

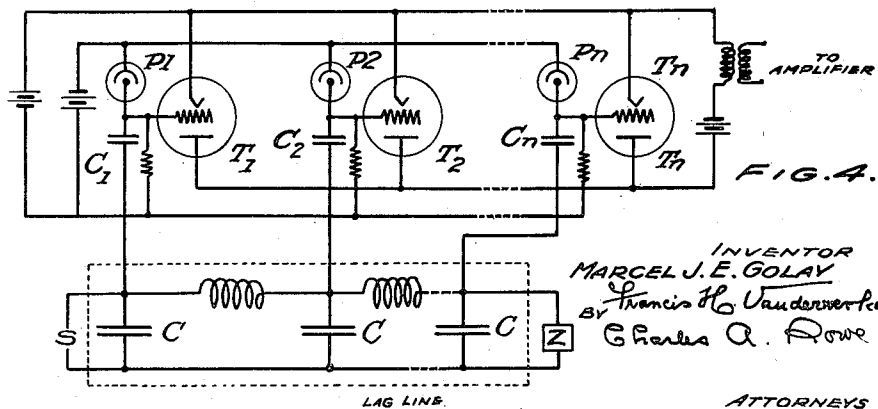
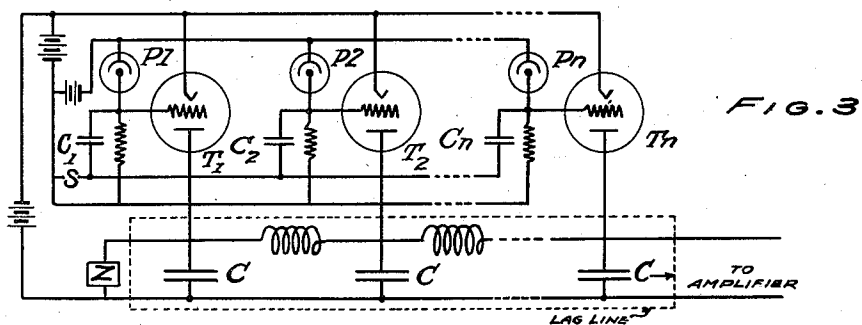
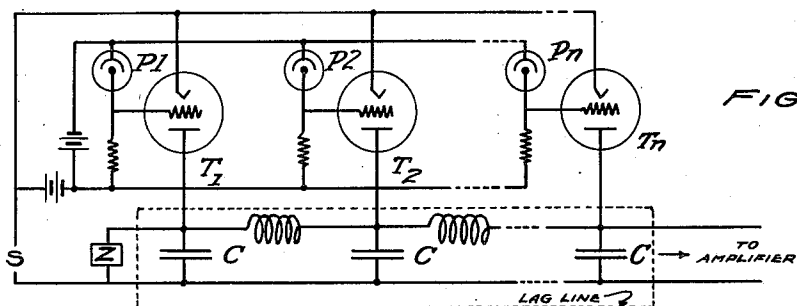
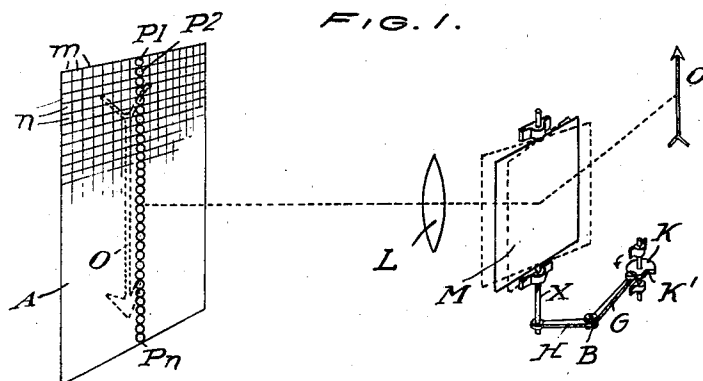
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TELEVISION TRANSMISSION SYSTEM

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TELEVISION TRANSMISSION SYSTEM

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7 Claims. (Cl. 178-7.1)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

5 This invention relates to television, and more particularly to television transmitting systems, and provides means whereby scenes of moderate illumination may be successfully televised without the aid of the customary "flying spot".

