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CONTROL DEVICE FOR RADIO RECEIVERS

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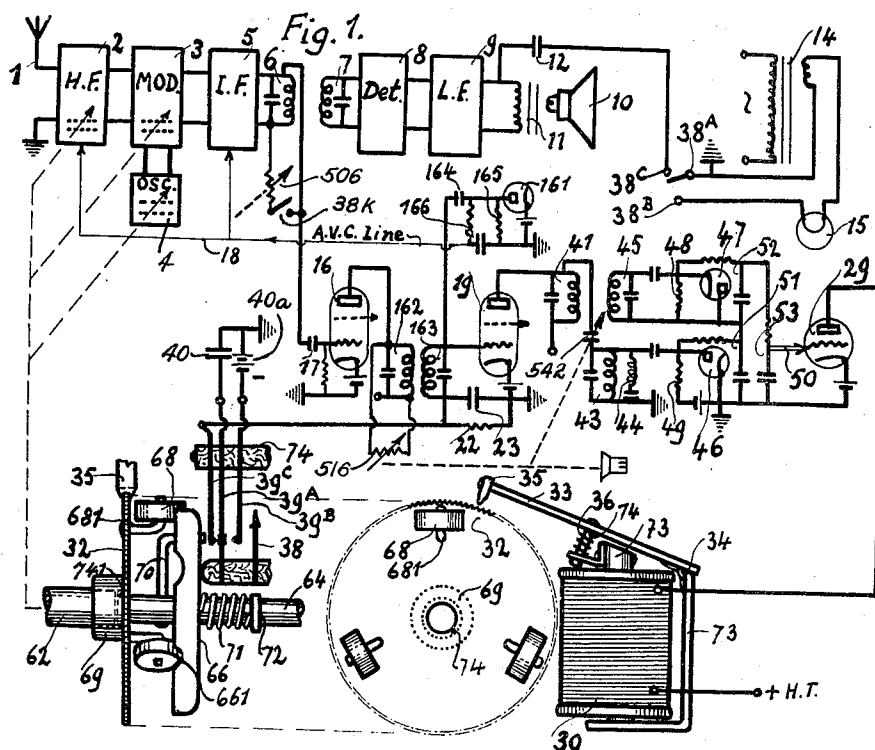
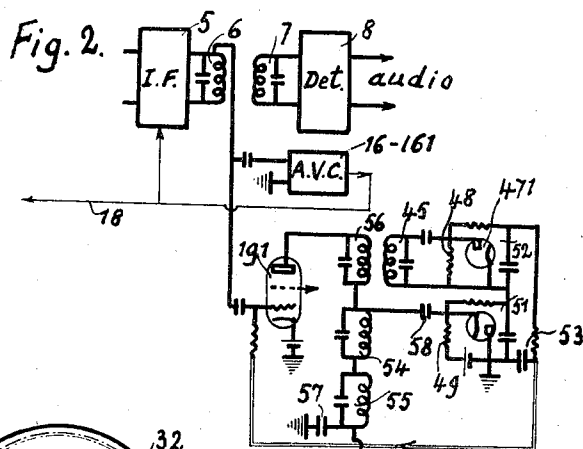
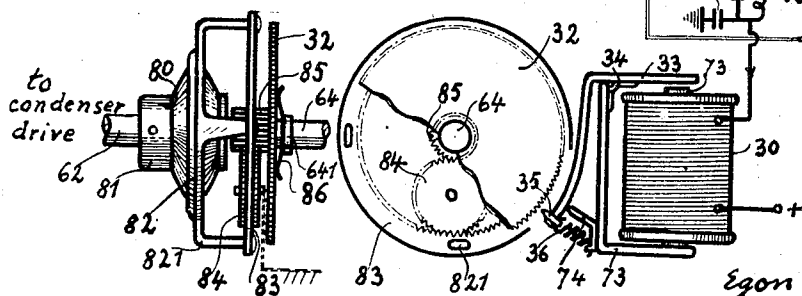


Fig. 2a.



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UNITED STATES PATENT OFFICE

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CONTROL DEVICE FOR RADIO RECEIVERS

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11 Claims. (Cl. 250—20)

My present invention applies to radio and like modulated carrier receivers, and is more particularly concerned with the tuning device of such receivers.

A main object of the invention is to provide a device of a new kind for detecting the tuning-in of the carrier wave of a transmitter. The invention finds a wide field of appliances in connection with means for disabling the reproducer between the stations so as to suppress the interchannel noise, and/or with means for visually indicating that a station is tuned-in, and/or with means for automatically "spreading" the exact resonance position, or with many other devices of more or less related character.

A characteristic feature of the many systems known in the art for providing inter-channel "muting" or illumination of the tuning dial when a station is in tune, or for many other more or less related purposes relying on the presence of a carrier wave, bases on the assumption that any high-frequency energy applied to the receiver, the amplitude of which exceeds a predetermined value, is due to the carrier wave of a transmitter station which may be heard under good conditions, and conversely, that all waves of lesser amplitude are due to "static" or are too strongly interfered to be received under adequate conditions. This assumption is however in practice entirely arbitrary since the amplitude of the background of "static" varies so much with the local reception conditions, with the day-time and season etc. The energy components of the "static" over the various wave bands and band portions are moreover not uniform nor is the sensitivity of the receiver uniform over the various wave ranges. Accordingly, even when the threshold of actuation of the utilization device is adjusted very carefully (which in practice is never the case when the receiver is operated by an unexperienced user), the inherent sensitivity is badly utilized on most wave bands, since the threshold of operation of the utilization device must be properly adjusted at frequencies whereat the gain of the receiver and the intensity of incoming static in substance are a maximum. By making effective a lower threshold value, the utilization device of course would be left operative through a frequency range of considerable width due to the reception of static and like interferences. On the other hand an adjustment of the character in question (or an overall adjustment of receiver sensitivity which is equivalent) is very complicated when the receiver must be remotely controlled, e. g. by the intermediate of a

flexible tuning control spindle or by means of an electric motor etc.

An important object of my invention accordingly consists in avoiding these inconveniences and in making available the entire "useful" sensitivity of the receiver, by relieving from the necessity of providing a definite adjustment of threshold with respect to the level of incoming high-frequency energy. The receiver sensitivity may for instance under all conditions be better than 5 microvolts, yet a station of such extreme weakness will automatically be allowed to actuate the utilization device in the event only of an exceptionally low interfering background, and the receiver will therefore remain muted etc., at the great majority of the possible tuning positions.

In accordance with an important feature of my invention I provide a "static" responsive rectifier which is associated with selective networks of such a type as to provide a resultant response curve characteristic responsive in larger proportion to waves of a frequency or frequencies slightly spaced from the operating tuning frequency (i. e. the intermediate frequency in the case of a superheterodyne receiver), e. g. distant by 2 kilocycles. Preferably a marked double-peaked response curve is utilized. Thus when a carrier wave is exactly in tune, it will produce a predetermined potential across this rectifier, but when comparatively strong "static" is present, the same will set up a relatively higher potential since including energy at frequencies which are more efficiently transferred. A second rectifier is provided of which the output potential remains in substance constant whether fed by energy due to a carrier wave or by energy distributed over a wide frequency spectrum. These two rectifiers cooperate in such a manner and are so connected to the utilization device that the same can only operate when the carrier wave is sufficiently high relative to the background of static. A trigger device may be embodied.

