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FEBRUARY 1961 493
**Suggested Circuits**

An annoying feature of domestic television viewing is the long period of time which elapses between switching on the television receiver and the appearance of a picture on the screen. The warm up time of the television receiver varies for different makes and models; it may be some three-quarters of a minute in one instance or as long as a minute and a half in another. It is possible in some cases to shorten the warm up time of a television receiver, and this month's article describes a very simple modification, for receivers operating from a.c. mains, which may effect a reduction of around ten to twenty seconds. For reasons which are explained later, several important tests have to be made before the modification can be finalised and, for this reason, the writer feels that it only should be attempted by constructors who are conversant with television theory and practice. The modification should not be made without carrying out the tests.

**Television Receiver Warming Up**

When a cold* television receiver is switched on, the mains supply is applied to its heater chain via a series resistor and a thermistor. The latter offers initially a high value of resistance which drops as the thermistor warms up. Thermistor warm up may take an appreciable time, and the heaters reach operating temperature at a later period than would occur were the thermistor not in circuit. After a time the cathodes of all valves except the booster diode and the e.h.t. rectifier reach emitting temperature. The operating valves include the h.t. rectifier (assuming this is a valve) whereupon the signal-handling stages commence to function, as also do the frame time base and the line sawtooth generator. A similar state of affairs would occur if the h.t. rectifier were a metal or silicon component, the only difference in this case being that h.t. would be present immediately after switching on.

One of the two valves not yet warmed up is the booster diode. Because high voltages appear between the cathode and heater of the line output valve, the line output stage cannot, therefore, function until the booster diode has reached operating temperature. Once the line output stage commences to operate, a heater supply becomes available for the e.h.t. rectifier. It is only when this last valve has warmed up sufficiently to allow an e.h.t. voltage to be applied to the cathode ray tube that a picture is eventually resolved.

**The Modification**

The modification suggested this month is illustrated in Fig. 2. Fig. 2 (a) shows a booster diode heater connected in conventional manner in the heater chain of a television receiver. Fig. 2 (b) illustrates the circuit after modification. In this diagram the booster diode heater is taken out of the chain, being replaced by a fixed resistor of equal resistance (and with a sufficiently high wattage rating). The booster diode heater is then connected to the secondary of a heater transformer, the primary of which is connected to the receiver mains input after the on-off switch. To retain approximately the same heater-cathode potential as existed before the modification, one side of the booster diode heater is connected to one side

---

1. The term "cold", as applied to a receiver or a valve in this article, infers that the receiver or valve has been previously switched off for at least twenty minutes.
2. This assumes that the line output stage is not part of the line sawtooth generator.
of the fixed resistor which takes its place. The heater circuit now functions in the following manner. When the receiver is switched on, the a.c. mains are applied both to the heater chain and to the primary of the heater transformer. The heaters in the chain commence to warm up, their temperature rising slowly at first because of the series thermistor. The booster diode, on the other hand,witches for a brief period to 110 volts as soon as the receiver is switched on, with the result that it commences to warm up without the time delay introduced by the thermistor. When the line output valve reaches operating temperature the booster diode may already be functioning. The booster diode may, alternatively, reach operating temperature and then give sufficient after the line output valve; but this will still be at an earlier time than occurs in the unmodified circuit.

As may be seen, the time advantage given by the modification is that the booster diode does not undergo the delay imposed on the other valves of the receiver by the thermistor.

Precautions and Tests
The usefulness of the modification will vary according to the make and type of receiver and the first step to be taken consists of ensuring in advance what saving in warm up time is to be expected with the particular receiver being modified. The latter, in its unmodified state, should be switched on from cold with a meter (to be discussed later) monitoring the drive voltage on the grid of the line output valve, and another meter monitoring the voltage on the boosted h.t. line. The periods elapsing between the moment of switching on, the appearance of grid drive to the line output valve, and the appearance of boosted h.t. voltage, should then be noted. The booster diode should next be connected up in a temporary test set-up as shown in Fig. 3. In this diagram the booster diode heater is connected to the heater transformer intended for use in the modification, a load resistor and voltmeter being inserted in its cathode circuit to check when emitting temperature has been reached. After heater supply is applied to the cold booster diode and the time taken for the cathode to reach full emission (as indicated by the test voltmeter across the load resistor) noted. If this period is significantly shorter than that needed for the formation of boosted h.t. voltage in the previous test, then the modification will be worthwhile. However, it should be borne in mind when evaluating the usefulness of modification that, should the booster diode reach operating temperature in a shorter period than that needed for the appearance of line output grid drive in the previous test, the line output stage in the modified receiver will commence operating only after delay voltage appears, even though the booster diode is already fully warm up.

If any initial test indicates that a worthwhile saving in warm up time is given by supplying the booster diode from the heater transformer, a final important check has to be made. This check is needed to ensure that, at no time during the warm up period, does the instance arise where both the line output valve and the booster diode achieve full operating temperature before a drive voltage appears on the line output grid. The risk of such a condition occurring is somewhat remote, but it should be noted that the condition could cause excess current to flow in the line output anode circuit.

The receiver should be temporarily put into the modified condition and a meter connected, as before, to monitor the drive to the line output grid. Also, an ammeter should be inserted between the h.t. positive rail and the anode of the booster diode to monitor line output anode current. The testing circuit arrangement is illustrated in Fig. 4. The receiver should then be switched on from cold. If line output anode current reaches its normal running value after the appearance of full grid drive voltage, the test may be considered satisfactory. Should line output anode current exceed its normal value during this test, the booster diode should be switched off at once. The test should next be repeated for different switching-on states of the receiver. These should be given by switching on a number of times, after switching off, switching on one minute after switching off, and switching on some three to four minutes after switching off.

Testing Requirements
As was observed at the beginning of this article, it is advised that the modification be carried out only by constructors who are conversant with television theory and practice. It will be noted also that the test equipment required for the modification checks is little more specialised than is usually the case with articles in this series.

The voltmeter employed for monitoring the drive to the line output grid should be an a.c. valve voltmeter or a d.c. valve voltmeter with a suitable thermionic rectifier. The instrument used has merely to indicate the presence of grid drive voltage, without loading the grid circuit of the line output anode. If available, an oscilloscope may be employed. The voltmeter needed to measure the boost voltage in the initial test, and the voltage across the load resistor in the set-up of Fig. 3, can be any high-resistance testmeter connected to the requisite voltage range. The test load of Fig. 3 is intended to draw some 10mA of current, and the h.t. supply may be obtained from any convenient source. Ideally, the test load should be a current around 100mA (as would be passed by the booster diode in the receiver) but this may prove inconvenient. Use of the 10mA load will, however, give accurate indications for present purposes.

The ammeter connected in series with the booster diode anode (Fig. 4) should have a full-scale deflection of 150mA or more. A testmeter switched to a suitable current range would cope here.

Booster Diode Heater Voltage
The booster diodes employed in normal series heater circuits are liable to have non-linear heater voltages, and the transformer may be experienced in obtaining heater transformers with suitable secondary voltages. This problem could, in some cases, be overcome by over-boosting to give a 6.3 volt equivalent of the original booster diode, this course allowing the use of a standard heater transformer. Only one or two 6.3 volt equivalents of the original diode should be employed.

The heater transformer used in the modification should, of course, have adequate insulation between primary and secondary windings in order to prevent incorrect voltages being applied to the other valves in the circuit.

3 Should be pointed out that these last requirements are somewhat rigorous. Incorrect operation of the line output stage for a short period of time in the event of receiver (without the modification discussed here) if they are switched on again soon after being switched on.

BRITISH SOUND RECORDING ASSOCIATION
A lecture will be given on Friday, 17th February, 1961, at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, at 7.15 p.m. on "Organ Pipes and Reeds", by Henry Willis, F.R.A. The lecture will deal with the history and construction of the various methods of constructing church and other organ pipes of differing tonal quality, with another demonstration of veiling a pipe and a reed. The lecture will be followed by a discussion.

Mr. Henry Willis is governing director of the pipe organ makers of that name, being a grandson of the "Father" Henry Willis, founder of the firm in 1845, and one of the most famous builders of church organs. Having been responsible for the building of organs in many countries, perhaps the most famous being the world's largest cathedral organ at Liverpool, Mr. Willis's experience is very extensive. It is not surprising, therefore, that he has published several books on pipe organ construction, particularly voicing, and his lecture should interest all who enjoy listening to the "king of instruments".

In connection with the above lecture, B.S.R.A. members will be able to visit the organ works of Henry Willis and Sons, in London, S.E.1, on Saturday, 18th February, at 10.30 a.m. Invitation tickets for non-members to attend the lecture can be obtained from S. W. Steventon-Stratton, F.R.A., Hon. Secretary, "Greenway", 40 Fairfield Way, Ewell, Surrey.

FEBRUARY 1961
IN YOUR WORKSHOP

This month Smithy the Serviceman and his able assistant, Dick, join forces in an episode which carries a pointed moral.

"COUGHS AND SNEEZES", QUOTED DICK, "SPREAD DISEASES!"

Smithy turned a tortured, watering eye upon his assistant, and opened his mouth preparatory to delivering a crushing retort. Before he could speak, however, his body was shaken by a gargantuan sneeze.

"Bless you," remarked Dick equably. "Indeed, after that one, I should say: bless you squared!"

The Serviceman staggered over to the Workshop sink and allowed a little water to flow from the tap into the bottom of a cup. He took a paper packet from a box nearby, opened it, and poured the contents into the cup. After stirring the mixture briskly with a screwdriver he swallowed the draught at one gulp.

"Ah, that's better," he remarked.

"That's the second powder you've taken in half an hour," his assistant reminded him accusingly.

"I can't help that," replied Smithy, a little brusquely. "It's just that I've got a bit of a chill this morning."

Dick raised a disbelieving eyebrow but made no further comment. Besides, he was at a very interesting stage in the repair of the stereo record player on his bench.

Stereo Record Player Fault

The stereo record player was of the more inexpensive type employing a single triode-pentode in each channel. (Fig. 1.) The triodes were voltage amplifiers, appearing in circuit immediately after the pickup, and their output fed into the grids of the pentode sections. A simple balance control, consisting of two ganged potentiometers, varied the relative a.f. levels applied to either output grid.

Before Smithy's attack, Dick had carefully placed the two speakers at either end of his bench and had reproduced a stereo record over the player. Reproduction had been acceptable, but there were occasional fleeting moments of just-perceptible distortion which passed so quickly that Dick had difficulty in identifying or locating them. Dick had decided to fall back on a simple testing device which Smithy had developed in the past for servicing record players of this type.

Smithy's testing device consisted, quite simply, of a three-way single-pole switch and a 1uf paper condenser mounted in a small box from which protruded three flexible test leads. (Fig. 2.) One test lead was intended to connect to the chassis of the equipment under test, and the other two to the grids of the output valves. By suitable manipulation of the switch it was then possible to silence either one output stage or the other, or to leave both unaffected. The silencing of the output stages was achieved by bypassing to chassis via the 1uf condenser the grid selected, the condenser ensuring that the appropriate grid bias arrangements were not upset. The presence of the condenser also allowed the second and third clips to be connected, if desired, to points which carried h.t. potential, such as would be present at the anodes of voltage amplifiers.

Dick quickly clipped the leads of the test unit into the chassis of his record player and selected a monaural test record. He next placed the speakers side by side on the bench and placed the pickup on the record. With the aid of the test unit switch he quickly adjusted the balance control of the record player so that the volume from one channel working on its own was equal to that from the other.

"You know, Smithy", he called out, "this test gadget of yours is jolly useful for checking the balance of stereo record players."

"What's that?"

"I said that your gadget is jolly useful for checking the balance of stereo players. You can click from one channel to the other instantaneously and judge the relative volumes as easy as anything."

"Oh, I see."

There was a noticeable lack of interest in Smithy's voice and, glancing over his shoulder, Dick saw that the Serviceman was gazing disconsolately at a television set, still in its cabinet, which was giving strong symptoms of sound-on-vision. Dick decided that he had enough problems of his own for the time being, and he returned to his record player.

He noted that the correct setting for the balance control was approximately at the centre of its travel, this indicating that both channels were providing the same degree of amplification. He adjusted the test unit.
Dick stopped for a second, as a thought suddenly struck him. "What about me?" he continued indignant, his voice tremulous with self-pity. "Here am I, a defenseless, sensitive lad, who is being forced to endure this disgusting torture."

Jubilantly, Dick switched both channels into operation and advanced the volume control on the record player to full. This had been done, he thought, to earn a humble crust of bread by working in a Workshop which is literally crawling with strept... strep..."

"Streptococci?" put in Smithy helpfully.

"Whatever you said," concluded Dick lamely. "I'm not at all certain," commented Smithy thoughtfully, "that streptococci have anything to do with colds."

"Well, common colds then," said Dick, swinging back into the attack. "Also, apart from myself, what about our customers? Do you realise that you have just sneezed violently into every single bit of equipment that's gone through your hands?"

This Workshop was now a common cold distribution center, radiating colds in all directions up to the range of the delivery van, each serviced receiver carrying into our trusting customer's house its deadly complement of vicious infection." "I have not sneezed into all the receivers which have been through my hands," interrupted Smithy hotly. "The only thing that can break this deadly radiation pattern", continued Dick, now completely carried away, "of which this Workshop, mark you, forms the hub, is for our driver to succumb completely under the concentrated attack of the virulent germs he carries in the back of his van. It is better for one man," finished Dick impressively, "to go to the wall than for countless others to suffer.

But his last words were lost in a gale of laughter from the Serviceman. "I can't see why you think my regard for other people is so funny," said Dick, hurt. "Well, it certainly cheered me up anyway," chuckled Smithy. "I must admit, though, that you're perfectly right, and that the best place for me is bed. I'll just clear up the job in hand, and then I'll leave you to look after things on your own for a few days. How's that stereo player of yours going?"

"Very well," said Dick, proudly. "I've located the fault, and all it needs is a new speaker on one of the channels."

"Let's hear it," commanded Smithy.

"Obligingly, Dick put the record player through its paces and demonstrated the fleeting distortion contributed by the speaker. "It doesn't sound too bad to me," remarked Smithy, "although it could, I suppose, be a source of irritation to someone who likes good music. Are you sure that you haven't merely got a bit of cabinet buzz?"

"How can I check for that?"

"Just play the part of the record which allows the distortion to appear and run your finger over the cabinet joints, the speaker mounting, and anything else which could cause a buzz or rattle at a low frequency. Press fairly heavily on each point you check—but not too heavily on things like expanded metal speaker fabrics which may bend—and the buzz will reduce or cease when you've found the right spot."

"That's a good idea," remarked Dick. "I'll try it out."

The loudspeaker cabinet was of simple design, and it did not take Dick long to find that it was not contributing to the distortion. "Fair enough," remarked Smithy, after Dick had completed his investigation. "Before we finally finish the job let's have a look at the speaker itself."

The obedient Dick removed the speaker...
from the cabinet and handed it over to Smithy.

