

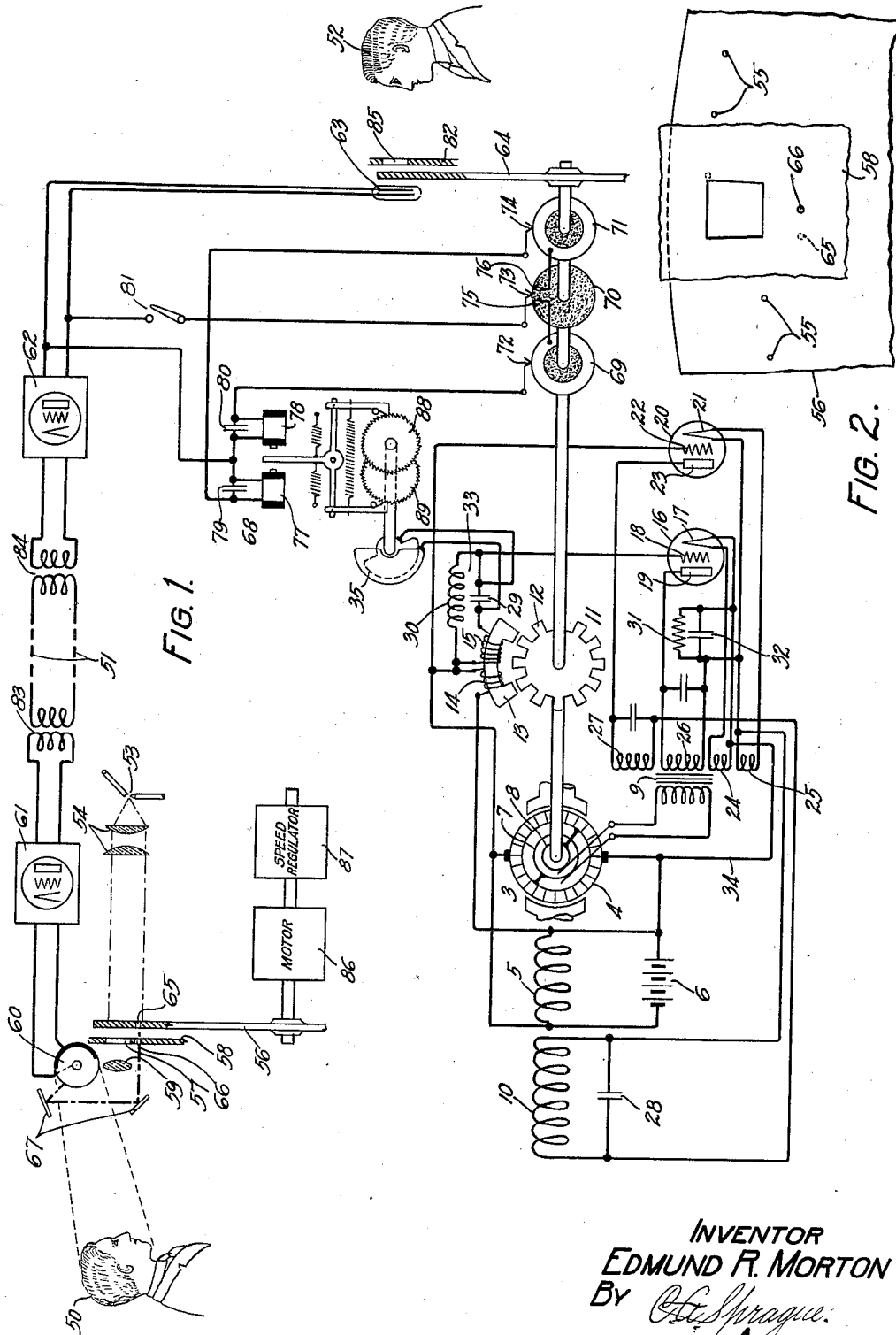
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SYNCHRONIZING SYSTEM

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SYNCHRONIZING SYSTEM

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This invention relates to synchronizing systems and particularly to a method and means for maintaining apparatus employed at different stations of television and picture transmission systems in synchronism.

It has heretofore been proposed in connection with picture transmission systems to transmit unmodulated carrier current of increased amplitude during the underlap period of the picture to maintain the receiving picture drum in synchronism with the picture drum at the transmitting station. The picture drums are driven by La Cour motors, each of which is actuated by a mechanical resonance means in the form of a tuning fork, for maintaining each motor at a substantially constant speed. When there is a departure from synchronism the synchronizing carrier current is employed to vary the position of weights on the tines of the tuning fork at the receiving station for increasing or decreasing the speed of the motor at this station.

