

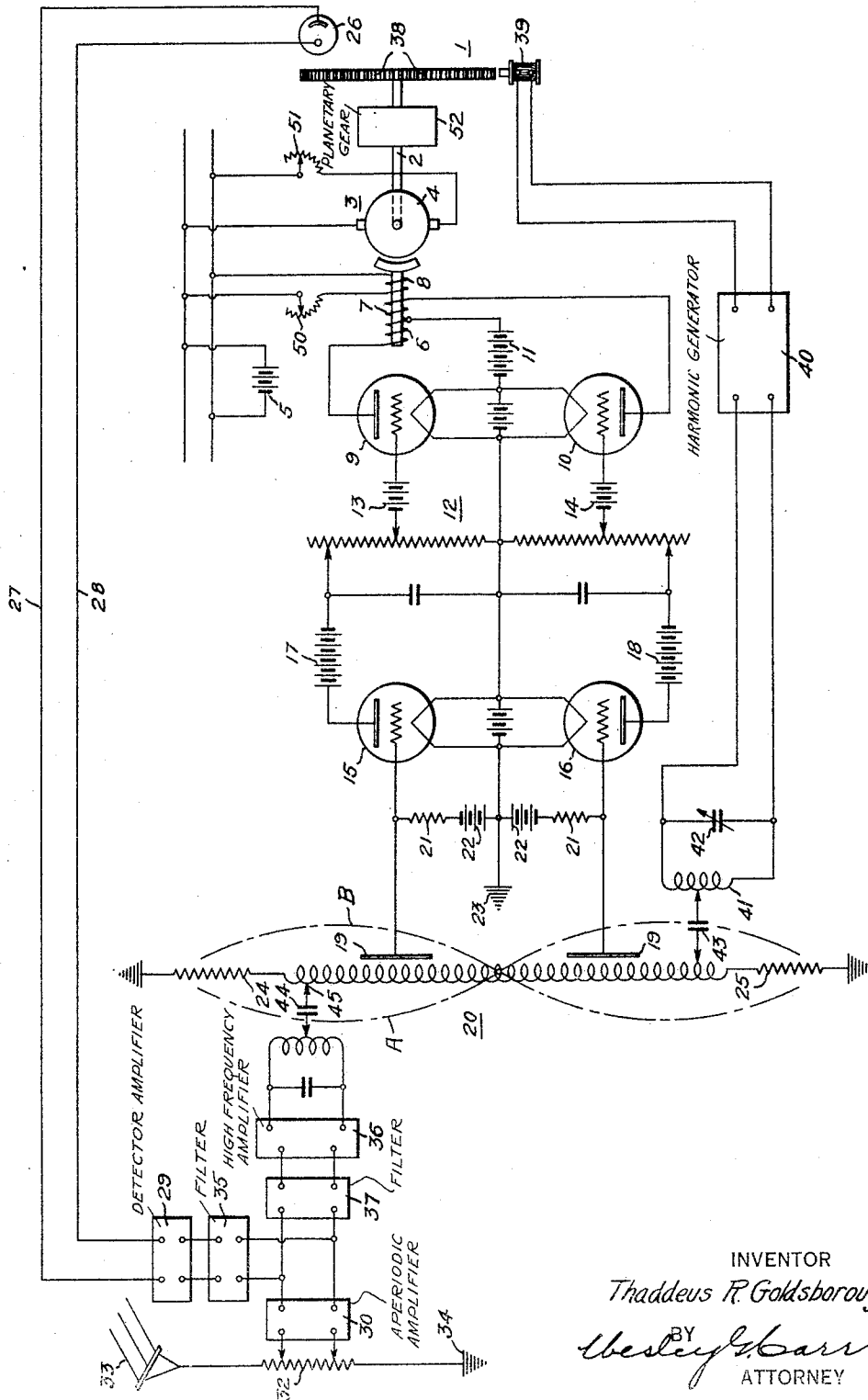
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CONTROL SYSTEM

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CONTROL SYSTEM

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My invention relates to control systems and it has particular relation to systems for securing motional synchronism between moving devices situated at geographically separated points and supplied with motive power from separate sources.

