit with a domestic receiver it is necessary to provide connections for the programme input and unit output leads (X and Y of Fig. 1). This can be conveniently arranged by disconnecting the top end of the receiver volume control and then connecting in the unit as detailed in Fig. 2. A connection will also have to be made between the unit chassis and the receiver chassis.

Protection of POWER PACK COMPONENTS

By K. G. HARVEY

MANY RADIOS AND AMPLIFIERS ARE LEFT switched on for long periods of time —sometimes unattended—and when this is likely to happen consideration should be given to providing power-pack components with some protection against destruction due to an electrolytic condenser becoming "closed circuit" or an output valve drawing too much current as a result of a defect in it. The following describes a cheap and effective method of applying the protection.

Electrolytic Condenser "Shorted"

Figure 1 (*a*) shows a typical power-pack circuit in outline. The resistances may be resistors, a choke or a loudspeaker energising coil, and the output valve may receive its h.t. through a transformer tapped either side of, or between, R_1 and R_2. Half-wave rectification is shown for simplicity.

Figure 1 (*b*) shows the same circuit with R_1, R_2, the rectifier and the mains transformer protected against overload due to a "short" in reservoir or smoothing electrolytic condensers. The cans of the condensers have been insulated from the chassis (the insulation must be capable of withstanding the full h.t. voltage) and the negative tags have been joined to each other and to the a.c. input, the latter connection via a bulb rated at 0.3 amp. (Providing a separate negative return path for h.t. electrolytic condensers is always a good procedure as it reduces hum by ensuring that the leakage current of the condensers is not flowing in the chassis.) A torch bulb or 6.3V pilot light is ideal.

If one of the electrolytic condensers becomes "closed circuit", the filament in the bulb burns out (the cause and effect is practically instantaneous) thereby isolating the condensers from the h.t. negative; the charge held by the remaining electrolytic condensers will be "emptied" through the resistance(s) but the current is sufficiently short-lived not to cause damage to those components. The Brimistor is inserted to protect the bulb from damage by the initial surge of current when the apparatus is switched on, and the 1MΩ resistor assists its operation by permitting the charge in the electrolytic condensers to drain away when the apparatus is switched off. The manufacturers recommend Brimistor CZ1 for currents up to 100mA, CZ6 for 100–200mA and C4 for over 200mA.

It must be stressed that the apparatus should not be switched off and on in quick succession.

Output Valve drawing Excess Current

Protection against damage as a result of the output valve drawing excess current can be rendered by the means about to be described if the normal cathode current (anode current plus screen-grid current) is in excess of 40mA.

Figure 2 (*a*) depicts an output valve with its associated connections to h.t. positive from the anode and to h.t. negative from the cathode. Figure 2 (*b*) shows the protection applied, and it will be seen that excess cathode current causes the bulb to burn out, resulting in bias voltage immediately increasing and the cathode current dropping accordingly. (The bulb may be used as a pilot light which will glow when the apparatus warms up.) Bulbs 6V, 40mA are primarily intended for use as bicycle rear-lights, and one would expect a considerable difference in characteristics between individual bulbs; however, it has been found that the Osram bulbs 6V, 40mA are close to specification.

The calculation of the values of R_3 and R_4 is comparatively easy and the following examples are based on a valve with a cathode current of $47\frac{1}{2}$mA (40 anode plus $7\frac{1}{2}$ screen grid) and a bias voltage of 8.5 (actually the details for AC/5PEN). Applying Ohm's Law, the bias resistor becomes $8500 \div 47\frac{1}{2} = 180$ ohms (approx.).

R_4. The resistor R_4 must be calculated first. Applying Ohm's Law to the bulb we find that its resistance with 40mA flowing is $6000 \div 40 = 150$ ohms. To ensure a long life it is advisable that about 36 mA flows through the bulb filament and at this current its resistance within 5% will be 120 ohms (the resistance is affected by the heat, which, in turn, is caused by the amount of current). R_4 and the bulb have to pass $47\frac{1}{2}$mA between them and their individual currents are inversely proportional to their resistance, i.e.

$$\frac{\text{Res. } R_4}{120} = \frac{36}{47\frac{1}{2}-36} \text{ or Res. } R_4 = \frac{36 \times 120}{11\frac{1}{2}}$$
$$= 376 \text{ ohms.}$$

