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BAND I TELEVISION PRE-AMPLIFIER

VOLUME 12
NUMBER 11
JUNE
1959

The RADIO Constructor

RADIO · TELEVISION · AUDIO · ELECTRONICS

The LUDFORD
A single valve Local Station Radiogram

by
John Woollen, B.Sc.

Included in this issue
INEXPENSIVE RECORD-PLAYER AMPLIFIER
TRANSISTOR R.F.—A.F. SIGNAL TRACER
VERSATILE NEON TEST UNIT
USING R.F. FEEDBACK
A VARIABLE MAINS SUPPLY · INEXPENSIVE HIGH QUALITY DOMESTIC SOUND SYSTEM

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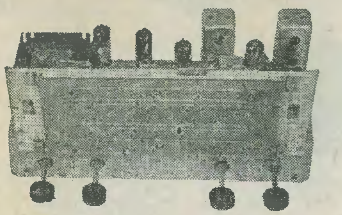

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3V4	8/6	6SJ7M	10/6	EBF80	10/6	P61	6/6
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5Y3	8/6	6V6G	7/6	ECF80	11/6	PCF80	11/6
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6BH6	10/6	12AU7	9/6	EF41	10/6	PY80	10/6
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STANDARD 250-0-250, 80mA, 6.3V tapped 4V 4A. Rectifier 6.3V 1A tapped 5V 2A and 4V 2A	22/6
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MIDGET. 220V 45mA, 6.3V 2A	15/6
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Mullard "510" 300,0-300, 120mA, 6.3V 4A c.t., 6.3V 2A tapped 5V	38/6

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16/450V	3/6	8+8/500V	5/–	6,000/6V	5/–
16/500V	4/–	8+16/450V	5/–	32+32/350V	4/6
32/450V	5/6	8+16(500V	5/6	50+50/350V	7/–
25/25V	1/9	16+16/450V	5/6	64+120/275V	7/6
50/25V	2/–	32+32/350V	4/6	64+120/350V	11/6
50/50V	2/–	32+32/500V	7/6	100+200/275V	12/6

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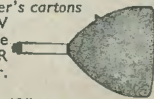

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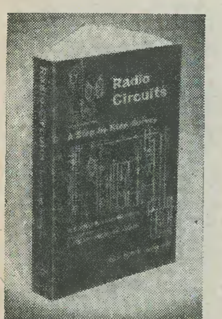

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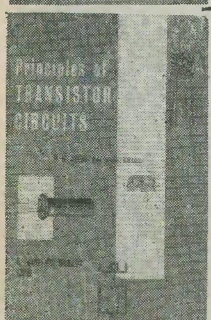

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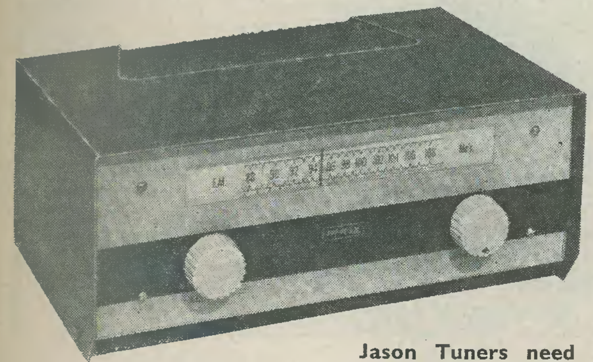
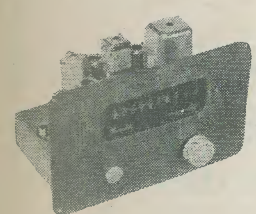


Illustration shows FM Fringe Tuner in standard Jason Kit Housing, which is also available for the standard FM Tuner. Below, standard tuner in chassis form.



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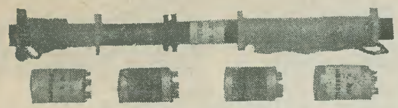

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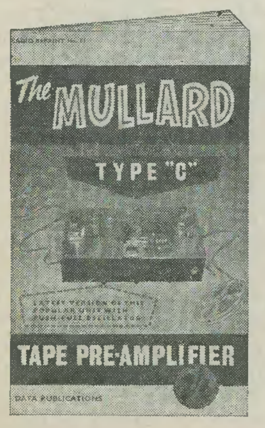

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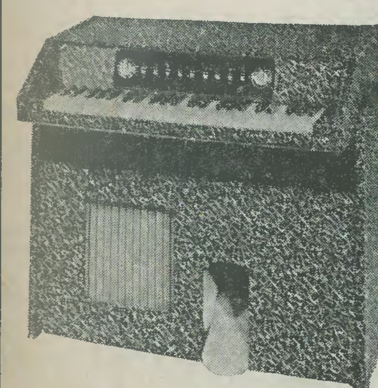

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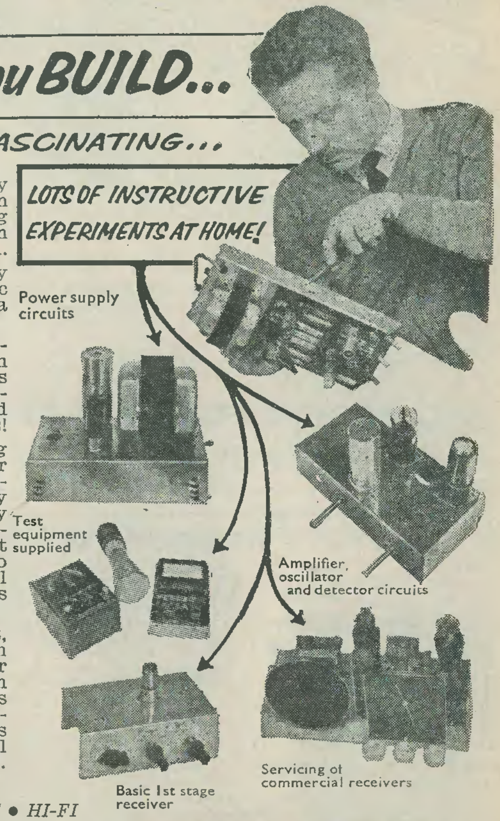

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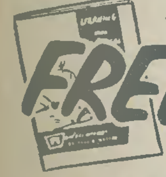

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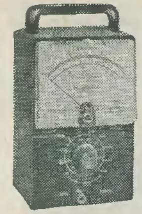
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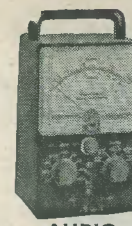
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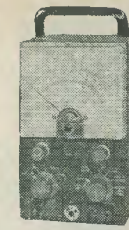
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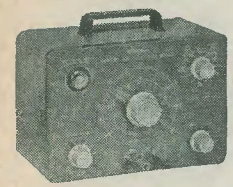
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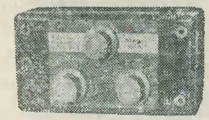
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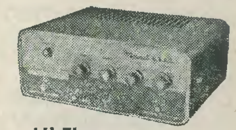
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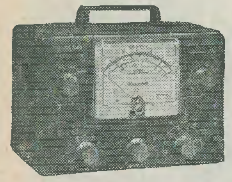
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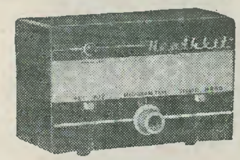
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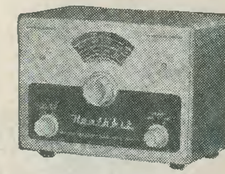
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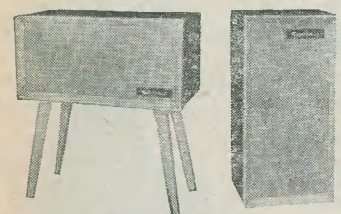
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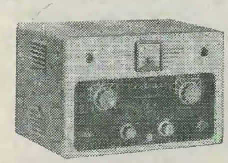
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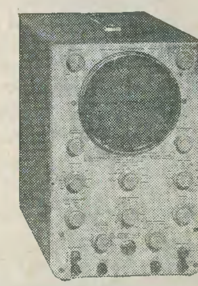
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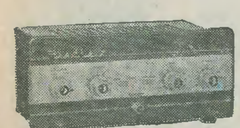
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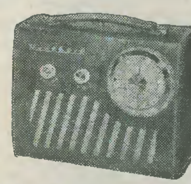
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THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as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

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

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

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No. 103 An Inexpensive Record-Player Amplifier

suggested circuits

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ONE OF THE MOST POPULAR SUBJECTS WITH readers of "Suggested Circuits" is a.f. amplifier design. The writer makes this statement with confidence, and bases it on a consideration of the correspondence he has received since the commencement of this series some eight and a half years ago. The present contribution describes another a.f. amplifier circuit, this being especially intended for those constructors who require a reasonably inexpensive unit which is simple to build and install.

It is proposed that the amplifier discussed in the current article be used, together with a crystal pick-up, in a record-player; whereupon it should be capable of being fitted in a cabinet of the type made popular by commercially-produced instruments of this type. In the interests of economy in space and cost, a single triode-pentode valve is employed, and this is powered by a "converter" mains transformer of the type which has become popular in television Band III converters. Three controls are included in the circuit, these varying volume level, treble response, and bass response. Whilst an amplifier of this type can obviously not be described as fully entering the hi-fi class, there is no reason why the reproduction it provides should not be equal to that given by conventional television and sound receivers employing single-ended output stages.

Before carrying on to details of circuit operation, a few further comments need to be made concerning the use of the "converter" mains transformer. In amplifiers of the type we are considering here it is common practice to employ live chassis techniques, the heater supply being provided either by a dropper resistor or by a heater transformer. "Converter" transformers are readily available in the home-constructor market at a cost which is by no means excessive, and it was felt that the use of such a transformer in this particular amplifier would be sufficiently desirable to offset the slight extra expense involved. The advantage afforded by the "converter" transformer is that it enables the amplifier to have a chassis which is completely isolated from the mains supply; thereby obviating, at a single step, the possibility of hum pick-up and, more important, the risk of accidental shock. When the "converter" transformer is employed the metalwork of the gram motor and turntable may be bonded directly to the amplifier chassis, and there is no necessity to use isolating condensers or to take the special precautions against shock which would otherwise be essential. The transformer specified in the circuit is a "standard" type having a primary voltage of 230, an h.t. secondary voltage of 200 at 30mA, and an l.t. secondary voltage of 6.3 at 0.6A. This

transformer is just fully loaded by the valve specified.

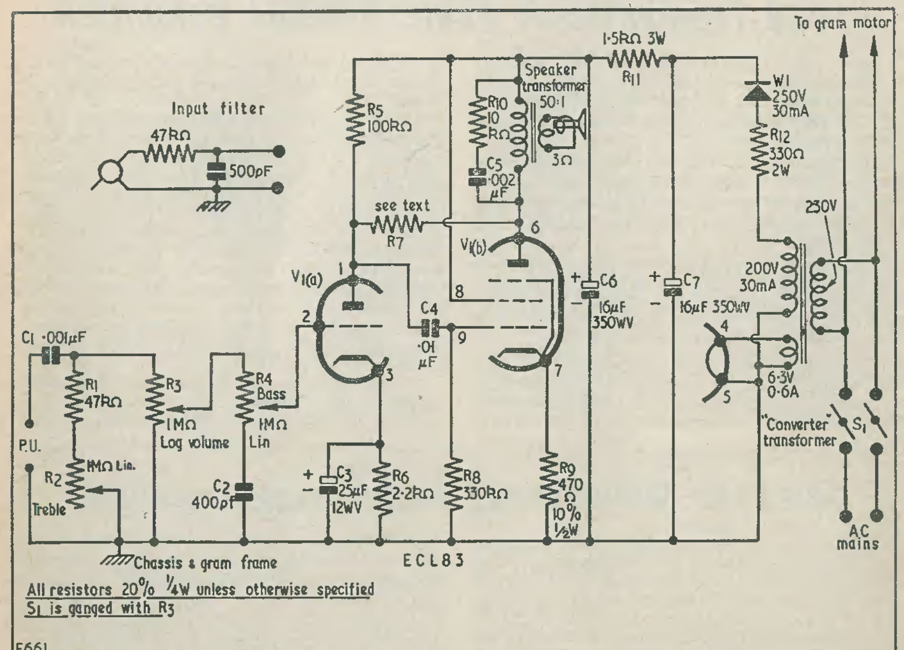
The Circuit

The circuit of the amplifier accompanies this article. Commencing at the input terminals, it may be seen that the pick-up is connected immediately to the volume and tone control section of the circuit. The slider of R_4, the final potentiometer in this section, next couples to the grid of $V_{1(a)}$, this being the triode section of the ECL83 triode-pentode.

$V_{1(a)}$ amplifies in normal fashion, its output being fed to the grid of $V_{1(b)}$. $V_{1(b)}$ does not have a cathode bias decoupling condenser, this component being omitted in order to provide a small measure of negative feedback at the cost of what should, in almost all instances, be expendable gain. The anode of $V_{1(b)}$ connects to the primary of the loudspeaker transformer, resistor R_{10} and condenser C_5 providing the "tone correction" normally encountered in single-ended pentode output circuits.

many cases it may be found that there is still some gain in hand, whereupon further negative feedback may be obtained by fitting a resistor between the anodes of $V_{1(a)}$ and $V_{1(b)}$. This resistor is shown in the circuit as R_7, and its value, found experimentally, should be that which allows the amplifier to provide a comfortable output level. The final value for R_7 should lie between 500kΩ and 5MΩ.

The power supply arrangements for the amplifier are very straightforward. The rectifier, W_1, may be any metal component capable of working at 250 volts and a minimum current of 30mA, and a contact-cooled type should be quite adequate here. As was mentioned above, the mains transformer is just fully loaded by the ECL83 and it would be advisable, after the unit has been completed and put into working order, to ensure that slight over-running does not occur. This point may be ascertained by checking the h.t. voltage, which should be less than 200 after the ECL83 has warmed up. If h.t. voltage is above this figure the



Usually, an a.f. triode and pentode in cascade will provide somewhat more gain than is really needed for satisfactory amplification of a crystal pick-up, and it is for this reason that it is possible to dispense with a cathode decoupling condenser for $V_{1(b)}$. In

value of R_{11} should be increased. It is doubtful, however, whether such an eventuality will occur in practice.

No precautions against mains modulation are taken in the circuit as it is doubtful if this trouble will arise with a relatively low-gain amplifier such as this. Nevertheless, if mains modulation *should* be evident it should be possible to remove it by reversing the connection to the mains supply. In obstinate cases a solution may be found by reversing the connections to the gram motor. (These comments assume that the gram metalwork and amplifier chassis are reliably bonded together.)

Constructional Points

The amplifier should give rise to little difficulty so far as construction is concerned. It is possible that some constructors may wish to mount the three controls, R_2, R_3 and R_4, on a separate panel for reasons of cabinet presentation. If this course is adopted the connection between the slider of R_4 and the grid of $V_{1(a)}$ should be made via screened cable.

Layout is not excessively critical, although it would be desirable to keep the anode lead of $V_{1(b)}$ dressed away from the wiring to the grid of $V_{1(a)}$. Also, the mains wiring to switch S_1 should be kept well clear of the a.f. wiring and components around R_2, R_3 and R_4. The metalwork of these three potentiometers should be reliably earthed.

It is possible, with some pick-ups, that reproduction may have an excess of treble. If this occurs, a low-pass filter should be inserted between the pick-up and the input terminals of the amplifier. A suitable filter is shown in the inset.

Other Applications

As was mentioned above, the amplifier should have sufficient gain, when employed with a crystal pick-up, to enable the cathode decoupling condenser for $V_{1(b)}$ to be dispensed with. Should the amplifier be used for applications which call for more gain it would be advisable to add the cathode bias condenser. If used, the additional condenser should have a value of 25μF at 25 w.v., and should be connected across R_9. Under such circumstances R_7 may be deleted.

1959 International Radio Hobbies Exhibition

This year's International Radio Hobbies Exhibition will open at the Royal Horticultural Society's Old Hall, Westminster, on Wednesday 25th November and will close on Saturday 28th November.

This year's show, which as always is organised for the Radio Society of Great Britain will for the first time have a wider international outlook as "Communication receivers of the world" will be the main feature.

Amateur television features will be well to the fore and many more do-it-yourself kits of radio, television, transmitters, test equipment, transistors and parts for the home constructor will be seen, many being shown for the first time.

This show, which is an important diary date for "Hams" from all over Britain, is beginning to attract overseas buyers and the general public alike. Both the number of stands and of visitors is expected to exceed last year's record figures when nearly 10,000 people came during the 4 days.

A silver trophy will again be awarded for the most outstanding item of home constructed amateur equipment and for the first time a silver trophy will be awarded for the outstanding piece of equipment manufactured industrially for Radio Amateur use on show at the Exhibition.

Last year excellent business was reported by the commercial exhibitors and the Radio Society of Great Britain who arrange interesting technical displays, reported a record number of new members. The Services exhibits attracted considerable attention which assisted them to obtain many recruits for the communications branches of the reserve forces.

Press Enquiries and details of available stand space can be obtained from: P. A. Thorogood, G4KD, 35 Gibbs Green, Edgware, Middlesex.

One-Knob Wavechange and Tuning Capacitor

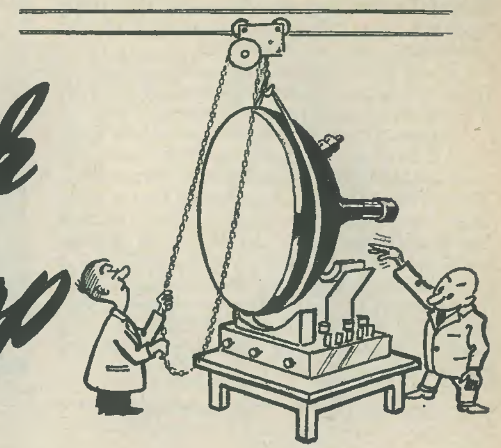
The introduction of switched variable capacitors enabling normal wave change and tuning operations on any two-waveband radio receiver to be carried out with only one knob is announced by The Plessey Company Limited. This new development makes possible such dual operation for the first time and represents an advance in component design.

The new capacitors incorporate a conventional moving vane spindle fitted with a link motion that moves a Plessey slide switch in one direction when almost fully meshed, and in the other direction when almost fully unmeshed. It is recommended that the switching is so arranged that the small loss of usable swing occurs at the high frequency end of the long waveband and the low frequency end of the medium waveband. By this means, any loss of station coverage is unimportant.

The switch is a two-pole change-over assembly but provision has been made, by the addition of a third pole, for dial lamp switching or similar operations; provision can also be made for mechanical waveband indication.

Plessey add that in addition to the facility of one-knob, two waveband control as a retail selling point for domestic receivers, a further economic factor worthy of consideration is the simplification of circuitry implied by the use of the new capacitors.

In your Workshop



This month Smithy the Serviceman gives his assistant, Dick, some further information on high fidelity equipment

As DICK PREPARED THE TEA, ONE BRIGHT summer morning, his actions displayed a purposeful energy which would, under normal circumstances, have warned Smithy the Serviceman that something was afoot. But Smithy was deeply engrossed in the chassis in front of him, and he had no eyes or ears for anything save the readings on his testmeter and the intermittent bursts of sound which came from the loudspeaker at his side.

"Tea's up," called out Dick loudly, as the battered Workshop kettle commenced to sing.

There was no reply from the Serviceman.

"Come on, Smithy," continued Dick, after a moment, "your tea's getting cold." The fact that he was, at that very moment, in the act of pouring the water into the teapot did not deter Dick from a little exaggeration.

The Serviceman still made no response.

Dick shrugged his shoulders and, after giving the contents of the teapot a vigorous stirring, commenced to fill Smithy's cup. He then walked over to the Serviceman and touched him on the shoulder.

"What's the trouble?" exclaimed the Serviceman, jumping up.

"It's all right, Smithy," said Dick soothingly. "I hate to bring you back into the world, but tea is ready."

"O.K., O.K.," said Smithy impatiently, "but leave me be for a minute. I've got a set with an intermittent, and it's playing up so beautifully just now that I daren't leave it."

Smithy re-applied his test prods to the receiver and watched the meter whilst listening to the loudspeaker. Dick watched over his shoulder and noticed that the meter gave an indication of some twenty volts whilst the receiver was working. When the receiver stopped, as it did at irregular intervals, the reading dropped almost to zero. Smithy removed the test prods, picked up a pair of nippers with insulated handles, and probed around the underside of the chassis. There was a snipping noise, after which the fault in the receiver cleared and it provided a continual and steady, albeit rather shrill, stream of music.

"That's good," said the Serviceman, with satisfaction. "Another intermittent bites the dust!"

He turned the volume control on the receiver to its minimum position and, walking over, settled himself down for his elevenses.

Periodic Fault

"The trouble with intermittents, Dick," he remarked musingly, "is that, when they *do* occur, you have to move so darned fast trying to locate them. Do you know, I've had that set cooking away quietly on its own now for two whole days, waiting for the fault to appear. It turned up about ten to fifteen minutes ago and I just had to drop everything so that I could discover the snag."

Dick wriggled on his stool a little impatiently. Had Smithy been as observant as he usually was, he might have sensed that his assistant was not overly interested in the case-history he was describing.

"It's a fairly simple set though, isn't it?" Dick remarked, rather disparagingly. "Just a medium and long wave sound receiver."

"Simple it may be," agreed the Serviceman, "but it's still just as tricky to service when the fault is intermittent. In this case I was lucky. The owner of the set complained that it went dead every now and again, and so I felt that the best thing I could do was to let it soak until it went dead in the Workshop."

"Did it go completely dead?" asked Dick. He sounded as though he wanted to run this particular subject to its end as soon as it could politely be done. But Smithy was not to be hurried.

"When the fault appeared the speaker went completely silent," remarked the Serviceman. "No hum, no background hiss, no nothing. This pointed to a blockage of signal in the a.f. stages, and a quick dab of my horny finger on the slider tag of the volume control—which connected to the grid of the first a.f. amplifier—resulted in no hum at all.[1] I didn't apply my finger to the grid of the output pentode because it was difficult to get at and because touching this point doesn't always result in a very loud hum from the speaker anyway. So I connected my test meter, switched to a suitable volts range, between the anode of the first a.f. amplifier and chassis (Fig. 1). When the set was working I got a nice crackle from the speaker whenever I connected the prods, whereas when the set was not working I heard nothing. Also, in both cases I got the same healthy anode voltage reading. So it looked as though the fault was in the output stage. I quickly checked the output cathode volts and these looked O.K. for both the dead and the good condition. So I took a guess at the output tranny."

"An open-circuit primary?" asked Dick, somewhat impatiently.

"Tut, tut," said Smithy reprovingly. "It couldn't have been an open-circuit primary or the output cathode bias voltage would have changed considerably when the set went faulty. And that's apart from the fact that the output valve would have been glowing like an electric fire after a few seconds of such a condition."

"Sorry, Smithy," said Dick contritely, "I wasn't thinking. Could it have been a *short*-circuit primary, then?"

"That's more like it! When you so rudely interrupted me I was in the act of putting my test prods across this winding. Whereupon, as you yourself saw, I got a voltage reading when the set worked, and none when it didn't. I took a guess and snipped one of the leads of what is gracefully described as the 'tone correction condenser' (Fig. 2 (*a*)). The rest," concluded Smithy, swinging his empty cup around with a grandiloquent gesture, "is history. More tea, please."

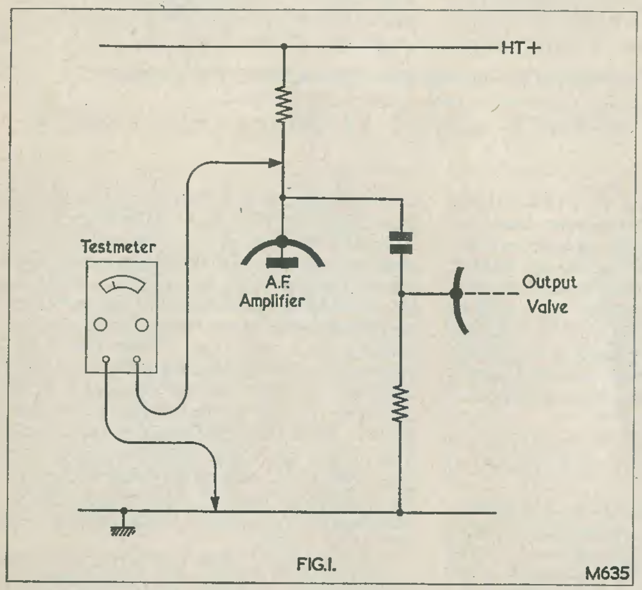


Fig. 1. Connecting a testmeter between amplifier anode and chassis in the a.f. stages of a receiver not only checks the anode voltage but also provides a rough test of the working of the output stage. A marked crackle should be heard from the loudspeaker when the testmeter prods are applied

[1] Such a test should be made with the volume control in a central position to obviate the risk of the slider tag being at chassis potential.

"I see," remarked Dick thoughtfully, as he re-filled Smithy's cup. "Is the tone correction condenser liable to go faulty very frequently?"

