

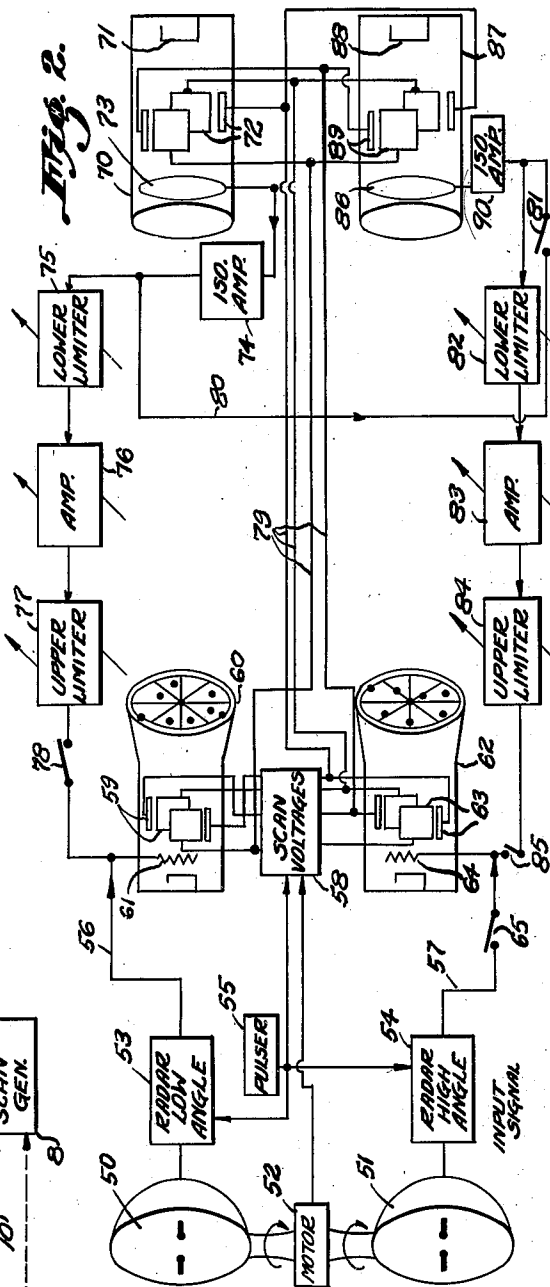
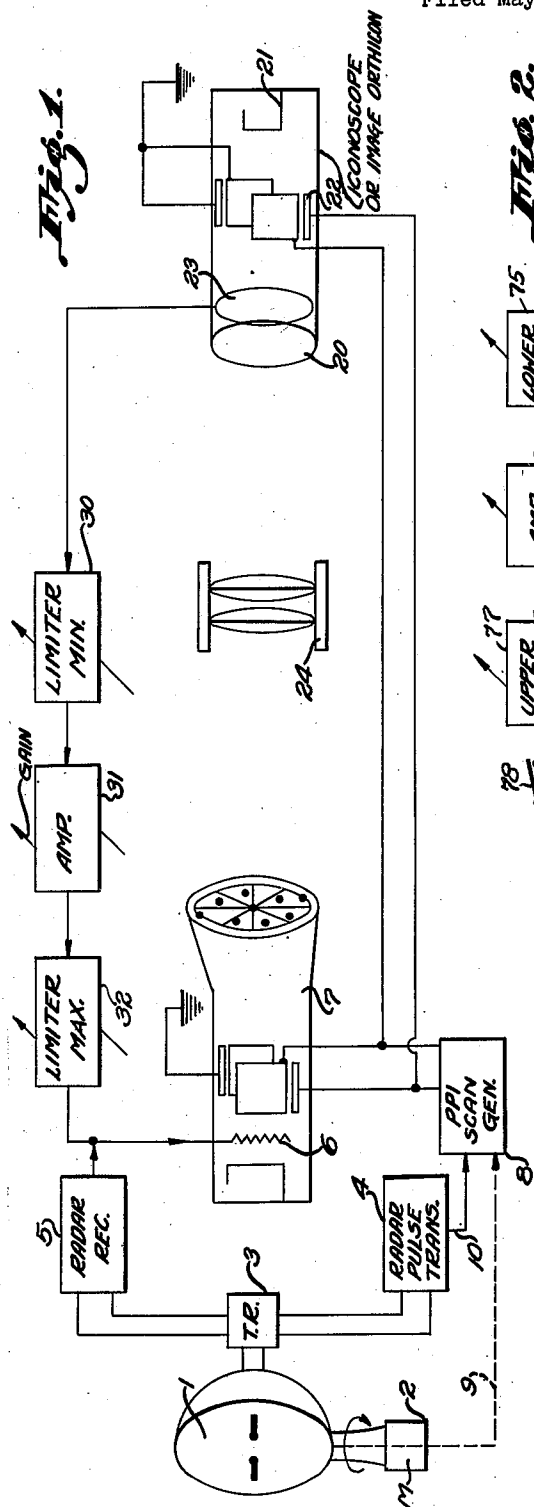
June 28, 1949.