This value is not too critical and the next highest "preferred value" is 390 ohms; if this is obtained in the 5% range it will be ideal. R_4 (390 ohms) and the bulb (120 ohms) are resistances in parallel and together they are equal to

$$\frac{390 \times 120}{390 + 120} = 92 \text{ ohms.}$$

R_3. It follows that, if R_4 and the bulb together equal 92 ohms, R_3 should be 88 ohms (to make up the total bias resistance of 180 ohms). As the first calculation has been made at 5% tolerance it is preferable for R_3 to be a more accurate resistor. An obvious method of obtaining a resistance near 88 ohms is to utilise three resistors of 270 ohms each in parallel, but in view of the fact that it may be difficult to purchase this value at close tolerance it is better to use 750 ohms (5%) in parallel with 100 ohms (1%); the latter is easily obtained at this tolerance as it is sold at $\frac{1}{2}$ watt rating for use as a meter

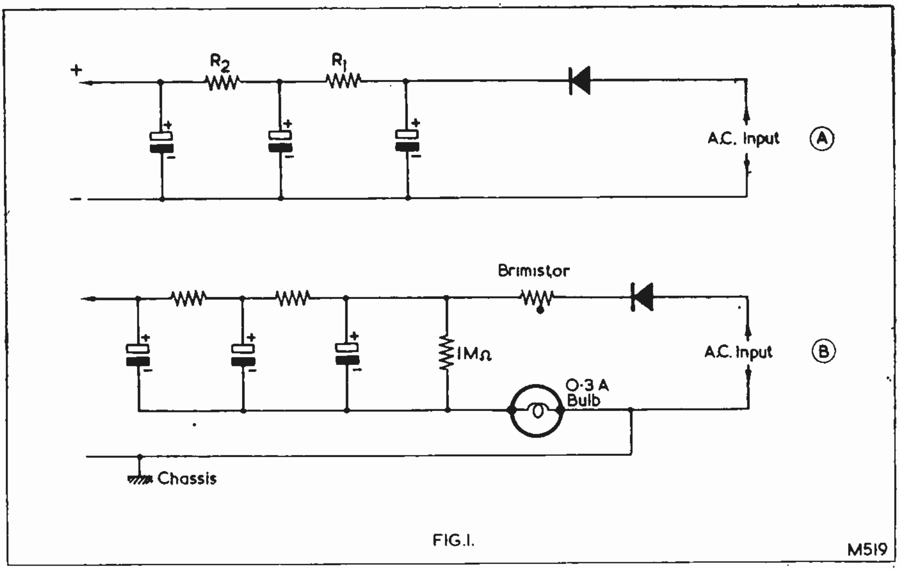


FIG.1.

shunt resistor. (750 ohms at 5% and 100 ohms at 1% in parallel give 88 ohms within 2 ohms either way.)

N.B.

(1) Fig. 1 (*b*). All electrolytic condensers connected to h.t. or to reduced h.t. must be joined to the line A–B, otherwise the protection will be only partial.

(2) Fig. 2 (*b*). The bias network is connected between valve and chassis. It is essential that it is *not* joined to the line A–B on Fig. 1 (*b*), as a short in an h.t. electrolytic condenser places this line at h.t. potential and the heater/cathode insulation of the average valve certainly will not withstand such a high voltage.

(3) Fig. 2 (*b*). The bias electrolytic condenser is not shown. The effect of its omission is to slightly reduce output by applying a small measure of negative feedback. It could be placed in parallel with R_3 to minimise this effect, but it hardly seems worthwhile. It is not recommended that it is employed in the usual position, as an electrolytic condenser which has been used for a long time at a particular voltage does not take kindly to a sudden voltage increase such as would result from the failure of the bulb. In any event, bias electrolytics have been known to "short" and this would defeat the whole object of applying the protective circuit.