"Not very often," said Smithy. "Despite the fact that it takes a fair old bashing in use. Just imagine a brass band thumping out *Zampa* at full belt and translate the resultant sound into a.c. volts across that poor little condenser! In practice, most manufacturers have the benignity to put a resistor in series with the condenser in order to give a less resonant output circuit (Fig. 2 (*b*)), and this relieves the condenser of a lot of its work. On the other hand, you sometimes meet such horrible things as the tone-correction condenser being connected in series with a pot, in order to give a top-cut tone control (Fig. 2 (*c*)). A frequent result of this arrangement is that, if the control is left at the full-cut end, the track burns out with the passage of time."

"You mean, the track is burnt out by a.f. only?"

"That's right," chuckled Smithy, "just a.f. with a watt or two of power behind it."

Dick realised that the present topic was, at last, nearly exhausted.

"Of course," he volunteered, "that's not the sort of thing you'd meet in hi-fi work."

More Distortion

The Serviceman sighed.

"O.K.," he said resignedly. "That must be about the twentieth hint you've made this week. I know I said we'd have another sesh on general hi-fi principles some time ago; so I suppose I'll get no peace until we have it."

"You must agree," said Dick, hurt, "that I've only hinted. I didn't ask outright."

"Fair enough," replied the Serviceman. "Well now, reverting to our last discussion[2], you may remember I talked about frequency distortion and non-linear distortion."

"That's right," chimed in Dick. "You started off by saying that distortion occurs when the output signal does not exactly resemble the input signal. You also said that frequency distortion occurs if all input frequencies within the band being handled are not given equal amplification by the system. And that non-linear distortion occurs when the input/output slope of the amplifier is not a straight line. Also you gave some hints on clearing these types of distortion."

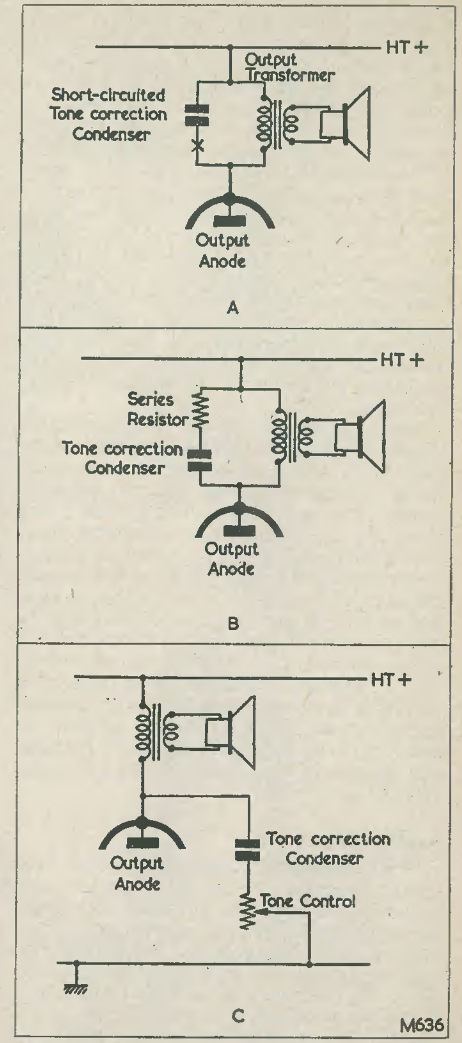


Fig. 2 (a) An intermittently short-circuit tone correction condenser caused the fault in the receiver being serviced by Smithy. When disconnected at the point marked with a cross, the fault cleared. (b) A resistor in series with the tone correction condenser provides a better response than is given by the condenser on its own. (c) A tone control circuit which is occasionally encountered. Typical values for condenser and potentiometer are 0.01µF and 100kΩ respectively

[2] Published in last month's issue.

"Good," said Smithy approvingly. "Now, I'd like to go just a wee bit more deeply into non-linear distortion before carrying on to other types. If, in an amplifier, we have non-linear distortion two effects are liable to result. One of these is the production of harmonics of the frequencies being handled by the amplifier; whilst the other is inter-modulation of one frequency by another.

"Let's deal with the harmonic one first. As you know, all sounds, apart from the pure tones you get from a.f. oscillators and such-like, possess harmonics. It is, indeed, these harmonics which give sounds their individual qualities. If an amplifier were to add further harmonics to the signals it handled there would, of course, be distortion because the quality of the sound would become changed as a result.

"Next, let's examine the intermodulation effects. When the input/output slope of the amplifier is not linear, one of the frequencies being handled will modulate the other or others. This sort of thing can be heard very obviously if you reproduce orchestral music over a badly non-linear amplifier. You may then hear heavy bass frequencies varying the strength of frequencies in the treble section, and so on. Milder intermodulation may be less painfully obvious, but its effects can still cause unpleasing reproduction of sound. What happens, whenever intermodulation occurs, is that sum and difference frequencies appear in the amplifier output in just the same manner as sum and difference frequencies appear in the output of an r.f. mixer valve."[3]

Audible Effects

"Just a moment," interrupted Dick. "I'm getting muddled. So far as I can see, non-linear distortion causes two things to happen. You first of all get the generation of harmonics, and then you get intermodulation with resultant sum and difference frequencies. Which causes the *audible* distortion?"

"In the first instance," said Smithy, "it is usually intermodulation which gives the noticeable distortion. If the sum and difference frequencies resulting from intermodulation do not blend with the original sound, audible distortion commences to be heard. As you know, you can thump out a series of chords on the piano and, providing you pick out the right notes, such chords can sound quite pleasing. If you pick the wrong notes you get sounds like Aunt Mathilda makes practising upstairs. The sum and difference frequencies, being unrelated harmonically to the original sounds, are quite liable to become Aunt Mathilda chords just as frequently as they become acceptable chords; and you get an unpleasant effect which is obvious distortion."

"So the production of harmonics doesn't come into it, after all?"

"It does, also," replied Smithy. "Certain harmonics can sound very unpleasant when added to the original sound, and these can either cause distortion on their own, or add to the general unpleasantness already given by the intermodulation. Speaking in approximate terms, however, you could state that if, starting from the purely linear state, you were to purposely make an amplifier more and more non-linear, the first noticeable distortion heard would be the result of intermodulation, the effect of excessive harmonic generation appearing later on. This does not, however, alter the fact that, in some cases, unpleasant distortion caused by harmonics *can* be heard before the intermodulation effect becomes noticeable. If you were to carry on further into the non-linear state, you would start to hear terrible things. In an advanced condition you would feed into the amplifier a sound signal consisting of a number of frequencies in the audio band, and would get out of the amplifier a ghastly porridge consisting of the original frequencies, their harmonics, their sum and difference frequencies, the sum and difference frequencies of the harmonics, and the harmonics of the sum and difference frequencies."

"Phew," said Dick. "What a mixture!"

"What a mixture, indeed," agreed Smithy. "But I must reiterate that the audible effects of such a salmagundi would only become apparent at a high level of non-linearity."

"What in heck's name is salmagundi?"

"Had you been brought up the way I was," said Smithy condescendingly, "you would know that salmagundi is a classy name for hash."

"Oh," remarked Dick, impressed. "Anyway, to get back to distortion, there's another thing I don't understand. If I look up the characteristics of an output valve I often see a reference to its 'harmonic distortion.' If intermodulation is the first offender in the non-linear distortion stakes, why not quote a figure for intermodulation?"

"Because," replied Smithy, "it is possible to define non-linearity by either of the two secondary effects it causes. Harmonic distortion is, usually, the more convenient to measure."

"I see," said Dick. "Now there's a further point I don't quite get. When I listen to an a.m. sound radio with plenty of top-cut, the distortion doesn't seem to be too bad, even though the output valve may be quoted as giving at least 5% harmonic distortion. At the same time, the distortion percentage figures for hi-fi amplifiers are very much lower than this. And yet the sound radio doesn't sound as awful as the very large difference in distortion figures might lead one to expect."

"Well," said Smithy thoughtfully, "the sound radio wouldn't sound all that good, you know, either. However, I think I know what you're driving at. Whereupon I would say that the major reason for this apparent discrepancy is that the sound receiver has a very restricted frequency range, and that it thereby takes advantage of the fact that tolerable distortion increases as frequency range decreases. Incidentally, the relation ship between tolerable distortion and frequency range explains why attempts at 'improving' a.f. amplifiers with single-ended output stages by extending their frequency range don't always come off. The increased frequency range makes whatever distortion is already present sound a lot worse."

Phase and Transient Distortion

"Any other types of distortion?" asked Dick.

"There are still a few left," replied Smithy, "but the two you are most likely to encounter from the servicing angle are *phase* distortion and *transient* distortion. Phase distortion occurs if the phase of any frequency in an audio signal becomes changed relative to the phase of the other frequencies. Thus, if an amplifier handled a sound signal consisting of a fundamental tone at 1,000 c/s and a third harmonic at 3,000 c/s, you would get phase distortion if one of these shifted in phase relative to the other. Don't forget, of course, that each voltage amplifier stage will, with normal circuitry, shift the phase of the signal applied to it through 180 degrees. Provided that all frequencies in the signal are shifted through 180 degrees this does not then, of course, result in phase eistortion."

"Can you *hear* phase distortion?"

"Not very readily," replied Smithy, "the audible effect is liable to be lost in most complex sounds."

"Then it shouldn't worry us," commented Dick.

"Don't jump to conclusions," said Smithy severely. "Whilst the audible effect may not be very obvious, the *electronic* effect may be disastrous. If you get phase shift greater than 90 degrees in an amplifier having negative feedback you may find that you get *positive* feedback, with resultant oscillation. Oscillations given by this effect are frequently at a supersonic frequency, whereupon, apart from anything else, they cause the bias conditions of the amplifier to be modified."

"How can you hear supersonic oscillation?" asked Dick, puzzled.

"You can't," replied Smithy. "Although you can, of course, detect it with a 'scope connected to the amplifier output terminals. Alternatively, if you suspect supersonic oscillation due to phase shift and you haven't got a 'scope, the effects it causes should disappear if you disconnect the n.f.b. circuit.

"From the servicing point of view faults causing excessive phase shift usually turn up in the output transformer or in the circuitry immediately around this component. With some amplifiers the phase shift may be caused by excessive capacity in the circuit between the amplifier output terminals and the speaker. Long runs of twin cable may add sufficient capacity to cause this trouble, and

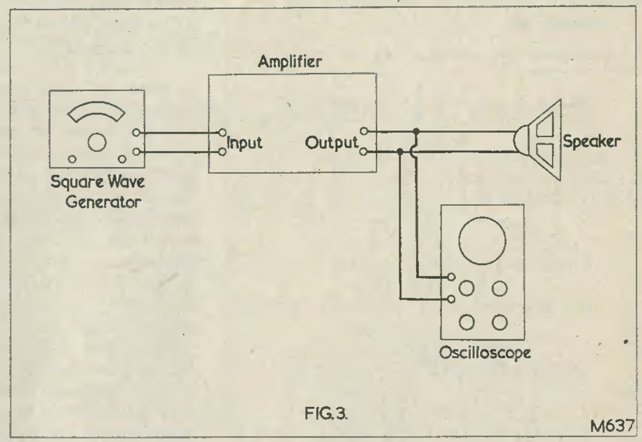


Fig. 3. Square wave testing of an a.f. amplifier may be carried out by injecting a square wave into the input of the amplifier with an oscilloscope connected to the output, the latter being loaded by the speaker with which the amplifier is used

[3] This comparison is true for *additive* frequency-changers such as the leaky-grid types found in television tuners and f.m. receivers.

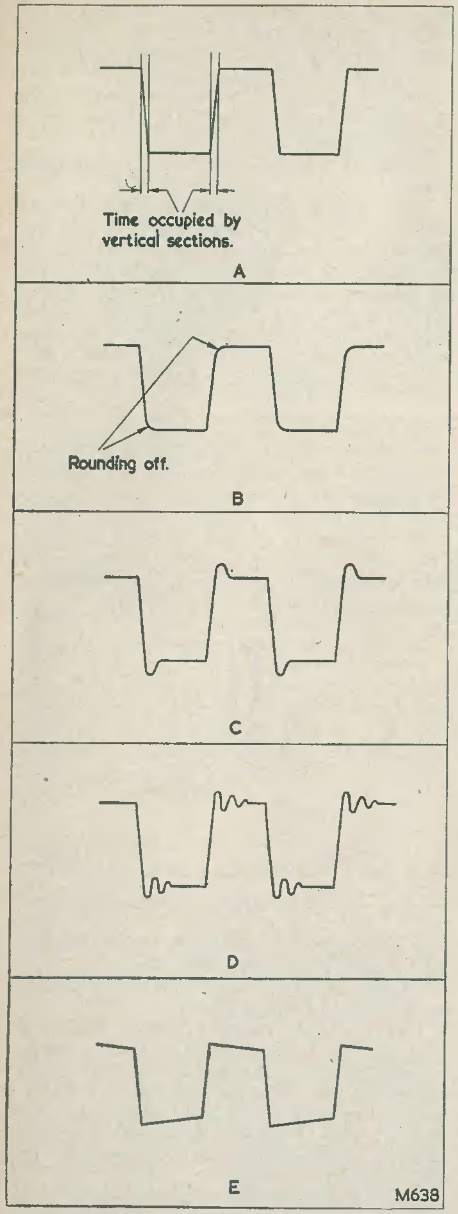


Fig. 4 (a) A square wave response, as given by an amplifier in good condition. (b) Provided it is not excessive, rounding off at the vertical sections of the square wave is usually permissible. (c) An example of overshoot. (d) The response given when ringing occurs. (e) If the square wave generator is set to a low frequency, the horizontal sections of the response will slope inwards, as shown here

the fault will disappear if a shorter length is employed. In a number of amplifiers it is accepted that quite bad phase shifts exist in the output transformer circuit at supersonic frequencies, whereupon steps are taken inside the n.f.b. loop to purposely reduce gain at such frequencies. These steps may consist of nothing more complicated than fitting a low-value condenser between a voltage amplifier anode and chassis. If such a condenser went open-circuit you could get supersonic oscillation."

"What about transient distortion?" asked Dick.

"Transient distortion," said the Serviceman, "occurs if transient—that is, very quick —changes in signal amplitude are not handled faithfully by the amplifier. Very often transient distortion is the result of phase distortion, the latter not being sufficiently bad to cause actual oscillation."

"Is this where square wave testing comes into the picture?"

"Square wave testing is a very good method of checking transient distortion," replied Smithy. "It's fairly easy to carry out; but you must, of course, have the requisite gear. A square wave generator feeds into the input terminals of the amplifier whilst a 'scope is connected across the output terminals, the latter being connected to the load with which the amplifier is used (Fig. 3). Injecting a square wave at between 1 and 5 kc/s helps to give an initial idea of the amplifier's performance. Ideally, you should get an output something like this (Fig. 4 (*a*)), wherein the amplifier provides a good copy of the input waveform. The vertical sections of the response slope a little in my sketch, this indicating that the change of amplified level is not instantaneous. Such a slope is permissible assuming that the time occupied by the whole vertical line is less than a half-cycle at, say, some 30 kc/s. You can check this point fairly accurately by comparing against the time occupied by the square waves, whose frequency you know. There may also be a *slight* rounding off at the end of the vertical sections (Fig. 4 (*b*)), and this, also, is O.K. provided that the time factor is right. Now, here's a sketch showing overshoot (Fig. 4 (*c*)). If overshoot occurs you may fairly safely assume the existence of phase shift somewhere. And here's another response (Fig. 4 (*d*)), wherein we have ringing. By counting the cycles of the damped oscillations which constitute each 'ring' and comparing with the square wave, you can make a good guess as to the basic frequency. If you vary the frequency of the square wave generator you may sometimes find that, at certain frequencies, overshoot changes to the ringing condition. The servicing procedure for overshoot and ringing is pretty much the same as that for phase distortion. If all else fails it would be fairly reasonable practice, with the cheaper sort of amplifier, to add a condenser having a value just sufficiently large to stop the overshoot, or ringing, between a voltage amplifier anode within the n.f.b. loop, and chassis. But this is a solution to be used with great care, as you might do more harm than good. Also, we're treading on slightly dangerous ground here, because we may be trying to make the amplifier better than its designer intended it to be.

"Incidentally, it doesn't do any harm to run the square wave generator down to 50 c/s or so, to see what the resultant response looks like. You should get something like this (Fig 4 (*e*)). The fact that the horizontal parts now have a marked inward slope indicates that the time constants in the intervalve circuits and in the output transformer coupling represent a noticeable fraction of the length of a half-cycle at 50 c/s. Too great a slope would indicate a serious reduction in these time constants, with a consequent drop in overall low frequency response."

Smithy stopped speaking, and his assistant looked at him expectantly.

"And now," remarked Smithy, "let us turn an honest penny. I hereby declare the session complete."

"But there are quite a few more questions I want to ask you," protested Dick.

"Sorry," said Smithy firmly. "That's your lot."

New Labgear "In-Line" 2-Band TV Aerials

Labgear Ltd., Willow Place, Cambridge, have released the following information on their new range of In-Line TV aerials, models C23, C24, C25, C26 and C27. The principle employed is a new one so far as domestic television aerials are concerned and utilises small, robust stubs attached to the Band I dipole element which effectively convert it into a high gain co-linear unit at Band III frequencies. It will be appreciated that in most conventional designs the Band I dipole contributes no more Band III signal energy than, at best, a single Band III element and frequently far less. In the new Labgear design the Band I element is no longer passive on Band III but provides substantial signal gain and when combined with a relatively small number of normal Band III directors forms a highly sensitive pick-up device out of all proportion to its size and weight.

In order to assess price comparison with existing conventional dual band aerials, the following approximate equivalents table will be of value:

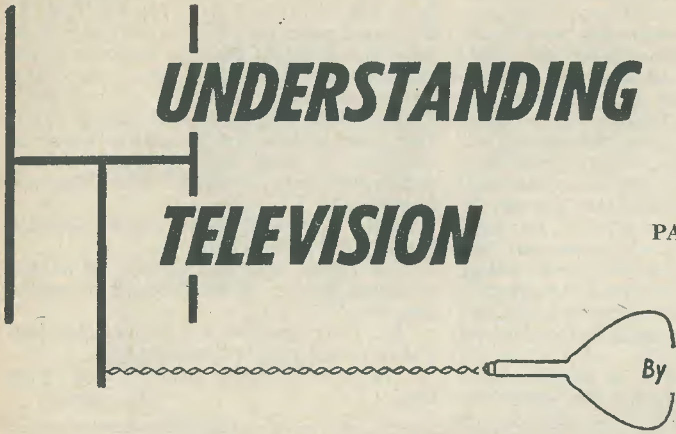
C23	(Equivalent to dipole +4) ..	42/6
C23/Z1	Ditto, with cranked arm and wall bracket	57/6
C23/Z2	Ditto, with cranked arm and lashings	75/6
C24	(Equivalent to dipole +5) ..	49/6
C24/Z2	Ditto, with cranked arm and lashings	82/6
C25	(Equivalent to H+5) ..	57/6
C25/Z2	Ditto, with cranked arm and lashings	90/–
C26	(Equivalent to dipole +7) ..	63/–
C26/Z2	Ditto, with cranked arm and lashings	96/–
C27	(Equivalent to H+7) ..	75/–
C27/Z2	Ditto, with cranked arm and lashings	108/–

New Safety Tool For "Jubilee" Clips

The manufacturers of the "Jubilee" Worm-drive Hose Clip, world famous since 1921, have produced a special non-slip safety "Jubilee Clipdriver." Apart from the fact that when clips are being applied in awkward situations there is the danger that an ordinary screwdriver may slip, it is often necessary to make the screws very tight to withstand high pressures. The tool, simple in conception and design, is made of bright cadmium plated mild steel and has a spring-steel tongue insert to engage in the slot of the screw head. A sleeve extended over the insert fits around the screw head and prevents slipping. The "T" bar is set at an angle to the main shaft of the "Clip-driver" to prevent the application of a large tube or socket spanner.

This new "Jubilee Clipdriver" is designed to fit "Jubilee" Clips only and is made in one head size, as the screw slot in the "Jubilee" Clip range is standard for all sizes. It is however, made in two lengths 6in to retail at 4/9 and 3½in to retail at 4/6 each. This tool will rapidly become an essential in all tool kits.

THEORY



UNDERSTANDING TELEVISION

PART 17

By **W. G. MORLEY**

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

In our consideration of the i.f. section of the television receiver we have, up to now, discussed the vision and sound i.f. amplifiers used in systems which have amplitude modulated sound channels.

We shall now turn our attention to the principles involved when the transmitted sound carrier is frequency modulated, as occurs with the C.C.I.R. 625 and American 525 line systems.

Frequency Modulated Sound

In the British 405 line system the sound carrier is amplitude modulated and we have already seen, in Figs. 79 and 80 (*a*),[1] how amplification of the sound i.f. signal may be achieved. In Fig. 79 the sound i.f. amplifier input was connected directly to the anode circuit of the mixer valve in the tuner, whilst in Fig. 80 (*a*) the sound i.f. amplifier was connected to the anode circuit of a common i.f. valve which amplified both vision and sound i.f.'s.

Exactly the same method of sound i.f. amplification can be employed for reception of transmissions which have frequency modulated sound, the only difference from the a.m. version being that the modulating signal would be reclaimed by a *frequency discriminator* instead of by an a.m. detector and that an *amplitude limiter* circuit would be employed to remove unwanted amplitude modulation. A block diagram depicting an i.f. amplifier of this type is shown in Fig. 97. The input to the sound i.f. stages illustrated in this diagram could be taken from the anode of the tuner unit mixer or from the anode of a common i.f. stage, in just the same manner as occurred with the sound i.f. amplifiers of Figs. 79 and 80 (*a*).

Early 525 and 625 line television receivers employed the arrangement of Fig. 97, but this has now been rendered almost com-

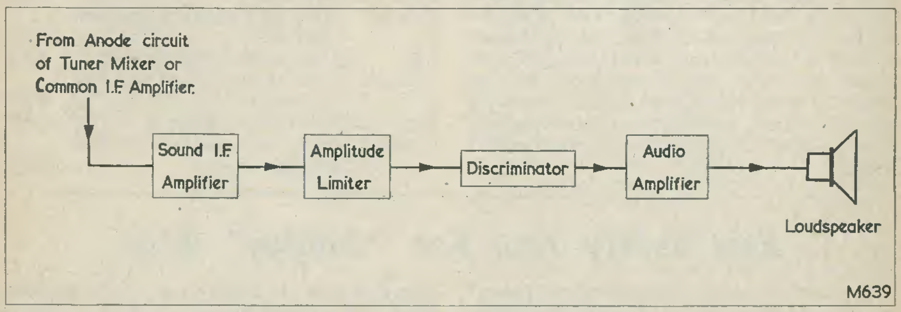


Fig. 97. A possible layout for the sound circuits of a television receiver intended for use with a frequency modulated sound channel

[1] Understanding Television, Part 14, February 1959 issue.

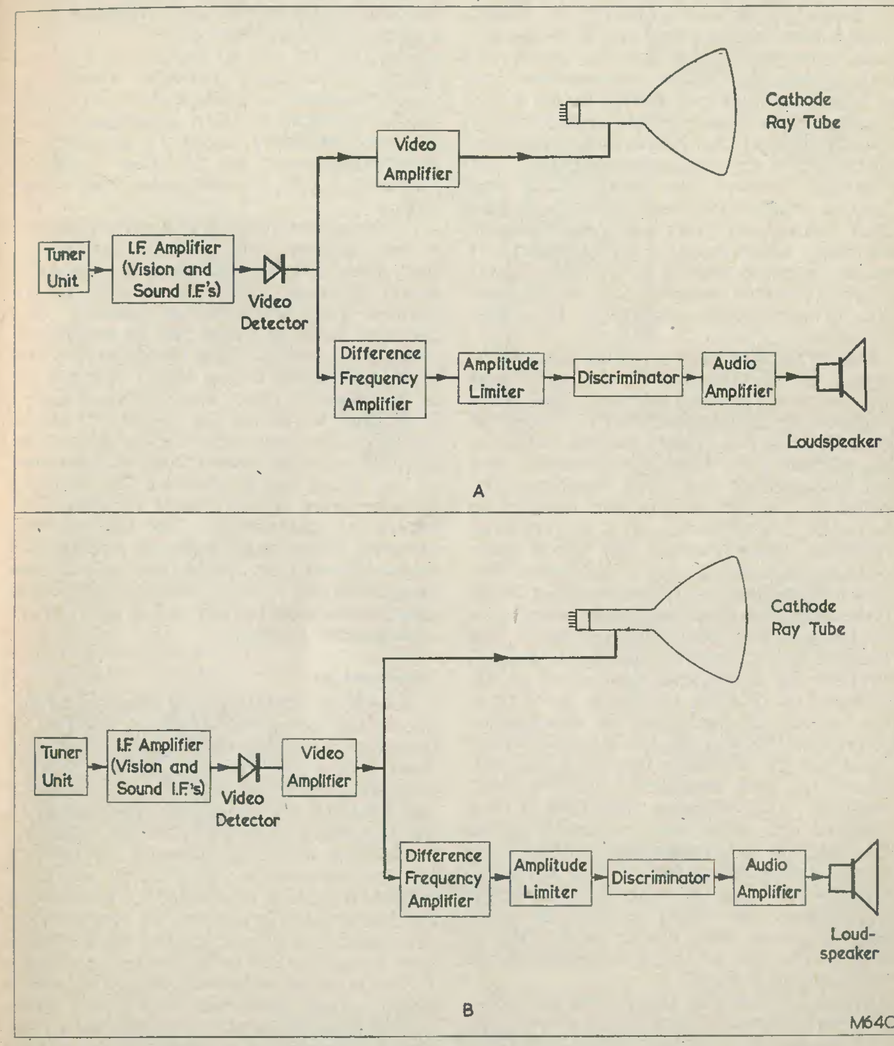


Fig. 98. In modern receivers the arrangement of Fig. 97 has been superseded by the intercarrier system illustrated here. Both vision and sound intermediate frequencies are handled by a single i.f. amplifier, and a difference frequency (equal to the difference between sound and vision carriers) becomes available at the video detector. In (a) the difference frequency is fed directly to a further amplifier, whilst in (b) it passes first through the video amplifier

pletely obsolete by the introduction of the *intercarrier* system of sound i.f. amplification. Since the intercarrier method of reception is now used almost universally we shall concentrate on this system.

