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NOISE SUPPRESSOR CIRCUITS

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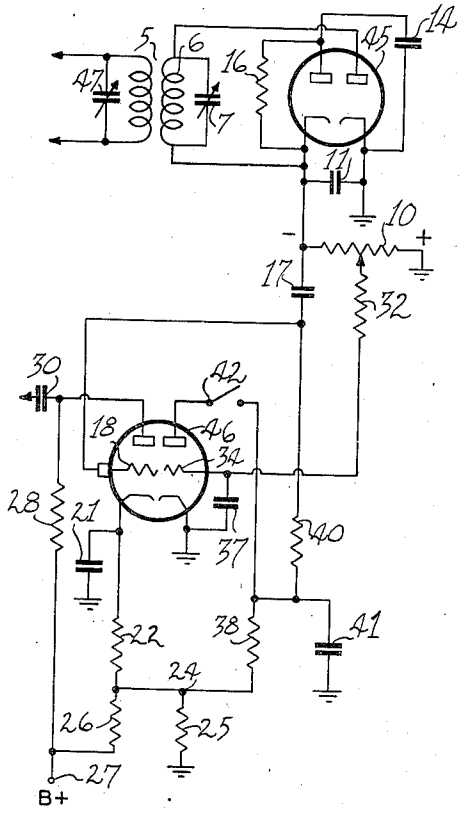


FIG. 2

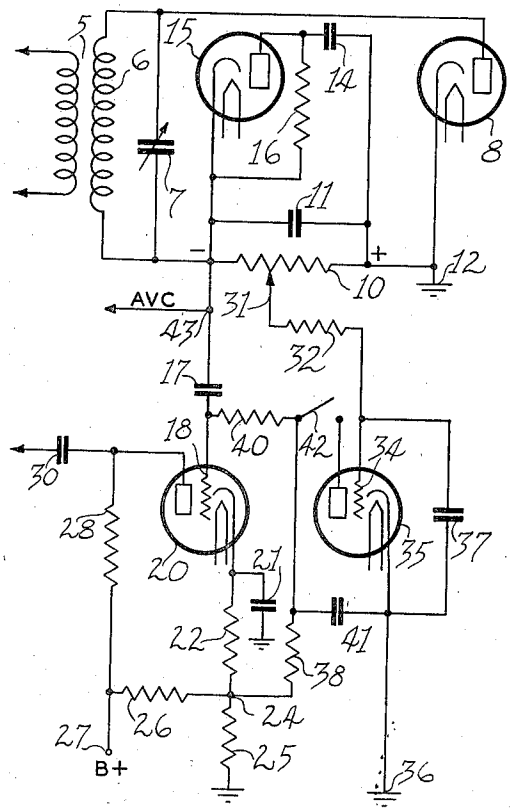


FIG. 1

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NOISE SUPPRESSOR CIRCUITS

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3 Claims. (Cl. 250—20)

This invention relates to radio receivers and more particularly to short-wave superheterodyne receivers employing a high intermediate frequency.

The main objects of the invention are to suppress noise in radio receivers and to improve the signal-to-noise ratio therein for both strong and weak signals.

Another object is to provide an improved combination of "noise suppressor" and "squelch" circuits in a radio receiver.

A specific object is to provide a receiver which is effective against ignition noise and the like, for mobile use; for instance, in police patrol cars for receiving radio signals of the order of 35 megacycles.

Other objects will become apparent as the description proceeds in connection with the accompanying drawing, in which:

Fig. 1 is a circuit diagram illustrating the main features of the invention; and

Fig. 2 is a portion of the circuit diagram of a receiver employing the invention.

Like reference characters indicate similar parts in both figures.

The most troublesome noise encountered in the use of radio receivers, especially on short waves, is caused by electric discharges such as are produced by A. C. power leaks, switches, keying of telegraph transmitters, defective neon signs, static electricity, and especially ignition systems of automobiles. Such noise is sometimes called the "pulse" or "shot" type, because its radio wave has a steep front of high peak amplitude and is highly damped. Its fundamental frequency may vary from individual clicks up to several hundred impulses per second. However, each impulse is of short duration relative to the time between successive impulses. The present invention employs this characteristic to distinguish between noise and signal so that the noise is suppressed in the receiver but the signal passes through substantially undisturbed. Preferably the noise suppressor is included in a detector circuit and is followed by a "squelch" circuit associated with the first audio frequency amplifier. The "squelch" circuit blocks the audio amplifier except when radio signals are being detected.