This invention contemplates a synchronizing system in which the speed of one of the elements to be maintained in synchronism is controlled by apparatus comprising electrical resonance means having a steep frequency-response characteristic, and means under the control of a synchronizing control station are provided for varying the natural period of the resonance means when these elements move out of phase.

In another aspect of the invention there is provided a rotating element containing unevenly spaced light transmitting portions for scanning a field or a portion of a field along groups of parallel lines successively, and means associated with the rotating element is employed for producing a synchronizing impulse between groups of parallel scanning lines.

There is disclosed in Patent No. 1,663,891, granted to H. M. Stoller and E. R. Morton, March 27, 1928, a speed regulating system which may be employed in connection with this invention. In this system a high frequency generator is mechanically connected to a motor for supplying alternating current through a tuned circuit to the grid of a vacuum tube. The speed of the motor is controlled, in response to variations in the frequency of the generator, through a field winding of the motor connected in the space current circuit of a second vacuum tube coupled to the first.

In the specific embodiment of this invention, herein shown and described for the purpose of illustration, a regulating system, similar to that disclosed in the copending application referred to

above, is employed in a television system, such as disclosed in a copending application of F. Gray, Serial No. 227,649, filed October 21, 1927, for controlling the speed of the motors which turn the scanning apparatus at the transmitting station and the image reproducing apparatus at the receiving station. For the purpose of scanning the object, an image of which is to be viewed at the receiving station, a motor at the transmitting station turns a disc having a plurality of spirally arranged apertures therein through which light is directed upon successive elemental areas of the object. One or more photoelectric cells are provided for receiving light reflected from the object and for generating a current which varies in accordance with the light intensity variations. A hole in a scanning disc displaced in a radial direction from the spirally arranged holes and positioned on a radius extending between the first and last holes of the spiral is provided for synchronizing purposes. Light passing through this hole is directed upon one of the photoelectric cells preferably through a system of mirrors, for setting up a synchronizing electrical impulse once per revolution of the scanning disc. These synchronizing impulses are transmitted over the same line that is employed for transmitting the image currents to the receiving station where they are impressed upon a circuit which controls the capacity of a condenser associated with the tuned circuit of a motor speed regulating circuit such as referred to above, thereby maintaining the apparatus at the two stations in phase.

The following is a detailed description of the embodiment of the invention referred to above. Reference is made to the accompanying drawing in which,

Fig. 1 shows a television system employing apparatus which is synchronized in accordance with the present invention and

Fig. 2 is an enlarged view of a portion of the apparatus employed at the transmitting station for scanning and synchronizing purposes.

Referring now to the drawing, the television system shown is adapted to generate electrical currents corresponding to the light reflecting properties of elemental areas of an object 50 at the transmitting station, transmit these currents over a transmission channel such as the line 51 and, by means of apparatus at the receiving station, to form an image of the object 50 on the eye of an observer 52. The object is located in front of a scanning apparatus which comprises an arc lamp 53 and an optical system for causing a slender pencil of substantially parallel rays

of intense light to sweep across the field in front of the scanning apparatus and scan the object in a series of successive parallel lines. The optical system includes a scanning disc 56 which has a number of small circular apertures 55 (shown in Fig. 2) arranged in a spiral extending around the disc near its rim. Light from the arc 53 is directed by a lens system 54 so that an intense beam of light passes through each aperture as it moves across the illuminated area of the disc. An opaque screen 58 in front of the disc is provided with a rectangular opening 57 of such width as to admit light from only one aperture at a time. Lens 59 bends the slender pencil of parallel rays passing through the aperture and the opening 57 to form an image of the moving aperture on the object 50. As a result of this arrangement the object is completely scanned once for each revolution of the disc in a series of successive parallel lines by a small, rapidly moving, intensely bright spot of light. As the spot of light passes over the object, light is diffusely reflected therefrom and a portion of the reflected light falls on the photosensitive surface of a large aperture photoelectric cell 60 which generates an electric wave varying in accordance with the light intensity variations reflected from the object. This type of scanning apparatus is described in more detail in the application of Gray referred to above.

The image waves generated by the photoelectric cell are amplified by an electric discharge amplifier 61 and transmitted through a transformer 83 to the line 51 which connects the transmitting and receiving stations.