The Intercarrier System

When the intercarrier system is employed there is no separate amplifier which handles the sound i.f. as such. Instead, the sound i.f. is passed through, and amplified by, the same strip which amplifies the vision i.f. Both sound and vision intermediate frequencies are, therefore, passed to the video detector. Due to the process of detection a second frequency-changing action takes place, whereupon a new frequency—equal to the difference between the intermediate frequencies which correspond to the sound and vision carriers—becomes available. This new frequency, which is frequency modulated in exactly the same manner as was the original sound i.f., is then available for amplification and for subsequent application to a discriminator.

Fig. 98 (*a*) illustrates a typical intercarrier layout. In this diagram we have both sound and vision i.f's leaving the tuner and being amplified by the single i.f. strip. After the video detector two signals become available. One of these is the detected video signal, and this is passed to the video amplifier and, thence, to the cathode ray tube modulating electrode. The second signal is the difference frequency between sound and vision intermediate frequencies. This difference frequency is passed to a further amplifier tuned to the difference frequency, and thence to an amplitude limiter and a discriminator. The resultant sound signal is then fed to the a.f. amplifier for subsequent application to the loudspeaker. Fig. 98 (*b*) shows an alternative method of employing the intercarrier system. In Fig. 98 (*b*) the detected vision signal and the difference frequency are both passed to, and amplified by, the video amplifier. The difference frequency is then extracted after this point. Apart from the fact that the video amplifier handles both signals, the arrangement of Fig. 98 (*b*) is basically the same as that of Fig. 98 (*a*). (In practice, the circuit of Fig. 98 (*a*) is more frequently used, due to the fact that it obviates the risk of intermodulation in the video amplifier stage.)

In the C.C.I.R. 625 line system the difference between sound and vision carriers on any channel is 5.5 Mc/s. In the American 525 line system the difference between sound and vision carriers on any channel is 4.5 Mc/s.[2] Thus, the difference frequency amplifier illustrated in Figs. 98 (*a*) and (*b*) would be tuned to 5.5 Mc/s if the associated receiver were employed with the C.C.I.R. 625 line system, and to 4.5 Mc/s if the associated receiver were employed with the American 525 line system.

Advantages

The intercarrier method of operation has a number of advantages over normal methods of sound channel reception. There are, also, a number of disadvantages.

The first of the advantages is that the difference frequency between sound and vision carriers is independent of tuner oscillator frequency. In consequence, an incorrect frequency cannot be presented to the discriminator due to tuner oscillator frequency drift or inaccurate fine tuner setting.

A second advantage is that the intercarrier system requires fewer stages in the receiver than does a system employing a separate sound i.f. strip. The overall cost of the receiver may, therefore, be reduced. The necessity for fewer stages may be appreciated when it is realised that the difference frequency provided at the vision detector (or at the video amplifier anode) is at a higher level than would be the sound i.f. at the anode of the tuner mixer valve. Also, since the difference frequency is fixed, the responses of the tuned circuit and the discriminator may be given just sufficient bandwidth to handle its modulation. The use of such response curves enables greater overall gain to be realised than would occur if sufficient bandwidth had to be provided to accommodate tuner oscillator drift and to allow "non-critical" fine tuning.

Disadvantages

Several disadvantages are incurred by the use of the intercarrier system. The first of these is that the difference frequency obtained from the video detector is very heavily amplitude modulated, not only by reason of the fact that the frequency modulation of the sound signal is converted to amplitude modulation in the i.f. stages of the receiver but also because the vision carrier frequency is itself amplitude modulated by picture and synchronising information. In consequence, very careful amplitude limiting of the difference frequency has to be carried out if distortion is not to be introduced into the sound signal. Also, since both sound and vision intermediate frequencies are handled in the single i.f. amplifier, intermodulation of the vision i.f. by the sound i.f. is liable to occur unless special precautions are taken.

The effect on the sound signal of the heavily modulated vision carrier may be largely cleared by ensuring that, at the video detector, the vision i.f. always has a high amplitude compared with the sound i.f. The difference frequency amplitude limiter may then operate at a level lower than that corresponding to minimum vision carrier. At the same time the risk of intermodulation in the i.f. amplifier may be reduced by fitting a sound rejector circuit (or circuits) at an early stage. As a result it is possible, by making the i.f. strip response such that sound i.f. amplitude is lower than vision i.f. amplitude, and by fitting a sound rejector, to achieve the dual results of reducing the effects of the heavily modulated vision carrier and of intermodulation. Unfortunately this technique makes it necessary to operate the fine tuner of the receiver such that the sound i.f. appears at the frequency to which the sound rejector circuit is tuned. Such a fine tuner setting is rather difficult of achievement by non-technical people because the effects of

[2] See Table 1 of Understanding Television, Part 4 April 1958 issue.

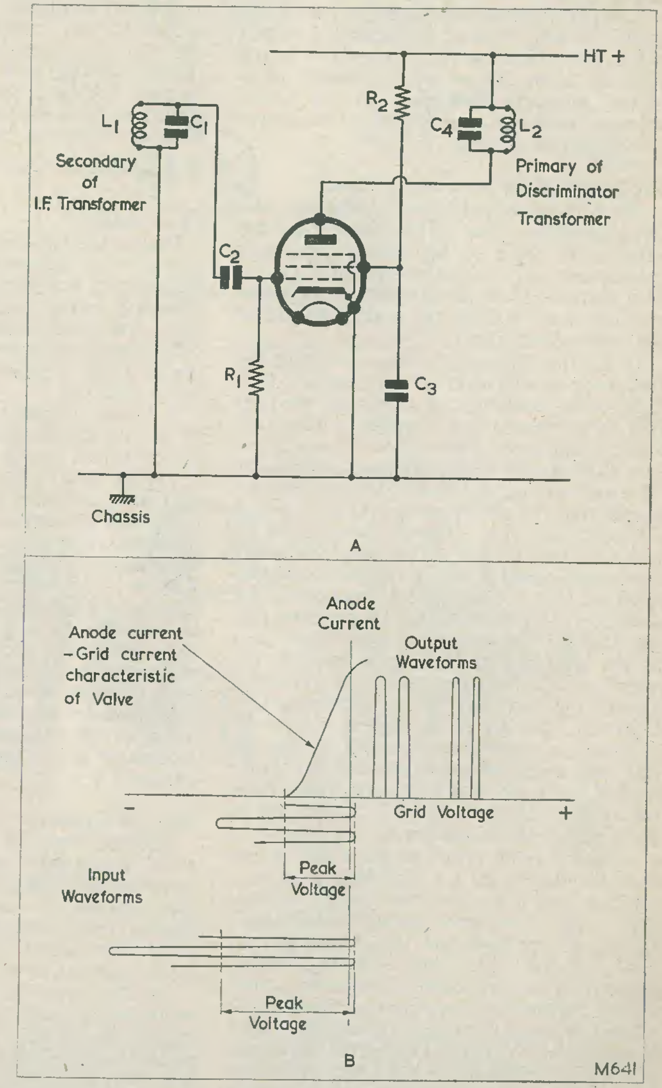


Fig. 99 (a). A simple amplitude limiter. (b) The action of the limiter. Although the two input waveforms have very different amplitudes, the output waveforms are at the same level incorrect tuning may not be immediately obvious from either picture or sound. In a well-designed receiver, however, the fine tuner setting required should be by no means as "critical" as would be needed if the inter-carrier system were not employed.

Another disadvantage given by the inter-carrier system is that it cannot function unless the vision carrier is present. In the event of a breakdown in the vision transmitter, messages broadcast on the sound channel cannot be reproduced on a receiver with intercarrier sound.

The Nature of the Intercarrier Signal

We have remarked above on the fact that the intercarrier signal derived from the video detector is liable to be heavily amplitude modulated due to several factors. Let us now examine these factors more closely and see how they qualify the overall nature of the intercarrier signal.

In the first instance it was stated that the frequency modulation of the sound i.f. is liable to be converted to amplitude modulation in the receiver i.f. amplifier. This conversion will occur if the sound i.f. is applied to a sloping part of the response curve of an i.f. amplifier stage. Since a sloping response means that the associated amplifier provides different gain at different frequencies, it follows that it will cause the frequency modulated signal to become amplitude modulated as well. Under ideal conditions this difficulty could be obviated by ensuring that the sound i.f. was applied to a "flat" part of the response curve of each stage in the amplifier, and that the tuner unit oscillator always operated at the correct frequency. However, this set of conditions cannot be achieved in a receiver designed within the economic requirements of commercial manufacture, and the fact that some amplitude modulation of the sound i.f. occurs has to be accepted as inevitable.

A second point raised above is that amplitude modulation of the difference frequency given at the video detector occurs because the vision i.f. is, itself, heavily modulated. It will be recalled that the American 525 and C.C.I.R. 625 line systems employ negative vision modulation whereby minimum transmitter output corresponds to white level and maximum transmitter output to sync level. As may be gathered, the degree of amplitude modulation of the difference frequency obtained at the video detector will depend to a large extent upon the amplitude of the picture being transmitted. It is interesting to note that the intercarrier system could not function if the transmitter modulation were made such that white level corresponded to zero transmitter output. The result of such modulation would be that the difference frequency would disappear during periods when white level was being transmitted; whereupon obvious sound distortion, beyond the capabilities of any limiter circuit to clear, would be the result. It is because of this fact that, in the C.C.I.R. system, minimum permissible vision carrier level is held at 10% of maximum level. The American 525 line television standard does not appear to cover this point quite so adequately because, although white level (and, hence, minimum transmitter output) is specified as 15% of maximum carrier level, a tolerance of $^{+0}_{-15}$% is allowed.[3]

The Limiter

Due to the very heavy amplitude modulation of the difference frequency given by intercarrier working, amplitude limiting is necessary in the difference frequency amplifier. The usual method of limiting consists of applying the signal to a valve having a sharp cut-off characteristic,[4] and employing leaky-grid bias.

A typical limiter circuit is shown in Fig. 99 (*a*). In this diagram the signal developed across tuned circuit L_1–C_1 is applied, via C_2, to the grid of the valve. R_1 provides the grid leak, and the cathode of the valve is connected directly to chassis. Fig. 99 (*b*) illustrates how the limiting action occurs. Due to the leaky-grid action given by C_2 and R_1, the positive tips of the input waveforms take up a position, in both cases shown in the diagram, at a point slightly positive of the vertical zero grid voltage line. Since the peak voltage of both waveforms is greater than the cut-off voltage for the valve, the amplitude of the voltage appearing in the anode circuit is the same for both waveforms. A limiting action has, in consequence, been obtained.

The Discriminator

The two types of frequency discriminator most commonly employed in television receivers are shown in Figs. 100 (*a*) and (*b*). That shown in Fig. 100 (*a*) is normally referred to as a *phase discriminator*, or *Foster-Seeley discriminator*, whilst that of Fig. 100 (*b*) is referred to as a *ratio discriminator*.

Of the two, the ratio discriminator is encountered much more frequently in currently manufactured receivers because it has an inherent limiting action of its own. However, this limiting action is normally insufficient for the requirements of television inter-

[3] These figures are taken from the synchronising waveforms for the American 525 and C.C.I.R. 625 line systems, reproduced as Figs. 17 (*a*) and 18 (*a*) of Understanding Television, part 4, in the April 1958 issue.

[4] That is, a valve whose anode current is cut off at a low negative grid voltage.

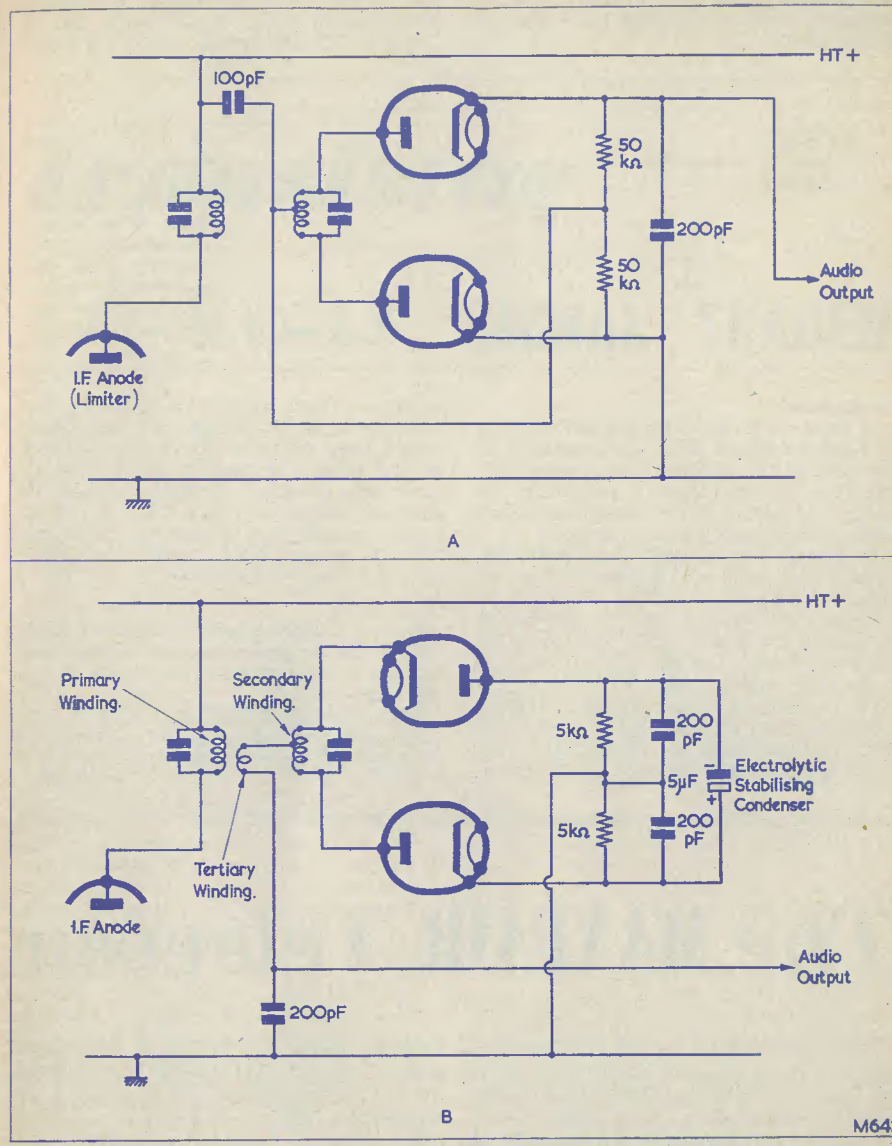


Fig. 100 (*a*). *A basic phase discriminator. Both tuned circuits resonate at the frequency of the applied signal. The stage preceding the discriminator will, normally, be an amplitude limiter. The component values shown are representative of those encountered in practical arrangements.* (*b*). *A ratio discriminator. Again, both tuned circuits resonate at the frequency of the applied signal. Normally, the tertiary winding is coupled tightly to the primary. Since the ratio discriminator has its own inherent limiting action, the preceding stage may not necessarily be a limiter. The component values shown are representative* carrier systems, and it is usual for the ratio discriminator to be preceded by a separate limiter valve. can 525 line system has a sound modulation pre-emphasis of 75 microseconds, and the C.C.I.R. 625 line system one of 50 micro-

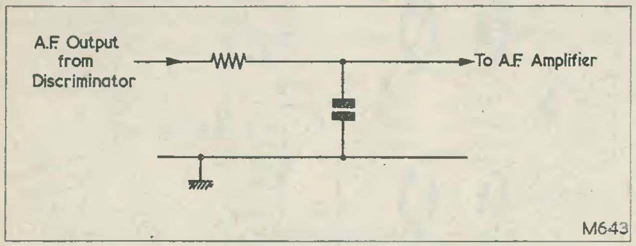


Fig. 101. *De-emphasis in an f.m. receiver may be achieved by fitting a simple filter of the type shown here immediately after the discriminator. Component values are discussed in the text*

seconds. Thus, suitable de-emphasis components in an American 525 line system would have values of 50kΩ and 0.0015μF, or any other combination which gave the same time constant. Similarly, suitable de-emphasis components for a C.C.I.R. 625 line system would have values of 50kΩ and 0.001μF, or any other combination which gave the same time constant.

Pre-emphasis

In order to ensure a good signal-to-noise ratio for the higher audio frequencies in an f.m. system, it is customary to increase their amplitude before they are passed to the modulating circuits of the transmitter. Such a process is described as *pre-emphasis.*

As a result it is necessary, in the receiver, to reduce the level of the higher audio frequencies by a similar amount. This process is known as *de-emphasis* and it is carried out by passing the audio signal obtained from the discriminator through a low-pass filter of the type shown in Fig. 101.

The component values needed in the de-emphasis circuit are specified by stating the time constant which the resistor and condenser should conjointly have.[5] The Ameri-

Next Month

In next month's issue we shall deal briefly with the a.f. amplifier stages of the television receiver, after which we shall carry on to the video amplifier.

[5] The time constant of a resistor and condenser combination, in seconds, is equal to the resistance in ohms multiplied by the capacity in farads (or resistance in megohms multiplied by capacity in microfarads).

The MAYFAIR *Televisor*

Those readers who have not yet completed this receiver, or who need replacement parts, will be glad to learn that **Direct TV Replacements,** 138 Lewisham Way, New Cross, London, S.E.14, have made arrangements to supply direct the following components: Frame and Line Output Transformers, Frame and Line Blocking Oscillator Transformers, and Scanning Coils.

Retail prices are as follows: Line Output Transformer, 37s. 6d.; Frame Output Transformer, 20s.; Blocking Oscillator Transformers, 15s. each; Scanning Coils, 33s. 9d. Orders under £1 in value, 1s. 6d. postage and packing; orders of £1 or over, 2s. 6d. postage and packing; orders for all five components, no charge for postage and packing. Cash with orders only.

Direct TV Replacements regret that they cannot enter into any correspondence regarding either these components or the "Mayfair" televisor.

An announcement regarding the availability of a suitable turret tuner will be made shortly. When available, the price will be £7 7s., and the tuner will cover one B.B.C. and one I.T.A. station.

A *transistor* R.F.—A.F. SIGNAL TRACER

By L. BAKER

THIS LITTLE SIGNAL TRACER WAS BUILT TO enable the serviceman or amateur to carry it around with him in his pocket and thus be able to apply it to a radio receiver chassis with the minimum of trouble. It can be used to locate faults in receivers and amplifiers, record-players and associated electronic equipment.

It is used in the manner common to all signal tracers, the principle being that the signal is traced aurally through the receiver or amplifier circuits. The built-in loudspeaker in the unit to be described enables the operator to listen to the signal in the various stages of the equipment under test. The recommended practice in signal tracing with this instrument is to short-circuit the loudspeaker terminals in the equipment under test, or better still to remove the leads from the loudspeaker and substitute a wire-wound load resistor in place of the speaker. Then, the tracer can be used to follow the signal from stage to stage in the equipment under test, checking the grids and anodes of valves, etc., until the signal is not heard in the speaker of the tracer, whereas if the set under test were normal a signal should be heard. One is then able to locate quickly the stage, if not the actual component, where the trouble lies.

To give just one example, let us say that we have a radio receiver under test which is completely inoperative. The signal is picked up by placing the probe of the tracer on the grid of the frequency-changer valve. If this is normal, the signal is then followed to the anode of the same valve, where it is heard again. Proceeding to the grid of the i.f. valve, the signal can be heard there again. All is in fact normal until the grid of the output valve is reached. Here it is observed that no signal is present. The probe of the tracer is moved back to the last place where the signal was heard—say, the anode of the double diode triode valve. Then the coupling between this valve and the output valve grid is suspected. The probe is placed on the anode side of the coupling condenser and the signal is heard there, but on the grid side of the condenser there is no signal. The fault is obviously an open-circuited coupling condenser.

This is just one of the many ways in which the instrument can be used. Obviously the same method of approach can be used when the set is not inoperative, but is weak, or noisy, or both. The tracer can be used to locate at least the faulty stage if not the actual faulty component.

The circuit diagram Fig. 1 shows the simple wiring and the small number of components. The two transistors shown are type CK722 which were made in U.S.A. These were only used because the writer already had these to hand. There is no reason why equivalent types could not be used. The detector is a type 1N34 crystal, this can also be substituted by a similar type crystal. All parts, especially the transistors and crystal, should be in known good condition.

For the case of the instrument the writer used a plastic type case obtained at Woolworths stores. The actual dimensions of this are not given as there are many other such boxes or containers which will suggest themselves to the constructor. It is advisable, however, to arrange things so that the wiring is short and neat. In the case of a plastic box being used to house the instrument, it is recommended that a metal chassis of the simple strip type be used (as shown in diagram) to hold the transistors and parts, and that all earth connections be soldered to this ensuring good connection. If aluminium is used, make all earth connections to the chassis with solder tags bolted firmly to the chassis. The earth or return circuit for the instrument (with the crocodile clip) can be made of the outer braiding of co-axial cable of narrow gauge, suitably flattened. This makes a good serviceable "flying lead." It should be noted also that the input to the instrument should be coaxial cable, and it is advisable not to use too long a lead. Eighteen inches of spare co-axial lead was used and this was found sufficient for all needs.

As will be seen from the circuit diagram, a 0.001μF condenser couples the input signal to the crystal diode which rectifies any r.f., and feeds it to the volume control which is used to vary the strength of the signal. The volume control also carries the contacts for the d.p.s.t. switch .

A small electrolytic condenser couples the signal to the first transistor TR_1. Resistor R_1 is the base return for this transistor, and also serves to supply the bias voltage. The coupling transformer used is an ordinary 5:1 interstage transformer.

The value of R_2 is somewhat critical, and it is suggested that different values be tried here; 250kΩ was used in the original model, but it is suggested that several values be tried to give maximum volume, or a 1MΩ carbon volume control could be wired in temporarily and, with the unit switched on and a signal fed in, the volume control varied until maximum volume is obtained. When this is done the correct value of R_2 can be taken from the 1MΩ volume control by removing it and measuring with an ohm-meter how much of it was in circuit, and then inserting a similar value carbon resistor permanently in place. When performing the above with the 1MΩ volume control, the built-in volume control of the instrument itself should be at maximum and it is advisable to have temporarily in series with the test volume control in the R_2 position a milliammeter so that the maximum permissible current for the transistor in use will not be exceeded. Once the correct value of R_2 is obtained without exceeding the current permissible (in the case of CK722, 5mA) the meter can be removed.

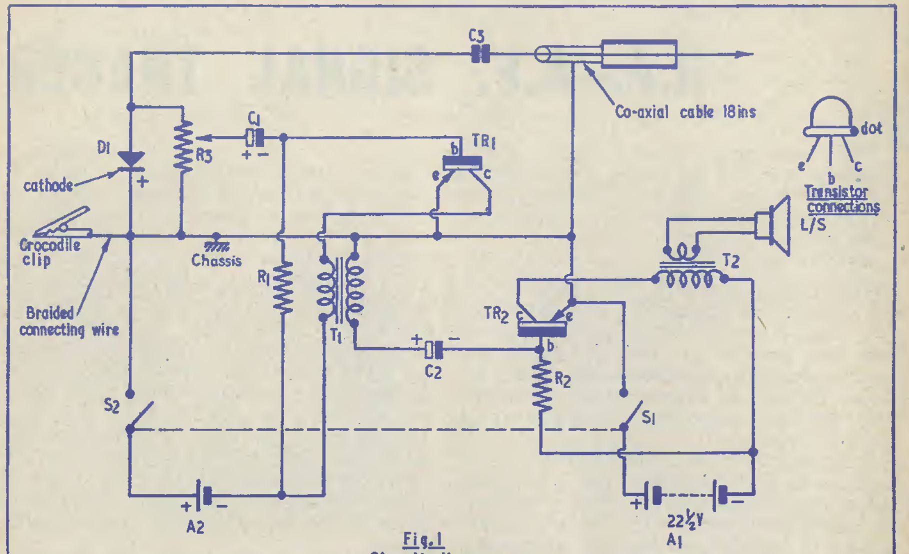


Fig. 1
Circuit diagram

COMPONENTS LIST

D_1	Germanium diode—see text	T_1	5:1 interstage transformer
TR_1, TR_2	P.N.P. transistors—see text	T_2	Output transformer, miniature
R_1	220kΩ $\frac{1}{4}$W	L.S.	$2\frac{1}{2}$in p.m.
R_2	See text	A_1	$22\frac{1}{2}$V hearing aid battery
C_1	10μF or 12μF 25V miniature	A_2	$1\frac{1}{2}$V dry cell
C_2	10μF or 12μF 25V miniature	R_3	1MΩ potentiometer with d.p.s.t. switch S_1–S_2
C_3	0.001μF miniature		

The 10μF electrolytic condenser C_2 couples the signal from the interstage transformer to the base of transistor TR_2. A small output transformer then feeds the signal to the $2\frac{1}{2}$in built-in loudspeaker. The power for the entire unit is supplied by the $22\frac{1}{2}$-volt hearing aid battery and $1\frac{1}{2}$-volt cell. As the drain on these batteries is very small they should have a long life. The d.p.s.t. switch S_1–S_2 cuts off the voltage to the transistors when the instrument is not in use.

