

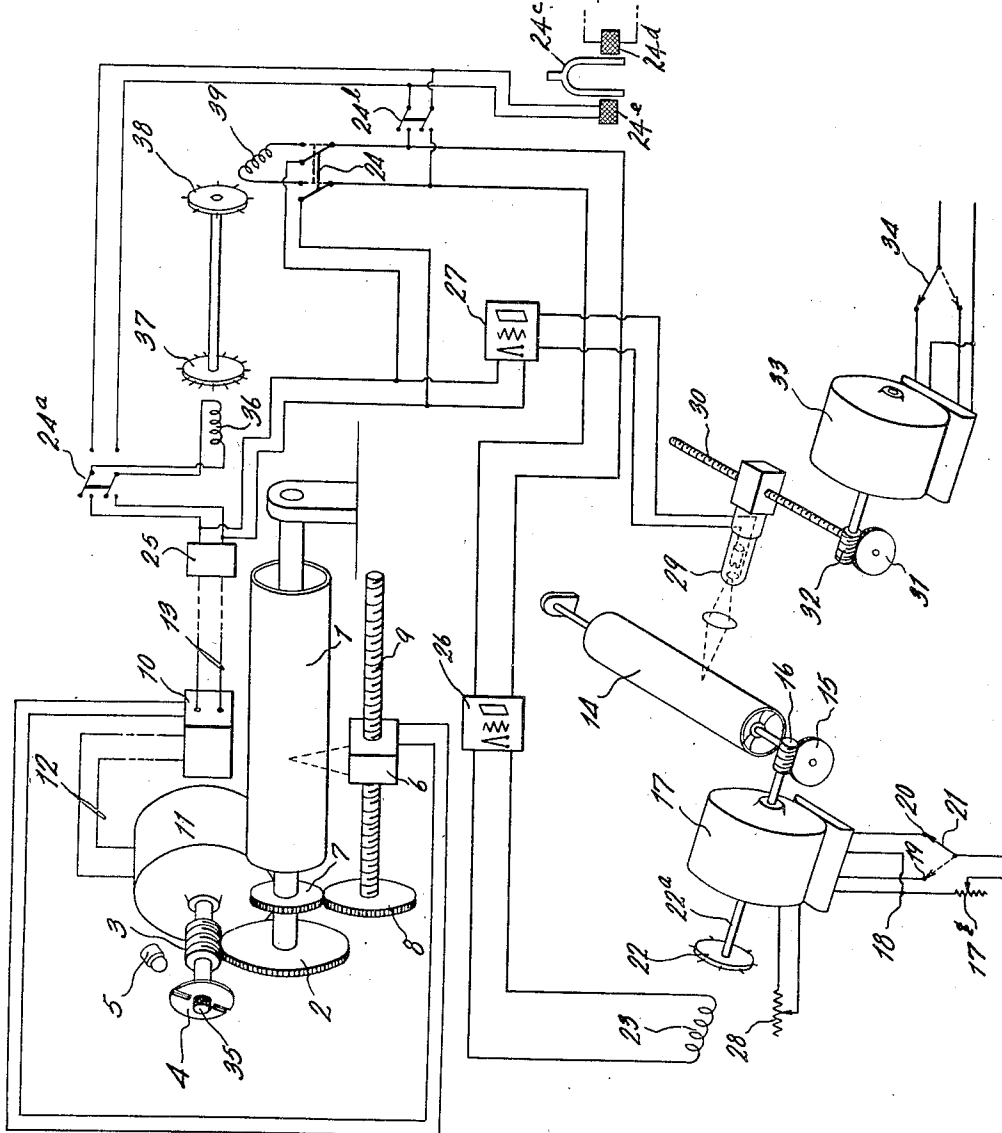
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ELECTRO-OPTICAL TRANSMISSION SYSTEM

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ELECTRO-OPTICAL TRANSMISSION  
SYSTEM

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This invention relates to electro-optical systems, and more especially to systems for transmitting visual representations to a distance and reproducing facsimiles thereof by electro-optical means.

A principal object of the invention relates to a facsimile transmission system having readily adjustable means for varying the speed of transmission or reproduction.

Another object relates to a system of facsimile transmission of the type wherein the facsimile signals are in the nature of modulated audio frequency carrier current, and wherein the speed of the scanning equipment at the transmitter or at the receiver can be adjusted while maintaining the said carrier frequency a constant function of the scanning rate.

A further feature relates to a facsimile system employing synchronous driving motors which will operate on the same impressed frequency at two or more harmonically related speeds whereby the speed of transmission or reception can be readily changed.

