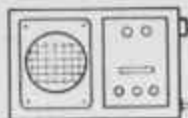


# In your work-shop



"IT'S FUNNY, YOU KNOW,"

Smithy, his disreputable tin mug poised half-way towards his lips, turned to his assistant.

"What's funny?"

"The fact that we nowadays hardly ever get any trouble with the f.m. front-end circuits in the transistor a.m.-f.m. portables we service."

Thoughtfully, Smithy drank from his mug.

"You've got a point there," he conceded. "The main reason for their reliability, I suppose, is that the design of transistor f.m. front-ends has become highly stabilized over the years. Manufacturers aren't going in for trick circuitry, and they are using well-proven designs which have become firmly established with time."

After which pronouncement, Smithy absently flicked off his trousers a crumb from the lunch he had just consumed, and resumed his peaceful contemplation of the opposite wall of the Workshop.

## F.M. FRONT-ENDS

Dick threw an irritated glance at the Serviceman.

"With these f.m. front-ends," he continued, "all we ever seem to have to do is to very occasionally replace components which have become obviously faulty. And even then it's only things like resistors which have gone open-circuit or something like that. And even *then* it's only once in a blue moon."

There was silence.

"And even *then*," persisted Dick, raising his voice, "it's only once in a blue moon."

Smithy sighed and brought himself out of his reverie.

This month Smithy the Serviceman attempts to obtain a little peace during the latter part of his lunch-break. But this is not easy to achieve when his assistant, Dick, is around, and Smithy eventually finds himself forced to hold forth on the mysteries of f.m. front-ends

"What on earth," he asked irately, "are you raving about now? *What's* only once in a blue moon?"

"When we replace parts in f.m. front-ends."

Smithy sat up straight and bestowed a glowering glance on his assistant.

"Now, look here," he announced, "I'll have you know that this is my lunch-break and that I intend to spend what's left of it digesting the food I've just eaten. I can't digest it properly if you're going to keep rabbiting on at me all the time about f.m. front-ends."

"I'm only trying to make conversation," returned Dick plaintively. "I always remember what happened when, years ago, I started work here. You told me *then* that if I displayed a really lively interest in electronics you would be more than satisfied with me."

"Of all the acts in my life which I deeply regret," stated Smithy bitterly, "my utterance of that statement is the one which causes me the greatest grief."

"You said just now," went on Dick inexorably, "that the design of f.m. front-ends has become stabilized over the years. What sort of circuits do these f.m. front-ends use?"

Directing an expression of resignation towards the ceiling, Smithy accepted the inevitable.

"Knowing you," he said shortly, "I'm quite sure I'll get no rest until I've fully satisfied your curiosity. So, come on over here. I'll get my notepad out and I'll show you how a present-day f.m. front-end works."

Delighted, Dick shot eagerly towards Smithy's side, bringing his stool with him. He perched himself comfortably on this and looked expectantly at the Serviceman's notepad, on which the first of Smithy's sketches, a block diagram, was already taking shape. (Fig. 1).

"Here we are," said Smithy, several moments later, as he put down his pen. "However, let us first of all define what it is we're going to talk about. What we're now about to discuss are the f.m. front-end sections of transistor a.m.-f.m. portable receivers. These receivers cover the f.m. band of, nominally, 87.5 to 100 MHz, and they have an intermediate frequency for f.m. of 10.7MHz. They will also have a separate a.m. front-end which covers the usual medium and long wave bands. Occasionally, you'll encounter a set which also operates on one or two short wave bands as well. All these are for a.m. reception and the a.m. intermediate frequency is normally between 450 and 475kHz according to the particular receiver model you're considering."

"I know all that bit," remarked Dick a little impatiently. "Both the f.m. and a.m. intermediate frequencies pass into a common i.f. amplifier which deals with a 10.7MHz i.f. when the receiver is switched to f.m., and which deals with the a.m. i.f. when the set is switched to a.m. At the end of the i.f. amplifier there are two detectors. One is a ratio discriminator for f.m. reception and the other is a standard a.m. detector for a.m. reception. Their

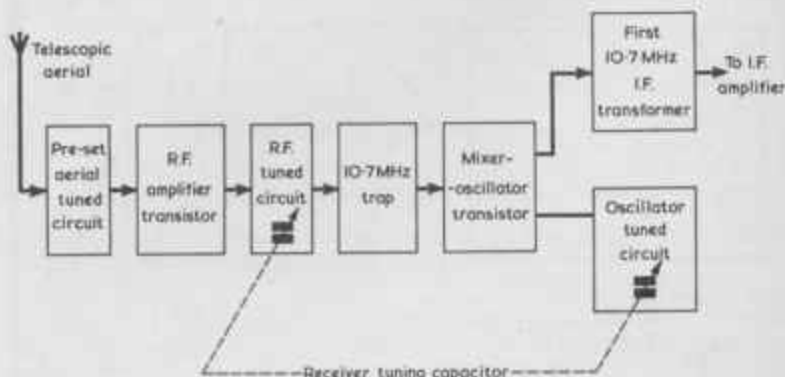


Fig. 1. Block diagram illustrating the successive sections of an f.m. front-end in an a.m.-f.m. receiver

outputs are switched by a section of the a.m.-f.m. receiver switch so that the correct one goes to the following a.f. amplifier stages."

