July 30, 1946. J. H. HAMMOND, JR 2,404,839

SECRECY COMMUNICATION SYSTEM

Filed Aug. 22, 1941 3 Sheets-Sheet 1

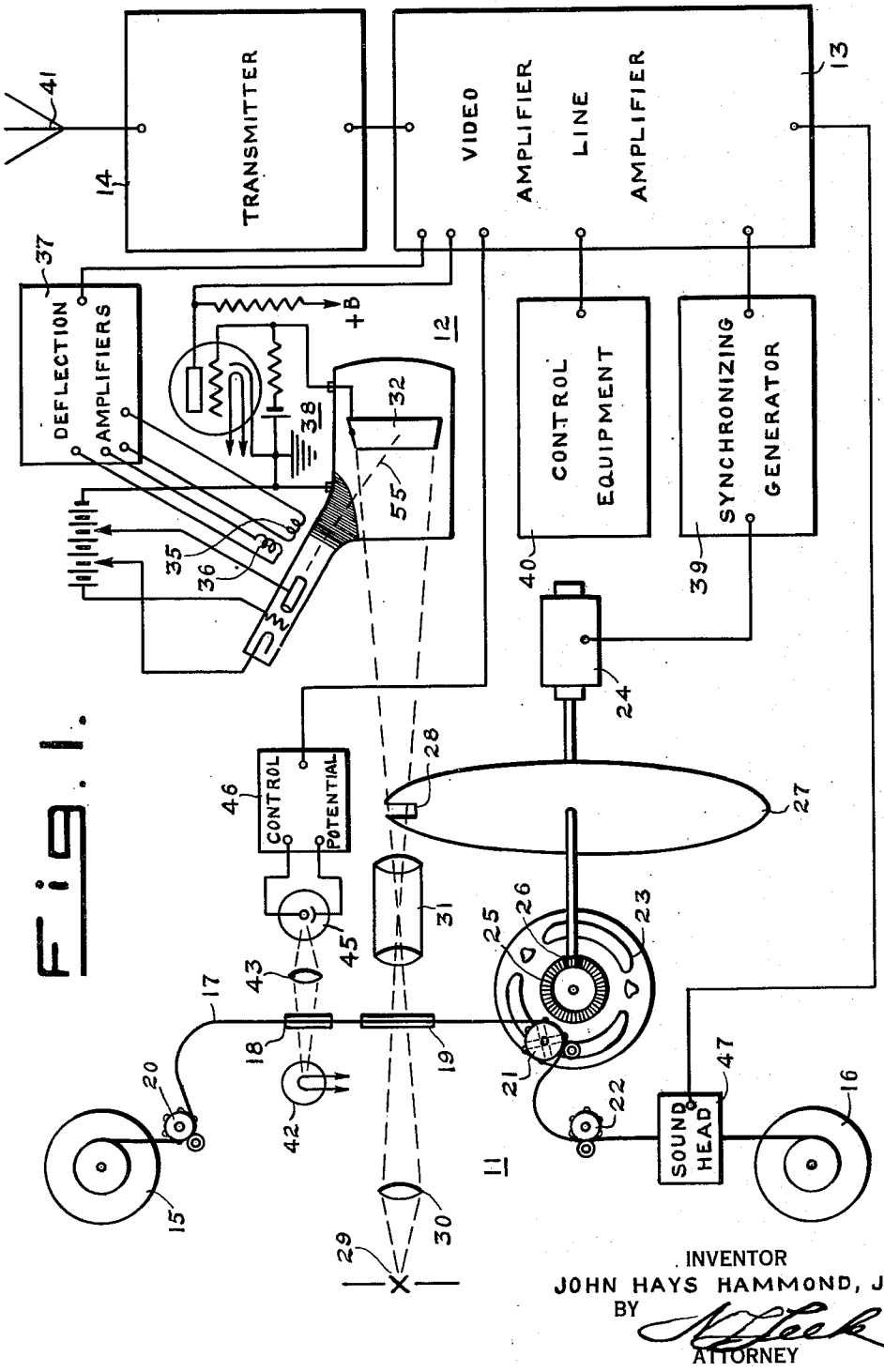


Fig. 1.