"If the speaker's at fault," continued Smithy, examining it carefully, "we might be able to do a simple repair. This particular unit isn't in what you could call the 'professional hi-fi' class, but it is still expensive enough to make it worthwhile seeing if we can do anything. I'm going to look for two common components first, before finally deciding on a certain. Ah, here's something. Look at this, Dick!"

Dick's eyes followed Smithy's pointing finger.

"Can you see that small tear in the cone?" queried the Serviceman.

"Just about," confessed Dick, moving round to get a good look. "There's a small V-shaped piece near the edge of the cone, torn along the two sides. (Fig. 3 (a)) The sides are about three-eighths of an inch long, I'd reckon.

"That's about it," confirmed Smithy.

"The V-shaped piece is virtually mounted on a hinge, with the result that it flaps around in the breeze rather. Feed a note of the right frequency and volume into the speaker and this torn bit will give the buzzing noise we heard just now."

"Is it repairable?"

"In this case I would say yes," said Smithy. "The tear is such that the fibres from the torn bits overlap each other, and it's not too near the corrugations on the periphery or the voice coil. I would suggest you apply a glue to the edge, hold the bits in position between your fingers for a very quick moment, and then let it set."

"What sort of glue should I use?"

"We require a quick-acting glue," replied Smithy, "but not one that sets to a rock-like hardness. The latter might cause the tear to reappear later. What we want is something that sets to a fairly rubbery consistency. I would suggest that a faint trace of Epo-Stik should do the trick. There's a tube of it in the spares cupboard."

Dick soon found the tube of Epo-Stik and he applied it to the speaker cone in the manner Smithy had described. (Fig. 3 (b)) As he went over to the sink to wash the glue off his fingers he found that Smithy had preceded him.

"You're surely not taking another powder!" protested Dick.

"Good gracious, no," replied the Serviceman. "This is just something to clear the old passages."

Dick waited patiently as, to an accompaniment of loud, mournful noises, Smithy squirted the contents of a plastic bottle first up one nostril and then the other. Dick then watched him walk back to his bench and take from a drawer a packet of large and pungent-looking cough lozenges. The Serviceman commenced to suck vigorously.

Meso and Stereo Styli

Dick sniffed appreciatively. "The place is beginning to smell like a sick bay," he complained.

"Don't be silly," replied Smithy. "I'm just employing one of my more common remedies. In fact, they're making me feel better already."

Assuming an expression intended to indicate a state of extreme well-being, the Serviceman lit a cigarette with a flourish. He was immediately assailed by a violent and continuous attack of coughing. Suddenly, a wild look came into his eye and, swallowing Dick out of the way, he rushed over to the sink.

Several minutes later he returned to his seat.

"What on earth happened then?" asked Dick.

"I swallowed the cough lozenges," replied Smithy mischievously.

The Serviceman picked up his still-glowing cigarette and stubbed it out disgustedly. Suddenly, a thought crossed his mind and, brightening up, he rummaged in the drawer of his bench again.

"What now? Magnification?"

"Nothing of the sort," snapped Smithy, busily applying a match to the jumbo-sized night-light he had just unearthed. "This is a new gadget designed to get off a delicious germicidal odour which is reminiscent of the forest."

Dick sniffed distrustfully, but made no further comment.

"Well, whilst the glue's setting on that speaker," he remarked, "we'd better carry on with fixing that t.v. set of yours."

"Just a minute," said Smithy. "There's one little matter to clear up on the last job first."

"What's that?"

"It's necessary to make the point that it isn't normally good practice to play a monaural record with a stereo pickup. This is because a stylus designed purely for stereo usually has a different tip radius to one intended for mono, and it can cause excessive wear on a mono record. So, when you use a mono record to check for faults in either channel of a stereo player, select one which is not of special quality and also the fact that tests of this nature often require lowering the pickup down on specific parts of the tracks, and this treatment is hardly the sort that you'd apply to expensive or treasured discs, anyway."

Smithy paused and gave a little experimental cough, followed by a tiny sneeze. His face lit up perceptibly.

Sound-on-Vision

"That forest-smell stuff is doing me good," he remarked, from the clouds.

Dick smiled and ushered Smithy to a seat. Dick sceptically. "Shall we have a stab at that t.v. on your bench now?"

"O.K.?, replied Smithy, equably. "I'll direct you from here."

Dick carried the receiver over to his own bench, where visibility was better. "I'll tell you that one to date," commented Smithy cheerfully. "As soon as I put the set on I noticed the sound-on-vision effect at once. So far as I could tell, the sound traps in the vision i.f. strip seemed to be working pretty well, and I..."

"Wait a minute," interrupted Dick. "You can't just say that the sound i.f. traps were working O.K. without even having got the set out of its cabinet!"

"You can get a pretty fair idea with some sets," replied the Serviceman, "although this involves getting used to the performance such sets have. In a number of receivers i.f. response has a very pronounced dip at the sound i.f., this being due to highly selective sound i.f. rejector circuits. (Fig. 4.) For the record, I should add that these rejectors are tuned to the standard British sound i.f. of 39 kHz. What I am referring to, i.e. being at 34.65 Mc/s. If the receiver has sufficiently good focus and resolution, you can often make out a 3.5 Mc/s 'grain' on the screen which is the selector or mixer transistor is incorrectly adjusted.

"I'm lost," confessed Dick. "To begin with, does where the 3.5 Mc/s come from?"

"It's the difference frequency between sound and vision i.f.s," explained Smithy. "If your fine tuner is adjusted such that the sound i.f. from the mixer gets into the vision i.f. strip at the wrong frequency it can beat with the vision carrier i.f. to give you a 3.5 Mc/s signal. Once you've got used to a particular make and model you can get a fairly accurate idea of the condition of its sound i.f. rejector circuits by slowly adjusting the fine tuner and noticing if the 3.5 Mc/s 'grain' clears sharply as you pass through optimum fine tuning in both directions."

"It sounds rather a complicated sort of test to me," remarked Dick.

"Well, there is a certain amount of experience involved. I've been using Smithy."

"And you have to get used to the performance given by individual makes and models. Quite a few t.v. receivers don't give the effect at all."

"I'll keep my eyes open for it in the future, anyway," Dick said.

"I should," replied Smithy. "But I must add that it is only useful if you repair lots of t.v.'s. It's not much use if you only fix the odd set now and again. Incidentally, the 3.5 Mc/s 'grain' shows up best against dark backgrounds, and you may have to turn the brilliance up slightly."

"Right," said Dick. "Well, let's assume that you have found the sound i.f. rejector circuits to be O.K. What's the next diagnosis?"

"The obvious one," said Smithy, "is of sound-on-vision being caused by acoustic feedback from the speaker to the tuner unit. The sound waves from the speaker cause the oscillator valve to emit some oscillation, which, by way of the volume control, to the speaker, which in turn emits a louder sound or a sound on a frequency at which the oscillator valve or components resonate. In severe cases of feedback you may get horizontal and vertical stripes on the screen, these corresponding to the frequency of the sound emitted by the speaker."

Fig. 4. The vision i.f. strips of some television receivers have very sharply defined dips at the sound i.f., as shown here. The frequencies quoted are the standard British television i.f.s.

"How does the sound get back to the tuner unit?"

"Via the cabinet or chassis, usually," replied Smithy. "Although, if the oscillator circuits of the tuner are very microphonic, feedback through the air itself could also cause the trouble. Things are pretty bad when that happens, though. As an aid to diagnosis, this particular fault is usually much worse on Board III than on Board I because, since the oscillator runs at a higher frequency on Board III, small vibrations in the oscillator valve or components cause a greater variation in oscillator frequency."

"Have you done to date with this particular receiver?"

"Swapped the mixer-oscillator valve, that's all," said Smithy. "Which gave no improvement. After that, I had a slight attack of sneezing, as you may have noticed."

Dick grinned.
"You mean you began to feel 1dB under!"

The Serviceman threw a suspicious glance at his assistant.

"Well, you'd better have a go at the set now," was his only comment.

Dick looked inside the cabinet.

"They've certainly taken care to prevent acoustic feedback in this particular receiver," he announced, "the tuner unit is mounted on grommets."

He next adjusted the channel selector knob.

"Why, that's funny," he remarked, "it feels as though it's binding against something."

He examined the knob further.

"It is definitely binding," he remarked excitedly. "The edge of the knob shaft is pressing against the hole in the cabinet. We'll soon clear that!"

Dick quickly eased the bolts holding the chassis in the cabinet. He then moved the chassis around experimentally until the channel selector knob shaft was clear of the cabinet hole. He tightened the bolts again and switched on. The sound-on-vision had cleared.

A NEW METHOD OF SIMPLIFYING KIT CONSTRUCTION IS THE BASIS OF THE "DIOEDEON" transistor radio. As may be seen from the accompanying photograph, the "chassis" is a single sheet of metal, has printed on it a layout drawing showing the positions and connections of the components employed. These components may then be mounted and soldered at the points indicated by the drawing. Terminals for aerial, earth and phones are available on the reverse side of the board, which has printed on it, also, a simple tuning scale.

To further ease construction, all components for the receiver are mounted on a card which indicates their value or circuit reference. These values or references correspond to those shown on the board.

The Diodion transistor radio is an "Osmabet!" product. Other units employing the same constructional technique are also available.

Smithy Goes Home

"Well, that's another job done," said Smithy cheerfully. "I wish all these sound-on-vision snags were as easy as that one! You'd better try out that speaker you re-paired next. The glue should have set sufficiently by now."

Dick refitted the repaired stereo speaker into its cabinet, and checked it. This also was working perfectly.

"I think that clears up all the outstanding jobs," remarked Smithy happily. "I might as well toddle off home now and pop into bed."

"You're certainly looking better," remarked Dick, surveying the Serviceman clinically. "Perhaps the powders and the spray and the cough lozenges and the essence-of-the-forest have done you some good after all."

"I'm certain they have," agreed Smithy, as he made for the door.

Left to himself, Dick first set about clearing the debris caused by Smithy's medicines. After he had put away the last item he stood thoughtfully in the centre of the Workshop, surveying the receivers awaiting repair.

Then he sneezed.

IN THE ARTICLE IN THIS SERIES published last month we discussed gated a.g.c. systems of the type employed in British receivers working with positive modulation signals. We saw that these systems derived an a.g.c. voltage which was proportional to blanking level, since this level was the only usable part of the received signal which maintained a sufficiently constant relationship to the strength of the received signal.

We shall now carry on to the a.g.c. system employed in receivers designed for negative modulation signals, following this with an introduction to power supply circuits.

Negative Modulation Sound A.G.C.

Since negative modulation transmissions employ frequency modulated sound, separate a.g.c. systems are not needed in the sound circuits of negative modulation television receivers.

The reasons for this fact are as follows.

It is desirable in an f.m. receiving system to prevent any amplitude modulation of the received signal (or any impulsive interference) from being fed to the a.f. stages for subsequent reproduction over the loudspeaker. Suppression of amplitude modulation is normally achieved by means of a limiter stage preceding the discriminator, further suppression being provided at the discriminator itself if the latter is a ratio discriminator.1 The presence of limiting circuits ensures that the audio frequency passed to the subsequent a.f. amplifier is that which would result from a constant amplitude f.m. signal. Variations in f.m. signal level due to fading, channel-changing, etc., should not therefore result in corresponding changes in a.f. level from the discriminator.

Despite the existence of limiting circuits it is common, in practical f.m. sound-only receivers, to employ simple a.g.c. systems in order that overloading of the l.f. stages does not occur. In television receivers, design requirements automatically ensure that the signal applied to the sound l.f. stages, or inter-carrier frequency stages, undergoes at least a rudimentary form of automatic gain control. If the sound circuits employ an l.f. amplifier following the tuner unit (and, in some cases, a common vision and sound i.f. amplifier), the vision a.g.c. applied to the tuner unit r.f. amplifier (and the common l.f. amplifier, if applicable) should exert sufficient control to prevent overloading of the sound i.f. stages. Modern receivers employ the intercarrier system (wherein the sound signal is extracted after the vision detector as an f.m. signal whose centre frequency is equivalent to the difference between sound and vision intermediate frequencies), with the result that the inter-carrier signal is subjected to the same degree of automatic gain control as the vision i.f. The combination of limiting action, together with the control offered by the vision a.g.c. circuits, obviates the necessity for a separate sound a.g.c. system in a

1 The two most commonly encountered f.m. discriminators are phase and ratio discriminators, the latter having an inherent a.m. limiting action. Alternative discriminators, which could also have an inherent limiting action, may be encountered.

2 F.M. sound circuits, including the intercarrier system, were discussed in "Understanding Television," part 17, June 1959 issue.
negative modulation television receiver.

Negative Modulation Vision A.G.C.

In the negative modulation vision signal, sync pulse tips correspond to maximum transmitter amplitude. It is a relatively simple matter to obtain an a.g.c. voltage which is proportional to the sync pulse amplitude, and such a voltage will be similarly proportional to received signal strength. This state of affairs differs considerably from that given with positive modulation a.g.c. systems, wherein it is either necessary to employ an a.g.c. voltage which is proportional to mean signal level, or to use complex gating circuits to obtain an a.g.c. voltage which is proportional to blanking level.

Single-Diode Negative Modulation A.G.C. Circuits

Fig. 224 (a) illustrates a simple a.g.c. detector for use with a negative modulation signal. The diode is coupled to the secondary winding of the last vision i.f. transformer in such a manner that a voltage which is negative with respect to chassis appears on the upper plate of condenser C1. If this condenser and its parallel resistor, R, have a time constant equal to the period occupied by some twenty or more lines of picture information, a substantially steady voltage, nearly equal to sync pulse tip amplitude, appears on the anode of the a.g.c. diode. Such a voltage will be proportional to received signal strength and may be employed for automatic gain control.

An alternative method of connecting the a.g.c. diode, and one which may be more frequently encountered in practical receiver circuits, is illustrated in Fig. 224 (b). This diagram shows the vision detector in addition to the a.g.c. diode. A negative voltage, nearly equal to sync pulse tip level, appears on the anode of the a.g.c. diode. Condenser C1 and R1, carry out the same functions as did C1 and R1 of Fig. 224 (a), and their time constant should be similar. (The a.g.c. diode circuit of Fig. 224 (b) is merely a rearrangement of the diode components of Fig. 224 (a).)

A voltage delay for the circuit of Fig. 224 (b) may be obtained by returning R1 to a point which is negative of chassis, as in Fig. 224 (c). The a.g.c. diode will not then conduct, and cause an a.g.c. voltage to be formed, until the signal applied to it has an amplitude greater than the delay voltage. Alternatively, a delay may be obtained by the use of a clamp diode circuit, such as that shown in Fig. 214 (d). A clamp diode may similarly be used to provide a delay for the circuit of Fig. 224 (a).

