

April 12, 1938.

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2,114,154

RECEIVER TUNING INDICATION CIRCUITS

Filed May 9, 1936

Fig. 1

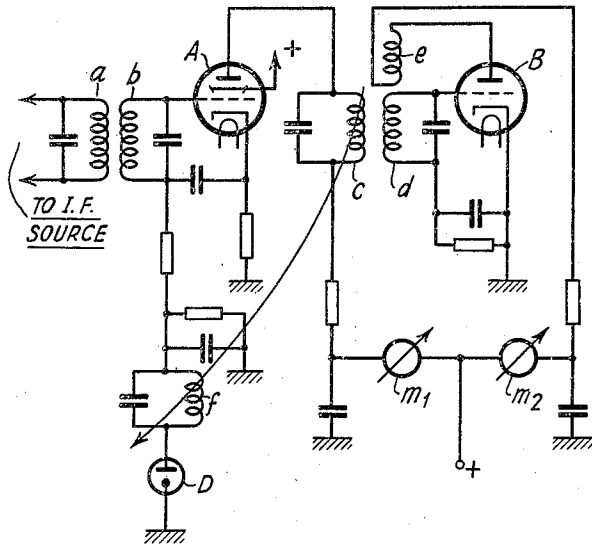


Fig. 3

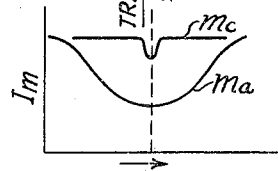


Fig. 4

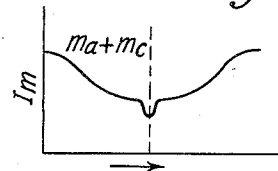


Fig. 5

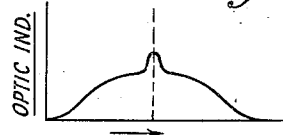
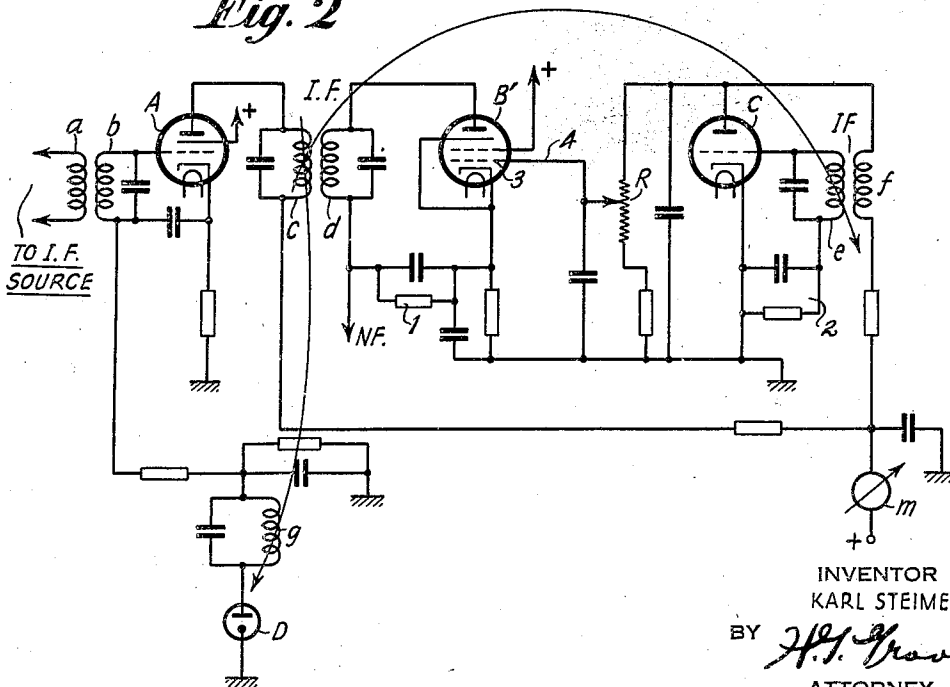


Fig. 2



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2,114,154

RECEIVER TUNING INDICATION CIRCUITS

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Application May 9, 1936, Serial No. 78,877
In Germany May 8, 1935

4 Claims. (Cl. 250—20)

This invention is concerned with a circuit arrangement for receiving and amplifying means for electric communication and intelligence transmission, especially of the radio-frequency kind, in which the tuning of such circuits as are designed for receiving and conducting electrical oscillations, in reference to the frequency of such oscillations, is indicated and read by optical ways and means. Optical indicator means of this sort have become extremely popular in modern receiver apparatus on the ground that by the aid thereof, say, in broadcast reception, the various adjacent transmitter stations are more readily located and the apparatus is more easily set thereto. Furthermore, when recourse is had to this principle, there is afforded the very desirable chance to reduce the receiver set in its gain or amplification while the tuning process is proceeding, and to restore the gain to such a value as is suitable for reproduction once the tuning process has been perfected and terminated.

