METHOD AND APPARATUS FOR TELEVISION

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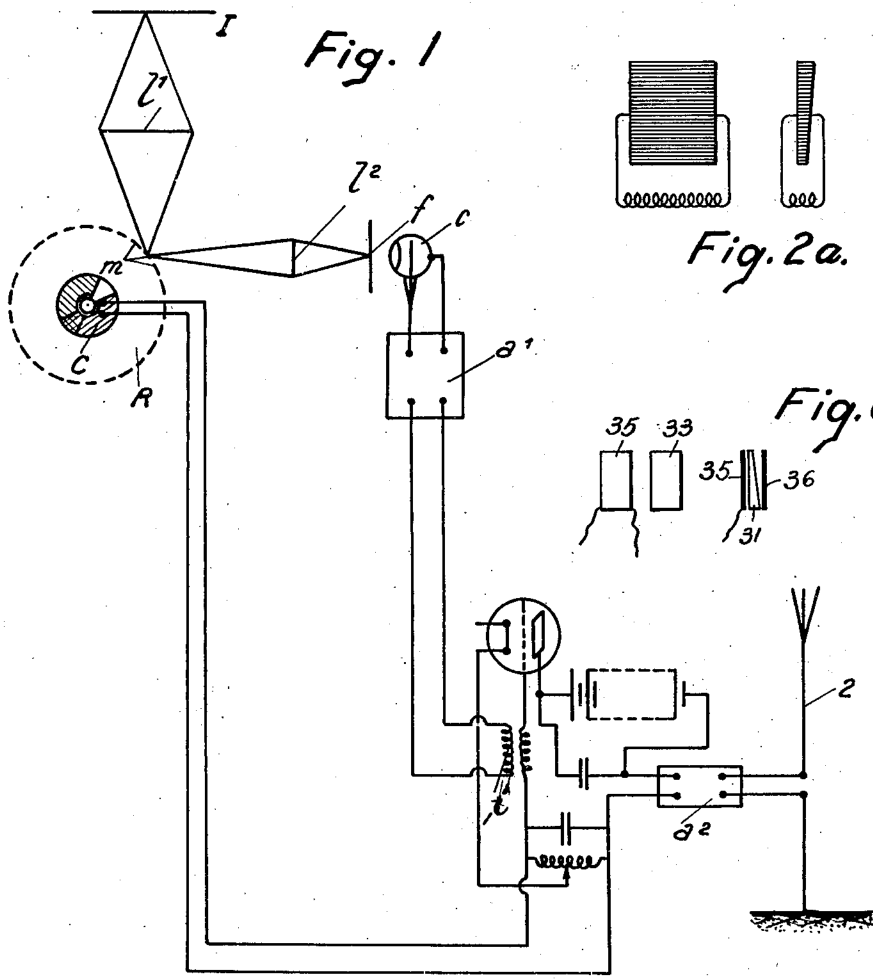
Fig. 1

Fig. 2a.

Fig. 6a.



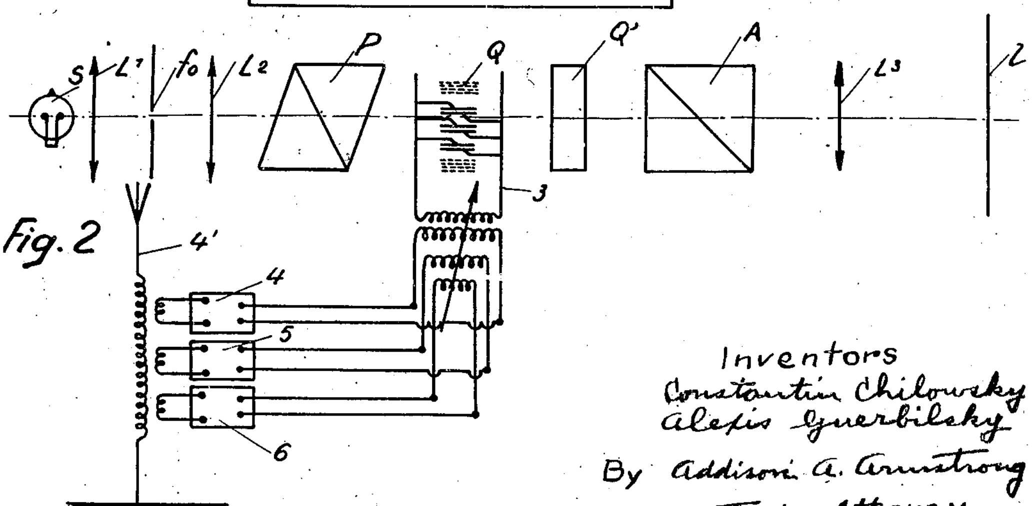


Fig. 2

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June 24, 1941. C. CHILOWSKY ET AL 2,247,051

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Fig. 8.

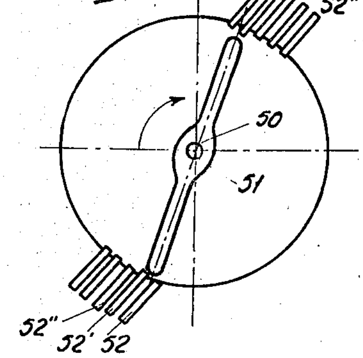

Fig. 5.