The probe for the unit was a probe from an old testmeter. A suitable substitute could be made from the case of an old fountain pen or ballpoint pen. The co-axial lead to the input socket is, of course, earthed at the socket end on the instrument itself. It is advisable to use holders for the transistors TR_1 and TR_2. This leaves them available for other uses such as experimental circuits, etc. Great care must be exercised when inserting the transistors into the sockets, and they should be double checked to see that they are inserted right way round. A certain amount of caution must also be exercised when wiring the crystal diode, which is wired direct to the appropriate tags. It is advisable when soldering this unit to grip the wire leads near the body with large metal pliers and thus absorb the heat as the soldering iron is applied. All connections should have good soldered contacts to ensure reliable and efficient operation of the finished instrument.

The diagrams and parts list make the construction and placing of the various parts self-explanatory. As stated previously, there is no reason to closely adhere to any particular case in which to house the unit. Any container which will house and protect the completed instrument complete with battery and built-in speaker will do. It is strongly advised, however, that short direct wiring be used. It is advisable also when the wiring is completed to check the instrument several times for possible errors before inserting the transistors.

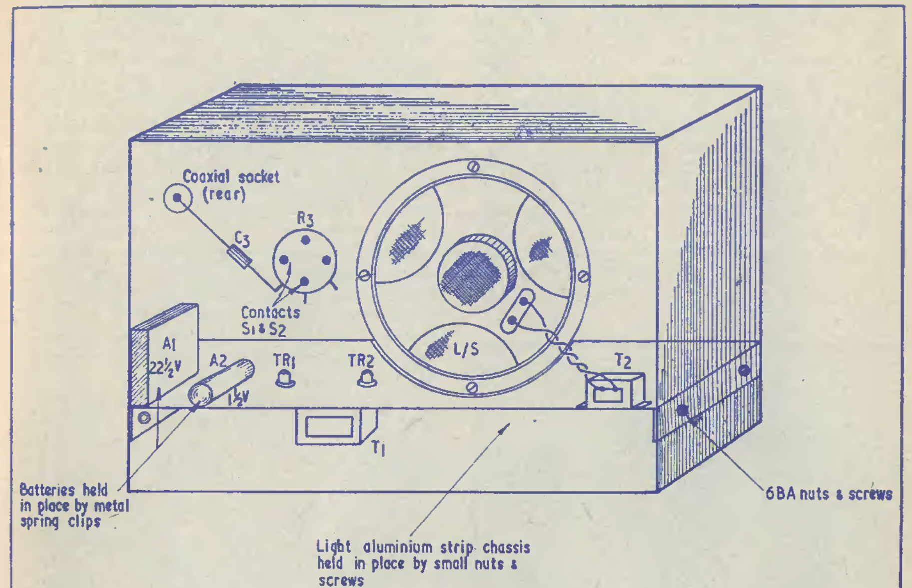


Fig. 2
Rear view of case & chassis

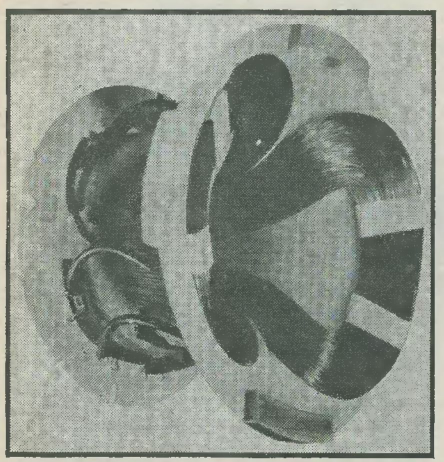
Apart from the example given earlier of signal tracing, no doubt the reader will think of all the other very many ways in which this instrument can be applied to quickly locate faults in equipment under test. With intelligent application it can locate faulty stages and parts in a matter of minutes which ordinarily might take hours of tedious testing.

A Constructor Visits The

R.E.C.M.F. EXHIBITION

THE R.E.C.M.F. EXHIBITION, HELD ANNUALLY at Grosvenor House, Park Lane (and in recent years at Park Lane House also) gives manufacturers of electronic equipment an opportunity to meet the manufacturers of the components used in their equipment and discuss their problems, both technical and commercial.

Many of the companies exhibiting supply only to industry, and many of the components shown are not available through wholesale and retail channels to the home constructor. However, the exhibition does give the constructor an idea of the trends in the radio, television and electronics industries.



Complete Plessey scanning unit for 110° t.v. tubes; note the pockets for anti-"pincushion" distortion magnets. This unit can be supplied with alternative forms of picture shift and picture height/width controls

Television

Perhaps the most noticeable trend in television is a further increase in the deflection angle of cathode-ray tubes to 110° which results in a reduction in overall length. Mazda were displaying two 110° tubes, the CME1703 (17in) and CME2101 (21in); Mullard were showing the AW43–88 (17in) and AW53–88 (21in), whilst the 17in Brimar tube C17AA was also on view. All these tubes have shorter gun assemblies than their predecessors the 90° tubes, which gives a further reduction in overall length. A 110° tube is about 23% shorter than its 90° counterpart. The shorter gun is made possible by the omission of the ion-trap, a feature which is no longer necessary with present-day vacuum techniques. The new tubes have smaller diameter necks (28mm) which permits the deflection coils to be placed nearer the electron-beam. The deflection power required is thereby reduced, which partly compensates for the increase necessary for the wider deflection angle.

The increase in deflection angle has meant new deflection coils, which are even more elaborate than the 90° type! New timebase valves have also been introduced; the PL84, frame-output pentode by Mullard and Brimar, and the triode beam-tetrode 30PL13 by Mazda are examples. The existing line timebase valves for 90° deflection are adequate for 110° circuits.

There are some significant changes in television tuners; the 13-channel tuner is giving way to 17 and 18 channel units providing for 13 t.v. channels, three or four v.h.f./f.m. radio channels and a further position for use when u.h.f. television becomes a reality. Tuners of this type were exhibited by A.B. Metal Products Ltd., Sydney Bird Ltd., and Brayhead Products Ltd. Most aerial manufacturers were featuring broadband Band III aerials which permit alternative Band III programmes to be received. There are also some developments in t.v. front-end valves. Mazda have a cascode double-triode, the 30L15, which shows an improvement in gain and noise performance over the 30L1, the type used previously. They also have the 30C15, a new mixer valve, an improvement on the 30C13.

Mullard have recently introduced the PCC89, a cascode double-triode of frame-grid construction with a slope of 12.5mA/V which gives 5dB more gain and a reduction in noise factor from 7.5 to 5.5dB compared with the PCC84.

Radio

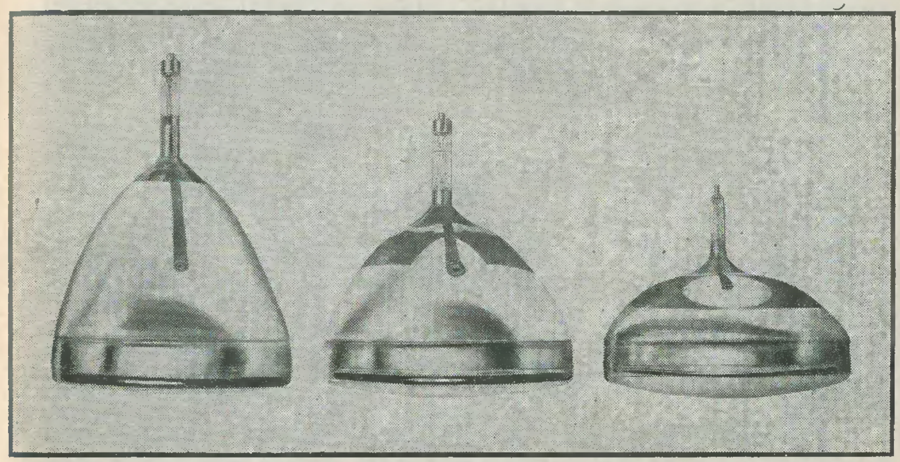
The main interest in radio receivers is now centred around the transistor portable, and many of the trends in components can be attributed to the transistor. There were no less than ten transistor manufacturers exhibiting. High frequency transistors capable of operation up to 200 Mc/s were shown by Semiconductors Ltd., and silicon power transistors with dissipations up to 70W (at 25° C) by Texas Instruments Ltd. Many of the transistors exhibited were for industrial applications. The next step in domestic radio will be an f.m. transistor receiver. A transistor which will be of interest in this application is the OC170 (Mullard) which is intended for use as a 10.7 Mc/s i.f. amplifier and has an alpha cut-off frequency of 70 Mc/s. Transistors such as this will no doubt be popular with model control enthusiasts when they become generally available.

The subminiature i.f. transformers intended for use in transistor receivers were also much in prominence. The Wireless Telephone Company were showing double-tuned i.f. transformers for these receivers. The trend towards miniaturization, evident in previous years, still continues. Morganite have recently introduced a new $\frac{1}{10}$th watt resistor type X which measures $\frac{1}{4}$in in length by $\frac{3}{32}$in diameter. A number of manufacturers are producing miniature controls for transistor receivers.

T.C.C. produce a range of miniature electrolytic capacitors (CE132 and 134) which are suitable for transistor circuits. The terminations of these have been changed from the old "pig-tail" type to neoprene end-seals. This results in a reduction in overall length, and makes the component more suitable for use with printed circuit assemblies.

A number of manufacturers make miniature tuning gangs for transistor portables. One of particular interest to home constructors is the Jackson Type 00 which can be supplied with a screen between sections, and with trimmers and printed circuit "feet" if required. Another optional "extra" is an integral slow-motion drive (giving a reduction of approximately 6:1) incorporated in the spindle.

Ever Ready are producing a new 9V battery for transistor receivers, the PP10, suitable for use with receivers having current consumptions of up to 150mA. This battery has three times the capacity of the PP9, and a correspondingly longer life. Another recent development in batteries is the new Mallory miniature cell with a capacity of 37mA hours and a volume of only 1/80th of a cubic inch.



70°, 90° *and* 110° 21*in television tubes shown together for comparison of overall lengths (Photo courtesy Mullard Ltd.)*

Audio

Truvox were displaying a new tape-deck, Mark IV, and a recorder incorporating this deck. The heads fitted to this deck have a 0.00025in gap, giving a frequency response of better than 40–15,000 c/s. B.S.R. were also showing a tape-deck—their first—a single-speed ($3\frac{3}{4}$in per sec.) unit. Staar Electronics were featuring a new battery-operated 6-pole motor for use with automatic

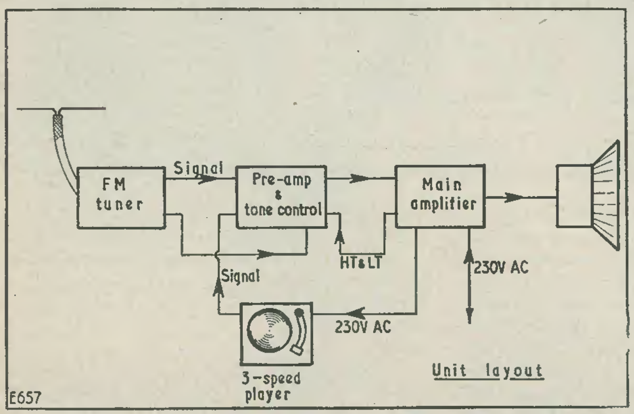
(continued on page 865

AN INEXPENSIVE HIGH QUALITY DOMESTIC SOUND SYSTEM

By **Gordon D. Everett**

RECENT YEARS HAVE BROUGHT ABOUT A very keen interest in high quality sound reproduction, but most of the available equipment has been expensive, and in many cases the technical specifications have been far superior to the quality of available programme material. There is a demand for a low-powered installation suitable for the average living-room, but the results must be superior to a commercial radiogram. These factors were borne in mind whilst the equipment to be described was being built, and the result can only be termed as very satisfactory.

Normally two programme sources would be available, radio and gramophone. The superiority of f.m. over a.m. radio, i.e. freedom from interference and background noise, and the wide frequency response available made an f.m. tuner an essential part of the equipment. The gramophone side was covered adequately by a three-speed turntable and a Collaro "Studio" pick-up. The complete installation consisted of an f.m. tuner, record player, tone control unit, main amplifier, and loud speaker, as shown in the block diagram.

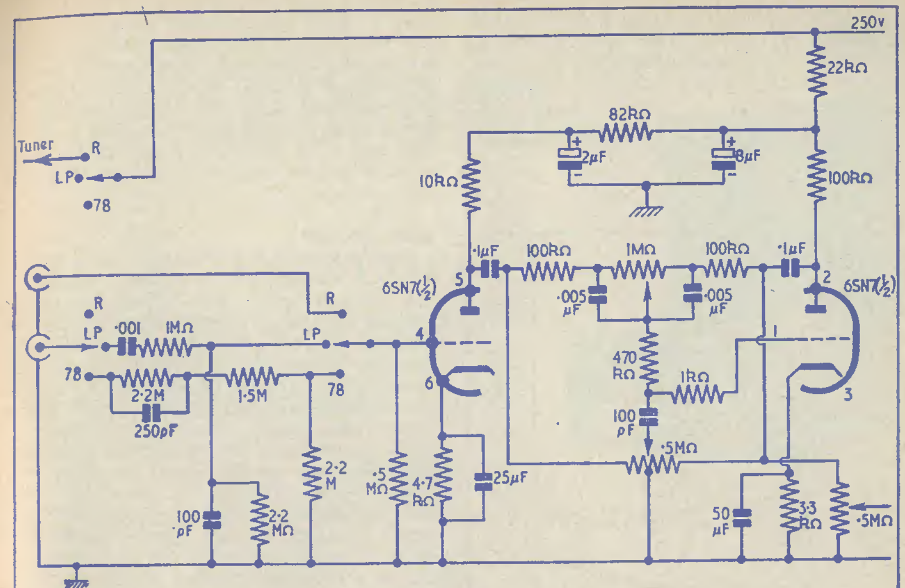


Unit layout

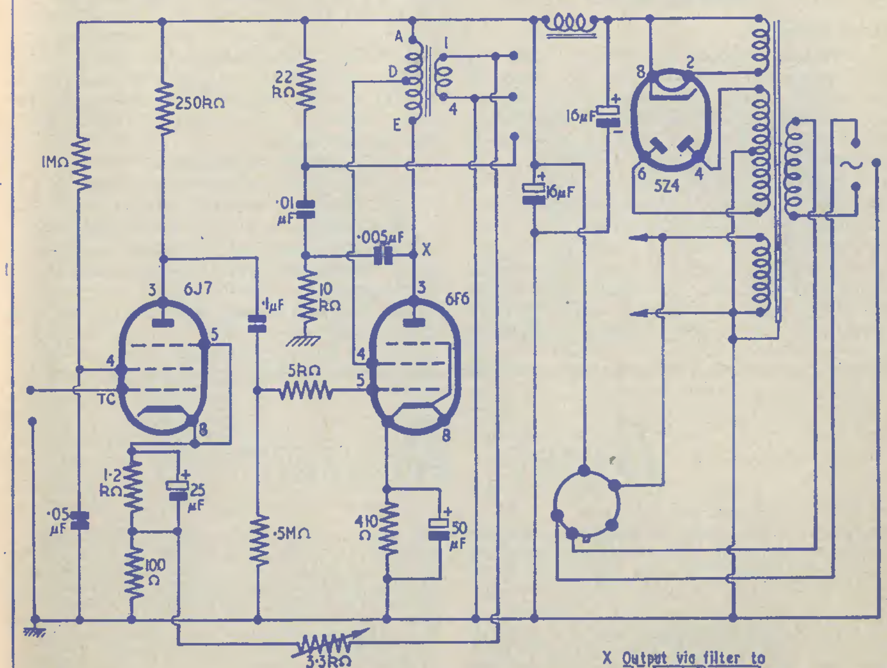
The f.m. tuner was built from a standard Jason kit, and provided the component layout is followed, no difficulty will be experienced in construction. All earthing points must be made with a really hot iron, and care must be taken not to overheat any of the smaller components. Although these tuners can be aligned by trial and error, it has personally been found best to make use of one of the many firms advertising this service. Correct adjustment of the discriminator is essential if the anti-interference properties of f.m. are to be fully realised. Power supplies for the tuner are taken from the main amplifier, the requirements being 250V at 25–35mA h.t. and 6.3V at 1.5A l.t.

Tone Control Unit

The unit performs the following functions: Selection of programmes, adjustment of bass, treble and volume and also switching the equipment on or off. By means of a selector switch, either radio, standard or l.p. records can be selected. When the records are being played, the selector switch enables the correct equalisation to be used. One valve is used in the unit, a 6SN7 twin triode; one half of this acts as an amplifier, a Baxandall type tone control being built around the other half. This tone control system has been found to be most satisfactory in practice, and the output can be connected to a reasonably long cable without attenuation of the higher frequencies or the introduc-

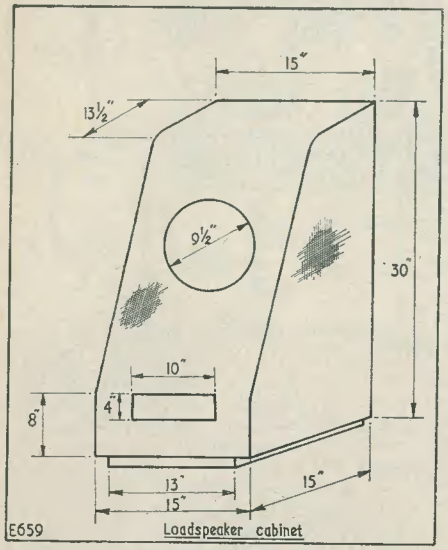


Tone Control



4W U-L AMPLIFIER

tion of hum. It will be noted from the circuit diagram that the h.t. to the tuner is switched off when the gramophone input is in use; this is to obviate any possibility of signal breakthrough.



E659 Loudspeaker cabinet

Main Amplifier

In order to reduce the overall cost, the usual push-pull amplifier was not used, as this would entail extra components, valves, etc. Instead, it was decided to experiment with a single 6F6 output valve, and eventually an ultra-linear output stage was used. A 6J7 is resistance-capacity coupled to a 6F6; negative feedback, which includes the secondary of the output transformer, being used over the two stages. The output transformer is a Gardner's 8-watt single-ended multi-ratio type, and the screen grid of the 6F6 is connected to a tapping which approximates 25%. It cannot be over-emphasised that a good transformer must be used; inferior results will occur with a cheap component. The power supplies are mounted on the same chassis as the output stage, a 5Z4 rectifier and choke capacity filtering being used. Throughout the tone control unit and main amplifier, one-point earthing ensures stable equipment with a very low hum content.

Loud Speaker

The bass unit is a Celestion 10in, with a T.S.L. electrostatic speaker resiliently mounted in front of it. This acts as a tweeter, and adds a surprising amount of realism to the reproduced sound; the tympany being especially well rendered. The cabinet is constructed of ¾in thick Weyroc to the dimensions shown in the diagram, and is a bass reflex design. The interior surfaces are lined with Celotex board, and all joints are screwed, and finally filled to make the assembly as airtight as possible. The existing design can be varied, provided the cubic capacity is kept approximately the same. The front panel is set at an angle to ensure a wider distribution of sound.

The entire equipment costs about £30, and gives results equal to many commercial sets costing well over double this amount. The tuner, tone control unit, main amplifier and turntable are mounted in a small cabinet which stands on four contemporary legs. The sides of the cabinet are made of peg board which not only look attractive, but enable the equipment to be well ventilated. The following points should be observed during construction:

(1) Single-point earthing.
(2) All signal-carrying leads screened.
(3) Potentiometer cans earthed.
(4) Good earth points on the tuner unit.
(5) Solid construction of the loudspeaker cabinet to avoid any unwanted resonances.
(6) A good output transformer must be used.

Book Review

THE RADIO AMATEURS' HANDBOOK. Published by the American Radio Relay League. Obtainable from the Modern Book Co., 19–23 Praed Street, London, W.2. Price in U.K., 32s. 6d., post 1/9.

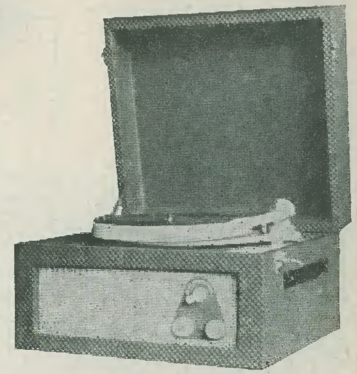
The 1959 edition—the 36th—is now available, and with the latest modifications included it is definitely indispensable to the serious transmitting amateur—and, indeed, is well worth considering as an acquisition by every constructor who is looking for a comprehensive and authoritative handbook on radio technique.

There are 25 sections of text matter totalling over 600 pages, covering the theory and practice of radiation, reception and transmitting, both h.f. and v.h.f. There are chapters on valve and transistor techniques, power supplies, aerials, mobile and portable equipment, construction techniques, measurements, practical constructional descriptions of receivers, transmitters and test apparatus, and some 30 pages of data on American valves, cathode ray tubes and transistors.

Your reviewer, having successfully built a number of items from past editions, is now busy collecting ideas from this one with a view to further modernising his station!

The LUDFORD

A SINGLE-VALVE LOCAL-STATION RADIOGRAM



Part I

By J. WOOLLEN, B.Sc.

This series of articles describes the construction of a simple radiogram which is capable of good quality reproduction from local stations and from records. The circuitry is simple, and the cabinet work is lucidly explained so that no difficulty should be experienced even by a beginner

Introduction

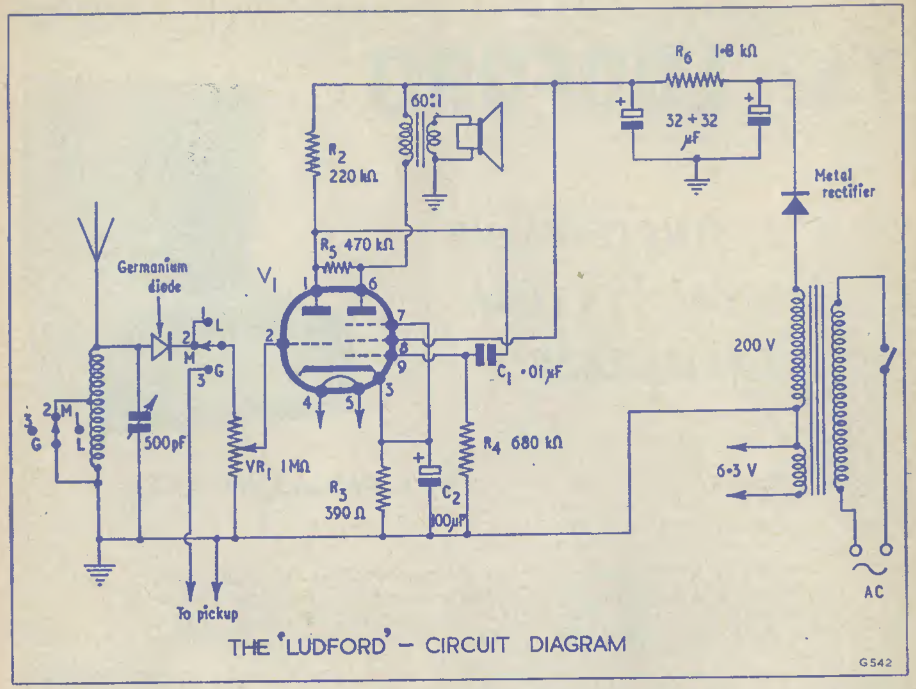
EARLY IN 1957 THE WRITER EMBARKED ON a project aimed at exploiting to the full the potentialities of that excellent valve the ECL80. The first results when using a Wharfedale Super 12 speaker gave extremely good quality reproduction and convinced the writer that, with careful selection of components and with a specially constructed cabinet, a first-rate radiogram could be produced. As the work progressed several difficulties were encountered, and by giving attention to small points each was overcome, until, on completion, a reproducer has resulted of which the writer feels very proud. At the same time, he urges any would-be constructor to adhere closely to the published design if he wishes to obtain performance comparable with that of the prototype.

The loudspeaker chosen was the Elac 9in x 5in elliptical model 59T. In order to avoid confusion at a later stage, let it be noted that its height is actually 5⅝in. Even ⅛in can make quite a difference in a cabinet of this type. The makers claim a very wide response for this model, and this claim is well borne out in this receiver as will be noted in the paragraph on performance. In the opinion of the writer this loudspeaker is the largest single factor in the success of the Ludford.

This receiver should not in any sense be considered as one from the junk box. During the period of development it is only natural that some used parts were employed. In no case was a used component incorporated where a new one would serve better. Quite a lot of thought went into the selection of a suitable speaker unit and Elac (Electro Acoustic Industries Ltd.) were very helpful in this respect. It should be noted that the entire success of the receiver can be lost should a miniature output transformer be used. No particular make of transformer is specified, as there are many good ones available. Select one of good quality.

