July 23, 1946. W. G. H. FINCH 2,404,571

SYNCHRONIZING MECHANISM

Filed Jan. 19, 1944 3 Sheets-Sheet 1

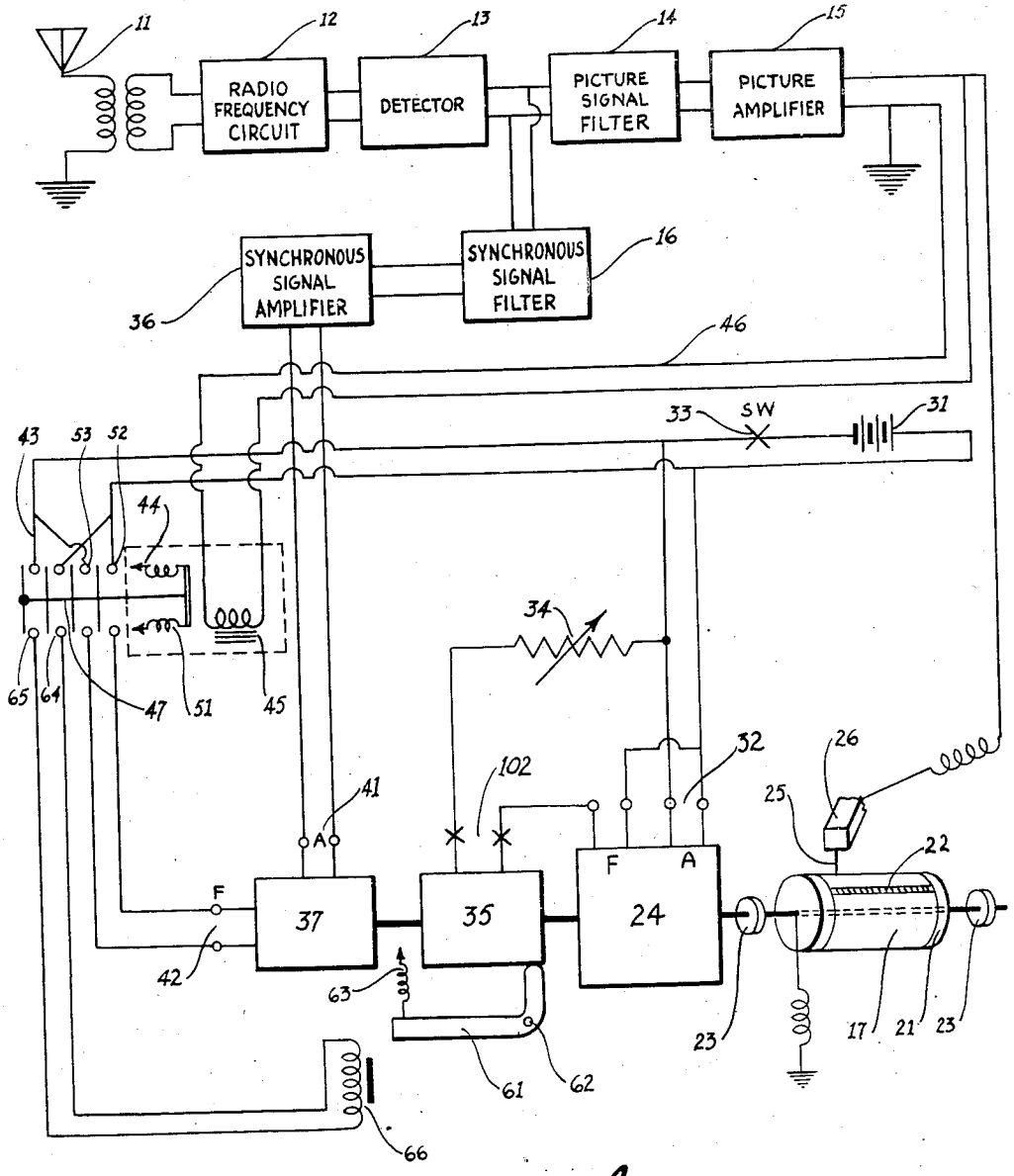


Fig. 1

INVENTOR
William G. H. Finch
by Samuel Ostrolenk
his ATTORNEY

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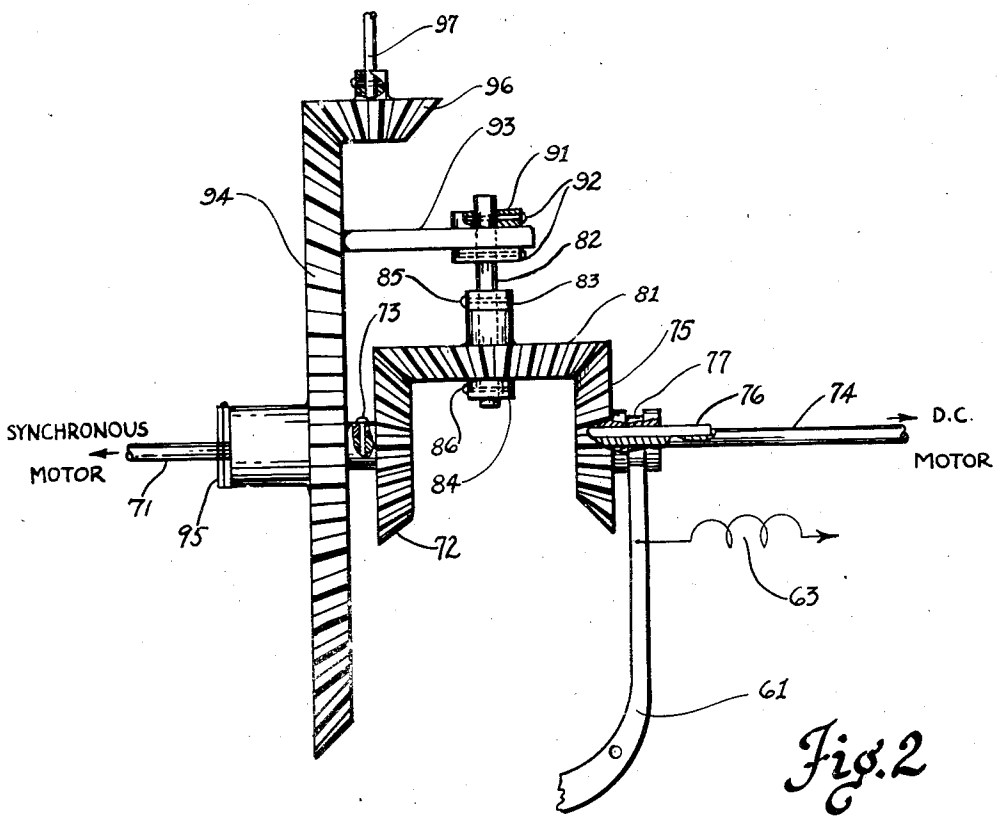


