Jan. 7, 1936. L. DE FOREST 2,026,872

TELEVISION RECEIVING METHOD AND APPARATUS

Filed April 24, 1931 2 Sheets-Sheet 1

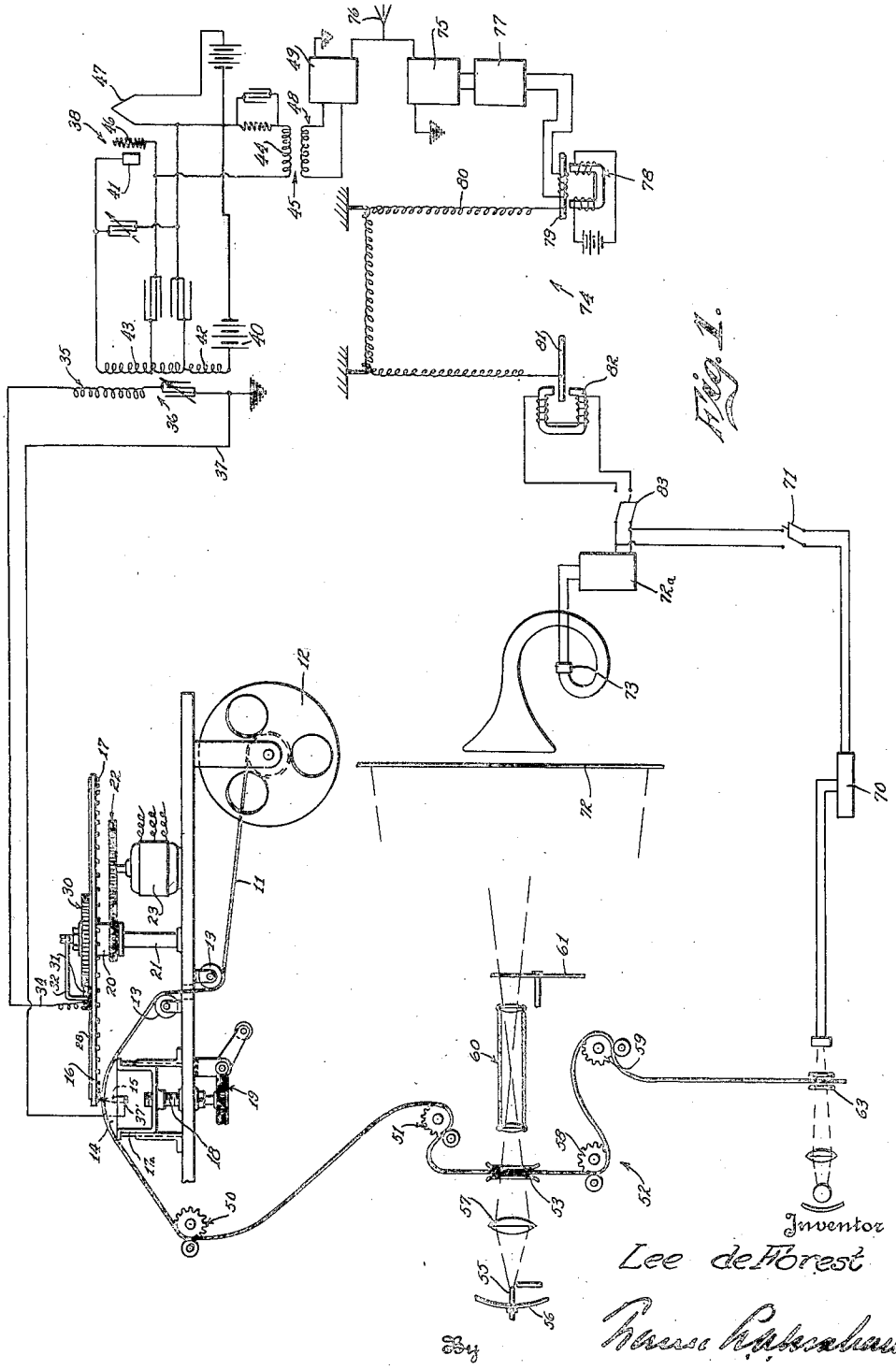

Fig. 1.