Referring to the drawing in detail, Fig. 1 illustrates a detector circuit, noise suppressor, squelch circuit, and first audio frequency amplifier for a radio receiver in accordance with the invention. A transformer 5 having a secondary 6 tuned by variable condenser 7 provides the input to the detector circuit. Transformer 5 may be the last intermediate transformer in a superheterodyne and may be preceded by a suitable antenna, first detector, and other intermediate frequency circuits (not shown). The current from secondary 6 is rectified by a diode detector tube 8 and impressed upon a load resistor 10 which is by-passed for the rectified frequency by condenser 11. The cathode of tube 8 and the positive end of resistor 10 are grounded at 12.

The noise suppressor comprises a condenser 14 and a diode rectifier 15 connected in series across resistor 10, the cathode of tube 15 being connected to the negative end of the resistor and its anode to condenser 14. A leak resistance 16 is shunted across the anode and cathode of tube 15.

The audio frequency amplifier starts from the negative end of resistor 10 which is connected through a coupling condenser 17 to the control grid 18 of an audio frequency amplifier tube 20. The cathode of tube 20 is by-passed to ground through a high capacity condenser 21 and is conductively connected through a bias resistor 22 to a point 24 between voltage-dividing resistances 25, 26 whereby point 24 is maintained about twenty volts positive to ground. A positive plate supply 27 is connected to one en dof resistance 26 and also supplies plate current to tube 20 through a load resistor 28. The audio frequency potentials developed across resistor 28 are passed through a coupling condenser 30 to a power amplifier and reproducer (not shown).

The squelch circuit comprises an adjustable tap 31 on resistor 10 connected through a high resistance 32 to the control grid 34 of a squelch tube 35, the cathode of which is grounded at 36. The grid and cathode of tube 35 are by-passed for audio frequency by a condenser 37. The plate of tube 35 is supplied with positive potential from point 24 through a resistor 38 and is also connected through a high resistance 40 to grid 18 of audio tube 20. A condenser 41 by-passes the plate and cathode of tube 35 for audio frequency. A switch 42 may be provided to disconnect the plate of the squelch tube and thereby render it inoperative when desired. The potential across resistor 10 may be tapped for automatic volume control as indicated at 43.

The operation of the arrangement shown in Fig. 1 is as follows:

The desired input frequency from tuned circuit 6, 7 is rectified in known manner by diode 8, the modulations carried thereby appearing across resistor 10 as audio frequency potentials superposed on the D. C. component of the rectified

frequency. The capacity of condenser 11 is large enough to make the D. C. component nearly equal to the peak voltage of the rectified frequency, but small enough to offer high reactance to the audio frequency modulations. The D. C. component also charges condenser 14 through diode 15 which is conductive in the proper direction for charging the condenser thereby. However, condenser 14 has a capacity such that many cycles of input frequency are required to build up its charge to the rectified potential. The audio frequency modulations further build up the charge in condenser 14 to their peak potential and this charge is retained therein because the condenser cannot discharge through tube 15 during the opposite half-cycles of the audio frequency. The charge thus built up in condenser 14 by both the rectified input and its modulations can only leak off through resistance 16. The values of condenser 14 and resistance 16 are selected to give a time constant which is long relative to the cyclic periods of the input frequency and its audio frequency modulations. For instance, condenser 14 may be .05 microfarad and resistance 16 may be 1 megohm, thus giving a time constant of .05 second whereby the condenser charge is substantially retained from peak to peak of the audio frequency.

With the desired signals being detected by tube 8 and with condenser 14 charged as stated, if a series of noise impulses (as above described) arrive at the detector input, they will be rectified by tube 8, but each impulse is of such short duration that it alone can not materially alter the charge on condenser 14. The low impedance offered by this large condenser permits the steep wave front of the impulse to pass between the plate and cathode of tube 15 whereby it is by-passed around the resistor 10. Hence the impulse is effectively suppressed. During the relatively long interval between one such impulse and the next, any slight increase in the potential of condenser 14 has time to leak through resistance 16 so that said next impulse also will be by-passed through tube 15 without building up a charge on condenser 14 such as is built up by the continuous rectified input and its audio frequency modulations. In this manner, the noise impulses are prevented from interfering with the detected signal modulations, which latter alone are passed on to the audio frequency amplifier.

The operation of such detector and noise suppressor circuits is independent of the strength or weakness of the received radio signals or of the percentage modulation because the combination of condenser 14, tube 15 and resistance 16 tends to prevent the noise impulses from changing whatever potentials are developed across resistance 10 by the rectified frequency and its modulations. Even when there are no signals present, the noise suppressor acts to by-pass noise impulses so that they are not heard in the audio frequency output.

