Nov. 26, 1935. H. O. PETERSON 2,022,478

VOLUME CONTROL

Filed Jan. 13, 1930

Fig. 1

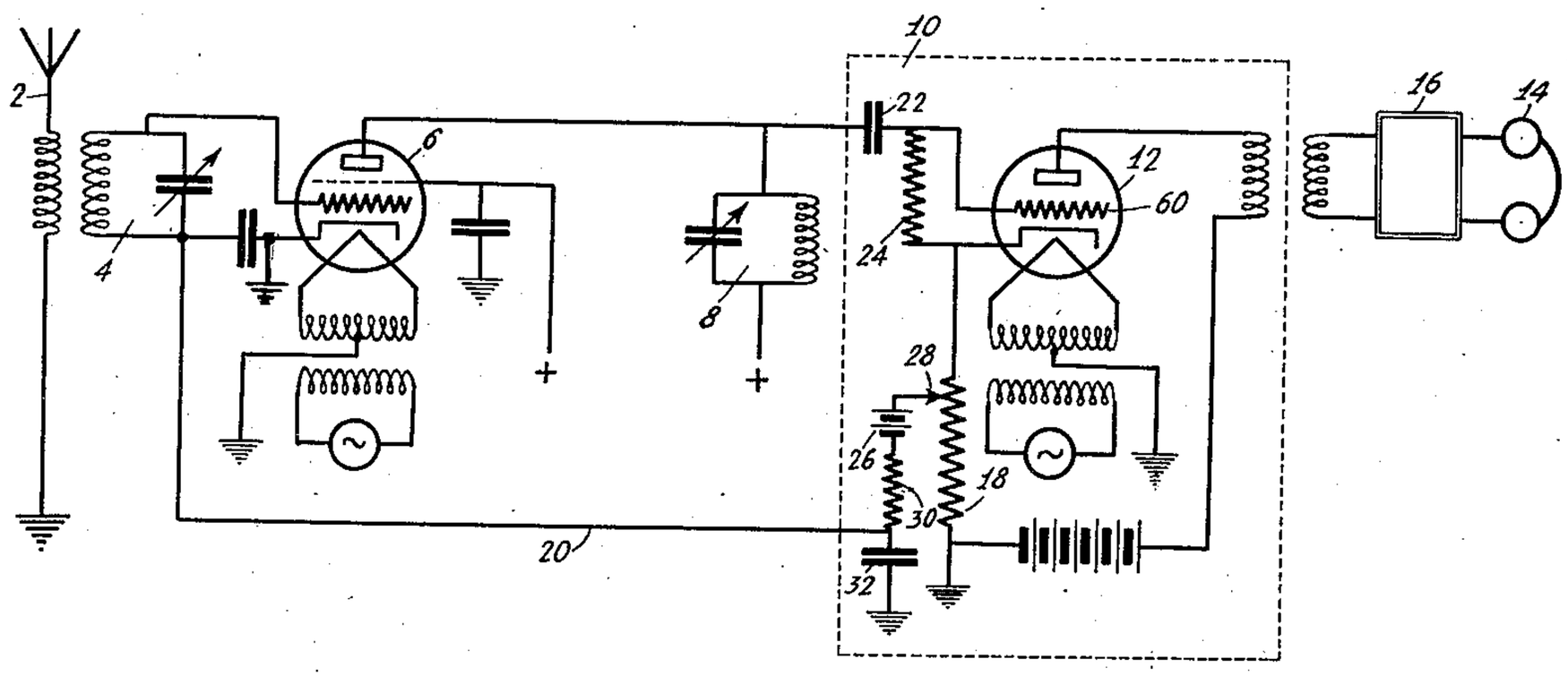


Fig. 2