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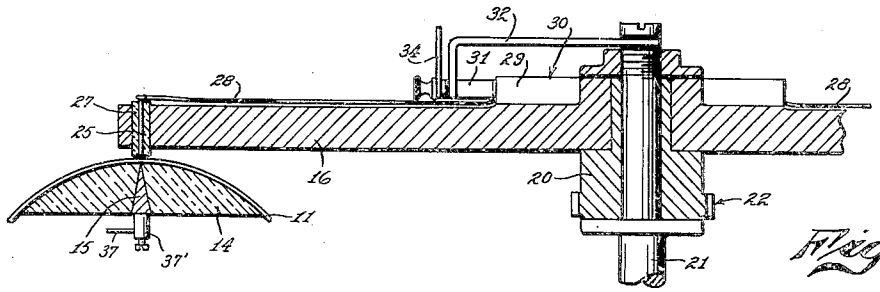

Fig. 3.

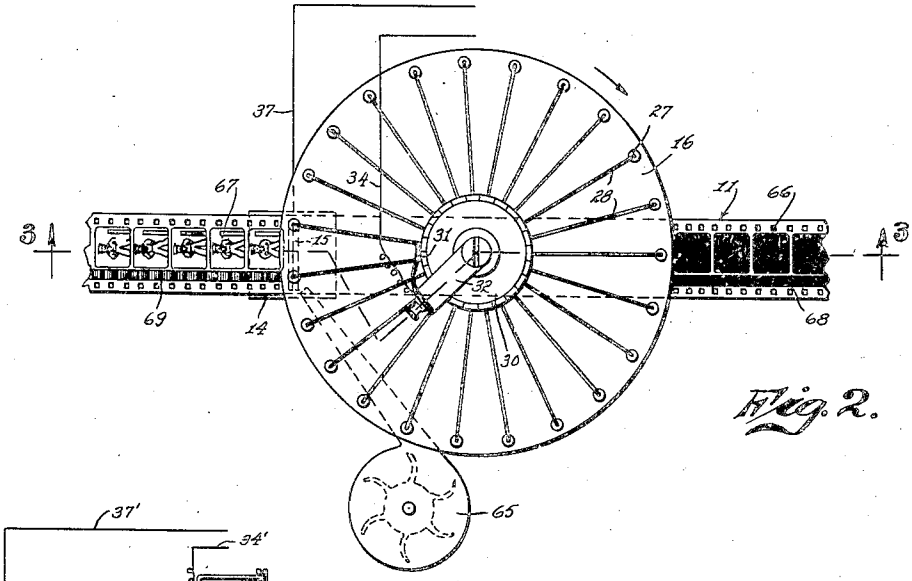

Fig. 2.