At the receiving station the image waves from the line 51 are transmitted through a transformer 84 to an electric discharge amplifier 62 by which they are amplified and impressed upon a neon glow discharge lamp 63 arranged in front of a scanning disc 64 similar in construction to the scanning disc located at the transmitting station. In front of the disc there is located an opaque screen 82 having an opening 85 of such size that at any one time only one of the apertures of the disc 64 is in the field of view of the observer 52. The lamp 63 is preferably of the type disclosed in detail in Patent No. 1,865,516, granted to F. Gray, July 5, 1932. The optical field defined by the opening 85 and illuminated by light coming from the lamp 63 through the moving apertures of the disc 64 is viewed by the observer 52 without the aid of any optical system. The observer sees at any instant a single aperture in the same relative position as a spot of light on the object 50 at the transmitting station and the brightness of the aperture corresponds to the amount of light reflected from that particular elemental area of the object. On account of persistency of vision the observer consequently sees an apparent image of the object on the front surface of the disc 64, complete views of the object being transmitted at the rate of about 18 per second so that the object can be seen in motion.

The disc 56 at the transmitting station is driven by a motor 86 which is maintained at a substantially constant speed by speed regulating apparatus 87. This motor and speed regulating apparatus may be the same as that employed at the receiving station for driving the disc 64 at a substantially constant speed and which will now be described.

The disc 64 is driven by the motor 3 having a commutator 4 and a shunt field winding 5

supplied with direct current from a source 6. The motor is also provided with slip rings 7 and 8 connected to commutator bars 180° apart. These slip rings are provided with brushes connected to a transformer 9 for supplying alternating current to the regulator circuit during the operation of the motor. The motor is also provided with a regulator field winding 10 which is so wound as to supply flux which aids that supplied by the winding 5. Directly connected to the motor 4 (or mounted in the same frame) is a high frequency inductor generator 11, comprising a toothed rotor 12 and a field structure 13 on which is mounted a field coil 14 connected to the direct current source 6 and a generator coil 15. As the teeth of the rotor pass the pole pieces of the field structure, the reluctance of the magnetic circuit is varied, thereby generating electrical variations of high frequency in the winding 15.

The regulator circuit proper comprises a detector tube 16, having a cathode 17, a grid 18 and a plate 19, and an amplifier tube 20, having a cathode 21, a grid 22 and a plate 23. Heating current is supplied to the cathodes 17 and 21 respectively from the secondary windings 24 and 25 of the transformer 9. Space current is supplied to the tubes 16 and 20, respectively, from the secondary windings 26 and 27, each of which is shunted by a condenser. The direct current source 6 is employed for negatively biasing the grids of both tubes as explained below. A tuned circuit 33 comprising a fixed condenser 29, a variable condenser 35 and an inductance 30 is connected to the winding 15 of the generator 11. The inductance coil 30 is connected in the grid circuit of the detector tube 16 in series with the source 6. The circuit may be traced from the grid 18, inductance coil 30, negative terminal of source 6, positive terminal of source 6, conductor 34 to cathode 17. A resistance 31 shunted by condenser 32 is connected in the plate circuit of the tube 16. Condenser 32 is given such a value that the voltage across the terminals of the resistance 31 is proportional to the value of the high frequency potential impressed on the grid 18 and practically independent of the low frequency plate current source. Resistance 31 is connected in series with the source 6 between the grid and the cathode of the tube 20. The circuit may be traced from grid 22, negative terminal of source 6, positive terminal of source 6, conductor 34, resistance 31 to cathode 21. The regulator winding 10 is connected in series with the secondary winding 27 of transformer 9 in the plate circuit of the tube 20. The condenser 28 is connected in shunt to the winding 10 to stabilize the intermittent current supplied by the tube 20.

The operation of the circuit is as follows: When the motor 4 is started it will accelerate until the frequency of the current developed by the generator 11 approaches the frequency to which the circuit 33 is tuned. As the speed increases, the potential of the grid 18, which is normally negative due to the bias of the source 6, is increased by the alternating voltage drop across inductance coil 30. This superposed potential causes space current to flow in the detector tube producing a voltage drop in the coupling resistance 31. This voltage is impressed upon the normally negative grid 22 of the amplifier 20, causing space current to flow in the amplifier tube and consequently in the regulator field 10. This cur-

rent increases the excitation of the motor and prevents any further rise in speed.