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2,474,628

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Filed May 20, 1948



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2,474,628

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Application May 20, 1948, Serial No. 28,222

8 Claims. (Cl. 315—9)

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This invention relates generally to cathode ray tubes circuits and particularly to arrangements for regenerating and retaining on the faces of cathode ray tubes, images there created by means of signals which may be of a transient nature.

It is an object of the invention to provide arrangements for regenerating images on the face of a cathode tube indicator.

It is a further object of the invention to provide arrangements responsive to the presence of an indication on the face of a cathode ray tube indicator for feeding to that indicator signals tending to regenerate the indication.

It is still another object of the invention to provide circuits of illumination responsive nature for scanning the face of a cathode ray tube indicator and for providing intensifying signals to the intensity grid of the indicator in response to the traverse by the scanning means of images on the face of the indicator.

It is still a further object of the invention to provide a system for transferring a visual image from one cathode ray tube indicator to another without interfering with the operation of the one cathode ray tube.

It is additionally an object of this invention to provide a system for transferring visual indications among a plurality of cathode ray tube indicators, and from one to another of the indicators, without interfering with the normal operation of the indicators in translating electrical signals into visual images.

Briefly described, the present invention involves a cathode ray tube indicator on the face of which is generated visual images, by intensity modulation of the cathode ray beam of the indicator. In one specific application of the invention, the face of the indicator may be scanned by applying to its beam deflection electrodes signals derived from a plan position indication scanning generator of conventional type, the generator forming part of a radar indicating system, and the indicator providing indications on its face of the ranges and bearings of remote targets. An image of the face of the indicator may be impressed by means of suitable lenses on the face of an iconoscope or image orthicon, having a light sensitive mosaic. The mosaic may be scanned by means of a cathode ray beam in known manner, the scanning taking place in synchronism with the scanning at the cathode ray tube indicator.

The output electrode of the iconoscope or image orthicon may be connected to the intensifier grid of the cathode ray tube indicator, in an intensity

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increasing relation. This connection may be made over an amplifier which may serve the purpose of isolating the source of normal signals applied to the grid of the cathode ray tube indicator from those regeneratively fed back from the iconoscope or image orthicon. By adjusting the gain of the amplifier an image originally produced on the face of the cathode ray tube indicator by an incoming signal may be intensified in response to the output of the regenerating circuit, or its decay may be delayed in accordance with the adjustment of the gain of the amplifier. In order to assure that the transient flashes or clutter on the cathode ray tube indicator are not intensified in the same manner as desired signals a low level limiter may be connected in circuit with the amplifier, which eliminates all feedback signals which are of less than of a certain predetermined amplitude. Additionally an upper limiting circuit may be inserted in series with the amplifier to prevent feeding back of signals of greater than a predetermined intensity, which might cause undue intensification of images on the face of the cathode ray tube indicator.

