former, they need to be joined by a short length of insulated wire.

The primary of the TT49 transformer has a resistance of 150Ω, so that VR3 is adjusted to cause 0.45 volt to appear across it at the required current of 3mA. The two transformers offer an overall ratio of 36:1.

It will be apparent that if, for any reason, the coupling between the drain of TR3 and the connection to L4 is of opposite phase to that existing in the prototype, the feedback to T1 will be negative instead of positive, with a consequent reduction in gain as VR4 is advanced. It is unlikely that this will occur if either of the alternatives for T2 is connected as described, and it can, in any case, be corrected by transposing the primary connections in the drain circuit of TR3. ■

In your work-shop

This month Dick and Smithy leave the realm of semiconductor devices and travel back in time to a subject which is of continual interest amongst readers: the repair and rejuvenation of old valve a.m. radios. Dick encounters a typical example of the receivers in this genre, whereupon Smithy is able to demonstrate the stock faults to which such receivers are prone, and to discuss their rectification

"FOR REPAIR IF ECONOMICALly justifiable."

Dick looked again at the ticket attached to the large mains radio on the 'For Repair' rack and scratched his head. To one of Dick's tender years the set appeared to be a very old receiver indeed. Its large wooden cabinet had collected a considerable amount of dust, and Dick blew some of this away so that he could peer at the tuning scale. So far as he could ascertain through the grime, the set was intended for long, medium and short waves.

Reluctantly, Dick picked up the set, carried it over to his bench and plugged it into one of the mains sockets at the rear of his bench. He tentatively tried the knobs on the front of the receiver and found the one which was coupled to the volume control and on-off switch. He turned this round. A weak pallid light behind the tuning scale gave witness of the electrical marvels of an earlier age.

After allowing a reasonable time for warm-up (since, as Dick correctly surmised, the receiver had been assembled before the junction transistor was even a gleam in W. Shockley's eye) Dick advanced the volume control to its fullest setting. There was no sound from the speaker. Dick turned back the volume control and experimented with the other knobs. The wave-change switch clicked mechanically in an encouraging manner, but there was no corresponding sound from the speaker. The tuning knob caused a cursor to move horizontally behind the tuning scale but it had, otherwise, no noticeable affect on receiver performance. A fourth control, which must obviously have been for tone, similarly failed to produce any audible results from the speaker. Dick switched the receiver off again.

A.M. VALVE RECEIVER

"Hey, Smithy!"

"What's up?"

"It's this weird radio I've got here," called out Dick. "I've never seen anything so old and grotty for ages."

Patiently, Smithy the Serviceman put down his test prods and turned round from the chassis he was working on. A gleam of recognition came into his eyes as he saw the receiver on Dick's bench.

"Well, well, well," he remarked. "Now, that's a model I've handled stacks of times in the past. It came out just after the war."

"The note tied to it," said Dick, looking at the ticket once more, "is something I've never seen in here before. It says the set's in for repair 'if economically justifiable'. All I've done up to now is to plug it in to the mains, and it seems to be completely dead."

"Economically justifiable, eh?" repeated Smithy. "Well then, the next thing you'd better do is to whip the back off and see what it looks like inside."

Smithy ambled over as Dick took the mains plug of the receiver out of the bench socket, turned the set round and then removed its back. Smithy looked inside interestedly.

"Ah yes," he remarked. "That chassis brings back a few memories to me. Almost all the radio sets in those days were four-plus-one jobs. This is one of them." (Fig. 1).

"Four-plus-one?"

"That's right. They were called four-plus-one sets because they all had four signal-handling valves and one h.t. rectifier valve. The signal-handling valves were a triode-hexode or triode-heptode frequency changer, a pentode i.f. amplifier, a double-diode-triode in which the diodes acted as signal and a.g.c. detectors and the triode as audio a.f. voltage amplifier, and an a.f. output pentode. This represented a stock receiver design and, to be frank, it used to work very well indeed. This set is a typical four-plus-one and, as you'll note, all the valves are on octal bases. It's also got a mains transformer, too."

"Will it be capable of being repaired without too much expense?"

"Oh, quite probably," said Smithy. "If there isn't anything excessively wrong with it, and it has been kept in a reasonably dry place, it may only need a few new components to get it working quite well once more. From the look of this particular set, I'd say it has been stored away in somebody's lumber room for years, and that that somebody has suddenly decided to see whether it's worth bringing it back to life again."