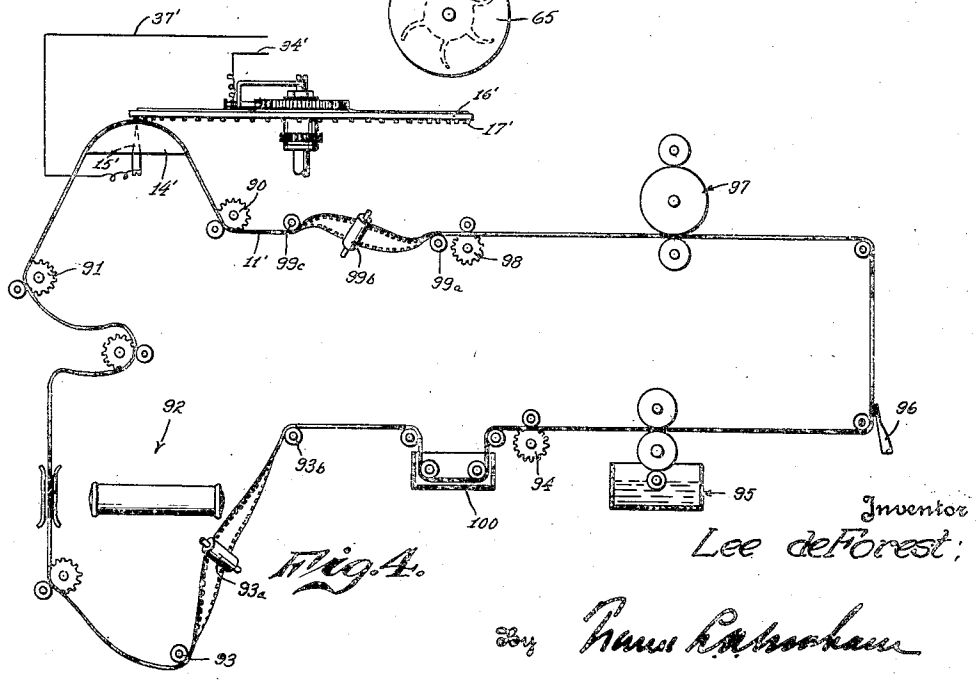

Fig. 4.

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Patented Jan. 7, 1936 2,026,872

UNITED STATES PATENT OFFICE

2,026,872

TELEVISION RECEIVING METHOD AND APPARATUS

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Application April 24, 1931, Serial No. 532,454

4 Claims. (Cl. 178—6)

This invention has to do in a general way with the art of television and relates more particularly to improved methods for receiving televised pictures and images.

It is well known to those familiar with the art that images can be converted into electrical impulse modulations which may be transmitted by radio or by wire and received at distant points, where, through the medium of so-called television receiving apparatus, they can be converted into images corresponding to the transmitted images. The reproduction of the images at the receiving station is generally accomplished by means of a pulsating neon light associated with a scanning disk, and since the quantity of light available is small, the reproduced image is very dim and is incapable of magnification. It, therefore, becomes a primary object of this invention to produce a method or methods of the class described whereby the televised images may be reproduced with light of sufficient intensity to permit their magnification, and if desired, their projection onto a much larger screen area than has heretofore been possible.

Pursuant to the attainment of this object the present invention contemplates the recording of the televised image upon the suitably prepared surface of a plate, strip or film of the motion picture type, and, if desired, the projection of these pictures by means of a projector of the type such as is ordinarily used in connection with motion pictures. By this method I am able to reproduce the received televised images with a much brighter light and may project them over a much greater screen area than has heretofore been possible.

Furthermore this method makes possible the projection of the received televised picture through a projector similar to that used in motion picture theatres whereby the greatly enlarged screen image of the picture is projected on a screen located at a long distance from the projector so that it may be seen by a large audience in a theatre.

In accomplishing this method I employ with the usual television signal receiver, whether these signals be received by radio or by wire, an equivalent of the ordinary television receiver scanning disk so designed that the received image is first impressed or delineated upon a strip of motion picture film which is immediately thereafter passed through a picture projection machine in all respects similar to those used in the motion picture theatres at the present time, whereby the received and recorded televised picture is projected in the manner customary to motion picture film with brilliant intensity upon a large screen located many yards distant from the projecting machine.

The method whereby the picture is recorded upon the film is in itself of novel character, and it is to be understood that while this method will be described with particular reference to motion picture film, it may be employed in any telephoto work for recording a televised image upon the properly coated surface of any suitable material.

In connection with this process my invention also contemplates the reproduction of sound in connection with the projected picture. In the event the televised images coming from the transmitting station have their source in a motion picture film, it will be apparent that the film may be of a type ordinarily used in talking pictures which carries a so-called sound track, and in this event the sound track is reproduced upon the film at the receiving station, a film of this character may be passed through the ordinary type of photo-electric sound reproducing apparatus so that the sound is reproduced in synchronism with the projected picture. Another method is to broadcast the sound record at the transmitting station running the record through the transmitter so that the sound is transmitted at a time interval "behind" the picture such that these impulses received at the receiver will be reproduced in synchronism with the projected picture. Where the televised image is that of actual action which is taking place at the transmitting station, it will be seen that if the usual type of radio receiving and sound reproducing equipment is used, the sound will precede the picture by several seconds. Where it is desirable, as is usually the case, to transmit the sound or voice simultaneously and in synchronism with the picture from the transmitter, this difficulty can be overcome in one of several ways, and it is a further object of this invention to provide a method or an apparatus whereby the sound coming from the transmitting station may be reproduced simultaneously and in synchronism with the projected televised picture.