The constants of the motor and regulator circuit are so adjusted that the operation of the motor is in equilibrium at a point on the ascending portion of the resonance curve of the tuned circuit 33. When the speed of the motor varies from this point, the current through the regulator field 10 is varied to correct the tendency of the motor speed to change. For example, if, due to a change in load or voltage, the speed of the motor decreases slightly and accordingly the frequency of the current in the winding 15 of the generator 11, the alternating component of the potential of the grid 18 of the detector tube is decreased causing a corresponding decrease in the voltage drop across the resistance 31 and a consequent decrease in the variable component of the potential of the grid 22 of the amplifier tube, thus resulting in a decrease in the current through the regulator field 10 which limits the tendency of the motor to further decrease in speed, as would occur in normal unregulated operation.

Since the frequency of the variations impressed upon the grid of the detector tube 16 is greater than the frequency of the variations impressed on the plate there will be variations of potential of both signs impressed upon the grid during the intervals when the plate is positive. In order to prevent a balance of effects due to the positive and negative potential alternations of the grid, the tube must be caused to function as a detector, that is, it must operate on the curved portion of its characteristic.

In order to prevent distortion of the image formed upon the eye of the observer 52 it is necessary to maintain the discs 56 and 64 quite accurately in phase and, for this purpose, the disc 56 is provided with an aperture 65 which is displaced from the spirally arranged apertures 55 and is located on a radius midway between the first and last apertures of the spiral, although it may also be located at other portions of the disc. Once per revolution of the disc 56, light from the source 53 is directed through the aperture 65 and the opening 66 in the screen 58 and is then reflected by mirrors 67 so as to impinge upon the photoelectric cell 60. The resulting current impulse generated by the photoelectric cell is transmitted to the receiving station where it is employed to actuate the polarized stepping relay 68 when the discs 56 and 64 are out of phase. For this purpose commutator discs 69, 70 and 71 having brushes 72, 73 and 74, respectively, are mounted on the motor shaft to which the disc 64 is secured. The periphery of the commutator discs 69 and 71 are made completely of conducting material, while the disc 70 is of insulating material and has the conducting segments 75 and 76 which are electrically connected to the discs 69 and 71, respectively.

When the discs 56 and 64 are exactly in phase the synchronizing impulse reaches the receiving station when the disc 70 is in the position shown, that is, such that the brush 73 engages the disc between the conducting segments 75 and 76, and the circuit including the windings of relay 68 is open. When disc 64 leads the disc 56 (assuming a clockwise rotation of disc 64 is viewed by the observer 52) the incoming current impulse will flow through the conducting segment 75 and through the winding 78 of relay 68 thus causing the toothed wheel 88 to be moved in a clockwise direction as viewed in the figure and the capacity

of condenser 35 to be increased. This increase in capacity causes the natural resonance of the circuit 33 to occur at a lower frequency. The current in this circuit is consequently increased thus increasing the current in the regulating winding 10 and reducing the speed of motor 3 as explained heretofore. When the disc 64 lags the disc 56, current flows through winding 77 of relay 68, which causes the capacity of condenser 35 to be decreased and consequently the speed of motor 3 to be increased. In order to increase the time during which the synchronizing current flows through the relay windings, condensers 79 and 80 are shunted across these windings. The incoming current impulses serve to charge one of the condensers which then discharges through the relay winding.

It is seen that the phase correcting apparatus is inoperative when the discs 64 and 56 are sufficiently out of phase so that the synchronizing impulse reaches the receiving station, when a portion of the disc 70 outside of the segment spanned by the conducting portions 75 and 76 is in contact with the brush 73. In this case the switch 81 may be opened and the setting of condenser 35 varied by manually operating the armature of relay 68 until the phase relation is within the limits of automatic phase correction. At this time switch 81 may be closed and the discs at the transmitting and receiving stations will consequently be brought accurately into phase where they are maintained.

It is to be understood that the details of the specific arrangement disclosed above may be considerably varied without departing from the spirit and scope of the invention. For instance, instead of employing the aperture 65 of the scanning disc at the transmitting station, an electrical contact element may be used for closing a circuit once per revolution of the disc, thereby setting up synchronizing impulses which are transmitted to the receiving station. These impulses may be of such an amplitude that they would overload the amplifier stage immediately following the photoelectric cell and for this reason the impulses are preferably impressed directly on the line or on an amplifier stage just preceding the line. Instead of employing a stepping relay for varying the setting of condenser 35 an arrangement may be used in which phase correction is realized by periodically increasing or decreasing the capacity of the condenser from its normal value only for the duration of the synchronizing impulse. For this purpose the movable plate of the variable condenser may be associated with the armature of relay 68, so that the capacity of the condenser varies directly in accordance with the position changes of the armature.

