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TELEVISION SYSTEM

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Fig. 1.

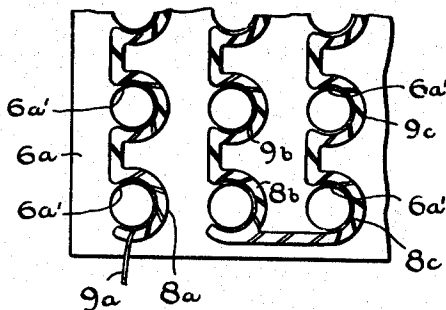
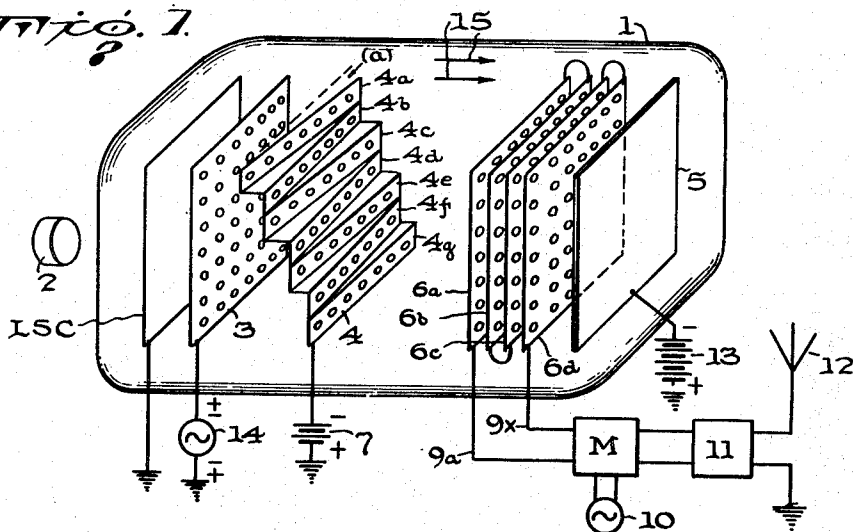
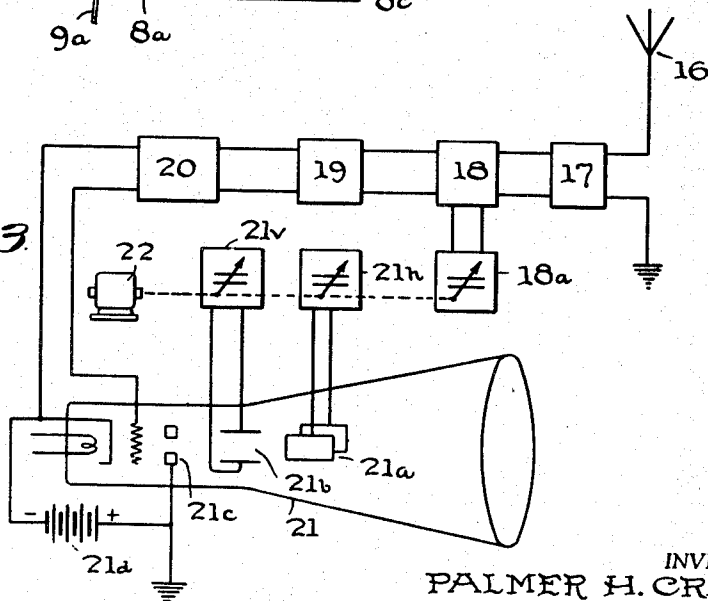


Fig. 2.

Fig. 3.



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TELEVISION SYSTEM

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13 Claims. (Cl. 178-6.8)

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This invention relates to a television system.

An object of the invention is to produce a television system in which the side-band width is materially reduced, thus making possible the use of a carrier frequency of longer wave length, and thereby increasing the geographic coverage of the television transmitter to approximately the same coverage as the present-day radio broadcast transmitter.