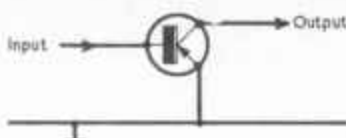
Smithy took a further draught from his tin mug.

"Very good," he remarked. "After having got the overall picture settled, let's next get down to the f.m. front-end section. This picks up the f.m. signal, usually by means of a telescopic aerial on the receiver, amplifies it and then converts it to the f.m. i.f. of 10.7MHz. In the standardised design I mentioned just now, and which you'll encounter in almost all a.m.-f.m. portables regardless of make, the aerial input is applied to a pre-set aerial tuned circuit which is broadly tuned to the centre of the f.m. band. You can see this tuned circuit in the block diagram I've just drawn. It is pre-set for a number of reasons, one of these being that a tuned circuit in this position tends to tune broadly in any case, and there would be little advantage in adding a further section to the receiver ganged tuning capacitor in order to tune it. Another reason is that the transistor into which the tuned circuit feeds is in the grounded base configuration and thereby offers a low input impedance, whereupon it is desirable to inject a fairly high signal current from the aerial to the transistor input. Yet again, the aerial employed, being a telescopic type, is likely to vary considerably in the impedance it offers to the first tuned circuit, these variations resulting from its positioning and the amount by which it is pulled out of the receiver case by the user. All these factors make it desirable, in domestic a.m.-f.m. portable receivers, to have the aerial input tuned circuit broadly tuned to the centre of the f.m. band."

"Why," asked Dick, "is the transistor into which the aerial tuned circuit feeds connected in the grounded base mode?"

"Because," replied Smithy, "a transistor in the grounded base configuration is able to amplify at much higher frequencies than it can do in the grounded emitter configuration. If you remember your transistor basics, you'll recall that a transistor can be connected in either the grounded emitter configuration, the grounded base configuration or the grounded collector configuration. These are alternatively referred to as the common emitter, common base and common collector configurations respectively, the word 'common' being used because the transistor electrode which is grounded is common to both the input and output circuits. And, of course, the word 'grounded' is the American version of our own word 'earthed', and it just happens to have become accepted terminology so far as transistor operating modes are concerned. I should add that the 'ground' connection can, in practice, be given via a high value capacitor having very low reactance at the signal

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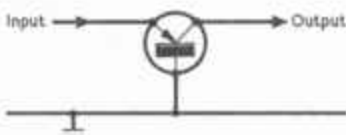


Grounded EMITTER

Input impedance - medium

Output impedance - medium

(a)

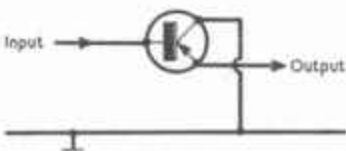


Grounded BASE

Input impedance - low

Output impedance - high

(b)



Grounded COLLECTOR

Input impedance - high

Output impedance - low

(c)

Fig. 2. The three basic transistor configurations with, roughly, their comparative input and output impedances

frequency which is being handled by the transistor."

Smithy sketched out the three circuit configurations, (Figs. 2 (a), (b) and (c)).

"The grounded collector configuration you've just drawn," remarked Dick, "is also known as the emitter follower, of course."

## INPUT AND OUTPUT IMPEDANCES

"Of course," responded Smithy. "Well now, whilst we're dealing with these configurations it will be worth our while to take a quick look at the main features given by these three methods of connecting a transistor. First of all, and as I've already mentioned, the grounded base configuration is capable, with a particular transistor, of offering amplification at a much higher frequency than occurs

with the same transistor in the grounded emitter mode. Other important attributes have to do with input and output impedances. The grounded emitter circuit gives, roughly, a medium input impedance and a medium output impedance. The grounded base mode gives low input impedance and high output impedance, and the grounded collector mode gives high input impedance and low output impedance."

"Fair enough," said Dick. "I must say that, although we're continually playing around with transistors in practice, it still doesn't do any harm to occasionally brush up on basic things such as those input and output impedances."

"That's very true," agreed Smithy. "Anyway, let's now get back to the f.m. front-end. Up to now we've passed our f.m. signal through the broadly tuned aerial tuned circuit and we next feed it into the emitter of the first transistor. This transistor is a straightforward r.f. amplifier without complications, and the amplified signal at its collector is passed to a tuned circuit which is resonant at signal frequency. This tuned circuit resonates quite sharply and its frequency is varied by one section of the receiver ganged tuning capacitor. The signal is then passed to the emitter of the second transistor which is a mixer-oscillator. Also, a 10.7MHz acceptor trap is connected between the emitter of this second transistor and chassis."

"What's the trap for?"

Smithy picked up his mug and drank deeply, then replaced it on his bench.

"Ah," he grunted in a tone of complete satisfaction, "that's just the job. I don't really know what I would do if I couldn't get the odd spot of tea every now and again."

"What," asked Dick patiently, "is the 10.7MHz trap for?"

"That 10.7MHz trap?" repeated Smithy. "Well now, that trap does several things. To start off with, it prevents any strong signals at 10.7MHz breaking through to the second transistor and from this into the 10.7MHz f.m. i.f. amplifier stages. The trap also prevents any of the 10.7MHz i.f. signal at the collector of the second transistor going back to the aerial."