10 As is well known, the conventional system of so-called day-light television transmission consists in having every element of the image of the scene being televised illuminate in turn a photo-electric cell. The very weak current delivered by

15 this cell is caused to flow through a resistance, and the voltage thus built up across the resistance is applied to the control grid of the first tube of an amplifier. Superposed on this signal voltage is another voltage having its origin in

20 the thermal agitation of this resistance, the average value of the square of this voltage being proportional to the value of the resistance and to its temperature. As it is desired to keep the signal voltage level above the thermal voltage level, there will be an advantage in making the value of the resistance high, as the signal voltage increases linearly with it, while the thermal voltage increases with the square root of the value of this resistance. An upper limit to this

30 resistance will be determined by the combined capacitance of the photoelectric electrode and the control grid of the first tube to the rest of the circuit as well as by the highest frequencies necessary to transmit satisfactory a preassigned number of images per second with a preassigned

35 detail. If it be desired to increase the detail, the size of the elements into which the image is scanned must be correspondingly decreased, the current output of the photo-electric cell is decreased, while it must flow through a smaller resistance as higher frequencies are required to transmit the scenes with the increased detail. All of these factors contribute to lowering the signal voltage over the thermal voltage ratio.

40 The photo-electric cells have a limited efficiency, the size of the lens forming the image of the scene to be scanned cannot be increased beyond certain practical limits, and when little or no control can be had over the illumination of the scenes to be televised a limit is soon reached for the detail with which they can be transmitted.

To obviate this difficulty, schemes, such as the one known as multiple band television, have been

55 tried consisting in dividing the scene into a

number of parts, each of which is handled individually by a television transmitter. With such schemes, the amount of necessary equipment is almost proportional to the number of parts into which the scene is divided in the television transmitter, while a similar increase in equipment is required at the receiving station.

The invention here disclosed consists in providing means whereby the scene to be transmitted is divided in a goodly number of parts, each of which is handled by an individual photo-electric cell, the output of which is partly amplified, and then directed in turn to a common transmitting apparatus.

The invention is hereinafter more fully described in detail with reference to the accompanying drawing, in which:

Fig. 1 is a view showing diagrammatically the image plane and arrangement of light sensitive cells in said plane; and

Figs. 2, 3 and 4 show different circuit arrangements, including lag line sections embodying the invention.

More specifically, the image of the scene or object is divided into n lines, each of which lines is divided into m elements. To each line is ascribed an individual photo-electric cell, which is illuminated successively by the various elements of the line, this being done simultaneously for all lines by oscillating the image parallel to the line. The photo-electric cells must be placed in a row, as close together as possible, in order that little light be lost. This row of cells is placed across one of the dimensions of the rectangular image plane of the projected image, which is caused to sweep over the row of cells during its oscillatory motion.

The operation of the system may be generally visualized by reference to Fig. 1 and is outlined as follows: The image O of an object O' is focused on image plane A by means of lens L and oscillating mirror M . The axis X of mirror M is given an oscillating motion by means of links H and G , jointed at B and actuated by cam K . The effect of this oscillation is to cause the image to sweep uniformly across the row of photo-electric cells P_1, P_2, P_n , placed in plane A and to resume its sweeping motion after having been brought back rapidly to its starting position, this action resulting when link G rides over the steep portion K' of cam K . The period of this oscillation should be about $\frac{1}{60}$ th of a second, or whatever is judged sufficiently rapid to give the illusion of optical continuity. The photo-electric cells are connected in proper relation in any one

of the circuits hereinafter more fully described in connection with Figs. 2, 3 and 4, and every time the image has progressed across plane A by $1/m$ th of its width, an electric commutation of the cells would have been effected as more fully explained in connection with the particular description of said circuits. The result is to direct to a common circuit the succession of impulses received from each cell and thus effect the scanning of the particular vertical line of the image then projected on the row of photo-electric cells.

In order to obtain the television signal corresponding to an $n \times m$ scanning of the scene, a lag line or recurrent delay network containing at least $n-1$ sections is associated with the photo-electric cells circuit, each circuit except perhaps the last being associated with a section of the lag line. The function of this lag line or recurrent delay network is to effect a commutation of the circuits of the various photo-electric cells, whereby the signal impulses are collected from these and delivered in turn to the transmission apparatus during the time necessary for the image to move a distance equivalent to the m th fraction of the length of one of the n lines.