Fig. 2

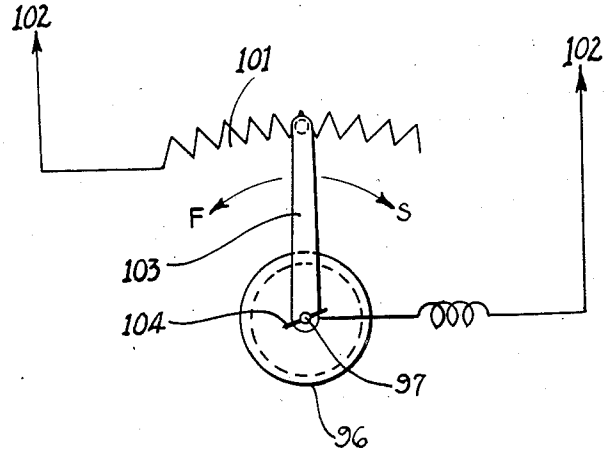


Fig. 3

INVENTOR

William G. H. Finch

by Samuel Ostrolenk

his ATTORNEY

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SYNCHRONIZING MECHANISM

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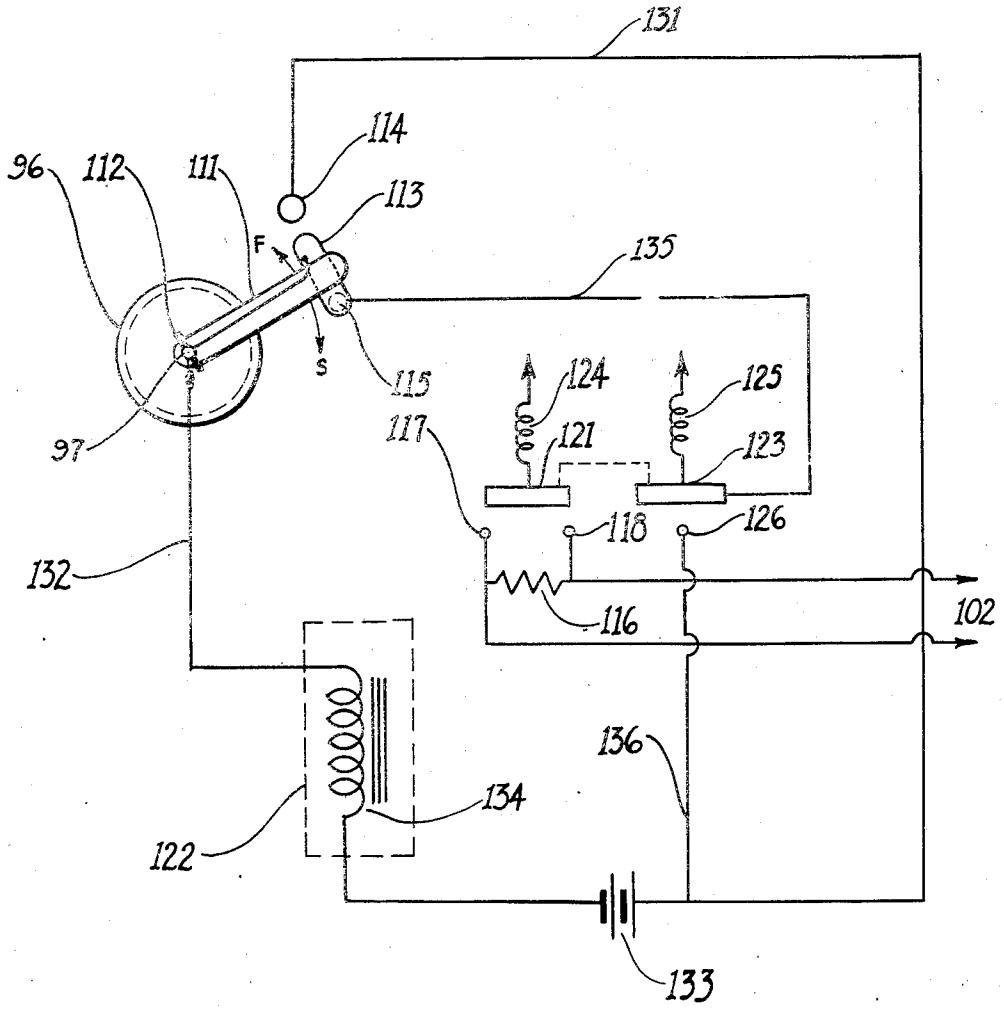


Fig. 4

INVENTOR
William G. H. Finch.
by Samuel Ostrolenk
his ATTORNEY

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UNITED STATES PATENT OFFICE

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SYNCHRONIZING MECHANISM

William G. H. Finch, Newtown, Conn.

Application January 19, 1944, Serial No. 518,837

8 Claims. (Cl. 178—69.5)

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My invention relates in general to the field of picture transmission and reception and more specifically to a novel continuous synchronizing mechanism.

In facsimile transmission, a signal is generated at the transmitter which represents the light shades of a single line of a picture. This signal is then amplified to a suitable energy level and transmitted by wire or radio to a remote receiver.

As is well known in the art of facsimile, it is essential that both transmitting and receiving apparatus operate in synchronism. In the past, synchronizing systems have primarily been stop-start mechanical systems wherein the receiver recording mechanism was operated at a somewhat higher speed than the transmitting mechanism. The scanning of a single line of the picture at the receiver was thus accomplished in less time than a corresponding cycle at the transmitter, and the recording mechanism was brought to a halt to await the receipt of a synchronizing signal from the transmitter. This synchronizing signal representing the start of a new scanning cycle at the transmitter would release the receiving mechanism to record the following line. The mechanical disadvantages of such a start-stop mechanism are well known in the facsimile art.

It is possible to obtain continuous synchronizing of transmitting and recording mechanism if both are operated from the same alternating current power supply. In this ideal instance, matched alternating current synchronous motors are utilized to provide absolute continuous synchronization between the rotational elements at each station. Obviously, such a transmission system would be limited to the area served by the one central power station and would be of no use whatsoever for facsimile systems operating between separated points such as ship-to-shore or airplane-to-ground, or the like.