Proceeding now with the operation of the audio amplifier and squelch circuits, the audio frequency modulations from resistance 10 are impressed through coupling condenser 17 upon grid 18 of the first audio tube 20 wherein they are amplified in the usual manner and then coupled to a power amplifier stage (not shown) by plate resistance 23 and condenser 30. When no input frequency is being rectified in tube 8, the grid 34 in squelch tube 35 is substantially at ground potential by reason of its conductive connection through resistance 32, tap 31, and resistor 10 to ground 12. The cathode of tube 35 also being connected to ground at 36, gives tube 35 a zero grid bias. The tube 35 will therefore draw plate current from point 24 through resistance 38, provided switch 42 is closed. By reason of the connection of the plate of tube 35 through resistance 40 to grid 18 of audio tube 20, said grid will be made negative with respect to its cathode by the amount of plate current drop in resistance 38. This negative potential on grid 18 blocks tube 20 and substantially prevents reproduction of any signals or noise whatsoever. However, when radio signals are received and rectified, a desired portion of the D. C. component across resistor 10 is tapped at 31 and impressed upon control grid 34 of tube 35. Grid 34 is thus made negative with respect to its grounded cathode and reduces the plate current substantially to zero. This action of tube 35 removes the potential drop in plate resistance 38 and thus removes the negative blocking potential from the grid 18, thereby permitting tube 20 to open up and amplify the audio frequency. Tube 20 obtains its normal operating bias from the plate current drop through resistance 22 in its cathode lead. Thus tube 35 permits amplification in tube 20 only when signals are being received and detected.

It is a feature of the present invention that the squelch circuit just described follows the noise suppressor 14, 15, 16. If a squelch circuit precedes a noise suppressor circuit as has heretofore been proposed, the noise impulses cause the squelch circuit to open up the amplifier and thereby cause the noise to be heard as intermittent pulses timed by the rate at which the squelch circuit can open and close the amplifier. An advantage of the arrangement disclosed herein is that noise impulses are by-passed as explained above and thus are unable to open up the squelch circuit.

The circuit shown in Fig. 2 of the accompanying drawing contains substantially the same elements and operates in the same manner as the circuit of Fig. 1 above described. Fig. 2 is part of a circuit employed in a commercial receiver wherein the detector and noise suppressor diodes are combined in a single tube 45 which may be a type 6H6 twin diode. Similarly the tube elements for the first audio amplifier and the squelch circuit are combined in a single tube 46 which may be a type 6C8G twin triode amplifier. The detector input transformer 5 is shown in Fig. 2 with a tuning condenser 47 in parallel with the transformer primary, said condenser and primary forming the output circuit of the last intermediate frequency stage of the receiver. The other circuit elements shown in Fig. 2 are numbered to correspond with similar elements in Fig. 1 and have the same function.

The circuits above described have been found to be especially suitable for reception in the police band of 30 to 42 megacycles with an intermediate frequency of 5 megacycles. On such short waves igniton noise is very troublesome, especially due to the operation of police cars in the midst of traffic and on streets shielded by buildings. Radio signals having a strength of only 1 microvolt per meter can be received successfully through serious ignition interference by means of the above circuits. It is obvious, that the invention is not limited to any particular band of frequencies or type of receiver, but is generally useful in radio reception.

Although a preferred form of the invention has been disclosed, it will be appreciated that

various changes and equivalent forms can be made without departing from the spirit or scope of the invention as defined in the appended claims.

What I claim as new and original and desire to secure by Letters Patent of the United States is:

1. In a radio receiver, the combination of a detector circuit, a noise suppressor associated therewith and adapted to exclude noise impulses from the output of said detector circuit independently of the amplitude or percentage modulation of received signals, and audio frequency amplifier coupled to the output of said detector circuit, and a squelch circuit connected to said amplifier whereby said noise suppressor prevents operation of said squelch circuit by impulse type noise in the absence of high frequency signals in said detector circuit.

2. The combination defined by claim 1 in which said detector circuit has an output resistor, and said noise suppressor comprises a condenser in series with a parallel-connected diode rectifier and leak resistance, said series-parallel combination being connected across said output resistor.

3. In a radio receiver, the combination of, a detector circuit, a noise suppressor circuit adapted to exclude noise impulses from the output of said detector circuit, an audio amplifier following said detector circuit, and a squelch circuit which normally blocks said audio amplifier and, in combination with the said noise suppressor circuit, permits amplification of detected signals only.

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