Aug. 4, 1936. H. P. DONLE 2,049,897

TELEVISION METHOD AND APPARATUS

Filed June 11, 1932

Fig. 1.

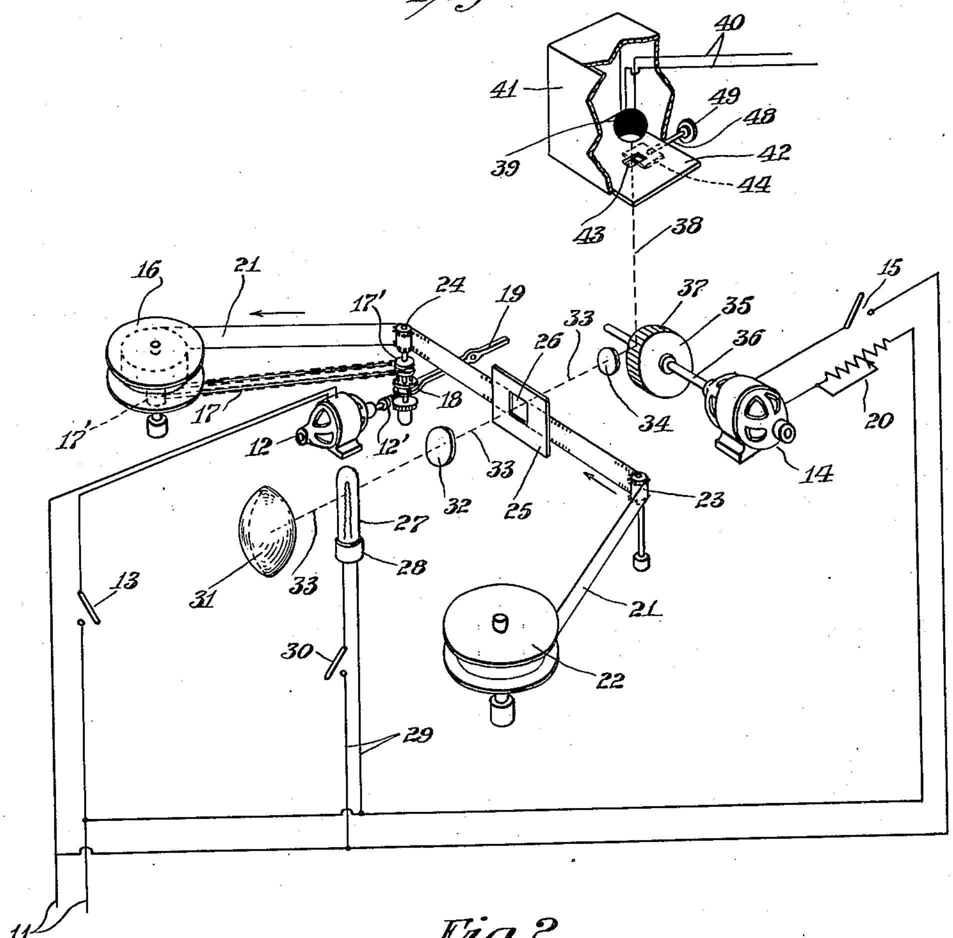
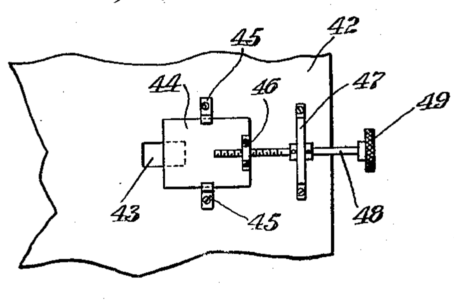


Fig. 2.



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TELEVISION METHOD AND APPARATUS

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Application June 11, 1932, Serial No. 616,607

1 Claim. (Cl. 178—6)

The present invention relates to an improved means and method for scanning motion picture film, as used in television transmission and the like.

More particularly this invention comprises a novel arrangement of apparatus and mode of operation of the same for easily and efficiently scanning motion picture film in continuous motion, and for translating its optical values into corresponding values of electrical current.

One purpose of this invention is to allow a comparatively simple and inexpensive light source and optical system to be employed in scanning motion picture film.

Another object is to attain greater optical efficiency in such scanning apparatus without the use of optical apparatus of great cost or complexity.

A further object of this invention is to use moving parts which do not include apertures, lenses, or optical parts other than simple mirrors, of a great degree of accuracy for the purpose of scanning motion picture film.