If the time constant of the resistor and condenser associated with the a.g.c. diode is very short, the voltage across the condenser will rise when the line sync pulses give way to blank frame pulses, and will fall when the blank frame pulses cease. This is because the blank frame pulses cause maximum signal amplitude to be applied to the a.g.c. diode for a longer period of time than do the line sync pulses. (The effect is largely absent during the equalising pulses which precede and follow the blank frame pulses because, although these occur at twice line pulse frequency, their width is half that of the line pulses.) Should the resultant a.g.c. voltage then be applied direct to the controlled valves the overall receiver gain would fall during the time that frame pulses were transmitted; with the circuit of Fig. 224 (a) there would be passed to the sync separator at reduced amplitude and the i.f. stages of the receiver would be modulated at frame frequency (and the taud signal by increasing the time constant of the resistor and condenser associated with the a.g.c. diode, or by causing the low-pass filter to which the a.g.c. voltage from the diode is applied to have a relatively long time constant. In practice it is usual to give the a.g.c. diode a relatively short time constant of the order of twenty frames and the low-pass filter a relatively long time constant of the order of ten frames or more).

An a.g.c. circuit commonly employed in negative modulation receivers is illustrated in Fig. 224 (d). In this diagram a single diode performs both as a vision and a.g.c. detector. As with positive modulation receivers, it is common practice for negative modulation receivers to employ a single video amplifier feeding a signal having positive-going sync pulses to the cathode of the cathode-ray tube. The signal passed to the grid of the video output valve from the vision detector has, therefore, negative-going sync pulses; whereupon this grid signal, after application to a suitable low-pass filter, can be employed for a.g.c. purposes. The circuit of Fig. 224 (d) has the disadvantage that the a.g.c. voltage obtained is not proportional to signal strength but to average signal level. The system becomes subject, therefore, to the same defect as occurs with a positive modulation mean level a.g.c. system, inasmuch that changes in the brightness of the transmitted scene cause changes in receiver gain. In this instance, however, a reduction in transmitted brightness will cause an increase in a.g.c. voltage together with a reduction in receiver gain, and vice versa.

The a.g.c. circuit of Fig. 224 (d) may be delayed by the use of a clamp diode.

If a noise pulse having a level greater than sync pulse tip amplitude is applied to an a.g.c. diode circuit of the type shown in Figs. 224 (a) to (e) the rectified voltage from the diode may rise nearly to the peak value of the pulse and cause an increased a.g.c. voltage to be passed to the controlled valves. The consequence is that receivers employing an a.g.c. circuit of this type may suffer temporary reductions in gain in the presence of impulsive interference. The effect is less troublesome with the circuit of Fig. 224 (d), because the a.g.c. voltage formed here is proportional to average applied level instead of peak applied level. It is occasional practice, in receivers employing peak a.g.c. detectors, as in Figs. 224 (a) to (e) to provide a pre-set adjustment of the time constant of the associated resistor and condenser. A typical instance would consist of making the variable component in series with a fixed resistor to restrict its range. In areas free of interference the variable resistor could then be adjusted to insert maximum resistance into circuit, thereby enabling the a.g.c.
diode to function as a peak detector and to provide an a.g.c. voltage proportional to applied signal level. In areas with heavy impulsive interference, the variable resistor could be adjusted to insert minimum resistance into circuit, whereupon the a.g.c. diode would operate as an average level detector.

Gated Negative Modulation A.G.C. Circuits

The single-diode a.g.c. circuits just discussed suffer from the defects that the associated system has to have a relatively long time constant, and that they are susceptible to impulsive interference. These

[Diagram of gate a.g.c. circuit for use in negative modulation receivers. The pentode screen grid requires a higher h.t. potential than the pentode cathode]

shortcomings may be largely overcome by the use of gated a.g.c. circuits.4

A very commonly employed gated a.g.c. circuit is illustrated, in basic form, in Fig. 225. In this diagram, the control grid of the pentode is connected, via a d.c. coupling, to the anode of the video output valve, the pentode cathode being returned to the h.t. positive supply rail for that anode. The signal at the video output anode has positive-going sync pulses and, provided the video output valve is not cut-off, the pentode grid is always negative of its cathode because of the voltage dropped across the video output

4 Gated a.g.c. circuits are often described in American literature, as keyed a.g.c. circuits.

upper end of R2 goes more negative when signal strength increases, and less negative when signal strength decreases. This voltage may in consequence be employed for automatic gain control. It might be noted, incidentally, that the circuit around the pentode functions in much the same manner as does that around the triode a.g.c. amplifier of Fig. 221. A pentode is needed in Fig. 225, instead of a triode, to reduce capacitive coupling between the anode and grid. Such coupling could cause the pulses from the line output transformer to be coupled into the video output anode circuit, whereupon sync separator performance might be adversely affected.

If a delay is required, a suitable clamp diode circuit may be added. The circuit of Fig. 225 has a number of advantages. Firstly, due to the inherent amplifying action provided by the pentode and the fact that high level signals (from the video output anode) may be applied to it, the gain of the a.g.c. system of which it forms a part is high. Secondly, the a.g.c. voltage obtained, being proportional to sync pulse tip amplitude, is similarly proportional to received signal strength. Thirdly, the circuit is much less liable to be affected by noise pulses than are the simple single-diode circuits of Fig. 224. The pentode does not conduct between pulses from the line output transformer, with the result that the only noise pulses which can affect the system are those which coincide with pulses from the transformer. Fourthly, the circuit does not suffer from paralysis or lock-out. This is because a large video signal suddenly applied to the video output grid causes this valve to become cut-off, with the consequence that the grid of the pentode assumes the same potential as its cathode. Condenser C1 receives, therefore, a high charge during pulses from the line output transformer and the a.g.c. line goes sufficiently negative to remove the overload. Fifthly, the circuit can be employed in an a.g.c. system having a short time constant because, during equalising and broad frame pulses, the grid of the pentode will still be at sync tip level when the pulse from the line output transformer is applied to the anode. In this instance, however, it would be advisable to change, by means of a differentiating circuit, the pulse from the line output transformer to a spike, so that it occupies a shorter period of time than the half-width equalising pulses. This would then ensure that the pentode grid was at sync tip level throughout the existence of the spike.

The main disadvantages of the circuit of Fig. 225 are that it cannot function correctly until the line sawtooth generator is in synchronism with the received signal, and that, immediately after switching on the receiver, no a.g.c. potential is developed until the booster diode has warmed up and gating pulses are available from the line output}

5 Published in last month's issue.
transformer. Both these shortcomings seem to be generally tolerated, in American
receivers at any rate, even though the second
results in a particularly obvious fault known
as “warm-up buzz.” If, during warm-up, the
receiver happens to be tuned to a powerful
signal, this is applied at a high level to the i.f.
stage. Before the appearance of an a.g.c.
voltage these stages operate at maximum
sensitivity, with the result that overloading
takes place and the sound i.f. is heavily
modulated by the vision i.f. The consequence
is that, until the booster diode warms up and
an a.g.c. voltage is formed, a loud buzz at
framing frequency can be heard from the loud-
speaker. Simple protection circuits or
deVICES to overcome or reduce this effect may
be fitted to later receivers.

Contrast Controls in Negative Modulation
Receivers
In positive modulation receivers it is
normal practice for the contrast control to
vary the bias applied to the r.f. and/or the
i.f. stages. Such a contrast control is usually
incorporated into the a.g.c. system itself.
In negative modulation receivers the contrast
control is normally inserted after the vision
detector, in which case it varies the gain
provided by the vision detector and the
modulating electrode of the cathode ray tube.
The a.g.c. system then functions independ-
ently of the contrast control.

Contrast control circuits which vary the
gain between the vision detector and the
modulating electrode of the cathode ray tube
fall into two basic types. The first type
employs a potentiometer to vary the screen-
grid or bias potential of the video amplifier
and, thereby, the gain it provides. The
second type employs a potentiometer which
functions in the same manner with the video
signal as does an a.f. volume control with an
audio signal. A representative example is
illustrated in simplified form in Fig. 226 (a),
wherein the potentiometer is part of the video
output anode load. The video signal tapped
off by the slider of the potentiometer is then
passed to the modulating electrode of the
cathode ray tube. The circuit around the
potentiometer, and the component itself,
requires care in design to ensure that stray
capacitances between the slider and chassis do
not cause attenuation of the higher video
frequencies when the slider is some way
removed from the anode end of the track.
Sometimes the possibility of high frequency
attenuation is overcome or reduced by
connecting a low value condenser (of the
order of 30pF) between the anode end of the
track and a fixed tap, as in Fig. 226 (e).

Power Supply Circuits
Domestic television receivers normally
obtain their operating power from the mains
supply. In Britain, mains supplies are
available at 200 to 250 volts, and 50 c/s
a.c. or d.c. (usually the former). European
mains supplies are normally 50 c/s a.c. at
voltages of 200 to 250, with lower voltages
occurring in certain countries. Australian
mains supplies are normally 200 to 250 volts
50 c/s a.c., whilst American mains supplies
are at 60 c/s a.c. with a nominal voltage of
117.

The purpose of television receiver power
circuits is to convert the power available
from the mains to an h.t. supply and a heater
supply. Other power requirements, such as
the boosted h.t. positive supply or potentials
negative of chassis for bias or a.g.c. protection
devices, are then obtained from the receiver
circuits themselves.

In early British receivers it was conven-
tional practice to employ an isolated mains
transformer similar to that illustrated in
Fig. 227 (a). A full-wave h.t. secondary fed
a conventional valve rectifier, and heater
supplies were obtained from one or more
heater secondaries. Later circuit arrange-
ments allowed a reduction in costs by the use
of an autotransformer, a typical example
being illustrated in Fig. 227 (b). In this
diagram the voltage of approximately 250 a.c.
is applied to a half-wave selenium rectifier
to provide h.t., whilst a heater secondary or
secondaries is provided as before. A sig-
nificant difference between the circuit of
Fig. 227 (b) and that of Fig. 227 (a) is that,
in the latter, the chassis of the receiver is
connected to one side of the mains supply in
order that an h.t. negative connection may
be made. The chassis is, in consequence,
“live”, and special precautions have to be
taken to prevent shock.

Both the circuits of Figs. 227 (a) and (b)
require that the television receiver be operated
from a.c. mains supplies only. They have
now been superseded in Britain by the
a.c./d.c. type of power supply shown in
Fig. 227 (c), which has become standard
practice for a considerable number of years.
In Fig. 227 (c) the mains supply is connected
directly to chassis and, via one or more
resistors, to the anode of a half-wave h.t.
rectifier. The heater supply is obtained by
wiring all the valve heaters in series, and
connecting these to the mains supply via one
or more resistors and a thermostat. In
Figs. 227 (a) and (b) varying mains supply
voltages are catered for by employing taps
in the transformer. In Fig. 227 (c) they are
catered for by selecting different values of
resistance in series with the h.t. rectifier and
the heaters. The power supply circuit of
Fig. 227 (c) is capable of functioning from

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6 American equipment manufacturers occasionally
specify an input voltage of 105–125 volts.
7 These are known, in American terminology, as the
B supply and the A (or “ filament”) supply respectively.
8 A thermistor exhibits high resistance when cold and
low resistance when warm. It consequently prevents a
heavy surge of current through the heaters when the
receiver is switched on.

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Fig. 227 (a). A mains transformer power supply circuit of the type employed in
early British television receivers
(b) A development of the circuit shown in (a), in which economy is obtained by
the use of an autotransformer. The resistor in series with the rectifier is intended
to limit the current it passes when it conducts.
(c) A power supply circuit of the type employed in current British receivers

FEbruary 1961
CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all replies, etc., received and to reimburse all reasonable expenses incurred by correspondents.

Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

THE BC-348 Receiver

The BC-348 is an American a.m. receiver intended for operation from 24-28 volt aircraft batteries (negative terminal earthed). It covers 10 kHz to 150 kHz and 1,500 kc/s to 18 Mc/s. Its main attraction, therefore, is a Short-wave receiver.

Before passing on to conversion details it will be helpful to quickly discuss the receiver in its unmodified state. The description which follows refers to the basic BC-348 and should be applicable to all models (distinguished by different suffix letters), available on the British surplus market.

The main controls available on the BC-348 are as follows: tuning condenser, band selector switch, combined on-off and a.v.c.-m.v.c. switch, b.f.o. switch, crystal filter switch, volume control, and dial light dimmer control. An aerial alignment control may also be fitted. The volume control consists of two ganged potentiometers, one acting as a conventional a.f. volume control in the grid circuit of the output valve, and the other as an r.f. volume control varying the bias on the cathodes of the two r.f. valves and the first and second i.f. valves. When the main switch is in the m.v.c. (manual volume control) position, the grid of the a.f. output valve is taken to the top end of the a.f. potentiometer track instead of its slider, with the result that the r.f. circuits operate at full gain and control of receiver volume is achieved entirely with the r.f. potentiometer.

When the main switch is in the a.v.c. position, the r.f. potentiometer slider is taken to chassis via a low value resistor, the output valve grid being returned to the slider of the a.f. potentiometer. Thus, on a.v.c., the f.f. and r.f. stages function with minimum cathode bias, and volume control is achieved entirely with the a.f. potentiometer.

The valve line-up in most BC-348 models, likely to be encountered, is as follows: 1st r.f., VT117 (6SK7 metal); 2nd r.f., VT117 (6SK7 metal); mixer, VT150 (6SA7 metal); 1st f.f., VT117 (6SK7 metal); 2nd f.f., VT117 (6SK7 metal); 3rd i.f., VT116 (6SJ7 metal); 2nd detector, a.v.c. diode, and b.f.o. triode, VT233 (6SK7 metal); a.f. amplifier and output, VT152 (6K6GT). Earlier receivers had the following line-up: 1st r.f., VT86 (6K7 metal); 2nd r.f., VT86 (6K7 metal); mixer, VT91 (6J7 metal); separate oscillator VT65 (6C5 metal), h.t. voltage regulator for the oscillator; 1st i.f., VT86 (6K7 metal); 2nd i.f. and b.f.o. triode, VT70 (6F7 metal); 3rd i.f., a.g.c. and a.f. diode, VT93 (68B metal); a.f. amplifier and output, VT48 (41).1

1 Variations such as 6K6GT instead of 41 in the second line-up may perhaps be encountered, but circuit functions should remain unaltered.

February 1961

by P. Meredith

Despite the considerable amount of time which has elapsed since surplus electronic equipment became available on the amateur market, readers still show keen interest in conversion details for the more commonly met receivers and test equipment. In this article our contributor discusses the conversion of the BC-348 receiver to amateur use. The conversion of other items of surplus equipment will be covered from time to time.—Editor.
considerable emphasis has been placed on ruggedness and reliability, and the cliché “built like a battleship” definitely applies. The BC-348 is not, however, a receiver in which all components are easily accessible, and this may be something of a deterrent to those wishing to modify the design. This point is taken into account in the conversion details given later.

**External Connections**

There are three sets of connections to the receiver.

Of these the first set consist of antenna and ground terminals mounted on the front panel. The antenna terminal connects to the arm of the first band-selector switch wiper and, hence, to the appropriate aerial coils. The ground terminal connects direct to chassis.