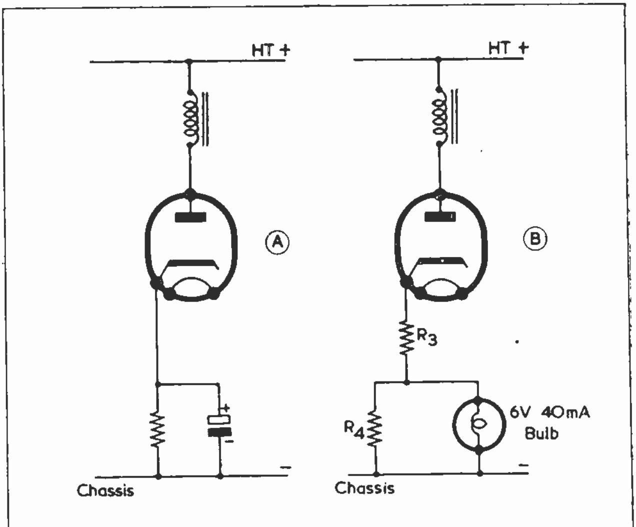


FIG.2.

(4) It is suggested that both bulbs shown in the diagrams be inserted so that the "screw" connection is the one joined to the chassis.

UNSPILLABLE 2-VOLT CELL

for light electrical duties

A completely unspillable Exide 2-volt 8A hour cell, type MFB9, has been produced by Chloride Batteries Ltd., of Clifton Junction, Manchester, for portable light electrical duties. Filled and charged, this compact, powerful cell weighs only 1lb 5oz, and is capable of providing high discharge currents, with high terminal voltage, over a wide range of temperatures.

It has numerous applications in radio and communications, particularly under conditions where its unspillable characteristics are important, in portable instrumentation, lighting, aircraft and guided missiles, and other light electrical fields.

The container and lid of the cell are moulded in translucent high impact polystyrene, and the lid is a specially designed one-piece moulding cemented to the container by a technique which ensures a leak-proof joint.

A vent which provides an exit for gases, and which incorporates a trap for acid spray, is moulded integrally with the lid. The vent outlet is so designed that it is virtually impossible for it to become blocked either by dirt or some object resting on top of the cell.

A filler plug, with a broad slot for tightening with a coin, is located alongside the gas vent. This arrangement, keeping the acid trap and gas vent separate from the filler plug, enables a more effective type of trap to be used.

The cell terminals consist of metal inserts moulded in the lid into which are screwed small bolts with insulated heads. When these bolts are tightened the cable ends are clamped firmly against lead alloy strips. These strips are positioned in recesses in the cell lid and are connected by lead burning to the connecting pillars which rise from the group bar. Special rubber bushes are fitted round the pillars where they pass through the lid and these bushes ensure a leakproof joint at the cell lid.

This method of terminal connection is remarkably free from corrosion troubles in service and is capable of standing up to considerable mechanical abuse, such as over-tightening, while any force exerted on the terminal bolt or to the external wiring is transferred directly to the cell container walls rather than to the internal assembly.

Porvic microporous separators are used which permit the cell to be stored under suitable conditions in a dry, unfilled state for an unlimited period without deterioration.

The MFB9 measures $3\frac{3}{16}$in wide by $1\frac{5}{16}$in long by $4\frac{5}{16}$in high and has a capacity of 8A hour at the 20-hour rate of discharge.

RADIO

A 2-valve Amplifier

for the

R.E.P. 1-valve Receiver

From **R. D. P. MICHELL**

LIKE MYSELF, MANY READERS MUST HAVE constructed the R.E.P. 1-valve battery receiver described in the April, 1958 issue of this magazine and, having done so, most probably desired a simple battery audio amplifier with which to boost the audio output of the receiver.

The simple amplifier about to be described was constructed as a separate unit entirely contained on a 6in x 2½in tagboard. The circuit of the amplifier is shown in Fig. 1, and from this it will be noted that it has been designed around the easily obtainable valve types DAF91, a single diode a.f. pentode, and a DL92, an output pentode type. The input to the grid of V_2 is via the condenser C_1 and potentiometer R_1, this latter control being mounted direct to the tagboard as shown in Fig. 2.

The original receiver will require some slight modification, this consisting of the replacement of the phones by a load resistor, R_L (which could be wired to plugs so that it could easily be removed if the receiver was required to be operated as a single-valver). The output is taken from the junction of R_L–R_2–C_5. The two chassis should be connected together.