The Receiver

This is essentially a two-stage amplifier taking its input, by means of a 3-position selector switch, from a crystal pick-up or a radio tuner employing a germanium diode and tuning to Medium and Long waves. Power is supplied by a half-wave metal rectifier, and a double wound mains transformer is used. In this way the chassis is isolated from the mains and is quite safe to handle. This, in the opinion of the writer, is a most important point.



THE 'LUDFORD' — CIRCUIT DIAGRAM

Components List

All resistors ½ watt 20% types, except R_6.

Resistors
- VR_1 1 MΩ with S.P. switch
- R_2 220kΩ
- R_3 390Ω
- R_4 680kΩ
- R_5 470kΩ
- R_6 1.8kΩ 1W

Condensers
- C_1 0.01μF
- C_2 100μF 12V working
- C_3, C_4 32+32μF 350V working was used

Miscellaneous
- V_1 ECL80
- 1 valveholder, B9A
- 1 metal rectifier 250V 30mA (Home Radio)
- 1 mains transformer, primary 230V, secondaries 200V 30mA, 6.3V 0.9A (Sterns type 653, or Jason MT2006)
- 1 output transformer ratio 60:1 (Wharfedale OP3 is suitable)
- 1 variable condenser 500pF, solid dielectric, (Home Radio)
- 1 wavechange switch (2-pole 3-way)
- 1 dual-range crystal set coil (Repanco)
- 1 germanium diode—OA81 or similar
- 1 9in x 5in elliptical speaker (Elac 59T)
- 1 coaxial plug and socket
- 1 A–E socket

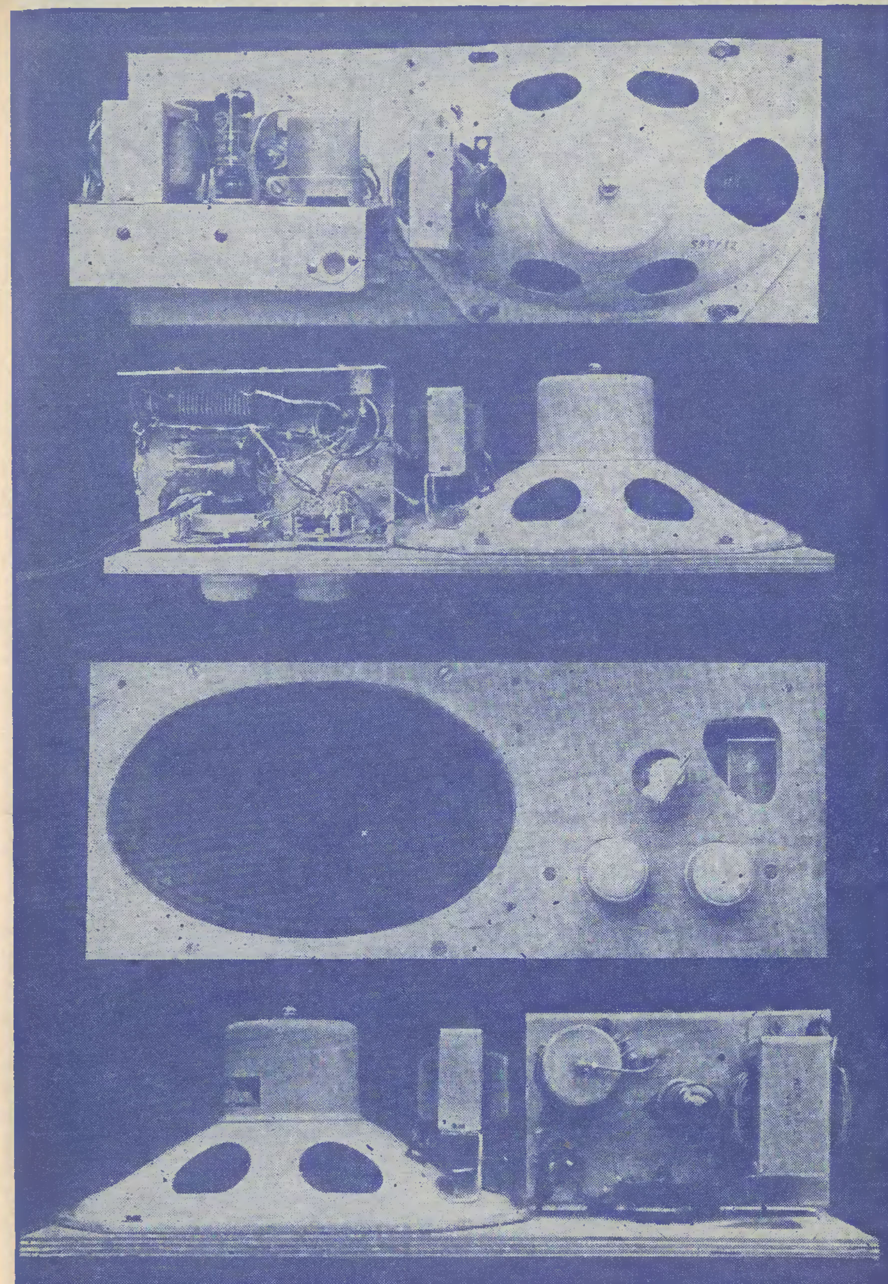
Sundries
- Nuts, screws, solder, tags, sleeving, mains wire and plug, rubber grommets.

A busbar of 16 gauge copper wire is used. It begins at the top of the 32–32μF electrolytic condenser, passes through the chassis in sleeving and terminates on the holding down nut of the mains transformer. All earth wires are connected to this busbar and the electrolytic condenser is isolated from the chassis by wrapping cellotape round it before putting it into its clip. Since he began to use this method, the writer has never been troubled with mains hum in this receiver. A measure of negative feedback is provided by R_5.

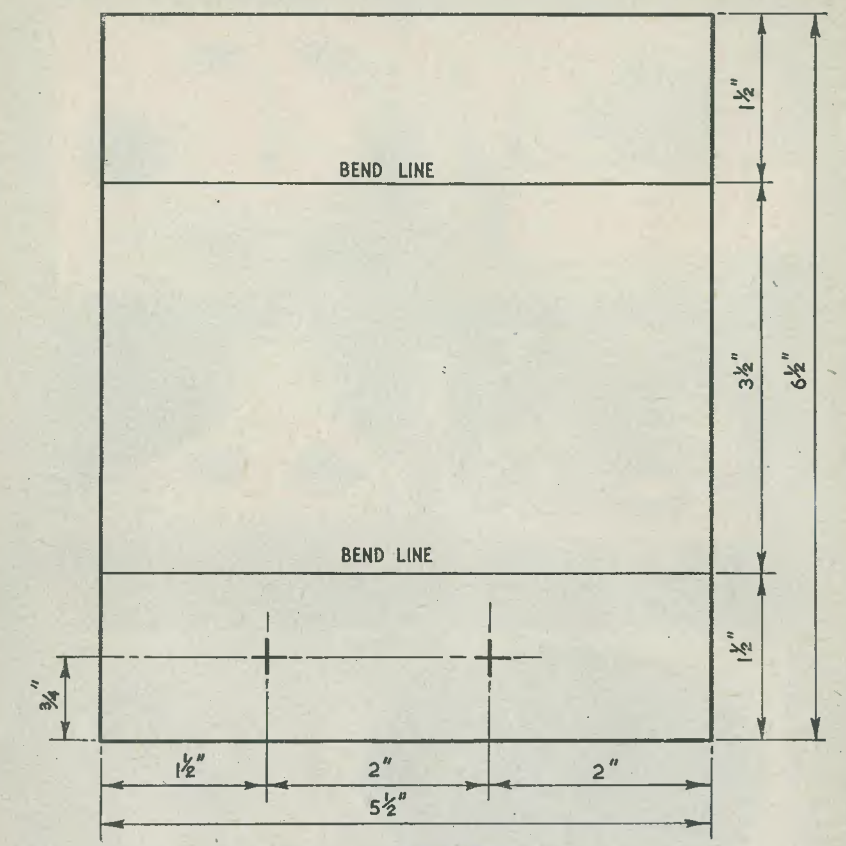
The Chassis

This is constructed from a piece of 18in gauge aluminium 5½in x 6½in. The top is 5½in long by 3½in wide, this being the width of the mains transformer. The sides of the chassis are 1½in deep and the ends are open.

A patch was added to take the tuning condenser, while a coaxial socket at the back



Views of the baffle with the receiver and speaker in position. Note, in the front view, the piece cut away to provide ventilation for the valve



CHASSIS DIMENSIONS

No further drilling instructions are given, in order to allow for alternative components. The constructor should arrange components on the chassis before drilling. The photographs will serve as a general guide

accepts the input from the pickup. The metal rectifier is mounted below the chassis, while the electrolytic condenser, valve, tuning coil and mains transformer are above. There is not sufficient room on the chassis to accommodate the output transformer, but this is mounted on the loudspeaker chassis (Elac will supply the speaker with a suitable output transformer already in position.)

Wiring

First of all the l.t. secondary wires from the mains transformer are closely twisted and taken to the appropriate valve tags. This is a most important point in reducing mains hum. Because of the small number of components, very little wiring is necessary. As in all receivers, grid and anode leads must be kept short.

As stated elsewhere, all earth connections are taken to the busbar, including the casing of the output transformer and the output transformer and the speaker chassis and one side of the secondary winding of the output transformer.

Assembly (Receiver)

The baffle is a piece of ⅜in plywood 14¼in x 5¾in. On this are mounted the loudspeaker and the receiver chassis. A port hole is cut on the side remote from the loudspeaker. Its main purposes are to provide ventilation and to obviate acoustic feedback between the gramophone and the loudspeaker; and these it does effectively. Whether or not it serves to produce any reflex action from the loudspeaker is a matter on which the writer is not prepared to express an opinion.

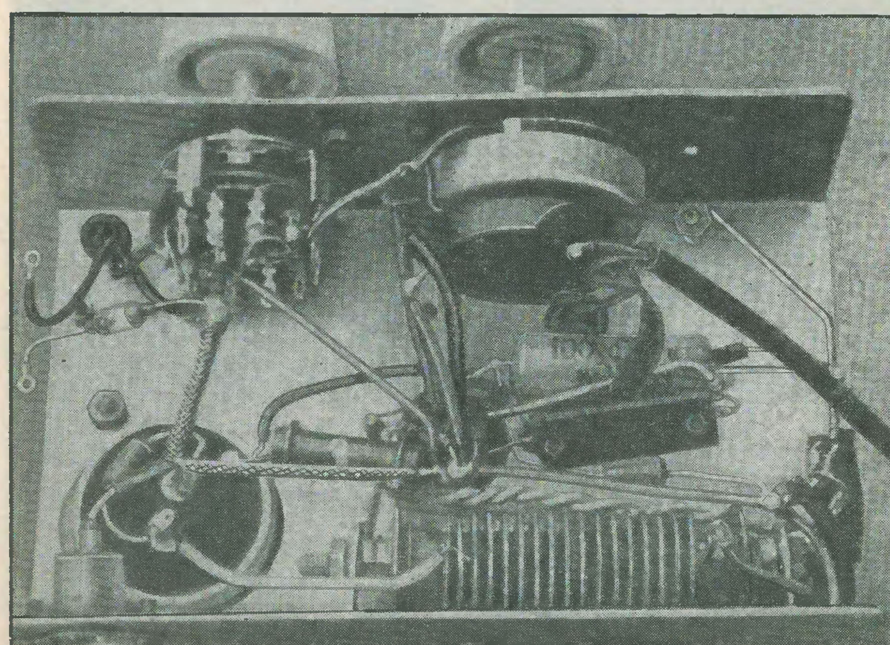
A cut-out is made for the loudspeaker, and holes are made to allow easy clearance for the three spindles of the receiver chassis. The holding nuts of the wavechange switch, tuning condenser and volume control/on-off switch are not used to fasten the receiver chassis to the baffle. Nuts and screws are used for this purpose. The baffle is just large enough to accommodate the loudspeaker and receiver, but there is nothing to spare. In fact it was necessary to use a hacksaw to take a "bite" out of the chassis to avoid it fouling the loudspeaker.

Assembly (Gramophone)

The gramophone unit is mounted on the motor board in accordance with the instructions provided by the makers. Fillets of wood are screwed to the sides of the cabinet to support the motor-board, which should be cut to allow the mains lead to be brought out from beneath it.

As the gramophone is the last item to assemble, the mains lead is provided with a plug and a mains socket is affixed to the inside of the cabinet to receive it. The pick-up leads plug into a co-axial socket on the back of the receiver chassis. The gramophone unit can thus be lifted out of the cabinet without the need for unsoldering any wires.

12in records can be played on the turntable with the lid closed. The size of the motor-board is the minimum recommended by the makers of the gramophone motor (14¼in x 12½in).



Underneath view of prototype showing component layout

After affixing the loudspeaker fret, the escutcheon and the knobs, the baffle is fixed in the cabinet. Wooden blocks are glued to hold it in position at the bottom and wood screws hold it at the top. Aerial and earth wires from the chassis lead to a 2-way A–E socket at the back of the cabinet.

Aerial

This is a point of considerable importance, as the writer experienced when he changed his residence during the course of the development of the receiver. At the new address it was found difficult at first to achieve satisfactory signal strength. On trying the effect of coupling up to the television aerial, it was found that this gave by far the best results experienced to date. The addition of an earth does not appear greatly to influence signal strength, but has quite an effect on the setting of the tuning condenser.

As only a germanium diode is used it is essential that the best aerial be employed, although if used in close proximity to a station it will be found that selectivity will present a problem. If this is so, it may be advantageous to use a tuning coil employing a tapping for the aerial.

Performance

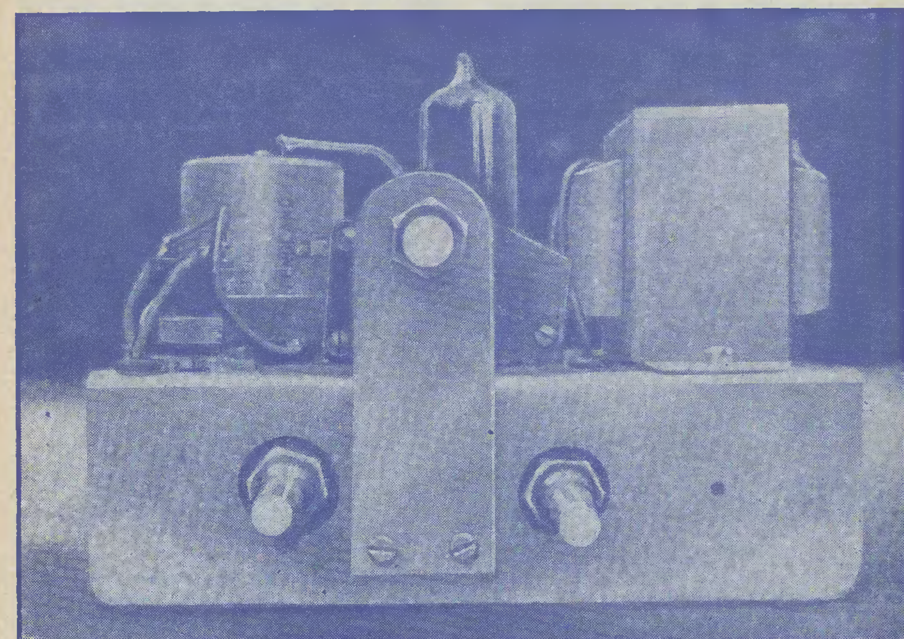
Can a single valve, together with a germanium diode, give a performance which will make this receiver a worthwhile proposition? The writer's experience is that it does so extremely well.

On radio the Light Programme on 1500 metres is received at very good strength (at Crewe) while the North Regional Station on 434 metres gives good strength. Luxembourg is received but is subject to fading.

The greatest volume is obtained from records, both 78 and L.P. The full volume available will be in excess of most requirements. Acoustic feedback between the motor and loudspeaker may be troublesome should full volume be used.

As for the quality of reproduction, the impression gained on listening to music is one of intimacy and wide response. The absence of background on radio is complete. On dance music the bass is firm while the treble is well reproduced; cymbals, wire brushes and all the paraphenalia of Latin American music coming through well.

The only equipment available for testing was Decca Test Record 1804 (78 r.p.m.).



Front view showing patch for holding tuning condenser

This gives bands from 14 kc/s descending in steps of 1,000 c/s to 1,000 c/s after which come 400 c/s, 100 c/s, 50 c/s and 32 c/s.

The record was played on the gramophone and the results, aural and also personal, must be taken for what they are worth.

In the bass 50 c/s is audible, but not 32 c/s. 100 c/s is very loud.

The writer (in age nearing 50) hears 11 kc/s as a loud noise, but 12 kc/s not so loud. Above 12 kc/s he can hear nothing. Taking 11 kc/s as strength 10, he would say the response at 12 kc/s is strength 2.

His 14-year-old son, however, gave quite a different picture. Taking 11 kc/s as strength 10, he said that he estimated 12 kc/s as strength 8, 13 kc/s as strength 7, and 14 kc/s as strength 4. *(To be continued)*

A VERSATILE NEON TEST UNIT

By **J. Brown**

THE WRITER HAS ALWAYS BEEN FASCINATED by the versatility of neons. They can be used as the basis for many types of electronic devices from simple "live mains" testers to such applications as providing a 32ft "acoustic drum" in an electronic organ.

Having had the idea of building a timer unit for photography for some time, the writer started on the project by trying out various circuits of more or less conventional types. The final circuit adopted proved very interesting, giving both visual and audio indication of time. It was found that the unit could also be adapted for many other jobs, some of which are described herewith.

The Basic Circuit

A more or less conventional circuit was used except for two unusual features.

Firstly, the neon is tuned by parallel capacitors, each giving a different frequency of neon firing. The larger the capacity, the slower the frequency, so that all one has to do to get the desired rate is to add more capacitors in parallel with the existing ones, if the rate is too fast, or alter the initial capacity if it is too slow. These capacitors must be good quality ones of reliable type and should be 1,000V wkg., except C_1, C_2 and C_3, which can be rated at 500V wkg.

Potentiometer P_1 controls the h.t. voltage to the neon and must be so adjusted that the neon ignites on every range of capacity, i.e. on every setting of S1. The output of this circuit is fed via S_2 to either the l.f. output socket (socket 1) or to the grid of the ECL80 via the gain control P_2. The ECL80 is a Mullard triode-pentode and is wired up as a triode l.f. amplifier fed into a pentode audio stage, which in turn feeds a 3½in to 5in speaker via an output transformer T_1. The type of neon is not critical, except that one without an internal resistance should be used. The metal rectifier MR_1 is a Brimar DRM2B and is obtainable complete with mounting bracket.

Construction

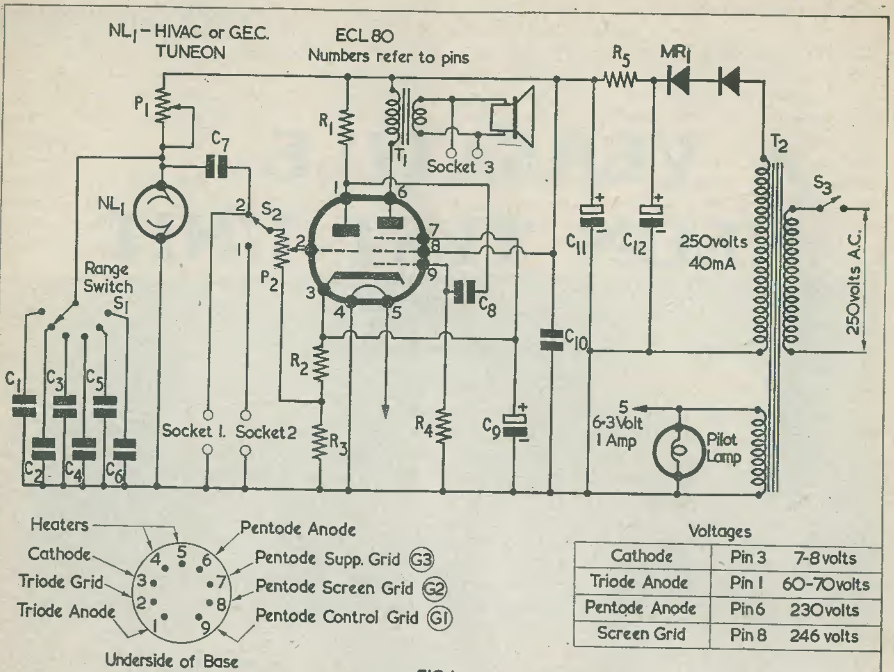
This follows normal practice and little comment on it is needed. The layout adopted depends on the case available in which to build the unit. A suitable "disposals" one can no doubt be obtained, although if a more professional looking job is desired, a small commercial cabinet can be used. Heater leads should be twisted and grid and anode leads kept as short as possible.

Testing

Check the wiring, and if in order connect the unit to a source of a.c. Switch on, when if all is well the neon should light up. It should flash at a speed depending on the setting of S_1. If the heater of the ECL80 glows, then all is well; and if S_2 is switched to position 1 and an earth lead is connected to the grid or gain control side of the socket, a loud hum should be heard in the speaker when P_2 is fully turned up. Should a hum be present without this, the wiring should be checked, the valve tested, or C_{11} or C_{12} may be open-circuited. On switching S_2 to position 2, there should be an audio noise in the speaker, either of a slow "put-put" nature or a high-pitched note, depending on the setting of P_1 and S_1. P_1 is adjusted so that a noise is heard on all settings of S_1.

Having got the unit working properly, we can investigate its uses which are varied and interesting. The various operations investigated by the writer are set out below.

Operation 1.—As already explained, the rate of charge and discharge of the neon depends on the setting of S_1. This gives six ranges which can be used for a variety of applications. The first three are intended for photography, i.e. mass printing, developing times, etc. The times of the ranges are as follows: Range 1 (C_1 in circuit), one flash and one "pip" in the speaker every 10 seconds; Range 2, the same every five seconds; Range 3, ditto every one second; Range 4, a frequency of approximately 400 cycles per



Voltages

Cathode	Pin 3	7-8 volts
Triode Anode	Pin 1	60-70 volts
Pentode Anode	Pin 6	230 volts
Screen Grid	Pin 8	246 volts

FIG. 1.
Unit shown set as Timer Unit – Range 2.

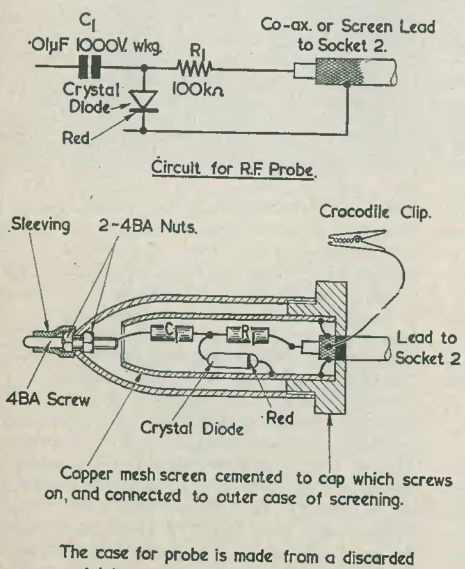


FIG. 2.
R.F. Probe.

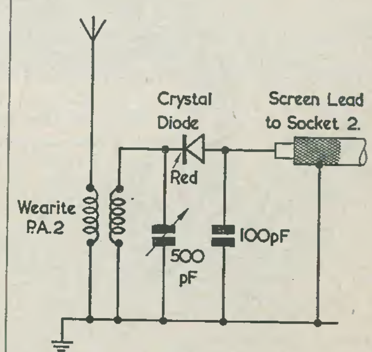


FIG. 3.
Medium Wave Local Station Tuner Unit.

M634

second; Range 5, approximately 1,000 cycles/second; Range 6, 2,500 cycles/second.

Operation 2.—With S_2 in position 1, the output can be taken from socket 1 via screened lead to the input of an amplifier or to the pick-up sockets of a radio receiver, in this way providing an oscillation suitable for testing the amplifier or receiver amplifier stages. The higher frequency ranges are obviously the most suitable for this purpose.

Operation 3.—The unit can be used as a straight audio amplifier by connecting a pick-up to socket 2. Pick-up repairs can be checked in this way and speaker testing can be carried out by substituting the speaker under test for the one in the unit.

Operation 4.—Finding a fault in a "dead" set can be a very tricky problem. The unit described can be used, with the addition of a "test-probe," constructed as shown, as a signal tracer. Either the local radio station signal or one from a signal generator may be used to feed the set under test. The probe should be connected to socket 2 and S_2 switched to position 1. If the probe is then applied to the signal grid of the set under test, the signal will be picked up and will become audible in the unit's speaker. The faulty section of the set under test can thus be traced out.

Operation 5.—By connecting one of the cheap, surplus, crystal microphones to socket 2, a "baby-watcher" can be set up or the activities of the juniors supervised when they are supposed to be in bed going to sleep!

Operation 6.—Used with the tuner unit shown, a local station reception unit can be set up. A good aerial and earth system are advisable and the combination will give resonable enough power for use as a handy bedside radio.

Final Remarks

The writer feels quite sure this little unit will appeal either in one way or another to readers who may also like to experiment with further applications. It could, for instance, be used as a Morse code practice oscillator, either for individual or class work.