What is claimed is:

1. In a synchronizing system, speed control means comprising variable electrical resonance means, the response of which varies sharply with a slight variation from the resonant frequency of energy supplied thereto, means for varying the natural period of said resonance means over a range of values between fixed limits and means under the control of the synchronizing control station for controlling said last mentioned means when there is a departure from synchronism.

2. In a system for maintaining a plurality of elements in synchronism, speed control means comprising a resonant circuit, the response of which varies sharply with a slight variation from the resonant frequency of current supplied thereto, means responsive to current transmitted

through said resonant circuit for controlling the speed of one of the elements to be maintained in synchronism, means for varying the natural period of said resonant circuit over a range of values between fixed limits and means under the control of the synchronizing control station, for controlling said last mentioned means when there is a departure from synchronism.

3. A synchronizing system comprising a dynamo electric machine at each station for driving the elements to be synchronized, means associated with said dynamo electric machine for generating an alternating current, means including a resonant circuit for utilizing said alternating current to maintain said machine at a substantially constant speed, means at one station for varying the natural period of the resonant circuit at said station over a range of values between fixed limits, and means at another station for controlling said last mentioned means and thereby determining the speed at which the machine at said one station is maintained constant.

4. A synchronizing system comprising motive means at each station for driving elements located at these stations, means comprising electrical resonance means for maintaining said elements at substantially the same speed, means at one of said stations for varying the natural period of the resonance means at that station over a range of values between fixed limits, and means controlled by the element at another of said stations for controlling said last mentioned means, thereby maintaining said elements in phase.

5. In a synchronizing system, a transmitting and a receiving station, a dynamo electric machine having a regulating field winding at each station for driving the elements which are to be maintained in phase, a source of alternating current the frequency of which varies in accordance with the speed of said machine, a frequency discriminating circuit, means for supplying current from said source to said regulating field winding through said frequency discriminating circuit for maintaining said dynamo electric machines at a substantially constant speed, and means for controlling the constants of the frequency discriminating circuit at one of said stations and thereby maintaining said elements in phase.

6. In a synchronizing system, a plurality of elements to be maintained in synchronism and located at different stations respectively, means associated with one of said elements for periodically setting up electrical impulses, electrical resonance means associated with another of said elements for maintaining it at a substantially constant speed, and means controlled by said electrical impulses for varying the constants of said electrical resonance means over a range of values between fixed limits, thereby maintaining said elements in synchronism.

7. In a synchronizing system, a plurality of dynamo-electric machines which are to be maintained in synchronism, means associated with one of said machines for periodically causing a beam of light to be directed upon a light sensitive device which, in consequence, generates corresponding electrical impulses, an electrical circuit associated with another of said machines for maintaining it at a substantially constant speed, and means controlled by said electrical impulses for changing the constants of said circuit and thereby increasing or decreasing the speed of said last mentioned machine.

8. In a system for producing an image of a field containing moving or changing objects, a

rotating element having unevenly spaced light transmitting portions for scanning the field or a portion of the field along groups of parallel lines successively, means including said rotating element for producing an impulse of synchronizing current between groups of parallel scanning lines, means comprising a second rotatable element and a driving motor therefor for producing an image of said field of view, and means responsive to said synchronizing impulses for controlling the energy supplied to said driving motor, thereby controlling its speed.

9. In a system for producing an image of a field containing moving or changing objects, scanning means comprising a disc containing a plurality of light transmitting portions arranged around the periphery thereof, the angular distance between two of said light transmitting portions being greater than that between others, means for transmitting an impulse of synchronizing current over the same channel that is employed for transmitting image currents, a similar scanning means for producing images of said objects, a driving motor therefor, and means responsive to said synchronizing current for controlling the energy supplied to said motor to control its speed.

10. In a system for producing an image of a field containing moving or changing objects, means for scanning the field or a portion of the field along groups of parallel lines successively, said means comprising a disc containing a plurality of light transmitting portions arranged around the periphery thereof, the angular distance between two of said light transmitting portions being greater than that between others, electro-optical means for producing an impulse of synchronizing current between said groups of parallel scanning lines, image producing means comprising a rotatable element to be maintained in synchronism with said scanning disc, a driving motor for said rotatable element, and means controlled by said synchronizing current for controlling the energy supplied to said motor to control its speed.

