Sept. 24, 1929. R. D. PARKER 1,728,978

TELEGRAPHIC TRANSMISSION OF PICTURES

Filed Oct. 1, 1921 3 Sheets-Sheet 1

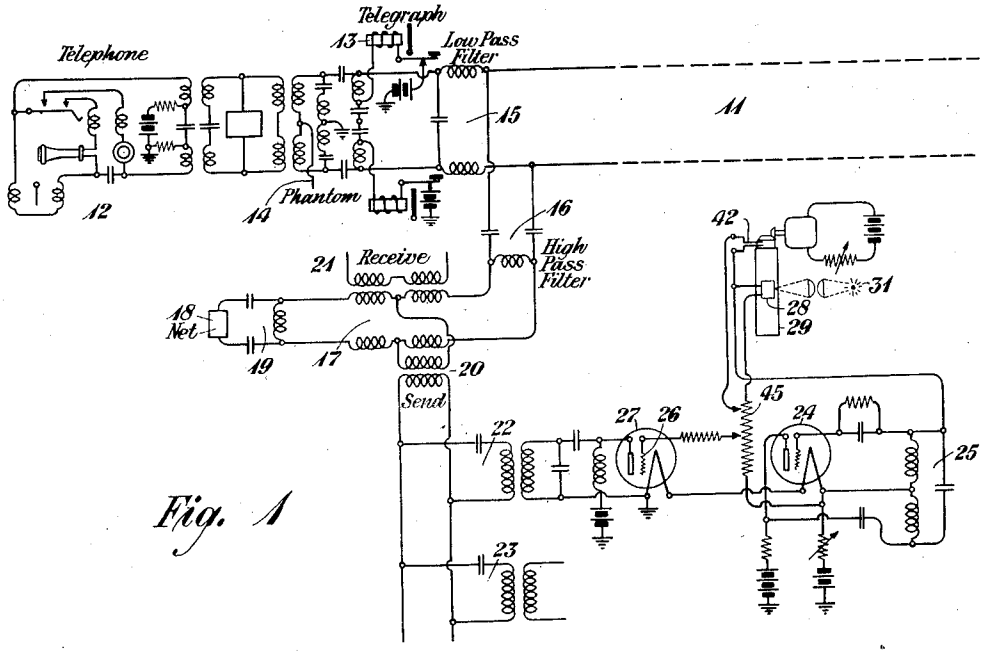


Fig. 1

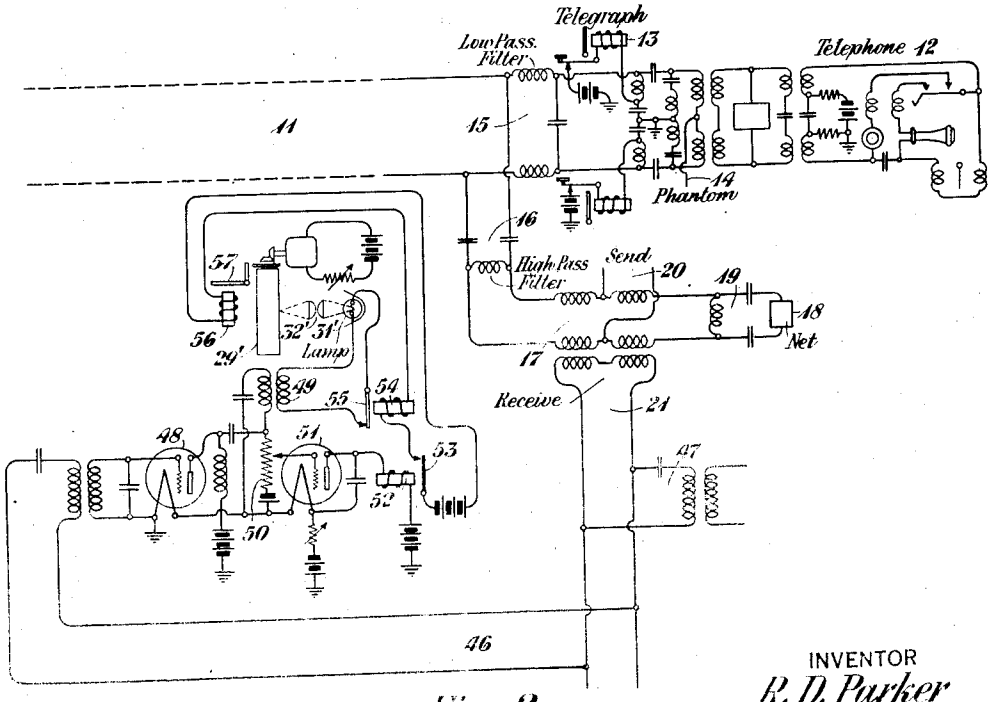


Fig. 2