Finally, will readers please note that when the unit is being used for testing a.c./d.c. sets with the possibility of a live chassis, the leads to either of the sockets S_1 or S_2 must be isolated by at least a 0.001µF 1,000-volt capacitor in each lead.

Components List

Condensers
- C_1 16µF 500V wkg
- C_2 8µF 500V wkg
- C_3 1.3µF 500V wkg (composed of 1µF plus 0.25µF plus 0.05µF in parallel)
- C_4 0.01µF 350V wkg
- C_5 0.005µF 350V wkg
- C_6 0.0025µF 350V wkg
- C_7 0.01µF 350V wkg
- C_8 0.01µF 350V wkg
- C_9 25µF 12V wkg
- C_{10} 0.1µF 350V wkg
- C_{11} 32µF 350V wkg
- C_{12} 32µF 350V wkg

Resistors
- R_1 220kΩ ½W
- R_2 200Ω ½W
- R_3 200Ω ½W
- R_4 500kΩ ½W
- R_5 1.5kΩ 1W
- P_1 2MΩ potentiometer
- P_2 1MΩ potentiometer

Switches
- S_1 Single-pole 6-way
- S_2 Single-pole 2-way
- S_3 Single-pole on/off

Transformers
- T_1 Speaker transformer to match ECL80
- T_2 Elstone or similar: 250V primary; 250V 40mA secondary; 6.3V 1A secondary

Miscellaneous
- 1 Neon lamp and holder
- 1 Pilot lamp and holder (*Both holders panel mounting*)
- 3 sockets
- 1 valve and Noval holder ECL80
- Wire, screws, etc.

Probe
- 1 case of discarded nasal inhaler
- 1 piece of wire mesh for screen
- 1 4BA bolt and 2 nuts and washers
- 1 crocodile clip
- 1 crystal diode
- 1 0.01µF miniature condenser
- 1 100kΩ resistor ½W

Tuner Unit
- 1 500pF variable condenser
- 1 100pF mica condenser
- 1 crystal diode
- 1 Wearite PA2 coil or similar for medium waves

Radio Miscellany

In the last two or three years I have often had an uneasy feeling that this column, or rather, its writer, has been in danger of "losing touch" or "going stale." Indeed, more than once I have suggested to the Editor that, good old soldier as it has been, it should be allowed to fade away. It was, after all, going before many of our younger readers were born, and many of the older readers no doubt ruefully think of the silver threads among the gold when they hark back to the days when they first knew it. Perhaps it is all due to a secret fear that, with my health playing me tricks, my old enthusiasm must be becoming attenuated. This month the old fervour must be low for once again I am a fellow-traveller of the Bedfast Club. I am assured it won't be for long, but I am *feeling* a great deal more ill than when the medicos took a much more serious view. Frankly, I think I am in need of an overhaul, rather than mere rest and re-charging. Maybe medical science is still on the wrong track. They keep on patching up the old parts instead of following the policy of all good radio servicemen and nipping out the old and failing parts and wiring in a few brand new components and a valve or two! What radio serviceman would dream of injecting a dose of new electrolyte into a failing capacitor or attempting to put a splint on a slipping line sync?

I suspect that most of this depression has been brought about by the dreariness of t.v. programmes. I dread switching the thing on except whenever there happens to be a "live" programme. Well-intentioned visitors ask "Shall I switch it on for you?" If only I had the strength I would find a savage delight in pushing their silly heads through the screen —at least as far as "entertainment" programmes are concerned.

What high hopes we had when "Independent" t.v. was promised. Instead, we find ourselves at the mercy of a carve-up by monopolies (one for the week-end, and one for the rest of the week) who hurl at us an incessant babble of bad films, sex, murders, violence and star-studded Spectaculars. And of all these evils the latter is the worst. I have seen more spontaneous fun and enjoyed heartier laughs from troupes of broken-down old-timers at third-rate seaside resorts. For this the promoters draw colossal profits—still without the threat of any competition. They seem to have found the perfect Fruit Machine. Follow the same old formula, however trashy, and win the Jack-Pot every night.

It is only at times when we have to sit back remote from it all that we begin to perceive things in their true perspective; and just at the moment I seem to see clearly what a Frankenstein t.v. has become. On top of this I read that a questionnaire answered by schoolchildren reveals that many of them admit to viewing for six or more hours a day. It leaves me wondering which is the greater menace to civilisation—Television or the H-Bomb?

Recommendation

Despite my misgivings that this column is slipping, the Editor has always insisted that it is still up to scratch and must go on. An even more decisive factor has been the number of friendly readers who, every month, not knowing of my doubts or poor health, write such kindly encouraging letters wishing more power to my elbow. Hence, creaking occasionally at the joints, we press on.

Judging from my mail quite a few readers got paper-backed copies of Robert Ford's *Captured in Tibet* following my February mention of it. They found it a very enlightening background to the recent heart-rending news of the Tibetan struggle to regain their liberty and the importance of the refugee Dalai Lama.

A few years ago in mentioning Reg Fox, a contemporary amateur operator of Ford in Tibet, I praised Hans Harrar's paper-back *Seven Years in Tibet*. Although this book makes only the briefest references to amateur radio, I thought it one of the most delightful books I have ever read. In fact, I was so disappointed to come to the end of it that I read it through a second time straightaway just in case there was anything I had missed, and enjoyed it equally well on the second reading. Strangely enough, I cannot recall a single reader at that time writing to say they found it equally impressive. Perhaps I only mentioned it and forgot to recommend it. If, like me, you are to be condemned to a spell of bedfastness in the foreseeable future put it right at the top of your reading list. It is guaranteed to transport you to another world for hours, and the magic doesn't wear off even when you have finished it.

How Much Extra?

Just lately this column must have appeared to go all Hi-Fi. At least that is the only thing to which I can attribute the recent spate in correspondence on reproducers which seems to really revolve on the problem "is that very expensive loudspeaker worth all that extra?"

In the literature produced for hi-fi fans one frequently sees speakers costing from seventy to eighty pounds. Actually, it has never ceased to be a source of amazement to me just how much the really keen quality merchant is prepared to spend on what he considers the latest and best. Because of this weakness a lot of so-called hi-fi stuff has found its way on the market at various times and been sold, apparently without difficulty, at inflated prices. There is today a similar tendency for the same thing to be happening with Stereo. Indeed, our friend, Jack Cooper in his article "Conversion of the 'Prodigy'" last month gives warning of it. However, it is the beginner's question, "What should one pay for a quality speaker?" that immediately concerns us.

Centre Tap talks about of items general interest

The models used by manufacturers of average quality family receivers can be bought for somewhere round the guinea upwards mark. Then we seem to jump to the seven to ten pounds class. Are they relatively all that better?

Although I have given this matter some thought, it is far from an easy question to answer. Yes, the speaker in the £7–£10 class is a great deal better than the guinea touch, although within its limitations the latter in a properly designed cabinet can be very good. Now the speaker in the £70–£80 price range is, of course, still better, but the difference between them is not so great as the difference between the cheapest and the £7–£10 models.

It seems when you get beyond the middle price range that the cost, even for slight improvement, rises very sharply. I am afraid the search for that little extra goes far beyond the range of my pocket, so I have to content myself with squeezing the utmost out of siting and baffle arrangements—and it's surprising what improvements can be obtained from a little patient experiment and a few records you really know.

Well Played!

Quite a few Classics Club Records enthusiasts have written commending my getting a true perspective in comparing these and the much more expensive standard recordings. The account of the direct trial of the sample I chose was apparently read with considerable interest, but those who have written say my selection was not truly representative. They offer a number of alternative titles which they feel worthy of being judged "side by side with the very best of the standard recordings." K.B. (Base Green, Sheffield 12) a hi-fi fan who has a wide range of records of various makes, and others, suggest that anyone who doubts to just what heights Classics Club Records can aspire should hear the recording by the London Philharmonic Orchestra playing Offenbach's "Gaité Parisienne." Other records warmly recommended by readers in this respect were Chopin's "Best Loved Works" and Rossini's "La Boutique Fantasque." I can see that during my convalescence I have some catching up to do!

Still on the subject of records reminds me that recently E.F.G. (Malvern) was good enough to send along a few recommendations in response to F.N.'s (Derby) appeal. In the accompanying letter he also included a few tips for the preservation of treasured and expensive records. It struck me that these hints might well prove useful to others. Surprisingly enough enthusiasts who go to no end of trouble over amplifier details, etc., often seem to fail to take the simplest precautions to see that the expensive records they buy are maintained in perfect condition. No amplifier or speaker system can put back what has been lost from the record itself.

Hence, he advises: Buy only guaranteed unplayed records. Remember microgroove records contain no abrasive and the main cause of wear to both record and sapphire is dust. Store in dust-proof cases at all times, and if in doubt clean the record itself with a specially prepared bad. The sapphire (or diamond) tip must be highly polished and spherical (one thou. radius), and must be changed as soon as appreciable flats develop. Weight at the needle point should not exceed 7 grammes.

Two inexpensive additions E.F.G. also recommends for F.N.'s consideration, which will no doubt be of interest to those similarly placed—the Goldring "Stylus Pressure Balance," 4s. 11d., and the Acos "Test Record," 17s. 6d.

Can Anyone Help?

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

Cossor type 343 Ganging Oscillator & Advance E.1 Signal Generator.—H. E. Livermore, 85 Edward Road, Christchurch, Hants., urgently requires instruction books and circuit diagrams. Any reasonable purchase price and expenses defrayed.

* * *

Scophony-Baird "Soundmaster" Mk. 1 Tape Recorder & Akkord-Radio "Bambi 55KM" Mains/Battery Radio.—C. H. Page, 60 Hillside Grove, Chelmsford, Essex, wishes to obtain any information on these. The recorder uses two 6SN7's and three 6V6's.

* * *

VCR97 Square Mask.—Can anyone advise a source of supply to R. Harwood, 32 Moorhey Road, Maghull, nr. Liverpool?

* * *

Short Wave Magazine, Sept. '58 & Jan. '59.—Wanted urgently, your price paid by G. Gallamore, Spring Grove, Loch Lane, Pantington, Urmston, Manchester. **FREE:** AVO tested Mullard AZ1, EBC3, 100%, ECH3 30%, EF9 25% output to anyone who cares to write for them.

* * *

Transmitter W7944 (7AM).—A. E. Harvey, 39 Curlieu Road, Oakdale, Poole, Dorset, urgently needs conversion details from present 85-95 Mc/s to 144 Mc/s, such as crystal frequency required, h.t. voltage, etc. All expenses gladly refunded. Makers, Eddystone, now unable to help.

* * *

Sobell type 615 Radio Receiver.—R. Hattersley, 141 Kinnaird Road, Sheffield 5., wishes to buy or borrow manual or service sheet. All expenses gladly refunded.

Mr. Hattersley has a number of service sheets, too numerous to list individually, which he is prepared to lend to readers for expenses only. Send S.A.E. quoting make and model required, please.

Murphy Radio B119 Receiver.—A. Hempstead, 38 Aycliffe Road, Borehamwood, Herts., wishes to obtain circuit and component list.

* * *

American Radio Magazines, "Radio," "CQ," "QST" and any books on short wave construction.—D. Bowers, 24 Home Park Road, Saltash, Cornwall, urgently needs books of this type.

* * *

CR.100 Communications Receiver.—The circuit and/or any other data is urgently needed by F. Reed, 353 Soundwells Road, Kingswood, Bristol 5

* * *

TR.1196 Transmitter/Receiver Unit.—D. A. Fathers, 16 Connaught Avenue, Kidderminster, Worcs., needs the manual and/or circuit diagram, on sale or loan—expenses gladly paid.

* * *

TR.1143 Receiver.—P. Holmes, St. Joseph's College, Birkfield, Ipswich, Suffolk, enquires if anyone can supply information on converting this to a v.h.f. receiver.

* * *

78 A.M. Receiver.—W. Rogers, 231 Bridgnorth Road, Wollaston, Stourbridge, Worcs., needs the circuit or other data. Any circuits paid for or returned at owner's request.

* * *

B.C.624.C (100-156 Mc/s) and 1392 (95-155 Mc/s) Receivers.—G. Clark, 49 Williton Road, Luton, Beds, wishes to buy the circuit diagrams and manuals for these receivers.

* * *

Amplifier Unit type 165, Ref. No. 1OU/14108.—D. J. Stern, 59 Southover, Woodside Park, London N.12, wishes to beg, borrow or buy a copy of the circuit and any other data. He would also like to know where to obtain the valves CK505AX and CK507AX. Expenses paid.

resistance/capacitance SUBSTITUTION UNIT

By M. A. HAMMOND

Conclusion

For the benefit of those not conversant with preferred resistor values, the table given here shows the nominal values obtainable in each of the three tolerance ranges ±20%, ±10% and ±5%.

STANDARD VALUES

Tolerance ±20%	Tolerance ±10%		Tolerance ±5%			
Resistance ohms	Resistance ohms	Resistance ohms	Resistance ohms	Resistance ohms	Resistance ohms	Resistance ohms
10	10	12,000	10	360	12,000	430,000
15	12	15,000	11	390	13,000	470,000
22	15	18,000	12	430	15,000	510,000
33	18	22,000	13	470	16,000	560,000
47	22	27,000	15	510	18,000	620,000
68	27	33,000	16	560	20,000	680,000
100	33	39,000	18	620	22,000	750,000
150	39	47,000	20	680	24,000	820,000
220	47	56,000	22	750	27,000	910,000
330	56	68,000	24	820	30,000	1.0 meg
470	68	82,000	27	910	33,000	1.1 meg
680	82	100,000	30	1,000	36,000	1.2 meg
1,000	100	120,000	33	1,100	39,000	1.3 meg
1,500	120	150,000	36	1,200	43,000	1.5 meg
2,200	150	180,000	39	1,300	47,000	1.6 meg
3,300	180	220,000	43	1,500	51,000	1.8 meg
4,700	220	270,000	47	1,600	56,000	2.0 meg
6,800	270	330,000	51	1,800	62,000	2.2 meg
10,000	330	390,000	56	2,000	68,000	2.4 meg
15,000	390	470,000	62	2,200	75,000	2.7 meg
22,000	470	560,000	68	2,400	82,000	3.0 meg
33,000	560	680,000	75	2,700	91,000	3.3 meg
47,000	680	820,000	82	3,000	100,000	3.6 meg
68,000	820	1.0 meg	91	3,300	110,000	3.9 meg
100,000	1,000	1.2 meg	100	3,600	120,000	4.3 meg
150,000	1,200	1.5 meg	110	3,900	130,000	4.7 meg
220,000	1,500	1.8 meg	120	4,300	150,000	5.1 meg
330,000	1,800	2.2 meg	130	4,700	160,000	5.6 meg
470,000	2,200	2.7 meg	150	5,100	180,000	6.2 meg
680,000	2,700	3.3 meg	160	5,600	200,000	6.8 meg
1.0 meg	3,300	3.9 meg	180	6,200	220,000	7.5 meg
1.5 meg	3,900	4.7 meg	200	6,800	240,000	8.2 meg
2.2 meg	4,700	5.6 meg	220	7,500	270,000	9.1 meg
3.3 meg	5,600	6.8 meg	240	8,200	300,000	10.0 meg
4.7 meg	6,800	8.2 meg	270	9,100	330,000	11.0 meg
6.8 meg	8,200	10.0 meg	300	10,000	360,000	12.0 meg
10.0 meg	10,000	12.0 meg	330	11,000	390,000	
12.0 meg						

A BAND I TELEVISION PRE-AMPLIFIER

By R. PRESTYN

This article describes the construction of a Band I version of the popular Hi-Gain Band III Television Pre-Amplifier which was featured in the March 1958 issue of this magazine

The Hi-Gain Band III Television Pre-amplifier[1] has proved to be a most successful and popular item of equipment. Quite a number of Hi-Gain Pre-Amplifiers have been constructed and performance reports appear to have been consistently good.

An interesting fact which has become evident since publication of constructional details on this unit is that, whilst demand for Band III pre-amplifiers is understandably high, there is also quite a large interest in pre-amplifiers covering Band I only. The pre-amplifier which is the subject of this contribution[2] is intended to satisfy such an interest.

Basic Design

The basic design of the Band I pre-amplifier described in this article is similar to that of the original Hi-Gain Band III model. There are only small differences in layout and, as with the Hi-Gain unit, the pre-amplifier is built on a modified Teletron converter chassis. The power unit circuitry used in the Hi-Gain is retained, although a smaller value electrolytic condenser is now recommended. Also, the rectifier is fitted at a different part of the chassis. As in the previous model, isolation of the pre-amplifier chassis from the mains supply is provided. Due to the lower signal frequencies now handled, layout details do not require quite as close attention as was necessary with the Band III version. Virtually the same low-noise input circuit is retained, but both input and output coils are now mounted above the chassis, instead of one above and one below.

As a result of the proportionately higher frequency range needed for Band I coverage, it has been found necessary to augment the tuning range offered by the output coil's iron dust core by connecting a 25pF trimmer across the tuned winding. A peaking choke is retained for the Band I unit, but it does not resonate in the centre of the band of frequencies covered, as occurred with the Hi-Gain model. In this pre-amplifier the peaking choke resonates at a frequency somewhat higher than Channel 5. Despite this the choke still serves a useful function, and it provides in practice a significant degree of enhanced gain, even on Channel 1.

The Circuit

The circuit of the pre-amplifier is given in Fig. 1. As will be seen, it employs a double-triode cascode valve, type ECC84, and a metal h.t. rectifier in the power supply section. The rectifier is of the miniature contact-cooled type.

The aerial input is applied direct to the coupling winding L_1. This couples to winding L_2, which is tuned by C_1 and the capacity offered by the valve input circuit. In this input circuit C_2 and C_3 provide neutralising for the C_{ag} of $V_{1(a)}$, the values of these two condensers being such as to ensure that good overall performance, both from the point of view of stability and of noise, is obtained. $V_{1(a)}$ is biased by the 100 ohm resistor, R_2, in its cathode circuit, the grid being returned to chassis via R_1. The 100 ohm cathode bias resistor enables a standing current of some 14mA to be passed by the ECC84, this being comfortably within the maximum value specified by the manufacturer.

[1] Designed by Derek Winters.
[2] Based on a design by Radio Component Specialists.

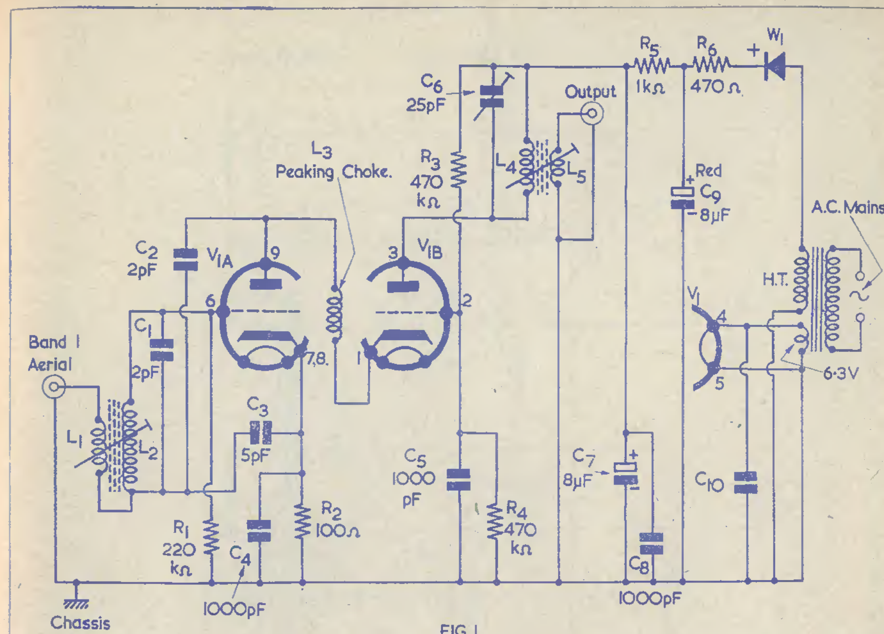


FIG. 1.
The Circuit of the Band I Pre-Amplifier.

Component List

Resistors
- R_1 220kΩ $\frac{1}{4}$W
- R_2 100Ω $\frac{1}{4}$W
- R_3, R_4 470kΩ $\frac{1}{4}$W
- R_5 1kΩ $\frac{1}{2}$W
- R_6 470Ω $\frac{1}{2}$W

Condensers
- C_1, C_2 2pF, ceramic
- C_3 5pF, ceramic
- C_4, C_5 1,000pF, ceramic
- C_6 25pF trimmer, ceramic base, air dielectric
- C_7, C_9 8+8μF, 275V d.c. wkg. electrolytic
- C_8, C_{10} 1,000pF, ceramic

Rectifier

Miniature contact-cooled. 250V, 30mA (or greater), mounting centres $\frac{13}{16}$in (see text).

Mains Transformer

Input 230V. H.T. Sec. 200V 30mA. L.T. Sec. 6.3V 0.6A. Mounting centres $2\frac{1}{2}$in.

Coils
- L_1, L_2 Input coil (Band I Pre-Amplifier)
- L_3 Peaking choke (Band I Pre-Amplifier)
- L_4, L_5 Output coil (Band I Pre-Amplifier)

All coils are available from Croydon Transformers, Bensham Manor Road Passage, Thornton Heath; or from Radio Component Specialists.

Chassis

Teletron Converter, chassis, modified.

Miscellaneous
- 2 coaxial sockets. Belling-Lee type L.604/S or equivalent
- 1 B9A valveholder, ceramic
- 1 2-way tagstrip
- Mains lead
- Wire, sleeving, etc., etc.

The anode of $V_{1(a)}$ couples, via the peaking choke, to the cathode of $V_{1(b)}$. $V_{1(b)}$ provides the grounded-grid section of the cascode amplifier, the grid being decoupled to chassis via the 1,000pF condenser C_5. The fixed potential divider R_3, R_4 allows the grounded grid to receive the requisite h.t. potential.