"Blimey," said Dick, surprised, "does it matter if the 10.7MHz signal does get back?"

"It could do," replied Smithy. "It could be radiated and picked up by other receivers. Don't forget that the simple v.h.f. tuned circuits that are used in the front-end are not capable of offering a high level of attenuation to 10.7MHz in either direction. However, what is probably the most important reason for having the 10.7MHz trap is that it isolates the aerial circuit from the i.f. amplifier of the receiver. If the trap were omitted the situation could arise where there is effectively an overall 10.7MHz amplifier extending all the way from

the aerial, through the two transistors in the front-end, and then through the i.f. amplifier itself right up to the f.m. ratio discriminator. With a set-up like that the whole lot could take off at 10.7MHz."

"You mean it could go unstable and start oscillating?"

"I do."

"But I don't get it," stated Dick, obviously puzzled. "Even if the front-end doesn't suppress the 10.7MHz signal, what coupling is there between the i.f. amplifier and the aerial?"

"There can," said Smithy in reply, "be all sorts of stray couplings. This is especially true in a small portable receiver with a telescopic aerial, which presents a relatively large mass of metal that is quite close to the final circuits of the i.f. amplifier. Another factor is that, with a telescopic aerial, the receiver metalwork acts as a counterpoise. The situation is rather like a quarter wave aerial over a reflecting surface. Like this."

Smithy scribbled out a further sketch on his note-pad (Fig. 3 (a).)

"With a receiver and a telescopic aerial," he resumed, "the reflecting surface is replaced by the receiver metalwork."

The Serviceman applied himself to his note-pad and produced a further sketch. (Fig. 3 (b).)

"In both these instances," he went on, "signals picked up by the aerial cause currents to circulate in both the aerial and the reflecting surface, which in my second sketch is the receiver metalwork. Conversely, any currents circulating in the receiver metalwork can enter the aerial input circuit of the receiver. With a small f.m. receiver in which most of the earthing is given by areas of thin copper foil on the printed circuit board there are liable to be quite widely circulating currents at 10.7MHz, this being particularly the case around the detector section which uses relatively low impedance circuits to handle signals having amplitudes of at least a few volts."

"Ah," said Dick, suddenly enlightened. "I can see it all now. What you're saying is that the output of the 10.7MHz i.f. amplifier can enter the aerial circuit both by stray couplings and, where the receiver employs a telescopic aerial, by way of stray 10.7MHz currents flowing in the receiver metalwork as well."

"That's exactly the situation," confirmed Smithy. "Both of these factors could cause i.f. instability or, if not that, at least sufficient regeneration to modify the shape of the 10.7MHz i.f. response curve. Fortunately, the whole problem can be cleared up very easily by the simple inclusion of the 10.7MHz trap in the f.m. front-end. This is an extremely inexpensive solution, too, as all that is required is a coil with a few turns on it, together with a small fixed capacitor. I'll be drawing up an actual front-end circuit soon, and you'll then be able to see just how simple that 10.7MHz trap is."

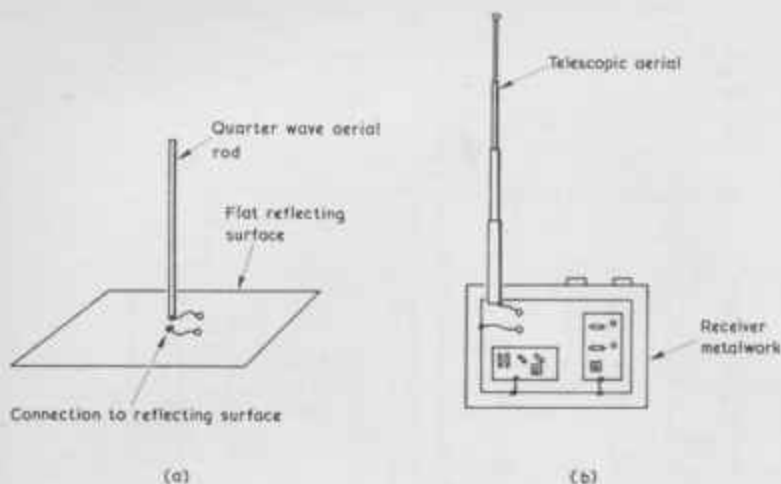


Fig. 3 (a). A quarter-wave aerial consisting of a quarter-wave rod above a flat reflecting surface. Connections are made to the bottom of the rod and to the reflecting surface beneath it  
 (b). In an f.m. receiver with a telescopic aerial, the receiver metalwork partially replaces the reflecting surface of (a)

## MIXER-OSCILLATOR

Smithy picked up his tin mug once more and, with one prodigious draught, completely drained it. Taking up an attitude reminiscent of a protagonist for Woman's Lib, displaying unwanted impedimenta before consignment to the flames, he held the mug up high at arm's length. Wordlessly, Dick took it from him and, walking over to the heterogeneous array of battered utensils which constituted the culinary effects of the Workshop, refilled it. He returned and placed the charged mug silently at Smithy's side. The filling of Smithy's mug was a custom of long standing.