"Well," conceded Dick, "there's certainly enough dust, both on the cabinet and on the chassis, to support that last remark. It looks as though it hasn't been used for years."

"Fair enough," said Smithy. "Anyway, the first thing to do is to see whether anybody's been messing about in it and has started changing a lot of components around. The set will be too much trouble to bother about if we've got to first of all put right a lot of poor work carried out by some ham-handed Henry in the past."

"So far as I can see," said Dick,

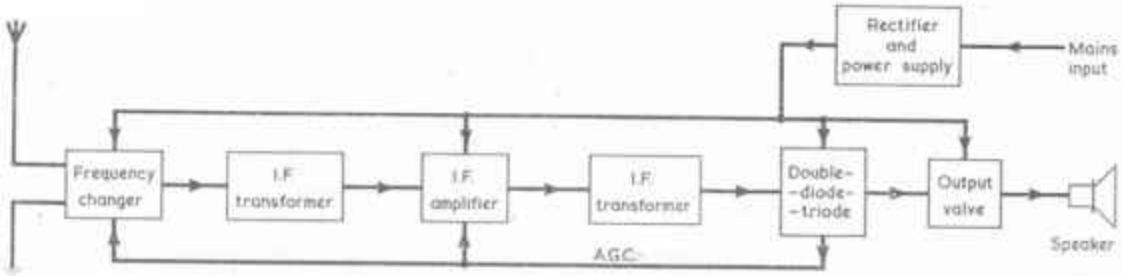

Fig. 1. Block diagram of a 'four-plus-one' a.m. valve receiver

taking a closer look inside the cabinet, "it looks all right above the chassis."

"Good," replied Smithy. "Let's next go through some other items which are likely to make the repair of sets of this nature uneconomical. To start off with, if the set has a push-button wave-change or station selection switch it would probably be best to forget about fixing it. These push-button switches tend to wear out more quickly than the rotary type and, to my mind, the replacement of what could well be a non-standard push-button switch would incur far too much trouble. See, also, that the tuning drive is in good condition. If a complicated mechanical drive is used and it's gone faulty, the set is again not really worth the bother of fixing."

"The tuning drive appears to be okay," remarked Dick. "And the wave-change switch on this set is a rotary one and it seems to have at least a good clicking action."

"That sounds promising," commented Smithy. "Well, you'd better get the chassis out and clean some of that dust off it."

Smithy returned to his bench, whilst Dick removed the chassis from the cabinet. He then took from its corner the Workshop's battered vacuum cleaner, in whose bag at some time had resided dust from most of the households in the locality, and proceeded to clean the top of the chassis. As a final act he coupled the hose of the cleaner to its blower end and blew away the final remaining traces of dust from odd crannies. On turning the chassis over, he was pleasantly surprised to find that the underside was quite clean, and bore only that particular patina which is peculiar to old radios. He examined the chassis underside carefully.

"This doesn't look too bad, Smithy," he called out. "I've taken a look at the wave-change switch, too, and it seems all right. Somebody in the past has changed one of the resistors, but he's made a nice neat job of it so *that* should be okay."

MAINS TRANSFORMER

"Fair enough," said Smithy, returning. "Now the set has got a mains transformer. If that proves to be all right then I think it might well be worthwhile getting this receiver to go again."

Smithy looked into the chassis, then picked up Dick's testmeter. He switched this to a resistance range and clipped one of the test leads to the chassis.

"We'll first check that the h.t. secondary is all right," he explained. "This set uses a standard full-wave rectifier circuit so there will be a centre-tapped h.t. winding to test."

The Serviceman applied the remaining test prod successively to two of the rectifier valve pins (Fig. 2) and looked at the meter needle.

"There's several hundred ohms in each half of the secondary," he said, "so that will be all right."

"The primary should be all right, too," put in Dick. "The tuning scale light lit up when I switched the set on."

"Did it?" said Smithy. "Then there's no point in carrying out any further tests, and we can say that the mains transformer is satisfactory."

"What," asked Dick, "is the next thing to do?"

"Make certain there are no shorts between h.t. positive and chassis," replied Smithy. "Seeing that you got no sound out of the set when you switched it on just now, it would seem reasonable to check that there are no broken-down h.t. smoothing electrolytics or any thing like that. We don't have to actually locate the positive h.t. line because we can, of course, check directly at the tags of the h.t. electrolytics themselves. I see that this set has three electrolytics in a single can with smoothing resistors between them."

Smithy applied the test prods of Dick's meter to the tags of the electrolytic capacitors. (Fig. 3).