In accordance with a modification of the present invention, displays presented on the faces of cathode ray tube indicators may be transferred from one to another of such indicators, and the transferred traces may be retained indefinitely on the other of the indicators, while the trace on the original cathode ray tube indicator is permitted to decay at its normal decay rate.

More specifically, in a radar system utilizing two radar equipments of complementary character, such as one which is adapted for air survey at low angles, and one which is adapted for air survey at high angles, or alternatively one which is adapted for long range operation, and one which adapted for short range operation, and each employing a P. P. I. type of presentation, signals from either of the P. P. I. indicators may be transferred to the other of the indicators and the total display on either of the indicators may be retained indefinitely, or permitted to decay at any desired rate.

For a more detailed explanation of the present invention reference is made to the following specification which may be taken in conjunction with the accompanying drawings, wherein:

Figure 1 represents in conventionalized functional block diagram, a specific embodiment of the invention as applied to a radar system, and

Figure 2 represents in conventionalized functional block diagram a further radar system utilizing my invention.

Referring now to Figure 1 of the drawings, an antenna 1 is provided which is rotated continuously by means of a motor 2, enabling the antenna 1 to scan continually all azimuthal directions surrounding its location. The antenna 1 is connected over a TR box 3, as is well understood in the art, it serving to protect the radar receiver 5 from direct transmissions originating in the transmitter 4 by short circuiting the input circuit of receiver 5 in response to each pulse transmission, the short circuit being eliminated upon termination of the transmitted radar pulse. A pulse of radiant energy is emitted by antenna 1 in response to each pulse provided by the transmitter 4, these pulses traveling at the speed of light to remote objects, and being reflected or scattered thereby, some of the energy returns to the antenna 1. Energy which returns to the antenna 1 is applied to the radar receiver 5 and amplified and detected, the detected signal being applied to a grid 6 of a cathode ray tube indicator 7 in such sense as to intensify the beam of the indicator 7. A linkage between the antenna 1 and the P. P. I. scanning generator 8 is conventionally indicated by the dotted line 9, which may represent a mechanical linkage, or a linkage by means of a Selsyn system. The linkage serves to impose or impress upon the P. P. I. scanning generator 8 a measure of the instantaneous direction or azimuth of the antenna 1. There is likewise impressed on the P. P. I. scanning generator 8 signals derived from the radar pulse transmitter 4 and impressed on the generator 8 over a line 10. The signals applied to the generator 8 over line 10 serve to initiate radial scan of the beam of the indicator 7, radial scanning taking place at a rate adequate to enable measurement of transmission time of pulses transmitted by the antenna 1, and received thereby after scattering or deflection from remote objects. The linkage 9, on the other hand, serves to modulate the output of the scanning generator 8 to effect proper angular positioning of the beam of the indicator 7, which is maintained by the linkage 9 at all times in correspondence with the azimuthal bearing of the antenna 1.

The beam of the indicator 7 is normally cut off, and in response to received signals, detected by the receiver 5 and applied to the grid 6, the intensity of the cathode ray beam is increased, providing a luminous spot on the face of the indicator at a radial position corresponding with range of a remote object and at an angular position corresponding with the angular bearing of antenna 1, at the times of signal reception. Thereby there is created on the face of the indicator 7 a so-called P. P. I. plot of remote objects surrounding the antenna 1. The plot may consist of single spots on the face of the indicator, corresponding with remote aircraft or vessels, or it may consist of a plot showing the outline of large land masses, or the like.

The system as so far described is completely conventional and is, per se, not my invention.

Positioned in optical relation to the cathode ray tube indicator 7 is an iconoscope or image orthicon 20 having a cathode 21, deflection electrodes 22, and an output electrode which comprises a light sensitive mosaic surface 23. Since the character and mode of operation of the iconoscope or image orthicon is well known, per se, in the pertinent art, no detailed explanation thereof is provided. Associated with the iconoscope or image orthicon 20 is a lens system 24

which serves to focus on the mosaic surface 23 of the iconoscope or image orthicon 20 the image provided by the face of the cathode ray tube indicator 7, there being a one to one correspondence between points of the face of the cathode ray tube indicator 7 and of the face of the mosaic 23 of the iconoscope or image orthicon. The output of the P. P. I. scanning generator 8 may be applied to the scanning electrodes 22 of the iconoscope or image orthicon 20 to cause the latter to scan in precise synchronism with the scanning of the beam of the cathode ray tube indicator 7.