The Serviceman picked up the mug and imbibed noisily.

"Just a few minutes ago," remarked Dick, as he watched Smithy with an air of fascinated revulsion, "you said you wanted to be quiet so that you could digest your lunch. With the vast quantities of tea you're now pouring down, that lunch must be washing around in your gut like jetsam at sea!"

"Nonsense, boy," retorted Smithy. "As it happens, I have a tea-oriented metabolism, and the occasional odd spot of the liquid just keeps my system nicely balanced. Anyway, let's return to our f.m. front-end. We've already amplified the f.m. aerial signal and passed it, through a signal frequency tuned circuit and the 10.7MHz trap, to the emitter of the second transistor. This transistor is the mixer-oscillator, and it is also connected in

the grounded base mode. It couples to the oscillator tuned circuit, which runs at a frequency removed from the signal frequency by 10.7MHz and which is tuned by a second section of the receiver ganged tuning capacitor. The first 10.7MHz i.f. transformer appears in the collector circuit of the mixer-oscillator transistor, and this feeds into the i.f. amplifier of the receiver."

"Well, that seems simple enough," remarked Dick. "Did you say just now that you were going to show me an actual circuit of the front-end?"

"I did," confirmed Smithy, "and that is just what I'm going to do next."

Fortified by his last intake of tea, the Serviceman tore off the top sheet of his note-pad and proceeded to draw a circuit diagram. (Fig. 4).

"Here we are," he announced proudly after some moments. "Now this is a typical circuit of the type you'll find used in practical receivers. Since the design of these f.m. front-ends has become so highly standardised over the years, it is possible to draw out a circuit diagram which is representative of nearly all the actual circuits you'll encounter. Incidentally, the fact that the two transistors in the front-end are in grounded base can sometimes be a help if you're looking for that front-end in a complicated a.m.-f.m. receiver circuit diagram. The transistors are nearly always shown with the base lines drawn horizontally, whereupon they stick out a mile from all the other transistors."

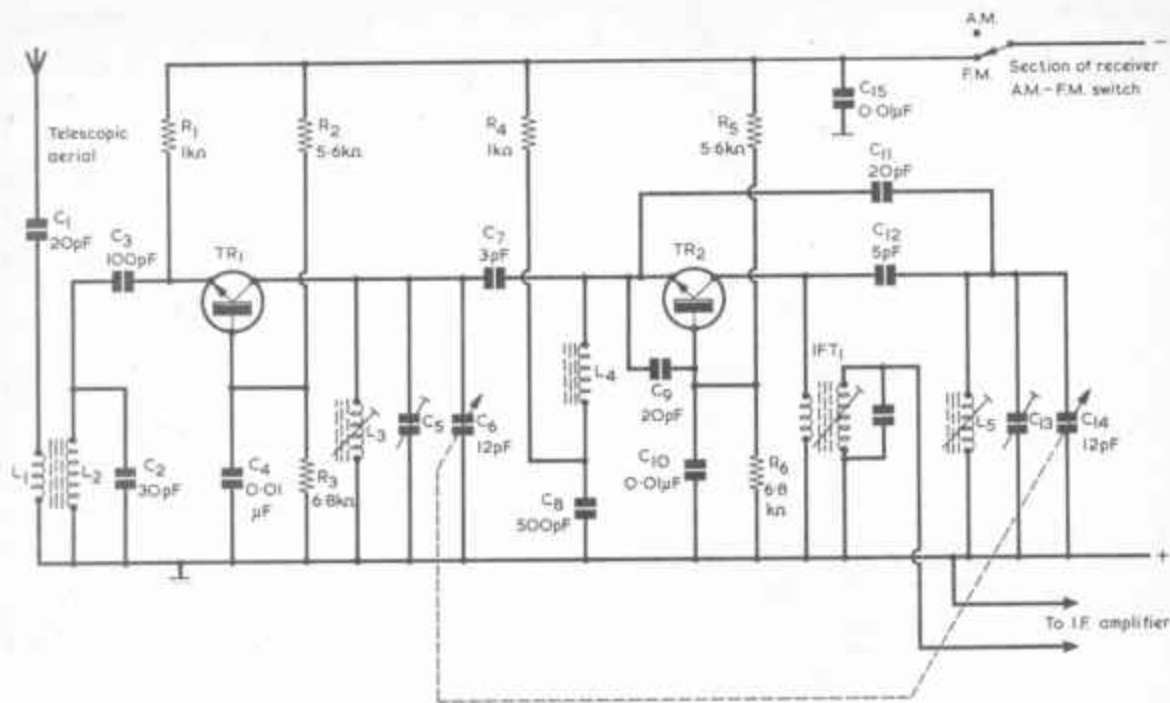


Fig. 4. Basic f.m. front-end circuit for an a.m.-f.m. receiver. Component values shown are intended to be representative only and do not apply to any particular manufacturer's design. In some instances the collector of TR1 may be coupled to a tap in L3, and/or a low value resistor may be inserted in series. Transistor types are, typically, BF222 for both TR1 and TR2.

"This circuit," commented Dick, peering closely at Smyth's diagram, "doesn't look too complicated to me."