Continuous synchronization of transmitting and recording equipment may also be obtained by the continuous generation at the transmitter of an alternating current synchronizing signal which is transmitted to the receiving station and amplified thereat to a level sufficient to drive all the required recording apparatus. With modern high speed telepicture apparatus, this particular synchronizing system becomes impractical, since the power requirements of the recording mechanism are comparatively high and require excessive amplification of the synchronizing signal by massive, inefficient electronic apparatus.

My present invention proposes continuous synchronization between transmitting and recording apparatus which utilizes a continuously transmitted alternating current synchronizing signal, but which does not require the excessive amplification thereof mentioned above. In accordance with my novel synchronizing mechanism, the recording apparatus is driven from any local power supply, which may take the form of alternating current mains, or a portable battery as employed in an airplane or other vehicle.

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If a battery supply is available at the receiver then the drive mechanism may consist of an ordinary direct current shunt motor of the required horse power. The speed of this shunt motor is controlled directly by comparatively simple and light apparatus which in turn is governed by a small pilot synchronous motor operated from a low level continuous synchronizing signal amplifier. Thus the transmitting apparatus has associated with it means for generating a continuous synchronizing signal and combining it with the picture signal to be transmitted. This multiple signal when received at the recording apparatus is separated electronically and the picture signal is passed through a recording channel while the synchronizing signal is impressed upon an amplifier having a signal output sufficient to drive the aforementioned small synchronous motor.

