July 26, 1949. H. WILKIE 2,477,028

DUAL CHANNEL GAIN CONTROL

Filed Feb. 3, 1945 2 Sheets-Sheet 1

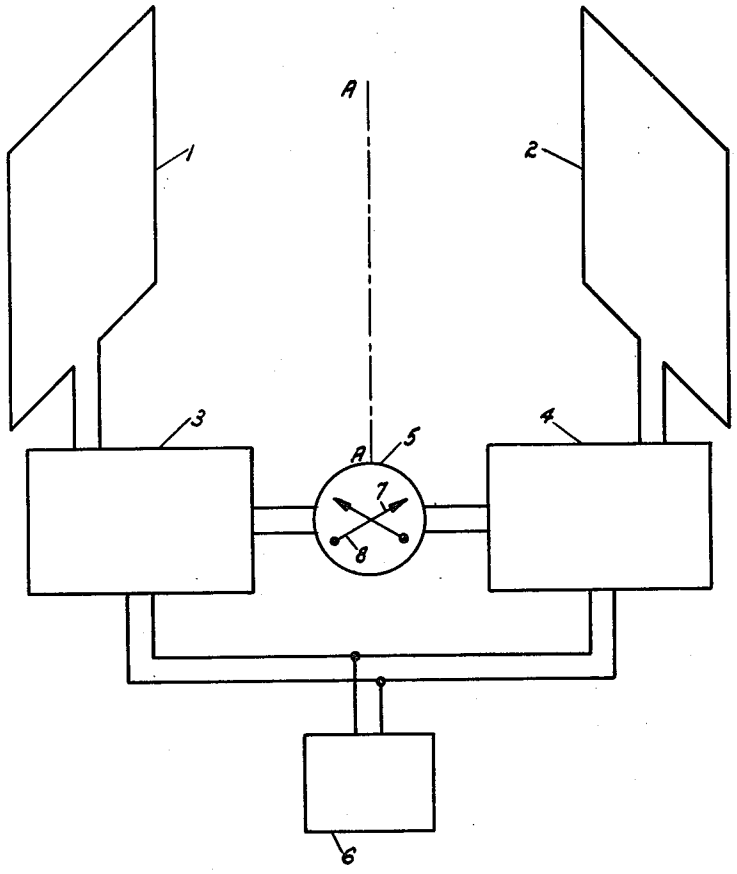

FIG. 1

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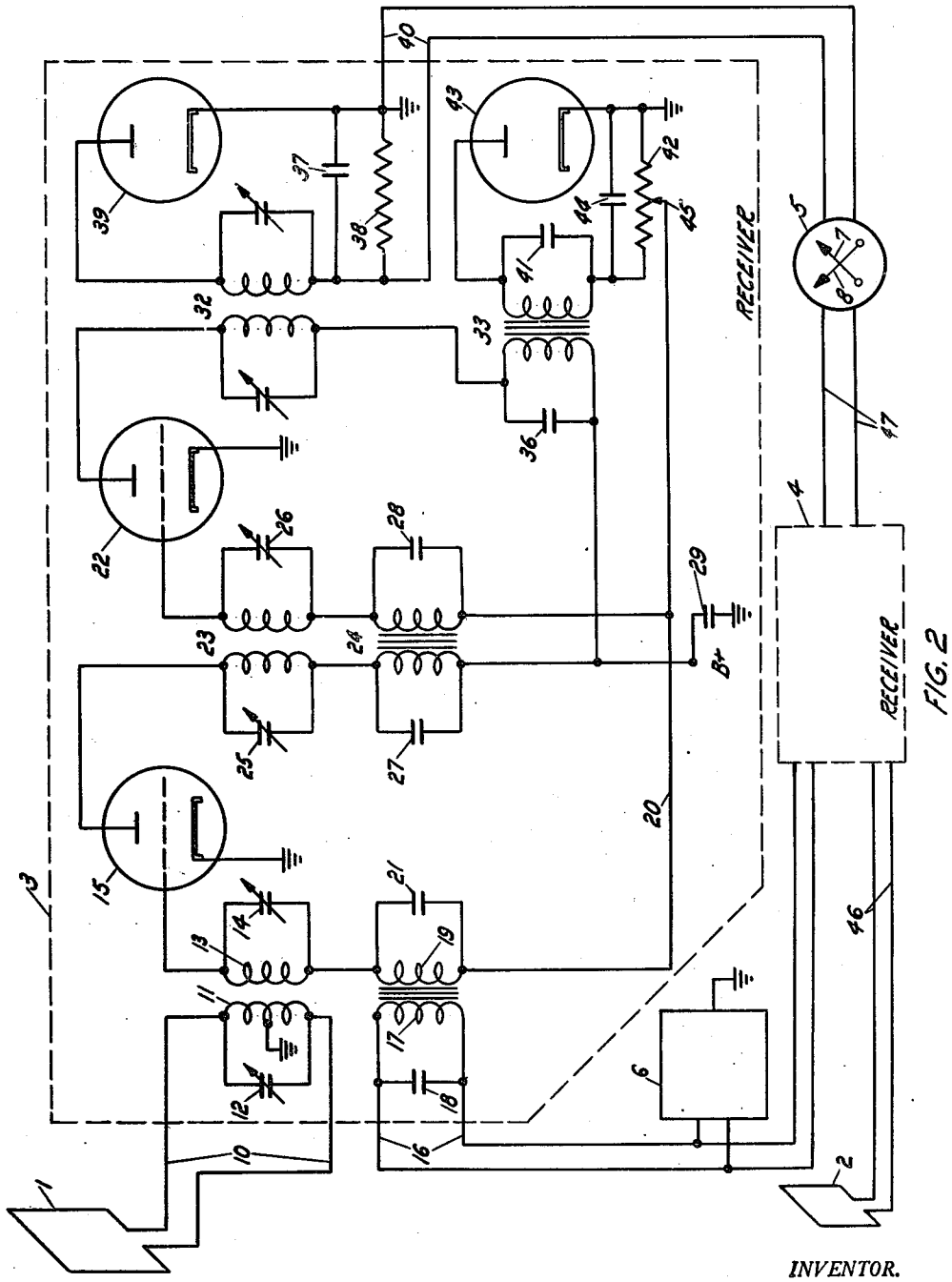