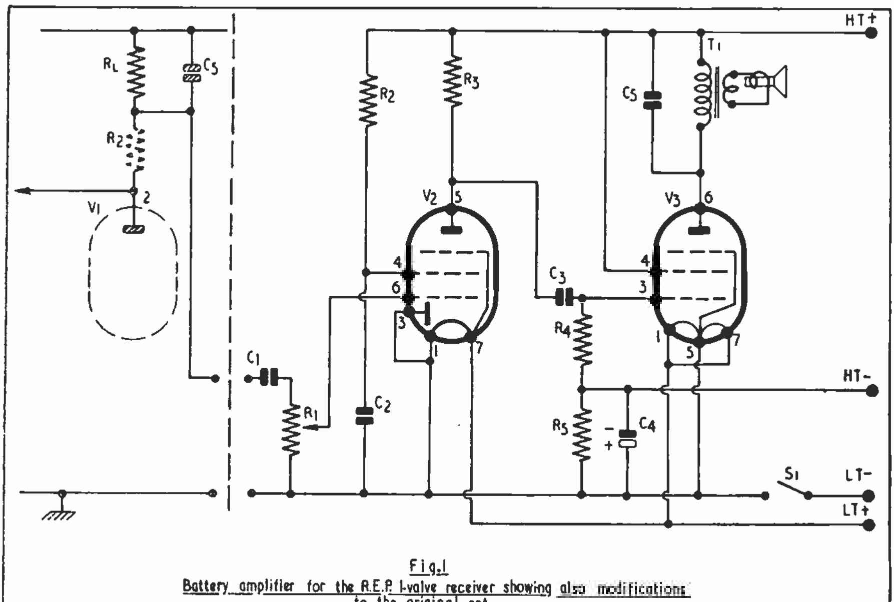
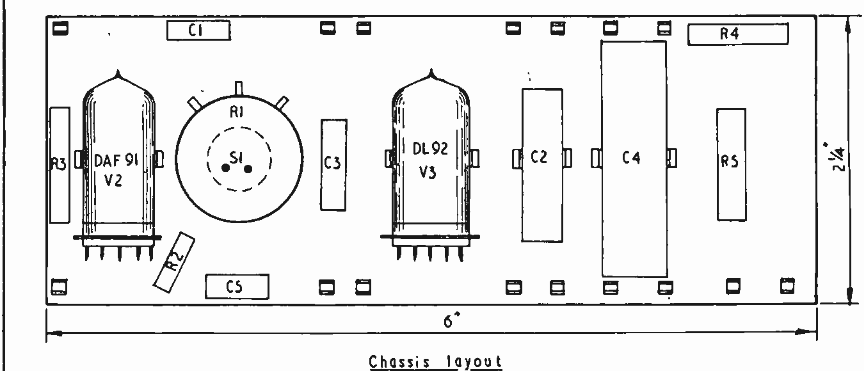


Fig. 1
Battery amplifier for the R.E.P. 1-valve receiver showing also modifications to the original set



Chassis layout

The power supplies of the amplifier have been kept separate from those of the receiver, in order that the amplifier can be a self-contained unit which may be used in conjunction with other apparatus.

The amplified audio from this first stage is passed into V_3 via the coupling component C_3. Bias for this stage is obtained from the resistor R_5 decoupled by C_4. The output transformer shown is of the type matching a 3S4 valve which may be easily obtained from most advertisers. A 5-in permanent magnet speaker is used in conjunction with this, and the results to date have been most pleasing.

The amplifier when completed can be mounted to the receiver chassis by means of small brackets, in which case common supplies may be used, but alternatively the whole amplifier may be used as an entirely separate unit, as mentioned above, it being suitable, by virtue of its small and compact nature, of being contained within a cigar box.

Dealing now with the constructional method adopted, the B7G bases are not fastened to the board in the conventional manner, the valves themselves being secured to the board by means of ½in "Terry" clips. The components C_1 and C_3 are retained in place by a further two "Terry" clips, these being of the ¼in type.

To commence construction, all the resistors and condensers should be fixed to the tagboard as shown in Fig. 2. The wire ends of these components should be as short as possible, and be covered with systoflex where required in order to prevent possible short circuits.