"It isn't," agreed Smyth. "And the knowledge we have gained by considering the front-end in block diagram form will make it easier still to understand. We'll start off once more at the aerial input. This couples via an isolating capacitor, C1, to the input transformer given by primary L1 and secondary L2. L2 is tuned by capacitor C2 and, as we've already noted, is broadly resonant at the centre of the f.m. band. TR1 is the first transistor and its base is grounded to chassis via the 0.01μF capacitor, C4. It is usual nowadays to employ v.h.f. silicon n.p.n. transistors in these f.m. front-ends and both the transistors in my diagram are of this type. Also, I've shown the lower supply line, which connects to chassis, as the positive one, and the upper supply line as the negative one. The emitter of TR1 couples to the negative supply line via R1 and the base is coupled to the centre of the fixed potentiometer given by R2 and R3. The collector couples to the positive line via coil L3. So far as d.c. supplies are concerned, TR1 is connected in the same manner as are many conventional grounded emitter transistors, since there is a resistor in its emitter circuit and its base is

coupled into a fixed potentiometer connected across the supply lines. However, in a grounded emitter circuit the signal input would be applied to the base and the emitter would be bypassed to chassis via a high value capacitor."

"And here," chimed in Dick, "we have the base bypassed to chassis by the high value capacitor and the signal applied to the emitter, thereby altering the mode to grounded base. That's right, isn't it?"

The Serviceman gravely nodded in assent.

"Good," said Dick. "Is the collector coil, L3, the r.f. tuned coil?"

"It is," confirmed Smyth. "And it's tuned by C6, which is one section of the ganged tuning capacitor for the receiver. The coil also has a trimmer, C5, connected across it and it has an adjustable iron-dust core. Since the output impedance of TR1 in the grounded base mode is high, the coil is in many cases connected directly to the collector in the manner I've shown, and it doesn't suffer serious damping thereby."

"The signal across L3," remarked Dick, tracing the line along Smyth's circuit with his finger, "goes next to the emitter of TR2 via C7, doesn't it?"

"Correct," assented Smyth, "and, in that emitter circuit, L4 and C8 form

the 10.7MHz trap I was chuntering on about earlier on. These two components form a series tuned circuit, or acceptor circuit, which offers minimum impedance at its resonant frequency of 10.7MHz."

"Isn't C8 rather high, at 500pF?"

"Oh no," said Smyth. "The usual values you find for this capacitor range from about 200pF up to 1,000pF, even. This means that L4 does not have many turns, although it still offers enough inductance to give a satisfactorily high reactance at f.m. signal frequencies. You'll note that L4 provides a convenient means of feeding the d.c. supply to the emitter of TR2, the end remote from the emitter coupling to the negative supply rail via R4."

"Ah yes, I see that," remarked Dick. "Neat, isn't it?"

"It is, rather," agreed Smyth. "The base of TR2 is effectively grounded by being coupled to chassis via the 0.01μF capacitor, C10. It also connects to the junction of the two resistors, R5 and R6, which connect across the supply lines. There is therefore a d.c. supply arrangement for the base which is similar to that for the base of TR1. As a further point, the collector couples to the positive supply line at the bottom via the primary of the first 10.7MHz i.f. transformer, I.F.T.1. The second-

ary of that transformer feeds into the following i.f. amplifier. Thus, TR2 receives power supply and signal connections in much the same way as does TR1."

#### COLLECTOR-EMITTER FEEDBACK

"What," asked Dick, "makes TR2 oscillate?"

"There's feedback," replied Smithy, "from its collector to its emitter. Remember that, with both transistors, the base does not enter any r.f. circuitry; and also that the collector and emitter of a transistor in grounded base are in phase. This phase relationship is pretty easy to envisage if you work on from what you already know about the more familiar grounded emitter circuit. In the latter the base and collector are out of phase; that is to say, when the base goes negative with respect to emitter the collector goes positive, and vice versa. If, instead, we refer to voltage changes with respect to the base, however, we can see that if the emitter goes positive with respect to base this is the same as the base going negative with respect to emitter. The result is that if the emitter in grounded base goes positive with respect to the base so also does the collector. Similarly, if the emitter goes negative with respect to the base so also does the collector. Because of this the oscillator feedback circuit is delightfully simple. The collector couples via C12 to the oscillator tuned circuit given by L5 and C14, and this couples in turn via C11 to the emitter.

The whole outfit then oscillates, the oscillation frequency being at the resonant frequency of L5 and C14. To obtain the correct phase relationship between the collector and the emitter of TR2 it helps to have the emitter offer a capacitive impedance, and this is provided by C9, which connects between the emitter and the base. It might appear that, since C9 has a higher value than C7, there is some attenuation of the signal input fed to TR1, but the circuit functions adequately in practice and is employed in virtually all the f.m. front-ends you'll encounter."

"I see," cut in Dick, "that C14 is a section of the receiver ganged tuning capacitor."

"That's right," confirmed Smithy. "There is also a parallel trimmer, C13, and the coil has an adjustable iron-dust core. In some versions of the circuit the collector doesn't couple to the outer end of the coil but into a tap instead. You may also bump into f.m. front-end oscillator circuits in which the emitter couples into the same tap, too."