"This is quite encouraging," he remarked cheerfully. "I got a sizeable kick in the meter needle when I first put the prods on, which

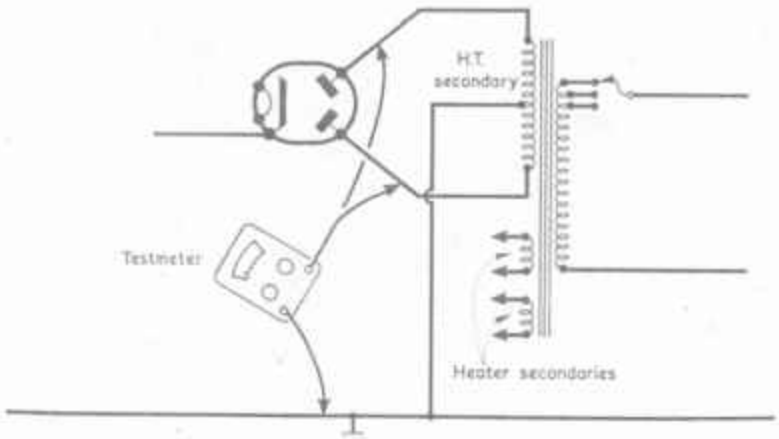

Fig. 2. Smithy checked the two halves of the mains transformer h.t. secondary by checking for continuity between chassis and first one anode and then the other anode of the full-wave valve h.t. rectifier

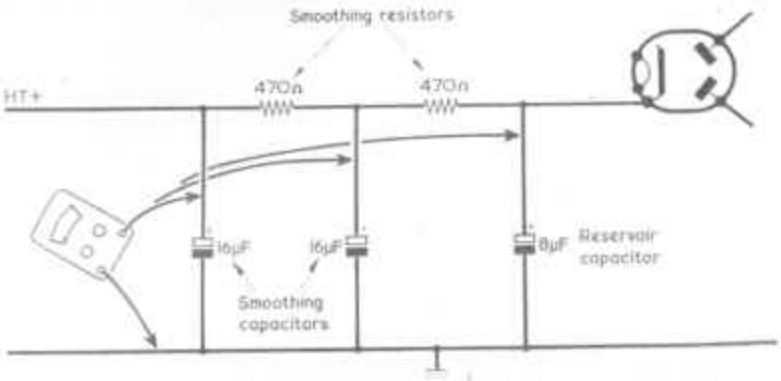

Fig. 3. Checking for h.t. short-circuits, Smithy tested between chassis and the positive tags of the h.t. electrolytic capacitors. This also enabled open-circuits in the smoothing resistors to be checked. The component values shown are typical

means that there's still a useful bit of capacitance in the smoothing circuit. And the final resistance to chassis at each of the positive tags was about 100kΩ. Sets of this nature don't usually have potential dividers in the receiver circuits, so that 100kΩ resistance is probably leakage resistance in the electrolytics. The fact that I got the same resistance reading on each of the tags also indicates that neither of the smoothing resistors is open-circuit. A figure of 100kΩ is a wee bit low for leakage resistance, but I think we can still switch the set on, nevertheless. Plug it in, Dick."

Smithy switched Dick's meter to a suitable voltage range, then reconnected it between chassis and the positive tag of the final electrolytic smoothing capacitor. At the same time, Dick put the receiver plug back in the socket at the rear of his bench. Smithy switched on the set. The tuning scale light, now relieved of its cocoon of dust, shone brightly. The heaters of the five valves in the receiver started to glow, shortly reaching full brilliance. The needle of Dick's meter suddenly shifted from its zero setting. As the seconds passed it ascended up its scale then slowed down to finish at a steady and triumphant 260 volts.

"There's plenty of h.t. there," remarked Dick. "Let's turn the volume up."

He reached over and turned the volume control spindle fully clockwise. As had occurred when the set was in its cabinet, there was still no sound from the speaker. Dick next attempted to adjust the wave-change switch, but it was too stiff to turn by means of its spindle only. Dick fitted its knob, then turned it experimentally from one position to the next.

There was a sharp crack, and a spark jumped between two pins of a valveholder on the other side of the chassis.

Dick turned the switch back to its previous position. Again there was a sharp crack, accompanied by the spark.

"Corluvaduk," exclaimed Dick, startled. "What have we got here?"