The output electrode or mosaic 23 of the iconoscope or image orthicon 20 is connected over a limiter 30 which passes only signals having intensities greater than a predetermined value, to an amplifier 31, the gain of which may be manually controlled. At the output of the amplifier 31 is connected an upper level limiter or maximum output limiter 32, which cuts off signals having greater than a given predetermined amplitude. Both the lower and upper limiters 30 and 32 may be manually adjustable, if desired, to enable modification of the limits between which signals are transmitted. The output of the limiter 32 is applied in intensifying relation to grid 6 of the indicator 7.

Turning now to the operation of the system, images present on the face of the indicator 7 are impressed on the light sensitive mosaic surface of the iconoscope or image orthicon 20, each spot or lighted portion of the surface 7 being duplicated on the light sensitive surface of the tube 20. As the beam of the tube 20 is caused to scan over the mosaic surface, signals are developed in the output electrode 23 which are impressed on the grid 6 of the tube 7. Accordingly, if an image is once produced on the face of the tube 7 in response to a transient voltage applied to the grid 6, the light so created will produce a voltage at the output electrode 23 which is fed back to the grid 6 each time that the scanning beam of the iconoscope or image orthicon 20 passes over the position corresponding with that spot. The spot, accordingly, is continually regenerated, whether or not signals continue incoming at the receiver 6, provided, however, that the persistence of the screen of the indicator 7 is greater than the total time required for a single scanning cycle.

By suitable adjustments of the limiters 30 and 32, and of the gain of the amplifier 31, an image once created on the face of the indicator 7 may be caused to increase in amplitude, to decay slowly, or to retain its brilliance. So if we imagine a single spot to have been created on the face of the indicator 7 in response to a given voltage or a voltage of a given magnitude, if the regeneration circuit or amplifier 31 is so set as to feed back to the grid 6 a voltage of that same amplitude in response to each traverse of the beam of the tube 20 across the position occupied by the spot, the spot will retain its initial brilliance. If, on the other hand, the fed back voltage is slightly less than this value the spot will slowly decay in brilliance. This decay time may be set to a desired value by suitable adjustments of the gain of the amplifier 21. On the other hand, a very weak spot created on the indicator 7 may be intensified by applying, over the regenerative network 31 and 32, signals of sufficient amplitude to cause a continually brighter spot in response to each fed-back intensifying pulse.

In systems of this character it may well happen that a transient undesired noise signal may create a spot on the face of the indicator 7. This signal,

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as well as desired signals, is fed back to the grid 6 of the indicator 7, and may be intensified. To avoid this possibility the lower limiter 31 is provided which prevents feed back of signals below a certain level, and which may correspond with undesired and extremely dimly lighted surfaces on the face of the indicator 7.

It is the function of the maximum limiter 22 to prevent passage to the grid 6 of regenerated voltages having greater than a predetermined magnitude, to avoid undue intensification of the face of the indicator 7. It is the function of the gain control amplifier 31, in accordance with its gain setting, to cause either an increasing brilliance of lighted portions of the face of the indicator 7, to cause lighted portions to be retained unchanged despite the cessation of signal output of the radar receiver 5, or to slow down the decay of the intensity of the face of the indicator.

It will be realized that the invention herein-described is of far broader application than its presently described application to P. P. I. radar indicators. Any image produced on the face of a cathode ray tube indicator in response to control by an intensity grid, or its equivalent in the tube, may be caused to regenerate by means of the iconoscope 20 and its associated circuits. The scan may be in rectangular, instead of in polar coordinates, or may be linear.