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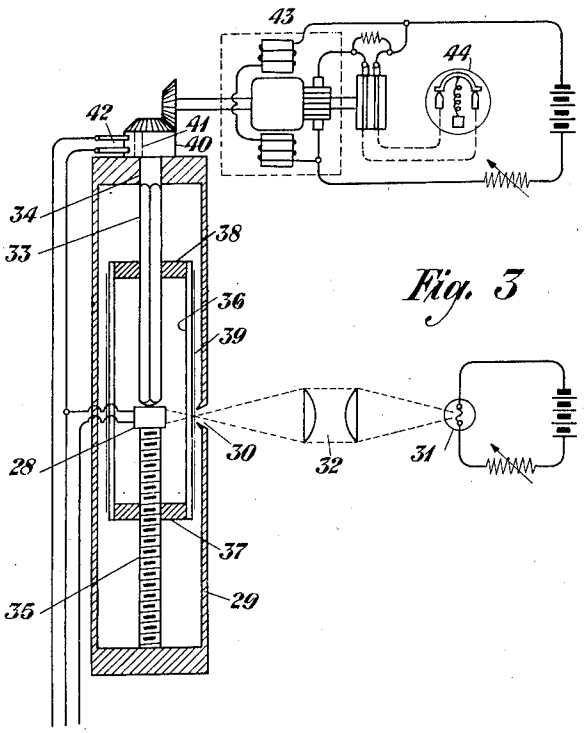


Fig. 3

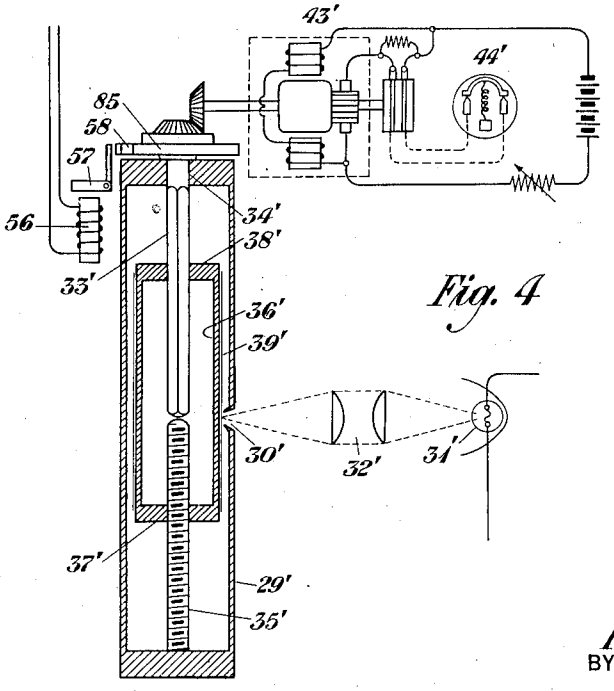


Fig. 4

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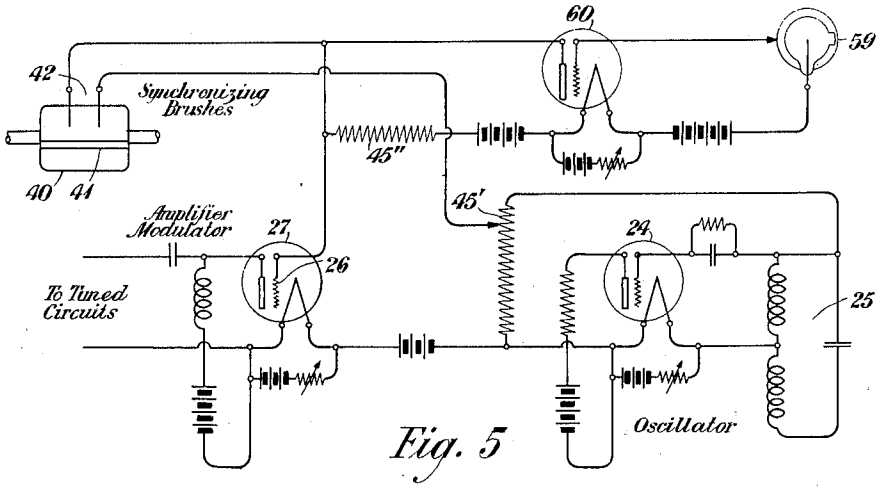


