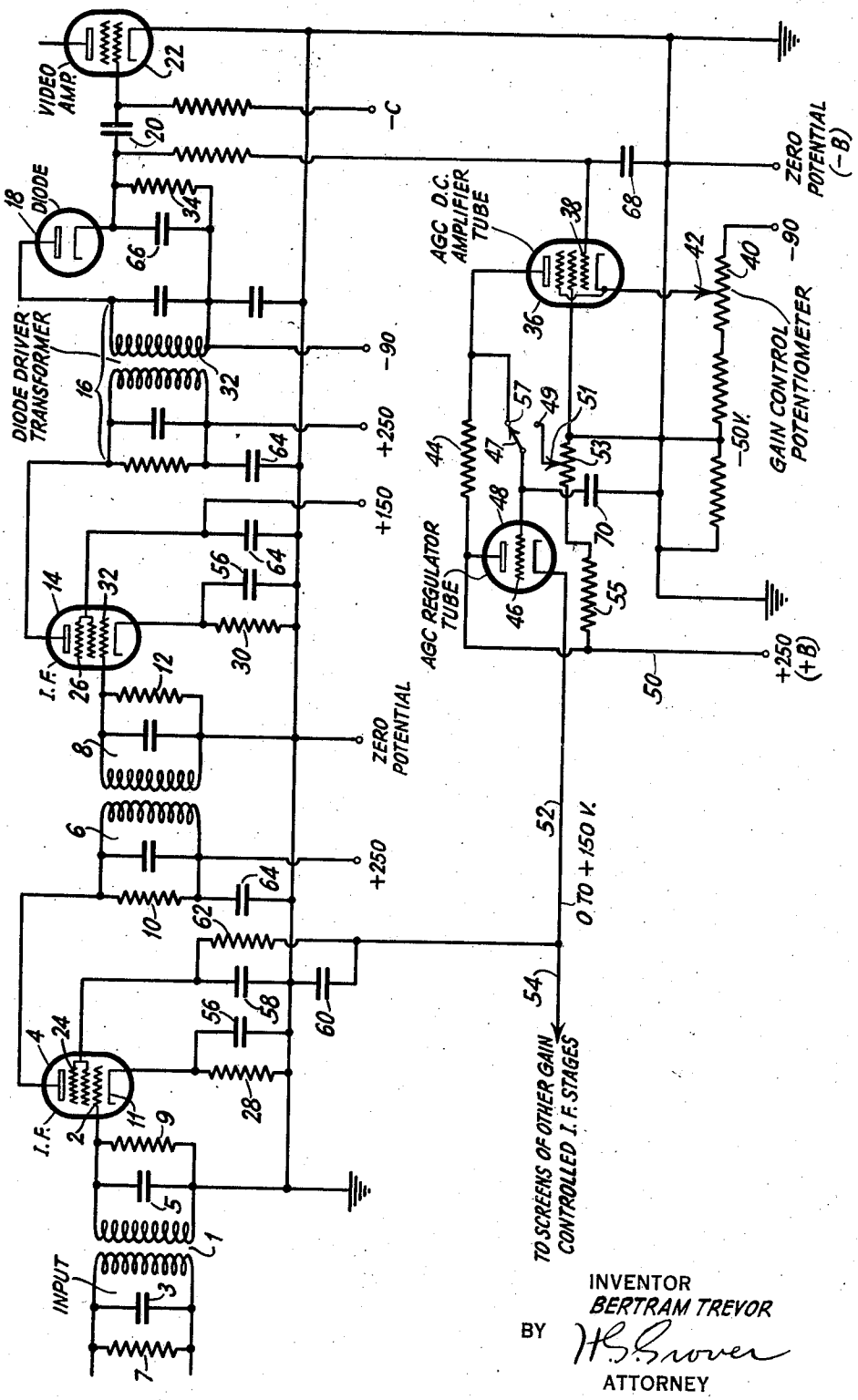
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AUTOMATIC GAIN CONTROL

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AUTOMATIC GAIN CONTROL

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My present invention relates to an automatic gain or volume controlled circuit.