The accompanying drawings illustrate a certain form of apparatus which I have invented whereby the methods or operations contemplated by this invention are made possible.

Referring to the drawings—

Fig. 1 is a more or less diagrammatic view showing one form of apparatus contemplated by this invention;

Fig. 2 is a plan view showing a part of the picture recording apparatus;

Fig. 3 is an enlarged sectional elevation which may be considered as having been taken in a plane represented by the line 3—3 in Fig. 2;

Fig. 4 is another diagrammatic view illustrating a modified form of apparatus for carrying out the method contemplated by this invention.

More particularly describing the invention as herein illustrated, reference numeral 11 indicates a strip of motion picture film which may be of the ordinary celluloid base or may be of other suitable diaphanous material, such as cellophane, carrying along its two margins the two standard film perforations. This film is specially prepared before it passes through the television scanning or reproducing apparatus so as to carry on one face a uniformly blackened or opaque surface. This blackened surface may be one of several suitable materials, for example, it may be formed by previously uniformly exposing, developing and fixing one of any number of standard motion picture film emulsions. Further the blackened surface may be composed of conducting or semiconducting ink or graphitized pigment, evenly and uniformly applied to the surface of the film base. The surface may be dry or moistened.

The film 11 prepared in this manner is shown as coming from a magazine reel 12 and passing over suitable guide rollers 13 to a block 14 composed of insulating material and provided with a curved strip 15 of conducting material which is mounted in and suitably secured to the block 14. In passing over the block 14 the film passes beneath the periphery of what I may term a scanning disk 16 which is provided with a plurality of discharge points 17 situated so as to pass immediately over the top edge of the conductor strip 15.

The conductor strip 15 is embodied in the block 14 so that its upper edge is flush with the top surface of the block and it will be observed that this block is supported by a bracket 17a which is adjustable by means of a screw 18 and a worm unit 19 so as to vary the distance between the edge of the conductor strip 15 and the plane described by the points 17.

The scanning disk 16 is mounted through the medium of a hub 20 upon an upright shaft 21 and is adapted to be driven at a high rate of speed in any suitable manner such as by means of the speed increasing gears 22 and the synchronous motor 23. It is to be understood that the present invention is not concerned with the means for synchronizing the receiver scanning disk with the transmitter scanning disk, and any of the well known means employed for this purpose may be used herein.

The points 17 are situated on equal radii of the disk 16 and are equally spaced apart a peripheral distance which is equal to the width of the picture carrying area of the film 11. In other words, for the standard type of motion picture film the needle points on the lower surface of the scanning disk are separated by a distance of approximately ¾ of an inch. The conductor plate 15 is curved as mentioned above with a radius of curvature slightly less than the scanning disk 16 so that during the rotation of the scanning disk one of the points 17 is always above a portion of the conductor strip 15.

The points 17 which may be hereinafter referred to as discharge points, are preferably constructed in the manner shown in Fig. 3 where the points are shown as comprising the lower end portions of fine pieces of conducting material such as platinum wire indicated by reference numeral 25. This wire is contained within a sleeve of insulating material such as glass, indicated at 27, and the upper end of each of the conducting wires or needle points is connected by means of a conductor 28 to a corresponding segment 29 of a commutator 30 which is mounted upon the upper face of the scanning disk 16. A single brush 31 is mounted upon a bracket 32 so arranged as to make contact with that commutator segment which is connected at any moment to the discharge point which is at that time traversing the film directly over the conductor strip 15.

The brush 31 is connected by means of a conductor 34 with one terminal of a high frequency transformer shown at 35. The other terminal of the high frequency coil is connected either directly or through a conductor 36 with a conductor 37, making contact with a pole 37' on the conductor strip 15.

