PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Radio Receiving Apparatus

We, FABBRICA ITALIANA MAGNETI MARELLI, an Italian Body Corporate, of 22, Corso Venezia, Milan, Italy, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to an arrangement for regulating the sensitivity of radio receivers which permits of maintaining over the entre range of regulation of the sensitivity, a high ratio between the signal and the background or noise arising in radio receivers as an effect of the operation of the electronic discharge devices and of their circuits.

It is known that in radio receivers the electronic discharge devices and the circuits in which they operate set up disturbances due to their operation, which appear in the form of a background or noise which interferes with reception.

This noise in the radio receiver is due to: (1) a thermal effect in the circuits, which is the result of electro-motive forces generated by electrons being out of balance in the circuits owing to the temperature differences, this effect being substantially constant if the impedance of the circuits is not varied; (2) the "shot" effect which arises in the tubes and is due to the intermittent and irregular emission of electrons by the cathode, this disturbance varying with the square root of the anode current of the tube under consideration.

In radio receivers provided with means for regulating the sensitivity, when the sensitivity of the receiver is adjusted to a high value, the ratio between the signal and the background or noise is also made high and consequently the noise interfering with reception is tolerable, but this ratio decreases in proportion to the reduction in sensitivity because, if the signal is reduced, the noise is not proportionately reduced; in fact, the impedance of the circuits at radio frequency and at intermediate frequency remains unchanged, while the reduction of the "shot" effect corresponds only to the square root of the signal. Consequently, when the sensitivity of the receiver is reduced the signal decreases much more rapidly than the background or noise which interferes with reception.

To remove said objectionable effect, in radio receivers having a plurality of cascaded stages and an automatic volume control, an automatic gain control has been suggested which is operative to different extents and with different rapidities on vacuum tubes in the different stages, by taking advantage of said automatic volume control and by making it operative on said vacuum tubes by means of diodes biased to different degrees, or by causing said automatic volume control to act on differently biased vacuum tubes.

Further thermionic tube amplifiers have been suggested which are provided with means for controlling in succession the amplification in the several tubes by varying the bias of said tubes to different extents either by hand or automatically, said control being effected by means of a bridge device and a series of biased diodes.

The arrangements of this class require a certain number of auxiliary diodes or complicated biassing means.

Also electric wave translators with cascade amplifiers are known, in which the gain in the subsequent amplifiers is controlled by adjusting the signal attenuation to different degrees in the input circuits of the subsequent amplifiers, by means of a plurality of mechanically intercoupled regulators which are actuated by means of a single manipulating member.

In the above mentioned known devices, when the signal amplitude is regulated at the input of the vacuum tubes, the sensitivity of said tubes is not modified and consequently the background or noise in said tubes is amplified to a maximum whatever is the amplitude of the signal impressed on the tube grid; in such conditions the ratio between the signal and the background or noise is adversely affected in the tubes of the controlled stages.

In radio receivers it has been suggested to adjust the bias of two amplifier tubes

by inserting variable portions of one and the same self biassing resistance in their cathode circuits. This arrangement is objectionable in that as the anode currents of both tubes flow always through that portion of said resistance which is inserted in the cathode circuit of each of said tubes, the bias adjustment can never be entirely independent for the two tubes.

It has also been suggested in radio receivers to intercouple a manual sensitivity control device for the radio frequency section of the receiver with a manual volume control device for the audio-frequency section of said receiver, in such a manner that a manual drive for said intercoupled control devices acts firstly on said radio frequency section and the subsequent manipulation of said drive is operative on said audio-frequency section only.

In television and like radio-signal receiving apparatus, a volume control device has been suggested which firstly reduces the intermediate-frequency gain and then reduces the radio-frequency gain, said device including two resistances and corresponding intercoupled brushes and the resistance values made operative by said resistances and brushes in their respective circuits varying in opposite senses when said intercoupled brushes are shifted on said resistances.

The present invention is directed to remove the above-mentioned objections and in accordance therewith and for the purpose described, for the regulation of the sensitivity of a radio receiver having cascaded vacuum tube amplifying stages, the cathode circuits of the vacuum tubes in the several stages include adjustable self biassing resistances for the purpose of effecting the adjustment of sensitivity of said stages and a resistance inserted for grid self biassing purpose in the cathode circuit of the tube or tubes of the stage or stages nearer to the receiver input is regulatable independently of the regulatable self biassing resistance inserted in the cathode circuits of the tubes of the subsequent amplifying stages.

In this manner it is possible, starting from the highest sensitivity value for the contemplated receiver with a corresponding minimum value of grid bias resistance, to increase firstly the value of the grid self biassing resistance in the stages following the input stage or stages only and then to increase the value of the grid self biassing resistance in that stage or those stages only when the signal is so strong as to require a reduction also in the sensitivity thereof to prevent the respective vacuum tube or tubes from being overloaded.