Fig. 5

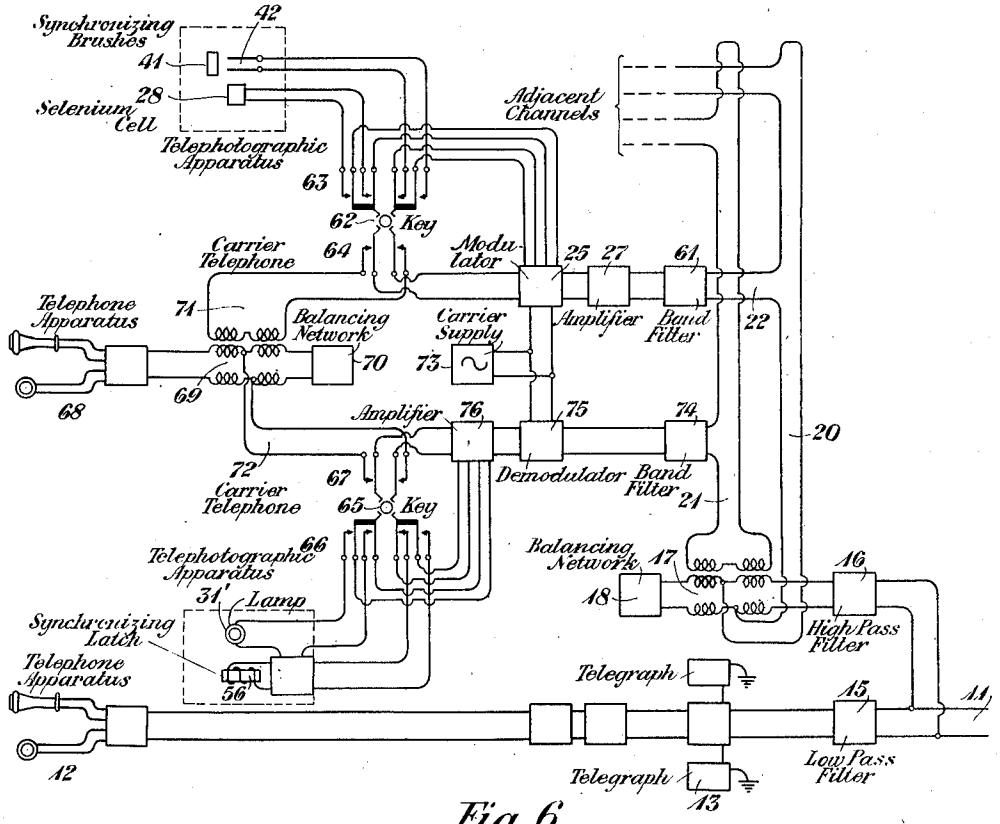


Fig. 6

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1,728,978

UNITED STATES PATENT OFFICE

RALZEMOND D. PARKER, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

TELEGRAPHIC TRANSMISSION OF PICTURES

Application filed October 1, 1921. Serial No. 504,680.

The principal object of my invention is to provide a new and improved system for sending pictures telegraphically over long distances. Another object of my invention is to transmit pictures in this way by means of carrier currents. Other objects of my invention relate to the transmission of pictures by the use of a single carrier current channel on a transmission line having several distinct channels of communication of that character. These and various other objects of my invention will become apparent upon consideration of a limited number of specific embodiments thereof which I have chosen for description in the following specification, taken with the accompanying drawings. In the following description I shall refer specifically to the particular embodiments of the invention referred to, leaving the scope of the invention to be defined in the appended claims.

Referring to the drawings, Figure 1 is a diagram showing the terminal apparatus at one end of the line, particularly the picture transmitting apparatus. Fig. 2 is a diagram for the other end of the line showing the picture receiving apparatus. Fig. 3 is a diagram of certain essential elements of the sending apparatus. Fig. 4 is a diagram of certain essential elements of the receiving apparatus. Fig. 5 is a diagram of modified transmitting apparatus and Fig. 6 is a diagram of circuit arrangements by which a carrier current channel can be utilized alternatively for telephone service or for picture transmission.