Reference numeral 38 indicates an oscillating audion with one type of oscillation or feed back circuit connecting the three elements of the audion. Such an oscillating system, for example, was shown in my United States Patent No. 1,507,016 issued on September 2, 1924. Reference numeral 40 indicates the source of high voltage for supplying circuit to the plate electrode 41 of the audion. 42 indicates the choke coil and 43 the primary of the high frequency transformer which is inductively associated with the secondary coil 35 referred to above. The inductive relationship between the two coils 35 and 43 may be varied as shown, or the capacity 36 of the conductor 37 in the secondary circuit may be variable. By such means I am able to accurately control the normal amount of high frequency energy passing from the oscillating audion system to the points of the scanning disk.

Ordinarily when the oscillating system 38 is in operation the needle or discharge points of the scanning disk passing in rapid succession over the blackened surface of the advancing film 11 acts to effect the opacity of the surface by either removing or rearranging the individual particles forming the coated surface through the medium of chemical action, burning, heat, electrical or magnetic action.

In Fig. 1 I have shown a method of grid modulation of the oscillating audion 38 wherein the secondary 44 of the transformer 45 is connected between the grid 46 and the filament 47 of the oscillator in a manner such as to transfer the incoming televised energy which is received from an output terminal 48 of a television receiver 49 which embodies the standard television receiver circuit. Any other suitable circuit arrangement for modulating, by means of the amplified received high frequency signals from the distant television transmitter, may be employed to modulate the high frequency energy generated at 38 and transferred by means of the transformer 35 to the scanning disk terminals.

Reference numeral 50 indicates a toothed sprocket which may be driven in any suitable manner and is adapted to engage the film 11 and to propel the same across the block 14 at standard motion picture speed. After leaving the sprocket 50 the film passes over the upper or pull down sprocket 51 of a motion picture projector 52. Reference numeral 53 indicates the usual aperture plate of the motion picture projector, such aperture plate being associated with an arc light 55, the usual parabolic reflector 56 and the condensing lens 57. Reference numeral 58 indicates an intermittent sprocket and 59 the

lower sprocket of the projector. Reference numeral 60 indicates the objective lens of the projector in front of which the rotating shutter 61 is located. Reference numeral 72 indicates the distant screen on which the image is projected and reference numeral 63 indicates the photo electric sound transferring apparatus ordinarily used in connection with the film method of reproducing sound.

It will now be seen that by means of the apparatus so far described, the blackened surface of the specially prepared film 11 as it is propelled over the conductor strip 16 and below the periphery of the scanning disk 17 by means of the sprocket 50, will be attacked and modified by the field of force or electrical discharge created between the rapidly moving points 17 on the scanning disk and the conductor strip 15 so that the modulated high frequency discharge passing between the needle points of the scanning disk to the film and directed at the conductor stip will reproduce in black, gray or white the outlines and graduations of the pictures which are being televised at the distant transmitter of the television system.

This system just described might be more specifically defined as one in which a coated surface is electrically etched by subjecting successive portions of the surface to the action of an electrostatic discharge which is modulated by impulses received in a television transmitter and where an etching system of this character is employed, I consider it important to provide some means for blowing away any dust, ashes or fine particles of emulsion which might otherwise accumulate and interfere with the progressive operation of the device. Reference numeral 65 (Fig. 2) indicates a blower which may be provided for this purpose.

It is to be understood that my invention is not necessarily confined to a process wherein material is actually removed from the coated surface, but that it might embody any process wherein a change in the opacity of the coating is effected by exposing successive portions of the coating to a modulated field of force which is electrically controlled by impulses received in a television receiver.

