May 4, 1943. E. H. ARMSTRONG 2,318,137

MEANS FOR RECEIVING RADIO SIGNALS

Filed Jan. 12, 1940

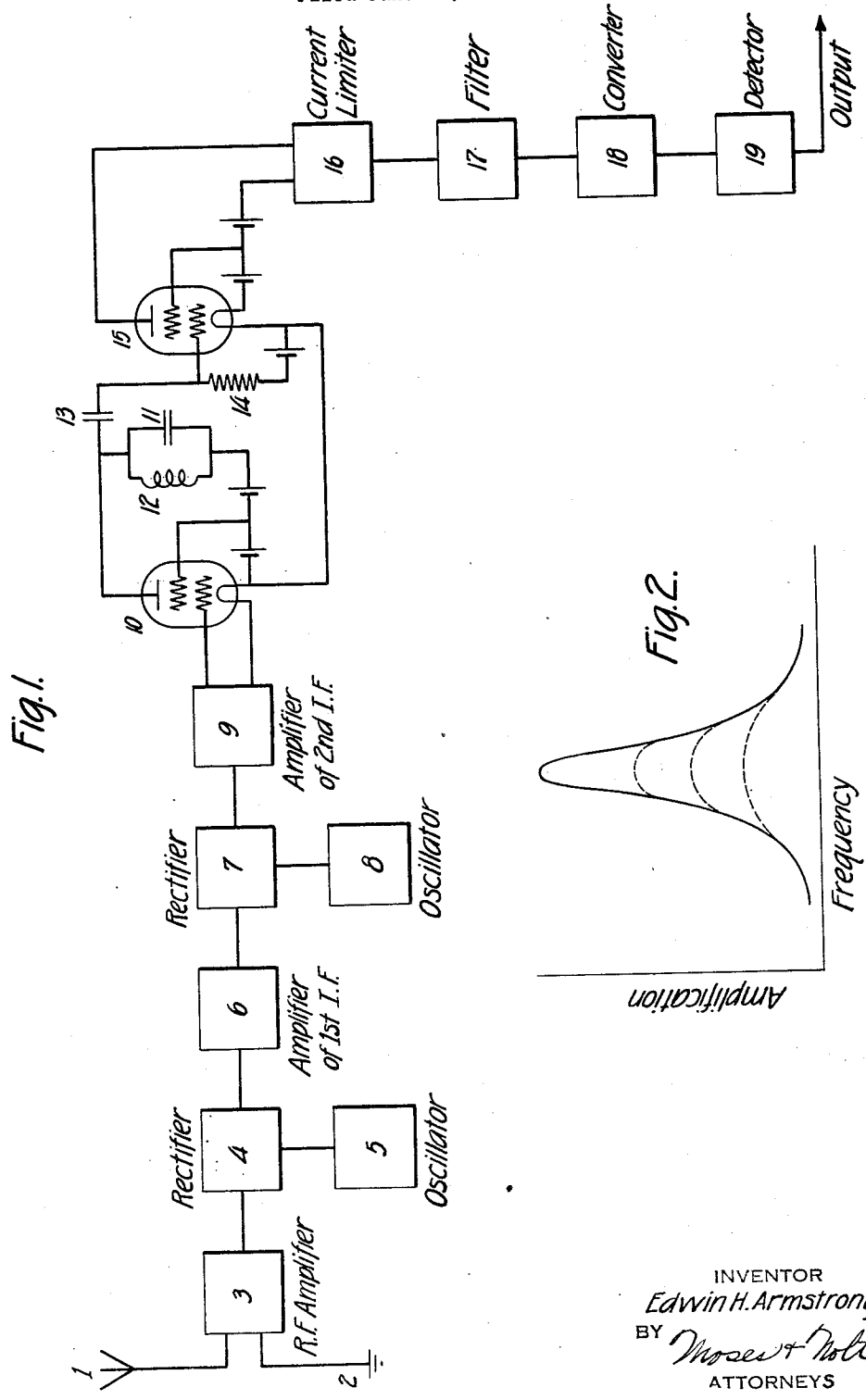

Fig. 1.

Fig. 2.

INVENTOR
Edwin H. Armstrong
BY Moser & Nolte
ATTORNEYS

Patented May 4, 1943 2,318,137

UNITED STATES PATENT OFFICE

2,318,137

MEANS FOR RECEIVING RADIO SIGNALS

Edwin H. Armstrong, New York, N. Y.

Application January 12, 1940, Serial No. 313,495

4 Claims. (Cl. 250—20)

This invention relates to an improvement in receiving apparatus for frequency modulated waves. It has for its object the provision of means for automatically adjusting the width of the admittance band of the sharp circuit in receivers of the type described in my U. S. Patent No. 2,116,502.

Referring now to the figures which form a part of this specification, Fig. I illustrates the general arrangement of the apparatus for carrying out the invention. Fig. II shows a series of characteristic curves which will be referred to hereinafter.

The general theory of the invention will be understood from the following explanation. In my U. S. Patent No. 2,116,502 I have pointed out how the effects of certain types of disturbances may be reduced in a receiver for a frequency modulated wave whose deviation is considerably greater than the frequency range of audibility by including in the filtering system a circuit whose band width is considerably narrower than the normal width of admittance. With this arrangement it is possible to produce at the current limiter a greater ratio of signal carrier to those disturbing currents resulting from ignition noises and the like, particularly during those periods when the transmission is not heavily modulated.