My television system involves a new method or principle of operation. The transmitter analyzes the entire picture area substantially instantaneously and transmits a complex wave on each analyzing operation, the wave being made up of component waves having different frequencies determined by the elementary image areas which are illuminated at any given instant. The transmitter of my system does not scan the image in the usual way, but each elementary area of the image to be transmitted acts simultaneously with the other elementary areas to establish separate component waves each of a frequency dependent upon the position of the corresponding elementary area in the image area, the amplitude of each component wave being dependent upon the degree of illumination of the corresponding elementary area. The analyzing operation is repeated periodically at a rate of sixteen times per second or higher, that is, a rate sufficient to secure the illusion of continuous change in the reproduced image at the receiving station.

At the receiving station, the transmitted image is reproduced by building up the elementary areas with scanning apparatus which traverses each point of the image area in the usual manner, but there is no necessary relation between the rate of scanning of the receiver and the rate of transmission of the composite wave from the transmitting station. At the receiving station a wave receiver is provided which may be tuned to selectively receive any component of the complex wave within the entire range of frequencies transmitted, and the tuning of the receiver is varied simultaneously with the scanning operation to select the wave component being transmitted by an elementary area of the transmitter image corresponding in position to the elementary area of the received image which is being scanned at the particular instant of consideration. The scanning cycle of the receiver is made sufficiently high to secure the illusion of continuous change in the reproduced image.

A preferred embodiment of my invention is illustrated in the accompanying drawing in which

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Figure 1 is a diagrammatic showing of the transmitting apparatus;

Figure 2 is a greatly enlarged fragmentary view showing one corner of one of the pick-up loop grids employed in Figure 1; and

Figure 3 is a diagrammatic illustration of the receiving apparatus.

Referring to Figure 1, the transmitting tube is shown in perspective. It is provided with an insulating envelope 1 in one end of which is located a light-sensitive cathode LSC on which an optical image is formed of the object or subject to be transmitted, the image being formed by a suitable lens system represented at 2. It will be understood that electrons are emitted from the surface of the cathode LSC in accordance with the degree of illumination of any particular point or area of the cathode. A control grid 3 is arranged parallel with cathode LSC, and this grid may be formed of a metallic plate having perforations formed therein corresponding to the various elementary areas of the image area on cathode LSC, or it may be formed of wire netting in the usual manner. A second grid 4 of special construction is positioned adjacent grid 3. A collector electrode or plate element 5 is positioned in the opposite end of the tube from the cathode LSC, and a number of perforated plates 6a, 6b, 6c and 6d are arranged in parallel relation in front of the collector plate 5. These plates carry pick-up loops which will be described hereinafter. The tube is filled with a suitable ionizable gas or a small quantity of mercury is included to provide a mercury vapor atmosphere within the tube.

Grid 4 is formed in a step-like construction as shown in Figure 1, the vertical parts of the steps being perforated with holes which are equal in number to the perforations in grid 3 and are in line with the holes in grid 3. The horizontal portions of the steps are of triangular shape as shown in the drawing, and this construction is provided so that the different linear portions of the vertical walls of the steps will be located at different distances from grid 3 or from cathode LSC. For example, the top vertical wall 4a is inclined to the plane of grid 3 by a small angle α , the left end of wall 4a being nearer to the grid than the right end. The right end of vertical wall 4b is at the same distance from the grid as the right end of the wall 4a, but wall 4b is inclined to the plane of grid 3 by an angle α but in the opposite direction so that the left end of wall 4b is spaced farther from grid 3 than the right end and wall 4b lies at an angle 2α with respect to wall 4a. In the same manner, walls 4c, 4d, 4e, 4f and 4g

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are all angularly related to the plane of grid 3 and are located at progressively increasing distances from grid 3. The result of this construction is that the apertures formed in the vertical walls of grid 4 are all located at different distances from grid 3, the aperture at the left end of wall 4a being nearest grid 3 and the aperture at the right end of wall 4g being located at the greatest distance from grid 3. Grid 4 is formed of conductive material and is maintained at a negative potential with respect to cathode LSC by a suitable source of current represented by the battery 7.

It will be understood that the perforations in grids 3 and 4 correspond to the number and arrangement of elementary areas in the effective image area of cathode LSC. In actual practice, these perforations would be of relatively small size by comparison with the effective image area and would be more numerous than in the arrangement shown in Figure 1, but for the sake of clearness of showing in the drawing, the perforations in these two grid elements are formed in seven columns of seven perforations, or a total of forty-nine perforations covering the entire effective image area. In actual practice, the image area would be divided into a much larger number of elementary areas, for example, the grids might be provided with perforations consisting of four hundred horizontal rows each containing six hundred perforations, which would correspond to two hundred and forty thousand elementary areas in the effective image area. In such an arrangement grid 4 would have four hundred vertical walls in the step-like arrangement.

