This invention relates to systems for transmitting to a distance synchronized moving images and sound, by such means as motion picture film provided with recorded sound carried upon the same film or upon a separate record or records. Such films as carry both visual and aural records are now provided with a sound track situated at one side of the image and bearing a constant spatial-temporal relationship to the image record, this relationship being such that apparatus for recording or reproducing the sound and the image can operate simultaneously upon different portions of the film, and yet produce proper ultimate synchronization of the two effects.

This invention has for one of its objects a provision of means for producing by the employment of film such operations as are necessary for transmission of the image and the sound record to a distance.

Another object is to combine such transmission with the transmission of uniform synchronizing signals over a common channel of communication.

Another purpose is to provide apparatus which can be readily changed so as to operate with either "sound" or "silent" films, by simple and rapid mechanical adjustments.

A further object is to allow picture film not carrying a sound track to be scanned and kept in synchronization with an external sound record, such as one of the usual disc type.

Another object is to allow continuous motion of the film throughout the transmitting apparatus, instead of the intermittent motion heretofore employed in projecting motion picture film.

My invention includes picture transmission and sound pick-up devices as well as synchronizing means applying to both the synchronizing of sight and sound and to the synchronizing of transmitter and receiver. This synchronization may be facilitated by operation of both transmitter and receiver from a common power line. In a preferred form illustrated in the accompanying drawings:

Fig. 1 is a standard motion picture film with sound track diagrammatically represented as of the variable intensity type, shown in side elevation and in relation to a scanning device according to my invention.

Fig. 1A shows a modified form of the screens of Fig. 1.

Fig. 2 is a plan view of the apparatus of Fig. 1.

Fig. 3 is a graphical representation of a typical composite wave form substantially as produced by a transmitter scanning the image of Fig. 1 on the line M—N.

Fig. 4 shows a "silent" film i.e., a film having no sound track used in this system.

Fig. 5 shows a wave form corresponding to the use of silent film as in Fig. 4.

Fig. 6 illustrates a combined picture and sound pick-up assembly.

Fig. 7 shows a transmitter utilizing a "silent" film synchronized with a disc sound record.

Figs. 8, 9, 10 show details of methods of automatically starting a film and sound record in synchronization.

One principle of my invention is illustrated by the drawings, Figs. 1 and 2, where 1 is a standard sound film, with sound track 2, and guide sections 3 perforated at 6. A picture is diagrammatically shown by 5.

Below this film (and shown spaced therefrom for purposes of clearer illustration) is a section of the edge of a scanning disc 10. The film 1 is in continuous downward motion, as indicated by the arrow, past the slit 14 in plate 16 which may be adjustable as to width but is in fixed position, and scanning disc 10 is in rotation as 25 likewise indicated by the arrow thereupon. Disc 10 is provided with radial slits 11 preferably narrower than slit 14 and cooperating with it to scan the image on the moving film.

At 20 in Fig. 2 is diagrammatically shown a 30 light source, casting a line of light upon a film image to be scanned, and at 21 a photo electric cell actuated by the scanning beam after passage through the film and scanner mechanism. The lines 22 represent the rays bounding the 35 beam of light utilized during the scanning process.

Wires 23 convey the electrical output of the device to the usual amplifiers and wires 24 furnish energy to activate light source 20.

The width of image scanned by this mechanism is delimited by movable screening pieces 12, supported on fixed members 15 and adjustable in relation to one another and to the film by the cooperation of slots 16 in the movable screens, 45 and fastening devices 13 in the fixed members 15. Any equivalent mechanical construction allowing adjustment of these screens can be employed. If desired, the film may be located to pass at a point remote from the scanning slot and disc, and the picture images projected optically upon the scanning system.

The relation of the distance between adjacent slits of the scanning disc, width of the aperture between the screens, and the width of various 55
portions of the film is of importance in the operation of my invention and to more clearly bring out its relationship I have indicated some important distances by letters and dotted lines in Figs. 1 and 4.

Referring to Fig. 1—AB is the width of the left-hand guide section. BC is the width of the sound track. CD is the width of the image track. DE is the width of the right-hand guide section. EF is a distance equal to BC, but not an actual physical measurement appearing on the film.