It has been found by experiment that the band width of the sharp circuit which is determined by the amount of resistance introduced into it is not a constant quantity for all values of signal to noise ratios. At its narrowest point, it is found that the width of the band is at least twice the frequency of the modulating current so that curtailment of the signal frequencies and resulting distortion is avoided. In general for strong signals the band width of this selective circuit may be made wide while for weaker signals the best results are obtained with a narrower band. This introduces an additional adjustment which it is desirable to avoid.

It is the purpose of this invention to provide a means by which the band width is automatically adjusted by means of the signal level itself. The manner in which this is accomplished may best be understood by reference to Fig. I. Referring now to Fig. I, there is illustrated a receiver of the type described in my U. S. Patent No. 1,941,069. 1—2 represents the antenna, 3 an amplifier for the received currents, 4—5 a rectifier and oscillator for heterodyning down the frequency of this current to a suitable intermediate frequency value, 6 an amplifier for this intermediate frequency and 7—8 a second rectifier oscillator combination for heterodyning the first intermediate frequency current down to a second intermediate frequency value. 9 represents an amplifier for this second intermediate frequency value. It will be understood that these intermediate frequency amplifiers have inherently selective coupling transformers which are adjusted to pass the total width of the frequency band transmitted with substantially equal facility.

The output of the amplifier 9 is supplied to an amplifier 10 which contains in its plate circuit a capacity 11 in parallel with an inductance 12, which is tuned to resonance at the midfrequency point of the second intermediate frequency. The voltage developed across this circuit is impressed on the grid of another amplifier 15 through a blocking capacity 13. A resistance 14 as shown acts both as a grid leak and as a damping resistance on the circuit 11, 12. This resistance will be referred to hereinafter. The amplifier 15 drives the current limiter 16 in the usual manner and the output of the limiter is passed through a filter 17 to remove harmonics, a converter 18 to change the frequency changes in the current into amplitude changes, and a detector 19 wherein the original currents of the signal are reproduced. Now it will be observed that the tuned circuit 11, 12 is placed in a tube circuit just preceding the current limiter. The level is, therefore, quite high as it ordinarily requires ten to twenty volts on the grid of the limiter for its proper operation. By adjusting the amplification of the tube 15 the voltage required on its grid to give sufficient output to make the current limiter operate properly may be made just less than would cause grid current to flow through the resistance 14. Under these conditions the width of the resonance curve of the circuit 11, 12 is determined solely by the value of the resistance 14 which may be set at the best value for a weak signal. When, however, a stronger signal is received the higher voltage developed across the circuit 11, 12 causes the tube 15 to draw grid current. The effect of this is to introduce additional resistance into the circuit 11, 12 and to therefore broaden out its resonance curve. Fig. II shows a series of resonance curves of circuit 11, 12 for various voltages impressed upon the grid of the amplifier 10.

It will be seen, therefore, that as the signal decreases in strength, the width of the admittance band of the tuned circuit may be made to close up to practically any desired value by the variation in the grid current drawn in the tube which is connected across the tuned circuit. By

proper proportioning of the various values involved substantially any law of response may be obtained.

I have described what I believe to be the best embodiment of my invention. I do not wish, however, to be confined to the embodiment shown, but what I desire to cover by Letters Patent is set forth in the appended claims:

1. A radio receiver for freuqency modulated signaling currents comprising, in combination, a resonant circuit adapted to pass a band of frequency modulated signaling currents, and control means for automatically increasing the pass band of the resonant circuit as the circulating current in the resonant circuit increases, said control means comprising a vacuum tube arranged to amplify the current in the resonant circuit, said tube having a grid and cathode and an input circuit conductive to direct current connecting said grid and cathode and means in said input circuit for supplying such a normal negative bias voltage to said grid that a progressively increasing amount of energy is consumed in the input circuit as the strength of the received signal increases, the increase in consumed energy providing an increasing load across the resonant circuit.

2. A radio receiver for frequency modulated signaling currents comprising, in combination, a resonant circuit adapted to pass a band of frequency modulated signaling currents, a vacuum tube having a grid circuit including means for applying a negative bias voltage to the grid of the tube, means coupling said resonant circuit and said grid circuit, and means whereby the voltage developed across said resonant circuit upon an increase in the strength of the received signal causes grid current to flow in said grid circuit whereby to load the resonant circuit and automatically increase its band width as the strength of the signal increases.

3. The combination with a radio receiver for wide band frequency modulated signaling currents, of a selective resonant circuit interposed in said receiver and adapted to pass a band of the received frequency modulated signaling currents and means responsive to the strength of the said frequency modulated currents, but substantially unaffected by the extent of the frequency deviations thereof, for changing the effective pass band of the selective circuit directly in accordance with the strength of the said frequency modulated signaling currents.

4. A radio receiver for frequency modulated signaling currents comprising, in combination, a selective resonant circuit tuned to a predetermined center frequency and adapted to pass a band of frequency modulated signaling currents and energy consuming means connected across the terminals of the resonant circuit and directly responsive to the amplitude of the circulating current in said circuit, but substantially unaffected by the extent of the frequency deviations thereof, for automatically loading the circuit, whereby the band width of the resonant circuit automatically increases as the strength of the received signal increases.

EDWIN H. ARMSTRONG.