The second set of connections consist of two a.f. output jacks of conventional design. These are wired in parallel and connect to the secondary of the a.f. output transformer. The jacks do not incorporate any switching circuits actuated by the insertion of a jack plug.

The third set of connections is to an 8-way plug at the rear of the receiver. The services provided by the pins of this plug are shown in Fig. 1. It will be seen, in this diagram, that the 24-28 volt aircraft supply is fed to four pins, these consisting of pins 8 and 7 joined together (and thence to chassis) for the negative connection, and pins 3 and 4 joined together for the positive connection. From pins 3 and 4 the positive supply passes through a fuse, the a.v.c.-off-m.v.c. switch, a connector between the main receiver and the dynamotor unit, and is finally applied to the motor section of the dynamotor. Also, via a jumper on the dynamotor unit, it connects back into the receiver to supply the heaters. The secondary of the a.f. output transformer couples to pins 1 and 5, pin 5 being at chassis potential. It will be noted that pins 1 and 5 are in parallel with the two output jacks referred to in the preceding paragraph and that they connect across the complete secondary winding of the output transformer. This connection provides a high impedance output. A low impedance output is available by connecting the non-earthed output lead to the tap in the secondary winding. (Incidentally, I have not personally encountered a BC-348 wired up for low impedance output.)

Pin 2 connects to B+ (h.t. positive) while pin 6, via various dropping resistors, is connected to the screen-grids of the r.f. and first and second i.f. valves, and to the anode circuit of the b.f.o. Pins 2 and 6 were originally intended for connection to a send-receive switch or relay. When the circuit between them is opened the receiver is muted, thereby enabling the associated transmitter to be operated. Pins 2 and 6 must be connected together if the receiver is to function.

**Power Supplies**

Having paid attention to the main features of the receiver we now continue with details of conversion. These apply to receivers having either the 6SK7 or the 6K7 line-up.

H.T. power in the unmodified receiver is obtained from the generator section of the dynamotor unit. For mains operation the transformer primary which is remote from the output valve anode. Zero resistance should be obtained between either of these points and the B- terminal. The B- (h.t. negative) terminal connects to chassis via an auto-bias resistor having a value around 500k. The negative connection to the heater network is made via chassis, and this is covered by a single terminal which is obviously at chassis potential. The remaining two terminals will be the two 24-28 volt positive terminals which were “jumpered” to the heater terminal.

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**Fig. 1 (left).** The receiver circuits immediately connected to the 8-way plug. **Fig. 2 (right).** The circuits around the dynamotor unit terminals.

**Fig. 3 (left).** A suitable mains power unit for the BC-348. **Fig. 4 (right).** How a 27 volt a.c. heater supply may be connected to the dynamotor terminals.

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**THE RADIO CONSTRUCTOR**

FEBRUARY 1961
over in the dynamotor unit. One of these will be the 24-28 volt input terminal, and this will show zero resistance to pins 3 and 4 of the 9-way plug (assuming a serviceable input fuse), or a varying resistance to chassis at the panel light dimmer is operated (assuming serviceable bulbs). The other terminal will be that which connects to the heater network. This will show a change of resistance to chassis if any valve is removed from its socket.

Later.) H.T. voltages above 250 are inadvisable, in my opinion, as the fractionally increased gain and output power which result are outweighed by the risk of broken down decoupling condensers or failure of the output valve (if this is retained). I would certainly suggest that the top limit for h.t. voltage be set at 280 when, with the receiver on m.v.c., volume is set to minimum. The h.t. supply will need to be reasonably well regulated by virtue of varying current demands, and it would be advantageous to fit a bleeder resistor taking some 10mA or so. A suitable h.t. supply is shown in Fig. 3. The h.t. secondary of the transformer in this diagram is specified as providing a current (for the receiver with unmodified a.f. circuits) of 90mA, as an extra 10mA approximately is consumed by the 22kΩ bleeder resistor.

The h.t. rectifier may be any indirectly heated full-wave type suitable for this class of work, such as the 5Z4, GZ30, etc. It is important to note that the h.t. negative line is not at chassis potential. Electrolytic condenser caps must therefore be insulated from chassis, where applicable.

A heater winding is shown on the mains transformer of Fig. 3, but no single voltage is specified. The reason for this is that it is possible to operate the heaters of the converted BC-348 in one of two ways. One method consists of modifying the heater winding such that all the valve heaters are in parallel, whereupon a 6.3 volt supply at 2.5 amps (ignoring current drawn by the panel lights and assuming unmodified a.f. circuits) becomes necessary. The alternative method of feeding the heaters consists of keeping the wiring in the receiver as it is, and of supplying the existing heater network with 27 volts a.c. at a current of 1 amp (assuming a panel light consumption of 0.3 amp and unmodified a.f. circuits). In my own opinion this second alternative is easier, because it completely obviates the necessity of altering heater wiring, some of which may be a little inaccessible. I must admit that my judgment may well be biased by the fact that I have been able to obtain specially-wound mains transformers fairly readily when carrying out my own conversions. If the reader is able to obtain a transformer with a 27 volt secondary (or is prepared to string several secondaries in series to obtain this voltage), all that is necessary is to connect one side of the 27 volt supply to chassis, and the other to the 24-28 volt terminals at the dynamotor unit in the manner shown in Fig. 4. All heaters should then light up correctly, as will also the dial lamps. I have found that this method of operation has caused no trouble whatsoever due to hum injection.

Having identified the various terminals to which the dynamotor unit connects, we next consider a suitable form of mains power unit. The receiver will work comfortably with an h.t. supply of 200 to 250 volts at a current, assuming no modification to the a.f. circuits, of 90mA minimum. (The question of modification to the a.f. stages is discussed

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To Chassis (6X7 Line-up)  
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500WV

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![Fig. 6](image)

(a) The output anode circuit in the unmodified receiver.
(b) Fitting a speaker transformer. The resistor previously connected across the primary is removed.
(c) A speaker silencing switch. The resistor should have a value approximately, equal to speech coil impedance.

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745GT
6V6GT

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![Fig. 7](image)

Fig. 7. Base connections to the 6X6GT, 6V6GT and 41

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THE RADIO CONSTRUCTOR

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For those who are prepared to change the heaters in the receiver over to parallel operation Fig. 5 (a) shows the heater network installed in receivers having the 6SK7 line-up which will have to be modified. As may be seen there are two chains, one of which consumes 0.3 amp, whilst the other consumes 0.4 amps. Apart from the 6K6GT, all valves draw 0.3 amp heater current. The 6K6GT draws 0.1 amp, and the consequent additional 0.1 amp in its chain is bypassed by the 190Ω resistor. If it is intended to convert to 6.3 volt operation the best procedure would consist of making the changes illustrated in Fig. 5 (b). In this diagram chassis connections are made at the centre and left-hand end of each chain, the 6.3 volt supply being then fed to the four intermediate points. Fig. 5 (c) illustrates the heater network in receivers having the 6K7 line-up, and to manufacturing changes, and this factor should be borne in mind when carrying out the modifications. It would certainly be wise to check that no short circuits have been accidentally introduced into the wiring before connecting up the 6.3 volt secondary winding. If it is felt worthwhile, the panel lights may be run from the 6.3 volt supply by connecting them up in the manner illustrated in Fig. 5 (d). In the modified arrangement of Fig. 5 (b) the two phone jacks are coupled to the output anode via a 0.05 μF-500 w.v. condenser and can, in consequence, accept high impedance phones. At the same time, pins 1 and 5 of the 8-way plug connect direct to the speech coil of the speaker. It is important to note that the secondary of the transformer should always be loaded by a resistor if the speaker is silenced, as the transformer may otherwise be damaged by high a.f. voltages on its primary. The speaker silencing switch of Fig. 6 (c) covers this point. As an aid to choosing the requisite speaker transformer it should be noted that the 6K6GT (or 41) is designed to work into an anode load of 7,600Ω and that its anode current will be of the order of 30mA.

Better results should be given by replacing the output transformer in the receiver with a standard speaker transformer, as demonstrated in Figs. 6 (a) and (b). In the modified arrangement of Fig. 6 (b) the two phone jacks are coupled to the output anode via a 0.05 μF-500 w.v. condenser and can, in consequence, accept high impedance phones. At the same time, pins 1 and 5 of the 8-way plug connect direct to the speech coil of the speaker. It is important to note that the secondary of the transformer should always be loaded by a resistor if the speaker is silenced, as the transformer may otherwise be damaged by high a.f. voltages on its primary. The speaker silencing switch of Fig. 6 (c) covers this point. As an aid to choosing the requisite speaker transformer it should be noted that the 6K6GT (or 41) is designed to work into an anode load of 7,600Ω and that its anode current will be of the order of 30mA.

My own experience with the 6K6GT as fitted to BC-348 receivers has been rather disappointing, in so far that its life tends to be short.2 Replacements are, also, rather difficult to obtain in this country. In consequence, it is not a bad plan to replace the output valve with a 6V6GT when carrying out the modification to mains operation. The 6V6GT has the same base connections as the 6K6GT and can be plugged into the same holder. It will be necessary, however, to change the base if a 41 is employed in the receiver. Fig. 7 illustrates the base connections for types 6K6GT, 6V6GT and 41. The 6V6GT draws some 10mA more h.t. current than the 6K6GT (or 41), and its heater is rated at 0.45 instead of 0.4 amp. This latter point necessitates an increase in heater current of 0.05 amp in both 6.3 or 27 volt heater supplies. Further, with the 27 volt heater supply, the 190Ω resistor of the 27 volt heater networks in Figs. 5 (a) and (c) will need to be altered to 130Ω instead, or be shunted by an additional 3800Ω 1 watt resistor, to bypass the extra 0.05 amp. A metal 6V6 can be used instead of a 6V6GT provided that pin 1 of its base (connecting to valve shell) is bonded to chassis. So far as the requisite speaker transformer is concerned, the 6V6GT requires an anode load impedance of 5,000Ω.

1 The same remark could, presumably, apply to the 41.

2 February 1961
2.5 MW Magnetron Helps Probe Moon’s Surface

In a letter to Nature recently, Mr. V. A. Hughes, of the Royal Radar Establishment at Malvern, gave news of recent investigations carried out into the roughness of the moon’s surface as a radar reflector.

From the results of these experiments the assumption is made that the surface has vertical irregularities which are greater than a wavelength and a horizontal scale which is considerably larger. The angular scattering properties of the lunar surface were measured at a wavelength of 10cm by a 45ft radio telescope, the radar transmitter being powered by an English Electric 2.5MW M543 magnetron.

This is one of the long anode magnetrons currently being produced by the English Electric Valve Co. Ltd., capable of delivering a very high mean power. Under typical operating conditions the mean power is 3.75kW at 300 p.s.s., with a pulse length of 5 μsec.

In this experiment a pulse length of 5 μsec, corresponding to a range resolution of 0.75 km, was used, and since the area of the lunar surface illuminated by the pulse at any one time is considerably larger than the beam, the data obtained by the radar after first contact with the moon to nearest point of the surface.

The law of scattering derived by Mr. Hughes is consistent with scattering from a rough surface which has irregularities much greater than a wavelength and a horizontal scale over twenty times the vertical deviations.

It will be found that the coupling condenser to the grid of the output valves in the receiver has a rather low value (0.001 to 0.0015μF). Bass response will be improved if this is replaced, or shunted, with a 0.01μF unit.

An Additional A.F. Valve

The BC-243A power triode can be converted by myself into a small FET amplifier and the output valve, thereby making the a.f. circuit consistent with that given in conventional communications receivers. There are a number of obvious ways in which such a modification may be carried out, but I feel that the simplest consists of fitting a two-stage amplifier on its own small chassis into the space previously occupied by the dynamotor. Such an amplifier can employ a modern triode-pentode of the type now common in television and radio receivers.

A typical example is illustrated in Fig. 8. The two-stage amplifier shown here employs an ECL82 or PCL42 triode-pentode, and obtains its drive via a 0.01μF condenser coupled to that terminal of the receiver output valve grid coupling condenser which is remote from grid. The 6K6GT (or 41) is now discarded. This method of operation has the advantage of obviating modifications to the auto-bias circuits in the receiver. The ECL82 has a heater voltage of 6.3 at a current of 0.78 amp and it should be used with parallel heater arrangements. The total parallel heater current will then become 2.88 amps (an increase of 0.38 amps over the figure applicable with the 6K6GT). There is no significant change in h.t. current requirements. The ECL82 should feed into an anode load impedance of 5kΩ.

If the original 27 volt heater wiring is retained, the extra amplifier may employ a PCL42. This has the same base connections as the ECL82, and its heater voltage is 16 at 300mA. The heater supply may then be modified in the manner shown in Fig. 9, whereupon the heater current requirement at 27 volts becomes 1.2 amps. H.T. consumption with the PCL42 increases by approximately 10mA, and its anode load impedance should be 5.6kΩ.

Send-Receive Switching and Tuning Meter

As was mentioned above, the receiver may be disabling by opening the circuit between pins 2 and 6 of the 8-way plug. These two pins can, in consequence, be wired to a send-receive switch.

Since the current drawn by the screen-grids fed via pin 6 vary with a.g.c. voltage it becomes possible to connect a tuning meter, or meter, to them. A suitable circuit, which includes a send-receive switch, is shown in Fig. 10. If there is evidence of current surges in the meter when the send-receive switch is closed, it may be protected by connecting a condenser of the same on the 3.2μF or so in parallel with it. It may be possible, especially with receivers employing the 6K7 layout, to employ a meter less sensitive than the 0–10mA unit shown in Fig. 10. This point may readily be checked with a test-meter before selecting a particular meter.

THE COOPER-SMITH 20 WATT POWER AMPLIFIER PROVIDES A TRUE HIGH FIDELITY OUTPUT AT HIGH POWER. IT IS AN INSTRUMENT WHICH IS IDEAL FOR HIGH GRADE SOUND REINFORCEMENT AND PUBLIC ADDRESS SYSTEMS, AND IT CAN ALSO BE USED IN APPLICATIONS IN THE DOMESTIC FIELD. IN THE LATTER CASE, THE AMPLIFIER WOULD NOTICED AS BEING OPERATED BELOW ITS RATED OUTPUT, THE FACT THAT IT HAS A SIGNIFICANT DEGREE OF UNDISTORTED POWER IN RESERVE WHEN SUCH TRANSCENDS AND THE LIKE ARE PRODUCED FREE OF CHARGE WITHOUT INTRODUCING OVERLOAD AT ANY TIME.

The photograph at the head of this article clearly illustrates the clean and well laid-out layout of the amplifier. An under-chassis illustration is also shown, and it will be seen from this that component layout has the same neatness, and exhibits the same care in design, as has been evident in previous equipments in the Cooper-Smith series.

Amplifier Features

The amplifier is designed to operate in conjunction with the Cooper-Smith Mk. II Control Unit, although other pre-amplifiers could be used instead if they met input requirements. Power supply sockets are available both for the pre-amplifier and for a radio tuner unit. There is also an outlet which may be used for supplying mains voltage to a gram motor or to any similar ancillary equipment. On-off switching for the power amplifier is achieved at the Control Unit, and the pre-amplifier socket carries the necessary wiring for this facility.