One of the most troublesome problems yet remaining to be solved, in connection with television systems, facsimile transmission systems and the like, is that of securing motional synchronism between the moving elements of the essential apparatus at the transmitting and receiving stations.

In television systems of the type wherein rotating scanning-discs, or analogous devices are used to analyze the image to be transmitted, and to synthesize the image from an incoming signal, it is highly essential that the said scanning devices shall move in exact synchronism, if the received image is to be kept steady.

When the transmitting apparatus and the receiving apparatus are both energized from the same source of electric current, or potential, which may well be the case if the transmission is not effected over very great distances, the problem of synchronizing the moving parts of the apparatus is not insurmountable and it may be solved, for example, by the use of methods similar to those disclosed in the patent to Merrill, No. 1,533,655.

In the event, however, that the signals, representative of the view, are transmitted by radio or by carrier-current over metallic conductors, to great distances, it is generally impossible to use a single source of power for the transmitting scanning devices and the receiving scanning devices, and it becomes necessary, therefore, to provide means, independent of the power source, for maintaining synchronism between the moving parts at the transmitting and receiving stations.

It is, accordingly, an object of my invention to provide means for maintaining motional synchronism among a plurality of moving elements, such as scanning discs, motors, generators and the like.

Another object of my invention is to provide means for maintaining motional synchronism among a plurality of moving ele-

ments, such means being substantially independent of the source of motive power for the said elements.

Another, and more specific, object of my invention is to provide, in a synchronizing system of the type referred to, means for giving an indication of the angular displacement from synchronism of a local moving element with respect to a similar, distantly situated, element and to automatically bring the local element into exact synchronism.

In carrying my invention into practice, I provide an alternator, or an equivalent device, for deriving a synchronizing frequency proportional to the rate of movement of a master-element, such as a scanning disc, with which additional, distantly situated, moving elements are to be synchronized. The synchronizing frequency is, thereafter, radiated, or impressed on metallic conductors extending to the locations of the distantly situated elements.

I also combine alternators, or similar devices, with each of the additional elements referred to, which elements will, hereinafter, be referred to as the local elements.

At the place where each local element is situated, I provide a resonance-wave coil, of the type described in the patent to Pupin, No. 1,456,909, or of the type shown in the patent to Mauborgne, No. 1,517,568, and impress potentials on the coil from the alternator associated with the local element. I also cause potentials representative of the incoming synchronizing frequency to be so impressed on the resonance-wave coil that a standing wave is developed thereon.

The standing wave on the coil is utilized to impress equivalent potentials on a push-pull detector-amplifier system, the output current from which is utilized to control the speed of a motor that drives the local element. In the normal condition, when the local element is in synchronism with the master element, the output currents from the push-pull system are in balance. Any departure from synchronism, however, causes the potential node on the wave coil to tend to move, thus destroying the balance of the push-pull system, and the resulting differen-

tial current in the common output circuit of the system is employed to either cause the motor to speed up or to slow down to restore the synchronism.

5 The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment, when read in connection with the accompanying drawing.

10 The single figure of the drawing is a diagrammatic view of a television receiving system comprising a preferred embodiment of my invention.

15 The apparatus illustrated in the drawing comprises a scanning disc 1, of the usual and well known type, mounted upon the shaft 2 of a direct-current motor 3. The armature 4 of the motor is supplied with direct current from any convenient source 5. The motor is provided with a plurality of field windings 6, 7 and 8. The winding 8 is connected in shunt to the armature and is supplied with current from the source 5. The windings 6 and 7 are included in the output circuit of a plurality of thermionic tubes 9 and 10, arranged in push-pull relation.

20 The winding 6, when current flows therein, aids the shunt-connected field winding 8, while the flux from the winding 7 opposes that from the shunt winding.