The invention is clearly distinguished from prior devices in which for the purpose of giving "aural" tuning indications or the like, relatively "double-humped" selectivity is used in the A. V. C. channel with respect to the selectivity response at the reproducer rectifier, and in which the resonance curve characteristic effective across this A. V. C. rectifier must present a single peak.

Further specific features of the invention consist in the mode of cooperation of the two rectifiers referred to in the above.

The invention is preferably adapted for cooperation with an A. V. C. device which in ac-

cordance with many forms of the invention may be arranged in quite conventional fashion. Alternatively, in accordance with one particular form of the invention, the A. V. C. rectifier may cooperate with the control device in such a way as to perform the function of the "static" responsive rectifier.

A subsidiary object of the invention is to provide means for adjusting the "useful" sensitivity of the receiver, i. e., the minimum signal to static ratio capable of actuating the utilization device.

The invention is more particularly concerned with uniform interferences, e. g. man-made or due to atmospherics. However, a subsidiary object of the invention consists in providing improved means for preventing the transmission and reproduction of brief interfering pulses due to static

Other features and objects of the invention will result from the detailed description.

The invention is described in detail in connection with some typical utilization devices, with reference to Figs. 1-4, of which:

Fig. 1 is a diagrammatical representation of a typical form of "control" device;

Fig. 2 shows a modified arrangement;

Fig. 2A shows a side view of a portion of the apparatus; and

Figs. 3 and 4 show alternative forms of "control" devices.

Reference should now be had to Fig. 1 in which a control circuit in accordance with the invention is incorporated in a receiver of the superheterodyne type, and is shown in connection with an electromagnetic system for giving "spreaded" tuning. The receiver includes a signal source 1, a radio frequency amplifier section 2, a modulator stage 3 cooperating with a local oscillator 4, and an intermediate frequency amplifier section 5 which through a tuned transformer having a tuned primary 6 and a tuned secondary 7 feeds the demodulating detector 8 which is coupled to an audio frequency section 9. A reproducer 10 is coupled to the audio section 9 through an output transformer 11. The sections 2, 3 and 4 include variable gang-controlled tuning condensers.

The signal energy across the tuned circuit 6 and hence across the detector 8, tends to be maintained substantially constant despite signal amplitude variations of the source 1, by means of an automatic volume control network of conventional design comprising a high frequency amplifier tube 16 and a rectifier 161, the amplifier 16 being also effective in amplifying the signal energy translated to the "control" channel. The tube 16 is coupled to the circuit 6 through a condenser 17 of small value, and is associated with an output transformer including the two sharply resonant circuits 162 and 163 which are tuned to the operating intermediate frequency, and of which the coupling is moderately tight, so that the adjacent carrier wave response (at ± 10 kilocycles) is low; preferably the frequencies up to ± 2 kilocycles are very efficiently translated, this being desirable to ensure correct operation of the "control" channel. The A. V. C. rectifier 161 is fed from the secondary circuit 163 through a condenser 164 of rather low value, and is biased negatively so as to prevent rectification of high-frequency energy below a predetermined signal strength so as to increase the efficiency of the automatic gain control action; the unidirectional potentials set up across the load resistor 165 are filtered at 166 and serve to vary the gain of the

amplifier sections 2 and 5, through the line 18.

The "control" channel includes a high frequency amplifier tube 19, a pair of rectifiers 46 and 47, of the indirectly heated diode type, and a direct current amplifier tube 29. The tube 19 is fed with signal energy through the tuned secondary 163, and its gain is normally fixed, but under certain circumstances as described hereinafter, the amplification may be briefly upset, the grid-cathode circuit including to this end a resistor 22 shunted by a by-pass condenser 23, of which the action may normally be neglected. The anode circuit includes a flatly resonating circuit 41 tuned to the operating intermediate frequency. The rectifier 46 is coupled to the circuit 41 through a network 43-44 comprising a flatly resonating "parallel resonance" circuit 43 tuned to the operating intermediate frequency and shunted by a sharply resonating "series resonance" circuit 44 also tuned to the intermediate frequency. The resonance curve proper of this network is markedly "double-humped"; the peak response being at ± 2.5 kilocycles from the intermediate frequency and being seriously higher (e. g. 3.5 times) than the "crevasse" response at the true intermediate frequency. The resulting response curve (when taking into account the selective circuits of the path extending from the signal source to the circuit 41 inclusive) is likewise double-humped (though in most cases in lesser proportions), the peaks being e. g. at ± 2 kc./s., the peak response being e. g. 2.5 times higher than the crevasse response. All the selective circuits preceding the rectifier 46 may attenuate the response at ± 10 kilocycles, so that no appreciable "adjacent carrier energy is transferred. The rectifier 46 is provided with a load resistor 49 and produces "negative" potentials, and the anode of the diode is biased negatively so that rectification can only take place when the high frequency energy applied to the rectifier exceeds the delay bias.

The rectifier 47 is coupled to the circuit 41 through a circuit 45 tuned to the operating intermediate frequency and having preferably (but not necessarily) a low decrement. The level of intermediate frequency energy is the same across the two rectifiers 46 and 47. The rectifier 47 is provided with a load resistor 48 across which are produced "positive" potentials. The unidirectional potentials produced by the two rectifiers are superposed with respect to a common outgoing control line 50; each rectifier is provided with a filter 51, and 52, of small time constant (such as $\frac{1}{100}$ second) to avoid undesired interaction, and a further filter 53 may if desired be provided for the control line 50.

The utilisation device is of the type fully described in my U. S. divisional application Ser. No. 201,204 filed April 9, 1938, originally disclosed in U. S. application Ser. No. 150,922 filed June 29, 1937, in which the spindle of the ganged variable condensers etc., is positively arrested and de-clutched from the spindle of the tuning handle, when a station is tuned in, the station being "dropped" by briefly upsetting the arresting means when the operator continues to rotate the tuning control member through a predetermined angle of rotation. The receiver is "demuted" and a visual indicator lamp lights up when the receiver is tuned to a station, these effects taking place indirectly, in the instance shown, by combination with the tuning drive mechanism. The spindle of the tuning control member is operated man-

ually, but if desired it might be driven by a motor adapted for remote control, etc.

The control line 50 serves to vary the anode current of the tube 29, the anode circuit of which includes the winding 30 wound on the core 73 of an electromagnet associated with the tuning drive mechanism. The electromagnet is provided with an armature 33 hinged at 34, and the extremity of the armature carries a sharp-edged part 35 adapted to engage the peripheral teeth of a toothed disc 32 so as to positively arrest the same as soon as a sufficient current flows through the magnet winding. The armature is normally maintained closely in front of the magnet core by means of a spring 36 and an abutment 74. The tube 29 is normally overbiased so that in the absence of high frequency energy it carries only a low anode current, the cathode being at a moderate positive potential (such as 3 volts) with respect to ground.

The toothed disc 32 referred to in the above is shown again in detail at the left of Fig. 1, and is secured to a spindle 62 which drives the variable tuning condensers through a slow-motion drive (not shown) of conventional design having preferably a high gear ratio. This disc forms part of the driven clutch element of the drive mechanism, and carries a plurality of projections 68 formed as rollers rotatably mounted on pivots 681 secured to the disc 32, there being provided three rollers in the instance shown which are distributed regularly on the periphery.