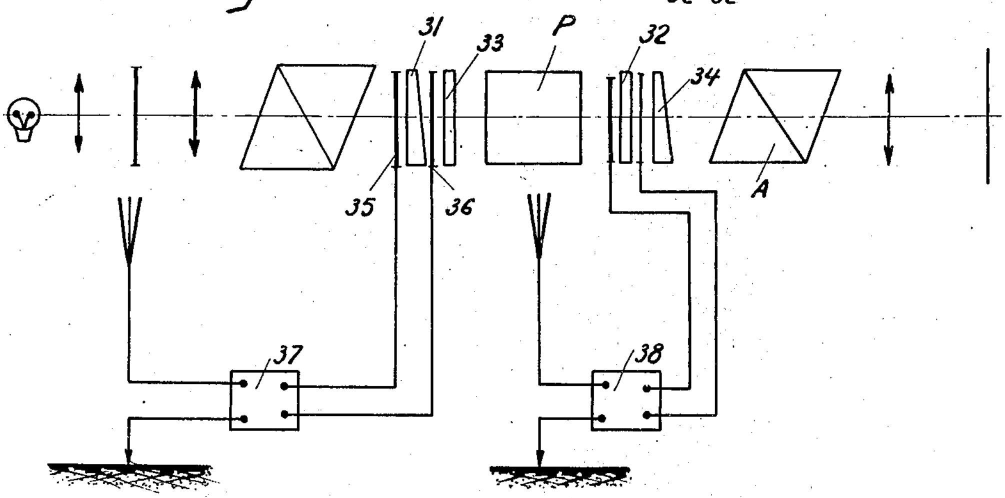

Fig. 6.

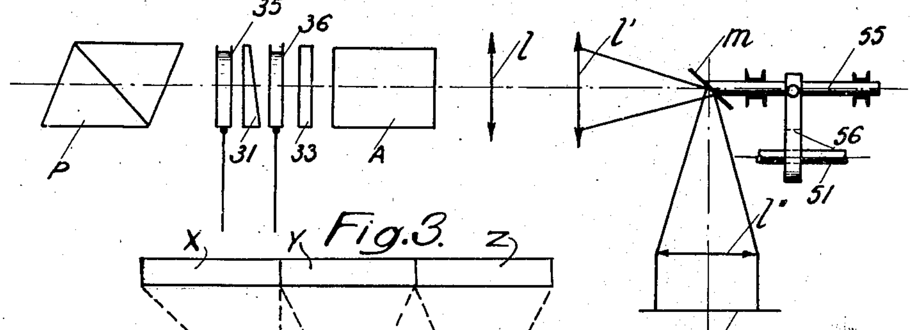

Fig. 3.

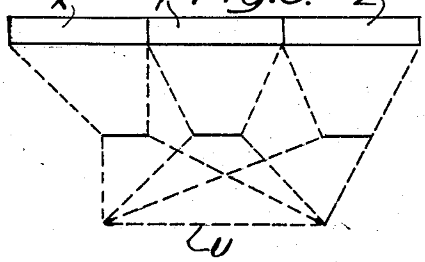

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Fig. 4.

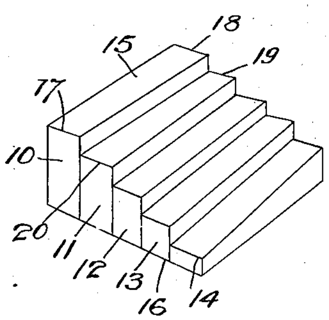


Fig. 9.

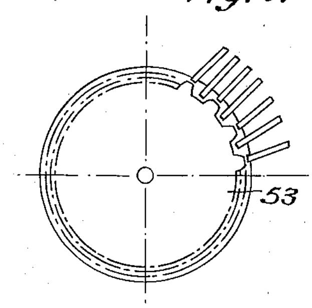


Fig. 7a

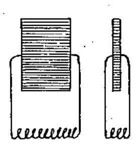
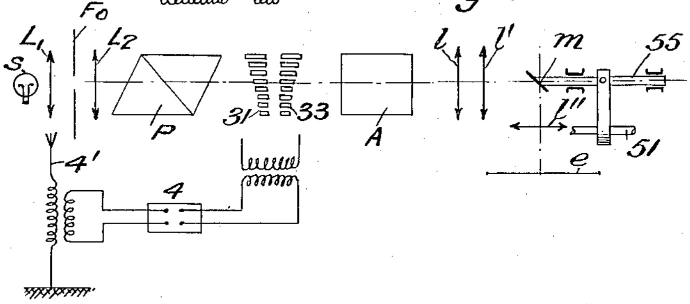


Fig. 7.



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UNITED STATES PATENT OFFICE

2,247,051

METHOD AND APPARATUS FOR TELEVISION

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Application April 23, 1928, Serial No. 272,319
In France April 26, 1927

17 Claims. (Cl. 178—6)

Methods and apparatus for the transmission of photographs, written matter and the like by means of Hertzian waves have heretofore been known. Nevertheless the correct transmission of images of animate or moving objects has never been achieved. The two problems are quite distinct. In the transmission of photographs and the like all the time necessary for transmitting the entire image point by point is available whereas, to produce television, it is essential to decompose the image into elements and to transmit said elements one after the other in such a manner that the impression of the first element still persists on the retina of the eye of the observer at the receiving station until the last element has been transmitted. If one assumes that the image is decomposed into one hundred rows and one hundred columns, say into 10,000 elements, these 10,000 elements ought to be transmitted in an interval of time less than the period of image-persistence of the retina, say about a tenth of a second. It is necessary, therefore, to transmit 100,000 elements per second.