As a result such noises as arise during the tuning act as well as the coming in of undesired transmitters while tuning are perfectly avoided.

With a view to solving this problem of creating optical indicator means, a number of circuit organizations and arrangements have been suggested in the prior art. For instance, in the simplest tube or valve receiver scheme, i. e., the grid-detector or audion set, an increase in grid alternating voltage is associated with a corresponding reduction of the plate current. Hence, in this simple circuit arrangement there already exists a chance of carrying the idea of optical indication into practice by inserting in the plate circuit an adequately sensitive galvanometer, optionally in combination with means insuring compensation of mean plate direct current.

Observing the needle of the instrument as the tuning dial is covered from one end to the other, the minimum deflection of the needle will coincide with the proper adjustment of the tuning circuit to the frequency of the transmitter oscillations.

Now, in up-to-date multi-stage receiver sets equipped with means insuring fading compensation or automatic volume control, with a view to insuring automatic tuning indication, it is possible to make use, for the purpose of visual indication, of the variation of plate current of the tube whose grid biasing voltage is a function of the intensity or value of the input potentials arising in the receiver. It is known from the art that these circuit organizations operate in

such a manner that with an increase of the input potential of the receiver set, either by an increment of the incoming field intensity, or else due to better tuning to the transmitter station to be received, the group of tubes subject to regulation or control action is impressed with a more negative grid voltage. Now, this step which in the first place is intended for gain regulation, occasions also a reduction of the mean plate current in proportion to the change in the grid potential, and this may be utilized for tuning indication in a way similar to the method above suggested in connection with a grid-detector or audion circuit scheme. This known scheme, however, involves a number of drawbacks which are obviated by the present invention.

Inasmuch as the processes of indicating the state of regulation in known circuit schemes as before described are predicated upon a utilization of the resonance properties of receiver tuning circuits, and since these resonance curves and characteristics must be chosen comparatively broad in view of the band widths to be transmitted, there results naturally an optical tuning indication which is too broad and blurred for practical purposes.

Since especially in the neighborhood of the crest of the resonance characteristic slight changes in tuning result in but insignificant differences in the amplitude of the oscillations arising in the circuits, exact and sharp tuning of the receiver circuits to the carrier frequency, say of a modulated transmitter, is not readily feasible.

Hence, according to the invention, the suggestion is made, in addition to the above-described method of coarse or broad tuning indication to provide a fine or sharp tuning indication so that by the aid of the former process, ready location of the transmitter station, and by the latter, an exact setting to the carrier frequency is accomplishable. For coarse or broad indication, recourse may be had to any one of such methods as have been disclosed in the earlier art, the more important ones of which have been discussed in the preamble.

This combined broad and sharp tuning indication, according to this invention, is to be effected by that the differences in resonance properties of different oscillatory circuits are utilized in this manner that by the oscillation amplitude in one or more oscillatory circuits responsive to a comparatively broad resonance curve, a coarse or broad tuning indication is effected, while by

the oscillation amplitude in at least one additional oscillation circuit with a narrower resonance curve fine tuning indication is accomplished. For instance, for coarse indication there

could serve the change in the plate current of the radio-frequency amplifier stages of the set operating with automatic volume control, in that an ammeter is included in the plate current supply lead brought to the radio frequency tubes.

For fine indication, a tuning circuit subject to particularly low damping is coupled with a radio-frequency circuit of the receiver, the potential of the said low-damped circuit being impressed upon the grid of a tube operating with grid detection (audion).

The plate current decremental curve as a function of the tuning insures an extremely sharp and precise "fine" indication provided that the oscillation circuit has sufficiently low damping, in other words, a narrow-topped resonance characteristic. If necessary, for reducing the damping, recourse could be had also to artificial reduction of damping (de-attenuation) by means of regeneration.