As shown by prolongation of these lines, the active scanning distance is delimited by the screens 12 to coincide with the portion CD of the film. Thus the photo-electric response is limited by the width of the visual image track.

The distance between two successive slits of the scanning disc, as indicated by dimension lines marked AD', is made equal or, where a projection system is employed, proportional, to the distance AD upon the film.

As the scanning disc rotates its is evident that there will be a time interval when no slit is scanning the image. This interval is spatially represented by AD'—CD. Since AD' = AD, this differential interval equals AC. Since AB = ED by the usual construction of motion picture film, and since EF was selected to equal BC, therefore adding equals, we obtain AC = DF. This means that the intervals of non-excitation of the light-responsive device 21 will be uniform, both in regard to their duration and their spacing from one another.

In Fig. 1A both screens are shown united into a single structure to facilitate adjustments.

In Fig. 3 is shown an approximately representation of the current curve due to an ideal photo electric cell when responding to the scanning of the image of Fig. 1, for one row of horizontal elements corresponding to the line indicated by MN. This curve does not show the current as delivered by the cell, but an exact inversion of the same. It is well known that when employing the usual resistance coupled multi-stage amplifier, such inversion is secured at alternate stages and corrected at each subsequent stage. The current pulses are ordinarily made "direct", i.e. proportional to the light intensity at any instant, for final delivery to the transmission channel.

In the usual method of transmission, these "direct" current impulses preserve their character while on the transmission channel, so that greater light intensity gives greater current, or greater high frequency energy, if carrier currents are employed.

In the receiver these signals may be inverted during amplification, but are usually delivered to the final translating device in the direct form.

With my invention, the inversion described at the transmitter, allows the inverted signal to pass over the transmission channel, and at the receiver to be re-inverted before final delivery to the translating device.

While not confining myself to the transmission of such an inverted signal, to be corrected by reinversion at the receiving station, I consider this inverted transmission preferable for some purposes and is a part of my invention, constituting an improvement over the prior art.

The intervals AC and DF as continuously repeated, constitute uniform and rhythmic impulses, positive in nature for the inverted signal shown, and negative for a non-inverted signal. These impulses can, by virtue of their distinctive character, be employed at the receiving mechanism to maintain synchronization of sound parts corresponding in general function to the transmitting scanning disc here shown and yet do not demand a transmission channel separate from that used for the image signals.

In Fig. 4 is shown the apparatus of Fig. 1 adapted to transmit film not bearing sound recorded thereon. In this case the image bearing portion of the film will be wider due to the omission of the sound track. Accordingly the screening plates are both shifted preferably so that one half of the width corresponding to the former sound track will be masked on each side.

This leaves the ratio of picture signal to synchronizing impulses the same as before since AD' equals AD of Figs. 1 and 3. Thus no readjustment of the receiver is required because of change from one type of film to the other at the transmitter. The loss of this small amount of the image space is of little importance compared with the maintenance of uniformity of transmitted impulses for the synchronizing system here employed.

Fig. 5 shows plainly that the synchronizing impulses remain unchanged. This is also evident from the fact that the slit spacing on the disc and the aperture width between the screens are both unchanged from their values as illustrated in Fig. 1, for "sound" film.

In Fig. 6 is illustrated diagrammatically the pick up for both image and sound operating upon a continuously moving film 1, carrying both records, which is moved by sprockets 29 from reel 32 onto reel 33, being optically scanned at the point 31 and having the point 39 located (either ahead or behind the image-scan point) at the proper distance from said point 31, to accord with the temporal-spatial relationship of the recording of image and sound upon the film.

Motor 28 drives scanning disc 10, and light source 20 and light cell 23 cooperate therewith to scan in the usual fashion. At point 33, light from a source 34—fed energy by wires 27—with suitable optical system, not shown, passes through the sound track and is analyzed into an electrical signal by the light sensitive cell 35 with wires 26 for output. The output of this cell is magnified by suitable amplifiers and passed to a communication channel. The optical pick-up system may be similar to that of Fig. 1.