FIG. 2

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DUAL CHANNEL GAIN CONTROL

Harry Wilkie, Dayton, Ohio, assignor to the United States of America as represented by the Secretary of War

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2 Claims. (Cl. 343—119)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to a means for maintaining constant the gain of an alternating current amplifier, and more particularly to a means for maintaining substantially equal a plurality of radio frequency amplifier channels such as are used in radio direction finders and the like.

In radio direction finders in use in the past, two independent loop antennas with separate radio receivers have been commonly used. The comparative strengths of signals that are intercepted by the loop antennas are indicated by two adjacent signal strength meters that commonly have their pointers crossed for ease in making comparative readings. Radio direction finders of this type have lacked automatic means for maintaining constant the gain of the plurality of alternating current amplifiers therein. Another type of direction finder in which two receivers are employed and in which the gains must be preserved equal and/or constant is disclosed in patent to Taylor, No. 2,361,436.

The objects of the present invention comprise the provision of an improved means for maintaining constant the gain of an alternating current amplifier; a means for maintaining substatially equal a plurality of radio frequency amplifier channels; a means for maintaining the gains of a plurality of alternating current amplifiers in substantially constant ratios with respect to one another; a means for maintaining substantially equal and constant the gain of radio receivers in a radio direction finder to impart improved functional advantages thereto; and a means for maintaining constant the gain of a radio receiver of an amplifier in certain forms of meters for measuring field strength.

The above objects are augmented by additional objects that will be apparent to those who are informed in the subject of radio devices from the following description of an illustrative embodiment of the present invention that is presented in the accompanying drawing, wherein:

Fig. 1 is a perspective view of a radio guide that embodies the present invention; and

Fig. 2 is a schematic and block diagram of a circuit that embodies the present invention and that forms a part of the radio guide that is shown in Fig. 1.

The radio guide that is shown in Fig. 1 and that comprises one type of physical device in which the present invention may be used, comprises a pair of loop antennas 1 and 2 that are fixed relatively to one another in intersecting planes and that preferably are vertically disposed. The loops 1 and 2 are mounted upon radio receivers 3 and 4, respectively, that have a meter 5 interposed therebetween and that receive output from a common audio oscillator 6 in accordance with the teaching of my invention. The radio guide as a whole is rotatable about a vertical axis A—A. Operatively, signal that is intercepted by the loop antenna 1 is fed to the radio receiver 3 where it is amplified and detected. A signal that is proportional to the strength of the radio signal that is picked up by the loop 1 is passed from the receiver 3 to a double signal strength meter 5 where a pointer 7 indicates the signal strength on a dial part thereof.