A still further feature relates to the method of adjusting an induction motor-synchronous motor combination so as to facilitate attaining and maintaining synchronous speed of the associated scanning equipment.

A still further feature relates to the novel organization, arrangement and relative location and interconnection of parts whereby a facsimile transmission system can be readily adjusted for different speeds of operation while permitting the widest dimensional tolerances of the mechanical parts such as gears, motor rotors and the like.

Other features and advantages not specifically enumerated will be apparent from the following detailed description and appended claims.

In the transmission of pictures or other visual displays by electro-optical or facsimile transmission, it very frequently becomes advisable to change rapidly the scanning speed. Thus, in the case of transmission over telephone lines, the scanning speed may have to be correlated to the transmission characteristics of the line. We have found that by using at the transmitter a specially constructed worm wheel for driving the transmitting drum, it is possible to employ readily replaceable worm drives each having a predetermined thread, for producing the required speed. As is well known in facsimile transmission, the apparatus must be synchronized with the utmost accuracy and while it may be possible to design a gearing arrangement between the driving motor and scanning drum employing ordinary toothed gears, we have found that where the speed is required to be changed, the requisite speed is not attainable with ordinary toothed gear wheels. However, by using a

common worm wheel which has the teeth specially "hobbed" or formed, it is possible to employ replaceable worms of different numbers of threads and still achieve the desired accuracy.

While these interchangeable worms are primarily useful at the transmitter, they may also be used at the receiver.

Referring to the drawing, there is shown in schematic form, a facsimile transmission system embodying the various features of the invention. The transmitting drum 1 around which the picture or other subject-matter is wrapped, is rotated about its axis, from the motor 11 through the worm wheel 2 and the replaceable worm drive 3 which is described in detail in application Serial No. 261,184, filed March 11, 1939 (U. S. Patent No. 2,212,807). A stroboscopic indicator wheel 4 is also carried as a unit by the replaceable worm and is illuminated by the stroboscopic lamp 5 which may be energized by currents from a source whose frequency is known. The members 3 and 4 form a readily replaceable unit with the stroboscope wheel definitely related to the pitch of the worm 3. The line feed for the illuminating optical scanning system 6 is effected by gear wheel 7 and gear wheel 8, the latter being fastened to the lead screw 9 to feed the system 6 which may be of any well-known construction including a light source and light-sensitive cell.

Associated with the drum 1 is any well-known form of optical system and light-sensitive pickup 6, and a modulating arrangement 10. The system 6 in the well-known manner includes a light source for illuminating the drum 1 with an elemental light spot, and the reflected light energizes a light-sensitive cell in the unit 6. The output of cell 6 is connected to the modulating arrangement 10. Preferably, although not necessarily, motor 11 drives an A. C. generator (not shown), for example a generator of 1800 cycle current which is fed to the apparatus 10 over the conductors 12 whereby the 1800 cycle current is modulated in the device 10 in accordance with the intensity of the light reflected from each successive elemental area of the picture on drum 1. A detailed description of such modulating system is given in Patent No. 2,015,742.

The amplified picture currents which are impressed on the transmission channel 13, therefore, have a carrier frequency which is locked to the speed of drum 1, since the motor which drives drum 1 also drives the A. C. generator. Consequently, as described in said Patent No. 2,015,742, these currents may be used to control the recording lamp at the receiver as well as to synchronize the receiving apparatus with the transmitter.

The receiver includes a rotatable drum 14 which is mounted for rotation about its axis

in suitable bearings and is driven by a worm wheel 15 carried by the drum shaft, which worm wheel is driven by a worm 16. Drum 14 is brought up to speed by a two-speed induction motor 17 having two sets of windings for the respective speeds. A common terminal 18 is provided for both windings and individual terminals 19 and 20 are provided for the other windings, these latter terminals being selectively connectable to the supply line by a switch 21. Preferably, a variable resistance 17g is connected in circuit with the common terminal and the primary of motor 17, and a variable resistance 28 is connected in circuit with the secondary winding of motor 17, for purposes to be described.

When the switch 21 is in the full line position the motor 17 will rotate, for example at 1800 R. P. M. which would be equivalent to 45 R. P. M. for the drum 14. When the switch 21 is in the dotted position, the motor 17 rotates at 3600 R. P. M. which is equivalent to 90 R. P. M. for the drum 14. Induction motor 17 is mechanically connected to the rotor 22 of a synchronous motor which controls the synchronous speed of drum 14. With this arrangement, the induction motor 17 brings the drum up to or near synchronous speed and provides enough power to take care of part of the fixed load such as steady friction from the various bearings, windage, etc. The remaining steady load and all load variations such as caused by slight speed changes at the transmitter, as well as power supply variations, are taken by the synchronous motor 22.