The output transformer is assumed to be mounted directly to the speaker chassis. If separate, a longer tagboard will be needed, when the transformer can be fitted on the extreme right-hand end, looking at Fig. 2.

This little amplifier is inexpensive to build, most of the parts coming from the inevitable "spares box", and its construction will be found to be very well worth while for those who require a greater output than that available from the R.E.P. 1-valve receiver alone. In any event, a speaker output is more often to be preferred than that of headphones for listening in to the Medium and Long wave transmissions.

Component List

Resistors

- R_1 1MΩ pot with switch S_1
- R_2 680kΩ ¼ watt
- R_3 100kΩ ¼ watt
- R_4 500kΩ ¼ watt
- R_5 1kΩ ¼ watt
- R_L 3.9kΩ ¼ watt

Valves

- V_2 DAF91 Mullard
- V_3 DL92 Mullard
- T_1 Output Transformer (see text)
- Speaker—5in PM type

Condensers

- C_1, C_2 0.1μF paper
- C_3 0.01μF paper
- C_4 25μF, electrolytic, 25V wkg.
- C_5 0.001μF

Sundries

- 6in x 2¼in Tagboard
- Terry clips ½in (2)
- Terry clips ¼in (2)
- 1 Control knob, wire, sleeving, etc.

TANTALUM condensers

By E. G. BULLEY

THESE CONDENSERS ARE SO DESIGNED THAT the aqueous electrolyte found in the conventional electrolytic condenser is replaced by a semi-conductor. They are, however, more or less stable as are the conventional types. The replacement of the electrolyte does not limit their use; in fact, they have an advantage over the conventional types in not drying out or evaporating in high temperatures; and likewise, at extremely low temperatures, the electrolyte does not freeze.

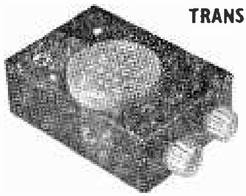
The anode of a tantalum condenser can be in one of a number of forms dependent upon the design and manufacturer, the most common being the use of foil. Other forms are that of wire or sintered bars. Whatever the form, the anode is made from tantalum, a metal that is now quite common to the electronic valve industry, as well as the medical world. Its use in the latter field is mainly because it has a high resistance to corrosion.

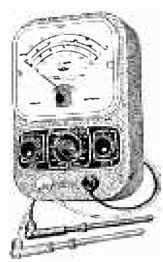
It is this characteristic that makes tantalum condensers more suitable for long storage without the necessity for re-forming. The leakage currents of these condensers are comparable to those of the conventional types.

These condensers have immediate application in transistor circuitry where size is of importance. Their usual application in such circuits is as bypass and coupling condensers; nevertheless, they have many uses in other circuit techniques. The use of tantalum provides capacitances from 1 to 200μF at d.c. working voltages from 6 to 150 volts.

The capacitance of such condensers is proportional to the surface area of the tantalum anode, the thickness of the tantalum oxide being the factor that determines the working voltage.

The experimenter and constructor alike will find these components most suitable for many applications, especially if one is experimenting with remote control or such like circuits subject to variations of temperature.





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(By W.B.)

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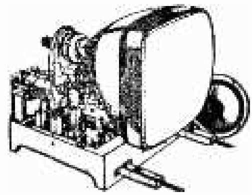
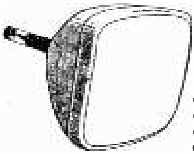
17″ Rectangular Tube on modified chassis. Supplied as single channel chassis covering B.B.C. channels 1-5, or incorporating Turret Tuner which can be added as an extra, at our special price to chassis purchasers, **50/–**, giving choice of any 2 channels (B.B.C. and I.T.A.). Extra channels can be supplied at **7/6** each. I.F.s 10.5-14 Mc/s. Chassis size: 12″ x 14½″ x 11″. Valves. Similar chassis were used by well-known companies because of their stability and reliability. With tube and speaker, **£19.19.6.** With all valves, **£25.19.6.** Complete and working with Turret Tuner, **£28.9.6.** 12 months guarantee on the tube, 3 months guarantee on the valves and chassis. Ins. carr. (incl. tube), 25/–