In order to obtain suitable resonance curves, a number of electrical ways and means are available. It is sufficiently well known that broad resonance curves allowing a wide band to pass are obtained, if care is taken so as to secure adequate damping of the circuits. Another means adapted to broaden the resonance characteristic for the purposes of coarse indication consists in using several inter-coupled oscillation circuits, the mutual coupling of the circuits being so chosen that the ensuing band-pass filter presents a resonance characteristic that has been made broader than that of a single circuit.

In order that for fine indication sufficiently narrow resonance curves may be produced, it would, fundamentally speaking, be feasible to use also several circuits coupled with one another, the coupling of these various circuits with one another being chosen so loose that the resultant band-pass curve is narrower than that of an individual circuit.

It has been stated above that, also, artificial reduction of damping leads to the desired end. Another means consists in the connection of two oscillation circuits coupled with each other in the manner of a band-pass filter, if the so-called crevasse between the two humps in the curve is used for fine indication.

One particularly advantageous embodiment of the basic idea of this invention consists in that for the simultaneous coarse and fine indication a single indicator means is used, the reading or indication of which is made a function of the sum or the difference of two resonance characteristics of dissimilar breadth. The said indicator instrument could consist of any one of the known electric current (ammeter) instruments, more particularly of those equipped with two separate windings (one winding for fine indication current, and the other one for coarse indication current) or else glow-lamps, glow-tubes, or visual signal indicators.

In the annexed Figs. 1 and 2, two exemplified embodiments of the basic idea of the invention are illustrated.

Figs. 3-5 are graphs showing the operating characteristics of the circuits of Figs. 1 and 2.

Referring to Fig. 1, A is an intermediate-frequency amplifier tube of the heterodyne receiver whose plate-current variation, as a function of the tuning, actuates and works upon the indi-

cator instrument m_1 (coarse indication), while B is an additional, grid-detector, tube in which the variation of the plate current actuates the indicator instrument m_2 (fine indication).

Referring to the left-hand part of the figure, a and b denote an intermediate-frequency transformer which impresses the I. F. oscillations produced from the incoming oscillations upon the grid of the amplifier tube A. The oscillations amplified by tube A become operative in circuit c whence they are transferred to circuits d and f . From the oscillations set up in circuit f , the regulator potential is obtained by the aid of the diode D, and this voltage applied to the grid of the tube A occasions automatic volume control. Inasmuch as the said regulator potential becomes negative as the input amplitudes increase, it results in a reduction in the plate current of tube A with increase of input amplitude. The ensuing sharpness of this regulation process in dependence upon the tuning is relatively small as a result of the use of oscillatory circuits having adequate band pass widths for the transmission of the sidebands. The oscillations transferred to the circuit d , however, cause a very abrupt decrease of the plate current of B, upon setting the apparatus to the carrier wave, particularly as a result of the feedback by the aid of e . Instrument m_2 similarly serves for fine indication. The tube B functions as the source of current for meter m_2 ; it does not affect the signal in its passage through the receiver. The audio signal may be derived from the I. F. energy in any well known manner.

Fig. 2 shows another improvement of the above described circuit schemes. Coarse and fine indication in this arrangement is effected simultaneously by one and the same indicator device m in which are operative the sum total of the two plate current variations of the tubes A and C.

Figs. 3 and 4 show graphically the indications as a function of the tuning as a result of summation or integrating action. In Fig. 3, m_a is the curve of the plate-current change for tube A, while m_c is the corresponding curve for tube C.

In Fig. 4, graph $m_a + m_c$ shows the ensuing integrated action. As results from the circuit arrangements hereinbefore suggested by way of example, there occurs a reduction of the current used for the indication as the proper tuning point is approached. If glow-tubes or incandescent lamps (glow-lamps) were used, this would imply a reduction of luminous action or an abbreviation of the luminescent glow column. In order that a reversal of this effect may be accomplishable, should this be desired, all that is necessary to do is to conduct in a compensation circuit scheme, in addition to the plate currents employed for indication, a sufficiently strong oppositely directed compensation current through the indicator device. The effect of this step is shown graphically in Fig. 5.