A special feature of the amplifier is given by the output transformer. This component is of heavy construction and employs C-cores instead of normal laminations to keep leakage inductances to a minimum. The transformer is coupled to the output valves in an ultra-linear circuit. Output impedances at 3.8, 8.5 and 15.2 ohms are available, these being selected by fitting individual plugs into a special 9-way matching socket. The plugs are identified by the output impedance they provide and they are wired internally such that appropriate combinations of the output transformer secondary windings are presented to the two loudspeaker terminals. The plugs also carry components which enter the negative feedback loop, these components ensuring that feedback at the correct level is achieved whatever output impedance is selected.

Special attention has been paid in the design of the amplifier to the prevention of hum. A centre-tapped 6.3 volt secondary on the mains transformer supplies the heaters of the first two valves in the amplifier circuit, and is available for use by the pre-amplifier and radio tuner unit as well. Main h.t. smoothing is carried out with paper, and not electrolytic, condensers. Fuses are provided both in the mains input and in the h.t. supply circuit.

The technical specification for the amplifier is as follows:

- Output: 20 watts nominal, 30 watts maximum.
- Distortion: 0.1% at full output.
- Input Sensitivity: 650mV referred to 29.3 kHz.
- Frequency Response: 30–30,000 c/s ± 0.5 dB.
- Feedback: 26dB.
- Noise Level: –80dB referred to 29.3 kHz.
- Output Impedance: 3.8, 8.5 or 15.2 ohms.
- Output: EL 34’s, ultra-linear.
- Size: 14in x 8.5in x 7.5in.
- Weight: 26lb.
Fig. 1. The circuit of the Cooper-Smith 20 watt Power Amplifier

Components List

(See out for easy reference to Fig. 1)

Resistors

(All 30% ± watt high stability unless otherwise specified.)

R1 1MΩ
R2 3.9kΩ
R3 68kΩ
R4 22kΩ
R5 220kΩ
R6 220kΩ
R7 1000Ω
R8 3.3kΩ
R9 1.2MΩ
R10 1MΩ, matched 2%
R11 10kΩ
R12 10kΩ
R13 Value dependent on tuner h.t. consumption
R14 4.7MΩ, matched 2%
R15 4.7kΩ, 1 watt
R16 47kΩ, matched 2%
R17 470kΩ
R18 470kΩ
R19 680Ω, 1 watt
R20 470Ω
R21 22kΩ, matched 2%
R22 10kΩ
R23 10kΩ
R24 470Ω, matched 3%, 3 watt wire
R25 1.2kΩ
R26 1.2kΩ

Condensers

C1 16μF 450 W.V. elec.
C2 8μF 450 W.V. elec.
C3 50μF 12 W.V. elec.
C4 50μF 12 W.V. elec.
C5 0.25μF 500 W.V. paper
C6 0.25μF 500 W.V. paper
C7 470pF mica
C8 470pF mica
C9 8μF 450 W.V. elec.
C10 5000pF mica
C11 5000pF mica
C12 0.47μF 500 W.V. paper
C13 0.47μF 500 W.V. paper
C14 50μF 50 W.V. elec.
C15 50μF 50 W.V. elec.
C16 7 or 8μF 500 W.V. paper
C17 7 or 8μF 500 W.V. paper

Valves

V1 12AX7/ECC83
V2 12AU7/ECC82
V3 EL34
V4 EL34
V5 GZ32

Miscellaneous

(All available from H. L. Smith & Co. Ltd.)

T1 Output transformer. C-core, ultralinear, 6.6kΩ anode-to-anode, tapped at 43%, 4-section secondary.
T2 Mains transformer. 400-0-400 volt 200mA h.t., 6.3 volt 3.5A centertapped heater, 6.3 volt 4A heater, 4 volt 3A heater.

CH1 Choke. 12H, 200mA
Input plug and socket, coaxial
Speaker plugs and sockets
Power plug and socket, pre-amplifier, International Octal
Power plug and socket, tuner unit, 5-way
Mains input plug and socket
Motor plug and socket
2 valveholders, B9A
3 valveholders, International Octal
Speaker matching socket
Speaker matching plug. 15.2 ohm or 8.5 ohm or 3.8 ohm
Mains selection panel and 2A fuse
H.T. fuse and holder, 250mA
Group board and fixing screws
Chassis, cover and base-plate
Screws, nuts, wire, sleeveing, etc.
to the grids of $V_2$ (12AU7). The triodes of $V_2$ amplify the a.f. voltages independently, but they share a common unbypassed cathode bias resistor in order to reduce the effects of any unbalance in the applied signals, or in the triodes themselves.

The two outputs from $V_2$ are fed, via $C_{12}$ and $C_{13}$ and the stoppers $R_{25}$ and $R_{26}$ to the grids of the output pentodes $V_3$ and $V_4$. These two valves are EL34s and they function in an ultra-linear circuit, their screen-grounds being returned to taps in the primary winding of the output transformer. The secondary windings of the output transformer connect transformer secondary to the cathode circuit of the left hand triode of $V_3$.

In the power supply section the mains input is applied to the Motor Socket and, via fuse $F_{S2}$ and the on-off switch, to the primary of the mains transformer, The Motor Socket is permanently connected to the mains supply and is not controlled by the amplifier on-off switch. This is to allow the motor to be switched off independently by its own control or mechanism, thereby obtaining the possibility of the formation of “flats” on its drive wheel. The on-off switch shown in Fig. 1 is, in practice, intended to

![Fig. 2. The different manners in which the output transformer secondary windings are interconnected by the matching plugs. The 15.2 ohm matching circuit is shown in (a), the 8.5 ohm circuit in (b), and the 3.8 ohm circuit in (c).](image-url)

![Fig. 3. The connections to (a), the pre-amplifier socket and (b) the tuner unit outlet socket. In both cases, the diagram gives a rear view of the socket](image-url)

to the 9-way matching socket, the required output impedance being selected by choice of the appropriate plug. Each of the output impedance matching plugs contains a resistor and parallel condenser which couples pin 5 of the matching socket to pin 1. As will be shown shortly (when the matching circuit is considered in greater detail) the matching plug then allows a negative feedback voltage to be applied from the output to be mounted in the pre-amplifier (a suitable switch is already available in the Cooper-Smith Mk. II Control Unit) and the appropriate wiring is, in consequence, coupled to the pre-amplifier socket on the amplifier chassis. Fuse $F_{S2}$ is incorporated in the bridging link of the mains voltage selection panel.

The 400-0-400 volt secondary of the mains transformer connects to the rectifier $V_3$. This is a GZ32 and the rectified voltage on its cathode is applied, via fuse $F_{S3}$, to the smoothing circuit given by paper condensers $C_{14}$ and $C_{15}$ and provides 2 amp duty smoothing choke $CH_1$. The smoothed voltage is supplied direct to the anode and screen-grid circuits of $V_3$ and $V_4$ and it is decoupled, by $R_{34}$ and $C_{16}$, to the output circuits of $V_3$.

This decoupled supply is further filtered, by $R_{3}, C_{14}$ and $R_{14}, C_{10}$, for use by the pre-amplifier and tuner units respectively.

The Loudspeaker Matching Circuit

As was pointed out earlier, the three output impedances available from the amplifier are obtained by fitting appropriate plugs into the 9-way impedance matching socket. The manner in which these plugs select the desired impedance is illustrated in Fig. 2.

Fig. 2 (a) shows the internal wiring of the 15.2 ohm plug, together with the resultant output transformer secondary connections. As may be seen, the plug causes all four secondary windings to be connected in series. Fig. 2 (b) gives the internal wiring and the resultant secondary connections effected by the 8.5 ohm plug. In this instance the two centre windings are connected in parallel, this parallel combination being in series with the two outside windings. In Fig. 2 (c) the 3.8 ohm plug, and the consequent secondary winding connections, are shown. This time the top and third windings are connected in series, as are the second and fourth windings. These two series combinations are then paralleled for application to the loudspeaker terminals. Fig. 2 clearly illustrates the fact that the different output impedances are obtained with optimum utilization of the four secondary windings.

The negative feedback circuit is completed, in each plug, by the parallel resistor and condenser connected between pins 5 and 1. For 15.2 ohm operation these have values of 470 ohm and 300pF, for 8.5 ohm operation values of 300 ohm and 470pF, and for 3.8 ohm operation values of 240 ohm and 600pF. Thus, the plugs automatically ensure that correct feedback is achieved, despite the varying a.f. voltages appearing at the loudspeaker terminals for different impedance connections.

If the amplifier is obtained in kit form, a 15.2 ohm plug is normally supplied unless alternative impedances are specified.

Pre-amplifier and Tuner Connections

The connections to the pre-amplifier and tuner unit sockets are illustrated in Fig. 3.

Fig. 3 (a) shows the International Octal 3-way pre-amplifier socket connections. Pins 2 and 7 carry the 6.3 volt heater supply, pin 3 provides the chassis connection and pin 6 the h.t. positive supply, via $R_2$. Pin 4 connects to the mains input and pin 5 to the mains transformer. Pins 4 and 5 have, therefore, to be bridged for the mains input to be applied to the power supply transformer. Such bridging is effected by the on-off switch in the pre-amplifier specified for use with the amplifier.

It should be pointed out that Cooper-Smith Mk. II Control Units may have a.f. output plugs different from the type required for the present amplifier. If this is the case, such plugs may be easily replaced by the type needed here; and a suitable plug is specified in the components list.

A 5-way socket is employed for the tuner unit, and this is wired as shown in Fig. 3 (b). The services provided here are an h.t. positive supply via $R_{14}$, chassis, and a 6.3V heater supply. The heater current available for both pre-amplifier and radio tuner unit is 2.8mA. The heater consumption of the Mk. II Control Unit is 0.5A, with the result that, if this pre-
amplifier is employed, 2.4A is available for the tuner unit. It is important to note that the heater supply for both tuner and pre-amplifier is taken from a heater winding whose centre-tap is connected to the power amplifier chassis. If the pre-amplifier or tuner unit has one side of its heater supply connected to chassis, such a connection must be broken before coupling to the power amplifier, or damage to the mains transformer or wiring will result.

The h.t. current available for both pre-amplifier and tuner unit is of the order of 40mA. A value for the series resistor, R14, is not specified, as this will vary according to the current and voltage requirements of the tuner unit.

(To be continued)

An Audio Frequency Oscillator

By A. G. BOOTH, B.Sc.

This article describes an original design for a transistor Wien bridge a.f. oscillator

This device was designed to meet the need for a cheap portable source of audio frequency signal, suitable for efficient checking of sound amplifiers.

Specification

The frequency range is approximately from 40 c/s to 40 kc/s in three ranges. Three transistors are used and the amplitude of oscillation is controlled by a thermistor. There is a variable output attenuator.

Since the thermistor allows less than 2% amplitude change with any change in frequency setting, the attenuator may be calibrated directly in output p.d. The rate of amplitude change with temperature rise is about -1% per Centigrade degree. The maximum available output p.d. is preset internally by potentiometer VR1, and is adjustable to about 1.5 volts r.m.s. on open circuit, which corresponds to 0.75 volt into a 1kΩ load.

At switch on, the thermistor takes about three seconds to reach the stable running temperature. Frequency drift at a constant dial setting is extremely small, but the frequency changes with temperature rise at a little less than -1% per Centigrade degree.

The power supply is three EverReady 4.5 volts pocket lamp batteries type 1289 with brass strip connections. The life of these is about 200 hours running time, since the total battery current is 7mA.

The harmonic content, chiefly second, in the output waveform is about 3% with VR3 at minimum resistance, falling to only 0.3% with VR3 at maximum resistance.

Principle of Operation

The oscillator section, comprising transistors TR1 and TR2, uses a Wien bridge for frequency control. The more familiar thermionic Wien bridge oscillator commonly uses the network shown in Fig. 1 for frequency control; the basis for this oscillator is the network shown in Fig. 2. Here the resistors are a two bank potentiometer, VR3, and the pair of condensers is selected by switch S2.

The signal at TR2 collector passes through the resistance/capacitance frequency selecting network to the base of TR1. The resulting signal at TR1 collector is applied to the base of TR2; this maintains the original signal at TR2 collector.

In the absence of the thermistor H1, the loop gain of this system would be much greater than unity. The presence of excessive signal amplitude at TR1 collector brings about an increase in the heating effect in the thermistor; the resulting increased conductivity of H1 applies degeneration to TR1 until the loop gain falls sufficiently to just maintain oscillation, that is, unity. Insufficient signal amplitude at TR1 collector allows the thermistor to cool; this increases the loop gain in order that the required amplitude shall be recovered.

The part of the signal at TR3 emitter which appears at the slider of VR3 is amplified by TR3. The high impedance of TR3 collector circuit provides the effect of a current generator applied between the slider and one end of VR3; because of this, the output impedance is very nearly constant for all settings of VR3.

Resistor R7 completes the direct coupled loop incorporating TR3, TR4 and TR3. This direct coupling serves to maintain correct levels of direct current and potential in the system.

Condenser C8 provides a decoupling path

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![Image of graph and circuit diagrams](image-url)
for the alternating currents when the battery resistance becomes appreciable. This effect lengthens the useful life of the battery.

Construction
The major part of the work of construction concerns making the box; nevertheless it is designed for construction with simple tools, and has no awkward sheet bending. There is a flat sheet forming two compartments, one for the batteries, the other for the circuit. The controls are recessed in order that the box will lay quite flat on any of its faces. The first part of the construction is to make the plain rectangular end plates, each with four countersunk rivet holes. The material for these end plates should be strong; 16 s.w.g. brass was used in the unit shown, but 10 s.w.g. aluminium would presumably be suitable. Next the \( \frac{1}{2} \) in x \( \frac{1}{8} \) in L-section bars can be riveted between the end plates with \( \frac{1}{16} \) in aluminium rivets. The remaining sheeting can be quite thin, say 20 s.w.g. The control panel is simply a flat plate fixed to the L-section bars with similar strips making contact with brass plates mounted on Paxolin insulating boards. The Paxolin insulators can be seen in the photograph at the ends of the row of batteries. The top edge of the battery compartment is lined with a further piece of Paxolin, and the batteries are held against this by the aluminium strip visible along the bottoms of the batteries. There is no need to clamp the batteries since the back cover stops them
from falling out.

The control panel is faced with a Perspex sheet, 3 mm thick. The calibration is drawn on white paper and sandwiched between the aluminium panel and the Perspex. The control pointers are also of Perspex. The front panel of the instrument is coloured though the photograph does not, of course, show this.

The wiring layout is not critical. It was found necessary to make a distinct electric connection between the box and the circuit, since without such a connection the frequency was liable to change slightly when the box was touched; the choice of the negative battery line as chassis connection was merely because it is common with one of the output terminals.

Most of the small components are carried on a group board, to be seen in the under-chassis illustration at the back of the circuit compartment. The thermistor is mounted in the centre of this group board.