Smithy scribbled out the circuits (Figs. 5 (a) and (b)), then added a third circuit (Fig. 5 (c)).

"Another variation you may find," he added, "has a resistor inserted between the collector of the oscillator transistor and the oscillator coil. This

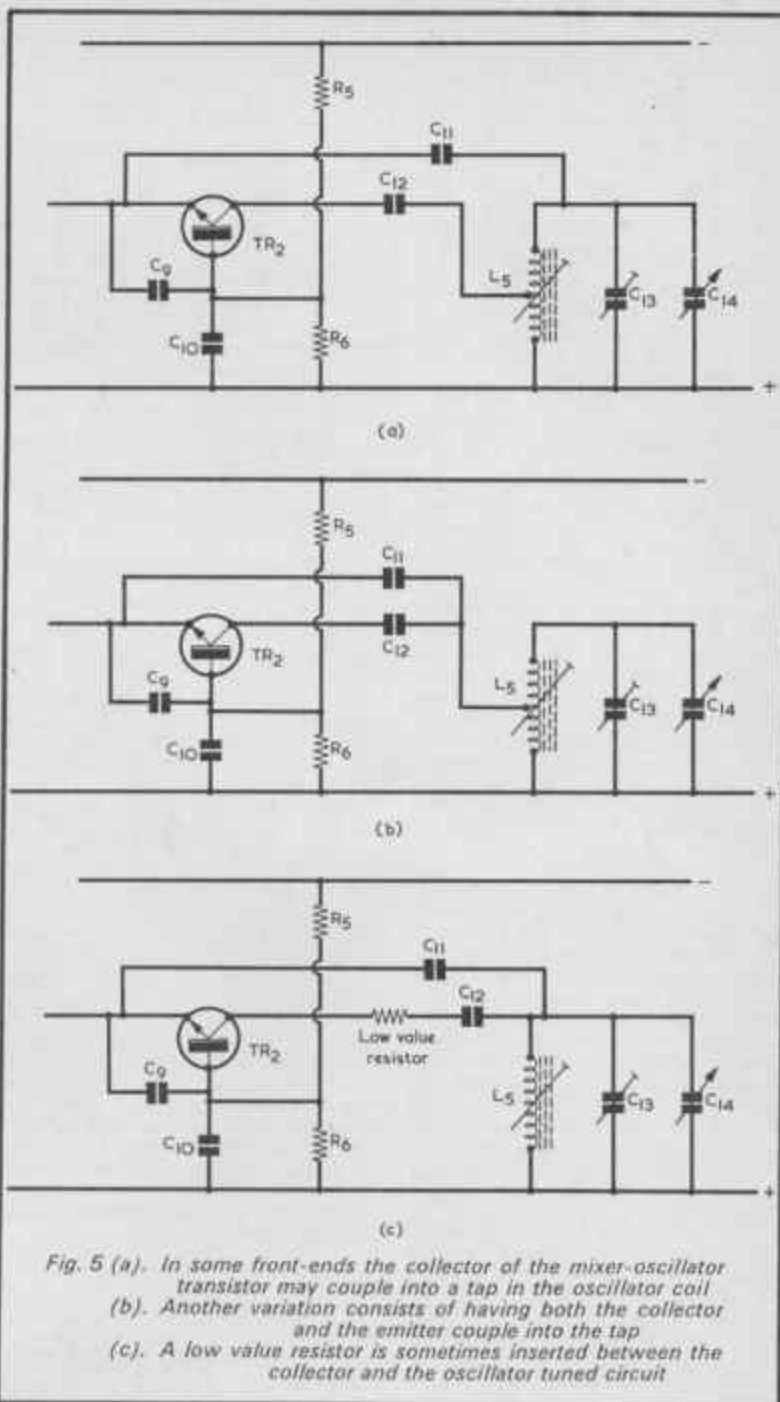


Fig. 5 (a). In some front-ends the collector of the mixer-oscillator transistor may couple into a tap in the oscillator coil  
(b). Another variation consists of having both the collector and the emitter couple into the tap  
(c). A low value resistor is sometimes inserted between the collector and the oscillator tuned circuit

resistor normally has a value lower than 100Ω or so and its main function is to prevent the transistor from oscillating too fiercely, whereupon it helps towards giving a constant oscillation amplitude over the whole tuning range."

"It looks to me," commented Dick, "that all these oscillator circuits have one basic factor in common. There is the first capacitor which couples the

collector to the tuned circuit and there is then the second capacitor which couples the tuned circuit back to the emitter."

"That's the basic form of the circuit," agreed Smithy. "It's a nice simple arrangement without any frills."

The Serviceman picked up his mug again and drank deeply.

"There are a few things I haven't mentioned yet," he continued. "For

instance, there's the a.m.-f.m. switching circuits in the receiver. The usual approach towards switching the f.m. front-end on or off consists of turning its supply on or off by means of a section of the receiver a.m.-f.m. switch. The first 10.7MHz first i.f. transformer usually stays in circuit both on a.m. and on f.m. and is not switched. In some sets, too, you'll find a slightly different first 10.7MHz i.f. transformer circuit. The usual alternative version consists of two separate coils both tuned to 10.7MHz and coupled to each other via a capacitor. The first coil will still carry the d.c. supply to the collector of the mixer-oscillator transistor.