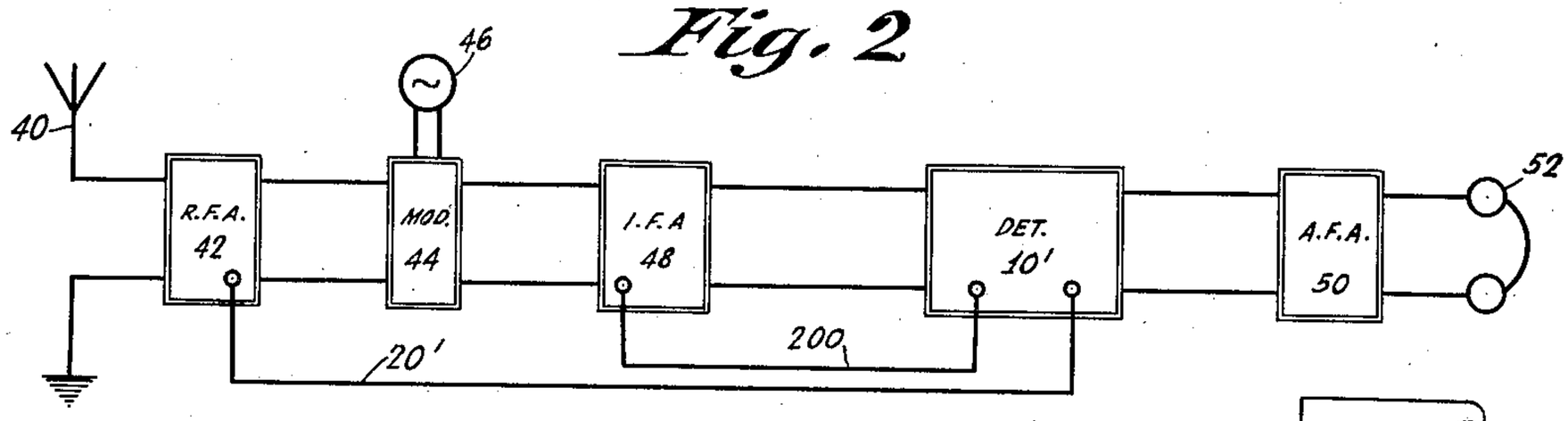


Fig. 4.

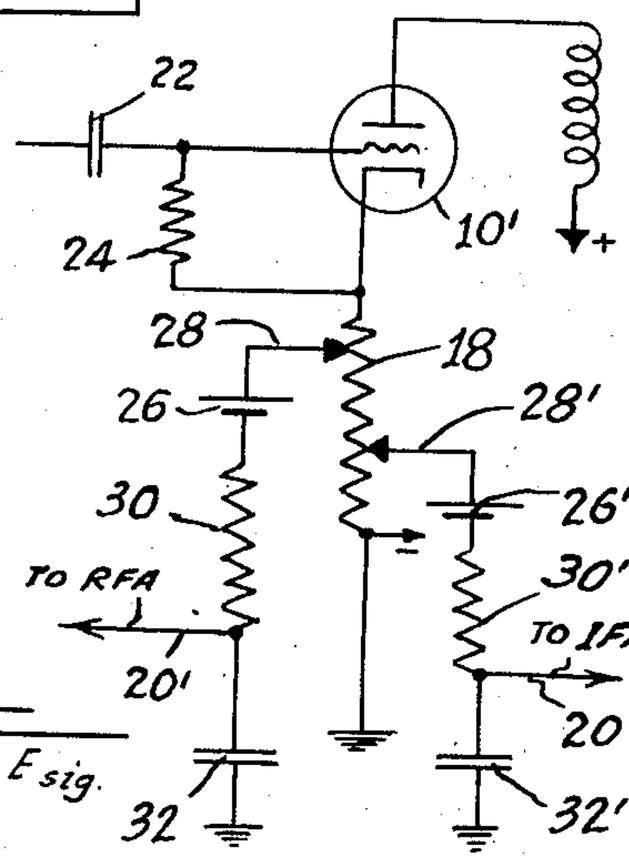
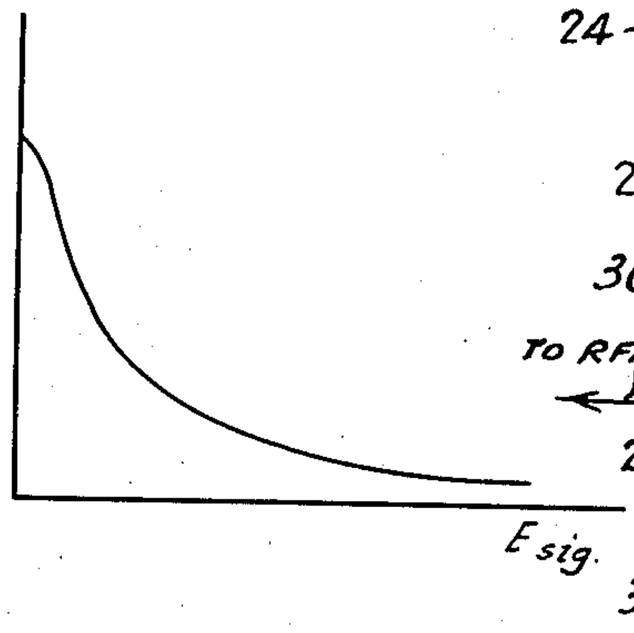


Fig. 3.