**General Notes**

Though a somewhat larger maximum output p.d. could be useful, the associated penalty in terms of cost did not seem justifiable. Modification of the buffer stage TR3 to incorporate a more powerful transistor, could yield the larger output if required.

To arrange a constant output impedance, 1kΩ, for any setting of the attenuator switch S5, the circuit of Fig. 4 may be used in place of the simple attenuator shown in Fig. 3.

It may be desirable to add a condenser, 0.1μF or 1μF, in series with the “live” output terminal to act as isolation of direct potentials between the generator and the load circuit; a resulting disadvantage is that the output impedance would be raised, and would become frequency sensitive.

If desired, the output control may be calibrated logarithmically in decibels; to achieve this it may be an advantage to use a semi-log potentiometer for VR3.

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**Modern Ceramic Condensers**

by J. B. DANCE, M.Sc.

**Components List**

<table>
<thead>
<tr>
<th>Resistors (all 1/2 watt)</th>
<th>Transistors</th>
<th><strong>Switches</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 180kΩ</td>
<td>TR1 Mullard OC44</td>
<td>S1 Single pole, single throw</td>
</tr>
<tr>
<td>R2 5.6kΩ</td>
<td>TR2 Mullard OC44</td>
<td>S2a -2 pole, 3 way, yxaxley</td>
</tr>
<tr>
<td>R3 1000Ω</td>
<td>TR3 Mullard OC44</td>
<td>S2b -2 pole, 3 way, yxaxley</td>
</tr>
<tr>
<td>R4 1500Ω</td>
<td></td>
<td>S3 Single pole, 3 way, yxaxley</td>
</tr>
<tr>
<td>R5 2200Ω</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R6 800Ω</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R7 100Ω 2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R8 10Ω 2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VR1 1kΩ linear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VR2a = 1.5kΩ V2 bank, inverse semi-log,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VR2b = 1.5kΩ [Reliance type TW/1]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VR3 - Linear</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Condensers**

- C1 2μF paper
- C2 2μF paper
- C3 0.2μF paper
- C4 0.2μF paper
- C5 0.02μF paper
- C6 0.02μF paper
- C7 8μF electrolytic 15W
- C8 100μF electrolytic 15W

**Thermistor**

“Stantil” type R24 (Standard Telephones & Cables Ltd.)

**Much Research Has Recently Been Carried Out on New Ceramic Dielectrics and on Methods of Using Them in Condenser Manufacture.**

An extremely wide range of ceramic condensers is already available in the smaller capacity values (up to about 20,000μF) and it appears highly probable that ceramics will replace paper condensers in almost all miniature equipment when they become more readily available in the larger capacity values. Ceramic condensers may be divided into two main types, namely the “ordinary” type and the “Hi-K” type.

**Ordinary Ceramics**

Ordinary ceramic condensers (i.e. those which do not have a “Hi-K” dielectric) are made in values ranging from about 1μF to several hundred μF. The usual r.c. working voltage is 500, but certain special types are manufactured with working voltages of several kilovolts. They have a low power factor (about 0.002) and a high insulation resistance (about 10,000MΩ), so the leakage is low. They are somewhat inferior to silver mica condensers when great stability of capacity value is required. Ceramic condensers can, however, be obtained with either positive or negative temperature coefficients and are therefore useful in certain high frequency oscillator circuits, because frequency drift with change of temperature can be minimised by using the correct proportions of capacity with positive and negative temperature coefficients. The construction is usually tubular with wire ends, the temperature coefficient often being marked on the case (e.g. N750 signifies that the condenser has a negative temperature coefficient of 750 parts per million per degree Centigrade, whilst PO30 means a positive coefficient of 30 parts per million per degree Centigrade). They can also be obtained with zero temperature coefficient (marked NPO). Some types are colour coded according to either the British or American system; the colour code not only signifies the capacity value, but also the temperature coefficient and tolerance.

**“Hi-K” Ceramics**

The capacity of a condenser increases with increasing area of the electrodes (or foils) and with increasing dielectric constant (or permittivity) of the material between the electrodes, but decreases as the distance between the electrodes is increased. A miniature condenser of moderate or large capacity value must therefore either employ a dielectric of high permittivity or have closely spaced electrodes or both. Limitations are imposed on the closeness of the electrode spacing because condensers which have thin dielectrics have a small working voltage.

Mica has a permittivity of about 6, but certain “Hi-K” ceramics (such as barium titanate) have a permittivity of over 1,000.
This is due to their “ferroelectric” properties—a name which is derived by analogy with the familiar magnetic phenomenon known as “ferromagnetism”. Such ceramics can therefore be used in the manufacture of condensers which, for a given value of capacity, are much smaller in size than those using mica or paper as the dielectric. These ceramic condensers are normally made in values ranging from about 50pF to 20,000pF, and the working voltage is 300 volts d.c. The power factor is in very good and the temperature coefficient is not usually quoted. They are especially useful for decoupling and are made in tubular, small disc and feedthrough types. A typical 1,000pF condenser may be encased in a tube ½ inch long and ½ in diameter.

Modern Miniaturisation

Ceramic materials with permittivities of up to 6,000 are now being used in the manufacture of condensers. Such ceramics are very brittle and impossible to handle when in the very thin sections (less than 0.005 in thick) required for the manufacture of miniature condensers. Special techniques have recently been developed in America to overcome such difficulties; the very thin ceramic dielectric is actually made on one of the electrodes.

One method commences with a number of thin ceramic rods (about 0.03 in diameter) which are coated—very thinly—with metal. A very thin film of the dielectric is placed on top of the metal and finally another layer of these rods may be bunched together in a honeycomb structure and placed inside a ceramic tube. The inner metal coatings are all joined together at one end to a wire and the other connection is made to the outer metal deposits. The length of the rods depends on the capacity required. The smaller the diameter of the rods, the greater the capacity/volume ratio; but it is not possible to work with rods which are very thin. This method of manufacture enables 1,000pF condensers to be made in a tube less than ½ inch diameter and ½ inch long. When 0.1µF can be made in a tube ½ inch in diameter and ½ inch long. These “Ceram” condensers will be invaluable in space search where a minimum of weight and volume are essential. A rather better technique is now available for capacity values above 0.1µF.*

Condensers of large value are best made by rolling the dielectric between two metal foils. Until recently, however, it has not been possible to produce rolled ceramic condensers owing to the non-flexibility of the dielectric. “Cerol” condensers are produced by rolling an extremely thin film of a material which will form the dielectric when heated between two very thin pieces of a precious metal.* The complete roll is then heated so that the ceramic dielectric is formed and the structure becomes sealed and rigid. The thickness of the ceramic dielectric controls the working voltage. “Cerol” condensers with a working voltage of 100 volts d.c. and a capacity of 0.1µF have been made with a size of only 0.2 in diameter by 0.65 in length. A 1µF condenser provided by this method would be about 0.4 in diameter and 0.75 in length. It is expected that these sizes will be at least halved in the very near future.

* “Ceram” and “Cerol” condensers were developed by Aerovox, in their High-Q Division.

AN IRON SAVER

by E. G. GWILLIAN, G3HLLZ

Many constructors will no doubt have had the same annoying experience as the writer when intermittently using an electric soldering iron. One either has to keep switching it on and off, or leave it on for perhaps three or four hours whilst only needing it a few times. In the first case there is often a maddening wait for it to warm up, or trying to use it before the correct temperature is attained. The alternative usually mean an overheating, and, of course, shortened life of both the element and bit. Resting the iron on a metal “heat sink” is not very successful, nor is an instant- heating iron always the answer (even if one can afford it!), and, anyway, there must be many thousands of the ordinary type in use.

The writer therefore decided that some form of switched series resistor was the best solution. It had to be simple, safe, cheap, adaptable, and within easy reach of the working position on the bench. The ordinary lighting bulb is ideal for this sort of job, and the gadget described, after long usage, has proved indispensable. The diagrams show how extremely simple it is, and there could be so many variations that anyone making it can modify it according to his own needs and junk-box contents. Fig. 1 illustrates the circuit used by the writer. For a 23 watt instrument iron, a 25 or 40 watt bulb has generally been used although it is easy enough to try various sizes, a higher wattage giving a higher “idling” voltage to the iron and vice versa. Incidentally, the difference between the actual and rated consumption of bulbs can be quite considerable.

The shorting switch is normally “off” and the bulb glows dimly. When the iron is about to be used the switch is closed, thus shorting out the bulb whereupon the iron attains full heat very quickly, the time depending on the size of the bulb used. The dim glow serves as a useful reminder that the iron is only “ticking over”.

Although the writer has not found it necessary, series-parallel switching, as shown in Fig. 2, may be preferred by some constructors, as this would give a full glow for “full on”, and a dim glow for “idling”.

Danish World Publication Fifteen Years Old

World Radio-Television Handbook’s 15th edition now available

World Radio Handbook—WRH—is known to all broadcasting circles the world over as an invaluable workbook for all radio listeners and broadcasters, thus furthering understanding between the peoples of the world. With its edition this year this International handbook is celebrating its fifteenth anniversary, and in this connection has received appreciative messages from broadcasting and other organisations all over the world—not forgetting the United Nations.

The new, extended edition now available is the only publication in the world that furnishes complete and up-to-date information about all the radio and television stations in the world. WRH is a radio and television reference book, by the help of which listeners can, without difficulty, listen to any station they want, and identify any station they may pick up by chance. The book also contains information about the addresses, principals, programmes, broadcasting hours, pause signals, advertising, etc., of all stations—in a word, it contains all information of interest concerning radio and television. In addition there are interesting photographs from many countries, practical articles about listening on all wavelengths, maps, tables and many other features.

Compared with earlier editions, the contents of the present number of WRH are quite new. The rapid development in the sphere of broadcasting and television means that information changes from year to year and a large number of new stations usually come into existence.

WRH is published by World Publications (Publisher O. Lund-Johansen), Lindorffsalle 1, Hellerup, Denmark, and can be ordered through bookellers.
Conversion of 1.4 Volt Superhet to Low Consumption Valves

by J. B. HALL

Editor's Note.—This short article describes a reader's experiences in converting a portable receiver from 50mA filament to 25mA filament valves, and the remarks apply to a receiver employing parallel-connected filaments running from a single 1.4 volt cell.

The modifications should, on no account, be attempted on receivers in which the valve filaments are connected in series or in series-parallel because they may cause one or more filaments to burn out. Receivers which should not be modified are mains/battery types and receivers whose filament supply voltage is greater than that provided by a single 1.4 volt cell.

The set in question was a conventional superhet employing the line-up: 1R5, 1T4, 1S5 and 3S4. By using the "96" series valves, the existing set and components would require a considerable saving on both h.t. and i.f. batteries was realised. The reading for I.T. before alteration was 1.4 volt 240mA.

A set of low consumption valves was ordered through one of the advertisers in The Radio Constructor, the cost being 35s. 9d., including postage. These valves are DK96, DF96, DAF91 and DL96.

Each stage was altered and checked with a meter separately, as some constructors for reasons of economy may wish to change one valve at a time. The greatest saving is made with the output stage. This was the 3S4 and the valve base requires slight modification to suit the DL96 filament and anode connections remain unchanged but the connections to pins 3 and 6 are changed over. The i.t. current on completion of the modification to this stage was reduced to 200mA. Some adjustment to the value of the auto-bias resistor is required but more about this later.

Working backwards, the next stage was the diode and first a.f. 1S5. This was directly changed to the DAF96. The i.t. current was now 170mA.

The i.f. amplifier was also changed directly from 1T4 to DF96. L.T. now read 155mA.

Finally, the frequency-changer 1R5 was replaced by the DK96. This required alteration to the valve base wiring, pin 5 changing from chassis to h.t. positive.2 Note that on some sets pin 5 is directly earthed to chassis and connection is made to the spigot and pin 1. Make certain such connections remain at chassis potential after the modifications. On completion of the modification, i.t. consumption was, as expected, 125mA, some 50% of the current drain when using the original valves.

Biasing the output value calls for some comment. Usually the value of auto-bias with a 3S4 is between 680 and 1,000Ω, and for the DL96 between 470 and 560Ω.

<table>
<thead>
<tr>
<th>Valve Equivalents</th>
<th>3S4</th>
<th>3V4</th>
<th>1S5</th>
<th>IT4</th>
<th>1R5</th>
<th>1A6</th>
<th>1A4</th>
<th>1A5</th>
<th>1P1</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>N17</td>
<td>N19</td>
<td>ZD17</td>
<td>W17</td>
<td>N17</td>
<td>X18</td>
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</tr>
<tr>
<td></td>
<td>1P0</td>
<td>1P1</td>
<td>1FD9</td>
<td>1F3</td>
<td>1C1</td>
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<tr>
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<td>DL94</td>
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<td>DAF96</td>
<td>DAF96</td>
<td>DAF96</td>
<td>DL96</td>
</tr>
</tbody>
</table>

With the receiver finally modified and an auto-bias resistor of 560Ω, h.t. current consumption was 12mA at 70 volts. This was considered too high. It was found possible to increase the auto-bias resistor in this particular receiver to 1,500Ω without the onset of distortion. The total current consumption then became 6.5mA.

The above relates to changing the valve line-up 1R5, 1T4, 1S5 and 3S4. If the line-up DK92, DF91, DAF91 and DL94 is employed in the receiver, this may be changed to "96" series without more than that of changing the value of the auto-bias resistor.3

3 Provided that the points covered by footnotes 1 and 2 are observed.

The final touch to the above set was the realignment of the i.f. transformers although throughout the modifications, the local station came in at a good volume.

The substitution in both the a.f. stages should require alteration of the anode loads but in actual practice no change was made and the valves operated quite normally with the existing loads.

CELLS

With the increasing use of transistors in electronic circuits, emphasis is being laid more and more on apparatus that is both compact and transportable. In order to supply power for such equipment use has to be made of batteries. However, the problem of reconciling compactness with life and efficiency can sometimes be very difficult indeed. It is hoped that this short article may prove to be of some help to the would-be user of both dry and wet cells—as well as a guide to the selection of the right cell for the right job.

The ideal cell should have the following: a high c.m.f., a low internal resistance, a long life, compactness, indefinite "shelf-life" (that is to say, it may be stored indefinitely under no-load conditions without loss of c.m.f.), it should be re-chargeable, it should be capable of being used under any condition of temperature or situation and, last but not least, it should be cheap. In practice, no cell satisfactorily meets more than two or three of these requirements.

Primary Cells

Primary cells are not re-chargeable by normal methods but some types offer compactness, relative cheapness, and a fair length of life.

(A) The Dry Leclanché Cell

The electrolyte in this cell, which is illustrated in Fig. 1, is a mixture of ammonium chloride (sal-ammoniac) and zinc chloride mixed into a paste of flour and water. The depolariser is manganese dioxide. The action of the depolariser is to remove the hydrogen produced in the cell on discharge which otherwise would impair its efficiency. This cell is never really dry because its action depends upon the electrolyte being damp. The true dry cell—the inert cell—is supplied with the electrolyte in a desiccated state and has to be activated by the addition of small amounts of water. The inert cell may be stored indefinitely in the dry state but must be used as soon as possible after the addition of the water. The normal dry cell may be...