Many inventors have suggested the use of the cathode oscillograph. However, such apparatus with fluorescent screens now known and available will not give the intensity of illumination which is demanded of them. Similarly it has been proposed to make use of piezo-electric crystals at the receiving station for the purpose of converting the variations of electric current into variations of luminous intensity. Actually if one imagines a lamina of piezo-electric crystal oscillating mechanically when it is placed in an alternating electrostatic field of high frequency and if one supposes that this lamina is traversed by rectilinearly polarised light and that said light after traversing the lamina, passes through an optical compensator (if necessary) and an analyser, then when the lamina oscillates the optical path followed by the light in the interior of said lamina will vary and the intensity on emergence from the analyser will vary equally and in conformity with (as a function of) the intensity of the electrical field in which the lamina is located. Up to the present no result has been obtained with this method even for the purpose of solving the problem of modulating light alone. The piezo-electric crystal having once been set in vibration does not return to rest for too long a time for the purposes of television. Attempts have been made to damp the oscillations of said crystal but this procedure has not been at all satisfactory because this damping can only be performed to the detriment of the acuteness and the intensity of the oscillation.

Apart from this, there is a further difficulty no less serious namely, it is necessary to produce two movements, one at the transmitting station and one at the receiving station, in such a manner as to be absolutely synchronous to the least part of their phases. This is essential with the method of decomposing and recomposing the image proposed hitherto.

The present invention remedies these difficulties and solves the problem on an entirely different principle.

The present invention is characterized by the production, at the same time as the variation of intensity in the electric current corresponding to the variations in the intensity of illumination at the various points of the image to be transmitted, of variations of frequency in said electric current, these variations corresponding at every moment to the position of the luminous spot being transmitted at that moment and doing this, moreover, even if the variations in position of said spot are very rapid. Conversely at the receiver it is possible by means of the variations of frequency in the electrical current received to determine the position of the luminous spot to be reproduced corresponding to the position of the spot transmitted and by means of the variations of electrical intensity of said current to determine the intensity of illumination of the spot reproduced.

The invention enables the following to be attained simultaneously:—

(a) the perfect synchronization of the apparatus at the transmitter and at the receiver, employed for analysing or reproducing the image.

(b) the conformity of modulation of the intensity of illumination of the point transmitted and that of the corresponding point received.

According to the invention a certain frequency, or a combination of two or more frequencies, of the electrical current or currents which effect the transmission of the image, is made to correspond to each element to be decomposed at the transmitter and recomposed at the receiver, so that the transmission of each element (or alternatively of each group of elements) is effected by a frequency proper to that element or to that group of elements, said frequency being reproduced periodically according to one or more continuous (or non-continuous) cycles of variations, and the period of this cycle or cycles of variation being, in general, less than the duration of the persistence of vision of the retina. In this manner the transmission of the image is, generally speaking, effected by one or more waves of variable frequency having periodically values forming a continuous or discontinuous series or in other words, by one, or possibly several, bands of frequency. At the receiver, this cyclically varying frequency sets in resonance oscillation a plurality of separate resonators or of resonators constituting one or more series, more or less continuous, of individual distinct frequencies lying within the limits which correspond to resonance with the extreme frequencies of transmission (or within their harmonics).

In practice the fundamental frequencies for television are extremely high and are generally of the order of magnitude of frequencies employed in wireless telegraphy. It is to be expressly noted that the transmission of the image may be by wire or by wireless transmission.

The resonators, commencing resonance successively in conformity with the variation in frequency of the transmission, effect the creation or maintenance of the image or the variation in intensity of illumination producing reconstitution of said image. The assembly of said resonators is disposed or arranged in space in such a fashion as to produce the proper location of the luminous points on the screen for reproducing the image.

Thus to every cycle or series of cycles of variations of electrical frequency, there will be a reconstitution of the image or the displacement of a spot of light in such a manner as to traverse all the elements of the screen. (In practice two cycles or bands of frequency are used in the preferred embodiment of the invention, as more fully set forth below.)

The resonators may be of various kinds but whatever they may be, their function is to maintain, create or modify luminous intensity when put into resonance by the electric currents or electro-magnetic oscillations.

The resonators may be of the following types:

(1) Piezo-electric resonators effecting the establishment or the variation of the light by the modification of the optical paths traversed by the light in one or a plurality of piezo-electric crystals in a state of resonance.

(2) Electro-mechanical resonators (piezo-electric in particular) coming successively into vibration and permitting a pre-determined movement to take place, thereby actuating optical devices such as revoluble or oscillating mirrors in such a manner as to throw at each instant a luminous beam in a different direction.

(3) Oscillating electric circuit producing luminous discharges in rarefied gas as for example a neon bulb.

(4) Oscillating electric circuit controlling the Kerr Phenomenon or the like.

The piezo-electric resonator can be used (*a*) directly by the variations of its optical properties or (*b*) indirectly by the utilization of the mechanical effects which it is capable of producing. One of the modes of using these mechanical effects constitutes a very important example of an embodiment of the invention.

It is also possible to combine the employment of the resonator with other methods known in their application to the problems of the invention. It is possible, for example, to employ revoluble or oscillatory mirrors, synchronous motors, and so on. Such combinations could be used in the following case:

The image is reconstituted by two distinct mechanisms each controlled by a separate band of cyclic variations of two fundamentally distinct frequencies.