Turning now to Figure 2 of the drawing, there is illustrated a pair of radar antennas, 50 and 51, which are rotated continuously in synchronism by a common motor 52, so that both antennas 50 and 51 always point in the same direction during rotative movement thereof. The antenna 50 may be adapted for low angle observation, while the antenna 51 may be adapted for high angle observation, it being usually the case that an antenna which is suitable for one purpose is not suitable for the other, so that simultaneous observation of the ranges and bearings of aircraft, some of which are flying at low angles and some of which are at high angles, becomes impossible when using a single radar equipment, the antenna of which scans in azimuth only. The radar equipments themselves may be represented by the blocks 53 and 54, respectively, which are supplied with synchronizing pulses from a common pulser 55, so that the transmissions from the two radar equipment occur simultaneously. Upon reception of a signal reflected from a remote object by the radar equipment 50, an output signal is developed in the lead 56. Upon reception of signals reflected from remote objects by the antenna 51, output signals are developed in the lead 57. The output signals in leads 56 and 57 are of pulse character, duplicating substantially the shape of the transmitted pulses, as is common in pulse radar systems. The angular positions of the motor 52 are transferred to a scanning voltage generator 58, to which is also applied signals from the pulser 55. Accordingly, the scanning generator 58 develops voltages which are suitable, when impressed on the deflection electrodes 59 of a cathode ray tube indicator 60, for causing P. P. I. scan of the cathode ray beam of the indicator 60, across the viewing face thereof. Output signals developed in the lead 56 are applied to the intensifier grid 61 of the cathode ray tube indicator 60, there being accordingly created on the face of the indicator 60 a plan-position plot of the locations of remote objects at relatively high angles. In the usual application these remote objects will be proximate aircraft.

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A further cathode ray tube indicator 62 is provided having deflection electrodes 63 and an intensifier grid 64. Pulse signals developed in the output lead 57 are applied to the control electrode 64, over a manually operable switch 65, serving to intensify the cathode ray beam of the indicator 62. To the deflection electrodes 63 of the indicator 62 is applied scanning voltages derived from the scanning voltage generator 58. Accordingly, there is created on the face of the indicator 2, a plan position plot of targets observed by the radar 54, and which are located at relatively high angles. It will be observed at this point that the scanning voltages applied to the cathode ray tube indicators 60 and 62 are identical, and accordingly that the cathode ray beams of the indicators 60 and 62 will trace out identical paths in precise synchronism.

The image created on the face of the cathode ray tube indicator 60 is impressed by suitable optical means, (not shown), on an iconoscope or image orthicon 70, having a cathode 71, beam deflection electrodes 72, and a light sensitive mosaic which provides an output electrode for the iconoscope or image orthicon 70. The output electrode 73 is connected over an isolating amplifier 74 with the input of a limiter device 75 which serves to only pass signals which have greater than a predetermined minimum value, this value being manually selectable. The output of the limiter 75 is applied to a signal amplifier 76 having adjustable gain, and the output of the latter is applied to a further limit of 77, which cuts off the peaks of signals having values about predetermined upper limits, the upper limits being manually selectable. The output of the upper limiter is applied over a manually operable switch 78 to the intensifier grid 61 of the cathode ray tube indicator 60.

The scanning voltages developed in the scanning generator 58 are applied over leads 79 to the deflection electrodes 72 of the iconoscope or image orthicon 70 so that the cathode beam of the latter traces out a path which duplicates the path traced out by the beam of the cathode ray tube indicator 60. Accordingly, each time that a spot is created on the face of the cathode ray tube indicator 60, a corresponding signal is generated in the output electrode 73 of the iconoscope or image orthicon 70, and that output signal is applied over the isolating amplifier 74 and over a lower limiter 75, the amplifier 76 and the upper limiter 77, to the intensifier electrode 61 of the cathode ray tube indicator 60. Accordingly, any image created on the face of the indicator 60 is regenerated by means of the iconoscope or image orthicon 70, and the associated circuits, and the image created on the face of the indicator 60 may be thus retained indefinitely if desired.