Perforated plates 6a, 6b, etc., are formed of suitable insulating material such as glass, mica or the like, and each plate is perforated with the same number and arrangement of perforations as grids 3 and 4. These plates are also arranged so that the perforations in the various plates are in line with each other and in line with the perforations in grids 3 and 4. In Figure 2 I have shown a greatly enlarged fragmentary view of the lower lefthand corner of perforated plate 6a, perforations being shown at 6a'. Since the constructions of all the pick-up plates are identical, only one plate will be described. Suitably secured to one face of the plate 6a is a series of magnetic strips 8a, 8b, 8c, etc., each strip being associated with a vertical row of perforations 6a', and the strips being formed to partially loop around each perforation as shown in Figure 2. These magnetic strips may be stamped out of a sheet of permalloy having a thickness of the order of 0.001 of an inch. The upper and lower ends of the strips may be joined by bridging portions, or bridging portions may be provided so that the strips are connected in series in zig-zag relation. For example, the upper ends of strips 8a and 8b may be provided with a bridging portion and the lower ends of strips 8b and 8c may be connected as shown in Figure 2, and so on. Each magnetic core member is wound with a pick-up conductor such as conductors 9a, 9b and 9c shown in Figure 2. This conductor may be applied in any suitable manner. One suitable method would be to form the pick-up conductor on the core strip by electrolytic deposition before the core strips are applied to the perforated supporting plates. To accomplish this, the core strips are first coated with a thin coating of insulating material such as enamel, then a coating of graphite is applied to the insulating coating. On

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top of this a masking sheet is applied to cover all portions which are not to be electroplated, and then the exposed portions of the graphite coating are electroplated in a plating bath, the masking sheet being of suitable configuration to form a continuous conductor on each core strip. An alternative procedure would be to deposit a conducting shell on all portions of the insulating coating, then apply a protective coating to the conductive shell, then engrave or remove the protective coating from portions of the conductive shell, and remove the exposed portions of the shell by a suitable etching solution. As shown in Figure 2, the pick-up conductors on the various core strips are connected in serial circuit relation. Also, as shown by the jumper connections in Figure 1, the pick-up conductors on the various perforated plates are connected in serial circuit relation, and the two terminal leads 9a and 9x are connected to the input circuit of a suitable modulator M supplied with carrier current from a suitable source 10. The output of the modulator M may be amplified by an amplifier 11 and supplied to antenna 12.

Collector plate 5 is maintained at a negative potential with respect to cathode LSC by a suitable source of current represented by the battery 13, and the voltage of this source is sufficiently high to maintain plate 5 negative with respect to grid 4.

Grid 3 is controlled in potential with respect to cathode LSC to cause the grid potential to alternately become positive and then negative with respect to the cathode. This may be accomplished by any suitable control circuit represented by the alternating current source 14. The purpose of changing the potential of grid 3 from negative to positive at periodic intervals is to produce "bursts" or clouds of electrons passing from cathode LSC through the apertures in grid 3 at spaced time intervals. These electron "bursts" are produced at a rate of the order of sixteen per second or higher. The electron streams passing through grid 3 ionize the gas in the space between grids 3 and 4 and cause streams of ionized gas molecules to pass through grid 4, through plates 6a, 6b, 6c and 6d to collector plate 5. The positive voltage pulses applied to grid 3 should be "sharp" to produce distinct "bursts" of electrons. A suitable focusing magnetic field represented at 15 is provided by external coils (not shown) for focusing the ion streams in parallel paths between grid 4 and plate 5, and for focusing the electron paths between cathode LSC and grid 3.