Immediately upon the receipt of a transmitted signal, the pilot synchronous motor operates to adjust the speed of the direct current motor to that of the corresponding scanning apparatus at the transmitter. Any fluctuation in speed of the direct current motor will thereafter be immediately compensated for by the small pilot motor and result in a change of electrical or mechanical circuit constants that will restore the speed of the direct current motor to the required synchronous speed.

It is therefore an object of my invention to provide a facsimile transmitting and receiving system wherein the recorder is continuously governed to operate at the speed of the transmitter.

It is another object of my invention to provide a continuous telepicture synchronizing system utilizing a small pilot synchronous motor at the receiver.

Still another object of my present invention is to provide facsimile recording apparatus which may be operated from any power source whatsoever and which is maintained in synchronism by a continuously transmitted governing signal generated at the transmitter.

A further object of my invention is to provide

a novel, differential speed adjusting means for maintaining a direct current motor in synchronism with a synchronous alternating current motor.

A still further object of my invention is to provide a novel electrical circuit for controlling the speed of a direct current motor within certain narrow pre-determined limits.

These and other object of my invention will now become apparent from the following specification taken in connection with the accompanying drawings in which:

Figure 1 is a schematic representation of one modification of my novel continuous synchronizing mechanism.

Figure 2 is a fragmentary view of the differential mechanism for governing the speed of a direct current motor.

Figure 3 is a fragmentary view of one form of speed control means; and

Figure 4 is another modification of a motor speed control mechanism.

Referring now to Figure 1, there is shown a schematic representation of a facsimile system operable from radio signals received by antenna 11 and coupled to the radio frequency receiving circuit 12.

The facsimile signal received in circuit 12 consists of a carrier signal modulated by audio-frequency currents representing the variations of light along individual lines of an image. These signals are generated at the transmitter as is well known in the art by an electro-optical scanning mechanism driven from a suitable source of power.

If an alternating source of power supply is available at the transmitter, then the transmitting scanning mechanism is driven by an alternating current synchronous motor. To obtain a signal at the transmitter, which is representative of the speed of the synchronous motor, it is then merely necessary to modulate the carrier with this alternating current.

If it is necessary to drive the transmitting scanning mechanism from a battery or other D. C. supply, it is then preferable to attach a small synchronous alternator to the scanning drive motor so that an alternating current signal having a frequency proportional to the speed of the scanning apparatus is generated at all times. As in the previous example, the output of this synchronous alternator is used to modulate the carrier to provide a transmitted synchronizing signal.

When wired transmission is employed, the picture signal and the continuous synchronizing signal may be directly applied to the lines and modulation of a carrier and the receiving radio frequency circuits may be dispensed with.

Since the picture currents and the synchronizing signal may be in the same frequency band, multiple transmission may be accomplished by translating either one of these two into another frequency band by the addition of a constant frequency signal thereto. At the receiver, as will be described, the two signals are separated and the translated current restored to its original frequency.

Again referring to Figure 1, the received signal is demodulated by the detector 13 and impressed upon the two-channel electronic circuit comprising the picture signal filter 14 and the synchronizing signal filter 16. If the synchronizing signal is, for example, an alternating current signal of approximately 60 cycles per second and the picture signals a translated band of higher frequencies, the filters 14 and 16 may be conventional high-pass and low-pass filters respectively.

The audio-frequency picture signals are amplified by amplifier 15 and impressed in the well known manner across an electrosensitive recording sheet 17, which may be a sheet of instantaneous facsimile recording paper of the conductive type.

As is schematically illustrated in Figure 1, the recording sheet 17 is mounted upon a rotating drum 21 by a mounting bar 22. The drum 21 is supported by suitable bearings 23 and is driven by a motor 24 of the required horse power. Scanning the surface of the recording sheet 17 is an electrically conductive stylus 25, supported on a suitable bracket 26, which in turn is driven by a conventional feed screw mechanism.

The picture signal output of amplifier 15 is impressed between the stylus 25 and the rotatable drum 21 whereby the incoming picture signal will flow through the recording sheet 17 and in the well known manner produce an instantaneous recording.

It will become evident that the present invention is not particularly limited to the recording drum 21 as illustrated in Figure 1, and that any other well known facsimile recording mechanism, such as the multiple stylus arrangement, or the reciprocating arm arrangement, may be directly substituted for the particular recorder described.

The power source comprises a battery or other direct current supply 31. The source of motive power for the drum 21, as shown, is a direct current shunt motor 24, the armature terminals 32 of which are directly connected to the battery 31 through a switch 33. The field of the direct current shunt motor 24 is also energized from the battery 31 through the field rheostat 34 and through a circuit contained in the speed control apparatus 35, to be described later.