Should the switch 78 be opened, however, regeneration is prevented, and the image present on the face of the indicator 60 is permitted to decay in accordance with the natural decay rate of the fluorescent material used in constructing the face of the indicator 60.

The output of the isolating amplifier 74 is further applied over a lead 80, via a manual switch 81, to a further lower limiter 82, any amplifier 83, and an upper limiter 84, connected in cascade, and via a series connected switch 85 to the intensity control grid 64 of a cathode ray tube indicator 62. The lower limiter 82, the amplifier 83 and the upper limiter 84 may be precisely identical with the corresponding elements num-

bered 75, 76 and 77, and accordingly any image present on the face of the indicator 60 may be transferred via the switch 81, if closed, to the intensity control electrode 64 of the cathode ray tube indicator 62, so that the presentation present on face of the indicator 62 duplicates that present on the indicator 60.

With the switch 65 open, the only presentation on the face of the indicator 62 corresponds with that present on the face of the indicator 60. However, with the switch 65 closed, two presentations are simultaneously created on the face of the indicator 62, one corresponding with the targets created in response to the high angle radar 54, and the other corresponding with the plot presented on the face of the indicator 60, and which corresponds with the plot of positions of low angle targets.

Accordingly, on the face of the indicator 62 is provided a total plot of all targets located both at low angles and at high angles. Any plot present on the face of the indicator 62, may be transferred optically to the photo-electric image mosaic 86 of the iconoscope or image orthicon 87, having a cathode 88 and deflection electrodes 89. The leads 79 convey to the deflection electrodes 89 the necessary deflection voltages to cause the cathode ray beam of the indicator 87 to travel a path identical with that traveled by the beams of the indicators 60 and 62, and by the beam of the iconoscope or image orthicon 70, and in precise synchronism therewith. Output signal developed by the photo-electric mosaic 86 may be applied over an isolating amplifier 90 to the input of the lower limiter 82, whence the signal is applied ultimately to the intensity control grid 64 of the indicator 62, serving to regenerate the image present on that indicator. Alternatively, or in addition, the image present on the mosaic 86 may be applied by the isolating amplifier 90 and via the switch 81, when closed, and the lead 80, to the input of the lower limit 75, the amplifier 76, the upper limiter 77, and then via the manual switch 78 to the intensity control grid 61 of the cathode ray tube indicator 60. Accordingly, any images present on the face of the indicator 62 may be transferred to the face of the indicator 60.

There is accordingly provided a system of radar indication, wherein the image presented on one cathode ray tube indicator may be transferred to another, and there retained, or permitted to decay, so that composite indications are made possible of range and bearing indications provided by a pair of radars, and selectively, either a long range or a short range plot on the same indicator.

The present system accordingly greatly enhances the utility of radar systems, at the cost of but slight increase in complexity, and without requiring modification of the basic radar systems involved.

While I have described the two specific embodiments of my invention, it will be clear that variations of the combinations disclosed, as well as of the details thereof, may be varied without departing from the true spirit and scope of the invention.

What I claim and desire to secure by Letters Patent of the United States is:

1. In combination, a cathode ray tube indicator having electron beam generating electrodes, electron beam deflecting electrodes, an electron beam intensity control electrode, and a fluorescent screen for providing visual indications in

response to variations of intensity of said electron beam, during deflection thereof, and means responsive to said visual indications for regenerating said visual indications on said cathode ray tube indicator.

2. The combination in accordance with claim 1 wherein said means for regenerating comprises a further cathode ray tube comprising a light sensitive mosaic.

3. In combination, a cathode ray tube indicator having electron beam generating electrodes, electron beam deflecting electrodes, an electron beam intensity control electrode, and a fluorescent screen for providing visual indications in response to variations of intensity of said electron beam, means for providing simultaneous electron beam deflecting signals to said electron beam deflecting electrodes to effect space scanning of said electron beam and information bearing signals to said intensity control electrode to provide intensity control of said electron beam, whereby to trace an illuminated pattern on said fluorescent screen, and means responsive to said illuminated pattern for continually regenerating said illuminated pattern on said cathode ray tube indicator.