Operation of the arrangement shown in Figure 1 is as follows: During the time intervals when grid 3 is negative in respect to cathode LSC, no electrons pass through the grid 3, and the tube is inoperative. During the intervals when grid 3 becomes positive with respect to the cathode, electron streams pass through the apertures in grid 3, and the quantity of electrons in each stream is dependent upon the degree of illumination of the image areas on the cathode directly in line with the respective apertures in grid 3. It will be understood that the positive potential on grid 3 accelerates the electrons towards the grid and the momentum acquired by the electrons carries them through the apertures of the grid and into the space between grids 3 and 4 where they strike the gas atoms and ionize the gas by bombardment. The electrons slow down in this region and reverse their direction of travel tending to return to grid 3 where their charges are

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neutralized. The positive ions proceed towards grid 4 and pass through the apertures of this grid and are accelerated towards collector plate 5 by the high negative potential applied to this plate, the ion streams passing through the respective apertures in pick-up plates 6a, 6b, 6c and 6d before reaching collector plate 5. Each group of positive ions passing through an aperture in one of the pick-up plates causes a variation in the magnetic condition of the core strip looped around the aperture, and thereby results in the generation of a voltage pulse in the pick-up conductor carried by the core strip. Accordingly, any given burst or group of ions which passes from grid 4 through the four pick-up plates to collector plate 5 will produce four voltage pulses in the input circuit of modulator M, and these voltage pulses will be spaced apart by time intervals dependent upon the distance of separation between the pick-up plates and upon the speed of travel of the ion burst. With a fixed spacing between the pick-up plates, each ion stream passing through the aligned apertures in these plates will generate a voltage wave in the input circuit of modulator M having a frequency depending upon the speed of travel of the ion burst along any given path. Due to the stepped construction of grid 4, where each aperture in this grid is located at a different distance from the collector plate 5, the ions will travel from grid 4 to plate 5 at different speeds in the different paths. Thus, a burst of ions passing through the aperture at the left end of grid wall 4a will produce a wave having a frequency located at one limit of the frequency band of the transmitter, while a burst of ions passing through the aperture at the right end of wall 4g will produce a wave having a frequency located at the other limit of the frequency band of the transmitter. It can be shown that with a separation of the plates 6a, 6b, 6c, etc., so that the pick-up loops on adjacent plates are spaced apart a distance of 0.001 inch, and using hydrogen as the ionizable gas, a potential of one volt per centimeter will produce a speed of travel of the ion burst sufficient to generate a wave in the pick-up circuit having a frequency of the order of twenty kilocycles. By using a heavier gas such as argon, a lower frequency may be obtained. Also, by spacing the pick-up plates farther apart, the frequency may be lowered.

From the foregoing it will be seen that the wave produced in the pick-up circuit by any given elementary area of the image on cathode LSC will be different in frequency from the wave generated by any other elementary area on the image area. Furthermore, the frequency of the elementary areas in the horizontal rows changes gradually from the lowest frequency to the highest, due to the special construction of grid 4. It is obvious that the intensity of the component waves generated in the pick-up circuit is dependent upon the intensity of illumination of the corresponding elementary image areas.

In an image area having two hundred and forty thousand elementary areas, the frequency interval between adjacent areas in the horizontal rows may be fixed at one-quarter cycle by constructing the grid so that the distances from plate 5 to two adjacent apertures differ by one ten-thousandth of an inch. With a frequency differential of one-quarter cycle between adjacent apertures, a picture area having two hundred and forty thousand elementary areas will require a frequency band width of sixty thousand cycles.

One suitable receiving arrangement for repro-

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ducing the transmitted image is diagrammatically shown in Figure 3. The complex wave transmitted from antenna 12 is received by antenna 16, amplified by amplifier 17 and supplied to heterodyne detector 18 which is supplied with a beating-wave from a variable frequency oscillator 18a. The output of detector 18 is connected to the input of a second detector 20 through a sharply tuned filter 19 which permits the passage of only one wave of a predetermined beat frequency. The output of detector 20 is supplied to the control grid of a cathode ray tube 21 of usual construction. The horizontal sweep plates 21a are supplied with a saw-tooth voltage wave generated by generator 21h, and vertical sweep plates 21b are supplied with a saw-tooth voltage wave generated by generator 21v. The apertured anode 21c of the cathode ray tube is maintained at a positive potential with respect to the cathode by means of a suitable source of current 21d.