The driving clutch element comprises a cup-shaped member 66 carrying a plurality of arcuate notches 661 around its periphery, and is secured to the spindle 64 of the tuning knob in such a manner as to admit a moderate axial motion whilst rotational slip is prevented by means of an arcuate rod 70 fixed upon the shaft 64 and projecting through an aperture in the member 66. A compressed spring 71 bearing against a flange 72 on the tuning shaft 64 normally urges the driving member against the driven clutch member. There are six notches 661 in the instance shown, which for a given relative angular position of the driving and driven clutch elements may register with the rollers 68 so as to engage part of their periphery; this relative position is assumed so long as no station is being received, and the shaft 62 is in this position driven with great reliability. The extremity of the tuning shaft 64 is provided with a flange 741 engaging a recess 74 in the bush 69 which is secured to the toothed disc, thereby preventing relative axial motion of the shafts 62 and 64.

A plurality of switches 38, 39, of the type comprising flat blades, are secured to the chassis at 74, and bear by the intermediate of a part 73 of insulating material against the surface of the member 66, so as to be actuated by an axial motion of the same. In the instance shown, there is provided a three-pole switch 39 A—C in view of allowing the station to be "dropped," and a further three-pole switch 38 A—C (of which the electrical equivalent is separately shown) serves to carry out various convenience purposes.

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

As long as no appreciable high frequency energy is applied to the control rectifiers 46, 47, the control line 50 is negative with respect to ground, the potential being that of the delay bias of the rectifier 46. The anode current of the tube 29 in such case is insufficient to energize the electromagnet.

When the receiver is in resonance with a carrier wave, sufficient energy may be impressed on the rectifier 46 to overcome the delay bias, of which the effect may in such case be in substance neglected, and the potentials produced by the rectifiers 46 and 47 may present the same amplitude, and since they are in opposition, they cancel each other with respect to the control line 50, which assumes substantially ground potential. The negative bias of the tube 29 is thereby seriously lowered and the anode current of the tube is considerably increased so that the magnet attracts its armature. It will be observed that in the particular instance shown the potential of the line 50 does not depend on the efficiency of the A. V. C. device (which determines the energy applied to either rectifier 46, and 47) nor even on the signal amplitude at 1. It is however preferable to provide an automatic gain control device having appreciable efficiency, in view of facilitating the adjustments of the control system.

When the receiver is slightly or moderately off tune (e. g. by 1 kilocycle) the negative output across the rectifier 46 increases, as either of the two peak response frequencies is approached; at the same time the positive output across the rectifier 46 relatively decreases, since the energy is attenuated by the selective circuit 45; these two effects are cumulative, the change in potential of the line 50 being particularly marked in close proximity of the exact in-tune position. It will easily be understood from the above that the decrease of potential of the line 50 remains sufficiently marked to allow an easy and reliable adjustment of the threshold of magnet operation, for a given small amount of off-tune, even when the A. V. C. device is not very effective, since the law of potential variation of the lead 50 (from ground potential to more negative values) in the case of small amounts of mistuning, remains in substance unaffected.

When the receiver is more considerably off resonance, (e. g. by 3 kilocycles), the energy applied to the rectifier 46 decreases rapidly but the outgoing lead of this rectifier cannot reach a potential more "positive" than defined by the delay bias. On the other hand, appreciable energy may still be applied to the circuit 41, in the case of a very powerful carrier, and it is therefore necessary, in view of preventing an erroneous operation of the electromagnet, that this energy be reduced in appreciable proportion before being applied to the rectifier 47; this condition, it will easily be understood, is quite easily fulfilled by the network 45 even when including a single resonant circuit since the amount of mistuning is high. It may thus be stated that an important function of the network 45 is to prevent "ambiguity" which tends to result from the double-humped resonance curve characteristic across the rectifier 46 (as distinct from such a characteristic of the network 43—44 only).

Let it now be supposed that the receiver is not tuned to a carrier wave, and that there is "static" of substantial amplitude. Since static is uniformly effective through a wide frequency band, it will be understood that the level of energy at the rectifier 47 is in the main defined by the frequency response at operating intermediate frequency, the rectifier potential being approximately that derived by exactly tuning in a carrier wave equivalent in intensity to the mean intensity of static. On the other hand the level of energy at the rectifier 46 assumes a relatively

higher value, and is in substance defined by the peak response, at the frequencies of the response peaks. There will accordingly be a predominant influence of negative output due to the rectifier 46, and the potential of the lead 50 cannot reach a sufficiently "positive" value to operate the electromagnet. Furthermore, when the A. V. C. device is at least moderately efficient, the excess of output of the rectifier 46 with respect to output at 47 is practically constant whichever may be the intensity of the "static," and it depends only on the ratio: peak response to crevasse response, of the resonance curve characteristic at the rectifier 46. This ratio defines the "useful" sensitivity of the receiver, as explained in more detail hereinafter.

When both carrier wave and moderately intense static are applied to the receiver, the potential across the rectifier 47 will not be seriously higher than that defined by the sole influence of the carrier wave. However, the potential across the rectifier 46 tends to be increased in proportion to the intensity of static, until same reaches or somewhat exceeds the value defined in the foregoing instance. When the ratio of the responses respectively at the peak and crevasse frequencies is given the value mentioned in the foregoing, the excess of potential at the rectifier 46 will be sufficiently low to energize the electromagnet as soon as the carrier wave is about 2 or 3 times stronger than static.

Although the foregoing was explained with particular reference to a rather uniform background of noise, it will be true in the case of brief interfering impulses of high intensity, due to atmospherics or to sparks of electrical engines or the like. In this case, a potential of substantial amplitude will be produced simultaneously at the rectifiers 46 and 47, and the output of the rectifier 46 will predominate so as to prevent an erroneous operation of the electromagnet or other utilization device.

When the operator rotates the tuning knob, it will be clear from the foregoing that the electromagnet will attract its armature as soon as the receiver is approximately in resonance with a signal. In such case the potential of the lead 50 is sufficiently near the potential of ground to cause a substantial anode current in the tube 29, the initial adjustments being easily carried out, e. g. by adjusting the cathode potential of the tube. The sharply edged part 35 of the armature will stop the toothed disc 32, but the operator will not notice a substantial change as concerns hardness in the driving conditions, and he accordingly continues to rotate the tuning knob; incidently, if desired, the spindle 64 might to this end be rendered somewhat difficult to operate, at all times. By reason of the relative rotation now taking place between the driving clutch member carrying the notches 661, and the driven clutch member carrying the projections 68, the projections will be forced out of engagement with the notches and the member 66 will accordingly carry out an axial movement (against the pressure of the spring 71), thereby actuating the switches 38—39. Further movement of the tuning knob, up to one sixth of a turn, does not now change the tuning frequency; the receiver is restored to normal reproduction condition by the opening of the contact 38 A—C which up to this moment short-circuited the loud-speaker circuit through the by-pass condenser 12 of high value, and a lamp 15 fed from the mains transformer 14 may light up behind

a window of the tuning dial to indicate visually that a station is being received; this lamp if desired might illuminate the name of the station, or project optically the name on to a ground glass screen; many other circuit combinations are possible, and a high number of switches 38—39 may readily be actuated. A condenser 40 having a high capacity value (such as 1 microfarad) is also charged in this receiver position, through the closed contact 39 A—B, by means of a source of potential 40a negative with respect to ground.