At each end of the transmission line 11, there are located apparatus 12 for ordinary telephony, apparatus 13 for ordinary superposed duplex telegraphy on each conductor; also branch conductors 14 for phantom lines are shown. Between all the foregoing mentioned apparatus and the line 11 is a low pass filter 15 and on the other side of this low pass filter 15 are branch conductors from the line 11 through a high pass filter 16 to the hybrid coil transformer 17, the usual network 18 being provided to balance the line and an interposed network 19 to balance the filter 16.

Associated with the hybrid coil transformer 17 are the sending circuit 20 and the receiving circuit 21.

Several different frequency channels may be put on the sending circuit 20 and the corresponding apparatus for one of these is indicated as connected at 22, and a connection for a similar channel is indicated at 23.

The vacuum tube oscillator 24 and associated circuits 25 give an output of high frequency alternating current which is applied to the grid 26 of the amplifier 27, which puts its output on the line through the branch conductors 22.

The stationary light-proof, cylindrical shell or casing 29 has a screw-threaded axial post 35, projecting inwardly from one end wall and this post carries on its end a selenium cell or other photo-sensitive device. Opposite this cell 28 there is a small opening 30 in the convex wall of the cylindrical casing 29. The light from an electric lamp 31 is focused by the lenses 32 upon this opening 30.

The shaft 33 is rotatably mounted in suitable bearings 34 in the end wall of the casing 29 opposite to that which supports the screw-threaded stem 35. Within the casing 29 the shaft 33 is squared and the end wall 38 of the glass cylinder 36 fits slidably on the squared shaft 33. The opposite end wall 37 of the cylinder 36 has screw-threaded engagement with the shaft 35.

Wrapped around the glass cylinder 36 is a developed photographic film 39. The surface of this film 39 comes very close at one point under the opening 30 in the casing 29.

At its exterior end the shaft 33 carries a drum 40 of insulating material with an embedded conductor bar 41 adapted at each revolution momentarily to establish conductive connection between the two brushes 42. The shaft 33 and the glass cylinder 36 are rotated at a very nearly constant speed by an electric motor 43, whose speed is controlled by a governor 44.

The output current from the vacuum tube oscillator 24 is applied to the grid 26, through the potentiometer 45. Superposed on this current are the variations of intensity due to the variation of resistance of the selenium

cell 28. A further superposed variation is due to the connecting of the brushes 42 at each rotation of the bar 41, and the consequent transient shunting of the cell 28 and part of the potentiometer winding 45.

The branch circuit 21 for receiving picture currents may have several branches therefrom for different frequencies, as indicated by the numerals 47 and 46. The branch 46 leads to an amplifier 48, whose output current goes through a transformer 49 to the lamp 31'. The electric motor 43' is controlled by the governor 44' so as to have its speed slightly in excess of that of the motor 43. The stationary casing 29' has the screw-threaded stem 35' within, fixed to one end, and the rotating squared shaft 33' projects through the other end. The cylinder 36' having appropriate engagement with the shafts 35' and 33' has a sheet of photographically sensitive paper 39' wrapped about it, one point of which is close to the opening 30' in the casing wall 29'. The light from the lamp 31' is focused by the lenses 32' upon the opening 30'. The shaft 33' and the cylinder 36' are rotated by the motor 43' but the driving connection comprises a friction clutch at 85.

In parallel with the primary winding of the transformer 49 is a potentiometer 50 with a tap leading to the grid of a vacuum tube amplifier 51. The output circuit from this amplifier 51 includes the winding of a marginal relay 52, whose armature 53 is normally open. The circuit controlled by the armature 53 comprises the windings of two relays 54 and 56. The armature 55 of the first mentioned relay 54 is normally closed but when the relay 54 is energized and this armature 55 is open, it opens the circuit of the lamp 31'. The magnet 56 has an armature 57 with attached dog that stands normally in the path of a tooth or prong 58 which rotates with the shaft 33'. Energization of the magnet 56 moves the armature 57 and hence the dog out of the path of the tooth 58.

Having outlined the structural relation of the elements shown in Figures 1, 2, 3 and 4 I now proceed to describe the manner of operation of the embodiment of my invention here disclosed.

As the glass cylinder 36 rotates, driven by the motor 43, it is slowly traversed lengthwise by the screw threaded engagement between the parts 35 and 37. The glass cylinder 36 is started in rotation from a position with the opening 30 near one end thereof. By virtue of the combined rotation and translation of the glass cylinder 36, all points of the developed film 39 pass successively under the opening 30, these points of exposure through the opening 30 lying in a helical course with its turns close together on the film 39.