"We've got a symptom," replied Smithy, "which explains why this set is so silent. What you haven't realised is that the valveholder where that spark is occurring is the one that holds the output valve. Switch the set off, then trace for an open-circuit between the secondary of the speaker transformer and the speech coil of the speaker."

I.F. INSTABILITY

Impressed by this immediate diagnosis of the cause of the spark, Dick turned off the set, located the speaker transformer and traced through its secondary circuit to the speaker.

"Blimey, Smithy," he called out suddenly, "You must be a magician, mate! It's just as you said; what's happened is that a wire from the speaker has broken off at the transformer secondary tag. It was still positioned close to the tag and it wasn't till I waggled it that I found it wasn't actually connected."

Dick indicated to Smithy the break in the circuit (Fig. 4) then picked up his iron.

"We'll soon get this fixed," he called out jubilantly. "Incidentally, what made you so sure that the transformer secondary circuit was open?"

"It was almost certain to be," replied Smithy. "If, in a single-ended valve audio output stage, as we have here, the secondary of the output transformer isn't loaded by the speaker, the impedance presented to the output anode is the inductance of the transformer primary

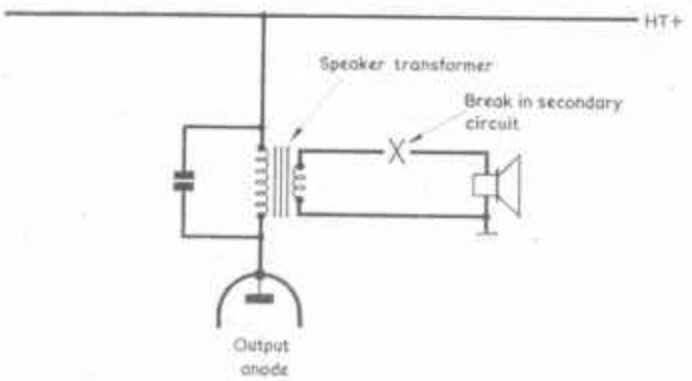

Fig. 4. The break in the speaker transformer secondary circuit. (The capacitor across the primary, normally around 0.1μF, is intended for 'tone-correction' and it reduces the shrill effect of third harmonic distortion in the output pentode.)

itself. This impedance is much higher than the normal anode load impedance, with the result that much higher a.f. voltages appear across it. If that secondary circuit hadn't been open just now there would have been a loud click from the speaker each time you moved the wave-change switch, this click being particularly loud since, as I noticed, you had the volume control at a full setting. With the speaker disconnected, though, that click became a large voltage pulse at the output anode instead, whereupon a spark jumped from the anode pin to the adjacent pin, which happens to be one of the heater connections. Incidentally, sparking at the output anode pin when the output transformer secondary circuit is open is quite a common occurrence. High level music or speech fed to the output valve can also cause it to happen."

"Well, that's something I didn't know before," said Dick. "Anyway, I've now repaired that secondary circuit connection, and I'm going to switch on again."

Dick turned the receiver on again. After a short wait, an h.t. voltage was once more indicated on the testmeter. Also, and much to the gratification of Dick's assistant, a hiss at comfortable level became audible from the speaker.

"We're really getting somewhere now," said Dick exhuberantly. "I'd better see if we can tune in a station."

He looked at the wave-change knob.

"We're switched to long waves," he continued. "Let's see if we can get Radio 2 on 1,500 metres."

"Plug an aerial in first," advised Smithy. "There were no such things as ferrite rods when this set was made. A few feet of wire will be enough for the time being."

Dick found an odd length of wire and inserted it in the aerial socket of the receiver. A comforting crackle was audible from the speaker at the instant of making the connection. Dick grinned. He then turned the tuning drive spindle between finger and thumb, whereupon a steady succession of further crackles was heard, these ceasing as he stopped turning. Dick's grin vanished abruptly and his expression changed to one of dismay.

"There's no point," he said gloomily, "in going any further with this set, Smithy."

"Why on earth not?"

"Didn't you hear those crackles when I turned the tuning drive spindle? The vanes in the tuning capacitor must have a shocking intermittent short-circuit between them somewhere."

"Nonesense," retorted Smithy. "Put the knob on that tuning drive spindle and try again."

Unwillingly, Dick fitted the knob to the spindle and turned it experimentally. Much to his amazement, he found that the crackles had disappeared completely.

"Stap me, Smithy, how do you do it?" he asked wonderingly. "And where did all those crackles go?"