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6 months full replacement, 6 months progressive. Made possible by the high quality of our tubes. Ins. carr. 15/6. 9″, 10″, 14″, 15″ and 16″ round tubes. Our special offer of these sizes, **£5.** 12″ TV Tubes, **£6.** Three months guarantee on round tubes. Ins., car. 15/6

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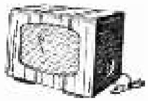
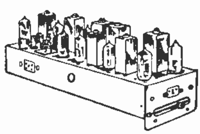


BEAUTIFUL EXTENSION SPEAKERS—29 9

Fitted with 8″ p.m. speaker, W.B. or Goodmans, of the highest quality. Standard matching to any receiver (2-5 ohms). Switch and flex included. Unrepeatable at this price. Money back if not completely satisfied. Ins. Carr. 3/6

8″ P.M. SPEAKERS, 8/9. At this price you can have one in every room. Let the lady of the house listen to that radio programme. With o.p. transformer fitted, **10/–**, postage 2/9



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Superhet. Tested. I.F.s 10.5 Mc/s sound. 15 Mc/s vision. 8 valve bases (6-6F1s and 2-6D2s, not included). Size: 8½″ x 5″ x 4½″ high. Post and Packing 2/6. The Turret Tuner plugs directly into this chassis.

SOUND AND VISION STRIP, 10/6. Superhet. Complete vision strip. Less valves. Not tested, drawings free. Postage 2/6

POWER PACK AND AMPLIFIER, 19/6. Output stage 6V6 with o.p. trans., smoothed h.t. 350V 250mA, 6.3V at 5A, 22V at 3A, 6.3V at 4A centre tapped. Less valves. Free drawings. Ins., carr. 5/6

POWER PACK AND AMPLIFIER, 19/6. Output stage PEN45, o.p. trans., choke. Smoothed h.t 325V at 250mA, 4V at 5A, 6.3V at 5A, 4V at 5A centre tapped. Less valves. Carr. 5/6

CHASSIS, 1/– each. 6 or 8 valve. Latest type midget valve design for a.m. or f.m. Brand new cadmium plated. Size: 12¼″ x 7¼″ x 2⅜″ Post 1/9. 4 for 4/-, post 3/–; 12 for **10/–**, carr. 5/–

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MAINS TRANSFORMERS, 9/9. 350-0-350. 250mA 6V at 5 amp. 6V at 5 amp. 4V at 4 amp. 22V at .6 amp. extra winding for 2V or 4V tubes. Primary 200-250V, 50 cycles. Postage and packing 3/9

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MAINS TRANS. 5/9. 280-0-280V 80mA 6V, 4V heaters. 200-250V prim. Post 2/3

O.P. TRANS. 1/3. Std. size. 2-5 ohms. Post 1/–. 20 for **£1.** Post 5/6

MAINS TRANSFORMERS, 12/9. 425V 300mA single secondary. 6.3 at 12 amp. 6.3V at 0.6 amp. 200-250V screened primary. Post and packing 3/6

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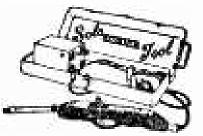

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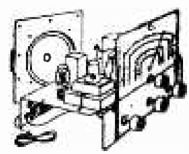
110V or 6V (special adaptor for 200/240V 10/– extra). Automatic solder feed. Including a 20ft reel of Ersin 60/40 solder and spare parts. It is a tool for electronic soldering or car wiring. Revolutionary in design. Instantly ready for use and cannot burn. In light metal case with full instructions for use. Post 2/9

TIMEBASE, 4/9. Complete including scanning coils, focus unit, etc., less valves. Post and packing 2/6

HEADPHONES, 1/9. Single earphone and band, CL-R type. Ideal for crystal sets, extension on radio, etc. Post 1/3

HOME RADIO — 79/6 5 valve (octal) superhet. 3 wave band receiver. Can be adapted for your gram, p.u. at a little extra cost. A.C. size: 9½″ x 20½″ x 11½″. Two a.c./d.c. sizes: 9¼″ x 18½″ x 11¾″, 9″ x 20½″ x 12″. Wooden cabinets. Ins. car. 4/6. Please state mains and size required when ordering.