Fig. 2 comprises another idea and object of this invention. The same resides in the double utilization of the additional tube C included in the circuit arrangement for the purpose of sharp indication. The idea is to use the change in plate current serving for fine indication, with high selectance, at the same time for the production of a regulator voltage, with a view to rendering the amplification of the set operative only upon the proper tuning positions having been ascertained. Circuit organizations designed to insure mute tuning are fundamentally known in the prior art. What is here disclosed is a particularly efficient and useful double utilization of tube

C for simultaneous fine indication and mute tuning.

The gain of I. F. amplifier A is regulated by diode D as explained in Fig. 1; the tuned circuit *g* being coupled to circuit *c*. The tube B' has its plate and cathode connected through tuned circuit *d* and load resistor *l*; thus providing a diode detector circuit. The audio signal is taken off at NF. The tube C has its input circuit *e* coupled to circuit *c*; the plate of tube C being regeneratively coupled to the circuit *e* by coil *f*. The resistor R is connected between the plate and cathode of tube C; the voltage drop across it is a maximum when no signals are received since network 2 in the input circuit of tube C renders it a grid rectification detector. The grid 3 of tube B' is connected to a point on resistor R by lead 4; and the grid 3 will be biased highly negative when no signals are received. The diode detection action of tube B' is prevented, and the receiver rendered quiet, when the grid 3 is biased highly negative. The meter *m* is in the plate circuits of tubes A and C. The circuit *e* is so loosely coupled to circuit *c* as to produce a narrow resonance curve. By means of the regenerative feedback through *f* the resonance curve will be made still sharper. Since the slope of the characteristic of detector B depends on the bias of grid 3, the detector efficiency can be varied through variation of the bias of grid 3. As stated in connection with Fig. 1, the coupling between circuits *c* and *g* is relatively broad.

What I claim is:

1. In combination in a receiving system, a signal transmission tube having signal input and output circuits, a rectifier having a signal input circuit coupled to said output circuit to provide a relatively broad resonance curve characteristic, means responsive to an increase of rectifier current output, for decreasing the tube gain, a space current device having input electrodes, a resonant network coupling said input electrodes to said output circuit to provide a relatively sharper resonance curve characteristic than said first characteristic, and current indicator means, responsive to the space current flow of said device, for indicating substantially exact resonance between said tube input circuit and signals impressed thereon, said indicator means being additionally responsive to the space current flow of said transmission tube.

2. In combination in a receiving system, a signal transmission tube having signal input and output circuits, a rectifier having a signal input circuit coupled to said output circuit to provide a relatively broad resonance curve characteristic, means responsive to an increase of rectifier current output, for decreasing the tube gain, a space current device having input electrodes, a reso-

nant network other than said rectifier input circuit coupling said input electrodes to said output circuit to provide a relatively sharper resonance curve characteristic than said first characteristic, and current indicator means, responsive to the space current flow of said device, for indicating substantially exact resonance between said tube input circuit and signals impressed thereon, and means for reducing the damping of the said resonant network thereby to further sharpen said second characteristic, said indicator means being additionally responsive to the space current flow of said transmission tube.

3. In combination in a receiving system, a signal transmission tube having signal input and output circuits, a rectifier having a signal input circuit coupled to said output circuit to provide a relatively broad resonance curve characteristic, means responsive to an increase of rectifier current output, for decreasing the tube gain, a space current device having input electrodes, a resonant network coupling said input electrodes to said output circuit to provide a relatively sharper resonance curve characteristic than said first characteristic, current indicator means, responsive to the space current flow of said device, for indicating substantially exact resonance between said tube input circuit and signals impressed thereon, and means responsive to a change in space current flow of said device due to absence of signals, for preventing signal transmission through said system, said indicator means being additionally responsive to the space current flow of said transmission tube.

4. In combination in a receiving system, a signal transmission tube having signal input and output circuits, a rectifier having a signal input circuit coupled to said output circuit to provide a relatively broad resonance curve characteristic, means responsive to an increase of rectifier current output, for decreasing the tube gain, a space current device having input electrodes, a resonant network coupling said input electrodes to said output circuit to provide a relatively sharper resonance curve characteristic than said first characteristic, current indicator means, responsive to the space current flow of said device, for indicating substantially exact resonance between said tube input circuit and signals impressed thereon, a detector tube having input electrodes coupled to the transmission tube output circuit, and means, responsive to a predetermined change in space current of said device due to absence of received signals, for rendering the detector tube inefficient, said indicator means being additionally responsive to the space current flow of said transmission tube.

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