"What was happening," said Smithy, "was that your body was acting as a counterpoise earth to that short aerial you fitted. The chassis of this set isn't earthed, and you were making an intermittent connection to it as you turned the spindle, the intermittent connection being given between the spindle and the holes in the chassis to which it's fixed."

Smithy indicated the points of contact. (Fig. 5).

"This intermittent connection," continued the Serviceman, "caused the effective counterpoise – you – to be coupled to the chassis by a

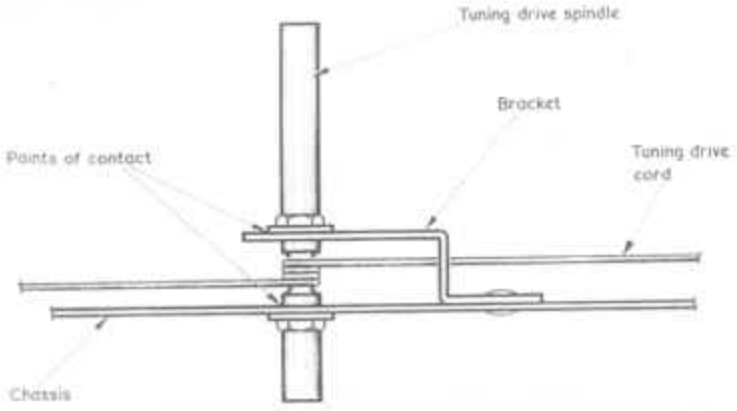

Fig. 5. In this typical tuning drive spindle mounting, the spindle simply revolves in holes in a mild steel chassis and support bracket. In consequence, the electrical contact between the spindle and the chassis, as the former is rotated, is of an intermittent character

'crackly' connection. After you'd put the knob on you were insulated from the spindle and so there were no more intermittent connections between you and the chassis, and hence no crackles. Okay?"

Dick looked at the receiver with a newly acquired respect.

"Servicing these old sets," he remarked, "involves a lot of tricks you don't encounter with modern receivers. Anyway, now that we've got the crackles out of the tuning, let's have another bash at picking up a station."

He turned the knob further and was rewarded by a high pitched whistle with a background of distorted music. The whistle descended in frequency as he turned the tuning drive and he was able to reach a position of zero-beat. The sound of heavily distorted music was loudly audible from the speaker.

"That's i.f. instability," remarked Smithy laconically. "The i.f. amplifier is oscillating at the intermediate frequency so that, when you tune in a signal, you get the same beat frequency effect as when you tune in a signal on a straight receiver in which the reaction has gone past oscillation point. Let's see if we can clear it up."

Smithy went to the spares cupboard and returned with a 0.5μF polyester capacitor. He applied this across the third electrolytic capacitor in the h.t. smoothing circuit. (Fig. 6). The beat frequency effect cleared immediately. With his free hand, Smithy turned the tuning drive of the receiver. The signal could now be tuned in and out in perfectly normal fashion, with no trace of the previous whistle. When tuned in correctly, the signal still exhibited a measure of distortion, but this was of a different nature and much less evident than that which had previously been present.

"You've done it again!" pronounced Dick incredulously. "That's the third snag you've cleared up first go. How on earth did adding that capacitor clear the instability?"

"To answer that question," replied Smithy, switching off the set again, "I must first tell you that quite a lot of these old valve sets have no anode decoupling for the individual stages at all. The frequency-changer anode load, the i.f. amplifier anode load, the a.f. voltage amplifier anode load and the output pentode anode load all go to the h.t. positive line direct. This is bypassed to chassis by the smoothing electrolytic capacitor which connects to the h.t. positive line, and there are no other anode bypass circuits whatsoever. It only requires the electrolytic capacitor to develop a little series impedance and the whole set takes off! The usual result is that oscillation takes place at the intermediate frequency because that's the frequency at which most amplification takes place."

NEW CAPACITOR

"Isn't it a bit naughty," queried Dick, "to expect an electrolytic capacitor to act as a bypass at intermediate frequencies?"