4. In combination, a cathode ray tube indicator having electron beam generating electrodes, electron beam deflecting electrodes, an electron beam intensity control electrode, and a fluorescent screen for providing visual indications in response to variations of intensity of said electron beam, means for providing simultaneous electron beam deflecting signals to said electron beam deflecting electrodes to effect space scanning of said electron beam and information bearing signals to said intensity control electrode to provide intensity control of said electron beam, whereby to trace an illuminated pattern on said fluorescent screen, and means responsive to said illuminated pattern for generating further signals corresponding with said information bearing signals, and means for applying said further signals to said intensity control electrode to regenerate said illuminated pattern.

5. In combination, a cathode ray tube indicator having electron beam generating electrodes, electron beam deflecting electrodes, an electron beam intensity control electrode, and a fluorescent screen for providing visual indications in response to variations of intensity of said electron beam, means for providing simultaneous electron beam deflecting signals to said electron beam deflecting electrodes to effect space scanning of said electron beam and information bearing signals to said intensity control electrode to provide intensity control of said electron beam, whereby to trace an illuminated pattern on said fluorescent screen, and means comprising a further cathode ray tube responsive to said illuminated pattern for generating further signals corresponding with said information bearing signals, and means for applying said further signals to said intensity control electrode to regenerate said illuminated pattern.

6. In combination, a cathode ray tube indicator having electron beam generating electrodes, electron beam deflecting electrodes, an electron beam intensity control electrode, and a fluorescent screen for providing visual indications in response to variations of intensity of said electron beam, means for providing simultaneous electron beam deflecting signals to said electron beam deflecting electrodes to effect space scanning of said electron beam and information bearing sig-

nals to said intensity control electrode to provide intensity control of said electron beam, whereby to trace an illuminated pattern on said fluorescent screen, and means comprising a further cathode ray tube responsive to said illuminated pattern for generating further signals corresponding with said information bearing signals, said further cathode ray tube comprising electron beam generating electrodes, electron beam deflecting electrodes and a photo-electric mosaic, means for applying said first mentioned beam deflecting signals to said last mentioned electron beam deflecting electrodes, means for optically comprising said illuminated pattern on said photo-electric mosaic, and means for applying said further signals to said cathode ray tube indicator to regenerate said visual indicator.

7. In combination, a first cathode ray tube indicator having cathode ray beam generating electrodes, beam deflection electrodes, beam intensifying electrodes, a fluorescent screen, a second cathode ray tube indicator having cathode ray beam generating electrodes, beam deflection electrodes, a beam intensifying electrode and a fluorescent screen, a photo-sensitive cathode ray tube having a photo-sensitive mosaic cathode ray beam generating electrodes and beam deflection electrodes, means for applying synchronous scanning signals to said first, second and third mentioned beam deflection electrodes to effect synchronous scanning of the beams of said cathode ray tubes with respect to said fluorescent screens and said photo-sensitive mosaic, means for applying signals to said first-mentioned beam intensifying electrode to create a visual pattern on said first mentioned cathode ray screen, means for optically projecting said visual pattern on said photo-electric mosaic, and means for applying signals developed by said photo-electric mosaic in response to scanning of said third men-

tioned cathode ray beam to said second mentioned beam intensifying electrode to recreate said visual image on said second mentioned fluorescent screen.

8. A system for transferring a visual pattern from one cathode ray tube indicator to a second cathode ray tube indicator, comprising a scanning signal generator, means for applying signals provided by said scanning signal generator to said first and second cathode ray tube indicator, to effect synchronous scanning of the cathode rays of said cathode ray tube indicators, means for creating a visual pattern in said first cathode ray tube indicator, a third cathode ray tube having a photo-electric mosaic, means for projecting said visual image on said photo-electric mosaic, means for applying said signals provided by said scanning signal generator to said third cathode ray tube to effect synchronous scanning of the cathode rays of said second and third cathode ray tubes, and means responsive to signals developed in said photo-electric mosaic for recreating said visual pattern in said second cathode ray tube.

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