The alternating current synchronizing signal flowing from the signal filter 16 is impressed upon a synchronizing signal amplifier 36 having a power output sufficient to drive the small pilot synchronous motor 37. It is important to note at this point that the direct shunt motor 24 is considerably larger than the pilot synchronous motor 37 and that the energy required to drive the recording drum 21 is supplied primarily by the direct current motor 24 operating from the local direct current source 31.

The output of the synchronizing signal amplifier is an alternating current synchronous with the alternating current utilized to drive the transmitting scanning mechanism, and is impressed directly upon the armature terminals 41 of the pilot synchronous motor 37.

The direct current field terminals 42 of the pilot synchronous motor 37 are energized from the local power supply 31 through the four-pole relay contacts 43. The relay 44 is picture signal operated and of the latching type. That is, upon the receipt of a picture signal through picture amplifier 15 the coil 45 of the relay 44 will be energized across the lines 46. The relay contact carrying arm 47 is normally biased as indicated schematically by springs 51 to the open circuit position illustrated.

Upon receipt of a picture signal over lines 46, the relay coil 45 will be energized and cause the movement of contact carrying arm 47 to the right as viewed in Figure 1, and accordingly close the four circuits illustrated.

Since relay 44 is of the latching type, any sub-

sequent temporary cessation of the picture signal will not cause the contacts 43 to open. The closure of contacts 52 and 53 of the relay 44 will, as illustrated, energize the direct current field at terminals 42 from the local D. C. supply 31, and in combination with the alternating current signal applied to the armature terminal 41, will cause the synchronous motor 37 to lock into synchronous speed, as is well understood in the art. The speed of this synchronous motor 37 is accordingly the speed at which it is desired to operate the direct current shunt motor 24. And as will be described later, the differential speed control mechanism 35 will in connection with the synchronous motor 37 provide means for continuously adjusting the speed of the shunt motor 24 to maintain the desired scanning speed.

The mechanism 35 is a mechanical coupling between the pilot synchronous motor 37 and the direct current shunt motor 24. Since it may be desirable to operate the shunt motor 24 when no picture signal is being transmitted, it is necessary to uncouple the mechanical linkage between the motor 24 and the synchronous motor 37. This is accomplished by a clutch mechanism operated by arm 61 pivoted at pin 62.

The normal position of the pivoted link 61 is determined by the spring 63 applying tension in the direction illustrated in Figure 1. However, upon the energization of relay 44 and the closure of contacts 64 and 65 by the contact carrying arm 47, the solenoid 66 will be energized and cause counterclockwise rotation of pivoted link 61 against the normal bias of spring 63. This, as will be illustrated later, will cause the mechanical coupling between the synchronous motor 37 and shunt motor 24 to maintain the desired synchronous condition.

Referring now to Figure 2, there is illustrated one possible mechanical structure of the synchronizing linkage between the pilot motor 37 and the shunt motor 24.

As illustrated, the synchronous motor 37 drives shaft 71 to which is secured bevel gear 72. The attachment is accomplished, as illustrated by pin 73 passing through the hub of gear 72 and through shaft 71.

The direct current shunt motor 24 drives shaft 74 to which bevel gear 75 is slidably but nonrotatably keyed. Thus, keyways milled in shaft 74 and bevel gear 75 engage a key 76 which is secured to the shaft 74. The keyway in bevel gear 75 is somewhat larger than the key 76 and hence the bevel gear 75 may move to the right or to the left as viewed in Figure 2.

The movement of bevel gear 75, is determined by the movement of coupling link 61 illustrated in Figures 1 and 2. The link 61 slidably engages the hub of the bevel gear 75 in a cylindrical depression 77 whereat friction has been reduced to a minimum by proper polishing.

The position of bevel gear 75 as illustrated in Figure 2, corresponds to the energization of solenoid 66 shown in Figure 1. Upon de-energization of this solenoid 66, the spring 63 will act to move bevel gear 75 to the right, as viewed in Figure 2, and cause the disengagement of the gear 75 with another bevel gear 81. The bevel gear 81 is rotatably positioned upon a shaft 82 by bushings 83 and 84 pinned to the shaft by pins 85 and 86.

The shaft 82 is rotatably positioned by fixed bushings 91 and 92 upon a link 93 which is an integral extension of a large bevel gear 94. The bevel gear 94 is rotatably positioned upon the synchronous motor shaft 71 between the hub of bevel gear of 72 and a pinned bushing 95.

It will now become evident that with the link 61 positioning bevel gear 75, as illustrated in Figure 2, rotation of shafts 71 and 74 at identical speeds but in opposite directions will cause the rotation of bevel gear 81 about shaft 82 but will not result in rotation of bevel gear 94.

Bevel gear 96 is continuously engaged with bevel gear 94 and hence under the last mentioned condition of identical speeds, the bevel gear 96 and its attached shaft 97 will remain stationary. If the speed of the direct current shunt motor driving shaft 74 deviates at any time from the speed of the synchronous motor driving shaft 71, it is evident that bevel gear 81 will continue to rotate about shaft 82 but will, in addition, exert a force upon the fixed link 93 which will tend to drive the bevel gear 94 about shaft 71.