By the above stated arrangement of this invention it is possible in a very simple and reliable manner to maintain the high ratio between the signal and the background or noise unaltered in the first portion of the receiver circuits while at the same time the amplification of said noise in the subsequent stages is reduced. In the case of very strong signals the sensitivity reduction in the input section, which acts adversely on the aforesaid ratio, is accompanied by such a reduction in the amplification in the subsequent stages that the background or noise has practically no effect on the reception.

The invention also comprises a device for carrying the invention into effect with the aid of a single sensitivity control which acts in the desired manner in all the stages subjected to the control and which, for this purpose, controls at the same time the two sensitivity regulators which correspond respectively to the first stage or stages and to the subsequent stages, so as to ensure the desired result.

More particularly this invention includes a device of the class above referred to in which the self biassing resistance for the first stage or stages of the radio receiver and the self biassing resistance for the subsequent stages are located adjacent to each other and the respective movable brushes thereof are coupled together while the operative portion of the resistance for the input stage or stages has an extent less than that of the resistance cooperating with the subsequent stages and the displacements of said brushes on the respective resistances cause variations in the same sense of resistance values operative in the respective circuits and the insertion of the first resistance commences after a portion of the resistance cooperating with the subsequent stages has been inserted.

By this arrangement the effect is obtained, in addition to that stated above, that the sensitivity regulation in the first stage or stages occurs within an adjustment range which is narrower than the adjustment range in respect of the subsequent stages. The sensitivity of the input stage or stages is thus regulated more rapidly than that of the other stages and thus whilst the reduction of the sensitivity of the input stage or stages is delayed, any risk of said input stage tube or tubes being overloaded is avoided.

The accompanying drawing shows, by way of example, an embodiment of the invention as applied to a super-heterodyne radio receiver, the essential parts of which are diagrammatically illustrated.

In this drawing, 1 designates the radio-

frequency amplifying tube fed by the aerial-earth input circuit 2. 3 is the tube of the converter stage, which is connected to the tube 1 by the transformer 4 and on which acts the local oscillator circuit 5 not shown in detail, which may be of any known type. The tube 3 feeds in the usual manner, with the aid of the transformer 6, the two intermediate frequency amplifying tubes 7 and 8 connected in cascade through the transformer 9, the tube 8 feeding the circuit 10 of the second detector. The following circuits of the apparatus are arranged in known manner and are not shown.

The tubes 1, 3, 7, 8 have their grids automatically biassed by the action of the potential drop which the cathode current of the said tubes set up across the terminals of the resistances r.1, r.3, r.7, r.8, inserted between the cathode of the tubes and the earth. This arrangement permits of modifying the sensitivity of the apparatus by modifying the grid bias of the various tubes, which is effected by modifying the value of the self biassing resistances r.1, r.3, r.7, r.8.

In accordance with the invention, in a circuit of the type described, the regulation of the resistance r.1 of the tube 1 is distinct from the regulation of the resistances r.3, r.7, r.8, so that when the sensitivity is adjusted the value of the resistances r.3, r.7, r.8 alone may be modified, while the value of the resistance r.1 may be left unchanged in order to fulfil the conditions indicated in the foregoing.

Further, in a preferred embodiment of the invention, controls for regulation of the resistance r.1 on the one hand and of the resistances r.3, r.7 and r.8 on the other hand are coupled in such a manner that after the sensitivity of the tubes 3, 7, 8 has been sufficiently reduced, a reduction also takes place in the sensitivity of the input tube 1.

For the purpose described, the resistance r.1 is connected to earth through a variable resistance 11 and the resistances r.3, r.7 and r.8 are connected in parallel and then to earth through a single variable resistance 12. Consequently, it is possible by varying the resistance 12 to modify as desired the sensitivity of the tubes 3, 7, 8 and then, by acting on the variable resistance 11, the sensitivity of the input tube 1 may be modified.

The regulators of the resistances 11 and 12 are coupled together so as to permit of automatically establishing the desired conditions for all the tubes with the aid of a single control or mono-control.

In the embodiment shown the resistance r.1 is connected by the conductor 13 to the brush 14 arranged to move over the resistance 11, one end of which is connected to earth, while the resistances r.3, r.7 and r.8 are connected by conductors 15, 16 to the brush 17 arranged to move over the resistance 12, one end of which is connected to earth.

The two brushes 14 and 17 are coupled together as diagrammatically indicated at 18 and the resistance 11 comprises a non-resistant or short-circuited zone, indicated at 11^1, on the portion of the path of the brushes 14 and 17 coupled together which corresponds to an extreme zone of the resistance 12 towards the earth.

Assuming that the brushes 14 and 17 are situated in register with earthed ends of the respective resistances 11, 11^1 and 12, these resistances are cut out of the circuit and the tubes 1, 3, 7, 8 are in a condition of maximum sensitivity owing to the fact that the bias of their grids is at a minimum.

When the two brushes 14, 17 are moved away from the earthed end of the resistances 11, 11^1 and 12, in the first part of their displacement, that is to say in the part corresponding to the inoperative portion 11^1 of the resistance 11, an increasing portion of the resistance 12 is inserted, whereby the sensitivity of the tubes 3, 7, 8 is reduced. This condition is dependent upon the resistance of the respective cathode circuits, and consequently the bias of the said tubes, increasing while the total resistance of the cathode circuit of the tube 1, and consequently the sensitivity of this tube 1, remain unchanged.