25 The thermionic tubes are provided with a common source 11 of plate potential, the positive terminal of which is connected to the junction between the field windings 6 and 7.

30 The common input circuit of the thermionic tubes 9 and 10 is constituted by a resistor 12, the midpoint of which is connected to the filaments of the tubes. The grids of the tubes 9 and 10 are adjustably connected to separated points on the resistor 12 through grid-biasing batteries 13 and 14, the positive terminals of which are directed toward the grids associated therewith.

35 The resistor 12 is included in a common output circuit for a plurality of thermionic tubes 15 and 16, and the midpoint on the resistor is also connected to the filaments of the latter tubes. The tubes 15 and 16 are connected in push-pull relation and are supplied with separate sources of plate potential, 17 and 18, respectively.

40 The grids of the tubes 15 and 16 are capacitatively, by means of coupling devices 19, connected to separated points on a resonance-wave coil 20 of the type shown and described in the patent to Mauborgne 1,517,568.

45 Each of the tubes is provided with a grid-leak 21 and a grid-biasing battery 22, and the filaments thereof are provided with a common ground connection 23.

The potentials of the biasing batteries 22 are so adjusted that the grids of the tubes 15 and 16 are biased negatively to approximately the cut-off point, whereby the said tubes function as detectors. Although not so illustrated in the drawing, a plurality of high-frequency amplifying stages may be interposed, if necessary, between the resonance-wave coil and the detectors 15 and 16.

50 The terminals of the resonance-wave coil are preferably connected to ground through resistors 24 and 25, respectively, of such value that reflection phenomena are minimized, or prevented entirely thereby.

55 A receiving lamp 26, of the well known glow type, is disposed adjacent to the scanning disc, the lamp being supplied with energizing potentials, representative of the incoming picture, over a plurality of conductors 27 and 28 that lead to it from a detector-amplifier 29. The detector is preferably energized from the output circuit of an aperiodic amplifier 30 having an input circuit constituted by a resistor 32 included in series between an antenna 33 and a ground connection 34. A suitable filter 35 is interposed between the aperiodic amplifier 30 and the input circuit of the detector-amplifier 29 in order to prevent the impression thereon of the synchronizing frequency, which frequency is present, as a modulation of the incoming carrier wave, in addition to the picture-frequencies.

60 A high-frequency amplifier 36 is also energized from the aperiodic amplifier, through an appropriate filter 37. The high-frequency amplifier 36 is tuned to the synchronizing frequency and has an output circuit coupled to one end of the resonance-wave coil 20.

65 The scanning disc 1 is preferably provided with a large number of peripheral projections 38, or teeth, the disc thus constituting the rotor element of a high-frequency alternator having a stator element 39, the winding of which may be connected to the input circuit of a harmonic generator 40. A similar disc and stator element are shown and described in the copending application of Frank Conrad, Serial No. 334,413, assigned to the Westinghouse Electric & Manufacturing Company.

70 The output circuit of the harmonic generator 40, which is preferably constituted by an inductor 41 and a tuning condenser 42, is coupled, through a blocking condenser 43, to the end of the resonance-wave coil opposite to the end to which the high-frequency amplifier 36 is coupled. Although I have shown the coupling between the coil 20 and the amplifier 36 as being accomplished through the blocking condenser 44 and a movable contact element 45, in a manner analogous to the systems shown in the Mauborgne patent, it is to be understood that any

other method of coupling which will produce the desired results lies within the scope of my invention.

The constants of the resonance-wave coil 20 are so chosen that, were the synchronizing frequency to be impressed upon it, in the absence of the terminal resistors, a standing wave would be developed thereon having a potential-node intermediate the ends of the coil.

The synchronizing frequency may be derived, at the transmitting end, directly by means of a scanning disc (not shown) constructed as an alternator, or it may be derived by impressing the current generated by the said alternator upon a harmonic producer, as shown in connection with the receiver. Any other convenient method of generating the synchronizing frequency may be utilized provided the phasing of the said frequency is always proportional to the movement of the scanning device at the transmitter.