INVENTOR
HAROLD O. PETERSON
BY W. S. Lower
ATTORNEY

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VOLUME CONTROL

Harold O. Peterson, Riverhead, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

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2 Claims. (Cl. 250—20)

This invention relates to a volume controlled electrical system wherein it is desirable to maintain constant energy output from a variable energy input.

In volume control schemes as applied to radio receivers, collected signal energy, varying in intensity, is split into two portions and separately rectified. One portion of the rectified energy is utilized for translation purposes and the other for volume control so that the translation energy is maintained at a constant volume. A disadvantage of the system described resides in the fact that separate detectors are required, one for translation purposes and one for providing rectified signal energy for volume control. An object of my present invention is to reduce the number of tubes required for volume control and I do this by utilizing one detector tube or electron discharge device for supplying rectified energy for both translation and volume control. More specifically I accomplish this object by the use of a detector tube having an impedance associated with its output circuit. The detector rectifies the entire amount of collected or input energy; and, by virtue of the impedance referred to, potential differences are set up thereacross which are utilized for controlling the bias on a preceding electronic amplifier thereby volume controlling the system. The remaining portion of the energy appearing in the output circuit of the detector, rectifier or demodulator, is utilized for translation purposes.

Moreover, in known volume control systems, grid biasing potentials are applied to the rectifier used for volume control, and the resultant anode current flow is utilized to vary the bias on the preceding radio frequency amplifier. In such a system with the input energy very weak, there is little flow of plate current which, as already indicated is to be used for increasing the amplification of the preceding amplifiers; and because of the small current flow, the system tends towards instability. A further object of the present invention is to provide a volume controlling system wherein a large current flow corresponds to a weak input and wherein the large current flow is utilized to control the amplification of the system. In this manner any tendency towards instability, for the reason mentioned, is effectively overcome.

Furthermore, in known systems, volume control is applied to only the radio frequency stages of a receiver. In order to improve sensitivity, a further object of this invention is to apply volume control to the intermediate frequency amplifier of a heterodyne system; and, to still further enhance volume controlling, it is a further object of this invention to apply volume control to both radio frequency and intermediate frequency amplifiers.

If volume control biasing potentials are applied to the amplifiers instantaneously; that is to say, with every minute and quick change in intensity of the input energy, the tendency of the volume control arrangement would be to destroy the modulation of the incoming energy. To avoid such an effect is a further object of my invention and this I accomplish by inserting in the volume controlling circuits a time delaying circuit which smooths out action and makes a volume control response depend upon more lengthy changes in intensity of the incoming signal energy.

The features which I believe to be characteristic of my invention are defined with particularity in the appended claims. However, it may best be understood both as to its structural organization and method of operation by referring to the accompanying drawing in which

Figure 1 shows my invention applied to a simple radio receiving circuit,

Figure 2 illustrates my invention applied to a heterodyne receiver; and

Figure 3 is given to aid in the explanation of the operation of my invention,

Fig. 4 shows the circuit connections for the automatic volume control arrangement used in Fig. 2.

Referring to Figure 1, radiated signal energy collected upon antenna 2 is fed through tunable circuit 4 to the input side of an amplifier comprising electron discharge device 6 of suitable type,—here shown as a vacuum tube having a screen grid and indirectly heated cathode. Although only one amplifier stage has been shown, for the sake of simplicity, any suitable number may be utilized. Amplified energy, from amplifier 6 having a tunable circuit 8 in the output circuit thereof, is fed to rectifying or demodulating apparatus 10 utilizing a single detector or rectifier 12 for rectifying or demodulating all of the collected signal energy. The output of detector 12 is fed to a suitable translating device such as phones 14 through, if desired, a suitable low frequency amplifier 16 of any well known type.