The anode of $V_{1(b)}$ feeds directly into the tuned winding, L_4, of the output coil. As was mentioned above, this coil is tuned by trimmer C_6 in order to extend the range offered by its dust core. The coupling winding L_5 provides an output at 75 ohms impedance, and is intended to be coupled to

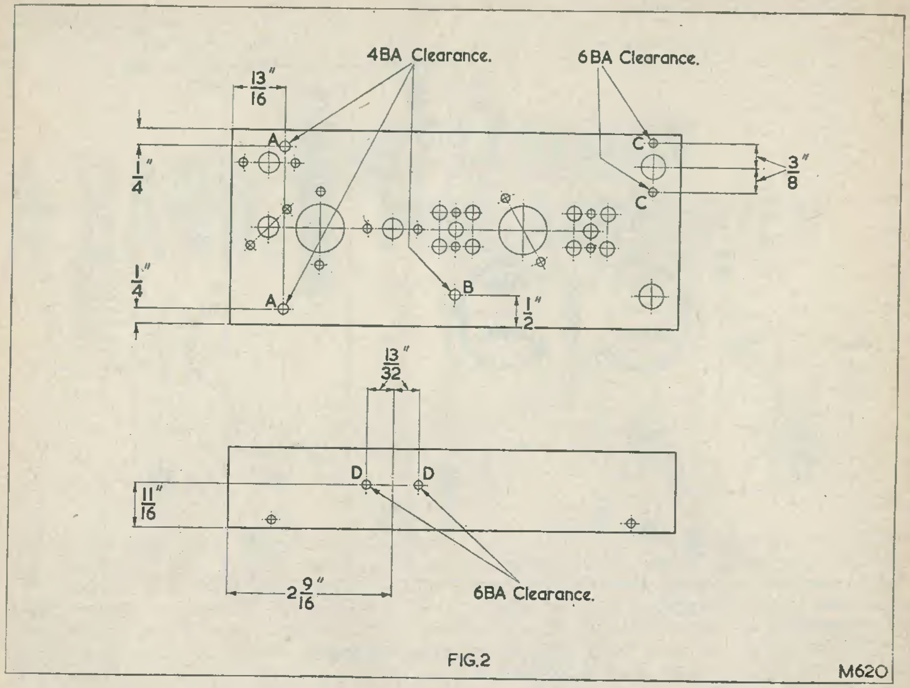


Fig. 2. This diagram, giving top and side views, shows details of the extra holes needed in the Teletron converter chassis

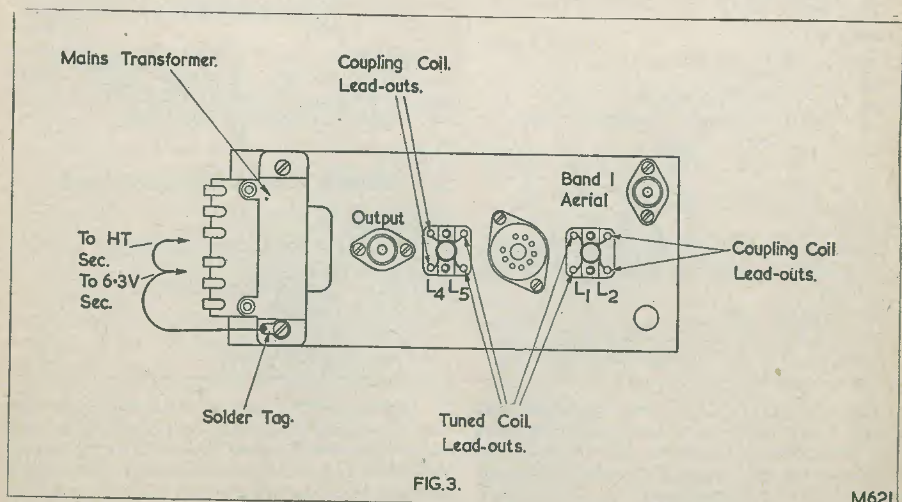


Fig. 3. The manner in which components above the chassis are mounted

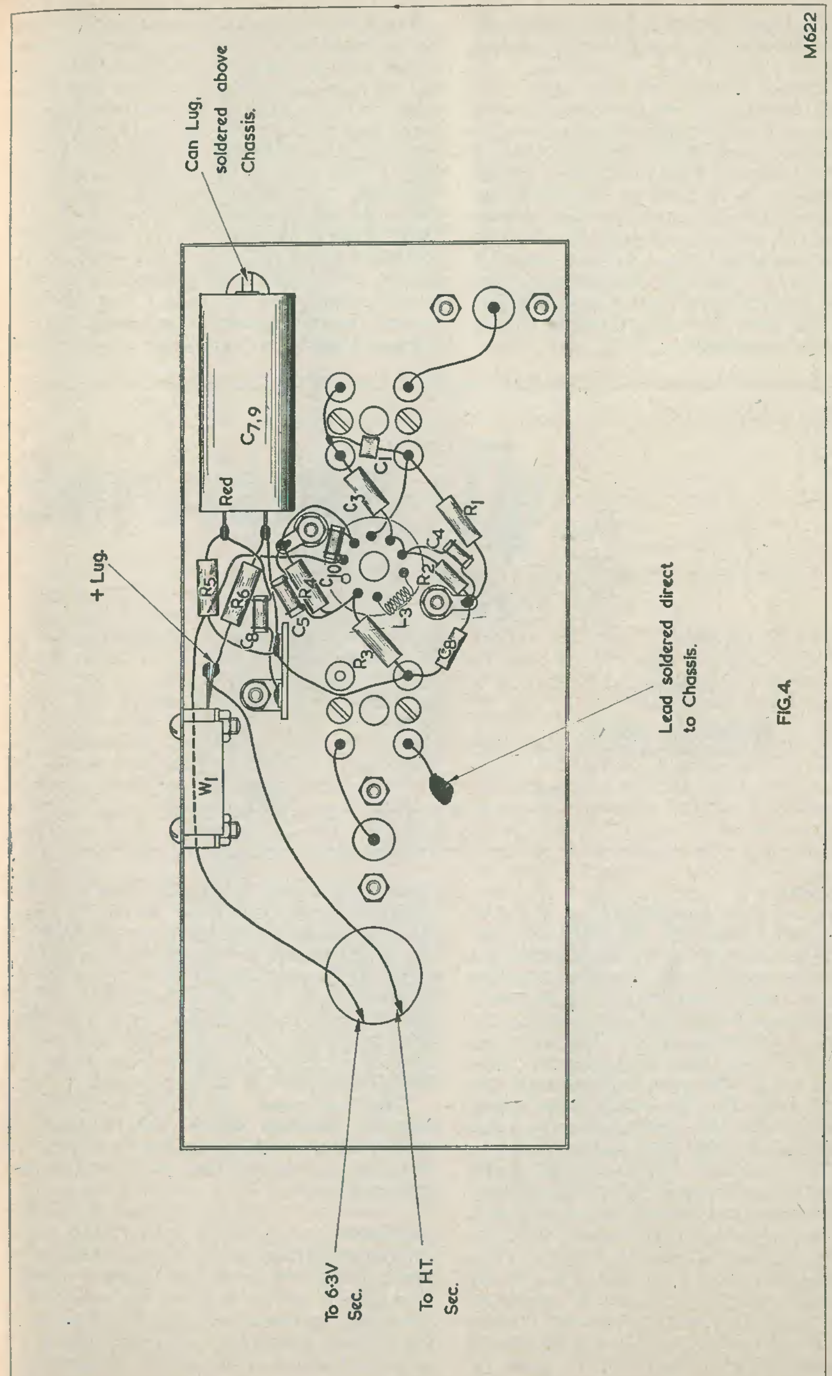


Fig. 4. Layout below the chassis. This diagram illustrates all the below-chassis components, with the exception of C_2 and C_6

the aerial input socket of the associated television receiver by coaxial cable of this impedance.

The mains transformer for the pre-amplifier consists of a "converter" type having a 6.3 volt heater winding and a single-phase h.t. secondary winding providing 200 volts at 30mA. The voltage given by the h.t. secondary is rectified by the miniature contact-cooled component, W_1, this connecting, via the limiter resistor, R_6, to the reservoir condenser C_9. R_5 and C_7 then smooth the d.c. voltage appearing across C_9. The 1,000pF condenser C_8 ensures that the h.t. line has a low impedance to chassis at Band I frequencies.

The coils, valveholder, coaxial sockets, and mains transformer are now fitted. These should take up the positions illustrated in the top view given in Fig. 3. Care should be taken to fit the coils such that their lead-out wires pass through the correct chassis holes. Fig. 3 clearly indicates the positions of the lead-out wires from the coupling and tuned windings. (The coupling windings are above the tuned windings on the formers and have fewer turns.) Attention should also be paid to ensuring that the valve socket is fitted with correct orientation. Fig. 3 illustrates how the chassis connection to the 6.3 volt and h.t. secondaries of the mains transformer is made. Fig. 4 gives an underside view of the chassis and shows the layout of most of the remaining components. It should be noted that the can of the electrolytic condenser C_7, C_9 is connected to chassis by passing its earth lug through the ⅜in hole in the corner of the chassis. The lug is then bent over and soldered above the chassis. It will be seen that the earthy end of coupling winding L_5 is soldered direct to chassis, no solder tag being employed for this connection.

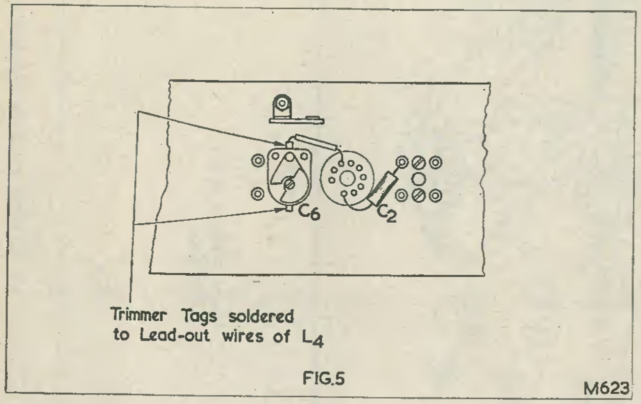


Fig. 5. Final steps in wiring the pre-amplifier

Construction

In order to construct the unit, it is first of all necessary to modify the Teletron converter chassis in order to enable it to take the components needed for the pre-amplifier circuit. All that is required is the provision of several new holes; and the positions of these are illustrated in Fig. 2. The two holes marked "A" in this diagram are 4BA clearance and are intended to take the mounting bolts for the mains transformer. Hole "B" is also 4BA clearance, and it takes the mounting bolt for the two-way tag strip. Holes "C" are 6BA clearance, and correspond with the mounting holes on a Belling-Lee 75 ohm coaxial socket. Holes "D" are, again, 6BA clearance and are employed for mounting the contact-cooled rectifier. If a rectifier other than that selected for the prototype is employed, it may be necessary to provide different spacing between the two holes "D." In this event the rectifier should still be mounted such that its centre lies on the centre line between these two holes.

The final stage in wiring is shown in Fig. 5. Trimmer C_6, in this diagram, is supported on the lead-out wires from winding L_4 and takes up the position illustrated.

Alignment

After construction has been completed the pre-amplifier needs to be aligned to the channel on which it is to be used. The television receiver should first of all be set to the channel concerned, and, with the aerial connected direct to its socket, adjusted for optimum signal level. The aerial should then be removed from the receiver socket and fitted to the input socket of the pre-amplifier. The output socket of the pre-amplifier is next connected to the input socket of the television receiver via 75 ohm coaxial cable.

The next process consists of adjusting the tuned circuits of the pre-amplifier for maximum signal in the receiver. The input coil L_2 is set up by adjusting its core only. In the case of L_4, however, it is necessary to adjust both C_6 and the core for the combination which offers optimum signal strength.

It is advisable, when setting up the pre-amplifier, to judge results by observing the reproduced picture only, rather than by attempting to simultaneously assess results on both picture and sound. In receivers employing vision a.g.c. it may be found difficult to obtain optimum alignment settings which are obviously correct owing to the "flattening" effect given by the a.g.c. circuits. With some receivers employing a.g.c. this trouble may be overcome by temporarily reducing sensitivity with the aid of the contrast or sensitivity controls, so that the effect of pre-amplifier tuning adjustments may become more marked. An alternative scheme consists of setting the pre-amplifier tuning cores mid-way between the settings which cause obvious picture degradation.

MISCELLANEOUS

Servicing Tip

By J. A. CUSDIN

Doubtless many amateurs have a fine collection of mains transformers of pre-war origin which they hate parting with, "just in case they should be useful one day," but which are never used because of the voltage of the heater windings, namely 4V for the rectifier and another 4V (possibly centre-tapped) for the receiver valves.

It is possible to change the rectifier winding to 5V or 6.3V and the other winding to 6.3V in order to use the transformer to supply the present preferred valves.

This is quite simply done in either of two possible ways. One is to add extra turns as necessary to both windings to obtain the desired voltages, these extra turns being wound outside the existing windings in the small gap which is usually present between the outer insulation and the laminations. The other way is to wind the extra turns outside the laminations in those cases when there is no gap.

These extra windings are then connected in series with their respective original windings with due attention being paid to connecting them in phase so that the output voltage is increased and not decreased. No harm will be done if they are connected out of phase at first, as an a.c. voltage check will soon indicate if the connections need to be reversed.

The exact number of extra turns required is found as follows: Wind outside the laminations a convenient number of turns, such as 20 or 30, and measure the output voltage accurately. Then divide the number of turns by the volts to obtain the figure of "turns per volt," which can now be multiplied by the extra voltage required to give the number of turns needed in the additional winding. E.g. 30 turns gives an output of 7.5V, hence "turns per volt" is 4; so to convert a 4V winding into a 6.3V winding needs an extra 2.3V at 4 t.p.v., giving 4 x 2.3 turns, i.e. 9.2 turns to be wound on and connected in series with the existing 4V winding. Since the voltage measurements will have been "off-load" it is fairly safe to increase the number of turns so found by 10% to allow for the slight voltage drop which will occur on load, so that in the example above 10 turns would be added.

Although mains transformers are nearly all wound with enamelled copper wire, it is not recommended for these extra windings due to the risk of scraping off the enamel during winding. It is better to use a d.s.c. or d.c.c. enamelled wire of suitable current carrying capacity, or 2 amp or 5 amp single flex with an insulation which will not melt if it runs slightly warm.

Needless to add, these extra windings are wound the same way as the existing windings and not at right-angles to them.

The foregoing system has been used with every success on an a.c. mains model television set as a means of boosting the tube heater voltage when the cathode emission started falling about nine months ago, thus avoiding the expenses of a separate boost-transformer.

Technical Forum

The Printed Circuit

Some readers may have encountered or even joined in the controversy which at present exists between the radio and television receiver manufacturers on the one hand, and the servicing industry on the other, over the use of printed circuits. Whilst their use in small three or four valve radio sets which use relatively simple wiring presented no very great difficulty, the compact and fairly complicated television receiver is a rather different matter. Here there are about sixteen valves located over three or four separate panels with interconnecting leads. These printed panels have a neat appearance and are usually situated in a position which permits ready access to most or all of the components. Why then all this argument; what exactly are the advantages and disadvantages of this relatively new form of wiring?

First, let us start with the advantages which it must be admitted are largely on the side of the receiver manufacturer, but nevertheless there are some in favour of the service engineer.

Automation

Production engineers have for a great many years thought over the problems of automation applied in some degree to their particular factory unit. Sometimes small jobs could be automated; perhaps relieving the operator of a tedious task, or perhaps the aim was to reduce some tolerance thereby making the final product more consistent in either size or performance. Steps such as these were often small and rather tentative, but fundamentally they were all aimed at enabling the factory to make a better product at a lower price. The ultimate goal which production engineers would often have in mind was a single machine into which the raw material could be fed at one end and the finished product appear at the other. The television receiver production line has attracted quite a lot of attention along these lines, as the work consists mainly of assembling a large number of small components in a given order. But how could a machine, no matter how complex, connect up and solder so many resistors, capacitors and inductors involving the cutting and bending of leads and the making of inter-connections.

When the idea of printing the wiring on an insulating board was first suggested, it seemed that at least the fully automated production unit was in sight. The individual components could be fed down separate channels, have their leads cut and formed to the required shape and then be automatically inserted into the holes in the printed circuit panel. Soldering would then be simply a matter of allowing the panel to float on a bath of molten solder for a second or two and the job would be completed. Machines which perform all these tasks have in fact been made, but they are still far from being the accepted method of assembling receivers. This may seem a little surprising in view of all the development work which has been applied to this form of automation and the success which has been achieved, but there are two reasons. Firstly, the machines are tremendously expensive, and on all except the very largest production units the original hand assembly method is cheaper. Secondly, the machine is inflexible as it has to be designed to make one particular receiver when it is fed with a closely specified series of components. Should one of these components not be available it is usually a very difficult matter to substitute a similar one which perhaps differs in some minor mechanical detail. Also, should the circuit of the receiver require some small modification such as may be called for from time to time, the assembly machine will have to undergo expensive changes which may take weeks to complete.

Thus the universal adoption of the fully automated receiver assembly line is still something for the future, but printed circuits were accepted as a major step in that direction and there are few manufacturers today who do not employ them. Their advantages in receiver production are cheapness arising from reduced assembly time, consistency, easier soldering inspection and the elimination of wiring faults.

Servicing

The advantages of the printed circuit to the manufacturer have been shown to be most important and the majority of the disadvantages have now been overcome. However, the service engineer would be very likely to see his position as being just the opposite; he may consider the printed circuit flimsy and easily damaged, difficult to trace out connections and more trouble when making measurements of current. However, as there seems every possibility that this form of wiring is here to stay, a few notes on the general method of handling may be useful.

Soldering

The use of a too large soldering iron on a printed panel must be avoided at all cost. Use a small pencil bit iron, preferably of the low voltage type, and do not keep it on the board longer than is essential. Should it be necessary to replace a condenser or resistor on a particularly fragile part of the board it may be prudent to first clip the leads of old components as close to its body as possible, and then solder the replacement on to the original leads, thus avoiding any soldering work on the panel itself (Fig. 1). Generally, this will be unnecessary, as it will be possible to completely remove the defective component by applying the soldering iron to the joint and straightening the lead where it has been bent flush with the panel. One side of the component can then be extracted. Whilst the soldier is still molten tap the panel on the bench to shake away the surplus solder and leave the hole in the wiring open to take the new lead.

The removal of components having more than two leads, such as i.f. transformers and valveholders, can be troublesome unless tackled carefully. Use a clean iron from which any surplus solder has been removed and pull the solder away from each joint in turn, shaking the excess from the iron from time to time. If any solder refuses to come away it can be shaken out by tapping the panel on the bench whilst the solder is still molten. When each joint has been loosened make sure that there are no bent-over tags still retaining the component, and then ease it free. Note that when changing resistors which dissipate more than 0.5 watts it is usual to mount them about $\frac{1}{4}$in away from the board to prevent it being damaged by heat. Also, of course, the body of the resistor must not be allowed to touch adjacent components, particularly if these should be waxed paper capacitors.

With certain types of printed circuit it is possible for the solder clad copper conductors to break, due perhaps to excessive bending of the paxolin caseboard. If the break occurs in a part of the circuit carrying h.t. current the fault can often be located by the tell-tale line of tiny sparks visible in the dark across the fracture. In other parts of the circuit the trouble must be located by the usual fault-finding procedure. Having found the break it should be repaired by soldering a jumper wire across it.

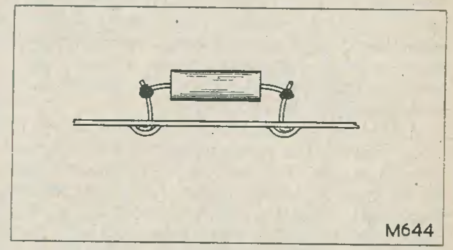


Fig. 1. A replacement capacitor soldered to the leads of the original component

After carrying out a repair on a panel it should be very carefully inspected for stray solder which can bridge the gap between adjacent leads and cause "shorts." It is obviously desirable to remove as few components as possible when fault tracing in a printed circuit, so wherever possible current measurements should be made in terms of a voltage reading. For example, instead of disconnecting one end of a resistor to insert the milliammeter in circuit to take a current reading, simply leave the resistor in place and measure the voltage across it with a high resistance meter. The current is then calculated by Ohms Law. Providing the resistance of the meter is greater than ten times the value of the resistor, a reasonably accurate measurement of current will be made.

Finally, it is good to note that one of the largest t.v. receiver manufacturers reports that since introducing circuit printing the fault tracers have actually reduced the time which they spend on each receiver. This is in spite of the initial complaints and delay whilst the new handling techniques were being learnt.

Using R.F. Feedback

by T.R.F.

IN THE EARLY DAYS OF RADIO, R.F. FEEDBACK or regeneration was vital for the "satisfactory" reception of any station. Its use lessened with the advent of the superhet and better quality valves, and finally almost disappeared, partly because "reaction"—to give its early name—results in a peaky and assymetrical response curve if pushed too near the point of instability.

Actually, if a reasonable amount of feedback is used, the performance of the simpler t.r.f. receivers, frequently built as second sets or as bedside models, can be substantially improved, especially those using air-cored coils (which usually have a low Q) or using very short aerials. The effect on the quality is not discernible, it being understood, of course, that no one expects "high-fi" from a 2½in or 5in speaker fed from a single-ended amplifier with no negative feedback, etc.

There have been designs for t.r.f. receivers published recently using r.f. feedback, but these require special circuits and are not immediately applicable to existing designs. The following method can be applied to almost any receiver with little trouble, expense or difficulty.

Part of the circuit of a standard t.r.f. receiver is given in Fig. 1, with in Fig. 2 the additions for Medium Wave feedback only, and in Fig. 3 the modifications for both Long and Medium waves. The author's experience is that LW feedback is unnecessary in the London area, but since conditions differ in other parts of the country, the LW circuit is given.

The only real modification is the addition of a wafer to the wavechange switch, and this is usually a simple job, although details depend on each model. If a change of switch is considered advisable, the Walters Type BT or the Bulgin miniature rotary is ideal.

The direction of the winding of L_1 with reference to L_2 must be correct, and this is best checked by trial and error, since under the wax covering it is often difficult to trace the various leads. In fact, L_1 and L_2 should appear to be wound as one coil, as far as direction is concerned, bearing in mind that the bottom of L_1 and of L_2 are connected (via decoupling) as far as a.c. is concerned.

Reference Fig. 2, for MW, TR_1 is set to minimum value and the receiver alignment checked accurately (at the h.f. end by the gang trimmers and at the l.f. end by the tuning slugs, if fitted). Then tune in a station at as high a frequency as possible and screw in TR_1 until the receiver becomes unstable. Reduce TR_1 to obtain stability, and screw out slightly more to ensure that the circuit is not on the edge. Tune in the loudest station at the h.f. end (usually the B.B.C. Light Programme) and ensure that the receiver remains stable. A good check at this point is to compare the position (and thus the value) of TR_1 to cause oscillation, with that originally found for the first case, which was for a higher frequency signal. Whichever value is least, this setting of TR_1 should be used, but reduced slightly more to ensure that any changes due to ageing, temperature or wire movements, etc., will not cause the receiver to become an oscillator.

The more correct method of setting up is to use a signal generator feeding the aerial socket, and, with a large input signal, search the whole of the band to find the frequency at which the setting of TR_1 is the lowest value to cause instability. At this frequency, reduce TR_1 until the set is just stable, measure the overall sensitivity, and then reduce the value of TR_1 to decrease this by approx. 3dB. It must be understood that this suggested reduction is a guess, and a far more effective method is to measure the sensitivity at the above frequency, with TR_1 set just to give stability, and then to take the figure again with TR_1 disconnected (i.e. no feedback). Take a mean of the two sensitivity figures, reconnect TR_1 and adjust this to give the new figure. At this setting the receiver should always be stable; but stable, higher sensitivity is perfectly possible and can be found by experiment.

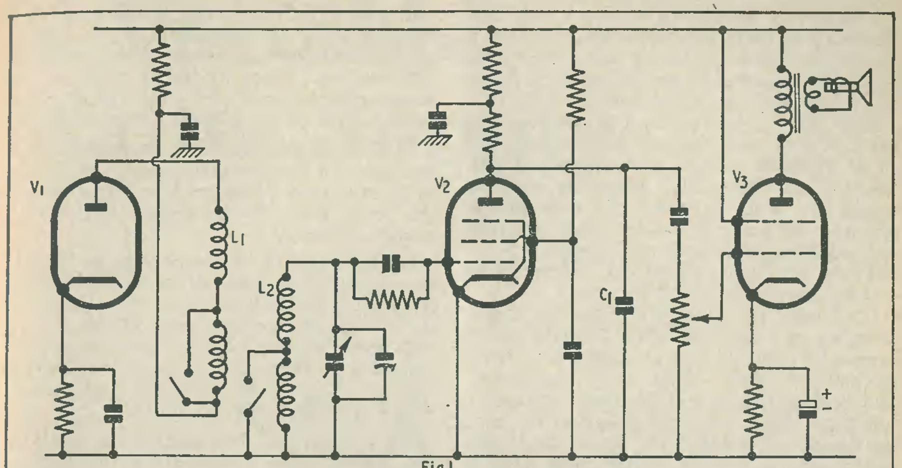


Fig.1
TRF Circuit (switches in LW position)

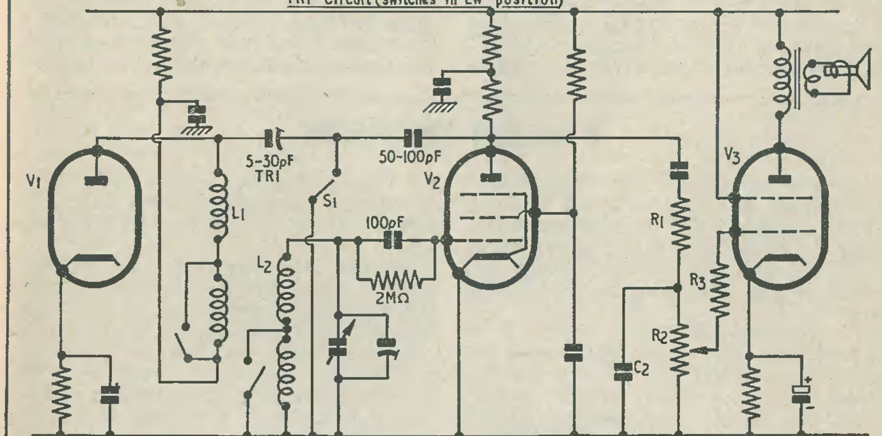


Fig.2
Medium wave regeneration only (switches in LW position)

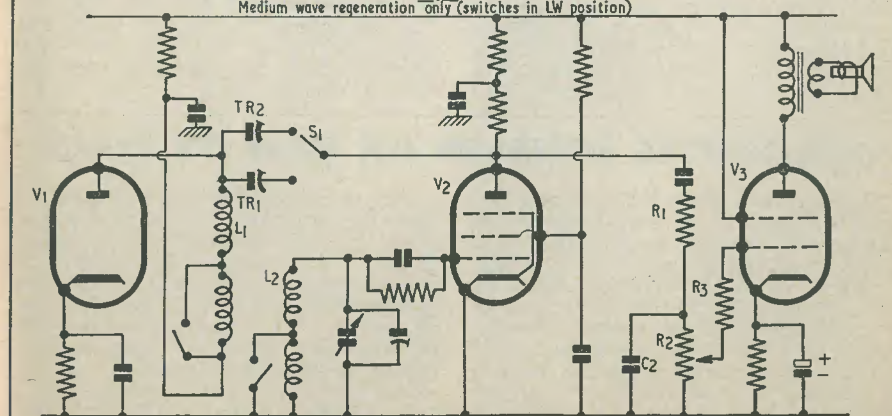


Fig.3
Long & medium wave (switches in LW position)

The circuit should be checked over the band with an aerial connected, and preferably allowed to operate inside its case for an hour or so, to ensure that no temperature drifts will affect stability, before locking TR_1.

With Fig. 2, no feedback is used on the Long Waves, and the switch S_1 shorts the r.f. at V_2 anode to earth and shunts the LW primary coil with TR_1, where its effect is negligible. Fig. 3 shows the connections required for Long Wave feedback, and the method of adjustment is as for MW.

There are four points to watch when making the above circuit changes:

(1) Since L_1 is perhaps designed as an r.f. coupling coil and not for r.f. feedback, it cannot be assumed that all coils will operate perfectly. Types using low impedance, switched, primaries will be found eminently suitable. High impedance coils may be more troublesome, giving too much feedback, which can be reduced either by putting a small capacitor (say 5 or 10pF) in series with the trimmer or by leaving C_1 in Fig. 1 in circuit, but reducing its value to, say, 20pF. The former method is preferable. In connection with C_1 in Fig. 1, this component has a dual purpose, i.e. bypassing r.f. to ground and a.f. top cutting to remove hiss and sideband splash. Since the latter effect is still necessary, the value of C_2 in Figs. 2 and 3 can be adjusted accordingly (see note 3).