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1 For a 90 volt h.t. supply the series screen-grid resistor (to pin 3 of the DF96) should have a value of 390Ω or more. No screen-grid series resistor is necessary for operation from a 67.5 volt supply.

2 Pin 5 of the DK96 should be connected directly to h.t. positive only when a 67.5 volt h.t. battery is employed. With a 90 volt h.t. battery a resistor of 120Ω should be connected in series and pin 5 bypassed to chassis via a 0.001μf condenser.
kept in good condition for many years by refrigeration. Perhaps we may see quick-frozen cells on the market in the near future!

(B) The Mallory Cell (Mercury Cell)
The Mallory cell is shown in Fig. 2, this diagram being simplified for purposes of explanation. The electrolyte is potassium hydroxide (caustic potash) and the depolariser mercury oxide. The steel case is positive and the cap negative.

(C) The Kallium Cell
This cell, shown in Fig. 3, is similar in action to the Mercury cell but, by use of different construction techniques, the case is made negative and the cap positive.

Secondary Cells
Secondary cells are those which may be re-charged. The lead-acid and the nickel-iron (Ni-Fe) cells, because of their large size and spillable electrolyte, have little to offer the miniature radio enthusiast. However, for the miniature record player or tape recorder enthusiast, there are two cells in this class which are very suitable, these being as follows:

1. Nickel-Cadmium Alkaline Accumulator
The construction of this type of accumulator is similar to that of the lead-acid type. The positive plate consists of nickel filings pressed into a plate of nickel, whilst the negative plate is made of cadmium sponge set into a nickel plated steel support. The electrolyte is a 20% solution of potassium hydroxide in water. The e.m.f. is about 1.2 volts and a high rate of discharge may be obtained from quite a small cell.

2. Vener Silver-Zinc Accumulator
The positive plate in this type of cell is made of silver peroxide and the negative plate of spongy zinc. The electrolyte is potassium zinicate, the cell giving an e.m.f. of about 1.5 volts on load. These cells are expensive and very limited and are not suitable for the radio enthusiast, the Venner L1 measures \( \frac{1}{5} \times 1 \frac{1}{2} \times 1 \frac{1}{8} \) in., weighs just under an ounce, and has a capacity of 1 amp/hour rated on the 20 hour basis.

Use of Cells
The electrolyte in all cells has a negative resistance coefficient. In consequence, the colder the cell the greater its internal resistance and the lower its terminal e.m.f. when delivering current. It is advisable, therefore, to keep your cell in a cool place when not in use. On the other hand, cells in storage should be kept as cool as possible. This has the effect of reducing the local action inside the cell and results in a longer shelf life. Cells are very much like hedgehogs: they are active when their surroundings are warm, they hibernate under cold conditions, and they always fold up on you at the wrong time when they realise they are the centre of attraction!

Testing Condensers

by GILBERT DAVEY

RECENTLY I DECIDED TO TRY BUILDING AN amplifier to a design which was popular some years ago and which used two large output triodes of the PX4 type in the output stage. These two valves were in push-pull and shared a 500Ω resistor in the filament circuit for biasing purposes, as shown in Fig. 1. As always when testing a new circuit I had placed a 50mA meter in the anode lead of one of the PX4s. As soon as I switched on I was extremely puzzled by the behaviour of the pointer. First it swung to the correct reading of 45mA then slowly sank to a steady reading of 10mA. Tying the meter in the other PX4 anode circuit showed a very unhappy state of affairs, the needle trying to swing right off the end of the scale. Hastily switching off, a little thought was given to the problem, and soon the conclusion was reached that the high anode current of one valve was, due to the common bias resistance, causing over-biasing of the other valve and the consequent drop in anode current.

The problem was not quite as simple as that, however, as subsequent investigation proved. The first thing was to discover the reason for the heavy anode current in one valve, and a glance at the circuit soon revealed this. The anode resistors in the leads to the ACHL valves are 22kΩ so that the dropping voltage drop across them and at least 150 volts reach the anodes of the valves. Also connected to the anodes of the ACHLs are 0.1µF condensers transferring the audio signals to the grids of the PX4s which, according to the circuit values, should each have 45 volts bias at which the anode current per valve would be 45mA. But, of course, as every reader has seen by now, one of the 0.1µF condensers had completely broken down and that particular PX4 had something like 155-165 volts on its grid position, which was the most unhealthy condition in which to run the valve. Testing the other 0.1µF condenser revealed that it was not 100% satisfactory, so a general review of the condenser stock was decided upon.

As indicated earlier, this amplifier was of an old design and the components used to make it were of the period when it was designed, which meant that the condensers had been in store, unused, for a good number of years. In order to test the stock the workshop power unit was connected up as shown in Fig. 2. Its output being 300 volts, a 6kΩ resistor was connected across it in series with the 50mA meter and a switch, a space being left in this chain across negative to positive for the insertion of the condenser under test. It was found convenient to have a pair of leads with crocodile clip terminations for attaching to the condenser wires or terminals.

Having rigged up this testing arrangement, the two condensers in the amplifier were removed and tested. One caused the meter needle to go rapidly to 50mA indicating a dead short. The other showed an initial leak of 2mA, but the needle gradually crept up to 20mA when the condenser was discarded as useless. Of two dozen condensers 0.1µF capacity which were in the component box, and which had recently been removed from an elderly receiver, only two were found absolutely perfect and suitable for the amplifier. Four had slight leaks of a couple of mA and could be used for decoupling purposes but, as such leaky types tend to worsen with use, it is preferable to discard them. That was the fate of the rest of my stock, all of which were really in bad shape. It was extremely interesting to watch condensers, which appeared in good order at first, gradually show signs of leaks when left on test, and also of interest to note that the two types which were in first class order were branded with names of top-quality manufacturers.

When testing larger condensers of 1µF or more, the initial “jump” which the meter needle gives is quite in order and only indicates a charging-up surge. In the case of large electrolytics the needle may rise quite a few mA and then, as the battery “forms”, drop slowly to a steady figure of 4 or 5mA. Do not be alarmed if these large electrolytic types maintain a few mA of steady leakage current, it is quite common practice with them and, of course, the larger the capacity of the condenser the greater the leakage. This is a factor which must be taken into account when designing a power pack.
for a large receiver or amplifier embodying a number of high-capacity electrolytic condensers. Large paper condensers should not leak at all but return to normal after the first "charging" jump of the meter needle. The best test for these types is to see how long they hold their charges. One of mine gave quite a lively shock about an hour after test when I picked it up to pack away. The best way to avoid this is to discharge the condenser after testing; although it is said to be bad for the condenser I have always done this by putting a screwdriver across the terminals and enjoying the resulting crackling spark. However, rather than give readers bad advice on this point, I had better advise discharging by holding a resistor of 1,000 ohms or so across the condenser.

In conclusion, I feel that I ought to mention that direct-coupled amplifiers which dispense with inter-valve condensers are specially designed to compensate for the unusual circuit conditions thus involved. There is thus no need for readers who use such amplifiers (as I do myself) to wonder if there is something missing which is likely to cause trouble. All is in order in such cases! It is hoped, however, that those readers who use junk-box condensers, or condensers from old sets or ex-Services equipment, will be encouraged to apply a few tests to them before use and avoid future troubles. The chief point to remember is that the test must be made at a voltage above that at which the condenser will be used. It is no use testing at 4.5 volts from a dry battery with a pair of phones, very likely at that potential the condenser will be perfect.

The Jabez Gough Loudspeaker Cabinet

There has been a notable amount of newspaper publicity over the last month or two concerning the invention by Mr. Jabez Gough, a Cardiff engineer, of a new loudspeaker cabinet. The first major newspaper story covering this cabinet appeared on the front page of The Observer of 27th November, some eight columns inches being devoted to the subject under the heading: "Experts Hail a £5 Hi-Fi Cabinet". This was followed by a story twice as long in The Times under the heading: "Hi-Fi Unit For Less Than £5". The Observer weighed in again on the following Sunday with: "Details Soon on £5 Hi-Fi For Amateurs" on a middle page. The Western Mail (published in Cardiff) gave further details, including a simple description of cabinet construction, on 9th December. There has also been a report on the cabinet in a Johannesburg newspaper, and I understand that it has been featured in a local news magazine programme put out on ITV.

Feeling that a high fidelity loudspeaker cabinet which merited front page presentation in a national Sunday newspaper merited investigation, I contacted Mr. Jabez Gough and examined his cabinet at Cardiff in December.*

The History of the Cabinet

Mr. Jabez Gough is a high fidelity retailer having premises in North Road, Cardiff. He commenced experimenting with his cabinet in the summer of 1960 and, with the help of Professor Frank Landgrebe of the Welsh National School of Medicine, produced a prototype measuring approximately 30in high by 30in wide by 18in deep, and employing two loudspeakers. The results from this encouraged him to work on a second version using a single 8in (7in effective cone diameter) loudspeaker. This second model represents the Gough cabinet principle so far as it has been developed to date. Its outside dimensions are approximately 24in wide, 28in high, and 12in deep, and it has a hinged lid at the top. Mr. Gough has also produced a third cabinet design, this being a scaled-down version of the second model and being fitted with a 5in speaker. The third cabinet design is not considered satisfactory as it stands, and it may either be developed or discarded.

* Just too late, unfortunately, for my report to appear in our January issue.
Cabinet Features
A noteworthy feature of the cabinet is that it is claimed to function with a relatively inexpensive loudspeaker unit. The cabinet design is based on a loudspeaker unit costing around £5 installed in it, and Mr. Gough states that he can get almost exactly good results with a much cheaper speaker costing £2. He deduced that the source of a cabinet designed as such employed a free from peaks in its frequency response as possible.

Mr. Gough was reluctant to release full technical details on his cabinet, because of pending patent rights, but he did allow the following information to be passed on. The single loudspeaker is mounted at the top center of the cabinet, and this is no need to the frequency range was not covered smoothly and uniformly and that one cabinet was handling the middle and treble in the design, and that the cabinet was handled low frequencies was entirely absent. Transients were handeled excellently. I could detect no colouration due to resonances in the cabinet.

I think that the Gough cabinet had a markedly lower bass response than the two other reproducers. Nevertheless, I preferred the Gough cabinet for all the orchestral and vocal music to which we listened. Part of the music contained a passage with a plucked double bass, and it was felt to be the lower bass response of the Gough cabinet, I preferred the reproduction it gave on this passage to that provided by either of the other two units. On piano the reproduction was excellent.

One of the tests included a reproduction of pipe organ music, during which a sustained heavy bass note was accompanied by variations in treble. The three reproducers gave quite different versions of this music. Working at full volume I felt that the £5 speaker was lacking bass note, and I thought that the £2 speaker was lacking bass note, and I thought that the £2 speaker was the best. I felt that the £2 speaker was the best. On piano the reproduction was excellent.

A point which needs elaborating on is the reference to a "£5 hi-fi cabinet". If, as a home-constructor, you wanted to build the single 8 in speaker version in the white, you could get the necessary timbering by the fact that you cannot be false from peaks in its frequency response as possible.

The Performance of the Speaker
It is an extremely difficult job to report on the performance of a high fidelity reproducing system because one's impressions are entirely subjective. In my own case, I spent a very pleasant three hours putting his cabinet through its paces and I shall do my best to report my reactions as accurately as possible. In some cases I was able to directly compare the Gough reproducer with two others, one retuning at around £23 and the other retuning at around £55.

My first reaction was that the Gough loudspeakers cabinet gave a definite impression of a wide spaced sound source. There was no apparent source of this reproduction, and, indeed, the reproduction was handled by the cabinet. The whole frequency range was covered smoothly and uniformly and the feeling that one cabinet was handling hand several of the Royal Navy ships, the middle and treble, the whole frequency range was covered smoothly and uniformly and the feeling that one cabinet was handling all frequencies was entirely absent. Transients were handeled excellently. I could detect no colouration due to resonances in the cabinet.

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Marconi Equipment Assists in Rainmaking Experiment
Unlike certain parts of England these days, rainfall in East Africa only occurs in the "long rains and the short rains", and to stimulate rainfall the East African Meteorological Department has been conducting experiments with rocketed into cumulus clouds. In these experiments, Marconi transceiver equipment has played a part, linking the "rainmaking" research teams to the Air Ministry authorities and the Central Forecast office in Nairobi over 100 miles away.

The experimental aircraft carried out by the East African Meteorological Department was on behalf of the London Farmers' Association at Rumuruti, just north of the equator, where there are cattle ranches and very marginal rainfall. Quick communication with the Central Forecast office was necessary to give up some of the cumulus cloud formation in the form of rainfall if "seeded" with common salt. The most recent technique used to seed these clouds has been to fire rockets of various types into them, and trials have been carried out in all three territories-Kenya, Uganda and Tanganyika.

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A Simple WIRED BENCH

by P. M. GARNER

This short article describes the construction of a simple but efficient bench and will be of especial interest to those constructors who have limited working space.

The use of the kitchen table as a bench presents a problem not only to the home constructor but to other members of the family. Most of us, including the writer, are not in the fortunate position of having a spare room that can be converted into a workshop. After a bit of deep thinking the writer decided to build up an old chest of drawers and to wire sockets and a light directly on to this instead of mounting them on the wall above the bench. These could then be fed from a handy wall socket via a switch fuse mounted on the side of the bench. Three five amp sockets were fixed at each end of the bench so as to avoid a large bundle of leads all going to one place. The bench length was extended by the addition of cupboards at both ends of the basic chest of drawers, each cupboard being about 4 ft deep. One cupboard housed the switch fuse and was fitted with a lock to prevent children tampering, whilst the other was provided with clips, etc., to hold the various tools. The two top drawers of the chest were fitted with shallow trays suitably partitioned to hold resistors and other small components, strips of flanged alloy being used to make the divisions. The uppermost, horizontal section of the strips was 3⁄8 in wide so that labels could be fastened on with the use of Sellotape, the Sellotape keeping them clean and secure.

The cupboards were soon made up from some 3⁄8 in match-boarding after removing the tongue and groove. The doors presented no problem, and consisted of just a light framework which may be faced with either plywood or hardboard to suit the personal taste and pocket. The diagrams accompanying this article are self-explanatory and even the most inexperienced of joiners should not suffer any headaches. Once the cupboards are assembled they should be fitted to the ends, care being taken to keep their upper surfaces level so that a sheet of hardboard may be placed overall to provide a good working surface free from cracks and joins.

For the light fitting a length of wood screwed to the back of the bench will serve to provide a fixing; although this may be varied to suit any type of light fitting.