INVENTOR
JOHN HAYS HAMMOND, JR.
BY
ATTORNEY

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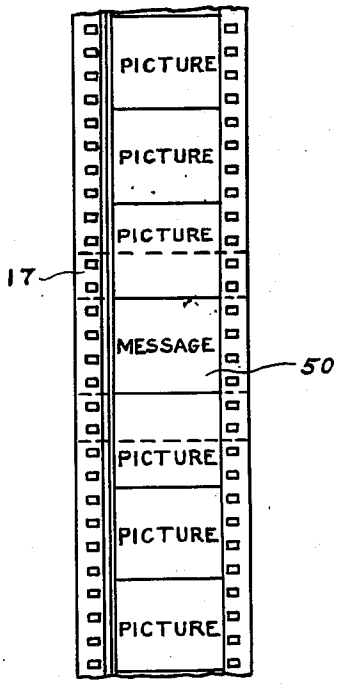


Fig. 2.

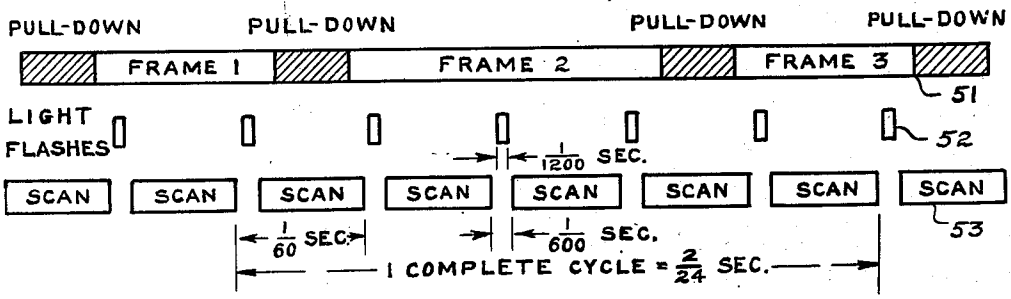


Fig. 3.

INVENTOR
JOHN HAYS HAMMOND, JR.
BY
ATTORNEY

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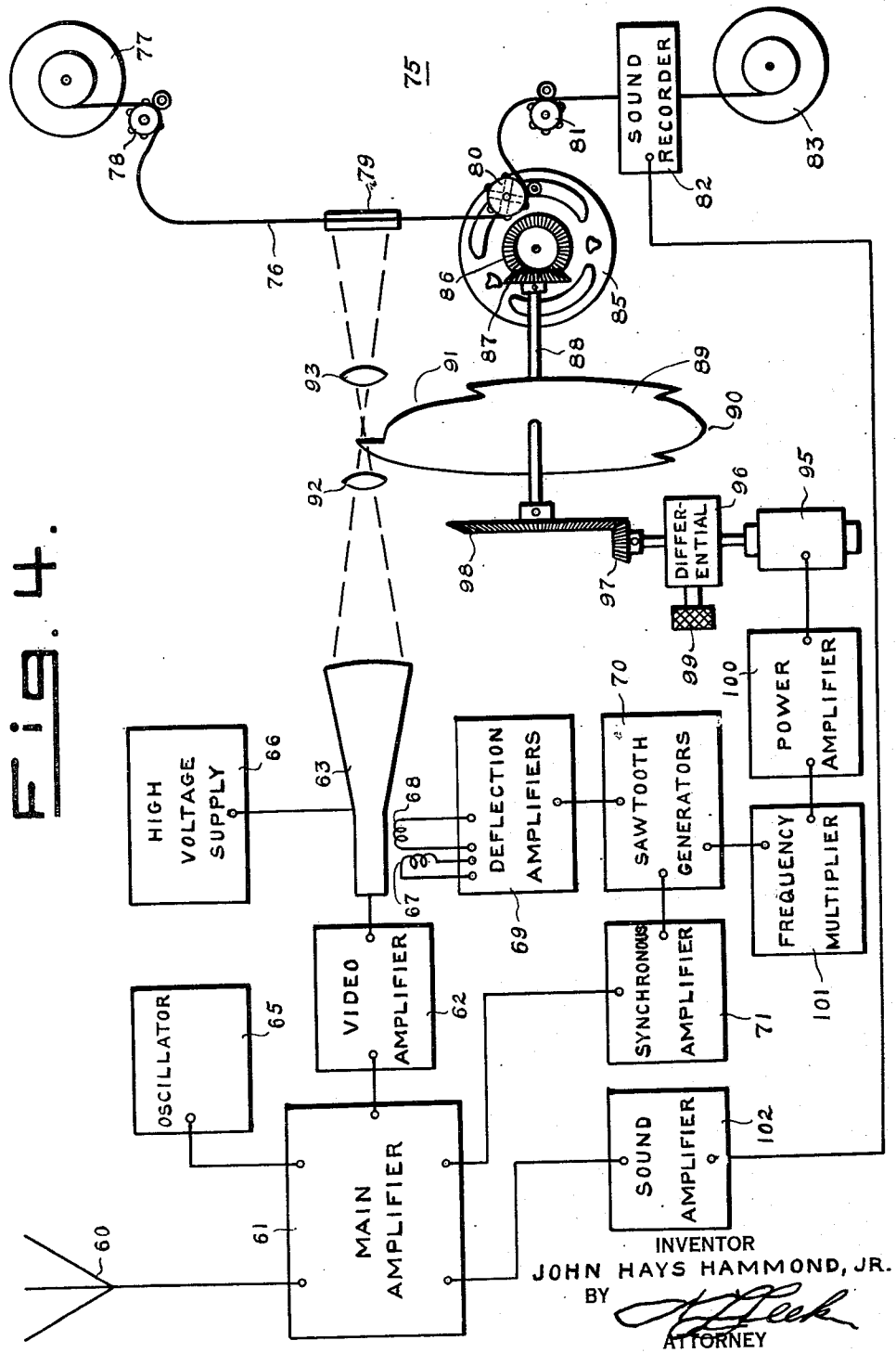