"Some of the more recent sets," volunteered Dick, "have an automatic frequency control which you can switch in or out."

"They do indeed," agreed Smithy. "These a.f.c. circuits are quite inexpensive and they function by taking advantage of the properties of a varicap diode."

"A what diode?"

"A varicap diode," repeated Smithy. "The term is short for 'variable capacitance diode'. Diodes of this nature are also referred to as 'varactors'. These are silicon junction diodes which, when reverse-biased, offer a capacitance between their terminals which varies according to the magnitude of the reverse voltage. A typical capacitance change is from 50pF at a reverse voltage of 1 volt to 20pF at a reverse voltage of 10 volts."

"How do they work?"

"Well," said Smithy thoughtfully, "they really exhibit a property which is evident in all semiconductor junction diodes. Briefly, if a junction diode is reverse-biased the depletion layer between the p and n sections becomes wider as the voltage of the reverse bias increases. The depletion layer consists of material where holes and electrons have cancelled out and it contains very few mobile charges. The result is that it resembles an insulator and can be looked upon as the dielectric of a capacitor, the two 'plates' being the p section on one side and the n section on the other."

"Oh, I see," remarked Dick brightly. "Then these varicap diodes are designed to purposely exhibit this latent property of semiconductor diodes in its most effective form."

"You've got the idea," said Smithy. "In a.f.c. circuits in a.m.-f.m. sets the varicap diode is coupled to the f.m. oscillator tuned circuit via a capacitor of the order to 5 to 20pF, according to receiver design, like this."

Smithy drew a further circuit on his note-pad, (Fig. 6).

"One terminal of the varicap diode," he resumed, "couples via a resistor of around 100kΩ to a fixed reference voltage, this being usually the terminal which couples to the oscillator tuned circuit. The other terminal of the diode is connected via a second resistor, which is also of the order of 100kΩ,

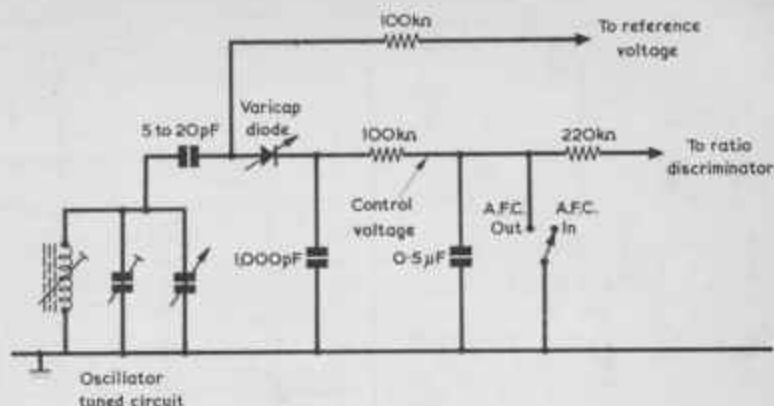


Fig. 6. Typical automatic frequency control circuit, with representative component values. The control voltage is derived from the audio take-off point of the ratio discriminator.

to a control voltage which is derived from the f.m. ratio discriminator detector of the receiver. This terminal of the diode is bypassed to chassis via a high value capacitor which is normally around 1,000pF. In some sets you'll find that the control voltage is applied to the end of the varicap diode which is coupled to the tuned circuit, whilst the other terminal of the diode connects to the reference voltage. In either case the diode changes the oscillator tuning as the reverse voltage across it varies."

"You've shown," remarked Dick, "a 220kΩ series resistor and a 0.5μF capacitor to chassis in the control voltage line from the ratio discriminator. What are they for?"

"To remove a.f. from the control voltage," explained Smithy. "The voltage is taken from the a.f. take-off point of the ratio discriminator and the resistor and capacitor ensure that only the average direct voltage from the discriminator appears across the capacitor. When the receiver is tuned in correctly this average direct voltage is at chassis potential. If the receiver tuning is adjusted away from its central setting, the average direct voltage goes increasingly positive or

negative of chassis according to which side of the central setting the tuning has been adjusted. In some receivers the a.f.c. control voltage is limited by two silicon diodes connected back-to-back. Like this."

Smithy sketched out a further circuit, (Fig. 7).

"I suppose," remarked Dick, "that those diodes are to restrict the range over which the a.f.c. circuit operates."

"That's right," said Smithy. "Too wide a control range can sometimes be more of a nuisance than a help. The usual way of using the a.f.c. circuit is to initially tune in a station with the a.f.c. switched out, this being effected by short-circuiting the a.f.c. control voltage to chassis. The a.f.c. circuit is then switched on by removing the short-circuit between the control voltage and chassis. If the initial tuning was correct the control voltage from the ratio discriminator will be at chassis potential and the oscillator frequency of the receiver remains unaltered. Should the initial tuning have been incorrect the control voltage from the ratio discriminator will be positive or negative of chassis. This control voltage changes the reverse voltage across the varicap diode, and

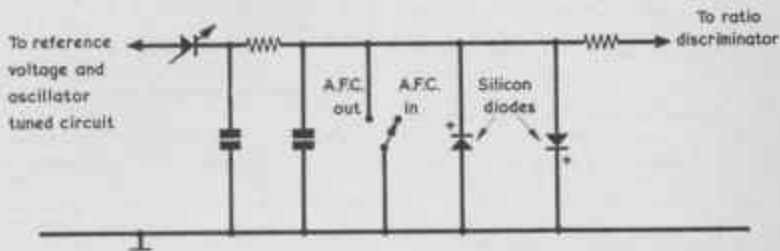


Fig. 7. In some receivers two silicon diodes are added to limit the range of a.f.c. control. Resistor and capacitor values here are of the same order as those in Fig. 6.