The angular speed of bevel gear 94 is directly dependent upon the different speed between the D. C. motor and the synchronous motor, and the direction of rotation thereof is dependent upon whether the speed of the D. C. motor is greater or less than that of the synchronous motor.

Correspondingly, the rotation of shaft 97 and the direction thereof is directly a measure of the non-synchronous condition of the D. C. motor and the direction of this deviation. As is evident from Figure 2, the angular movement of bevel gear 96 will be considerably greater than that of engaged bevel gear 94 and hence, is an extremely sensitive detector of this aforementioned non-synchronous condition.

In accordance with my invention, I propose to utilize the rotation of shaft 97 to maintain a facsimile recorder at the speed of a corresponding unit at the transmitter.

The speed of the shunt motor 24, as is well known in the art, is determined by the magnitude of its shunt field current which in turn is determined by the variable resistor 34, and additional electrical means in the differential mechanism 35. The means of accomplishing the speed control of direct current shunt motor 24 is illustrated in Figure 3.

The variable resistor 101 is connected in series with the shunt field circuit at the terminals 102, as illustrated, and hence the complete shunt field circuit comprises resistors 34 and 101, and the field itself.

The bevel gear 96 and the attached shaft 97, which is preferably of an insulating material, control the magnitude of the resistance 101 inserted into the shunt field circuit. Thus, conductive arm 103 is rigidly attached to shaft 97 by means of a pin 104, and completes the circuit from the rheostat 101 through the lines 102.

When the D. C. motor begins to run below the synchronous speed, arm 103 will tend to rotate in the direction of the arrow S, as illustrated in Figure 3. Such rotation will increase the resistance in the shunt field circuit, thereby decreasing the current and causing an immediate increase in the armature speed thereof.

It is important to note that it is desirable to have the resistor 101 of such magnitude that extremely small rotation of the arm 103 will cause a considerable variation of resistance in the shunt field circuit, thus resulting in an immediate tendency to restore the speed. Conversely, any tendency of the direct current motor to run at above the synchronous speed of the motor 37 will cause the arm 103 to rotate in the direction F, as illustrated in Figure 3, and result in an increase of

field current which will tend to restore the speed to that which corresponds to no rotation of the bevel gear 96.

It is therefore evident that by utilization of an extremely small synchronous motor governed by signals transmitted from the scanning apparatus at the transmitting station, I have been able to synchronize a comparatively large direct current motor thereby and insure proper operation of the recording apparatus 21.

The power requirement of the synchronous motor 37 is extremely small, and as may be seen from Figure 2, is only that required to overcome friction of the gears, and the rheostat mechanism. The synchronous motor 37 does not to any extent contribute directly to the driving force required by the rotatable drum and scanning mechanism 21.

Another modification of my novel speed control mechanism is illustrated in Figure 4, and utilizes the differential gear mechanism illustrated in Figure 2. Thus, differences in speed between the D. C. motor and the synchronous motor results in rotation of bevel gear 96 and attached shaft 97, the direction being dependent upon the relative speeds thereof.

As illustrated in Figure 4, a link 111 of insulating material is attached at one end to shaft 97 by means of a pin 112, and carries at the opposite end thereof a conducting contact bridge 113. The length of contact bridge 113 is sufficient to interconnect contacts 114 and 115 which are fixed to the frame of the facsimile apparatus. As illustrated in Figure 4, the circuit between contacts 114 and 115 is not completed by the bridge 113.

For this modification, a fixed resistor 116 is connected in series with the variable resistor 34 and the shunt field of motor 24 at the terminals 102, as is illustrated in Figure 1. Contacts 117 and 118 disposed at the ends of resistor 116 are engageable by the armature 121 of a relay 122. The armature 121 and an additional contactor 123 of the relay 122 are normally biased by the spring 124 and 125 respectively, into position wherein they are normally disengaged from the contacts 117, 118 and 126.

Energization of the relay 122 will cause the displacement of armatures 121 and 123 against the normal spring bias illustrated, and cause the engagement of the armatures with their respective contacts. With the contact bridge 113 in the position illustrated in Figure 4, the resistor 116 is part of the shunt field circuit. This resistor 116 has been adjusted in connection with the variable resistor 34 so as to provide a speed of the D. C. motor 24 which is above that of the synchronous motor 37 when in circuit and a speed lower than that of motor 37 when shorted out of the circuit.

As previously described in connection with Figure 2, such a condition of relative speed will cause the rotation of bevel gear 96 and hence, of link 111 in the direction marked F in Figure 4.

The continued rotation of the link 111 and its associated contact bridge 113 will ultimately cause the closure of contacts 114 and 115. Closure of the contacts 114 and 115 will, through wires 131 and 132 and the battery supply 133, cause the energization of the coil 134 of relay 122 which in turn will cause the displacement of armatures 121 and 123 against their normal spring bias.