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5-valve superhet chassis including 8″ p.m. speaker and valves. Four control knobs (tone, volume, tuning, w/change switch). Four w/bands with position for gram. p.u. and extension speaker. A.C. Ins., carr. 5/6

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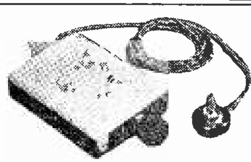

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Total cost **47/6** complete

NOW! with stamped-out chassis and mounting brackets for aerial and battery.
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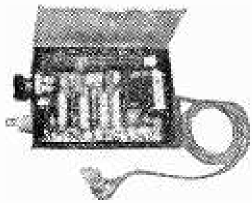

Medium wave, Variable tuning. Total cost, as specified, including Transistors, Transformers, Coils, Condensers and Battery, etc., with circuit and plastic case. All items sold separately. **70/–** POST FREE. With Min. Hearing Aid, **86/–**

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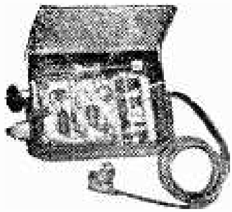

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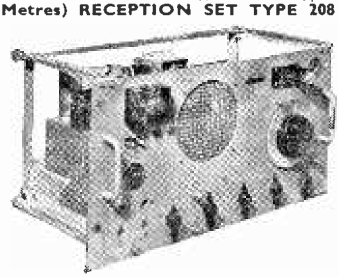

Complete with 6 valves, 2 6K8G, 2 EF39, 6Q7G and 6V6G. Internal mains power pack and 6V vibrator pack. Built-in 6½" speaker. Muirhead slow-motion drive. B.F.O. and R.F. stage. I.F. freq. 2 Mc/s Provision for phones and muting and 600 ohms. **Input 110/250V** a.c. 6V vibrator pack included for battery operation. All sets in new condition and air tested. **£6 . 19 . 6.** Carr. 15/6
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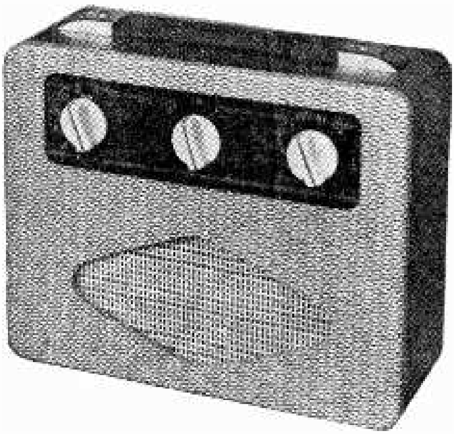
Push-Pull Portable Superhet



COMBINED CAR RADIO & PORTABLE

TWO SETS FOR PRICE OF ONE

TEN STAR FEATURES

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This Portable 8-Transistor Superhet is tunable for both Medium and Long Waves and is comparable in performance to any equivalent Commercial Transistor Set. Simplified construction enables this set to be built easily and quickly into an attractive lightweight cabinet supplied.

All components as specified can be supplied at an inclusive price of **£11.10.0** p.p. 2/6
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N.B.—Pair of XC101's for larger output supplied at additional cost of **40/-** Call and hear demonstration model

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Six-Transistor Pocket Radio

CAN BE BUILT FOR £11.19.6

SPECIAL FEATURES

- T.C.C. Printed Circuit
- Medium and Long Waves
- Six Selected Transistors
- All Modern Components carded with Values shown
- Rola $2\frac{1}{2}$" Speaker
- Attractive Plastic Case size $6\frac{1}{8}$" x $3\frac{1}{4}$" x $1\frac{11}{16}$"
- Powered by two No. 8 Batteries
- Total Weight 20 oz.

THIS SET IS TRULY RECOMMENDED AS AN IDEAL POCKET PORTABLE CONTAINING ALL THE LATEST FEATURES, GIVING NOT ONLY SIMPLICITY IN CONSTRUCTION, BUT WHEN BUILT IS REALLY SENSITIVE AND SELECTIVE, BRINGING IN A HOST OF FOREIGN STATIONS.