Distance 30—31 can be varied to secure proper synchronization, by moving either of these points with respect to the other, 30 being in general the simpler to move.

In case that a non-sound bearing film is used, it may be synchronized with a disc, upon which appropriate sound has been recorded, in the manner indicated in Fig. 7, where the scanning disc and the record turntable are shown as operated by preferably synchronous motors 40, 41 driven from the same electrical energy source delivered over a common distributing channel 42. The synchronous motor 41 may be provided with moving elements of comparatively great mass such as the flywheel shown at 47 or other means may be employed to secure a "flywheel" effect. This is better because the manner in order that the motor, which is already operating at synchronous speed, be caused to leave this speed when the electrically governed clutch 43 controlling the operation of the turntable 48, the latter preferably of light weight, is operated upon the starting of the film moving mechanism 29, 45, 50, 51 by the means 75.
hereinafter indicated. 46 is a suitable device abstracting power from the power mains and delivering it to clutch 43, when contact device 44 is operated. 52 is a sound pick-up, 53 a transmission circuit to amplifier 54 whose output is delivered through conductors 55 to the channel for sound transmission. Scanning disc, light source, photoelectric cells, etc., are numbered as in Figs. 1 and 2, and may be identical with those in Fig. 10 elements in that figure.

Drive sprocket 29 upon shaft 51' receives power through clutch member 48, upon the same shaft which latter in turn is actuated by clutch member 50. This last member is driven by key 80 from shaft 51 upon which it can slide to engage member 49. Shaft 51 is indirectly driven from motor 40, and therefore is in synchronism with the scanner disc. Suitable speed reduction gears 10, chain 11, sprocket wheel 72, and shafts 73 and 74, may be employed for this purpose. The slots 56 in member 48, determine the functioning of the clutch at certain points only. This assures the proper relationship of the scanner disc and the film movement, and likewise assures that the receiver, kept in synchronism by the device of Fig. 1, or otherwise, will receive the inauguration of the transmission in the usual manner, provided it was properly adjusted for a prior film transmission. Figure 8 represents a portion of one device for securing simultaneous starting of record sound 48 and the film. Upon record 48 are shown blank groove A and sound bearing groove B, joining point C. If there were no lag or inertia to the entire starting mechanism the needle of the sound pick-up would rest at this point. Due to the inevitable presence of some inertia it may be desirable to start the record slightly before the sound track itself is reached. B represents such a prior point of needle rest.

Likewise some yielding device such as a damped spring member, not shown, may be employed between the clutch and turntable, to lessen the shock of starting suddenly. This member should be so constructed as to yield only at starting, and thereafter, during operation, to return automatically to an unflexed position.

Fig. 9 shows one method of giving the automatic starting impulse. Starting point E upon the film is in the position of its normal use. A depression 61 in the edge of the film, at a suitable interval from point E, allows a light contact actuating member 88 to function, as said depression passes this member, thereby closing momentarily contacts 83, controlling the release of the record clutch through wires 68 and the control mechanism 44-45-46-40 of Fig. 7.

Fig. 10 indicates another method of deriving the starting impulse, where the contact actuating member 88 momentarily falls into a depression 61' in a disc 87, mounted on the shaft 51', bearing driving sprocket 29.

In order to start transmission with any of these devices, the film and sound disc are set to the starting marks. The motors 40 and 41 of Fig. 7 are running. Clutch device 49-50 is open and hence the film stationary. When ready to inaugurate transmission, this clutch may be closed by hand or otherwise. Upon rotation of sprocket 28, a consequent movement of film 4, the contact making devices of Figs. 9 or 10 function at the proper time. The electrical impulse derived therefrom cooperates with signal power box 45 and electrically operated clutch 43, to engage the latter, thus starting synchronous transmission, as explained in the connection with Fig. 8.

My invention has many advantages which are apparent from the foregoing description, of which some are here mentioned. The use of motion picture film in continuous motion at both the image and the sound pick-up points greatly simplifies the operation of the transmitter system. No complicated means for exposure of a single image held stationary for a fixed interval while being scanned is needed. Also no "loop" of film between the two pick-up points is needed, thus promoting more accurate synchronization of image and sound. Another advantage consequent from the use of film continuously moved is that less power is required for its movement, than when it is stopped and started many times per second, as in the usual mode of operation.