When the operator desires to hear another programme, he continues to rotate the tuning knob, and after one sixth of a turn, the projections 68 and notches 661 will again be engaged, whereby the reverse switch operations will take place. At the same time, the condenser 40 discharges into a resistance 22 (e. g. of one tenth of a megohm) shunted by a high frequency by-pass condenser 23 of moderate value (e. g. 0.02 microfarad), thereby impressing a negative overbias to the grid of the amplifier 19 (through the circuit 163), which prevents the transmission of energy to the rectifiers 46, 47. The potential of the tube 29 tends therefore to resume quickly its overbiased condition, and the associated electromagnet ceases to arrest the variable tuning impedances so that other frequencies are tuned in, since the operator continues to rotate the tuning handle, and since the clutch elements remain engaged. The negative overbias of the amplifier 19 vanishes quickly, and the tube after e. g. one fifth of a second resumes its initial operative state, but the receiver is meanwhile off-tune with respect to the station just tuned in by e. g. 1 or 2 kilocycles.

It is sometimes desirable to provide a means adapted for manual control, to adjust the minimum value of the ratio: signal to static, capable of causing operation of the electromagnet or other utilization device. This ratio defines the utmost "useful" sensitivity of the receiver, and is to some extent a subjective value, depending on the desire of the listener, and also on the character of the programme to be listened; for instance, a dance band may be listened at with a higher noise level than symphonic music. The operation of these control means of course its quite noncritical, and may be further facilitated to inexperienced users, by being carried out stepwise instead of uniformly e. g. by means including a switch; there may for instance be provided two positions: "high sensitivity," and "pureness" (low noise level).

This control may inter alia be carried out by varying the ratio: peak response to crevasse response, of the resonance curve characteristic at the rectifier 46, e. g. by varying the characteristics, the damping etc., of the network 43—44; for instance a switch-operated resistor may be connected in series with the acceptor circuit 44 and/or the rejector circuit 43; or the selectivity at some other point in the "control" channel or in the high frequency amplifier path preceding the rectifier 46 may be varied; preferably for analogous reasons, the selectivity of this path is in substance predetermined during the tuning process; accordingly when an automatic selectivity control system is embodied, the same is preferably rendered inoperative when tuning, e. g., by means of an additional switch contact 38—. In some instances a combined control of the frequency response curve and of the overall level of the energy transferred to the rectifier at 46 is useful. Alternatively the selective network

43—44 may at all times provide a comparatively very high peak response (with respect to the crevasse response at intermediate frequency) of the resonance curve characteristic across the rectifier 46, (e. g. of ratio value 8:1) so as to provide the possibility of adjusting a high ratio: carrier wave level to noise level, and in the high sensitivity position a high threshold bias of the rectifier 46 may be provided, or the output of the rectifier 47 may be lowered or the threshold of operation of the utilization device may otherwise be varied. Some typical arrangements of adjusting the desired value of "useful sensitivity" are illustrated in Fig. 1. As shown, the resonant circuit 6 is shunted by a variable resistor 506 for controlling the damping thereof. A similar variable resistor 516 is provided across the terminals of circuit 162. The resistor across circuit 6 may be cut out while the receiver is not tuned to a station, for instance by means of the switch 38K for operation through the automatic tuning control mechanism. It will be understood that increased damping causes reduced response at frequencies moderately spaced from the tuning frequency, hence reduced response at the peak response frequencies as effective across rectifier 46, while leaving unchanged the ratio of the response values at the frequency corresponding to exact tuning, if it be supposed that a station is exactly in tune. The net effect is that a higher level of static is required to bring about negative excess-bias across rectifier 46 and in the lead 50 which controls the operation of the utilization device. The adjustable resistors 506 and 516 obviously may be uncontrolled. Furthermore, as shown, the coupling condenser 542 in the feed path of the circuit 43—44 and rectifier 46, is rendered variable to enhance the control effect of the elements 506, 516. It will be understood that by decreasing the capacity of condenser 542, the response to received energy of frequencies corresponding to peak response at the rectifier 46, will be decreased. Providing the threshold bias of this rectifier, as defined by the potential of the battery therewith associated, is normally comparatively high, and preferably of about the same value as the amplitude of the normal carrier-dependent output of rectifier 47, the said change in peak response caused by condenser 542 will leave the output of the rectifier 46, as well as the balance condition of the outputs of the rectifiers 46 and 47 substantially unchanged while a carrier is being received. The control effect upon lead 50 is therefore cumulative with that of elements 506 and 516. When the control device is adjusted during the tuning process to operate only for a relatively low noise level, it may happen when the station is definitively listened, that the level of "static" rises to a high value, so as to destroy the entertainment value of the programme; it is desirable that in such case a switch device etc. be provided for "muting" the reproducer; since the switch contact 38 in Fig. 1 cannot perform this function a further muting device may be provided, which may be of a simple kind when used in combination with the main switch 38— since this latter prevents a distorted reproduction which tends to arise in some off-resonance positions; thus the potential of the line 50 may be directly applied to the grid of a normally overbiased amplifier tube in the reproducing channel, without the interposition of a "trigger" device.

It is also desirable in many instances that a higher noise level be admissible when the tuning process is terminated, to avoid unstable reception

when the local reception conditions and the fading are bad etc. For instance a further switch contact 38— or other manually operated switch means etc. preferably automatically actuated when the hand of the operator releases the tuning knob, may place the receiver in the "high sensitivity" position referred to in the above; other threshold adjusting means may be utilized.

It was shown that a strong interfering impulse due to a flash etc. cannot cause an erroneous actuation of the utilization means; however in most present day receivers a high potential will in such event be produced across the A. V. C. rectifier and will vanish rather slowly by reason of the time constant of its filtering network, thereby decreasing the sensitivity of the receiver and the energy fed to the "control" device, and when the carrier wave is rather weak the receiver may be briefly muted with some types of muting systems; to avoid this inconvenience the time constant of the filter 53, or of the filter 51, may be increased in a desired proportion e. g. by means of switch system, when the hand of the operator releases the tuning knob, or an additional filter of high time constant may be provided in the control line actuating the additional switch system referred to in the above.

Alternatively the transfer of such interfering impulses may be "suppressed" by means of circuits of a known kind, or an upper limit of energy transfer may be provided in the amplifier section 5 etc., either by means of control circuits of a known type operating in response to a predetermined amplitude adjustment, or preferably, in view of facilitating the initial adjustments, and of allowing the detection of the presence of relatively weak impulses, by means of a device closely connected with the rectifier 46 and the selective networks feeding the same. Thus an additional rectifier biased to a higher value may be fed in parallel with 46 and may control the gain of an amplifier tube in the amplifier section 5, energy of operating intermediate frequency being unable to exceed this threshold bias; preferably this additional rectifier may be of the push-pull type so that the associated filter may have a very low time constant, the network 43—44 being accordingly slightly modified; or the rectifier 46 may be of the push-pull type, and a further inferior limit means may be provided in the path of the additional control line. Of course, the "control" channel may be fed from some other point in the amplifier section 5, in which the selectivity is lower.

Many alternative types of selective networks may be associated with the rectifiers 46 and 47. A type of filter of the general class illustrated in Fig. 1, for the rectifier 46, with a resonant circuit tuned to and adapted to reject the operating intermediate frequency, is in cases particularly useful and effective. However, one or more circuits tuned to a frequency moderately spaced from adjacent the operating intermediate frequency, may alternatively or conjointly be utilised, or again overcoupled band-pass filters etc. A quartz filter or other mechanical resonant device might also be utilized. It will be observed that it is not essential that a double peaked resonance curve characteristic be effective across the rectifier 46, although such a response is particularly useful, a single peak would be suitable, when making the selective properties of the network 45— associated with the rectifier 47 sufficiently pronounced.