In Fig. 2 the control grid voltage of the n tubes $T_1, T_2, \dots, T_n$ is controlled at all times by the photo-electric current of the associated cells. The plate voltage is inserted in S and consists of a surge of voltage of short duration at fixed intervals. This renders the tubes $T_1, T_2, \dots, T_n$ operative for an instant, and causes the various condensers C of the lag line to be variously charged according to the control-grid voltages of the associated tubes. These charges proceed then to flow out in both directions on the lag line. On the left side they are dissipated in the properly adjusted impedance Z, while on the right side they reach the amplifier in a definite sequence, the lag line or recurrent delay network being thus used to transform the space variation of light across the row of photo-electric cells into a time variation of the corresponding signals. When the impulse has reached the amplifier, another surge of plate voltage is sent from S, and the image to be televised having moved the distance corresponding to one picture element, another line is recorded on the lag line and shifted to the amplifier.

Fig. 3 shows another possible application of the principle disclosed here, whereby the plate voltage is maintained at a fixed value, while the tubes are normally biased to cut-off, except when periodic surges, inserted in S render the tubes operative and cause appropriate charges to be placed on the condensers of the lag line, the other phases of the process being the same as for the circuit of Fig. 1. These surges are inserted in S, and by means of the small condensers C_1, C_2 , etc., raise all grid voltages in turn by an approximately equal amount.

In the application shown by Fig. 4, the tubes $T_1, T_2, \dots, T_n$, are normally biased to cut-off. A periodic surge of voltage placed in S proceeds through the lag line and raises for an instant the grid voltage of the tubes $T_1, T_2, \dots, T_n$ in turn by means of the small condensers C_1, C_2 , etc. This renders the tubes operative for an instant, causing them to deliver to a common circuit a current which shall be a function of the illumination of the photo-electric cells with which they are respectively associated.

It is obvious that all isomorphic elements such as photo-electric cells, tubes, condensers, etc.,

must be as nearly alike as possible, which calls for careful matching of such elements, and a suitable lag line must be used.

As will be apparent to those skilled in the art, the individual signals placed in the form of pulses, as illustrated by Figures 2 and 3, should be propagated along said lag line with a minimum of attenuation or distortion, so as to reach the amplifier as a distinct sequence of signals representing the illumination of the individual surface elements comprised in any single line of the scanned object or image of the object. In the system illustrated by Fig. 4 it is equally obvious that the single pulse propagated at regular intervals along the lag line for the purpose of "triggering" the individual amplifying circuits should also be subjected to as little distortion or attenuation as possible. A suitable lag line should therefore have as little dispersion as possible, i. e., the velocity of propagation of a signal of a certain frequency along the lag line should be as little dependent as possible upon the value of this frequency, for all values of frequencies inferior to a certain pre-assigned frequency, so that the bulb of the various sinusoidal components of a single pulse signal will travel together along the line.

While Figs. 2, 3 and 4 illustrate a lag line made up of series inductance and shunted capacitance, and provide only one section per photoelectric-cell circuit, it is obvious that, were one or more sections intercalated between the sections associated with a photoelectric-cell circuit, the undesired effect of dispersion would be minimized. Thus, in the arrangement illustrated by Figs. 2 and 3, the spreading of any single pulse might be confined to few enough sections so as not to mix appreciably with the preceding or succeeding pulse. Conversely, in the arrangement illustrated by Fig. 4, the spreading of the "triggering" pulses might be so confined as to never affect more than one photoelectric-cell circuit at any one time.

Another refinement of a lag line, inherent in the present invention and well known to the art, consists in allowing a certain amount of mutual inductance between the inductance coils of adjacent sections, or even between the inductance coils of alternate or more distant sections.

It is also obvious that a suitable lag line should be made up of elements which are as little dissipative as possible. While it is physically impossible to build a lag line without a certain amount of dissipation due to the resistance of the coils and the leakage of the transformers, it is quite feasible to build one in which the pulse currents alone are attenuated, while the pulse voltages are propagated without appreciable change; or, conversely, a lag line may also be built in which the pulse voltages alone are attenuated, while the pulse currents do not suffer any appreciable loss, and any one of these two arrangements may be used to transmit some characteristic of the signal pulses; i. e., voltage or current, without attenuation.

What is claimed is:—

1. In a television transmission system, which employs an image plane divided into lines; means for translating light energy into electrical energy, comprising light sensitive cells arranged in a column and corresponding in number of units to the number of said lines; means for projecting upon the cells the image of an object to be transmitted and for shifting the image across said column of cells; circuit means operatively coupled to the output of said cells, comprising a general circuit and a series of local circuits; and

means to effect a commutation of the signal impulses comprising lag line sections operative with each local circuit whereby a signal impulse will cause a charge to be placed upon the lag line sections which is a direct function of the illumination of their respective cells at any instant, all of said lag line sections being serially connected to form a single lag line which is characterized by a time delay which determines the time consumed in scanning one column of points of said image plane.