This allows smaller driving motors to be used than with intermittent motion, for equivalent constancy of speed, or vice versa.

Likewise the wear and tear on the film, especially around the sprocket holes, will be lessened. Operation will be more nearly silent. Economy of apparatus and maintenance thereof will result.

Another advantageous result of continuous motion of film, is that the intervals ordinarily caused by the movement of film, between pictures, will be greatly reduced, and with pictures spaced properly upon the film, may be made 20 to almost reach zero. This means a greater average illumination at the receiver, amongst other advantages.

The presence of a time lag between throwing the load upon film drive motor and sound disc 25 drive motor, respectively, distributes the sudden load upon the power line in a fashion less likely to cause disturbances thereof.

The employment of a single channel for the transmission of image and synchronizing impulses results in simplicity of apparatus, conservation of channels, especially important for radio transmission, and economy due to saving of apparatus, lines, power, etc.

The slight adjustment of the screening members, necessary to change from sound to silent film is easily made, and may be performed simultaneously upon both members by simple mechanical means, such as making the members 12-12 integral as a diaphragm plate having a rectangular aperture of width C-D Fig. 1. The injection of signals, giving a positive character to the synchronizing signals, as well as to shaded portions of the image, makes use of the power available to keep a higher average level, and promotes easier reception, especially with a radio link of varying attenuation present in the transmission channel.

The arrangement of Fig. 7 allows either special or the usual starting marks of records and films to be employed in order to assure immediate synchronization, upon starting. Also special starting systems other than those of Fig. 8 can be used. A dark or light section in the film can actuate a special light sensitive cell, for example, which can actuate the record clutch through a suitable amplifier and relay system, the essential being to start the film in proper phase relation to the line alternations and hence all receivers synchronize therewith, and to start the sound synchronously with the film.

Many variations in the details of the apparatus herein described as illustrative of my invention are possible without departing from the scope of the same, as set forth in the appended claim.
The light source and light sensitive cell may have their relative positions reversed instead of allowing the illumination of only one element of the film at one moment. The method shown, however, may be of advantage if the light is accompanied by a considerable amount of radiant heat. Whichever arrangement of these two units is employed, it is possible, and may be preferable, to confine the illuminating beam to cover merely the total area of the fixed slot. This may be done by well known optical means. For example, a straight filament lamp may lie in the focal axis of a cylindrical mirror, or cylindrical lenses may be employed, or a simple apertured screen.

The screens delimiting the horizontal size of the image scanned may be transparent in part for purposes of improved synchronization by modified synchronizing impulses, as described in my co-pending application Ser. No. 465,126, for Television synchronization.

Movements of these masking screens may be coordinated with each other and/or with other mechanical or mechano-electrical movements designed to rapidly and expeditiously secure such rearrangements, reconnections and readjustments of the illumination of electrical units, and of the mutual cooperation of the same, as may be needed to readily change the transmission from that of silent to that of sound film (either recorded on the film or externally) or vice versa, as the case may be.

To aid in securing synchronism it is often desirable, when possible, to operate or control the scanning elements at both transmitter and receiver from a common source of power, for example by using synchronous motors driven from a common power network carrying alternating current of a uniform frequency.

In case that it is desired to operate the device with a separate sound record not made in synchronism with the film, it is possible to employ the adjustable speed coordinator shown in my co-pending application, Ser. No. 455,677, for Moving picture and sound control for the securing of this result.

Other modifications in the mechanisms and processes may be made within my invention the scope of which is defined in the claim.

I claim:

A television transmitting system operating upon motion picture film bearing a series of discrete images to be transmitted, including means for scanning said film transversely of its length and at a relatively high speed, discrete and independent means for moving said film in the direction of its length so as to cause it to be scanned at a relatively low speed in a direction perpendicular to said first-mentioned scanning, and unitary coupling means whereby said means for moving said film may be made operative only at a predetermined point of phase in relation to the position of the boundaries separating said series of discrete images and are prevented from becoming operative at all other points of phase relationship.

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