In some instances a threshold bias of the rec-

tifier 47 in addition to the bias of the rectifier 46, and of lower value, is useful. In others it may be preferable to omit bias or equivalent inferior limit means of the rectifier 46, and to increase the response at operating intermediate frequency at the rectifier 47, so that the same may appreciably exceed the intermediate frequency response at the rectifier 46; however it is understood that in such case a very effective A. V. C. device is useful to render the threshold adjustment of the utilization means (e. g. of the tube 29) more easy.

Fig. 2 shows a modified form of control circuit, in connection with an electromechanical mechanism for providing "spreaded" tuning, of a type fully disclosed in U. S. patent application Serial No. 150,922, filed June 29, 1939, in which the normal gear ratio of the slow motion drive is increased in close proximity of the exact tuning position, and changed down again to its normal value when the amount of mistuning reaches again an appreciable value.

As shown, the control channel includes a high frequency amplifier tube 191 which is fed directly from the tuned circuit 6, which latter is coupled to the intermediate frequency amplifier as in the foregoing arrangement. In the present instance the tube 191 fulfills also the purpose of the direct current amplifier tube, (29), and includes to this end the winding 30 of an electromagnet similar to the one described in the foregoing, this winding being bypassed at 37, from the high frequency view point. The phase of the rectifiers 461 and 471 is reversed as compared with 46 and 47 in the instance of Fig. 1, the rectifier 461 producing positive potentials when the high frequency energy exceeds a threshold value, whilst the rectifier 471 produces negative potentials. The two sets of potentials are again superposed with respect to the control line 501, of which the potential is normally in the absence high frequency energy positive with respect to ground, due to the delay bias of 461; the line 501 is applied to the grid of the tube 191 of which the cathode is moderately positive with respect to ground, the resultant grid bias being normally slightly negative, so that the tube amplifies under optimum conditions.

It will be observed that in the instance shown, the potential variations of the "control" line (501) are substantially independent of signal strength and likewise of course of the gain of the high frequency amplifier tube 191, and the D. C. control of this tube accordingly does not bring about any additional repercussions, the small decrease in gain at in-tune being meaningless.

The energy level in the plate circuit of 191 is maintained nearly constant by means of the A. V. C. device 16—161 fed in parallel with the "control" channel. The anode circuit of the amplifier 191 includes a network comprising three rejector circuits 56, 55, 54, connected in series, of which the circuit 56 sharply resonates at operating intermediate frequency whereas the circuits 54, 55 are tuned to frequencies situated respectively on either side of the operating intermediate frequency and distant by about equal amounts (such as +.25 and -2.5 kilocycles). The rectifier 471 is coupled to the circuit 56 through the resonant circuit 45 defined in Fig. 1. The rectifier 461 is fed through the small condenser 58 from the tap of the circuits 56 and 54—55, the response curve characteristic of the network being from the viewpoint here concerned substantially equivalent to response provided by the

network 43—44 of the foregoing arrangement, i. e. the transmission of energy of intermediate frequency is lowered in substantial proportion and the transmission of energy in frequencies close to the tuning frequencies of the circuits 54, 55 takes place in substantial proportion. When a carrier wave is exactly tuned in, the tube 191 is biased to a more negative value its anode current decreases and the electromagnet 73 releases its armature under the tension of the spring. . . . The operation under various other tuning conditions will readily be understood when considered in connection with the foregoing explanation. An erroneous actuation of the electromagnet in the case of a very powerful carrier wave and the receiver being so considerably mistuned as to set up no appreciable potential across 471, may be prevented by means of the selective circuit 45 etc. as in the foregoing arrangement. Alternatively or conjointly, this result may easily be obtained in this and in other instances by interposing between the circuit 6 and the rectifier 161 of the A. V. C. device a selective network such as an overcoupled band pass filter etc. presenting a relatively double-peaked resonance curve characteristic, the resultant response at 161 presenting for instance a very flat single peak. More generally the relative resultant response of the A. V. C. rectifier as compared with the response at the rectifier 471 may be higher at frequencies in the immediate neighbourhood of the peak response frequencies at 461. In such case, the gain of the amplifier path of the rectifier 471 is decreased in a sufficient proportion by the relatively high A. V. C. potentials.

The control drive mechanism for the ganged variable condensers includes in the instance a planetary drive indicated by the general reference 80, of the ball-bearing type, and serving to superpose two different movements both derived by turning the tuning knob. The inner ball race is formed as a whole with the tuning spindle 64 carrying the tuning knob (not shown), and is accordingly driven at all times. The ball cage 81 is fixed to the spindle 62 of a conventional slow motion drive associated with the variable ganged tuning condensers. The outer ball race 82 is driven by the spindle 64 through a friction clutch and through toothed gearing including a gear wheel 85 clutched to the spindle 64, an annulus 83 secured to the outer ball race 83 which latter is to this end formed with radially projecting arms 821, and an interposed gear wheel 84 freely rotatable about a pivot secured to the chassis. A toothed disc 32 is secured to the gear wheel 85, and the clutch comprises a spring 85 frictionally engaging the disc 32 and a flange 641 on the tuning spindle. When no station is being received the anode current at 191 is a maximum and the electromagnet stops the disc 32, 60 and the associated outer ball race. Accordingly the planetary gearing may function as a quite conventional slow-motion drive. When the receiver is nearly in tune with a station, the toothed disc is released by virtue of the decreasing anode current; when the operator continues to rotate the tuning knob, the outer race 82 is rotated in opposite direction, the gear ratio at 82—84—85 being so chosen with respect to the ratio of the planetary drive proper that a small excess movement of the inner ball race remains, whereas the ball cage is rotated at an extremely slow speed, until tuning is altered through the point of exact resonance, to leave again a small proportion of mistuning.

Of course, the tuning control device might be combined with visual indicator means or with means for muting the reproducer to suppress noise then tuning from one station to another. The noise suppression means might for instance be of the type shown in Fig. 4, or might be switch operated through the electromagnet 30—73 or might be of a purely electrical-type.

The super-imposition of the outputs of the rectifiers 46 and 47 may alternatively take place in many different manners; for example a potential derived from each rectifier may be applied to a D. C. amplifier tube, the outputs of the two tubes flowing through the same winding of an electromagnet performing the desired functions, or flowing alternatively through a common resistance connected to the utilization device; or a valve with two control grids able of influencing the space current in approximately the same way, may be utilized.

Fig. 3 shows another form of control circuit in which the two control rectifiers co-operate in "multiplicative" fashion, the output of the rectifier 46 being arranged to alter the level of energy at the rectifier 47.

The control system includes an amplifier channel switched "on" in response to the output of a control channel of the type specifically set forth in this invention, and being switched "off" again in response to the output of a further control circuit designed as described and claimed in my divisional U. S. patent application Ser. No. 234,154, filed October 10, 1938, originally disclosed in U. S. application Ser. No. 150,922 filed June 29, 1937. There is also provided a so-called trigger-circuit, for abruptly altering the gain of the controlled amplifier channel.