Generators 21h and 21v are driven in timed relation with each other by means of a suitable motor 22, generator 21h causing the electron beam to traverse the receiving screen in horizontal paths at a uniform rate with a quick return, while generator 21v causes a vertical shifting of the traversing path to cover the receiving screen in a well known manner. The tuning element of oscillator 18a is also controlled in timed relation with generators 21h and 21v so that the frequency of oscillator 18a is continuously increased (or decreased) from a given value at the beginning of a picture scanning cycle to another value at the end of the picture scanning cycle, and then the same tuning cycle is repeated for each scanning cycle. The arrangement is such that in the beginning of the scanning cycle, oscillator 18a will have a frequency which when combined with the component wave produced by an ion burst passing through the aperture at the left end of grid wall 4a will produce a beat frequency wave having a frequency which will be passed by filter 19. As the scanning progresses along the first horizontal traverse of the electron beam, the frequency of oscillator 18a will progressively change, and when the electron beam arrives in positions corresponding to the different apertures formed in grid wall 4a of Figure 1, the frequency of oscillator 18a will be of a proper value to combine with the corresponding component wave and produce a beat frequency wave which will pass through filter 19. The grid circuit of cathode ray tube 21 is normally biased to prevent the beam from reaching the screen, but input signal from detector 20 will permit the beam to pass in varying degrees depending upon the strength of the signal. From the foregoing, it will be seen that with no radiation from antenna 12, the receiving screen in Figure 3 will remain dark. If all frequency components are present in the wave radiated from antenna 12, all elementary area portions of the receiving screen in Figure 3 will be illuminated. If certain frequency components corresponding to certain elementary image areas on cathode LSC are absent from the transmitted wave, then at the instants when the cathode ray beam would normally occupy corresponding positions on the receiving screen, there will be no received wave to beat with the wave from oscillator 18a, and therefore the corresponding areas on the receiving screen will appear dark. Thus, by controlling the tuning of oscillator 18a synchronously with operation of scanning generators 21h and 21v, together with the action of sharply tuned filter 19, the receiving screen of

tube 21 will be illuminated only in the elementary areas corresponding to the elementary areas which are illuminated in the image area on cathode LSC at the transmitter.

Filter 19 should be a highly selective filter in order to discriminate between the different beat-wave components, and for this purpose I propose to use a crystal filter of the type manufactured by Western Electric Company. Such a filter will have sufficient selectivity when using a carrier wave of one hundred kilocycles to discriminate between the component frequencies which differ from each other by only one-quarter of a cycle. The terminal impedance of the filter should be mis-matched in order to secure the necessary selectivity. It may be found desirable to include a "clipper" circuit following the filter so that only the crests or peaks of the waves will be transmitted. The "clipper" circuit would respond only to the crests of waves differing by only a few db. This will differentiate between complete light or complete dark areas on the image. By re-sending each frame a number of times, with successive decrease in illumination (or its equivalent) for the entire picture, an effect would be obtained equivalent to transmitting a series of silhouettes which gradually decrease in the number of areas of light in the picture area, and this effect would produce the illusion of gradations of light for a moderately illuminated area.

Other known types of scanning devices may be employed in the receiver instead of the cathode ray tube. For example, a scanner of the type employing a light beam deflected in two coordinate directions by rotating mirror drums or other means may be used. In such case the output of detector 20 would modulate the light beam, and the tuning of oscillator 18a would be varied synchronously with the movement of the scanning device. Also, it would be obvious that motor 22 may be replaced by any equivalent electronic means for simultaneously varying generators 18a, 21v and 21h.

The tube of Figure 1 may be operated as a pure electron discharge device by reversing the polarity of sources 7 and 13, or by omitting grid 3 and source 7 and controlling grid 4 by the control 14, plate 5 being maintained at a positive potential. In the case of electron bursts, the speed of travel of each burst will be many times that of an ion burst, and the frequency induced in the pick-up conductor will be correspondingly higher. It will be understood that in all cases, the number of pick-up grids may be made greater or less than the four shown in Figure 1, and the spacing between these plates may be set at any desired value.

What I claim is:

1. A television system comprising, means for transmitting a complex wave having a different frequency component for each elementary area to be transmitted, a receiver having wave-selecting means for receiving only one of said components at a time, said wave-selecting means being variable throughout the range of said frequency components to receive all of said components in succession, an image reproducer including means for traversing a scanning beam over a receiving screen according to a predetermined path, and means for modulating said beam in accordance with said selected wave components.