(2) Decoupling in the detector anode circuit is not essential, but modern practice is to fit this since it reduces hum from the h.t. line to V_3 grid. A grid-stopper (R_3) for V_3 is also advisable.

(3) Addition of r.f. decoupling to V_3 grid is required (Figs. 2 and 3) since the r.f. shunt (C_1 in Fig. 1) has been removed. Values for R_1 of 10% of R_2 and approx. 100pF for C_2 will filter out the r.f. and cause negligible loss of a.f. From the point of view of a.f. top cut, C_2 may be increased as required; 300pF is a suggested top figure.

(4) It must be remembered that leads to the wave-change switch from the various coils and V_2 anode can, if too close together, cause feedback which is not controlled by the trimmers, and may give spurious results. The remedy is obvious and not very difficult.

TRADE REVIEW

We have received for review from Messrs. **R. Fagelston**, 46 Hardwick Road, London, N.13, a sample "Alfa" Multi-Range Meter model TS.58, which they are marketing at £6 19s. 6d., including batteries, postage and packing 2s. (Trade distributors: Sam Mozer Ltd.).

This instrument, with a resistance of 3333Ω/V, has two resistance ranges of 0–20kΩ and 0–2MΩ, five a.c. and five d.c. voltage ranges of 0–6V, 0–12V, 0–60V, 0–300V and 0–1200V, and three d.c. current ranges of 0–300μA, 0–30mA and 0–300mA. Any of these ranges may be selected by means of a 15-position rotary switch. In addition, there is provided a third test-prod socket by means of which a.c. voltages can be read in circuits containing a d.c. component. Two dB ranges, −20 to +23dB and +20 to +37dB are also marked on the scale, which on the outer arc (ohms) has a length of some 2⅝in.

On test the meter performed creditably when compared with an Avo Model 8, which has a much higher resistance of 20,000Ω/V. The pointer is well damped, and comes to rest immediately. Readings on the current and voltage ranges—the latter from low impedance supply sources—were in all cases practically identical. The largest discrepancy occurred on resistance readings, but here the greatest error was only 5%.

In our opinion the "Alfa", which is of Belgian origin and is housed in a very attractive plastic case, represents very good value for money.

GUARANTEE DOUBLED ON NEW TV TUBES

Siemens Edison Swan Ltd. announce that from 1st June, 1959, all new Ediswan Mazda cathode ray tubes will be covered by a 12 months guarantee instead of the 6 months guarantee which has previously operated. The company states: "Since the purchase tax on cathode ray tubes was removed at the last Budget there has been a five-fold increase in the demand for new tubes, and the company is confident that this extended guarantee period will further increase the sales of new tubes as against repaired tubes."

Siemens Edison Swan Ltd. emphasise that under this new scheme they must have every guarantee card registered when a tube is installed and the card must be returned when a faulty tube is sent back under the guarantee. New guarantee cards will be issued as soon as possible. In the meantime any tube registered after 1st June will automatically be guaranteed for a full 12 months.

This announcement means, of course, that the guarantee on cathode ray tube now lines up with the TV setmaker's guarantee.

A Variable Mains Supply

An aid to rapid servicing

By G. W. JENKINS

As is well known, the pressure of the mains supply in this country varies from 100 volts to 250 volts according to locality. This may be either alternating current or direct current, but in this particular instance only alternating current is envisaged. In the London area it often happens that there are no less than three different potentials available in one small borough! The manufacturers of all but the cheapest equipment do their best to ensure that their products are operated at the correct voltage by providing taps on the primary of the mains transformer in the case of a.c. equipment and tapped ballast resistors in the case of universal equipment.

Many constructors carry out repairs for their friends, and others are professional servicemen. These types find that people bring along all sorts of gear to be repaired and that much of it is adjusted for a different mains voltage from that of the workshop. While in most cases it is a relatively simple matter to adjust the mains tap, it is just as easy to forget to put it back in its original place after the repair has been carried out. This can lead to at least blown fuses when the equipment is operated once more at its usual place of abode. An even more important aspect of altering the tap is that the result may mask or cure the fault on the defective apparatus, especially if it is of the a.c./d.c. type. With this sort of equipment, the tap, while ensuring that the valves are operated at their correct current rating, is not so particular about keeping the h.t. potential constant. Consequently, a receiver operating on 250 volts usually produces far more h.t. than one operating on 200 volts. It may be said that, within limits, an increase of h.t. volts on a receiver will bring about an increase in that receiver's performance. Indeed, in the case of some early television receivers, the manufacturers stipulated that they should not be operated with a supply voltage of less than 230 volts.

With a mains supply that is adjustable, in steps of 10 volts between 200 volts and 250 volts, it is a very simple matter to make the supply suit the set and so any alteration to the mains tap is avoided. Apart from the time saved in eliminating this adjustment, there are other benefits to be gained. In the case of television sets all pre-set controls may be left undisturbed. Thus it may be seen at a glance if the picture size is correct and if the frame and line holds are operating satisfactorily. In connection with the repair of battery-mains portables, this unit is even more useful. Many of these sets cease to function simply because the frequency changer stops oscillating. It is usually found that the valve is perfectly O.K. but will not work because of a low h.t. voltage. This in turn is almost always due to the valve or metal rectifier being low in output. The diagnosis is complete within a minute by turning the switch on the unit to an extra 10 volts of mains, after which the set invariably returns to life.

As can be seen from Fig. 1, components are few and can be varied to suit individual requirements. The mains transformer should preferably have a series of 10-volt taps from 200 volts to 250 volts and a tap at 110 volts would be most useful for sets with defective line cords. It should also be rated at around 100 watts. All unused windings should be removed. This is not a difficult job since secondaries are invariably very accessible. Should the unused windings not be removed they must be very well taped unless the ends terminate in tags fixed to the body of the transformer. If a transformer with a faulty secondary should happen to be around it could be pressed into service provided that the primary had not been seriously overheated. In this case it is essential that all secondary windings are removed. In the diagram the mains are shown connected to the 200 volt section. This will, of course, be altered to match the local supply voltage.

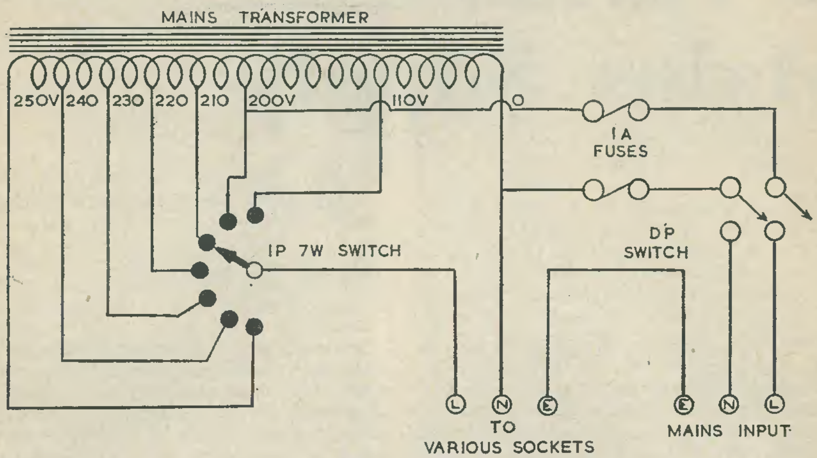


FIG.1

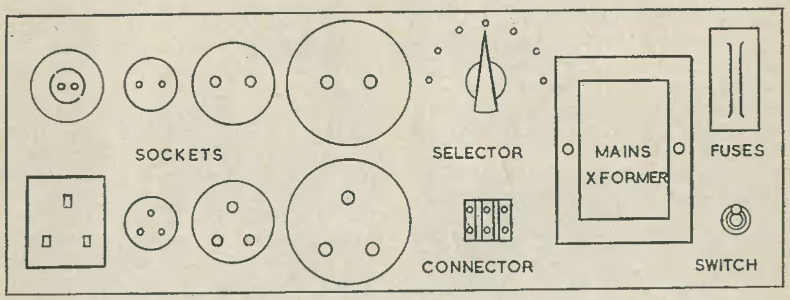


FIG.2

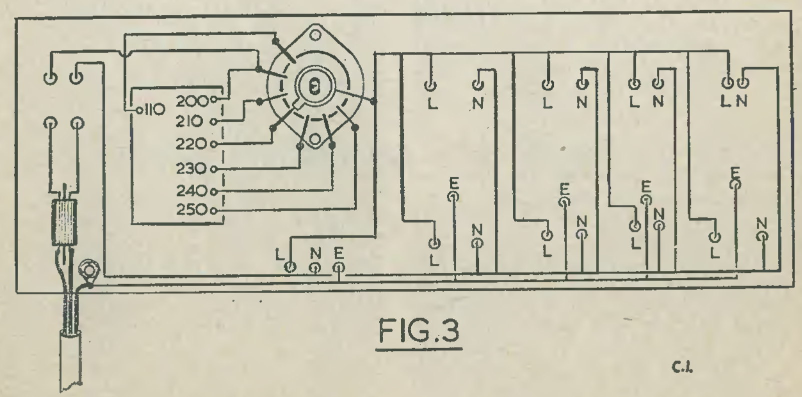


FIG.3

The Yaxley selector switch should present no problems. After four years of fairly constant use the one in the original unit continues to give trouble-free service. The double fuse carrier was used simply because it was to hand. Any other type will do just as well. It is recommended that every type of mains socket be fitted to the outlet panel, including the bayonet type normally reserved for lamps. A three-way connector is also very useful for the sets that arrive minus a plug. It is well worth the trouble to check a plug arriving with a piece of apparatus. The fault has been found in the connections thereto on more than one occasion.

Fig. 2 shows the general layout of the components. No dimensions are given since these will vary with the size of the mains transformer, etc. One-eighth of an inch paxolin sheet makes an ideal mounting board since it is very easy to work and is well suited to the type of component to be mounted. If a substantial piece of wood is used there will be the usual difficulties in recessing the holes for the selector and toggle switch. As a rough guide, the dimensions of the panel will be in the neighbourhood of 16in by 6in.

As can be seen from Fig. 3, all sockets are wired in parallel and the live side of the mains goes to the selector switch. Every care should be taken to wire the sockets up correctly. In the case of the three-pin sockets each connection is marked, but the two pin types are not. With these the live wire should be taken to the left-hand connection when viewed from the back. This will make the right-hand socket live when viewed from the front, which will conform with standard three-pin socket practice. This can be remembered to advantage but should the memory be rather poor a spot of red paint near the appropriate socket is recommended.

For fellow sufferers who live in an area of a dismal 190 volts (winter time), this unit can be an absolute tonic for jaded soldering irons for obvious reasons. Gone are the days when the bit of the iron had to be thrust into the open grate to assist the mains to make the solder run!

A Constructor Visits The R.E.C.M.F. Exhibition

continued from page 835

record changers or tape recorders.

There were a number of stereo pick-ups on show, both high and low output types. Electronic Reproducers (Components) Ltd., were featuring a new ceramic pick-up for stereo. The Goldring No. 300 is a new magnetic cartridge giving an output of 100mV at 1.2 cm/s. A second version of this cartridge, suitable for directly feeding a 3-transistor amplifier, is also available.

Ganged potentiometers were also in evidence this year—another requirement of the stereo market. With the majority of these units, the two potentiometers are matched within 20% of each other, although Morganite do offer controls which are within 10% over the upper 75% of rotation.

Miscellaneous

Other new trends in the resistor world include miniature preset controls with printed circuit "feet", and a range of edge-controls.

Capacitor manufacturers are producing smaller and smaller capacitors. T.C.C. have introduced a range of miniature tubular paper capacitors with two separate thicknesses of dielectric to each solid foil electrode, in the same size as metallised paper capacitors.

Eddystone were showing a new dial and gear drive assembly (Type 898) which should prove of particular interest to amateurs. A new v.h.f. double tetrode, the 11E13, which is equivalent to the well-known QQVO3–10, was shown by Mazda.

Another item of interest to experimenters and service engineers who have to handle a.c./d.c. receivers with live chassis is an isolating transformer made by Hinchley. This is available in four sizes 65, 100, 200 and 350VA, and is fitted with the new Mycalex snap-action terminals, allowing speedy connection of apparatus. V.T.R.

A NEW MAGNETS BROCHURE

The first fully comprehensive publication on permanent magnets to be issued by Preformations Limited deals with the development and performance of the "Magloy" range of magnets.

Under the title "Magloy Permanent Magnets" the brochure discusses various magnet materials together with dimensions and tolerances, surfaces and the location of magnetic poles, all of which vary according to specification.

The publication is well illustrated with photographs, tables and performance charts clearly indicating the variety of applications for "Magloy" permanent magnets, which include radar, television, electronic, aircraft, and automotive equipment.

Copies of "Magloy Permanent Magnets" are available from Preformations Limited, Cheney Manor, Swindon, Wilts.

An efficient FLYBACK ELIMINATOR

for use with the Miller Transitron Timebase

By C. HUSKINSON

THE MILLER TRANSITRON SAWTOOTH generator, while enjoying great popularity with oscilloscope designers as a timebase, also introduces one or two undesirable features when flyback suppression is used.

Fig. 1 shows the basic circuit from which most suppression circuits are derived, and at a first glance this would appear to be quite satisfactory. The screen goes positive during the timebase sweep, the diode clips the top to make it flat and, behold—a nice square wave to feed to the grid of the cathode ray tube.

An inspection of the screen waveform and a closer look at the circuit will show that this theory doesn't hold good at all timebase frequencies

Fig 2 (*a*) shows the screen waveform at 50 c/s and although it is substantially square only about 10V of it is positive to earth

The diode cathode in Fig. 1 is biased positively (about 50V) with respect to earth. The anode must, therefore, rise to this same value before it will conduct and so limit the positive excursion of V_1 screen.

Since, however, the screen does not rise to this value the true waveform will be fed to the tube, with the result that the trace will be of uneven brilliance. Dark at the ends and bright in the middle.

As this occurs at frequencies up to about 800 c/s, in the opinion of the writer this is basically an undesirable feature.

Fig. 2 (*b*) shows the screen waveform about 25 kc/s.

The leading edge of the pulse, instead of being almost instantaneous, is taking a finite time to rise.

This constitutes a fair percentage of the time taken to scan the tube. The result is, again, uneven brilliance of the trace.

One further disadvantage with this type of circuit is the lack of d.c. restoration. Every time the frequency of the timebase is changed the brilliance level has to be adjusted to counteract the difference in level of the flyback suppression pulse.

In the design of his own oscilloscope the writer evolved the following circuit, which has substantially minimised all of these undesirable characteristics.

Circuit Description

In Fig. 3, V_1 is the Miller timebase generator from the screen of which is fed the positive-going waveform to V_2 grid via the network C_1, C_2, R_1, R_2.

The reason for this network will be explained later.

V_2 has both its grid and cathode returned to earth and is therefore conducting fairly heavily. As the screen of V_1 rises the grid of V_2 will go positive with respect to its cathode and will draw current. The anode will quickly bottom and stay in that condition until the waveform fed to the grid ceases.

From the previous paragraph it will be obvious that when the grid draws current the internal resistance of the valve decreases; and were it not for the resistor R_1, C_1 would be effectively connected to earth. This would have a serious effect upon the working of V_1.

C_2, in shunt with R_1, increases the high frequency response of the system, the result being that an extremely square negative pulse is produced at the anode of V_2 at any frequency of the timebase.

This pulse is fed via C_3 to the cathode of the tube, thereby cutting off the beam current during the flyback period.

The value of C_3 is determined by the lowest frequency that the timebase is required to operate at and the resistor network of the tube.

The time constant of C_3 and this resistor network should not be less than the time taken for one cycle of the timebase at its lowest frequency.

Should it be less, then the pulse will not be flat, and uneven brilliance will be the result.

R_3 and R_4 limit the amplitude of the pulse and ensure that V_2 is kept within its rating.

V_3 acts as a d.c. restorer and with C_4 and R_6 ensures a fairly constant level of brilliance irrespective of timebase frequency.

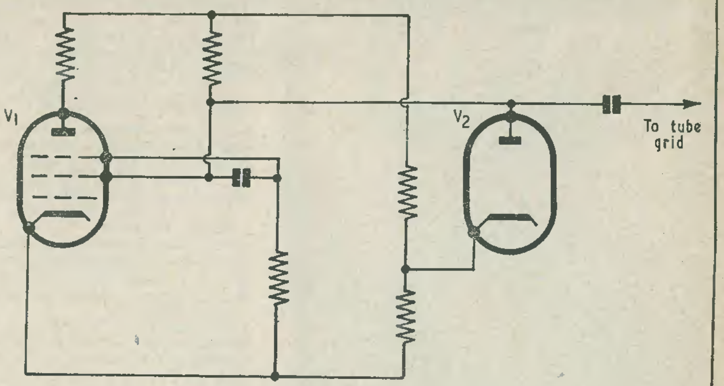


Fig.1

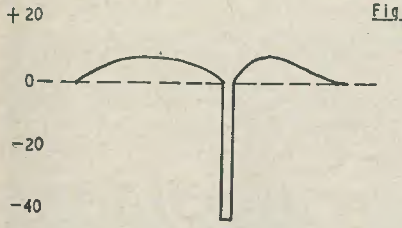


Fig.2(a)

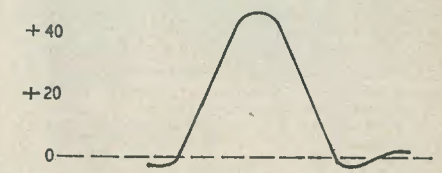


Fig.2(b)

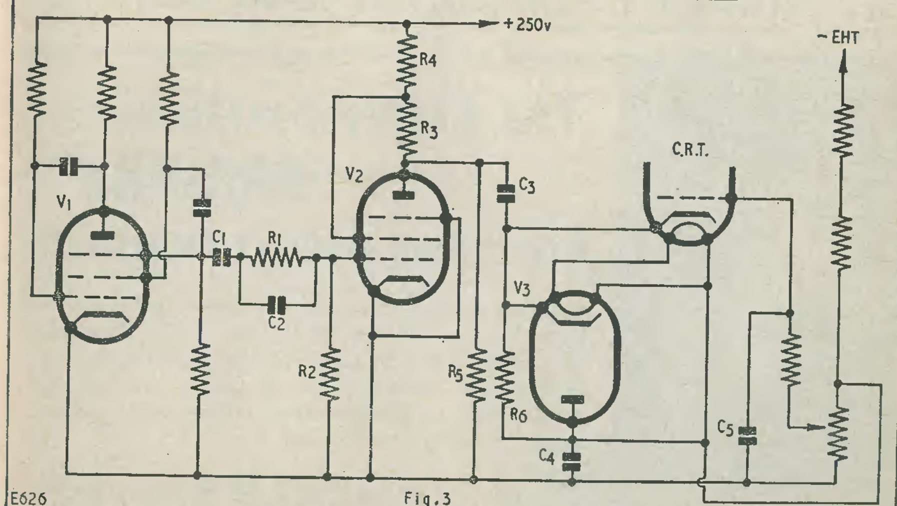


Fig.3

In the construction of this circuit, the main thing to bear in mind is that stray capacities can ruin the high frequency response.

Use a low-loss holder for V_2 and keep the wiring to the tube cathode away from the chassis and surrounding wiring as much as possible.

Components Values

R_1	330kΩ ¼W	C_1	0.01μF mica
R_2	33kΩ ¼W	C_2	27 pF mica
R_3	47kΩ ½W	C_3	See text
R_4	47kΩ ½W	C_4	0.5μF
R_5	47kΩ ¼W	C_5	0.25μF
R_6	330kΩ ¼W	V_1, V_2	EF50, 6AM6, SP61

★ VALVES NEW TESTED AND GUARANTEED

1R5	7/6	6X4	7/6	DK91	7/6	EF92	5/6
1S5	7/6	6X5G	6/–	DK92	9/–	EL41	10/–
1T4	6/–	12AH8	9/6	DK96	9/–	EL84	9/–
3S4	7/6	12AT7	7/6	DL92	7/6	EL91	7/6
3V4	8/–	12AU7	7/6	DL94	8/–	EY51	10/6
5U4G	6/–	12AX7	9/–	DL96	9/–	E135	8/–
5Z4G	9/–	12K8GT	13/6	EB91	5/6	EZ40	8/–
6AM6	6/9	12K7GT	8/6	EBC41	8/–	EZ80	8/–
6AL5	5/6	12Q7GT	7/–	EBF80	9/6	EZ81	8/6
6AT6	7/6	25A6G	10/6	ECC81	7/6	PCF82	11/–
6BA6	8/6	25L6GT	7/6	ECC82	7/6	PL81	13/6
6BE6	7/6	35Z5GT	8/6	ECC83	7/6	PL82	10/6
6BR7	10/6	35L6GT	9/6	ECC84	8/6	PY81	8/–
6BW6	8/6	53KU	11/6	ECF82	11/–	PCC84	9/–
6J5G	5/6	807	6/9	ECH81	10/6	PCF80	9/6
6J7GT	8/6	5763	10/6	ECH42	10/–	U76	8/6
6K7G	2/6	DAF91	7/6	ECL80	12/6	UBC41	10/–
6K8G	7/6	DAF96	9/–	EF36	7/6	UCH42	9/–
6Q7GT	8/6	DF91	7/6	EF39	5/6	UV41	10/–
6SL7GT	8/–	DG96	9/–	EF41	9/–	UL41	9/6
6SN7GT	8/6	DH76	8/6	EF80	8/–	UY41	8/–
6V6G	7/6	DH77	7/6	EF91	6/9	W76	8/6

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

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

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

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

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

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

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

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

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

Valveholders. 4, 5, 7 pin English and U.S.A. B7G, B9A, I0, M0, B8G, **9d.** each; B7G, B9A with screening can, **1/6**; B12A, **1/3**. Aladdin formers ¼" with core, **8d.** each

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

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

2-Gang Condensers, 0.0005µF small size, **7/6**

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

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

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

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

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

Paper Capacitors, tubular, 0.01µF 1,000V, **1**/–; 0.1 to 0.5µF 500V, **10d.**

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

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

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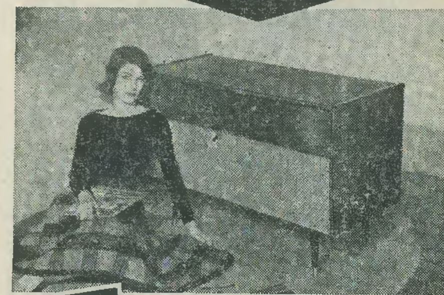

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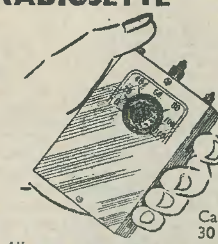

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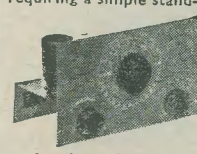

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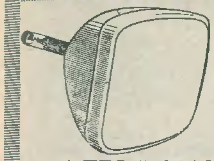

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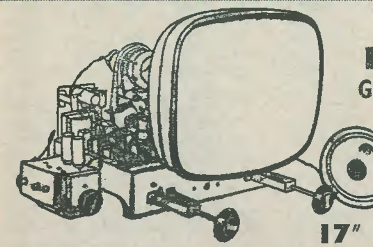

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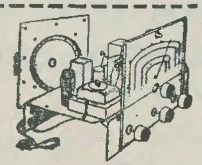

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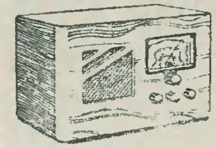

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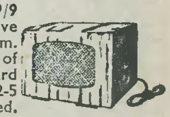

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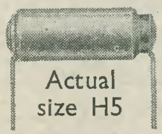

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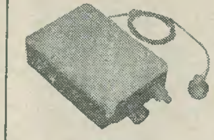

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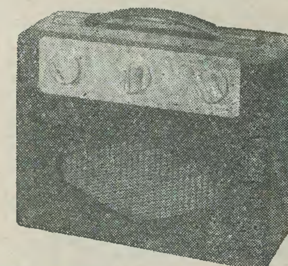

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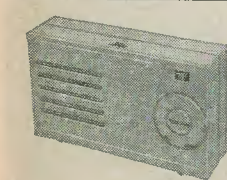

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continued on page 879

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6BR7	11/6	12C8M	7/6	ECH81	10/–	UBF89	9/6
6BW6	9/–	12K7GT	6/6	ECL80	12/6	UCC85	9/6
6C4	4/6	12K8M	12/6	ECL82	12/6	UCH42	9/6
6F6M	5/6	12Q7GT	6/6	EF36	4/–	UCH81	9/6
6J5GT	4/6	12SC7M	2/6	EF39	4/6	UF41	9/6
6J5M	5/–	12SJ7M	5/–	EF41	9/6	UF89	9/6
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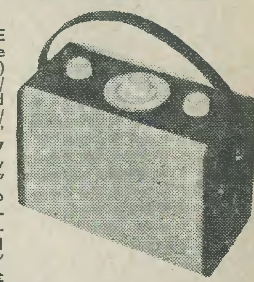

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continued from page 877

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