The specific "control" channel in the present instance comprises two separate high frequency amplifier tubes 192 and 193 fed in parallel by high frequency energy derived directly from the tuned circuit 6 in a manner similar to that shown in Fig. 2. The amplifier tube 193 amplifies under constant gain conditions and feeds the rectifier 46 producing "negative" potentials across the resistor 49, through the selective network 43—44 providing a "resultant" markedly double humped resonance curve characteristic across the rectifier, the arrangement being quite similar to that shown in Fig. 1; a negative threshold bias is also used but may in some instances be dispensed with. In analogous manner the amplifier tube 192 feeds the rectifier 47 producing "positive control" potentials, across the load resistor 48, through a selective filter 451 passing in the main energy of intermediate frequency only. The gain of the amplifier tube 192 is normally optimum and decreases in response to potentials of the rectifier 46 applied to its grid through the lead 87. It may first be assumed that the anode of the diode 47 is at predetermined potential, moderately (positive with respect to ground).

The operation of the control circuit shown in Fig. 3 is as follows: When the receiver is exactly tuned to a moderately strong carrier wave, a predetermined output results at the rectifier 46, as defined by the crevasse response; the gain of the amplifier 192 is of predetermined value, and the energy is effectively translated through the filter 451 to the rectifier 47 so as to actuate the utilization device. When a very powerful carrier wave is tuned in, the input to the amplifier 192 will increase to a moderate extent when the A. V. C. device is not perfectly efficient. This

increase if desired may be compensated by the output potential of the rectifier 46, by arranging matters so that the output of this rectifier increases progressively as the input of the amplifier 193 increases, whereby the resulting increased negative bias may be applied to the tube 192 to decrease the gain thereof; the input of the rectifier 47 and the potential of the outgoing control line 502 may as a result remain at about the same value as in the foregoing instance; an analogous compensation effect will take place when a very weak carrier wave is tuned in. The rectifier 46 particularly when of the push-pull type and associated with a filter 51 of very low time constant may also prevent the effect on the control line of brief interfering impulses as referred to herein before.

When the receiver is responsive to static only the energy across the rectifier 46 assumes a substantial value as compared with the energy across the rectifier 47, since the peak response at 46 is comparatively much higher; accordingly the gain of the tube 192 will accordingly be lowered sufficiently to prevent the actuation of the utilization device by the output of the rectifier 47. Further the actuation of the utilization means is prevented when both a carrier wave and comparatively intense static are applied to the receiver, and likewise when the desired carrier wave is adjoined by another interfering carrier wave e. g. due to a C. W. transmitter, transmitting on a closely adjacent frequency (e. g. at ± 3 Kc.). The arrangement may if desired be such that the negative bias of the tube 192 increases when a carrier wave is moderately off resonance so as to translate more energy to the rectifier 46 by reason of its peak response tending to be the more effective. When a high amount of mistuning is reached, the input of the rectifier 47 decreases, and the gain of the tube 192 increases (the same being preferably limited by reason of the threshold bias of the rectifier 46), but the energy reaching the rectifier 47 is substantially attenuated by the circuits 451 which thus remove "ambiguity."

The control line 502 is coupled to the grid circuit of an amplifier tube 90 in the reproducer channel so as to be disabled when the receiver is not tuned to a carrier wave, and this tube is at the same time in the path of a tuning corrector device A. F. C. 91 of conventional design, of which the output potentials are applied through the lead 92 to a controlled impedance in the local oscillator section as is well known to those skilled in the art. A trigger device is interposed between the control lead 502 and the grid circuit of the tube 90, and includes a tube 88 with a high frequency impedance 93 in its anode circuit, and a rectifier 89. The auxiliary (trigger) tube 88 is of the hexode type or the like, and comprises a main control grid connected to the "control" lead 502, and another grid capable of controlling the amplification of the tube, referred to as the gain control grid. The cathode of the tube 88 is considerably positive with respect to ground (e. g. at +10 volts) there being accordingly under normal conditions (in the absence of a signal) a rather considerable negative bias, less however than cutoff bias. The tube 88 is fed with high frequency energy, either from an auxiliary source of which the frequency and output potential amplitude are not critical, or by signal energy, in the instance shown, derived from circuit 6, and applied to the main control grid through a small condenser 94.

The amplification of the tube 88 is accordingly normally very low, and the energy appearing in its anode circuit is in the present instance further reduced when the receiver is not tuned to a signal, since due to the signal itself.

When the amount of mistuning with respect to a carrier wave decreases sufficiently, high frequency energy is applied to the tube 88 and the potential of the line 502 increases toward more positive values as explained hereinbefore, thus lowering the negative bias of the main control grid. The gain control grid is normally maintained at a rather high negative value, and despite the same lowering the gain of the tube, an appreciable high frequency energy will be set up across the anode load resistor 93. This energy is applied to the rectifier 89 which produces "positive" potentials across a load resistor 95 provided with a tap, which latter is connected to the gain control grid through the lead 96, a filter 97 and a further lead 98. Accordingly the gain of the tube 88 will increase in response to its high frequency output. It will readily be understood that the anode of the rectifier 89 of the diode type, is at the desired potential relative to the cathode of the tube 88. A negative threshold bias is provided for the rectifier 89, and is adjusted in such a way as to be exceeded by the high frequency energy applied to the rectifier when the amount of mistuning is less than for instance 1.5 kilocycles. When this tuning-in value is exceeded the resulting lowered negative bias of the gain control grid will bring about an increased high frequency energy in the output circuit and thus a further lowered bias, which rapidly would tend to reach a positive value the tube risking to be damaged; an inferior limit means for the negative bias is accordingly provided which is interposed between the lead 96 and the filter 97, and comprises an auxiliary diode 100 associated with a resistor 99 connected in series between the lead 96 and the point 101 having the desired limit potential toward positive values, the diode cathode being connected to said point 101. The lead 98 is connected through the filter 97 to the tap of the resistor and diode and cannot exceed the potential of the point 101 since the diode grows conductive and assumes a low internal resistance in comparison to the associated resistor 99, when the lead 96 reaches more positive potentials.

The potentials across the diode load resistor 95 are applied through the leads 503 and 504 to the grid of the amplifier tube 90 which is normally biased to cutoff, a limit means of analogous design 991—1001 being provided for limiting the minimum value of negative bias in the operating condition, and an analogous filter 971. In some instances the same limit means may serve for both tubes.

As soon as the negative overbias of the tube 90 is somewhat lowered, a small frequency corrector potential appears in the lead 92, and the resulting improved in-tune condition increases the potential of the line 502 and through the improved gain of the tube 88 further increases the corrector potential at 92. This effect tends in itself to give a trigger action and is cumulative with the trigger action through the gain control grid explained in the above, and accordingly the tuning is very quickly rendered nearly perfect and the reproducer is rendered operative.

The reproducer and frequency control channel are released again in the instance, when the absolute amplitude of the corrector potentials ex-

ceeds a predetermined value, such a device rendering the initial adjustments very easy and providing an excellent stability of operation, as explained in the patent application referred to in the above. To this end the lead 92 is applied to a "double-wave-rectifier" means including a direct current amplifier tube 102 with an anode load resistor 103 and a cathode load resistor 108, the former having a considerably higher value, the A. F. C. potentials being for instance amplified 10 times across 103 whilst the "amplification" at the cathode load resistor is slightly less than unit. Part of the anode potential variations is tapped off by means of a potentiometer 105—106, the potential variations at the tap being about equal in amplitude but of opposite phase as compared with the potentials dispensable at the cathode. Another potentiometer is connected between the cathode and the tap just mentioned and comprises a unidirectional conductor 108 such as the space path of a diode included in the same bulb as the triode 102, in series with a resistor 107 of rather high value, the diode cathode and the cathode of the triode 102 having a same sleeve.