Fig. 4.

INVENTOR
JOHN HAYS HAMMOND, JR.
BY
ATTORNEY

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UNITED STATES PATENT OFFICE

2,404,839

SECRECY COMMUNICATION SYSTEM

John Hays Hammond, Jr., Gloucester, Mass., assignor to Radio Corporation of America

Application August 22, 1941, Serial No. 407,891

4 Claims. (Cl. 178—6.7)

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This invention relates to secrecy communication systems and more particularly to a system for communicating messages by television.

The invention further relates to means for inserting a message in a single frame of a television moving picture transmission system and means for recording this message on a moving picture film.

The invention also relates to means for sending a message as a single frame of a television transmission system at a predetermined time and means for receiving the message on a photographic film.

The invention also relates to a novel and improved television receiving system.

The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which

Figure 1 is a schematic diagram of a typical transmitter which may be utilized in a system embodying the present invention.

Figure 2 illustrates a section of film used in the transmitter shown in Figure 1.

Figure 3 illustrates diagrammatically the sequence of events in the transmitter shown in Figure 1.

Figure 4 is a schematic diagram of a receiver embodying the present invention.

Like reference characters denote like parts in the several figures of the drawings.

In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to the accompanying drawings and more particularly to Figure 1, a standard television film transmitter is shown comprising a motion picture projector 11 which projects a standard film upon an iconoscope camera 12, the output circuit of which is connected to the necessary amplifiers 13 and radio transmitter 14.

The projector 11 is provided with the usual feed and take up reels 15 and 16 upon which is wound the film 17. The film 17 passes thru two gates 18 and 19 and over a number of sprockets 20, 21

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and 22. The sprocket 21 is driven intermittently by an intermittent cam and spider-follower 23 of the early Powers type, in which the throws are located 144° and 216° apart respectively. This mechanism is driven by a 3600 R. P. M. synchronous motor 24 thru a bevel gear and pinion 25—26 having a 5:1 ratio. Mounted on the shaft of the motor 23 is a shutter disc 27 which is provided with a slot 28.

Light from a source of illumination, such as an electric arc 29 passes thru a lens system 30, the light gate 19, film 17, and a second lens system 31 and is focused upon the iconoscope mosaic 32. The iconoscope 12 is of standard and well known construction and is provided with the usual horizontal and vertical deflection coils 35 and 36 which are connected to the deflection amplifiers 37. The iconoscope mosaic 32 is connected thru an output circuit 38 to the amplifier 13.

A synchronizing generator 39 is connected to the amplifier 13 and controls the speed of the motor 24. Control equipment 40 is connected to the amplifier 13 and the transmitter 14 is provided with the usual antenna 41. A light souce 42 is located near the gate 18 and is focused by a lens 43 upon a photo-electric cell 45 which is connected to the control potential means 46 which in turn is connected to the amplifier 13. The sound head 47 is connected to the amplifier 13.

The film 17 used in this invention may be the standard motion-picture film with one or more of the picture frames replaced by the message 50. (Figure 2.) This replacement may be done in any manner well known in the art, such as cutting the film and inserting a section bearing the message.