The engagement of contacts 117 and 118 by the armature 121 will short-circuit the resistor 116 and hence reduce the total resistance in the shunt field circuit of the motor 24. This reduction will immediately result in an increase in field current which correspondingly causes a decrease in the speed of the motor 24. This decrease in speed will through the differential mechanism illustrated in Figure 2, immediately re-act to cause the rotation of bevel gear 96 in the direction marked S in Figure 4. Continued rotation in this direction will first cause contacts 114 to disengage from the contact bridge 113. However, this disengagement of contact 114 which accordingly results in an open circuit between contacts 114 and 115 will not cause the de-energization of contact relay coil 134, since this relay, when first energized, caused the engagement of armature 123 with contact 126, which through wires 135 and 136 serves to supply an alternate path for energization of the coil 134.

Accordingly, the short-circuiting of resistor 116 which tends to slow down the shunt motor 24 will continue even though 114 has been disengaged by the arm 113.

As the shunt motor continues to run below the speed of the synchronous motor, the arm 111 will continue to rotate in the direction F of Figure 4 until the contact bridge 113 leaves the contact 115, under which circumstances both paths through which relay coil 134 could be energized are open. This will immediately cause springs 124 and 125 to open circuit contacts 117, 118 and 126 resulting in the re-insertion of resistor 116 into the field current circuit of the shunt motor 24.

Accordingly, as previously mentioned, this will again, due to the predetermined value of resistor 116, result in an increase of speed in the motor 24.

Consequently, it may be seen that the electromechanical circuit illustrated in Figure 4, will serve to maintain the shunt motor 24 in a non-synchronous condition by maintaining the speed either above or below the synchronous speed of motor 37. However, it is important to note that the angle of rotation of arm 111 is comparatively great for even extremely small differences in speed between the pilot motor 37 and the shunt motor 24. Evidently, therefore, the departure from synchronous speed can be made to be extremely small by the continuous and rapid opening and closing of the contact arm 121 of the relay 122. That is to say, that the shunt motor 24 when operated by the control mechanism illustrated in Figure 4, will be continuously hunting, that is, fluctuating about the synchronous speed of the motor 37, and will on the average run at synchronous speed.

The maximum departure from synchronous speed as determined by the angular displacement of contacts 114, and 115, will be so small as to make the effect upon a straight line in a picture transmitted indiscernable.

Summarizing, therefore, the circuits of Figure 3 and Figure 4 when utilized with the mechanical linkage between the synchronous motor and the shunt motor illustrated in Figure 2, comprise a governor of the speed of motor 24. However, it is evident that the governor thus formed is at all times responsive to changes in synchronous speed which may be encountered at the transmitter, particularly if the transmitter as previously described is operated by a battery which in turn serves to generate an alternating current signal for synchronizing signal transmission.

If, as previously mentioned, between picture transmission it is desirable to operate the direct current motor 24, the latching relay 44 may be released to the open circuit position illustrated in Figure 1. This will immediately de-energize

the solenoid **66** and cause the rotation of link **61** under the influence of spring **63** as illustrated in Figures 1 and 2. This will cause slidably positioned bevel gear **75** to move to the right and result in disengagement thereof from bevel gear **81**.

Accordingly, the mechanical linkage through the synchronizing mechanism as illustrated in Figure 2, will not be complete between the shafts **71** and **74**.

The synchronous control mechanism described in the above paragraph obviously may be extended to the speed control of various other types of motors. Thus, the shaft **97** controlled by rotation of the bevel gear **96** may be used to actuate mechanism to control the speed of various other forms of motive power including the well known alternating current speed control motors.

Accordingly, I do not wish the scope of the present invention to be limited to the particular modifications described above, but to be bound by the appended claims.

I claim:

1. In a picture transmission system, a transmitter for generating signals in accordance with the lights and shades of a picture, means for generating a continuous alternating current signal of a frequency representative of the speed of said transmitter, means for transmitting said signals, a receiver for receiving said signals, means for impressing said picture signals upon a picture recording mechanism, means for driving said recording mechanism, comprising a motor, means for impressing said alternating current signal upon a synchronous pilot motor, said driving motor and said synchronous motor being mechanically coupled, said coupling comprising comprising means operative upon a speed difference between said motors to adjust the speed of said drive motor to the speed of said synchronous motor.

2. In a picture transmission system, a transmitter for generating signals in accordance with the lights and shades of a picture, means for generating a continuous alternating current signal of a frequency representative of the speed of said transmitter, means for transmitting said signals, a receiver for receiving said signals, means for impressing said picture signals upon a picture recording mechanism, means for driving said recording mechanism, comprising a motor, means for impressing said alternating current signal upon a synchronous pilot motor, said driving motor and said synchronous motor being mechanically coupled, through a differential mechanism having an element responsive to the difference in speed between said motors, said element being continuously operative to maintain the speed of said driving motor at the speed of said synchronous motor.