The conventional method of controlling the gain of radio frequency or intermediate frequency amplifier stages of a radio receiver is to change the control or signal grid bias. If this scheme is used in connection with wide band receivers, such as are used for the reception of ultra short wave television modulated radio waves, the changes in control or signal grid bias produce harmful changes in grid input capacitance. These changes detune, for example, the intermediate frequency amplifier, producing distortion and this effect is particularly objectionable in wide band television intermediate frequency amplifiers because of the small tuning capacitances used. Accordingly, one object of my present invention is to provide an automatic gain control circuit which does not cause appreciable detuning. In carrying this object into effect, I provide tube amplifying stages which are provided with self-biasing cathode resistors. In addition, the automatic gain controlling voltages are applied to the screen grids of the tubes. By virtue of this arrangement, the control grid bias voltage changes with the screen voltage because of the self-biasing feature, as a consequence of which large changes of grid input capacitance with change of gain of the volume or gain controlled tubes is substantially eliminated.

A further object of my present invention is to provide an improved circuit for applying automatic gain or volume controlling voltages to screen grids of amplifying tubes. Briefly, I accomplish this by placing an automatic gain or regulator tube in series with the screen grid supply voltage lead. The conductivity or resistivity of this tube is varied in such a way that automatic volume controlling action takes place by virtue of the controlled voltages applied to the screen grid or grids of the tube or tubes employed in the system.

The accompanying drawing is typical of the manner in which the principles of my present invention may be carried into effect. In brief, the drawing shows my improved automatic gain control circuit applied to the intermediate frequency stages of a wide band television receiver.

Received television modulated ultra short waves after being heterodyned to a suitable intermediate frequency are fed to the grid 2 of an intermediate frequency amplifying tube or stage 4. The output of tube 4 is fed through the tuned coupling circuit 6, 8 broadened by the action of resistors 10, 12 to a second intermediate frequency amplifier tube or stage 14. The output of this tube is fed to a driving transformer system 16 for applying the amplified intermediate frequency voltages to a diode detector 18. The output of the diode 18 in turn is fed through a blocking condenser 20 to a suitable video amplifier 22 of which only one tube or stage is illustrated for the sake of simplicity.

Tube 4, upon the screen grid 24 of which is impressed variable screen grid voltages for automatic gain control, is provided with self-biasing cathode resistor 28, so chosen that the bias voltage upon the control grid 2 is normal or slightly above normal with maximum screen voltage. In this way, large changes of grid input capacitance with changes of gain of the intermediate frequency tube 4 is largely prevented or substantially eliminated.

In the event that it is desired to switch from automatic volume control to manual volume control, switch 47 is thrown to its lower contact 49. Manual volume control may then be effected by adjustment of potentiometer tap 51 upon resistor 53, in turn connected to lead 50 through resistor 55.

Normally, with switch 47 closed against contact 57, the secondary 32 of the diode transformer system 16 and the associated diode load resistor 34 are maintained at a potential of minus ninety volts with respect to ground with the condition of no signal. In the presence of signal voltages eventually applied to the control grid 2 of the first stage 4, the high side of the diode load resistor 34 becomes relatively more positive in potential by, for example, five volts. Under this condition, the control grid 38 of the automatic gain control direct current amplifier tube 36 assumes a potential of, for example, minus eighty-five volts. With proper grid bias of tube 36, set by means of the gain control potentiometer 40 and cathode tap 42, plate current will flow through the tube 36 and through the plate resistor 44 which may, for example, be five megohms in value. The current is adjusted to just the right value to bias the control grid 46 of the automatic gain regulator tube 48. This tube is connected in series between the leads 50, 52, leading respectively to a source of screen grid voltage and to the screen grid 24 of intermediate frequency amplifier tube 4. Accordingly, tube 48 acts as a controlled variable resistance or conductance in series with the screen grid supply 50 for the intermediate frequency amplifier tube 4.