2. In a television transmission system, which employs an image plane divided into lines; means for translating light energy into electrical energy, comprising light sensitive cells arranged in a column in said plane and corresponding in number of cell units to the number of said lines; scanning means for shifting the image of the object to be transmitted across said column; circuit means operatively coupled to the output of said cells, comprising a general circuit and a series of local circuits and including an electronic amplifier for each cell; and means comprising a lag line section for each local circuit to effect a commutation of the output of said cells whereby impulses impressed on the lag line at regular intervals travel along said lag line and cause each local circuit to deliver in turn to a common transmission circuit a signal which is a direct function of the illumination of the respective cells associated with said circuits, said lag line sections being serially connected to form a single lag line which is characterized by a time delay which determines the time consumed in scanning one column of elements of said image plane.

3. In a television transmission system, which employs an image plane divided into lines; means for translating light energy into electrical energy, comprising light sensitive cells corresponding in number to said lines; circuit means coupled to the output of said cells, comprising a general circuit, and a series of local circuits, including one section of a common lag line and an electronic amplifier for each local circuit; means for projecting upon the cells the image of an object; means for shifting said image across said cells; and means for causing all local circuits to impress at regular intervals upon their associated lag line section a signal impulse which is a direct function of the illumination of their respective cells, said lag line sections being connected in series to make up a single lag line whereby a time delay is produced substantially equal to said time interval between said impulses.

4. In a television transmission system, which employs an image plane divided into lines; means for translating light energy into electrical energy, comprising light sensitive cells arranged in a column and corresponding in number of units to said lines; means for projecting upon the cells the image of an object to be transmitted; means for shifting said image across said column of cells; circuit means operative with the cells, comprising a local circuit and an amplifier for each cell; and means to transform the space variation of light across the said column of cells into a time variation of the signal impulses, said means comprising a lag line section fed from the output of each amplifier to effect a commutation of said signal impulses, said lag line sections being con-

nected in series to form a single lag line which is characterized by a time delay which determines the time consumed in registering one column of the image as it passes over said column of cells.

5. In a television transmission system, which employs an image plane divided into n lines, each line being divided into m elements; means for translating light energy into electrical energy, comprising light sensitive cell units arranged in a column in said plane, the number of cell units corresponding to the number of lines; means for projecting upon the cells as a group the image of an object to be transmitted; means for shifting said image across said column of cells; circuit means operative with said cells, comprising a general circuit and a series of local circuits including an electronic amplifier for each local circuit; and means coupled to the local circuits and comprising lag line circuits including at least $n-1$ sections, to effect a commutation of the energy output of said cells whereby the signal impulses are collected and fed to one transmission channel during the time necessary for the image to move a distance equivalent to the m th fraction of the length of one of the n lines, said lag line circuits being serially connected to form a single lag line which is characterized by a time delay substantially equal to one/ m th of the time consumed in scanning the whole image plane once.

6. In a television transmission system, which employs an image plane divided into lines; means for translating light energy into electrical energy, comprising light sensitive cells arranged in a column in said plane, and corresponding in number of cell units to the number of said lines; scanning means for projecting upon the cells as a group a succession of portions of the image of the object to be transmitted; circuit means operative with said cells, comprising a local circuit and an amplifier for each cell, each amplifier including an electron tube having its control grid coupled to each of said cells, and means comprising lag line sections fed from said amplifiers to cause said amplifiers to deliver to a transmission channel a signal impulse which is a function of the illumination of said cells, said lag line sections being serially connected and constituting a single lag line to produce a time delay which substantially determines the time consumed in scanning one of said successions of portions of the image.

7. In a television transmission system, means for dividing the image of the object to be transmitted into n groups of m surface elements each; means for translating light energy into electrical energy comprising n circuits, each including a light sensitive device, an electrical amplifier and one section of a common lag line, said lag line being characterized by a time delay which is substantially equal to one/ m th of the time consumed in scanning once the whole image plane; means for projecting said image on the light sensitive devices in such manner that each device will be covered in turn by each of the m surface elements of one of the n groups; and means operative with said lag line whereby the individual signals corresponding to the illumination of the surface elements projected on said light sensitive devices are delivered in series to a common transmitting circuit.

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