"It is rather, I suppose," said Smithy. "But the use of an electrolytic in this manner was an extreme-

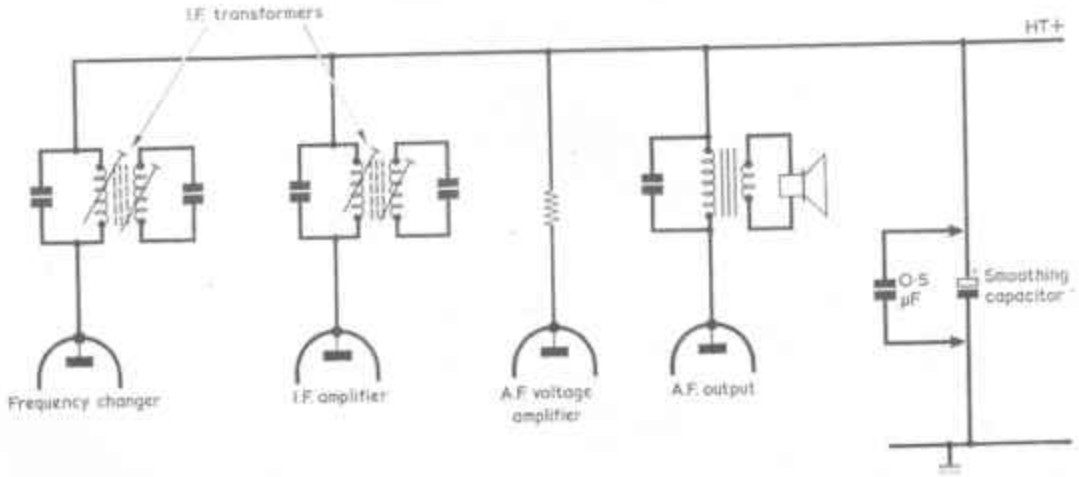

Fig. 6. In many a.m. valve receivers the final smoothing electrolytic capacitor bypasses the anode loads of all the stages. Smithy connected an 0.5μF capacitor across this capacitor to see whether it was causing i.f. instability

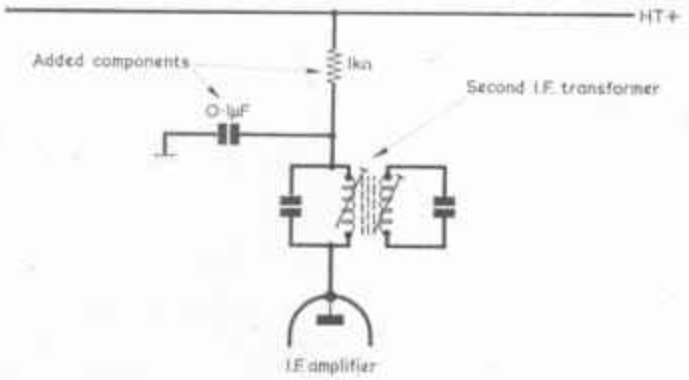

Fig. 7. An added h.t. decoupling circuit at the second i.f. transformer can, in some instances, cause an improved performance in valve a.m. receivers

ly common practice at the time. You'll have noticed, incidentally, that I only needed a 0.5μF capacitor to provide the bypassing that was required to clear the i.f. instability, so perhaps employing an electrolytic for the job isn't such bad practice after all. By the way, if you ever want to *improve* the i.f. response of one of these old sets, it's a good plan to add an h.t. decoupling circuit to the primary of the second i.f. transformer. A 1kΩ resistor and 0.1μF capacitor will be quite adequate." (Fig. 7).

"What does the decoupling circuit do?"

"It increases the isolation between the two i.f. transformer primaries," explained Smithy. "There is then less chance of regeneration from the anode circuit of the i.f. valve back to its grid circuit, and you can align the transformers to give really symmetrical responses. Adding the decoupling circuit doesn't *always* produce a significant improvement in receiver performance, but it's worth trying, just on spec."

"That's something I'll bear in mind for the future," said Dick. "At the time being, though, it looks as if I'd better fit a new electrolytic to this set."

"It does, rather," agreed Smithy. "As a matter of fact I would probably have suggested that you replaced the h.t. electrolytics in any case, even if they hadn't given rise to trouble or were allowing excessive hum to appear. Electrolytics as old as these ones are tend to fall into the category of components that are liable to give trouble at any time."

Dick walked over to the spares cupboard and selected a suitable triple electrolytic capacitor for replacement. Smithy watched him thoughtfully as he mounted it on the chassis and then soldered it into circuit.

"Whilst talking about i.f. instability," Smithy remarked, "another component which was likely to give rise to trouble on this score is the screen-grid bypass capacitor for the i.f. valve. This connects, of course, between the screen-grid and chassis."

"Why should it cause trouble?"