The frequency derived at the receiver, and applied to the end of the resonance-wave coil, is the same as the incoming synchronizing frequency and it is essential that the phasing of the local frequency bear the same relation to the movement of the local scanning disk as does the phasing of the frequency at the transmitter to the movement of the transmitting scanner. In other words, the rotation of the said scanning disks to the same angular position with respect to a zero position must cause the generation of an equal number of cycles of synchronizing and local frequency in exact synchronism, provided the angular movements of the two disks take place in equal time intervals.

When, therefore, the local frequency and the incoming synchronizing frequency are applied to opposite ends of the resonance-wave coil, the impressed potentials therefrom simulate the reflections that would take place from the ends if one of the frequency sources should be omitted and if the grounding resistors were also omitted. A static condition can, therefore, exist whereby a standing wave is developed on the coil having a potential distribution such as is approximately indicated by the dotted lines A and B.

The potentials applied to the grids of the tubes 15 and 16 from the coil may, therefore, be adjusted to substantial equality by disposing the coupling devices 19 at equal distances, electrically, from the potential node, to remain so adjusted so long as the potentials impressed on the opposite ends of the coil are in synchronism. In such case, by reason of the detecting action of the said tubes, the currents flowing in opposite directions in the two halves of the output resistor 12 may be made to balance, and the potentials of the points on the resistor to which the grids of the amplifying tubes 9 and

10 are connected may be adjusted to exactly, or partially, neutralize the positive potentials impressed upon the said grids by the grid-biasing batteries 13 and 14.

The currents, therefore, that flow in the output circuits of the amplifier tubes 9 and 10 balance, and the flux developed by the coils 6 and 7 of the field winding exactly neutralizes, leaving the flux developed by the shunt winding 8 and the current through the armature 4 as the factors which determine the normal speed of rotation of the disc. The normal speed may be approximately attained by adjustment of a plurality of rheostats 50 and 51 that are serially connected with the shunt field winding 8 and the armature 4 respectively.

In the event, however, that the motor 3 tends to exceed the normal speed, provided the incoming synchronizing frequency is representative of normal speed at the transmitting end, the potentials impressed upon the resonance-wave coil 20 from the harmonic generator 40 will tend to lead the potentials impressed thereon from the amplifier 36. The potential node will, accordingly, tend to move upward along the coil. Potentials of greater amplitude will be impressed upon the grid of the thermionic tube 16, while lower potentials will be impressed upon the grid of the thermionic tube 15. In such event, the plate current from the tube 16 will tend to increase, and the plate current from the tube 15 will tend to decrease.

An increase in the plate current through that portion of the resistor 12 associated with the tube 16 will permit the grid of the tube 10 to become more negative, while a decrease in the current through that portion of the resistor included in the output circuit of the tube 15 will permit the grid of the tube 8 to become more positive.

A current larger than the current during the normal, or balanced, condition will accordingly flow in the field winding 6, and a current less than normal will flow in the field winding 7. Inasmuch as the field winding 6 is so disposed as to aid the field winding 8, and the field winding 7 is so disposed as to oppose the field winding 8, the net result of the current changes in the windings 6 and 7 will be an increase in the total field flux. The motor, consequently, tends to slow down, thus bringing the potentials impressed on the resonance-wave coil from the harmonic generator into phase with the potentials impressed thereon from the amplifier 36.

If, on the contrary, the potentials impressed on the resonance-wave coil from the harmonic producer lag the potentials impressed from the amplifier, 36, the exact converse of the aforesaid sequence of events takes place and the motor tends to increase its speed.

In the event that a sufficiently high frequency can be derived from the scanning disc

directly, it is not necessary to make use of a harmonic producer at either the transmitting or the receiving station. It is considered essential, however, that a relatively large number of cycles of the synchronizing frequency shall be generated during a very small angular movement of the scanning discs.