When the potential of the corrector line 92 decreases with respect to ground, the potential of the tap 105—106 increases with respect to a reference potential whilst the potential of the cathode decreases. Accordingly the diode 108 is conducting and the potential of the outgoing line 109 connected to the tap of 107—108 assumes in substance the cathode potential. When the A. F. C. potential increases, the diode is non-conducting and the decreasing potential of the tap 105—106 determines the potential of the lead 109. The potential of this lead accordingly decreases for potential variations of either sense of the line 92 and when they reach a predetermined minimum value they are capable to trigger the tube 88 out of operation. To this end, the potentials of the lead 109 are superposed through a filter 111 of moderate time constant such as $\frac{1}{2}$ second and through the further lead 110 to the potentials of the rectifier 47.

Whilst the effect of this superposition is meaningless when the receiver is not tuned to a carrier wave, it will be noted that a negative potential component appears as concerns the lead 502 when the tube 88 is triggered into operation since the amount of "physical" detuning (as defined by the main tuning condenser or the like in the local oscillator section) is at this moment rather considerable and hence the corrector potential; for this reason, the excessive increase of energy across the load resistor 93 of the trigger tube resulting from the improved in-tuned condition is to some extent counter-acted, but the speed of operation of the trigger action is not appreciably thereby lowered.

Suppose that the receiver is exactly in tune, there being no corrector potential; then the gain at 88 will be a maximum and there will be a predetermined excess of potential of the line 96 with respect to the point 101. With increasing negative bias of the main control grid due to increasing corrector potential values the gain of the tube 88 is lowered and the excess of potential decreases progressively until the potential at 96 is less than the potential at 101, so that the negative bias of the gain control grid will slightly increase; a lowered gain will result and a further increased gain control grid bias, and very quickly the tube is triggered back into the inoperative condition, releasing thereby the tube 90. The large "physi-

cal" amount of mistuning will rapidly be effective since no longer compensated by the potentials of the line 92 and the output potential of the rectifier 47 will decrease so as to maintain the inoperative state, even when the potential of the line 110 resumes the reference potential with a speed depending on the (relatively high) time constant of the filter 111. Of course, if desired, separate amplifier tubes or other controlled means might be used for the A. F. C. channel and for the reproducer channel, in which case the threshold of operation might be adjusted independently for each device. A visual indicator means comprising for instance a neon lamp may also be actuated by the potentials of the lead 504.

Many other devices giving a trigger action may alternatively be interposed between the utilization device and the "control" line, as will readily be understood by those skilled in the art; for instance, a device of the multivibrator type including an auxiliary direct current amplifier tube directly coupled to the tube fed by the control line may be used, or again a neon lamp with a threshold illumination potential etc.

It will also be understood by those skilled in the art that an arrangement offering some analogy with that shown in Fig. 1 may be obtained by using an auxiliary source of high frequency energy of non-critical frequency and approximately (but not critical) predetermined amplitude, of which the energy is translated through an amplifier tube or path controlled by the rectified potentials of the rectifiers 46 and 47, e. g. applied to the two control grids of a hexode tube.

Alternatively, a related class of arrangements would comprise a direct current amplifier e. g. comprising a hexode tube, the anode current of which is controlled by means of two control grids in response to the outputs both of the rectifier 46 and of 47.

Fig. 4 serves to illustrate a further alternative form of the invention in which the utilization device is connected to the rectifier 47 through the lead 505, the transfer characteristics of the path between the source of signal energy and the rectifier 47 being again varied in response to the output of the rectifier 46, as in Fig. 3, but a separate controlled means in the channel of the rectifier 47 being dispensed with by controlling the gain of the intermediate frequency amplifier 5 and if desired of other amplifier sections preceding the branch-off point 6 of this channel. This control is carried out through the A. V. C. control line, in addition to the normal effect of this latter device. Moreover in the instance shown, the rectifier 46 and the rectifier of the A. V. C. device are confounded, the common rectifier being provided with a selective network of the type described in the foregoing so as to respond preferably to "static" if the same is present.

In the instance shown the control rectifier produces "positive" control potentials.

To facilitate the explanation it may first be assumed that the anode of the rectifier 46—A.V.C. is connected to ground and that the A. V. C. device is perfectly efficient, with respect to 47. When a carrier wave is exactly in tune a predetermined potential appears at 47 which is able of actuating the utilization device. When the receiver is only tuned to "static" of a substantial amplitude, a relatively higher negative potential is produced across the load resistor 491 of the A. V. C. rectifier, even when the level of interme-

diate frequency energy remains the same. The gain of the amplifier section 5 etc. is thereby lowered and the energy across the rectifier 47 decreases sufficiently to prevent the actuation of the utilization device. A higher potential will also be produced when the receiver is moderately off tune, on either side of the operating intermediate frequency, by virtue of the symmetrical network 43—44, and the selective circuit 45 need not therefore to have marked selective properties for small mis-tuning amounts whilst the actuation of the utilization device is prevented. The circuit 45 in the present instance again serves to remove "ambiguity" of actuation, when appreciable energy continues to be present across the circuit 6 in the case of a very powerful carrier wave, in case when the amount of mistuning exceeds the peak response frequencies at the rectifier 46 so that the A. V. C. potential is moderate.

In many instances the efficiency of the A. V. C. device is not so high as desirable, and substantial energy may in such last-named case be applied to the rectifier 47, unless the circuit (or circuits) 45 affords a very substantial attenuation. A compensation arrangement is in such case desirable for partly balancing the output of the rectifier 47 when the energy across the circuit 6 is high; the selectivity of the path feeding the balancing rectifier must be less high, and this rectifier must be provided or associated with a limit means to prevent in substance an effect unless the energy exceeds a threshold value.

In the instance shown, part of the output of the A. V. C. rectifier is led off through a tap on the load resistor 491 through the lead 112 indicated by the dotted line, and through a filter 113, whereby these potentials are super-imposed to the potentials of the rectifier 47, the A. V. C. rectifier being of the biased type, this also improving the efficiency of the automatic gain control.

The utilization device in Fig. 4 comprises a relay 115 included in the anode circuit of a tube 114 and operating a three-pole switch 148 which in one position short-circuits the loudspeaker circuit and in the other extinguishes an indicator lamp in a manner analogous to that shown in Fig. 1.

The arrangement of Fig. 4 may alternatively be so modified that the potentials of a separate rectifier 46 are superposed to the potentials of the A. V. C. rectifier, the former preferably associated with a threshold bias or equivalent. Or the rectifier 47 may be confounded with the demodulating detector. In some instances the A. V. C. rectifier may perform the function of the rectifier 47. Of course the channel of the rectifier 46 may be fed from an early stage of the receiver where the selectivity is broad, e. g. from some point of the control channel of the automatic selectivity control system of U. S. 85,166. Additional frequency changer means of any suitable kind may of course be interposed if desired. A further rectifier may if desired be associated with the rectifier 46 to cancel out adjacent channel response, by means of the compensation arrangement described in Luxemburg Patent No. 22997. Many other modifications will suggest themselves to those skilled in the art.