Operation

In the operation of the transmitter shown in Figure 1 the film 17 is moved intermittently by means of the cam and spider-follower 23. The cam is driven at 12 revolutions per second by the synchronous motor 24 which runs at 3600 R. P. M. This causes the film 17 to be pulled down at unequal intervals as the throws of the cam are located 144° and 216° apart. The motion of the film 17 is shown at 51 in Figure 3 in which the shaded areas indicate the pull down motion. The light from the arc 29 after passing thru the gate 19 is chopped 60 times per second by the shutter 27. The shutter 27 is so timed relative to the cam 23 that the film 17 is always stationary when the light flashes occur. The sequence of light flashes is indicated at 52 in Figure 3. These light flashes are of only $\frac{1}{1200}$ second duration.

The chopped light after passing thru the shutter 27 is focused upon the iconoscope mosaic 32. This mosaic is scanned 60 times per second as indicated at 53 in Figure 3. The scanning periods 53 occur between the light flashes 52 so that the television picture signal is produced and transmitted during periods when no optical image is on the mosaic 32. During these periods, however, an electrical image is present on the mosaic 32 in the form of bound electrostatic charges on the minute photo-sensitized silver globules comprising the mosaic 32.

During the scanning periods the sensitized mosaic 32 is scanned by a moving beam of electrons 55 which is caused to scan the image on the mosaic 32 by means of the deflection coils 35 and 36 in a well known manner. The deflection coils 35 and 36 are energized from the deflection amplifiers 37 which are controlled by the synchronizing generator 39 acting thru the amplifier 13. As the synchronizing generator 39 also controls the synchronous motor 24, the operator can make the short $\frac{1}{1200}$ second light flashes fall within the $\frac{1}{600}$ second intervals between the vertical scanning periods with some tolerance on each side as depicted in Figure 3.

This arrangement of moving film and scanning is necessary as the standard film moves at the average rate of 24 frames per second while the television apparatus operates at 30 frames per second and 60 fields per second, interlaced, so that the projector must flash a still picture on the mosaic every $\frac{1}{60}$ of a second with each flash lasting about $\frac{1}{1200}$ second.

A fuller description of the construction and operation of the transmitter is set forth on pages 48–61 in the R. C. A. review, volume IV, 1939–1940. It is to be understood that this particular transmitter is described merely as an example of a suitable system to which this invention may be applied and that other devices capable of scanning a motion picture film and transmitting the scanned image may be used.

The receiver embodying the present invention is shown in Figure 4 as comprising an antenna 60 which is connected to the input of the amplifier 61, the output of which passes thru a video-amplifier 62 to a cathode-ray tube 63. An oscillator 65 is connected to the amplifier 61 and a high voltage supply source 66 is connected to the tube 63. The deflection coils 67 and 68 of the tube 63 are connected to the deflection amplifiers 69 which in turn are connnected to the sawtooth generators 70. The sawtooth generators 70 are controlled by the synchronous amplifier 71 which is connected to the main amplifier 61.

For making a photographic record of the pictures produced by the cathode ray tube 63, a moving picture camera apparatus 75 is provided. The sensitized film 76 of this apparatus is unwound from a supply reel 77, passes over a sprocket 78, thru a film holder 79, over sprockets 80 and 81, thru a sound recorder 82 and is wound upon a take up reel 83.

The sprocket 80 is driven intermittently by an intermittent cam and spider follower 85, which is similar to the cam and spider-follower of Figure 1. The cam 85 is driven by a 1:1 ratio bevel gears 86—87, the latter being secured to a shaft 88 to which is attached a shutter disc 89. The shutter 89 is provided with two slots 90 and 91 and passes between two lens 92 and 93 which focus the television image upon the film 76. The shaft 88 is driven from a 3600 R. P. M. synchronous motor 95 thru a differential 96 and a set of bevel

gears 97—98 which have a 1:5 ratio. The differential 96 is operated by a knurled knob 99. The motor 95 is driven from a power amplifier 100 which is controlled by a frequency multiplier 101 connected to the sawtooth generators 70. The sound recorder 82 is operated by a sound amplifier 102 connected to the main amplifier 61.

Operation

In the operation of the receiver depicted in Figure 4, the television program is received by the antenna 60 and is fed to the main amplifier 61 which, for example, may consist of a first detector, three stages of intermediate frequency amplification and a second detector and synchronizer. The output from the second detector is fed to the video amplifier 62 where the picture signal is amplified and fed directly to the cathode ray tube 63. The second anode of the tube 63 is supplied with high voltage, for example, 200 volts direct current, from the full wave rectifier 66. Low voltage power may be supplied to the tube 63 from a source not shown.