Thus, the light transmitted from the lamp 31 to the selenium cell 28 will vary in intensity according as the portion of the film 39 under the opening 30 varies in transparency. By virtue of its characteristic property the variation in the light falling on the selenium cell causes a variation in the current flowing therethrough, and thus the oscillatory current to the grid 26 is varied in intensity or modulated. This modulated oscillatory current is amplified by the amplifier 26 and put on the line and sent to the receiving station shown in Fig. 2.

At each rotation of the glass drum 36 the conductor bar 41 passes under the brushes 42 and shunts the selenium cell 28 and part of the potentiometer winding 45, thus transmitting a pulse of current of comparatively great intensity.

At the receiving end the current having the character described, but of course, attenuated by transmission, is blocked by the low pass filter 15 from reaching the telephone apparatus 12, the telegraph apparatus 13 and the phantom line branches 14; but this current that we are considering passes through the high pass filter 16 to the hybrid coil transformer 17 and thence over the receiving conductors 21 to the appropriately tuned branch 46 and the grid of the amplifier 48. The corresponding output current from this amplifier 48 goes through the transformer 49 to the lamp 31' and causes an illumination there which corresponds in intensity to the intensity of the transmitted current. Accordingly, the light from lamp 31' varies in intensity in exact correspondence with the light transmitting character of the portion of the film 39 passing under the aperture 30 at the transmitting station. This light of variable intensity radiated by the lamp 31' is focused by the lenses 32' on a spot of the photographically sensitive paper 39', which spot is moving progressively over the surface of the paper. Thus, the exposure of the sensitive paper 39' corresponds to the light transmitting property of the film 39 at the sending station, point for point, and upon development the paper 39' will give a picture corresponding to the film 39.

The foregoing statement of correspondence between the picture 39' and the film 39 depends upon the synchronous movement of the two drums 36 and 36'. The dimensions of the apparatus are such that this synchronous movement is secured if the drums rotate at the same angular velocity. The motor 43' is adjusted to give a speed of rotation very slightly in excess of that given by the motor 43. The dog 57 lying normally in the path of the tooth 58 arrests the rotation of the drum 36' once at each revolution; but with only very slight delay thereafter, the intense current pulse caused by the members 41 and 42 at the sending station comes over the line, and actuates the marginal relay 52, causing a withdrawal of the dog 57 and permitting the rotation to go on for another turn. At the

same time that the dog 57 is withdrawn the relay 54 opens the circuit of the lamp 31′ to protect it from the excessive current pulse. The developed film 39 is wrapped on the glass drum 36 so that its meeting edges pass under the aperture 30 when this current pulse is given. It will be seen that the slight difference in speed of rotation of the sending drum 36 and the receiving drum 36′ will accordingly cause a slight shortening of dimensions on the received picture in a direction corresponding to the circumference of the drum 36′. This will be entirely too small to be objectionable.

Instead of a selenium cell at 28, a photo-electric cell may be employed as shown at 59 in Fig. 5. The photo-electric current may be so slight as to require amplification by the amplifier 60 before it is applied to modulate the oscillatory current that is delivered from the oscillation generator 24 to the grid 26 of the vacuum tube amplifier 27. In Fig. 5 the potentiometer 45 is shown in two parts designated 45′ and 45″. The amplified current from the photo-electric cell 59 and amplifier 60 is applied across the potentiometer element 45″ but this is shunted out by the conductor bar 41 and brushes 42 causing the current pulse of increased intensity at each revolution, as described for the form of the invention shown in Figs. 1 to 4.

Fig. 6 shows how an ordinary carrier current telephone channel determined by band filters, may be employed alternatively for picture transmission and receiving, or for ordinary signal use. When the keys 62 and 65 are thrown toward one another, as indicated in Fig. 6, the telephone or other signal circuits are closed and the picture transmitting circuits are opened. A mere reversal of these keys opens the telephone circuits and closes the picture transmitting and receiving circuits. Band filters are shown at 61 and 74 which determine a frequency range for the carrier current. This range will be wide enough to take care of the essential voice frequencies and may pass both side bands of frequency with respect to the carrier frequency or only one such side band. The carrier current generated from the oscillator 73 will be the same for the telephone operation as for the picture transmitting and receiving, and will be passed through the same modulator 25 in sending and the same demodulator 75 in receiving. In case the channel is being utilized for telephony, the carrier current will be modulated at 25 by the voice frequency currents from the apparatus 68, but in case the channel is being utilized for picture transmission the same carrier current from the source 73 will be modulated at 25 by the variable current through the selenium cell 28.