An increase in signal level will cause a larger voltage drop across the diode load resistor 34

which, in turn, will cause the grid 38 of the automatic gain control D. C. amplifier tube 36 to go relatively more positive. This small change in potential is then amplified by the direct current amplifier tube 36, giving a large negative swing to the grid 46 of the regulator tube 48, tending to make this tube approach cutoff. The effect of this is to merely reduce the current feed and also the voltage supplied to the controlled intermediate frequency screen grid 24 from the source 50. Obviously, the process is reversed if a decrease in signal level appears at the input terminal 2.

Although the lead 52 has been shown as leading to only the screen grid 24 of the intermediate frequency amplifier tube 4, it may, of course, be connected by way of conductor 54 to the screen grids of other gain controlled intermediate frequency stages and/or radio frequency stages. Also, if desired, the screen grid 26 may be connected to lead 52 should it be desired to automatically volume control tube 14.

In shunt to the cathode bias resistors 28, 30, I have provided by-passing condensers 56. By-passing condensers 58, 60 are provided for the screen grid 24 and voltage dropping resistor 62. Other condensers 64 are provided to by-pass the leads to which they are connected.

Condenser 66 functions as a by-pass condenser. Condenser 68 may be of 0.01 microfarad in value and condenser 70 may be one microfarad in value. Both condensers 68 and 70 serve as both by-passing and time constant condensers.

To restate matters briefly, intermediate frequency waves are fed through the tuned transformer 1 to the grid 2 of the first intermediate frequency tube stage 4. The primary and secondary of the transformer should be tuned by way of condensers 3 and 5 and to adapt the system for wide band reception, broadening resistors 7 and 9 are provided. If the tube 4 were volume controlled in the ordinary way as, for example, by applying automatic volume controlling or gain controlling voltages to the grid 2, the grid input capacitance or the capacity across the grid 2 and cathode 11 would vary, causing detuning of the input circuit 1, 3, 5.

As explained hereinabove, the automatic volume controlling voltages are applied by way of tubes 36, 48 to the screen grid 24. Application of the automatic gain controlling voltages to the screen grid 24 rather than to the control grid 2, together with the cooperative action of the cathode biasing resistor 28, prevents and substantially eliminates variations in input grid 2—cathode 11 capacitance. It, therefore, follows that with my system automatic volume control is obtained without the heretofore concomitant disadvantage of changes in input capacitance which, I have found, prove exceedingly troublesome in wide band television receivers.

Also, from a qualitative point of view, when automatic gain control is supplied to the control grid in the conventional way, variations in grid voltage vary the cloud of electrons in the space between grid and cathode, thereby varying the input capacity. With the system described herein, the distribution of electrons in the space between grid and cathode remains substantially constant because any tendency towards a change produced by variation in screen grid voltage is compensated in the reverse manner by the resistor in the cathode return lead providing control grid bias.

Having thus described my invention, what I claim is:

1. An amplifying system comprising a tube having a cathode, an anode, a control grid, and a screen grid, a tuned signal input circuit connected between the control grid and cathode, an output circuit connected between the anode and cathode, and means for automatically controlling the gain of said tube without substantially affecting the input capacitance between the control grid and cathode of said tube, said means comprising a signal-responsive circuit for applying an automatic gain control voltage to the screen grid of said tube, and a resistor connected in the return lead to said cathode, said resistor having a value such as to provide a normal negative control grid bias for the control grid of said tube when the screen grid voltage is a maximum, the screen grid and control grid voltages being so related over the operating range of said signal-responsive circuit that said input capacitance remains substantially constant thereover.