For example the original "unetched" or "unexposed" surface may embody a thin uniform application of some readily oxidizable chemical substance, preferably light colored and translucent. It is well known that a point electric discharge, whether of high frequency or unidirectional, ozonizes the air in its immediate vicinity. This freshly ozonized air, at the point of the fine wire or discharge point on the scanning disk will instantly oxidize, more or less, the surface application mentioned above, rendering it more or less opaque in proportion to the intensity of the electrical potential existing between the point and the strip at that instant. It will be understood that the chemical action may be the reverse of the above, where the transparency of an opaque surface is affected by the varying ozonizing action at the discharge point. I also contemplate by my invention the use of a material which is similarly affected by a magnetic field and under these circumstances the discharge points will be replaced with miniature electromagnets which will create magnetic fields of varying flux density while traversing the surface.

In Fig. 2, reference numeral 66 indicates one manner in which the opaque surface of the film may be prepared, and reference numeral 67 indicates the manner in which the film appears after it has been subjected to the above described process.

As was pointed out in the fore part of the specification, this invention contemplates the reproduction of sound in connection with the projection of the pictures, and such sound might be reproduced by impressing upon one edge 68 of the film a sound track 69 which corresponds to the sound track on the motion picture film at the transmitting station, in the event the transmitted impulses originate from motion picture film. It is in connection with a film of this nature that I propose to use the photoelectric reproducing unit 63. The unit 63, it will be observed from Fig. 1, is connected to an audio amplifier 70 which in turn is connected through a switch 71 with a power amplifier 72a associated with a loud speaker 73 which is situated behind the screen 72.

In the event the picture recorded on the film 11 corresponds to images of actual action which is occurring before the scanning disk of the television transmitter, and in the event sound is being broadcast in connection with such action by means of the usual radio broadcasting equipment, it is necessary to provide radio receiving means in connection with which sound delaying means must be provided so that the sound is finally reproduced simultaneously and in synchronism with the projected pictures. As pointed out above, in securing this delay in the reproduction of the sound, I may utilize between the detector of the radio receiver which is bringing in the sound from the distant televised screen and the loud speaker located behind the screen of the receiving station, one of the types of "delayed circuits" well known in the telephone art, or I may employ an apparatus such as is indicated generally by reference numeral 74 in Fig. 1. This apparatus comprises the usual receiver 75 which is connected with the antenna 76 and in which the output is connected with an audio amplifier 77 which in turn is connected with a loud speaker head 78. This head, instead of being associated with the usual type of diaphragm has its armature 79 connected with a long coiled wire 80 which may be composed of steel or bronze, and which has its other end connected with an armature 81 of a pick-up head 82. This head is shown as being connected through a switch 83 with the power amplifier 72a which in turn is connected with the loud speaker 73. By means of the coiled wire I am able to obtain by purely mechanical means almost any desired lapse of time between the application of the sound impulses at the armature 79 and the taking off of such impulses at the armature 81. This time lapse depends upon the mechanical characteristics of the transmitting wire, that is its overall length, its unit mass, its state of tension, etc. I have found that by such means it is not difficult to introduce the desired three or four seconds lag between the receipt of the sound impulse from the distant transmitting station and its reproduction in the loud speaker 73 so as to bring the sound into perfect synchronism with the delayed film picture which is being projected upon the screen in the manner outlined above.

Although the above described method of recording the televised images has certain advantages in that it produces a permanent record of the transmitted image, there are times when it is undesirable to produce and thereafter preserve the long strip or strips of film carrying

the blackened exposed photographic surface of the type referred to above. In other words, I have found that it is often desirable to employ a less expensive method wherein a single comparatively short strip of endless film or its equivalent is employed as the medium for receiving and carrying the picture record.

In Fig. 4 I show a preferred form of apparatus which may be used in carrying out this last mentioned method. In this figure reference numeral 16' indicates a scanning disk of the type described above and reference numeral 14' a guide block which contains the conductor strip 15'. The scanning disk 16' is provided with discharge or needle points 17', such points being electrically energized through a conducting system similar to that described in connection with Fig. 1, which includes a conductor 34' and the conductor strip 15' being energized by a conductor 37'.