3. In a picture transmission system, a transmitter for generating signals in accordance with the lights and shades of a picture, means for generating a continuous alternating current signal of a frequency representative of the speed of said transmitter, means for transmitting said signals, a receiver for receiving said signals, means for impressing said picture signals upon a picture recording mechanism, means for driving said recording mechanism comprising a direct current motor, means for impressing said alternating current signal upon a synchronous pilot motor whereby said synchronous motor is continuously operative at the speed of said transmitter, a differential coupling gear between said direct current motor and said synchronous motor having an element responsive to speed differences between said motors, said speed responsive element being continuously operative to adjust the field of said direct current motor to maintain said direct current motor at the speed of said synchronous motor.

4. In a picture transmission system, a transmitter for generating signals in accordance with the lights and shades of a picture, means for generating a continuous alternating current signal of a frequency representative of the speed of said transmitter, means for transmitting said signals, a receiver for receiving said signals, means for impressing said picture signals upon a picture recording mechanism, means for driving said recording mechanism, comprising a motor, means for impressing said alternating current signal upon a synchronous pilot motor, said driving motor and said synchronous motor being mechanically coupled, said coupling comprising means to cause said recording motor to fluctuate in speed, said fluctuations being rapid and continuous and within narrow predetermined limits above and below the speed of said synchronous motor.

5. In a picture transmission system, a transmitter for generating signals in accordance with the lights and shades of a picture, means for generating a continuous alternating current signal of a frequency representative of the speed of said transmitter, means for transmitting said signals, a receiver for receiving said signals, means for impressing said picture signals upon a picture recording mechanism, means for driving said recording mechanism, comprising a motor, means for impressing said alternating current signal upon a synchronous pilot motor, said driving motor and said synchronous motor being mechanically coupled, said coupling comprising means to cause the speed of said recording motor to first rise above the speed of said synchronous motor and operative when said recording motor has reached a predetermined upper speed limit to cause said speed to fall below the speed of said synchronous motor, whereby the average speed is equal to the speed of the synchronous motor.

6. In a picture transmission system, a transmitter for generating signals in accordance with the lights and shades of a picture, means for generating a continuous alternating current signal of a frequency representative of the speed of said transmitter, means for transmitting said signals, a receiver for receiving said signals, means for impressing said picture signals upon a picture recording mechanism, means for driving said recording mechanism comprising a direct current motor, means for impressing said alternating current signal upon a synchronous pilot motor whereby said synchronous motor is continuously operative at the speed of said transmitter, a differential coupling gear between said direct current motor and said synchronous motor having an element responsive to speed differences between said motors, said element being operative continuously to insert or remove resistance from the field circuit of said direct current motor whereby the speed of said direct current motor is caused to rise above and fall below the speed of said synchronous motor.

7. In a picture transmission system, a transmitter for generating signals in accordance with the lights and shades of a picture, means for generating a continuous alternating current sig-

nal of a frequency representative of the speed of said transmitter, means for transmitting said signals, a receiver for receiving said signals, means for impressing said picture signals upon a picture recording mechanism, means for driving said recording mechanism comprising a direct current motor, means for impressing said alternating current signal upon a synchronous pilot motor whereby said synchronous motor is continuously operative at the speed of said transmitter, a differential coupling gear between said direct current motor and said synchronous motor having an element responsive to speed differences between said motors, said element cooperating with an electrical time delay circuit to insert resistance into the field circuit of said direct current motor until the speed of said direct current motor rises to a predetermined speed above the speed of said synchronous motor and then to remove resistance from the field circuit of said recording motor until the speed of said recording motor falls to a predetermined speed below the speed of said synchronous motor.

8. In a picture transmission system, a transmitter for generating signals in accordance with the lights and shades of a picture, means for generating a continuous alternating current signal

of a frequency representative of the speed of said transmitter, means for transmitting said signals, a receiver for receiving said signals, means for impressing said picture signals upon a picture recording mechanism, means for driving said recording mechanism comprising a direct current motor, means for impressing said alternating current signal upon a synchronous pilot motor whereby said synchronous motor is continuously operative at the speed of said transmitter, a differential coupling gear between said direct current motor and said synchronous motor having an element responsive to speed differences between said motors, said element cooperating with an electrical time delay circuit to insert resistance into the field circuit of said direct current motor until the speed of said direct current motor rises to a predetermined speed above the speed of said synchronous motor and then to remove resistance from the field circuit of said recording motor until the speed of said recording motor falls to a predetermined speed below the speed of said synchronous motor, said resistance variations being continuous and rapid whereby the average speed of said recording motor is equal to the speed of said synchronous motor.

WILLIAM G. H. FINCH.