2. In a wide band television receiver, an amplifier tube of the type having at least a cathode, control grid, screen grid and anode, a resonant input circuit being connected between the cathode and control grid, said circuit being tuned to a modulated carrier frequency lying in the ultra-short wave range, an output circuit coupled to the cathode and anode; an automatic gain control arrangement for said amplifier tube which includes means, responsive to an increase in carrier amplitude, for decreasing the positive voltage of said screen grid, and additional means, responsive to the said screen grid voltage decrease, for adjusting the potential difference between the control grid and cathode in a sense, and to an extent, such as to prevent changes in inter-electrode capacitance of the said tube which affect the tuned frequency of said resonant input circuit.

3. In a wide band television receiver, an amplifier tube of the type having at least a cathode, control grid, screen grid and anode, a resonant input circuit being connected between the cathode and control grid, said circuit being tuned to a modulated carrier frequency lying in the ultra-short wave range, an output circuit coupled to the cathode and anode; an automatic gain control arrangement for said amplifier tube which includes means, responsive to an increase in carrier amplitude, for decreasing the positive voltage of said screen grid, additional means, responsive to the said screen grid voltage decrease, for adjusting the potential difference between the control grid and cathode in a sense, and to an extent, such as to prevent changes in inter-electrode capacitance of the said tube which affect the tuned frequency of said resonant input circuit, said additional means consisting of a resistor disposed in the space current path of said tube, and the resistor having a magnitude sufficient to bias the control grid to its maximum negative value when the potential of said screen grid a maximum.

4. In a wide band television receiver, an amplifier tube of the type having at least a cathode, control grid, screen grid and anode, a resonant input circuit being connected between the cathode and control grid, said circuit being tuned to a modulated carrier frequency lying in the ultra-short wave range, an output circuit coupled to the cathode and anode; an automatic gain control arrangement for said amplifier tube which includes means, responsive to an increase in car-

rier amplitude, for decreasing the positive voltage of said screen grid, and additional means, responsive to the said screen grid voltage decrease, for adjusting the potential difference between the control grid and cathode in a sense, and to an extent, such as to prevent changes in inter-electrode capacitance of the said tube which affect the tuned frequency of said resonant input circuit, said decreasing means including a rectifier, direct current amplifier and an electronic impedance arranged in cascade.

5. In a receiving system comprising a plurality of tuned signal amplifier tubes arranged in cascade, a diode having a signal input circuit coupled to the last of said tubes, a load resistor in circuit with the diode, a tube having its input electrodes connected to said load resistor in such a manner that an increasing positive voltage is impressed on the last named tube as the signal carrier amplitude increases, at least one of the cascade tubes including a gain control electrode connected to a source of positive voltage, and said connection including a tube, functioning as a variable impedance, having a control electrode thereof connected to said last named tube output.

6. In a receiving system comprising a plurality of tuned signal amplifier tubes arranged in cascade, a diode having a signal input circuit coupled to the last of said tubes, a load resistor in circuit with the diode, a tube having its input electrodes connected to said load resistor in such a manner that an increasing positive voltage is impressed on the last named tube as the signal carrier amplitude increases, at least one of the cascade tubes including a gain control electrode connected to a source of positive voltage, said connection including a tube, functioning as a variable impedance, having a control electrode thereof connected to said last named tube output, and said one tube having a self-biasing resistor in the space current path thereof to provide a normal negative signal grid bias when the said gain control electrode voltage is a maximum.

7. A signal-translating stage comprising a vacuum tube having input and output electrodes and an auxiliary control electrode, means operating automatically for applying simultaneously adjustable-bias potentials to said input and auxiliary control electrodes, thereby to vary the transconductance of said tube, said adjustable potentials being proportioned to maintain substantially constant the input capacitance of said input electrodes throughout a substantial range of adjustment of the transconductance of said tube.

8. A signal-translating stage comprising a vacuum tube having input and output electrodes and an auxiliary control electrode, signal-responsive means for adjusting simultaneously the potentials of said input and auxiliary control electrodes, thereby to vary the transconductance of said tube, said adjustable potentials being proportioned to maintain substantially constant the input capacitance of said input electrodes throughout a substantial range of adjustment of the transconductance of said tube.

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