Another purpose is to allow the ready synchronization of a plurality of television transmitters operating from a common power source, so that a receiver will remain in synchronism with any one of the transmitters which may be operating at any given instant, and will not require resynchronization if a different transmitter is put into operation.

A still further purpose is to confine the necessity for a high degree of mechanical and optical precision in scanning apparatus to a relatively small number of substantially simple mirrors.

Yet another object of this invention is to provide substantially instantaneously operative and mechanically simple means for the control of one or both dimensions of an elementary scanning area in television scanning systems.

A limitation common to many previously employed methods of scanning has been the necessity of providing a light source whose optical output would be concentrated to a great degree. Optical methods of securing such a high degree of concentration frequently have proven to be both expensive and inefficient. The present invention does not attempt to concentrate the light beam to such an excessive extent, but leaves it of a cross section covering the area of an entire line of the picture to be transmitted, i. e., much greater than that of a single elementary area.

Another difficulty with previous scanning apparatus has been the necessity of providing expensive and elaborate scanning lenses or apertures located in moving parts. The present invention confines the use of any optical device located upon moving parts to the provision of a relatively small number of substantially simple mirrors upon the surface of a drum or the like. Such mirrors may be produced by comparatively simple and inexpensive milling, plating and polishing operations or may be separate structures affixed to the drum.

A further limitation of other methods of scanning has been the large size of apparatus, usually involving large moving discs or drums. The present invention utilizes parts of small size and a relatively short light transmission path, thus allowing a compact assembly of the whole.

The present invention utilizes certain means and methods disclosed in my co-pending application, Serial No. 544,718, filed June 16, 1931.

This invention broadly comprises the substantially continuous movement of motion picture film before an opening whose size substantially exceeds that of a single elementary area and is commensurate with the size of at least a complete line of the picture upon the motion picture film. A comparatively broad beam of light is projected through this opening and the film which lies before the same. The beam which has passed through the film continues through an objective lens and is then reflected by means of a plurality of mirrors on a drum, which latter is rotated so as to cause a scanning motion in one dimension of the images reflected therefrom upon one face of a camera obscura containing a photo-electric cell. The face of the camera which receives the reflected image is provided with an opening at least one of whose dimensions correspond to those of an elementary scanning area. Since the reflected image is moved in one direction by the motion of the reflecting mirrors, and in the other direction by the motion of the film, a complete scanning of the subject upon the film takes place as its image sweeps over the aperture in the camera face.

The details and operation of this invention will be more clearly apparent from the appended drawing where:

Fig. 1 represents in perspective the essential details of a scanning system illustrating one form of my invention.

Fig. 2 shows a detail of one form of apparatus for adjusting the size of an elemental scanning area, which may be employed with this system.

Referring now especially to Fig. 1, the energy for operation of the apparatus is conveniently supplied in an electrical form over conductors 11. A motor 12 is controlled by switch 13 and another motor 14 is controlled by switch 15. These two motors are preferably operated synchronously with one another.

Motor 12 serves to drive a motion picture film sprocket 24 and take-up reel 16 through the intermediary of gears 12′, a clutch device 18 actuated by a control handle 19, and a belt 17 engaging pulleys 17′ upon the sprocket and reel shaft.

The clutch device may be of any suitable type but is preferably of the type disclosed in my copending application above referred to, which type allows the driving and driven members of the clutch system to engage one another only at certain predetermined angular relationships between the same, in order that the motion picture image shall be properly framed in one dimension. At 20 is indicated an adjustable series impedance which may conveniently be employed to determine the phase angle relationship of motors 12 and 14. This method of changing the phase angle of one moving element scanning in one dimension in relation to another moving element scanning in the other dimension in order to secure proper framing in relation to each other is disclosed in my co-pending application 558,486, filed August 21, 1931, and any of the alternative forms therein described may likewise be employed for this purpose.

A motion picture film 21 passes from the reel 22, upon which it is wound, over a suitable idler 23 and driving sprocket 24 and then is rewound upon reel 16. During its traverse this film passes before a mask or screen 25 provided with an opening 26 which may be substantially of the same length as a single complete picture upon the film, or may be made slightly smaller than the picture in the dimension of line-scanning in order to secure synchronizing signals. This opening should be at least as wide as a single elementary area.

A suitable light source 27 is provided, which is shown as an incandescent lamp preferably furnished with a long and narrow filament, such as the type produced by coiling a length of filament into one or more helices. If a lamp of the type with more than one helix is employed, I prefer to turn the lamp at such an angle that a plane passing through all of the helices shall fall almost in the line of projection from the light, so that the beam emitted shall have a substantial part of its intensity concentrated in a relatively narrow path.