What I claim is:

1. In a radio receiving system, a utilization device of the character described; means adapted to inhibit the operation of the said device in response to the impression thereon of potentials

in substance exceeding a threshold value; a device for causing inhibition in response to incident static likely to cause appreciable interference, and comprising two branch devices; a coupling connection for said branch devices to a desired point in the receiving system; means in the first branch device for deriving a unidirectional potential, in response to incident static, and selective means in said branch device for providing predominant response to incident energy of frequencies moderately spaced from the tuning frequency of the receiver; means in the second branch device for deriving a unidirectional potential, and a selective energy feed path therefor having substantial response at frequencies about the tuning frequency of the receiver; means for utilizing said first-named unidirectional potential to tend causing inhibition; and means for causing said second-named unidirectional potential to counteract the effect on said inhibitory means, of the first-named branch device, whereby effectively to alter the operating threshold value.

2. In a radio receiver, a utilization device of the character described; means adapted to inhibit the operation thereof; in response to the impression thereon of a potential in substance exceeding a threshold value; a device for discriminating between carrier waves and static, for operating inhibition in response to the reception of static likely to cause interference; means for deriving a unidirectional potential in response to incident static, and a selective energy feed path therefor, having predominant response to incident energy of frequencies moderately spaced from the tuning frequency of the receiver; means for deriving a further unidirectional potential, and a selective energy feed path therefor, having substantial response to incident energy of frequencies about the tuning frequency of the receiver; a substantially predetermined response level relationship at the inputs of the two unidirectional potential providing means, for energy of frequencies in proximity of the tuning frequency of the receiver; means for combining in opposed relationship the effects of the two unidirectional potentials, and influencing therewith the aforesaid inhibitory means in such a way that the first-named unidirectional potential tends to operate inhibition, the rate of effectiveness of the said potential being governed by the amplitude of the second-named potential.

3. In a radio receiving system, a utilization device of the character described; means adapted to inhibit the operation of the said device; in response to the impression thereon of voltages exceeding a threshold value; a biasing voltage for normally causing inhibition; a device discriminating between static and carrier waves, for controlling the inhibition, and comprising two branch paths coupled to a desired point in the receiving system; means for deriving a unidirectional potential from one of said branch paths, in response to the reception of substantially any incoming high-frequency energy, whether due to a carrier wave or to static; and selective means in the energy feed path for said unidirectional potential providing means, having substantial response to energy of frequencies at about the tuning frequency; means for utilizing said potential to upset the effect of the aforesaid biasing voltage; means for deriving another unidirectional potential, in response to the reception of static, from the other of said branch

paths; and selective means in said second branch path for ensuring predominant response to incident energy of frequencies moderately spaced from the tuning frequency of the receiver; means for causing said second unidirectional potential to counteract the effectiveness of the energy feed path for the first-named unidirectional potential providing means, to prevent the inhibition from being upset when the amplitude of the second-named unidirectional potential exceeds a substantially predetermined value, relatively to the amplitude of incoming energy energizing said first-named unidirectional potential providing means.

4. In a radio receiving system, a utilization device of the character described; means adapted to inhibit the operation of said device in response to the impression thereon of a potential in substance exceeding a threshold value; a device for causing inhibition in response to received static likely to cause appreciable interference, including means for deriving a unidirectional potential, and a selective energy feed path therefor, having predominant response to incident energy of frequencies about the tuning frequency of the receiver, said potential tending to reach a substantial value in response to the reception of static; means for deriving a further unidirectional potential, and a selective energy feed path therefor, having substantial response to incident energy of frequencies about the tuning frequency of the receiver; means for utilizing the effects of the said two unidirectional potentials in opposed relationship, and influencing therewith the inhibitory means in such a way that the first-named potential tends to operate inhibition, the rate of effectiveness of said first-named potential being governed by the amplitude of the second unidirectional potential; and an automatic gain control network responsive to received energy of frequencies at about the tuning frequency of the receiver, arranged to alter the level of energy feed to the two unidirectional potential providing means, at substantially the same rate.

5. In a radio receiving system, a utilization device of the character described; means adapted to inhibit the operation of the said device in response to the impression thereon of a potential in substance exceeding a threshold value; a device for causing inhibition in response to received static likely to cause appreciable interference, including two branch paths coupled to a desired point in the receiving system; means in one of said paths for deriving a unidirectional potential, and a selective energy feed path therefor having predominant response to incident energy of frequencies moderately spaced from the tuning frequency of the receiver, said potential tending to reach a substantial value in response to the reception of static; means for deriving a further unidirectional potential, from the other of said branch paths, and a selective energy feed path therefor, having substantial response to incident energy of frequencies about the tuning frequency of the receiver; means for utilizing the effects of the said two unidirectional potentials in opposed relationship, and influencing therewith the inhibitory means in such a way that the first-named potential tends to operate inhibition, the rate of effectiveness of said first-named potential being governed by the amplitude of the second unidirectional potential; said receiving system being characterized by the provision in said first-named branch-path, of se-

lective means including a rejector circuit tuned to reject in substantial proportion incoming energy of frequencies closely around the tuning frequency of the receiver.

5 6. A receiver according to claim 2, characterized in that the first-named unidirectional potential providing means is operatively associated with limiting means providing a fixed threshold of operation and comprising a source of direct
10 current potentials, whereby to prevent a change of output potential as long as the received energy impressed upon the input of said unidirectional potential providing means does not exceed a threshold value, and wherein furthermore the
15 amplitudes of the potentials respectively derived from the said first-named unidirectional potential providing means provided with the said limiting means, and from the said second-named unidirectional potential providing means, in response to the reception of energy of about the
20 tuning frequency, are relatively adjusted to exert substantially the same control effect upon the utilization device, whereby to permit balancing out substantially exactly the control influence
25 which tends to take place at both uni-directional potential providing means in response to the reception of a carrier wave.

7. A receiver according to claim 2, further characterized by the provision of means for
30 utilizing the algebraic sum of said two unidirectional potentials for controlling the inhibitory means, the said means including a direct-current connection to both of said unidirectional potential providing means.

35 8. A radio receiver according to claim 3, characterized by the provision of gain control means in the first-named branch path, and of means for altering the gain of said branch path in response to the amplitude of the potential derived
40 from the second-named branch path.

9. A radio receiver according to claim 3, characterized

by the provision of an automatic gain control network including means for deriving a unidirectional potential in response to incoming energy of frequencies at about the tuning frequency of the receiver, and arranged to tend to minimize the output variations at the receiver point whereat the aforesaid paths branch off; and further characterized by the provision of means for additively combining the said automatic gain control potential and the unidirectional potential derived from the second-named branch path, whereby an increase in energy at the unidirectional potential providing means thereof, is met by a decreased potential at the output of the aforesaid first-named branch-path,
15 in response to received static.

10. A radio receiver according to claim 3, characterized by the provision of an automatic gain control network arranged to minimize in substance the output variations at the receiver point whereat the two branch paths branch off, for energy of frequencies at about the tuning frequency of the receiver; and further characterized in that said automatic gain control network cumulates the function of the second-named of the two branch paths, said network including means for deriving a unidirectional potential for controlling the gain, and a selective means for ensuring predominant response to energy of frequencies at about the tuning frequency of the receiver.
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11. A receiver according to claim 2, characterized by the provision of adjustable means, for altering to a desired value the response to incident energy of frequencies moderately spaced from the tuning frequency of the receiver, of the feed path of the means for deriving the first-named of said unidirectional potentials; with a view to altering thereby the amplitude of incoming static causing inhibition.
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