11. In a system for producing an image of a field containing moving or changing objects, means for scanning the field or a portion of the field along groups of parallel lines successively, said means comprising a rotating disc containing a plurality of spirally arranged light transmitting portions the angular distance between two of which is greater than that between others, an auxiliary light transmitting portion aligned on a radius passing between said two widely separated portions and means for transmitting light through said last mentioned portion to produce synchronizing impulses.

12. In a synchronizing system, speed control means comprising variable electrical resonance means, the response of which varies sharply with a slight variation from the resonant frequency of energy supplied thereto, means for varying in steps the natural period of said resonance means over a range of values between fixed limits, and means under the control of the synchronizing control station for actuating said last mentioned means when there is a departure from synchronism.

13. In a system for maintaining a plurality of elements in synchronism, speed control means comprising a resonant circuit, the response of which varies sharply with a slight variation from the resonant frequency of current supplied thereto, means responsive to current transmitted

through said resonant circuit for controlling the speed of one of the elements being maintained in synchronism, means for varying in steps the natural period of said resonant circuit over a range of values between fixed limits and means under the control of the synchronizing control station for actuating said last mentioned means until the condition of synchronism is established.

14. In a synchronizing system, a plurality of elements to be maintained in synchronism and located at different stations respectively, means associated with one of said elements for periodically setting up electrical impulses, electrical resonance means associated with another of said elements for maintaining it at a substantially constant speed, and means controlled by said electrical impulses for varying in steps the constants of said electrical resonance means over a range of values between fixed limits thereby maintaining said elements in synchronism.

15. In a system for producing images of a field of view, the aspects of which may be changing, a rotatable scanning element having light transmitting apertures for repeatedly scanning said field of view and having an opaque portion for interrupting the scanning between successive scanings of the field of view, means for producing synchronizing current only during the period that said scanning is interrupted, a second rotatable element to be maintained in synchronism with said first rotatable scanning element, a direct current driving motor for said rotatable element, a speed control winding for said motor, and means responsive to said synchronizing current for controlling the amplitude of the current supplied to said speed control winding, thereby controlling the speed of said motor.

16. In a system for producing images of a field of view the aspects of which may be changing, a source of light and a rotatable scanning element having light transmitting apertures arranged therein for directing light from said source to elemental areas in succession of said field of view and an opaque portion for preventing the illumination of said field of view for a period between successive scanings of said field of view, light sensitive means for receiving light from the successively illuminated elemental areas of said field of view to produce an image current, and means directing light upon said light sensitive means during the period that said illumination of the field of view is interrupted for producing synchronizing current.

17. In a system for producing images of a field of view the aspects of which may be changing, a source of light and a rotatable scanning disc having light transmitting apertures arranged therein along a spiral path for directing light from said source to elemental areas in suc-

cession of said field of view and an opaque portion for preventing the illumination of said field of view for a period between successive scanings of said field of view, a light sensitive element for receiving light from the successively illuminated elemental areas of said field of view to produce an image current, means for producing synchronizing current during the periods that the illumination of said field of view is interrupted, a similar rotating scanning disc and a driving motor therefor at another station, and means at said other station controlled by said synchronizing current for controlling the amplitude of the current supplied to said motor to maintain said scanning discs in synchronism.

18. Television apparatus for producing images of a field of view at a rate such that each image is produced within the period of persistence of vision, comprising a source of current comprising time-separated portions of image current corresponding to the tone values of elemental areas of a field of view and portions of synchronizing current occurring between successive image portions, means for producing light the intensity of which is controlled by current from said source, movable image synthesizing means for directing light from said light producing means, a motor for driving said image synthesizing means, and means for controlling the amplitude of the current supplied to said motor under control of the synchronizing portions of said source of current, thereby controlling the speed of said motor.

19. Television apparatus for producing images of the field of view at a rate such that each image is produced within the period of persistence of vision, comprising a source of current comprising time-separated portions of image current corresponding to the tone values of elemental areas of a field of view and portions of synchronizing current occurring between successive image portions, means for producing light the intensity of which is controlled by current from said source, movable image synthesizing means for directing light corresponding to the image portions of said current and for intercepting light corresponding to the synchronizing portions of said current, a motor for driving said image synthesizing means, and means for controlling the energization of said motor under control of the synchronizing portions of said source of current, thereby controlling the speed of said motor.

20. A scanning disk provided with a series of scanning openings spirally arranged therein, the ends of the series of such openings having a blank sector therebetween, the scanning disk being also provided with a synchronizing aperture disposed in a predetermined relation to such blank sector, but not within the series of scanning openings.

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