The canning and synchronous control auxiliaries make use of the second stage of the second detector, which may be used as a clipper rectifier to provide the synchronous pulses separated from the picture impulses. The output of the clipper rectifier leads to the synchronous amplifier 71 which acts to separate the vertical synchronous pulses from the horizontal. The sawtooth generators 70 may include a blocking oscillator and discharge tube which may be used to develop sawtooth waves of voltage under control of the vertical impulses and a second blocking oscillator and discharge tube may be used to develop sawtooth waves of voltage for the horizontal direction. The outputs of these two circuits control the vertical and horizontal deflection amplifiers 69 which in turn control the operation of the vertical and horizontal deflection coils 67 and 68.

The television picture is produced on the fluorescent screen of the cathode ray tube 63 in the usual manner, the picture signal being supplied by the video amplifier 62 and the cathode ray beam being deflected by means of the coils 67 and 68. As already described the picture on the screen will consist of two images of frame 1, three images of frame 2, two images of frame 3, etc. As only one image of each frame is to be photographed the disc 89 is provided with the two slots 90 and 91, which are 144° and 216° apart respectively. The disc 89 is rotated at $\frac{1}{5}$ the speed of the disc 27 (Figure 1) or one revolution in $\frac{2}{24}$ second. This speed of rotation is accomplished by driving the shaft 88 from a synchronous motor 95 thru a set of bevel gears 98—97 having a 5:1 ratio. The motor 95 is driven in synchronism with the motor 24 from the power amplifier 100, which is controlled by the frequency multiplier 101, which in turn is controlled by the sawtooth generators 70.

The shaft 88 drives the cam 85 at the same speed as the disc 89 by means of the 1:1 ratio bevel gears 86—87. The cam 85 drives the sprocket 80 intermittently so that the film 76 is drawn down twice during each revolution of the disc 89. This draw down motion takes place when the slots 90 and 91 are not in line with the axis of the lens system 92—93. The differential 99 is used to obtain the proper relationship between the slots 90 and 91 and the scanned images. When the slots 90 and 91 are in line with the optical axis of the system one image of

each frame will be completely scanned on the screen of the tube 63 and a photographic record of each frame will therefore be made on the film 79 which will include the frame 50 containing the message.

When the film 76 is developed and printed it is slowly run thru a standard type of projector until the frame 50 containing the desired message is projected on the screen where it may be read or an enlarged photographic record of it made.

The system may be operated for only a very brief interval of time by opening the circuit of the video amplifier in the transmitter so that only the synchronizing signal is transmitted. The system could then be put in operation at a predetermined time, the mechanical apparatus synchronized and as the message frame 50 approaches the picture gate 19 the circuit of the video amplifier could be automatically or manually closed and a few frames of the picture transmited which would include the message frame 50. In this way the signals would be transmitted for only a fraction of a second, thus increasing greatly the secrecy of the system as there would not be time for unauthorized persons to tune in on the video signal.

Although only a few of the various forms in which this invention may be embodied have been shown herein, it is to be understood that the invention is not limited to any specific construction but might be embodied in various forms without departing from the spirit of the invention or the scope of the appended claims.

What is called is:

1. The method of secret communication which comprises inserting a message on a single frame of a standard motion picture film, scanning said film, transmitting the images thereof by television, receiving said images at a suitable receiving point, impressing the same photographically on a sensitized motion picture film at said point,

and developing said film to reproduce said message together with the transmitted picture in the frame sequence corresponding to that of the film at the transmitter.

2. The method of secret communication which comprises incorporating a message on a single frame of a standard motion picture film, transmitting said message by television during an interval of about one-sixtieth of a second, receiving the transmitted message at a remote point, transferring the same onto a sensitized motion picture film, and developing said film to thereby reproduce said message.

3. The method of secret communication which comprises inserting a message between picture frames on a standard motion picture film, scanning said film, transmitting the images thereof by television, receiving said images at a suitable receiving point, impressing the same photographically on a sensitized motion picture film at said point, and developing said film to reproduce said message together with the transmitted picture in the frame sequence corresponding to that of the film at the transmitter.

4. The method of secret communication which comprises the steps of inserting a single film frame area of a graphical message representation at predetermined spaced positions in a sequence of film frame areas of pictorial representations, scanning all of the film frame areas of the graphical and pictorial representations in sequence to produce signalling energy representative of the scanned film frames, and transmitting the produced signalling energy with the two groups of signals in an associated and intermingled relationship whereby the signalling energy representative of the graphical film frame areas is substantially masked and rendered secret in the transmission by the predominating sequence of picture signalling energy.

JOHN HAYS HAMMOND, JR.