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In a similar manner, signal that is intercepted by the loop antenna 2 is fed to the radio receiver 4 and a signal that is proportional to the strength of the signal that is intercepted by the loop 2 is passed from the receiver 4 to the double signal strength meter 5 where a pointer 8 thereof indicates the signal strength on a dial part thereof. The meter 5 comprises a pair of usual meters that are positioned so that preferably their pointers cross each other and preferably in their null positions are collinear and are oppositely directed.

The radio receivers 3 and 4 each receive a common auxiliary gain control signal from an audio oscillator 6, by means of which the gains of the two receivers 3 and 4 are maintained constant and equal to each other. The present invention comprises means for maintaining the gain of the receivers 3 and 4 constant and equal upon the interception of signal by the antennas 1 and 2, and a preferred circuit therefor is shown in Fig. 2 of the accompanying drawing.

The circuit that embodies the present invention and that is shown in Fig. 2 of the drawings is applicable to the individual receivers 3 and 4 that are shown in Fig. 1 and its presentation as a part of the receiver 3 may be taken as being illustrative of its application to other receivers, such as the receiver 4 or the like, as well as to its application in general.

In the circuit that is shown in Fig. 2, radio signal is fed to the receiver 3 thru the pair of antenna terminals 10 that connect directly to a radio frequency transformer primary winding 11 that is tuned by a variable condenser 12 and that is balanced to ground as shown. A transformer secondary winding 13 is inductively coupled with the primary winding 11, is tuned variably by a condenser 14, and is connected at one

end to the grid of an amplifier tube 15 that has its cathode to ground.

An auxiliary gain control audio oscillator 6 is connected to the receiver 3 thru a pair of terminals 16 that connect with a primary winding 17 of an audio transformer within the receiver 3. The transformer primary winding 17 is shunted by a fixed condenser 18 and is inductively coupled with a secondary winding 19.

The transformer secondary windings 13 and 19 are connected in series between the grid of the amplifier tube 15 and a grid bias supply lead 20. A capacitor 21 provides a by-pass for radio signal around the audio transformer secondary winding 19 and, if desired, provides a means for tuning the audio transformer to the frequency of the auxiliary gain control signal from the audio oscillator 6.

The interstage coupling between the amplifier tube 15 and the succeeding amplifier tube 22 is seen to be by transformer coupling through two transformers, one variably tuned radio frequency transformer 23, the other an audio transformer 24. The primary windings of such transformers are in series in the plate circuit of tube 15; the secondary windings thereof are in series in the grid circuit of amplifier tube 22 between the grid thereof and grid bias supply lead 20. Capacitors 27, 28 by-pass radio frequency current around the primary and secondary coils, respectively, of audio transformer 24 and may be used to tune audio transformer 24, if desired. The primary and secondary windings of the transformer 23 are preferably variably tuned by suitable means such as by the variable capacitors 25 and 26 or the like.

The output circuit of amplifier tube 22 is entirely similar to that of amplifier tube 15. The primary of a tuned radio frequency transformer 32 is connected in series with the primary of an audio transformer 33, the two being in series between the plate of amplifier tube 22 and the plate voltage supply B+. Radio frequency current is by-passed about the primary coil of transformer 33 by a capacitor 36, which may also be used to tune audio transformer 33.

The variably tuned secondary winding of the radio frequency transformer 32 is connected in series with a load resistor 38 across a diode detector tube 39. The load resistor 38 is connected in parallel with a radio by-pass capacitor 37. The output of the receiver 3 appears across a pair of terminals 40 that are connected to the ends of the load resistor 38. The output of the receiver 3 is a signal that is proportional to the signal strength of the input radio signal that is intercepted by the loop antenna 1 and that is passed to the meter 5 where it causes a deflection of the needle 8 part thereof to give a signal strength reading.

The secondary winding of the audio transformer 33 is tuned by a capacitor 41 that also serves to by-pass radio frequency energy thereabout, and is connected in series with a load resistor 42 in parallel with an audio by-pass capacitor 44, across a diode detector tube 43. An adjustable tap 45 at the end of the grid bias supply lead 20 and variably engaging the load resistor 42 provides a controlled grid bias supply to both of the amplifier tubes 15 and 22. The cathodes of the amplifier tubes 15 and 22 and of the diodes 39 and 43 are grounded as shown.

The circuit of the receiver 4 is substantially a replica of that of the receiver 3, receiving radio signal that is intercepted by the antenna 2 thru

a pair of leads 46 and supply output thru the pair of leads 47 to the meter 5 where the output signal strength thereof is recorded by the position of the meter arm 7. It is connected to auxiliary gain control audio oscillator 6 in parallel with receiver 3 and in similar fashion.