One of the frequencies has for example a very quick cycle of variation, one thousandth of a second, ensuring a very rapid displacement of the luminous spot. The other has a very slow cycle of variation, as for example, one tenth of a second, ensuring a slow displacement of the luminous points controlled by the preceding cycle according to a second co-ordination. The first displacement, according to the first co-ordination, is brought about by an arrangement of resonators suitably disposed and conveniently localizing the light. The displacement according to the second co-ordination (slow displacement) is effected by known synchronization means such as synchronous motors and the like. It is possible, however, for the synchronous motor itself to be constituted by a large number of resonators, and piezo-electric devices in particular, successively controlled by a band of frequencies thereby providing a synchronous motor operative in accordance with the second co-ordination for displacing the luminous spot proceeding from the first group of resonators.

The variable frequency of the transmitting station can also operate simultaneously upon the decomposing set and, at the receiving station, upon the set which reconstitutes the image. These two sets or installations will comprise, for example, resonators (preferably piezo-electric devices) alike or co-ordinated in an appropriate manner. They effect in the decomposition, the successive projection of the elements of the image upon a photo-electric device which modulates an electric current in accordance with the luminosity of the successive elements received. At the receiving station, they effect the luminous reconstitution of the image.

A feature of the present invention is a method of transmitting images electrically which comprises establishing an oscillating current, decomposing the image to be transmitted in elements through a scanning device, successively projecting the said elements so as to vary photoelectrically the intensity of the said current, and varying the frequency of the said current under control of the functioning of the said scanning device.

Another feature of the invention consists in that the frequency of the oscillating current utilized for transmitting the elements of the image is varied in accordance with the variation in position of a movable member simultaneously actuated with the scanning device decomposing the image in elements.

The following description with reference to the accompanying drawings, which is by way of example, enables the manner in which the invention may be carried out to be readily understood.

Figure 1 is a diagram of a transmitting set for television.

Figure 2 is a diagram of a corresponding receiving set. Figure 2*a* shows a detail of the Figure 2 in side elevation.

Figure 3 shows diagrammatically a modified detail of the receiving set.

Figure 4 shows a piezo-electric block in steps replacing a group of laminae.

Figure 5 shows a variant of Figure 2 in which are utilized two series of crossed piezo-electric elements.

Figures 6 and 7 show two variations of Figure 5 in which a group of laminae is replaced by an oscillating mirror. Figures 6*a* and 7*a* show respectively details of Figures 6 and 7 in side elevation.

Figures 8 and 9 show arrangements in which the piezo-electric elements operate at the reception station by regulating the speed of a motor.

Figure 1 illustrates the first mode of carrying the invention into effect in a transmitter. The image I to be transmitted is projected by a lens l' upon a wheel R fitted around its periphery with mirrors m. The inclination of the mirrors to the plane of the figure is variable so that in the rotation of the wheel bearing the mirrors all points of the image I are successively projected by the mirrors m and the lens l_2 to an aperture f behind which a photo-electric cell c or some other photo-sensitive element. This employment of a mirror-carrying wheel as a scanning device is already known.

In accordance with the invention, the wheel R determines the variation, either continuous or discontinuous, of a variable capacity C, or of some other electric device such as an inductance, such capacity or other device being connected in the transmission circuit so that the frequency employed in such transmission depends upon it. Thus at each position of the wheel R and as each element of the image is projected upon the photo-electric cell, a corresponding frequency is determined for the transmission. For example, the wheel R may be geared with the spindle of a suitable variable condenser or it may carry plates connected with the transmission circuit and making contact successively with the brush terminals of different condensers.

The currents which traverse the photo-electric cell c, after amplification in the amplifier a' act upon the transmitting circuit through the medium of the inductance i for modulating the intensity of transmission. The transmission circuit is illustrated very diagrammatically in Figure 1, and it is understood that it could be replaced by any other oscillatory circuit. This circuit operates through the medium of the amplifier $a2$ upon the transmitting antenna 2. The emissions from this transmitting station are of a frequency which varies according to the position of the elements explored by the wheel and of an intensity which varies with the brightness or luminosity of that element.

The receiving set as shown in Fig. 2 comprises primarily a field of light polarized and parallel or almost parallel and provided by a source of light S, a condenser lens L', an aperture f_0 upon which forms the image of the source S. This image placed at the focus of the lens L_2 gives a pencil of parallel rays traversing a polarizer P. At the exit from the polarizer P there is provided a pile of laminae of piezo-electric crystals interposed between armatures in such manner as to constitute an arrangement of condensers.

Each lamina of piezo-electric crystal is placed in the path of the bundle of luminous rays bounding an element of the image. It has been explained that for each element of the image there is a corresponding emission frequency. Consequently the laminae of piezo-electric crystal will be constructed in such a manner that each lamina has an appropriate frequency of vibration and that such lamina resonates when it is excited by an alternating electrostatic field having a frequency corresponding to that element of the image to which the lamina itself corresponds. The polarized light, after having traversed the laminae Q, passes through the compensator Q' constituted for example, by laminae of the same crystal of the same length or thickness (according to whether the light traverses the piezo-electric laminae in the direction of their length or in the directon of ther thickness). The slow and rapid axes of these crystal laminae of the compensator Q' are displaced through 90° with relation to the similar axes of the laminae Q in such manner as to bring about, in known manner, the compensatory effect on the luminous rays. Next, there is provided an analyzer A arranged in such a manner as to obtain an extinction when all the laminae are in repose. The rays are projected by the lens L^3 upon a screen l.