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continued on page 79

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2X2	3/6	6SA7M	7/6	866A	12/6	EZ40	8/6
3A4	5/6	6SG7M	7/6	959	5/–	EZ80	8/6
3Q4	7/6	6SH7M	5/–	1616	5/–	GT1C	10/–
3S4	8/6	6SJ7M	7/6	1629	4/–	HK24G	25/–
5763	12/6	6SK7M	6/6	EA50	1/6	KT33C	9/6
5B/254M		6SL7GT	7/6	EABC80	10/–	PCC84	10/6
	21/–	6SN7GT	6/6	EAC91	4/6	PCF82	10/–
5Y4G	6/6	6SQ7M	7/6	EAF42	10/6	PL82	9/6
6AC7M	5/–	6X4	6/6	EB34	2/6	PL83	10/6
6AG5	3/6	6X5GT	7/6	EB91	6/6	PCL83	12/6
6AK5	5/–	7B7	9/–	EBC33	7/6	PY80	8/–
6AL5	6/6	7C5	9/–	EBC41	10/6	PY81	9/6
6AM6	7/6	7C6	9/–	EBF80	10/–	PY83	11/6
6AQ5	8/6	7S7	10/–	EBF89	10/–	R19	12/6
6AT6	8/–	7Y4	8/6	ECC82	9/6	SP61	3/–
6AU6	8/6	12A6M	7/6	ECC83	9/6	TT11	4/–
6B8G	4/6	12AT6	8/–	ECC84	11/–	UAF42	10/6
6BA6	8/6	12AT7	9/–	ECC85	10/6	UBC41	10/6
6BE6	7/6	12AU6	9/–	ECF80	12/6	UBF89	10/6
6BH6	7/6	12AU7	8/6	ECF82	11/6	UCC85	10/–
6BJ6	7/6	12BE6	8/6	ECH42	10/6	UCH42	10/6
6BR7	11/6	12C8M	7/6	ECH81	10/–	UF41	10/6
6C4	5/–	12Q7GT	9/–	ECL82	12/6	UF89	10/6
6C5M	5/6	12K7GT	9/–	EF36	4/–	UL41	10/6
6F6M	5/6	12SC7M	2/6	EF39	5/–	UY41	8/6
6F8G	4/6	12SK7M	7/6	EF41	10/6	UY85	10/–
6G6G	4/6	12SQ7M	8/6	EF50	3/–	UABC80	
6J5GT	5/–	35L6GT	9/6	EF50(S)	4/6		10/6
6J5M	6/–	35Z4GT	8/6	EF55	7/6	VU39	9/6
6J6	4/–	35Z5GT	8/6	EF80	9/–	VR150/30	
6K7G	5/6	42	7/6	EF85	10/–		7/6
6K8G	7/6	50L6GT	9/6	EF89	10/–	VR116	4/–
6K8M	10/6	80	8/6	EF91	7/6	VS70	3/–
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3. I.F./O.P. Unit less valves, **35/–**, or **30/–** if ordered with units 1 and 2

R109A Receivers, 2–8 Mc/s, less valves, **35/–** each, carr. paid

Modulator 67. Contains a.c. power pack, input 230V 50 c.p.s., output 350V 120mA (transformer rated 200mA), 6.3V 5A with heavy duty choke. 5Z4, 11 other valves, switches, pots, etc. Brand new, boxed, **39/6** each carr. paid

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Post 9d. Free over £2 *S.A.E. Enquiries*

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continued from page 77

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FOR SALE German naval battery receiver, medium/long waves, 1,525–72 kc/s; 5 wavebands, 9 valves, 8 positions selectivity, BFO, xtal, coil turret. Massive job, weighs 50lb approx. Selective and sensitive, OK for MW Dx enthusiast. Bargain at £10. S.E.E. battery-operated xtal calibrator (multi-vibrator) giving 1,000 kc/s, 100 kc/s, 10 kc/s and 1 kc points, £4. S.E.E. frequency meter, 0.97–20 Mc/s, requires slight attention, weighs approx. 50lb, bargain, £6. Complete Baird projection television chassis, good condition, 3 years old, ITV/BBC, £20. Cabinet available.—Box No. E171.

FOR SALE "Sound" tape recorder, perfect condition, still under guarantee, unused and in maker's packing case. Complete and ready to use, £40.—Box No. E178.

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