It will be seen that by interstage transformer coupling of two transformers with primaries and secondaries respectively in series, one transformer being at radio frequency, the other at audio frequency, the receiver system of receiver 3 amplifies simultaneously two signals, one radio the other audio. It is seen that the radio and audio signals are coupled into the system independently, they pass through independently, and each is detected independently. The detected radio signal forms the output signal of the radio receiver 3. The detected audio signal supplies the grid bias voltage for the amplifier tubes 14 and 22, and operates after the manner of a conventional automatic gain control voltage. For example, if the plate voltage supply to amplifier tubes 14 and 22 should increase, the resulting increased gain of the amplifier stages would effect an increase in the audio input to detector 43 and an increased direct voltage drop across load resistor 42. This, in turn, would increase the negative bias on amplifier tubes 15 and 22, which would introduce a decrease in gain and thus offset the initialing increase in gain. The gain of the receiver 3 for radio frequency signal would thus be maintained constant.

It is to be noted that while the customary operation of automatic gain control is to maintain a constant output signal for a varying input signal by automatic variation of amplifier gain, the operation of my invention is to preserve constant the gain of the amplifier circuit in the presence of disturbing influences by the use of a constant intensity of auxiliary signal input and the use of the output signal corresponding thereto to maintain constant the gain of the amplifier.

The successful operation of my invention is based on the fact that the radio and audio signals may be passed through the system independently and without interaction, and that insofar as electronic factors are concerned the operation of the circuit is identical for both, and variations of the electronic factors affect the gain of a receiver embodying my invention equally for both the radio and audio signal.

It will be noted that the frequency difference between the radio and audio signals need not be extreme; it is only requisite that the frequencies be readily separable by tuned filters in the detector stages of the particular circuit involved.

Where desired, a volume control, not shown, may be disposed within the audio oscillator 6 whereby the amplitude of the auxiliary audio signal may be varied and, in turn, the set gain of the receiver 3. The increase of the auxiliary signal serves to decrease the gain of the receiver.

The circuits in the receivers 3 and 4 are substantially identical and are fed by the same auxiliary gain control signal from the audio oscillator 6, as previously stated. The radio signal that is supplied to the receiver 3 and 4 may be of the same frequency in which event the receivers 3 and 4 will be tuned alike, or they may be of different frequencies, in which event the receivers 3 and 4 will be tuned differently.

Since the receivers 3 and 4 are substantially alike in circuit, construction, and mode of operation, and since both of the receivers have their automatic gain controls controlled by auxiliary

signal in common from the single source of the audio oscillator 6, the gains of the two receivers may safely be assumed to be equal, at least for a common frequency of radio signal.

When the two signals to be compared are of unlike frequencies, the gains of the receivers may be different due to variation of circuit Q with frequency. The variation of gain with frequency may be determined by well-known means and allowed for.

The output signals from the receivers 3 and 4 will, therefore, be in the same relative proportion as the input signals that are supplied thereto. This constancy of proportion between the two input signals and the two output signals will be consistently maintained even though the character of the auxiliary signal varies somewhat, because the gains of the two amplifiers for a radio signal would tend to be maintained alike even though not strictly constant. It will, therefore, be observed that the device that is contemplated hereby serves to compare the ratios of two radio signals that are too weak to be compared directly.

It is to be understood that the direction finder, the circuit and the particular circuit components that have been described and disclosed herein have been submitted for the purposes of illustrating and describing one embodiment of the present invention and that the circuit that is disclosed herein may be adopted for use in devices other than the direction finder that is illustrated in Fig. 1 of the drawings and that similarly operating modifications and changes in the circuit and in the components thereof may be made without departing from the present invention as defined by the appended claims.

What I claim is:

1. A radio direction finder system including two independent channels, each of said channels comprising an amplifier tube, means supplying thereto a principal signal for amplification, means supplying an auxiliary continuous uniform signal superimposed upon the principal signal in said amplifier tube, detector means selectively responsive to the auxiliary signal, and automatic gain control means responsive to said detector and maintaining constant the amplification of said amplifier tube simultaneously with amplification of the principal signal therein.

2. A radio direction finder system including two independent channels, each of said channels comprising an amplifier tube, means supplying thereto a principal signal, means supplying thereto an auxiliary signal constant and continuous and having a frequency distinct from that of the principal signal, an amplifier tube amplifying both signals simultaneously, detector means selectively responsive to the amplified auxiliary signal on the basis of frequency, and an automatic gain control responsive to said detector and maintaining constant the gain of said amplifier tube simultaneously with amplification of the principal signal therein.

HARRY WILKIE.

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