All the armatures of the condensers which such armatures form with the piezo-electric laminae Q are mounted in parallel in the circuit **3**. The manner of mounting of the laminae Q and Q', which is well known in the art, is apparent from the showing on Fig. 2 of the circuit **3**; this circuit is coupled with the receiving circuit **4** which is itself coupled with the antenna **4'**. It is possible to arrange that the receiving circuit **4**, which is a resonant circuit, has a resonance curve too limited to embrace all the frequencies to which the piezo-electric laminae can vibrate. Also, it is possible to associate with the receiving circuit **4**, the receiving circuits **5** and **6**, coupled like the circuit **4** with the circuit **3**. The circuits **5** and **6** have resonance curves (intensity as a function of or plotted against frequency) differing from the resonance curve of the circuit **4** and the three circuits are chosen, for example, in such manner that the bands of increasing frequencies for which they are respectively in resonance overlap slightly. It will be clear that with such an association of circuits, it is then possible to cause the piezo-electric laminae to vibrate between much greater frequency limits. The three circuits **4**, **5** and **6**, instead of being coupled with one and the same inductance **3** can be associated, for example, with three distinct circuits each comprising a tier of piezo-electric laminae Q. Three circuits **4**, **5** and **6** have been illustrated but it is possible to use two or a greater number than three.

When, during the transmission, the wheel R projects the luminous rays and an element of the image upon the photo-electric cell a corresponding crystal lamina at the receiving station is put into vibration and produces light at the exit of the analyser, with amplitudes which are greater as the intensity of transmitting current and consequently the mean light of the element are greater.

When the wheel R revolves at the transmitting station, observation is kept on the surface of the laminae Q, or the analyser A, or upon the screen **l**, and there will be seen successively all the elements of the image with corresponding degrees of brightness and in order or range similar to the elements of the transmitted image. When the wheel R turns sufficiently rapidly for the impression of the first element to remain upon the retina of the observer at the instant that the last element appears, the observer will see the ensemble of the image or object transmitted either with the naked eye or upon the projection screen, whether the transmitted object is fixed or mobile.

The plurality of piezo-electric laminae can be replaced by one or more piezo-electric laminae the thickness of which varies from point to point or from place to place, the dimensions of the places corresponding with those of the decomposition elements of the image. This variation in thickness is sufficient, in effect, to create variations in resonance. In this case, the electrical axis of the lamina, assuming it to be sufficiently thin, preferably coincides with the direction of the light. One way of producing such a device is illustrated in Fig. 4, wherein the said device is formed of a series of prisms 10, 11, 12, 13, 14, the lower faces of such prisms being in the same plane 16. The upper face 15 of the prism 10 is inclined to the plane 16 in such manner that the edge 17 is nearer to the plane 16 than the edge 18. In the next prism 11, the edge 19 is at the same distance from the plane 16 as the edge 17 but the edge 20 is nearer to the plane 16, and so on.

One important modification of the receiving installation consists in replacing the multitude of piezo-electric laminae by an arrangement comprising two piezo-electric plates or blades 31 and 32 (Fig. 5) having a trapezoidal parallel and thin section. They are disposed one after the other perpendicularly to the parallel and polarized rays of light and separated by a polarizer P. Compensators 33, 34 are placed after each blade or plate and analysis is effected by an analyser A. The arrangement is such as to obtain an extinction at the exit of the analyser when the blades or plates 31, 32 are at rest. The functioning of each of the blades or plates 31, 32 is analogous to that of each of the steps in Fig. 4 and each could be replaced by an assemblage of laminae such as those marked Q in Fig. 2. The two blades or plates 31 and 32 are disposed at 90° one with reference to the other, i. e. their trapezoidal cross-sections are respectively in the plane of the figure and in a plane perpendicular thereto, the said cross-section being of course in each case perpendicular to the axis of the light beam to be modulated; consequently each element 31 and 32 will allow light to pass through a band of definite thickness corresponding to resonancy with the incoming frequencies, said frequencies being submitted to a double modulation in accordance with the movement of the scanning means along two coordinates of the picture to be transmitted, as will readily be understood. The luminous point provided by the intersection of the two allowed passages for the light will thus correspond to the frequency determined by the coordinates of the corresponding point of the picture, as transmitted through the two circuits 37, 38. In this case, it is apparent that instead of a single band or group of bands of frequencies, as in Fig. 2, there will be two such bands, one for each circuit corresponding to each coordinate.

It is to be noted that when use is made at the receiver (Fig. 2) of one or several piezo-electric laminae and when use is made at the transmitter (without piezo-electric laminae) of the mirror arrangement of Fig. 1, the fact that the vibrations of the laminae do not cease immediately is not troublesome because it is possible to allow for a period of damping or dying away equal to the time of transmission of the image, which may be of the order of one-tenth or one-twentieth of a second. The time of damping or dying away being almost the same for all the laminae, there is nothing to adversely affect the relations of luminous intensities transmitted by the different laminae, but on the contrary the effect is to render the image particularly luminous.

Instead of having a single circuit of variable frequency and intensity at the transmitter, it would, of course, be possible to provide two distinct circuits, one in which the intensity is fixed and the frequency variable and the other in which the frequency is fixed and the intensity is varied by the photo-electric cell.

At the receiver it is possible to reduce the number of resonating elements, that is to say, of the piezo-electric lamina, and as a consequence appreciably to approach the limits between which the transmission frequencies should be included. To this end it is possible to substitute an oscillatory mirror which receives the luminous band coming from the first element 31 and ensures the recomposition of the image according to the second axis of the co-ordinations, for one of the groups of resonating elements described in connection with Fig. 5, that is to say for instance, for the lamina 31 or for the lamina 32, but in practice preferably for the latter lamina (which, it will be remembered effects the recomposition of the image according to the second axis of the co-ordinations of slow variations). Two examples of such arrangements are shown in Figs. 6 and 7. To carry out this method it is necessary to have a motor enabling the mirror to be rotated with a sufficiently high degree of precision (that is to say in very close synchronization with the transmission). This motor may be constructed in the manner which will be described below.