In order that the "framing" of the received picture may be expeditiously accomplished, it is advisable to interpose a planetary gear, or an equivalent device, indicated by a dotted-line rectangle 52, between the motor shaft and the scanning disc.

Although I have illustrated my invention as being particularly applicable to a television system, it will also be useful in many systems, such as facsimile transmission system, and the like, wherein it is necessary to maintain motional synchronism between separated moving elements.

While I have described but one specific embodiment of my invention and have mentioned only a few modifications in the details thereof, many other modifications thereof, and many variations in the application of the principle of my invention will be apparent to those skilled in the art. I do not intend, therefore, to be limited except as required by the prior art or as indicated in the accompanying claims.

I claim as my invention:

1. A synchronizing system comprising, in combination, a plurality of sources of alternating potentials, means for impressing said potentials on a resonance-wave coil, and means, coupled to said wave coil, for indicating a lack of synchronism of said impressed frequencies.

2. A synchronizing system comprising, in combination, a plurality of sources of alternating potentials, means for impressing said potentials upon a resonance-wave coil to develop standing-wave phenomena thereon, and means, coupled to said wave coil, and responsive to changes in said phenomena for maintaining said potentials in synchronism.

3. A synchronizing system comprising, in combination, a plurality of sources of alternating potentials, means for impressing said potentials upon a resonance-wave coil to develop standing-wave phenomena thereon, and means, coupled to said wave coil, and responsive to changes in said phenomena for influencing the frequency of one of said sources.

4. A synchronism system comprising, in combination, a plurality of sources of alternating potentials, means for impressing said potentials upon a resonance-wave coil to develop standing-wave phenomena thereon, a balanced amplifier system associated with said coil, and means, coupled to said wave coil, whereby the balance of said amplifier system is disturbed in response to changes in said wave phenomena.

5. A synchronizing system comprising, in

combination, a resonance-wave coil, an amplifier coupled thereto and an alternating-current generator so disposed as to be influenced by said amplifier.

6. A synchronizing system comprising, in combination, a resonance-wave coil, a balanced amplifier coupled thereto and an alternating-current generator so disposed as to be influenced by a state of unbalance in said amplifier.

7. In combination, a resonance-wave coil, means for impressing a plurality of alternating potentials thereon to develop standing-wave phenomena, a balanced detector system associated with separated points on said coil, and means, coupled to said wave coil, whereby one of the sources of said alternating potentials is controlled in response to an unbalance in said detector system.

8. A synchronizing system comprising a plurality of sources of alternating potentials and means for impressing said potentials on a resonance-wave coil, in combination with a push-pull detecting system coupled to said coil, a push-pull amplifying system coupled to said detecting system, and means disposed in the output circuit of said amplifying system for indicating a variation in the properties of said impressed frequencies.

9. A synchronizing system comprising a plurality of sources of alternating potentials and means for impressing said potentials on a resonance-wave coil in combination with a balanced amplifying system coupled to said wave coil and a prime mover actuated, by the power delivered thereto from said balanced amplifying system, to vary its speed in accordance with variations in the properties of said alternating potentials.

10. A synchronizing system comprising a plurality of sources of alternating potentials, and means for impressing said potentials on a resonance-wave coil, in combination with a balanced amplifying system coupled to said wave coil and having in its output circuit certain of the field windings of a prime-mover that supplies the power for producing at least one of said alternating potentials.

11. In combination, a balanced amplifying system and a motor having a plurality of field windings, certain of said windings being included in an ordinary power-supply circuit, certain others of said windings, the flux through which aids the flux through said first mentioned windings, being included in the output circuit of said amplifying system, and the remainder of said windings, the flux through which opposes the flux through said first mentioned windings, also being included in the output circuit of said amplifying system.

In testimony whereof, I have hereunto subscribed my name this first day of April 1929.

THADDEUS R. GOLDSBOROUGH.