2. A television system comprising, means to transmit a complex wave having a different frequency component for each elementary area of

the image to be transmitted, said components having frequencies which change progressively along a given path in which said elementary areas are arranged in succession, means for receiving said complex wave, means for combining said complex wave with a beating-wave to produce a beat-wave for each component, a scanning receiver including means for traversing a scanning beam over a receiving screen according to said path of elementary image areas having progressively changing wave components, means for progressively varying the frequency of said beating-wave to produce a predetermined frequency difference between the beating frequency and the frequency of the component wave corresponding to the position of the elementary area being traversed at any instant, means for selecting the beat-waves of a frequency equal to said frequency difference, and means for modulating said scanning beam in accordance with said selected beat-waves.

3. A television process comprising, transmitting a complex wave having a different frequency component for each elementary image area to be transmitted, receiving said complex wave, combining said complex wave with a beating-wave to produce a beat-wave for each component, traversing a scanning beam over a receiving screen, varying the frequency of said beating wave in timed relation with the movement of said beam, and modulating said beam in accordance with beat-waves of a predetermined frequency.

4. A television process comprising, transmitting a complex wave having a different frequency component for each elementary image area to be transmitted, the frequency of each component being related to the position of the corresponding elementary area in the image area, receiving said complex wave, combining said complex wave with a beating wave, cyclically varying the frequency of said beating wave through a frequency range to produce a beat-wave of varying frequency for each component wave, traversing a receiving screen with a scanning beam, and modulating said beam in accordance with beat-waves of a predetermined frequency.

5. A television process comprising, transmitting a complex wave having a different frequency component for each elementary area of the image to be transmitted, said components having frequencies which change progressively along a given path in which said elementary areas are arranged in succession, receiving said complex wave at a receiving station, combining said complex wave with a beating-wave to produce a beat-wave for each component, traversing a scanning beam over a receiving screen according to the said path of elementary image areas having progressively changing wave components, progressively varying the frequency of said beating wave to produce a predetermined frequency difference between the beating-frequency and the frequency of component wave corresponding to the position of the elementary area being traversed at any instant, selecting the beat-waves of a frequency equal to said frequency difference, and modulating said scanning beam in accordance with said selected beat-waves.

6. A television transmitter comprising, electro-optical means for transmitting periodic bursts of electrical charges along a predetermined path, said bursts varying in magnitude in accordance with variations in light value of an elementary image area, and a pick-up conductor having different linear portions thereof arranged adja-

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cent said path at points equi-spaced along said path whereby each burst of charges passing along said path induces in said conductor a voltage wave of predetermined frequency.

7. A television transmitter according to claim 6 wherein said electro-optical means transmits periodic bursts of electrical charges along separate paths for the different elementary areas of the image to be transmitted, the bursts in different paths being transmitted at different speeds, and said pick-up conductor having portions associated with each path whereby a complex wave is induced in said conductor having a separate frequency component for each elementary image area.

8. A television transmitter according to claim 6 wherein the linear portions of said pick-up conductor located at spaced points along the path of said charges are wound around magnetic core elements positioned adjacent said path.

9. A television transmitter according to claim 6 wherein said electrical charges are ionized gas particles.

10. A television transmitter according to claim 6 wherein said electrical charges are electrons.

11. A television receiving system comprising, a heterodyne receiver having a beating oscillator with frequency varying means therefor, a scanning device including a receiving screen and a scanning beam, means for modulating said beam by a beat-wave from said heterodyne receiver, means for traversing said beam over said screen

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in periodic cycles, and means for varying the frequency of said beating oscillator in timed relation with the movement of said beam.

12. A receiving system according to claim 11 wherein said scanning device comprises a cathode ray tube, and the beam-traversing means includes two saw-tooth wave generators driven in timed relation with each other and with the oscillator frequency varying means.

13. A receiving system according to claim 11 and including a single-frequency pass-filter interposed between said heterodyne receiver and said scanning device whereby said device is modulated only at times when said receiver produces a beat-wave of a frequency which is passed by said filter.

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