In Fig. 8 a paddle member 50 fixed to a shaft 51 is driven continuously to rotate in the direction of the arrow by an appropriate mechanical or electro-mechanical arrangement, for example, a rotary field arrangement. On a circumference having as its centre the axis of rotation of the paddle there are disposed the piezo-electric laminae 52, 52', 52'', preferably of quartz on account of the mechanical qualities and the sensitiveness of the crystal. When a lamina in front of the paddle is in vibration, it will hinder actively the motion of the latter either by direct contact or, better, through the intermediary of the cushion of air which surrounds it and in which it spreads its vibrations. If the laminae enter into vibration one after the other at precise instants due to the fact that they are disposed in a receiving circuit for the electrical waves in the manner of the laminae Q of Fig. 2 and if, for example, 100 laminae of quartz are provided and the complete cycle of variations of frequency at the transmitting station is effected in 1/10 of a second, then the laminae 52, 52' commence to receive vibrations successively at 1/1000 of a second intervals and thus correct the precision of the paddle movement in such a manner that the advance or retardation at any instant may not exceed 1/100 of a revolution, say 1/1000 of a second and in practice will always be considerably less than this amount.

The piezo-electric resonators are constituted in this case preferably in such a manner that their electrical axes are directed according to their thickness that is to say perpendicularly to the useful elongations of the laminae.

Fig. 9 illustrates a variant of the method, the quartz laminae being, for purposes of explanation, considered to be numbered in order. If all the even laminae are vibrated at one and the same frequency and the odd laminae are vibrated at another frequency, the paddle 50 being replaced in this variant by the disc 53 carrying teeth of an appropriate profile and the spacing or pitch of which corresponds to that of two laminae vibrating at the same frequency, all the laminae of similar frequency are vibrating simultaneously and the braking and controlling effort is multiplied by the number of laminae vibrating simultaneously. Fig. 6 illustrates the application of this motor to the carrying out of the method of recomposition of the image in which a group of piezo-electric laminae and the motor are employed.

As shown in Fig. 6, a bundle of rays traverses the polarizer P, the piezo-electric prism 31, the optical compensator 33, the analyser A, a cylindrical lens *l* which transforms the luminous bands transmitted by the prism 31 into points, and an objective *l'* which concentrates all these points upon the mirror *m* oscillating about an axis 55 perpendicular to the edge of the prism 31. The oscillation of the mirror is produced by means of the motor described with reference to Fig. 8 or Fig. 9, but which can be replaced by another appropriate motor such as a high frequency synchronous motor, and also by means of a mechanism such as an eccentric 56, crank and connecting rod, or any other appropriate cinematic mechanism. The light is then projected by an objective *l''* upon the screen *e*. The mirror *m* projects the light coming from the analyser according to different bands of the screen. The local resonances of the prism 31, or the resonant elements of an assemblage of piezo-electric elements, by which the prism may be replaced, as will be seen farther on, determine at each instant a luminous point of these lines. Together, the position of the mirror and the place of local resonance of the prism, or of the resonant piezo-electric element, determines with the two co-ordinates the luminous point of the image. Each line containing an assemblage of points (elements), at each position of the mirror, should correspond to an entire cycle of displacements of the local resonance of the prism. As the mirror is not arrested, in order to avoid deformation of the image (or of the image band) it is possible to turn the prism through a certain angle about the axis of the bundle of rays traversing it, in order to correct or straighten the band. The armatures 35 and 36 of Figs. 5 and 6 can be constituted by two transparent containers, glass for example, containing a transparent liquid conductor such as nitrobenzole. This arrangement shows how it is possible, in general, to have an electric field disposed according to the direction of the light without preventing the light from passing.

The prism 31 can be replaced by a series of superposed laminae, 100 for example, of different lengths varying between the same limits as the thicknesses of the prism. Fig. 7, which illustrates this, shows the prisms 31 and 33 replaced by two such series of laminae of similar lengths. The remainder of the arrangement remains the same.

It is also possible in the receiver to combine several resonators for obtaining the variation of one of the co-ordinates in such a manner as to diminish the range of frequencies utilized. An arrangement of this kind is shown by way of example in Fig. 3, wherein a series of piezo-electric elements, or a series of analogous resonators, is arranged, for the purpose aforesaid, to correspond to a fraction of the image, this fraction being one-third in the example illustrated. The first time that the said series of elements at U are traversed by the cycle of frequencies, the corresponding luminous points impinge upon the zone X, the second time upon the zone Y and the third time upon the zone Z. For this purpose, optical devices are disposed between the elements U and the screen and such devices project the light coming from U upon the three zones X, Y and Z. With each of these optical devices there is combined an electro-optic relay, as for example a piezo-electric resonator inserted between a polarizer and an analyser, controlled in such a manner that the light at any given instant can pass to a single one only of these three zones according to the fraction of the picture which is being transmitted at this moment. These electro-optic relays are actuated either by a current from the transmitting station or by a current which is established or cut off each time that the series of resonators U has been traversed by a complete cycle of frequencies. It is possible for this purpose to make use of basculators of a known type, as for example thermionic tubes mounted in a special manner.