When the synchronism is to be controlled by the transmitted carrier, the stator winding 23 of the synchronous motor is supplied with part of the received picture carrier current through a double-pole double-throw switch 24 when the latter is in the full-line position shown. At the same time the switch 24a is closed on its left-hand contacts and switch 24b is open. It will be understood of course, that the received picture signals are suitably amplified in amplifiers 25, 26 and 27, and preferably the amplifier 26 which feeds the stator 23 is biased as will be described in detail in application Serial No. 261,184, filed March 11, 1939 (U. S. Patent No. 2,212,807). This bias is related to the resistance 28 in circuit with the wound rotor of induction motor 17 as will also be described below so as to operate the motor 17 on a predetermined portion of its torque-speed characteristic curve. The motor 17 will then be constrained to run at or near the synchronous speed of the motor 22, the latter acting as a speed control for the induction motor. Consequently, as the drum 14 approaches the synchronous speed, the motor 17 readily falls into step with the received signal.

The position of recording lamp 29 is controlled by the line feed screw 30 driven through worm wheel 31 and worm 32 from a two-speed induction motor 33 similar to motor 17. Motor 33 is provided with a switch 34 so as to connect in circuit either the low or high speed winding as desired. The lamp 29 is energized from its associated amplifier 27.

It will be assumed for purposes of illustration, that in the arrangement as shown, drums 1 and 14 are being driven at 90 R. P. M. and that the generator which supplies the carrier current to device 10 delivers an A. C. of 1800 cycles. Under this assumption therefore, switches 21, 24 and 34, are in their full line positions whereby motors 17 and 33 rotate at 3600 R. P. M. Should it be de-

sired to change the speed of rotation of the drum 1, the double-thread worm and stroboscope assembly 3, 4, is removed by loosening thumb nut 35, and is replaced by a single-thread worm as described in detail in application Serial No. 261,184, filed March 11, 1939 (U. S. Patent No. 2,212,807). At the receiver, the double-thread worm 16 may, if desired, be also replaced by a single-thread worm.

Instead of using a replaceable worm 16 to drive the receiving drum at different speeds, the stator 23 of the synchronous motor can be supplied with a different frequency current which nevertheless is related to the picture carrier, by moving switch 24 to its dotted line position. In this case, the 1800 cycle picture signal which is received over line 13, energizes the stator winding 36 of an 1800 cycle synchronous motor whose rotor is indicated by the numeral 37. Rotor 37 is mechanically coupled to the rotor 38 of another synchronous generator whose stator winding is indicated by the numeral 39. The synchronous speed of rotors 37 and 38, are so designed as to be multiples or harmonics of each other. Thus, assuming the rotor 37 is an 1800 cycle synchronous rotor then the rotor 38 may be a 900 cycle synchronous rotor in which event a 900 cycle signal is supplied through switch 34 and amplifier 26 to winding 23. The synchronous motor 22, 23, is designed so that it can operate synchronously at two different speeds, for example, 900 R. P. M. or 1800 R. P. M. or any harmonic thereof. At the same time, switch 24 was operated to its dotted line position, switch 21 was likewise operated to its dotted line position causing motor 17 to run at half speed, thus driving drum 14 at 45 R. P. M. in synchronism with the drum 1 of the transmitter. The line feed motor 33 however, may, if desired, be left running at 3600 R. P. M. but if desired, it may be run at half speed by operating switch 34 to the dotted line position.

In the foregoing description, the synchronization is effected under control of the carrier current which is transmitted over the line or channel 13. In certain cases, it may be desirable to effect the synchronization locally at the receiver under control of a vibrating member such as a tuning fork, an oscillator or the like. For this purpose, there is provided a tuning fork controlled oscillator 24c which is adapted to be excited by a source of constant frequency oscillations (not shown) connected to the exciting winding 24d. Associated with the fork is a pick-up winding 24e by means of which the local oscillations are transferred either directly to the amplifier 26 or through the frequency changer 37, 38. Assuming that the fork 24c delivers an 1800 c. p. s. signal and assuming that this signal is to be used directly to synchronize, then the switch 24b is closed on its associated contacts whereby pick-up winding 24e is connected directly to the synchronizing amplifier 26. In this condition, the switch 24a is maintained open. When it is desired to deliver a 900 c. p. s. signal to the amplifier 26, the switch 24b is opened and the switch 24a is closed on to its right-hand contacts whereby the winding 24e is connected in circuit with the winding 36 of the frequency changer. Consequently the drum 14 may be driven at either of the two frequencies, under control either of the carrier signal method or under control of the local synchronizing signals from winding 24e.