The received current, whether modulated by voice currents or in accordance with a transmitted picture, will be received by the demodulator 75. In case this current has been modulated by voice currents the key 65 will be thrown to send the demodulated current over the receiving conductor 72 to the telephone apparatus 68. But in case the received current in the demodulator 75 embodies the picture elements it will pass to the picture receiving apparatus comprising the lamp 31′.

It will be seen that by means of the apparatus shown in Fig. 6 a regular carrier current telephone channel can be utilized on occasion for picture transmission and receiving.

I claim:

1. In combination, a transmission line means to apply thereto at one end currents of different frequency ranges, means to modulate the current of one frequency range in accordance with the elemental parts of a picture to be sent, means at the receiving end to separate into respective channels the currents belonging to the different frequency ranges, and within the picture range to affect a light sensitive surface in correspondence to the modifications of the currents in that range.

2. In combination, a transmission line, means for putting on that line currents of different frequency ranges, means for modifying the currents in one or several such ranges in accordance with telegraph or telephone impulses, means for modifying the current in another such range, in accordance with the elemental parts in orderly succession of a picture to be sent, means to separate the currents on the transmission line into different channels according to the different frequency ranges, means associated with appropriate channels for receiving the telephone or telegraph messages, and means associated with the channel for the frequency range for pictures for exposing the parts of a sensitive surface in orderly succession to be affected by the current as modulated by the picture to be sent.

3. In a carrier current transmitting system, message sending apparatus and picture sending apparatus at one station, means to modulate carrier current of a certain frequency range alternatively by said message sending apparatus or said picture sending apparatus and means at another station to deliver such current from the line alternatively to message receiving apparatus or picture receiving apparatus.

4. In a picture transmitting apparatus, a light-proof casing, a stationary screw-threaded shaft and a rotatable squared shaft in alignment within this casing, a cylindrical drum having end walls appropriately engaging the said two shafts, said casing having an opening in its side closely adjacent to the cylindrical surface, and means to rotate the

squared shaft and thereby to rotate the cylinder and traverse it slowly in the direction of its axis, so as to bring all the points of the cylindrical surface successively under said opening in helical order.

5. In a picture transmitting apparatus, a light-proof casing, a stationary screw-threaded shaft and a rotatable squared shaft in alignment within this casing, a cylindrical drum having end walls appropriately engaging the said two shafts, said casing having an opening in its side closely adjacent to the cylindrical surface, a light-sensitive element mounted on the end of the screw-threaded shaft opposite said opening, and means to rotate the squared shaft and thereby move all points of the cylindrical surface in helical order past the said opening in the casing.

6. In a carrier current multiplex transmitting system with a plurality of carrier current channels of different frequencies, message sending apparatus and picture sending apparatus at each of several stations, means to modulate the carrier current of a channel alternatively by said message sending apparatus or said picture sending apparatus, and means to receive such modulated current from the line and deliver it alternatively to message receiving apparatus or picture receiving apparatus.

7. The method of utilizing a line for the simultaneous transmission of messages and pictures which consists in putting carrier currents of different frequencies on the line, modulating one frequency in accordance with a message and another in accordance with the elements of the picture, separating the modulated currents by means of filters and delivering them to respective message receiving and picture receiving apparatus.

8. An electro-optical transmission system comprising means to generate a sustained high frequency alternating carrier current, means to scan point by point an object whose image is to be produced at the receiving station, means comprising a source of light, photoelectric means sensitive to variations in light from said source, means to cause the current from said photoelectric means to modulate said carrier current, means to periodically interrupt said modulating for a short interval, a transmission circuit, means for impressing said modulated current thereupon, a receiving circuit, means for detecting said modulated wave received from said receiving circuit, means including an element to be moved in synchronism with said scanning means for producing an image of the object in response to the detected current, means controlled by said carrier current during said brief interval for controlling the movement of said element, and means for simultaneously impressing upon said transmission circuit signaling current outside the frequency range of said modulated carrier current.

9. The method of utilizing a single transmitting circuit for simultaneous transmission of message currents and image currents, which consists in putting carrier currents of different frequencies on said transmitting circuit, modulating one frequency in accordance with a message and another frequency in accordance with the tone values of the elements of the object, separating the modulated currents by means of filters and delivering them to respective message receiving and image producing apparatus.

In testimony whereof, I have signed my name to this specification this 27th day of September, 1921.

RALZEMOND D. PARKER.