It is also possible to employ, for the same purpose, light sources illuminating successively the elements U, each source being conjoined with one of the optical devices aforesaid, and one source effecting the lighting whilst another is extinguished each time that the series of resonators U has been traversed by the complete cycle of frequencies.

In order practically to apply this mode of reception it will be necessary in some cases to deform the image in such manner as to give for example the form of a narrow band. It is to be understood that upon reception appropriate optical arrangements will produce the appropriate or definitive aspect.

There are many piezo-electric crystals, notably quartz, Rochelle salt, and tourmaline. Rochelle salt is very sensitive, quartz is sensitive and robust, and is also very bi-refracting. One of these two crystals would usually be selected but the others could also be employed.

In the foregoing it has been assumed, for the sake of clearness, that the variation of frequency of currents received acts only for correctly disposing the element of the image to be re-composed. In fact, however, this variation of frequency contributes also to the production of a variation of the brightness of the light. It is, therefore, possible that in the various regions of the image which have corresponding different frequencies, the light brightness for the same amplitude of wave may be different. Such variations of brightness may be corrected in reception by causing the luminous rays to traverse laminae of unequal transparency.

The employment of piezo-electric crystals is not indispensable and these crystals at the receiving station may be replaced by a rarefied gas bulb (a neon bulb for example), the wall of which is interiorly metallized while being transparent to the light.

In a modification of this arrangement the single bulb or tube may be replaced by a plurality of lamps adapted for giving luminous discharges in rarefied gas, and in particular neon lamps. These are connected in a number of resonant electric circuits, which can be furnished with piezo-electric frequency stabilizers, constituting a series of frequencies appropriate and distinct, these circuits being actuated in their order by the periodic variation of frequency of reception current.

In cases where it is desired to decompose the image to be transmitted into a particularly high number of elements, several posts of television may be installed each transmitting a part of the image and all functioning simultaneously.

If it is desired to avoid the employment of optical compensators, monochromatic light may be made use of. In this case, in order to obtain extinction at the exit of the analyser, the crystalline thickness traversed by the polarized light would be calculated so that they are "lames ondes" or "lames demi-ondes" for the radiation selected.

Instead of light, other radiations may be employed. At the transmitting station it would be possible, for example, to "light" the object with ultra-violet radiations, the photo-electric cell being particularly sensitive to these radiations.

At the receiving station, it would be possible to utilize ultra-violet rays which would be rendered visible by fluorescent screens.

Throughout the foregoing, photo-electric cells have been referred to, but it is to be understood that it is possible to replace these cells by other devices capable of translating luminous intensity variations (or variations of radiations other than light) into variations of electric current, or into variations of fields either electric or magnetic. For example, it is possible to utilize selenium cells, or ionization chambers (for the ultra-violet).

What we claim is:

1. In the art of transmitting vision employing a line scanning system for picture transmission, a luminously responsive receiving screen comprising a plurality of electrical conductors associated with a body of inert gas, said conductors being arranged in a plurality of parallel planes corresponding in number and arrangement to the different lines described across the transmitted picture, means for making said conductors luminous, and means for causing each point of a conductor to glow with the proper intensity to reproduce a picture point.

2. A television system comprising means for transmitting variable frequency signals, means for receiving variable frequency signals, and a screen for visually reproducing the variable frequency signals comprising a multiplicity of parallel extending luminous portions electrically connected to each other and with said receiving means, means for making said portions luminous, and means for causing each point of a luminous portion to glow with the proper intensity to reproduce a picture point.

3. An apparatus for the electrical transmission of images, which comprises in combination, means for producing electromagnetic waves, photo-electric means for varying the amplitude of electromagnetic waves thus produced, non-electric movable means for causing said photo-electric means to be illuminated with successive luminous intensities corresponding respectively with the luminous intensities of all the elements of the image to be transmitted, movable means distinct from said photo-electric means for varying the frequency of electromagnetic waves thus produced, means for simultaneously actuating both of these movable means, and receiving means responsive to said electromagnetic waves for reproducing said decomposed image.

4. An apparatus for the electrical transmission of images, which comprises in combination, means for producing electromagnetic waves, photo-electric means for varying the amplitude of said electro-magnetic waves, non-electric movable means for causing said photo-electric means to be illuminated with successive luminous intensities corresponding respectively with the luminous intensities of all the elements of the image to be transmitted, movable means distinct from said photo-electric means for varying the frequency of said electro-magnetic waves, means for simultaneously actuating both of said movable means, and receiving means responsive to said electromagnetic waves for reproducing said decomposed image.

5. An apparatus for the electrical transmission of images, which comprises in combination, means for producing electromagnetic waves, photo-electric means for varying the amplitude of electromagnetic waves thus produced, movable optical scanning means for successively projecting all the elements of the image to be transmitted onto said photo-electric means, movable means distinct from said photo-electric means for varying the frequency of electromagnetic waves thus produced, means for simultaneously actuating both of said movable means, and receiving means responsive to said electro-magnetic waves for reproducing the image.

6. An apparatus for the electrical transmission of images which comprises in combination, means for producing electromagnetic waves, photo-electric means for varying the amplitude of said electromagnetic waves, movable optical scanning means for successively projecting all the elements of the image to be transmitted onto said photo-electric means, movable means distinct from said photo-electric means for varying the frequency of said electromagnetic waves, means for simultaneously actuating both of said movable means, and receiving means responsive to said electro-magnetic waves for reproducing the decomposed image.