In order to utilize the same detector for volume controlling amplifier 6 as well as for supplying translation currents to translating device 14, an impedance in the form of a resistance 18 is placed

in series with the output electrodes of rectifier 12. By means of a connection 20 between the output circuit of detector 12 and amplifier 6, the amplification thereof is varied inversely to the strength of the energy collected on antenna 2 and directly as the unidirectional output current flow of the detector 12. In this manner, a single rectifier 12, is utilized to provide both translation and volume controlling potentials.

In the ordinary type of detector utilized in the ordinary receiving circuit, the grid or control electrode thereof is biased negatively by a suitable potential source. However, if such a scheme were utilized in connection with detector 12, with a weak incoming signal there would be a small current flow through resistance 18, resulting in unstable control of amplifier 6. Therefore, to provide a large current flow through resistance 18 when the incoming collected energy is weak, I bias the grid of tube 12 to a point such that in the presence of weak signals there is a large plate current flow. Preferably I do this by the use of a blocking condenser 22 and a grid leak 24 rather than by biasing the grid 60 of the rectifier tube 12 positively. The relation of anode current to signal strength for the tube 12 is shown diagrammatically in Figure 3 where, for small signal values, plate current is a maximum. I have found that the use of large current flow to increase amplification of the amplifier 6, materially improves stable action.

By virtue of the large unidirectional current flow through resistance 18 too large voltages may be applied to the grid of the amplifier tube 6. To preclude this possibility I insert in connection 20 a source of potential 26 opposed to the voltages produced across resistance 18. Voltage control may further be assisted by the use of variable tap 28 terminating connection 20.

Biasing or control potentials applied to the radio frequency amplifier 6 need not necessarily be limited to the input or control electrodes thereof but may, by the suitable choice of elements such as resistance 18 and source of potential 26, be applied to the screen grid or anode thereof.

To smooth out the action of the volume controlling apparatus and to make it unresponsive to sudden changes in volume caused, for example, by signal modulation of the collected high frequency energy, I associate with the volume control connection 20 a time delaying circuit comprising resistance 30 and condenser 32. By suitable choice of values for resistance 30 and condenser 32, volume control action may be made as fast or as slow as desired.

My invention as applied to a heterodyne receiver is illustrated diagrammatically in Figure 2. Electromagnetic energy collected upon a suitable antenna 40 is amplified by radio frequency amplifier 42 of any desired number of stages. The amplified energy is fed into a modulator 44 together with locally generated energy generated by means of a generator 46. Beat frequency energy resulting from the modulation is fed into and amplified by an intermediate frequency amplifier 48, the output of which is detected or rectified by a suitable rectifier 10' similar to that shown in Figure 1. The output of the detector 10' may then be amplified by amplifier 50 and translated by a suitable translating device 52.

For volume control, connections 20' and 200 similar to connection 20 of Figure 1 are taken from detector 10'. As desired, volume control biasing potentials may be applied to the control electrodes, screen grids or anodes of the amplifiers, and they may be obtained from separate resistances placed in the output circuit of detector 10' or preferably from the same resistance using separate terminating taps for connections 20' and 200. Moreover, each connection 20', 200 may contain potential sources of the same or different values as well as time delaying circuits similar to that shown in Figure 1. Fig. 4 shows the latter connections. The connection 200 between the intermediate frequency amplifier and resistor 18 includes the tap 28', voltage source 26', resistor 30' and condenser 32'. The detector 10' utilized in Figure 2 is preferably given, as described, the characteristic shown in Figure 3 whereby amplification of the amplifiers is varied in accordance with or directly as the unidirectional component appearing in the output circuit of the detector 10'; or, in other words, inversely to the strength of the signal collected upon antenna 40.

Having thus described my invention what I claim is:

1. In combination with the radio frequency and intermediate frequency amplifiers of a superheterodyne receiver, a second detector of the leaky grid type, a biasing control path in the anode to cathode current path of the detector, and independent direct current connections solely from said biasing path to an amplification control electrode of each amplifier for regulating the gain of the amplifiers in a manner inversely proportional to the receiver signal input variation, said connections being made to points of different potential of said biasing path.

2. In combination with the radio frequency and intermediate frequency amplifiers of a superheterodyne receiver, a second detector of the leaky grid type, a biasing control path in the anode to cathode current path of the detector, and independent direct current connections solely from said biasing path to an amplification control electrode of each amplifier for regulating the gain of the amplifiers in a manner inversely proportional to the receiver signal input variation, said connections being made to points of different potential of said biasing path, and each connection containing a source of positive potential and a time delay network.

HAROLD O. PETERSON.