While one particular embodiment has been

described herein, it will be understood that various changes and modifications may be made without departing from the spirit and scope of the invention.

This application is a continuation-in-part of application Serial No. 261,184, filed March 11, 1939 (U. S. Patent No. 2,212,807).

What we claim is:

1. A tele-facsimile system comprising a transmitting scanner for controlling the generation of facsimile currents, a receiving scanner, a synchronous motor for driving said receiving scanner, said motor being designed to run synchronously at two different speeds, means to receive and apply said facsimile currents to reproduce the lights and shades of the subject scanned by said transmitting scanner, a source of regular frequency synchronizing oscillations local to said receiving scanner, means to apply said oscillations to drive said motor at one synchronous speed, a frequency converter comprising an input stator, an output stator, and toothed rotors for said stators, said rotors being connected to rotate in unison, and means to connect said local source to said input stator, and means to drive said motor at said other synchronous speed under control of said output stator.
2. A tele-facsimile system comprising a transmitting scanner, a receiving scanner including a rotatable drum and line feed mechanism, a synchronous motor for rotating said drum, a motor for driving said line-feed mechanism, said synchronous motor being designed to operate synchronously at two different speeds which are multiples of each other, a source of regular frequency synchronizing oscillations local to said receiving scanner, a frequency converter comprising an input stator, an output stator, and toothed rotors for said stators, said rotors being connected to rotate in unison, a switch effective in one position to apply the oscillations from said local source without conversion to operate said motor at one synchronous speed, said switch being effective in another position to apply the said oscillations to the input stator of said converter before application to said motor, to drive said motor at the other of said synchronous speeds under control of said output stator.
3. A tele-facsimile reproducing system comprising a rotatable scanning drum adapted to be driven at two different speeds in accordance with the desired detail of reproduction, means to drive said drum comprising a two-speed induction motor and a two-speed synchronous motor, means to drive said induction motor from the local power supply means, a source of regular frequency oscillations for generating a synchronizing signal independent of the speed of a distant transmitter, a frequency converter comprising an input stator and an output stator, and toothed rotors for said stators arranged to rotate in unison and means to operate said synchronous motors at one of said speeds under control of said oscillations independently of said converter, and means to apply said oscillations to the input stator of said converter to operate said synchronous motor at the other of said speeds under control of said output stator.
4. A tele-facsimile reproducing system according to claim 3 in which said frequency converter is provided with a switching arrangement where-

by the said oscillations can be applied to control said synchronous motor after being acted upon by said frequency converter.

5. A tele-facsimile reproducing system comprising a rotatable scanning drum adapted to be driven at two different synchronous speeds in accordance with the detail of reproduction desired, a line-feed device, means to drive the drum comprising a two-speed induction motor coupled to a two-speed synchronous motor, a separate induction motor for driving said line-feed device, a tuning fork-controlled source of oscillations, means to operate both said induction motors from local supply mains, and means to operate said synchronous motor selectively at two different speeds under control of said tuning fork-controlled source, the last-mentioned means including a frequency converter having an input stator, an output stator, and a pair of rotors for said stators arranged to be operated in unison, and switching means effective in one position to impress said oscillations on the motor independently of said converter and effective in another position to impress said oscillations on said input stator to control said motor by said output stator.

6. A tele-facsimile system comprising a facsimile transmitter for producing picture currents having a regular frequency component substantially locked to the speed of a transmitting scanner; a tele-facsimile receiver including a scanner, a picture signal amplifier, and a synchronizing signal amplifier; means to apply received picture signals simultaneously to both said amplifiers for converting electrical synchronizing waves from one frequency to another frequency; a frequency converter; switching arrangements for selectively connecting said frequency converter in circuit with the synchronizing amplifier prior to the application of said picture currents to said amplifier whereby the receiver can be synchronized with the transmitter at two different speeds through the intermediary of said regular frequency component; a source of regular frequency synchronizing oscillations local to the receiver; and other switching arrangements for connecting said local source to said synchronizing amplifier whereby synchronism is effected independently of said regular frequency component.

7. A tele-facsimile receiver comprising a rotatable scanning mechanism, means to receive synchronizing signals from a distant transmitter, means to generate other synchronizing signals locally at the receiver, a frequency converter common to both said signals for converting electrical synchronizing waves from one frequency to another frequency, a first switching arrangement for selectively connecting the received synchronizing signals directly to said synchronizing amplifier, and for selectively connecting the said signals to said synchronizing amplifier after being acted upon by said converter, and a second switching arrangement for selectively connecting said local source directly to said synchronizing amplifier or after being acted upon by said frequency converter whereby said scanner can be driven at two different synchronous speeds in accordance with the detail of reproduction desired.

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