7. A system for the electrical transmission of images, which comprises in combination, means for producing electromagnetic waves, photo-electric means for varying the amplitude of electromagnetic waves thus produced, non-electric movable means for causing said photo-electric means to be illuminated with successive luminous intensities corresponding respectively with the luminous intensities of all the elements of the image to be transmitted, movable means distinct from said photo-electric means, for varying the frequency of electromagnetic waves thus produced, means for simultaneously actuating both of said movable means, and a receiving device including, a source of light, a plurality of optical effect producing resonators adapted to coact with said source of light for establishing one of the coordinates of the elements of the image to be tarnsmitted, a movable optical system adapted to coact with said source of light for establishing the other coordinate of these elements of the image, a motor for driving said optical system at a predetermined speed, electrical receiving means responsive to electromagnetic waves of varying frequency for imparting vibrations to said resonators, and means responsive to electromagnetic waves of varying amplitude for controlling the amplitude of said vibrations.

8. A system for the electrical transmission of images, which comprises in combination, means for producing electromagnetic waves, photo-electric means for varying the amplitude of electromagnetic waves thus produced, non-electric movable means for causing said photo-electric means to be illuminated with successive luminous in-

tensities corresponding respectively with the luminous intensities of all the elements of the image to be transmitted, movable means distinct from said photoelectric means, for varying the frequency of the electromagnetic waves thus produced, means for simultaneously actuating both of said movable means, and a receiving device including, a source of light, a plurality of optical effect producing resonators adapted to coact with said source of light for establishing one of the coordinates of the elements of the image to be transmitted, a movable optical system adapted to coact with said source of light for establishing the other coordinate of these elements of the image, a motor for driving said optical system at a predetermined speed, electrical receiving means responsive to electromagnetic waves of varying frequency for imparting vibrations to said resonators, and means responsive to electromagnetic waves of varying amplitude for directly modulating the intensity of the light beam from said source.

9. An apparatus for the electrical transmission of images, which comprises in combination, means for producing electromagnetic waves, photo-electric means for varying the amplitude of electromagnetic waves thus produced, non-electric movable means for causing said photo-electric means to be illuminated with successive luminous intensities corresponding respectively with the luminous intensities of the elements of the image to be transmitted, movable means distinct from said photoelectric means, for varying the frequency of electromagnetic waves thus produced, and means for simultaneously actuating both of these movable means.

10. An apparatus for the electrical transmission of images, which comprises in combination, means for producing electromagnetic waves, photo-electric means for varying the amplitude of said electromagnetic waves, non-electric movable means for causing said photo-electric means to be illuminated with successive luminous intensities corresponding respectively with the luminous intensities of all the elements of the image to be transmitted, movable means distinct from said photo-electric means for varying the frequency of said electromagnetic waves, and means for simultaneously actuating both of said movable means.

11. An apparatus for the electrical transmission of images, which comprises in combination, means for producing electromagnetic waves, photo-electric means for varying the amplitude of electromagnetic waves thus produced, movable optical scanning means for successively projecting all the elements of the image to be transmitted onto said photo-electric means, movable means distinct from said photoelectric means for varying the frequency of electromagnetic waves thus produced, and means for simultaneously actuating both of these movable means.

12. An apparatus for the electrical transmission of images, which comprises in combination, means for producing electromagnetic waves, photo-electric means for varying the amplitude of said electromagnetic waves, movable optical scanning means for successively projecting all the elements of the image to be transmitted onto said photo-electric means, movable means distinct from said photo-electric means for varying the frequency of said electromagnetic waves, and means for simultaneously actuating both of said movable means.

13. In an electro-optical system for producing images of a field of view, a plurality of piezo-electric elements, and means for exciting said elements in succession periodically to resonate with amplitudes corresponding respectively to tone values of elemental areas of said field of view, said means including a means for applying a high frequency field across the crystal in a direction such that each vector of said field passes only through a single crystal element.

14. In an electro-optical image producing system, means for producing the image by light emanating therefrom and having a plurality of portions each responsive to a selected frequency and corresponding in position to an elemental area of a field of view, a source of variable high frequency electric current having amplitudes representative of tone values of the elemental areas of the field of view for controlling the excitation of said portions repeatedly in succession to cause them to emit light to produce said tone values, and means for causing each said portion to maintain the emanation of light from that portion for a period after the frequency of said current has ceased to be that to which that portion is responsive, said period being of substantially the same duration for each of said portions.

15. A piezo-electric crystal having a pair of opposite faces non-uniformly spaced at different points throughout their area, said crystal being adapted to vibrate for a band of frequencies corresponding to the dimensions of the crystal between said non-uniformly spaced points, and means to apply a high frequency field across the crystal in a direction such that each vector of said field passes only through the portions of the crystal belonging to a single resonant element.

16. A piezo-electric crystal having a pair of opposite faces tapered toward each other, said crystal being adapted to vibrate for a band of frequencies corresponding to the dimensions of the crystal between its tapering faces, and means to apply a high frequency field across the crystal in a direction such that each vector of said field passes only through the portions of the crystal belonging to a single resonant element.

17. A piezo-electric crystal having a pair of opposite faces non-uniformly spaced at different points throughout their area, said crystal being adapted to vibrate for a band of frequencies corresponding to the dimensions of the crystal between said non-uniformly spaced points, and means to apply a high frequency field across the crystal in a direction such that each vector of said field passes only through the portions of the crystal belonging to a single resonant element, at least one of said faces being step-shaped.

CONSTANTIN CHILOWSKY.
ALEXIS GUERBILSKY.