"Because the i.f. amplifier valve is expected to provide a very high level of amplification," explained Smithy. "With the result that, in many of these old sets, its screen-grid had to be tied down to chassis really good and tight. If you had a faulty screen-grid capacitor, or if the leads to it were too long, the set could similarly go unstable. Another cause of i.f. instability, in the *really* old sets, was the result of the metallising on the glass envelope of metallised valves becoming unstuck from its earth lead."

"Valve metallising? Blimey you're going back a bit, aren't you?"

"Perhaps I am," confessed Smithy, "but if we're going to talk about old sets, we might as well cover the subject completely. These valves were octal types with the control grid brought out to a top cap, and they were screened by a layer of metallising on the outside of the glass, this metallising connecting to a wire which went down to an earth pin. Very often the glass used to come adrift from the bakelite base of the valve and the connection to the earth pin would then break away. If the valve was an i.f. amplifier the set would probably go into i.f. oscillation as a result. The cure was to re-stick the glass of the valve to its base and then wrap a few turns of thin bare tinned copper wire round the metallising at the bottom. This wire was then run down the outside of the base to the earth pin and soldered to it at the point where its pin left the base." (Fig. 8).

"I had a go myself once," commented Dick thoughtfully, "at soldering to one of the pins of an octal valve. I had a dickens of a job getting the solder to take."

"You need to give the pin a touch with a file first," advised Smithy. "Just enough to remove the plating at one point and show the brass underneath. Have you got that new electrolytic in yet?"

A.F. DISTORTION

"Just finishing," said Dick.

Carefully, he completed the last connection, then he placed his soldering iron on its rest and switched on the receiver. Both of them listened critically to the music, without whistle, that the set now reproduced.

"The new electrolytic," remarked Dick, "has certainly cleared the i.f. instability. But the sound still seems a little distorted to me."

"Yes, it is a bit," agreed Smithy, picking up a screwdriver with an insulated handle. "Let's check the a.f. coupling capacitor to the output grid."

Smithy put the blade of the screwdriver on the chassis alongside the output pentode valveholder and touched its metal shaft to the control grid tag. With a crackle, the sound ceased. (Fig. 9). Smithy re-

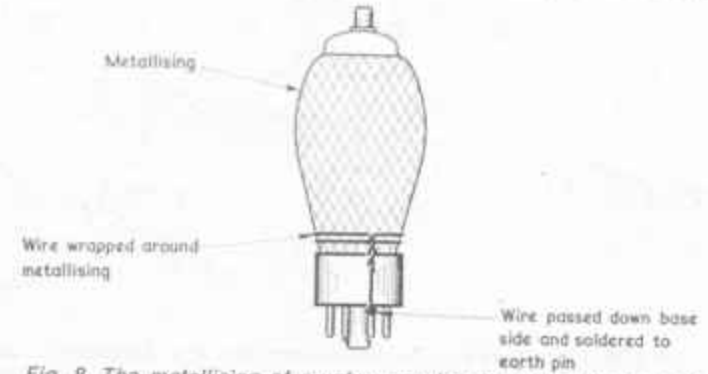

Fig. 8. The metallising of a valve may be connected to its earth pin externally

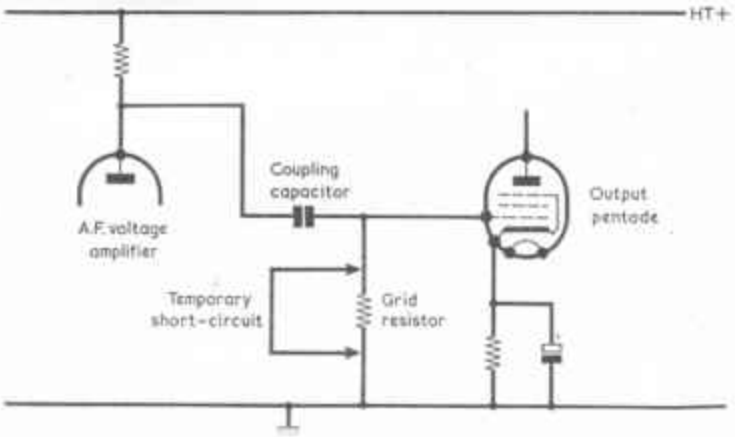

Fig. 9. Checking for a leaky a.f. coupling capacitor. If a crackle is heard when the grid resistor is short-circuited the coupling capacitor is leaky

moved the screwdriver whereupon, with a further crackle, the sound resumed.

"The coupling capacitor between the output grid and the previous anode has gone leaky," Smithy pronounced decisively. "New capacitor to be fitted, please!"