The ratio between the signal and the disturbance is consequently maintained unchanged at its high value in this tube 1, while the sensitivity of the tubes 3, 7, 8 is reduced. In this way, the amplification of the output current of the tube 1 effected by these tubes and consequently the amplification of the noise are also reduced. During the further displacement of the brushes 14, 17, when the signal is of such strength as to necessitate reducing also the sensitivity of the tube 1 to avoid overloading it, the brush 14 passes over the operative portion of the resistance 11 and introduces an increasing portion of the said resistance into the cathode circuit of the tube 1, while the brush 17 co-operating with the resistance 12 further reduces the sensitivity of the tubes 3, 7, 8 as well as the amplification which they apply to the output of the tube 1 and consequently to the noise.

Under these conditions, the ratio between the signal and the noise also decreases in the first tube, but in this part of the range of regulation the large

reduction of the amplification of the tubes of the following stages results in the noise having substantially no influence on the reception.

The conditions described for the tube of the first stage may, if desired, be created for several successive stages near the input, when it is necessary to effect a strong amplification and at the same time to maintain a high ratio between the signal and the noise in the receiver.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. An arrangement for regulating the sensitivity of radio receivers having cascaded vacuum tube amplifying stages and for maintaining a high ratio between the signal and the background or noise in the input stage of the receiver when the amplification is reduced in subsequent stages, characterised by the fact that the cathode circuits of the vacuum tubes in the several stages include adjustable self biassing resistances for the purpose of effecting the adjustment of the sensitivity of said stages and the resistance inserted for self biassing in the cathode circuit of the tube or tubes of the stage or stages nearer to the receiver input is regulatable independently of a regulatable self biassing resistance inserted in the cathode circuits of the tubes of the subsequent amplifying stages.

2. An arrangement according to Claim 1, characterised by the fact that said first and second mentioned resistances are located adjacent to each other and the respective movable brushes are coupled together and their displacements on the respective resistances cause variations in the same sense of the resistance values operative in the respective circuits while the operative portion of the resistance for the input stage or stages has an extent less than that of the resistance for the subsequent stages and the insertion of said first resistance commences after the insertion of a portion of the resistance for the subsequent stages has taken place.

3. An arrangement for regulating the sensitivity of radio receivers substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 11th day of May, 1940.
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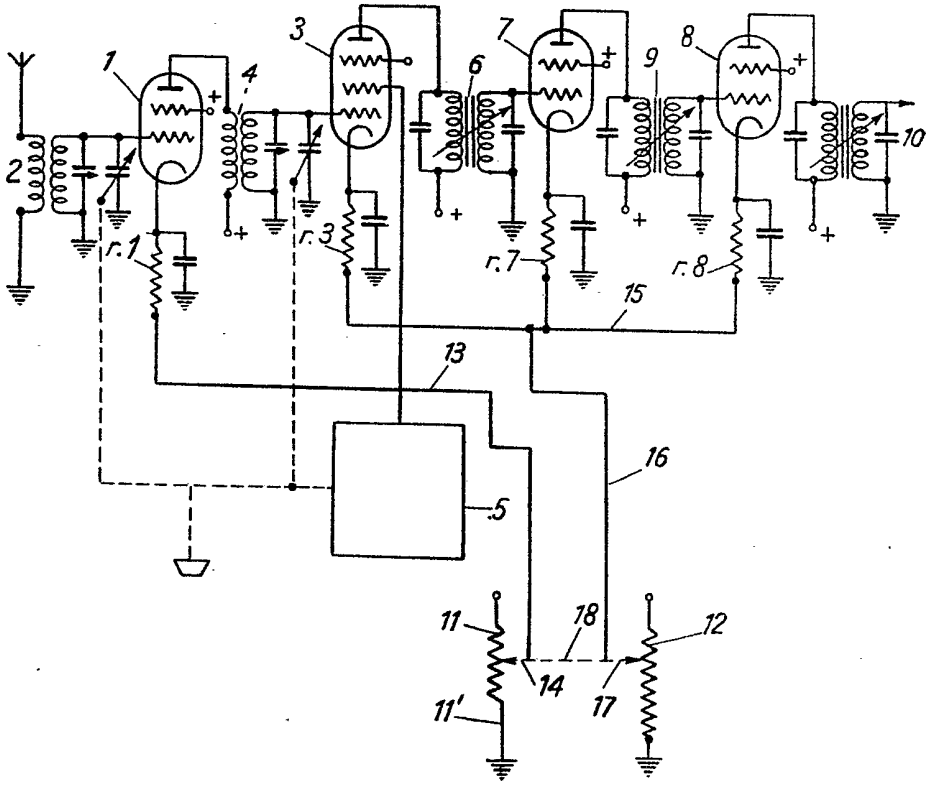

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