Reference numeral 11' indicates an endless film which is coated by a method similar to one of the well known processes employed in printing, for facing one surface of paper or fabric with a uniform coating of ink or coloring material. The freshly prepared opaque surface of the looped film passes below a driven sprocket 90 and is drawn over the block 14' by means of a sprocket 91. After leaving the sprocket 91 the film passes through the projector indicated generally at 92 from which it is led over guide rollers 93, 93a and 93b for carrying it out of the plane of the projecting lens to a driven sprocket 94 from which it passes through an inking device indicated at 95 and past a flattened nozzle 96 where it may be subjected to a stream of heated or ozonized air for drying the ink. The film then passes between blotting rollers 97, being drawn therethrough by means of a sprocket 98, after which it is brought over guide rollers 99a, 99b and 99c to bring it back into the plane of the sprocket roller 90.

It will be apparent that the application of ink to the previously etched or treated surface will obliterate the pictures thereon, but if it is preferable the film may, before passing to the inking device, be led through a solvent tank 100 wherein all of the coating material is removed before the film is again inked. As pointed out above, this procedure has certain advantages over that described in the fore part of the specification, although it has one disadvantage in that it is impossible, through the use of this procedure, to form a permanent record of the televised picture.

I do not deem it essential in this specification to in any wise describe the television transmitter which may be any one of several well known types, for example one whereby motion picture film is passed in front of the televisor scanning disk and the outlines of the pictures on the film transmitted by means of a photo electric cell into variations of electric current which when suitably amplified are caused to modulate the high frequency energy radiated from the electrical transmitter. I have shown and described above means whereby a picture may be reproduced on film similar to the picture at a distant transmitter and immediately thereafter projected upon a motion picture screen located near the receiver. Such means may also be employed for reproducing or forming pictures of actual action which occurs at the transmitting station and in both instances I have shown means whereby sound originating at the transmitter may be reproduced at the receiver in synchronism with the projected image.

Many other modifications and changes in details will occur to those skilled in the art without departing from the spirit and scope of my invention as defined in the appended claims; but having now set forth the object and nature of my invention and having shown and described structures embodying the principles thereof and illustrating the method employed in accordance therewith, what I claim as new and useful and of my own invention and desire to secure by Letters Patent, is:

1. The method of receiving television signals which comprises electrically imposing a patent image of the received electrically transmitted pictures on a moving film in a two-dimensional pattern through the medium of the electric discharge and immediately passing the film through a motion picture projector at motion picture speed of travel of the film so that the receipt of the picture and the projection thereof are substantially coincident.

2. The method of receiving television signals which comprises subjecting a moving film to electrical influence actuated by, in accordance with, and at the time of receipt of the electrically transmitted pictures to thereby impose a patent image of the pictures transmitted on the film in a two-dimensional pattern and immediately passing the film through a motion picture projector at motion picture speed of travel of the film so that the receipt of the picture and the projection thereof are substantially coincident.

3. An apparatus for producing motion pictures from televised images embodying: a conductor strip, a disc rotatably mounted in spaced relation with said conductor strip, a plurality of angularly spaced discharge points mounted in said disc in opposed relation with said conductor strip, a commutator on said disc having segments corresponding with and connected to said discharge points, a brush associated with said commutator and arranged to engage each segment as the corresponding discharge point passes the conductor strip, a record strip comprising a transparent base and a volatile opaque coating means for advancing said record strip transversely through the space between the conductor strip and the disc, and means for energizing the brush and the conductor strip from a television receiver, a motion picture projector, and means for feeding the record strip to the projector directly from said advancing means.

4. An apparatus for producing motion pictures from televised images embodying a conductor strip, a disc rotatably mounted in spaced relation with said conductor strip, a plurality of angularly spaced discharge points mounted in said disc in opposed relation with said conductor strip, a commutator on said disc having segments corresponding with and connected to said discharge points, a brush associated with said commutator and arranged to engage each segment as the corresponding discharge point passes the conductor strip, a record strip comprising a transparent base and a volatile opaque coating means for advancing said record strip transversely through the space between the conductor strip and the disc, and means for energizing the brush and the conductor strip from a television receiver, said discharge points being spaced apart at a distance corresponding to the width of said coated film, a motion picture projector, and means for feeding the record strip to the projector directly from said advancing means.

LEE DE FOREST.