"Blow me," protested Dick, "you aren't half diagnosing faults in a hurry today. How the deuce can you be so sure that the coupling capacitor is leaky?"

"Because that output grid has got a standing direct voltage on it," replied Smith, "which is why I got a crackle when I short-circuited its grid resistor. If it hadn't had a direct voltage on it, the sound would simply have ceased without a crackle. This test is a reliable and quick one, but make certain you know which *is* the control grid pin if you carry it out. You can do a lot of damage if you accidentally short the wrong pin to chassis!"

Dick went to the spares cupboard and found a new replacement coupling capacitor. He switched off the set, soldered the capacitor in, then switched on again. The distortion was now completely cleared.

"Do you know, Smithy," remarked Dick after some moments, "this set sounds really *good*. The quality seems to be a darned sight better than what you get on many of the modern solid-state jobs we handle."

"When they're working properly," commented Smithy, "these old valve sets can sound very nice indeed. To start off with, they've got a straightforward Class A output stage with no complications, instead of the present-day transistor Class B circuits. Secondly, the sets were built in large wooden cabinets, which means that their speakers, which themselves are quite a big size, have a good effective baffle area to bring up the bass. I'll be the first to agree that the sound these sets give isn't high fidelity and that it isn't up to the high quality mark, even. And I'd agree also that the i.f. stages are usually sharply selective, so that you get an output which has a fair amount of top-cut to add to any bass thump that may be given by the large speaker and cabinet. Nevertheless, I still feel that these receivers can give quite a good performance. Try the other bands on the set."

Dick proceeded to put the set through its paces and found that it performed remarkably well. Long and medium wave reception was very good, and the set produced the usual staccato stream of signals as he swung over the short wave band. The more powerful short wave stations could be resolved with ease.

"Not bad at all," commented Smithy. "I think we can say that we have now achieved an acceptable repair at quite a reasonably low cost, both in components and in time. Admittedly, we were lucky to find that the set had the more usual stock faults on it. I tell you what: now that we've got it going, how about giving the cabinet a bit of a polish up?"

"Why not," replied Dick enthusiastically. "To tell you the truth, I'm beginning to fell quite a lot of affection for this old-stager, and I'd be only too happy to give its box more than the average amount of bull."

Dick found some rags and a tin of furniture polish, these being employed occasionally to give the more expensive receivers a final finishing. He polished away cheerfully to the accompaniment of mellow music from the old radio.

Smithy's assistant gave the cabinet of the receiver a final rub and then put the polishing cloth on one side. The receiver, its early post-war cellulose covering restored to its original splendour, gleamed in front of them. The tuning panel, now cleaned and fully illuminated, was radiant with a tuning scale pattern of many colours.

"The owner of this set," said Dick proudly, "can certainly be grateful to us for the work we've put in on it."

A thought suddenly occurred to him.

"Hang on a minute," he went on, frowning, "I've just remembered something. The ticket tied to that set didn't have any owner's name and address written down on it."

Smithy turned a guileless eye towards the ceiling.

"There's something fishy here," continued Dick, a tone of suspicion rising in his voice. "It's the rule that all the fault-tickets used here should have the set-owner's name and address on them. I must say it's funny that the first unusual job I've tackled for ages should also be accompanied by a label with no name and address on it."

The innocence exhibited in Smithy's face had now become so intensified as to approach the imbecile. Dick turned an accusing glance at him.

"Don't tell me," he intoned furiously, "that that set is yours!"

"I cannot," replied Smithy sweetly, assuming the mantle of the infant George Washington, "tell a lie. Yes, it is my set. As it happens, I found it when I was cleaning out the loft the other day."

"Why, you rotten old devil," spluttered Dick, "You *planted* that set on the rack. You snuck it in first thing this morning, before I got to work, and you darned well secreted it amongst all the other sets on the shelves."

Dick's sense of outrage grew even keener at the recollection of a further affront.

"Flaming heck," he fumed, "I've actually been vacuum-cleaning and polishing up that set, when it's *your* private job! No wonder there's a generation gap these days. It's because the people in the older generation are all like you – shysters and con-men!"

"You must at least admit," said Smithy soothingly, "that I've given you a chance to get in some experience in rejuvenating old sets."

"Well," conceded Dick grudgingly, "I suppose that that is true. But I still think you've been taking a liberty. However, I'll forget all about it on one condition."

"And what's that?"

"That you let me have a really good long gen-session with you during today's lunch-break."

And to that Smithy wearily agreed. ■