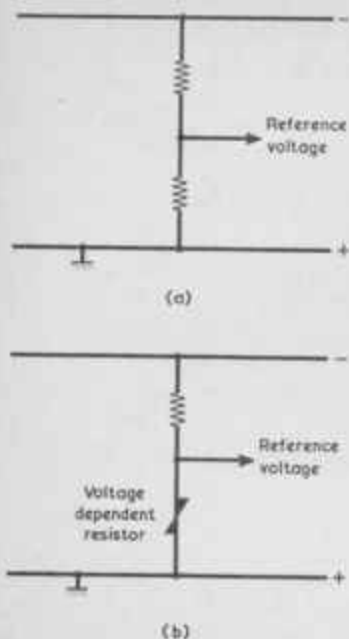


Fig. 8 (a). The reference voltage for the a.f.c. varicap diode may be obtained from a fixed potentiometer connected across the supply lines

(b). The reference voltage may also be obtained from a voltage dependent resistor, as shown here

the consequent variation in the capacitance of the diode largely compensates for the initial mis-tuning."

## REFERENCE VOLTAGE

"Well, that seems fair enough," remarked Dick. "Where does the varicap diode get its reference voltage from?"

"There are several ways of providing that voltage," said Smithy. "The simplest consists of obtaining it from a fixed potentiometer connected across the supply lines. Another method uses a voltage dependent resistor connected across the supply rails in series with a resistor. The voltage dependent resistor provides a measure of stabilization of the reference voltage."

Smithy sketched out the two methods of obtaining the reference voltage. (Figs. 8 (a) and (b).) He then picked up his tin mug and, with one gargantuan swallow, once again drained it of its contents.

"More?" asked Dick, rising.

"Yes, please," said Smithy. "All this nattering has made me thirsty."

"I wonder," called out Dick from the Workshop sink, where he was busy replenishing Smithy's mug, "whether we could next have a natter about the i.f. and detector stages in these a.m.-f.m. sets."

But Smithy had now resumed his earlier attitude and, with hands comfortably clasped across his stomach, was surveying the opposite wall with an expression which clearly indicated that technical discussions were now over for the day.

"We could have such a natter," he remarked firmly, "but not today. I'll leave that particular subject for our next little gen-session together."

And no further pleadings from his assistant could cause Smithy to depart from his resolute course of silence, accompanied by the leisurely but belated digestion of his lunch. ■

## THE ROYAL TELEVISION SOCIETY

### Programme of Meetings

Thursday, Feb. 3	ANCHOR - An Electronic Character Generator, R. J. Taylor (BBC).
Thursday, Feb. 17	GRAPHICS IN BBC TELEVISION, Colin Chessman (BBC).
Thursday, March 2	THE TECHNICAL FUTURE OF TELEVISION. J. S. Sansom (Thames Television Ltd.)
Thursday, March 16	TV AND CHIPS - Integrated Circuits in TV Receivers. S. N. Doherty (Rank Bush Murphy), M. C. Gander (Mullard Ltd.), R. Saxby (Rank Bush Murphy) and a representative from Motorola.
Thursday, April 6	ANNUAL GENERAL MEETING
Thursday, April 13	FLEMING MEMORIAL LECTURE - A Television Service Fit For Artists. A discourse on engineering - the engineer out of television. Dr. G. B. Townsend (ITA). At the Royal Institution, Albemarle St., London, W.1. at 7.00 p.m. (Tickets are required only for non-members).
Thursday, May 4	CAMERA TUBE TESTING - luxury or necessity? John Tanner (Link Electronics Ltd.)
Friday, May 12	ANNUAL BALL - Dorchester Hotel, London, W.1.
Thursday, May 18	THE TOTAL COMMUNICATION CONCEPT FOR THE FUTURE E. J. Gargini (Rediffusion Research Ltd.)
Thursday, June 1	SINGLE TUBE COLOUR CAMERAS. J. E. Attew (Electrocraft Instruments Ltd.)
Thursday, June 15	MICROWAVE LINKS FOR TELEVISION OB'S Speakers from Microwave Associates Ltd.
Thursday, June 29	TELDEC VIDEO DISC - technical and marketing details with demonstrations. R. W. Bayliff and K. G. Thorne (Decca Ltd.)

All meetings, unless otherwise stated, are held in the Conference Suite, I.T.A. 70 Brompton Road, London S.W.3. and commence at 7.00 p.m. Non-members of the Society are admitted to meetings on presentation of a signed ticket obtainable from any member or from the office of the Society at 166 Shaftesbury Avenue, London WC2H 8JH.