A Simple Short-Wave Superheterodyne

By "Cathode"

WITH the release to the licensees of the Radio Corporation of America of the patents involved in the superheterodyne principle of reception, there has taken place a most remarkable revival of interest in this type of receiver. Those manufacturers who had previously had some experience with superheterodynes and who could consequently enter on their production with a minimum of delay have found themselves in the fortunate position of being able to cope with the sudden demand.

Some manufacturers, indeed, are concentrating upon superheterodyne receivers to the exclusion of the very fine t.r.f. receivers, with which they built their reputation. Many authorities consider that except for small low-priced receivers, the doom of the t.r.f. is sealed. We must admit that we would hardly like to go so far as this ourselves.

We intend to describe in these pages the design and construction of two superheterodyne receivers of widely different type.

The first, intended for short-wave reception, is battery-operated, and is an example of the simplest possible type of superhet. receiver.

The second receiver to be described is of a much more elaborate type. It is entirely a.c. operated, provision being made for the excitation of a dynamic speaker field. Three band-pass filters are incorporated in the intermediate amplifier, giving an order of selectivity far greater than any commercial receiver, yet without introducing high-note loss.

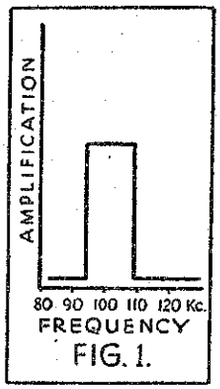

FIG. 1.

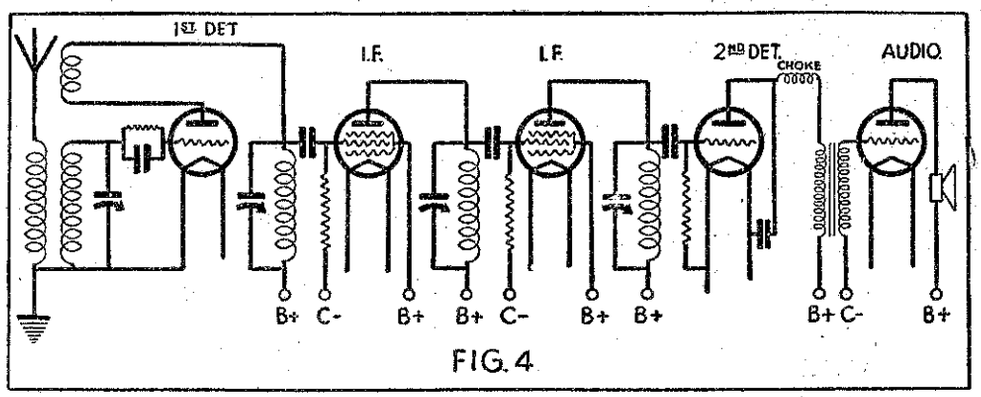

FIG. 4

A radio-frequency stage is used ahead of the screen-grid first detector so as to permit of an outdoor aerial being used if desired, although the available amplification of over ten million times makes it unnecessary to use anything but a small indoor aerial.

In short, it is a receiver whose owner could confidently place it alongside any set commercially available in New Zealand, secure in the knowledge that it will more than favourably compare with any opponent. One last word—it works splendidly on short-wave.

Features of the Superhet.

BEFORE dealing with the details of the design and construction of the simpler superhet., a few notes on the unique features of this type of receiver will render it easier to understand why manufacturers have pounced upon it immediately the patents became available.

Briefly, the essential feature distinguishing a superheterodyne is the conversion of the incoming signal frequency to one of lower frequency, but carrying the original modulation. This lower frequency is then amplified and detected just as if it were an incoming long-wave signal.

Practically all superhets. employ substantially the same means of changing the frequency. In addition to the incoming signal frequency, an oscillating valve is employed to generate oscillations of a frequency differing somewhat from that being received. The two frequencies are then applied to the grid of the first detector valve.

It can be shown mathematically that, as a result of the beating of the two frequencies, the input to the first detector is the sum of the two applied frequencies, but modulated at a frequency of half their difference. The effect of the first detector, of course, is to convert the modulation into a new wave form of twice the modulation frequency, just as an ordinary detector valve does in the case of modulation at audio frequencies.

In the output of the first detector, then, there is present, among other things, a frequency equal to the difference between the incoming and generated oscillations, and this new frequency carries the original modulation transmitted by the broadcasting station.

It may, therefore, as previously explained, be amplified, detected, and made to operate a loudspeaker just like any other signal.

At first sight it may appear that we have gone to a lot of trouble without accomplishing very much. In the output of the first detector we still have modulated high-frequency oscillations just like those collected from our aerial except that they are of lower frequency. But how much easier to handle is this lower frequency. Whereas amplification of the incoming frequency would be fraught with difficulties, the lower (but still super-audible) frequency can be amplified with the greatest ease.

Moreover, since by adjusting the frequency of the local oscillator we can vary the "lower" frequency (or, as we will now call it, the "intermediate frequency") to what we will, we can tune the amplifier once and for all and make the frequency suit the amplifier instead of vice-versa. Thus the necessity for constantly adjusting the several tuning condensers of a multi-stage amplifier is gone. The intermediate tuning is fixed, the tuning of the local oscillator being varied instead.

Selectivity Problems Vanish.

LASTLY, the superheterodyne has the inherent advantage of outstanding selectivity. This is due to the fact that a difference of frequency appears unchanged after the first detector, and is a larger percentage of the small intermediate frequency than of the large original frequency; and selectivity depends on percentage differences.

Thus, take a 300-metre signal modulated at 1000 cycles. Because of the side bands, this acts as if it were a mixture of three currents, at 999 kilocycles, 1000 kilocycles, and 1001 kilocycles respectively. If we set to beat with it a current of 900 kilocycles we shall have in the output (among others) currents of 99 kilocycles, 100 kilocycles, and 101 kilocycles. Thus the modulation is preserved unchanged.

Now, suppose an interfering station on 297 metres (1010kc.) This is 1 per. cent away from the first, and is hard to tune out. Our beating current of 900 kilocycles will set up in the detector output a current of 110 kilocycles, which is not 1 per cent. off but 10 per cent. off that which we are trying to get. In fact, the separation (in percentage) of the two stations is multiplied by the ratio of the intermediate to the incoming frequency.