The light source 27 may be provided with a suitable base or socket 28 and may be connected by conductors 29 through a suitable controlling switch 30 to any appropriate source of electrical energy such as the line wires 11.

Behind the light source I prefer to place a reflector 31 in order to increase the efficiency of projection in one direction. This reflector may be of any suitable optical type. A condensing lens 32 is preferably placed between the light source and the active area of film 21. While I have shown this condensing lens as of a spherical type, it is also possible to employ at this point, either in lieu of lens 32 or in addition thereto, a cylindrical lens with its axis parallel to the filament of the light source 27. Both the filament and the axis of curvature of this lens, if the latter is employed, are placed at right angles to the direction of motion of the film 21. The use of an elongated filament and/or a cylindrical lens enables a greater concentration of the light emitted by the filament in a direction across the film which is passing behind screen 25. While such concentration is not necessary to this invention, it may increase the brilliancy of illumination of the portion of the film which is actually being scanned at a given instant and accordingly may be desirable.

The path of the light emitted from source 27 is indicated by a dotted line 33 and is shown as passing through the moving film 21 and then through an objective lens 34. This latter objective lens may be omitted, modified or added to, if the mirrors 37 be suitably modified so that they will project upon the camera a real image of the subject being scanned.

Motor 14, previously referred to, is provided with a drum 35 preferably located directly upon an extension of its shaft 36, although other less direct means of drive may be employed. Drum 35 bears upon its periphery a plurality of mirrors 37. These mirrors may be of any suitable material such as silvered glass or suitable metallic materials such as chromium or Monel metal. These mirrors may likewise either be constituted of independent structures suitably affixed to the periphery of drum 35, or they may be formed directly upon the surface of the drum, if the latter is of a suitable material, such as, for example, one of the metals above mentioned.

The light rays 33 after passing through lens 34 impinge upon the mirrors 37 and are reflected therefrom at an angle whose average value may conveniently but not necessarily be such that the incident and reflected beams are mutually at right angles. The path of the reflected rays is indicated by the dotted line 38. I prefer to have the beam 33 of such width in the direction of the line scanned on film 21 that it will cover the surface of two adjacent mirrors 37 at a single instant. This is done in order to ensure the presence of at least one complete mirror in the path of the light beam at all times. Under these conditions, the utilized reflected light beams 38 will be of substantially uniform brilliancy irrespective of the angular position of mirrors 37 while in the active scanning field.

The light sensitive cell 39 is connected by conductors 40 to the amplifier system which may be of any customary type. This cell is enclosed in a substantially opaque camera 41, which is shown broken away in the drawing to more clearly indicate the details of construction.

Referring now in addition to Fig. 2, the lower surface 42 of camera 41 is provided with a suitable opening 43 over which slides an opaque shutter 44. This shutter may have its path determined by suitable guide clips 45 and be provided at the end distant from aperture 43 with a fixed internally threaded member 46. Upon another portion of the face 42 of camera 41 is provided a stationary thrust member 47. A rod 48 is threaded along its length in a manner suitable to engage moving threaded member 46 and provided with collars on either side of thrust member 47. This rod may conveniently be provided with a knurled handle 49 for purposes of adjustment. This shutter device serves to vary the size of scanning aperture 43 in one direction. A similar device may be employed, if so desired, to delimit aperture 43 in the other dimension.

The operation of the apparatus of my invention is substantially as follows, although the sequence of parts and their positions relative to one another may be varied without departing from the spirit of the invention.

The motors 12 and 14 are set in operation in synchronism with one another and the film 21 threaded into position. The light source 27 is excited and the beam of light proceeding through film 21 and objective 34 is reflected by mirrors 37 upon drum 35 and forms several adjacent images of the film subject upon the lower camera surface 42, which images are moving in one direction due to the action of the moving mirrors 37. These images are focused by means of the objective lens 34 and adjustment of the optical distances of various parts of the system in a manner well known in the art. The number of mirrors 37 which are employed and the angular speed of drum 35 will determine the frequency of traverse of these images across aperture 43. As an image sweeps over aperture 43 it is scanned in one dimension by the relative motion between the image and the aperture.

In order to initiate scanning in the other dimension clutch device 18 is actuated by means of control lever 19. The special clutch system indicated in Fig. 1 ensures the setting into motion of film 21 at a certain position or positions, as indicated in my co-pending application Serial No. 544,718, previously referred to. This determines the proper framing of the image in one direction, since the movement of film 21 in a direction at right angles to light beam 33 secures scanning in the dimension at right angles to the scanning caused by mirror drum 35.