If care is taken with the woodwork and
The Frequency Stability of R.F. Oscillators

by R. J. Stephenson

Some time ago whilst designing a signal generator the author had occasion to investigate the effects of a variable h.t. supply and a variable load upon the frequency of an oscillating tuned circuit. The theoretical aspects are well known, being treated in many text-books, but there seems to be little practical data available giving, say, the alteration in frequency for an alteration of 10V in the h.t. supply, or for a different load. A series of experiments was therefore conducted to investigate the problem, the operating frequency chosen being 1 Mc.

The equipment employed for the experiments was a signal generator with a dial absolutely free from backlash and capable of being read accurately for small changes in frequency, a normal a.m. radio receiver, a power pack with an adjustable h.t. supply, a voltmeter, and enough spare components to "mock up" several different oscillators. Measurement of oscillation frequency was obtained by causing the signal generator to "zero-beat" with it, the frequency then being read from the latter. A block diagram of the set-up is given in Fig. 1.

The oscillator under test was supplied from a power pack with a variable h.t. output ranging from 50 to 250 volts. Both the oscillator and the signal generator were loosely coupled to the receiver by fixing a short length of insulated wire to the aerial socket and allowing it to trail on the bench near the signal generator output terminal and the tuned circuit being investigated.

Results

The first oscillator checked employed a tuned anode circuit, and a triode valve of Ra = 3.7kΩ. The frequency obtained was plotted against anode voltage. This valve was then replaced with a triode of Ra = 15kΩ and another set of results obtained. The second valve was next replaced by a pentode of Ra = 1MΩ and the results again plotted. The three graphs obtained are given in Fig. 2. It should be noted that, when the pentode was used, the supply voltage was fed also to the screen grid.

The next stage was to repeat the whole process with a tuned grid circuit, the graphs obtained being given in Fig. 3. Finally, the process was repeated again, this time using a cathode tap for "electron-coupled") oscillator, the results being given in Fig. 4.

From Fig. 3 it will be seen that, with a tuned anode circuit and a valve of low Ra (3.7kΩ), the alteration in frequency for change of h.t. voltage of 75-250V is about 9 kc/s, and about 8 kc/s with a valve of medium Ra (15kΩ). When a pentode of high Ra (1MΩ) was used the change in frequency was not only much smaller (2.2 kc/s), but was a decrease in frequency instead of an increase. With a tuned grid stage the changes to variations in h.t. supply voltage, the tuned grid slightly less so, and the cathode tapped oscillator considerably less susceptible than either. Also, frequency variations decreased as the Ra of the valve increased. It should be noted that, in practice, h.t. voltage would
not vary as much as it was made to do in the experiments, but the anode voltage could still, nevertheless, easily swing above and below the nominal supply voltage by quite large amounts under conditions of anode modulation, giving a considerable amount of unwanted frequency modulation. Since a stable oscillator, such as a cathode tapped, high Ra pentode circuit (or electron-coupled oscillator) shows a change of frequency of only about 100 cycles for a 10% change of supply voltage, it does not seem worth while to stabilise the supply voltage, unless an exceptionally high degree of oscillator stability is required.

[Diagram of oscillator circuit]

Loading the Oscillator
The next problem investigated was the effect of loading the oscillator tuned circuit. A common method of taking a load from the oscillatory circuit is to provide a separate winding as shown in Fig. 5. A tuned grid oscillator was first investigated. For experimental purposes a coil was wound over the grid coil having one-third the number of turns of the grid coil and tightly coupled to it. It was realised such a coupling coil would have a far bigger effect than a smaller winding, or one loosely coupled, and it was fitted intentionally in order to exaggerate the results. With no load (open circuit) across the load terminals the frequency was adjusted to 1 Mc/s. As a preliminary test to ensure that the circuit was behaving as it should, the load terminals were shorted across the tuning terminals to the load terminals. The frequency then increased to 1.2 Mc/s, a frequency change of 200 kc/s. Next, various values of resistance were connected across the load terminals and the results are shown in Fig. 6.

Next, condensers of various values were connected across the load. This reduced the frequency, as shown in Fig. 7.

Inductive loads were not tried, since insufficient inductors of known inductance and self-capacity were available.

The loading experiments were repeated again, this time with a very much smaller coil, very loosely coupled. The reduced coupling reduced the frequency shifts due to varying load to about one-tenth of the values previously given, but the result was not sufficiently great to allow accurate calibration of the oscillator tuning condenser if the latter were intended for use in, say, a signal generator. In any case the amount of power available was so low as to be useless without further amplification.

Finally, an electron-coupled oscillator was constructed with the load in the anode. With this circuit, the frequency change for all values of load was so small that it could not be measured. A slight change in beat note was noticed, but it was impossible to measure the change of frequency with any accuracy. To draw one or two conclusions from the loading experiments, it seems that the loading must be very light, the load must have a constant value. This could be obtained by the simple circuit of Fig. 8, where the impedance of the attenuator, R, is very small compared with the impedance of any load likely to be connected across the terminals. In the view of the writer, a much better arrangement would be to take the load from a valve electrode not concerned with the tuned circuit (as in the electron-coupled oscillator) or to use a "buffer" valve between the tuned circuit and the load, or, better still, to use both. It will be seen that, unless great care is taken with loading the circuit, it can have far more serious effects upon the frequency stability than even the most erratic fluctuations in h.t. supply voltage.

An Automatic-Location Aerial Bracket

by L. H. BROWN

This article describes an aerial bracket in which ingenious, but simple, principles have been employed to enable an aerial mast to be raised, lowered or rotated from the ground.

Frequently happens that an aerial mast may be most conveniently mounted by securing it to the side wall of a house as illustrated in Fig. 1. It will be noted that the mast is secured by two brackets and that, whilst the lower bracket is within easy reach of anyone standing on the ground, the upper bracket must necessarily be mounted as high up the wall as possible in order to achieve maximum stability of the mast and aerial. The fact that the upper bracket is well above ground level causes difficulties if it is desired to raise or lower the mast, or to rotate it. Such operations necessitate the use of long ladders in order that the upper bracket fixing may be loosened, and there is a risk of personal danger whilst handling an inevitably top heavy aerial and mast assembly under such conditions.

An Alternative Upper Bracket

It is possible to dispense with all these inconveniences and hazards by employing an automatically locating upper bracket such as that described in this article. After such a bracket has been initially fitted to the wall there is no need to touch it again, all subsequent handling and fitting of the mast being carried out from ground level.

Top and side views of the automatically locating bracket are shown in Figs. 2 (a) and (b). As may be seen, the working part of the bracket consists of an arm, pivoted at its centre, and having a "C" socket piece at one end. The latter has an inside diameter which gives sliding clearance to a 2in mast section, its opening permitting access to a 1¾in mast section. Two wires fastened to the arm allow it to be pivoted, from ground level, to any desired angle.

The aerial mast employed with the bracket should consist of an upper section having a diameter of 1½in and a lower section having a diameter of 2in.

When the mast is to be fitted to the bracket its upper 1¾in section should be placed against the opening of the "C" hole, whereupon it will enter the socket piece as shown in Fig. 3 (a). The arm is then kept at right angles to the mast by controlling the wires which are coupled to it, the mast then being raised until it is at the desired height. This will cause the 2in diameter section to appear inside the socket piece, as in Fig. 3 (b). The wires from the arm are next left free and the mast allowed to drop slightly. At once the arm will assume the angle shown in Fig. 3 (c), whereupon the top left-hand

Fig. 1. A typical aerial mast installation
allow it to drop again, whereupon the arm automatically takes up the weight once more.

General Points
As may be gathered, the automatically locating bracket is ideal for all mast-borne aerrals, whether those be employed for television or v.h.f. reception, or for amateur transmission and reception. Not only does it allow directional arrays to be rotated to

and bottom right-hand inside edges of the socket piece bite into the mast and prevent it falling further.

The mast is now secured laterally and its entire weight is taken up by the upper bracket. The only force apparent at the lower end of the mast is the slight rotational force caused by the weight of the mast attempting to pivot on the upper bracket pivoting bolt. Once the upper bracket has taken the weight of the mast and aerial it is an extremely simple matter to finally secure the lower end of the mast with a conventional bracket.

Lowering and Rotating the Mast
If it is desired to lower the mast it is necessary to reverse the sequence of operations just described. After loosening the lower bracket, the mast is raised slightly to free it from the socket piece. By means of the hanging wires, the arm is then kept at right angles to the mast whilst the latter, now a sliding fit in the socket-piece, is lowered. When the 1in section of the mast is in the socket piece, the mast may be lifted out.

To rotate the mast it is merely necessary to raise it slightly so as to free it from the socket piece, rotate it to its new position and any desired direction, it also enables the mast to be quickly lowered for maintenance or modification to the aerial.

In the case of the installation employed by the writer all parts, including the lower bracket, were made out of iron by a local ironworker at a cost of 25s. The ironwork should be protected against the weather with, at least, a heavy coat of good paint, galvanising, if possible, is preferable.

Fig. 2 (a) and (b) Side and top views of the automatically locating bracket.

Fig. 3 (a) On initial installation the aerial mast is first dropped into the socket piece (b) The 2in diameter section of the mast slides freely in the bracket (c) Releasing the arm causes it to rotate slightly and take up the weight of the mast

Transistorised Test Oscillator Tackling Car Radio Interference 10-30 Mc/s Aerial Matching Unit

NEXT MONTH

BOOK REVIEWS

THYRATRONS. By C. M. Swenne. 82 pages, 5½in x 8½in, 68 illustrations, 4 plates. Price 12s. 6d.
The growing importance of electronics in industry has necessitated the design of valves specially for industrial use. Control or switching operations on comparatively large currents or high frequencies are often needed; for these purposes high vacuum valves are less suitable and gas-filled types of various kinds are employed. This book deals with one of these, the thyatron.
The great advantage of a thyatron is its use as a fast switching device; it combines the functions of a pulse-controlled fast switcher and a regulator.

In a simple way construction, operation and electrical characteristics of thyatrons are here explained. Chapters are devoted to the basic circuits of these valves and their application in simple industrial devices, for instance relay circuits, timing circuits, d.c./a.c. converters and automatic circuits, to regulate the speed of electric motors and to stabilise rectifiers: applications in which thyatrons show to full advantage.

This book employs only the most elementary mathematical expressions and operations; it is intended for those who want to get a general impression of one currently rather important field of industrial electronics.


INDUSTRIAL ELECTRONICS APPARATUS: STEPS IN DESIGN AND MAINTENANCE. By P. van der Ploeg. 116 pages, 5½in x 8½in, 22 illustrations, 33 photographs on art paper. Price 9s. 6d.

Through the fast development of industry fresh fields of applications are discovered almost daily and new construction elements continually widen the scope of industrial electronics in our daily life. The business of ensuring that the equipment is always in efficient working order will remain one of the most important aspects of industrial construction and general maintenance.

The object of this book is to show both the designer and the service-engineer the extent to which trouble-free operation of electronic equipment is dependent on the little things that matter in the design, production, use and maintenance.

The development of a typical item of electronic equipment is traced step by step in a logical classification from the first experiment in the laboratory to the production and subsequent maintenance of the final unit. Throughout the book practical tips and hints are given.

For convenience sake the second part of the book contains some general remarks on the interpretation of tube data with particular reference to gas-filled rectifiers and thyatrons, which are often used in industrial control equipment.


Practical Transistor Circuits. 52 pages. 80 figures. 7½in x 9½in. Published by Henry's Radio Ltd. Price 3s. 6d. post free.

Compiled by D. J. French, Grad. I.E.E., Practical Transistor Circuits No. 2 is a most useful and practical publication for those interested in transistorised equipment construction. Within the covers are featured some 40 designs each complete with circuit diagram and most having a point-to-point illustration. The contents include such varied designs as A 3-Transistor Hearing Aid, Variable Frequency Oscillator, Sub-Miniature Pocket Transmitter, Transistor Timer, Headlamp Dimmer, Portable Baby Alarm, Telephone Pick-Up Amplifier, Miniature RF, IF, Audio Tracer, 10 Watt Portable Loud Hailer, Light Sensitive Power Switch and Multi-Channel Radio Control Receiver, etc., etc.

This extremely useful and informative book is recommended to our readers and should find a place on every home constructor's book shelf.


Compiled by G. C. Fox, A.M.I.E.E., G3AEK, this second edition includes a large number of
new service valve types which have appeared since the previous edition was published. Additional information on the structure or function of each type has been added thus considerably increasing the usefulness of the booklet.

This booklet will undoubtedly meet the need for a source of information on the commercial equivalents and the manufacturers of the numerous CV coded valves, cathode ray tubes and semi-conductor devices now generally available to the radio amateur and home constructor.

Thoroughly recommended to all our readers as a most informative and helpful publication and representing extremely good value at the small cost involved.


The 1961 edition of this well known and indispensable work of reference contains, in addition to the calls, names and addresses of radio amateurs resident within the British Isles and Eire, a complete list of the Societies and Clubs in affiliation with the R.S.G.B., a list of Amateur Radio Prefix—Country Order, Amateur Abbreviations, British Isles Two Metre Band Plan details, R.S.G.B. Contests Diary for 1961, a list of bands available to U.K. Amateurs, Types of Emission details, the Morse Code and Sound Equivalents, and the European Band Plan.

Since the last edition (1960) appeared in November 1959, more than 450 new calls have been issued, more than 100 old calls have been re-issued, upwards of 1,000 changes of address have been recorded and about 250 calls have been cancelled. The latest (1961) edition reflects these additions and changes.

The First One. 14 pages (duplicated) plus cover. 7½in x 8½in. Published by The K. & M. Printing and Publishing Company, 18 Melville Road, Birmingham 16. Price 1s. 3d. plus 2d. postage.

This booklet, The First One, deals with the construction and operation of a mains one valve radio receiver for the Medium and Long waves. Written by James S. Kendall—a well known contributor to the radio press—this publication should prove of interest to the beginner in that the design of the receiver is simple and inexpensive to construct. Complete with circuit diagram, point-to-point wiring and layout drawings, the booklet will be of value to those about to embark on building their first receiver.

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**CATALOGUE RECEIVED**

Home Radio (Mitcham) Ltd., 187 London Road, Mitcham, Surrey, have just released the revised third reprint of their Component Catalogue. This year, the catalogue has been brought up to date by means of a supplement and, except for this and the cover, it is identical to that issued after 6th June, 1960. Those readers who purchased their catalogues after this date will, in most cases, automatically receive the supplement, whilst those who obtained an earlier catalogue will, if they send to Home Radio (Mitcham) Ltd. the front cover from the old edition and 9d. postage, receive the latest publication free. In this manner, those who find the catalogue useful will be able to obtain at regular intervals the most up to date copy, the cost being only that of the postage.

Comprising some 128 pages plus art cover, 7½in by 9½in (approx.), the catalogue is literally crammed from cover to cover with details of almost every type of electronic component, kits, complete equipments of all types, accessories, etc., complete with type numbers and current prices. Supplied with the sixteen supplement and handy book mark, the catalogue is extensively indexed thus making the location of any component or unit an easy matter. This well produced and lavishly illustrated catalogue is available direct from Home Radio (Mitcham) Ltd. at 2s. 6d., plus 9d. postage.

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