The scanned light passing through aperture 43, falls upon photo-electric cell 39 and is transformed into corresponding electrical impulses which are transmitted over conductors 40 to the usual amplifying apparatus and may then be employed for transmission to a distant point by wire or radio channels.

The device of Fig. 2 may then be manipulated by the operator so as to change the size of an elementary scanning area in one dimension. Certain advantages of varying one dimension of a scanning area are set forth in my co-pending application Serial No. 433,670 filed March 6, 1930, and include the production of a picture of high detail without unduly increasing the number of scanning lines.

The mechanism disclosed in the present invention allows the ratio of the two dimensions of a scanned area to be easily and accurately adjusted without causing any interruption of the scanning action. This is particularly desirable as films vary in density and it has been found desirable in many cases to increase the size of an elementary scanning area when the film is very dense, thus allowing more light to fall upon the photo-electric cell. On the contrary, when the film is of a lower density, it is possible to secure greater detail in the transmitted image by reducing the size of an elementary scanning area, as previously mentioned. The adjustment of this slit is thus seen to act as a volume control at the transmitter.

While not limiting myself to any particular dimensions or details of the apparatus employed, the following figures are representative of apparatus which has been successfully operated.

A standard 35 m. m. motion picture film with four sprocket holes per frame may be passed over a driving sprocket having sixteen teeth, thus giving four frames per revolution. This sprocket may be driven at 300 R. P. M., thus giving a picture repetition frequency of 20 pictures per second.

To secure the frequently employed scanning rate of 60 lines per picture, a mirror drum using 40 mirrors and driven at 1800 R. P. M., may be used. Such a drum may conveniently be three inches in diameter and one inch long. The separate mirrors may then have a width of approximately 0.23 inch and a length of one inch and may be firmly secured to faces milled upon drum 35.

As a light source I have found it convenient to employ a standard 500 watt motion picture projection lamp. A condenser lens having a focal length of three inches and a diameter of two inches has been found suitable and an objective lens with a focal length of 2½ inches and a diameter of one inch has been found suitable when placed approximately 3½ inches from the film.

The aperture in my camera box containing the photo-electric cell may be placed approximately 8¾ inches from the active mirrors on drum 37 and the aperture therein may have an average size of approximately 0.03 inch in the fixed dimension and be variable over a considerable degree in the other dimension.

I have found it desirable to so adjust the focal length of my objective lens and its position relative to the film and photo-electric cell, that each image at the plane of the aperture in my camera box will be slightly spaced from the image produced on the same plane by an adjacent mirror of my rotating drum. This ensures the production of a frame line between adjacent pictures and gives rise to a definite line repetition frequency in the transmitted signal, which is often desirable for framing and/or synchronizing purposes.

It is desirable that the beam from my light source should be uniformly distributed over film 21 in a direction at right angles to its motion, although it may be concentrated in the other dimension as already described.

By suitable disposal and arrangement of parts it is possible to use a single photo-electric cell and mirror drum to scan in one dimension two separate films. This may be of advantage to allow continuous transmission when shifting from one film to another and to allow synchronism to be more easily maintained when so shifting films.

By suitable changes in the construction of this apparatus a single driving motor can be used, and other methods of changing the relative phase of the two scanning members may then be employed, such as the mechanical device disclosed in my co-pending application Serial No. 425,785 filed February 4, 1930.

It is also possible in some cases to narrow aperture 26 in mask 25 so that it determines one dimension of an elementary area. In this case the aperture 43 may serve to limit only the other dimension of an elementary area.

Other variations of the above described apparatus will be apparent to those skilled in the art since this invention is susceptible to many modifications and combinations, and is limited only by the hereunto appended claim.

I claim:

In a television scanner a source of light, a condensing lens receiving light from said source, a film receiving light from said condensing lens, means for moving said film at a substantially constant rate of speed, an objective lens receiving light from said film and focusing an enlarged image of the illuminated portion thereof at a distant point, a fixed apertured plane member located at said distant point of focus and limiting at least one dimension of a scanning element, a mirror drum provided with facets much wider than either dimension of an elementary scanning area, means for rotating said drum in a plane perpendicular to the plane in which said film is moved, said drum being situated in the cone of light extending from said objective lens to said fixed apertured plane member, so that at least two facets of said drum are included within said cone of light and so that an unobstructed optical path exists between said drum and said apertured plane member whereby the angular displacement of the light beams impinging on said aperture is due solely to the motion of said drum, and a photo cell adjacent said aperture and illuminated by the light passing through said aperture, all of said elements being arranged substantially in the order described.

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