

March 26, 1929.

P. MERTZ

1,706,538

TESTING TELEVISION AND LIKE SYSTEM

Filed June 22, 1927

FIG. 1

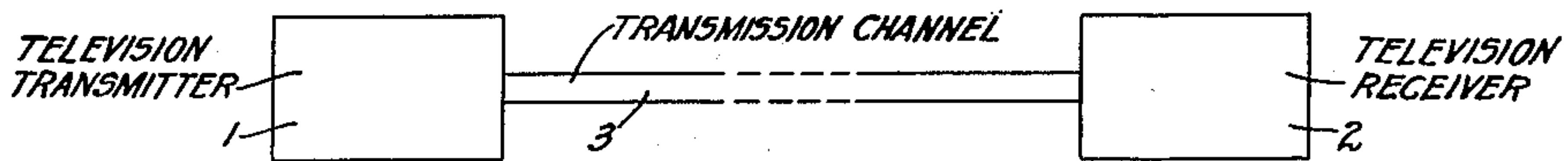


FIG. 2

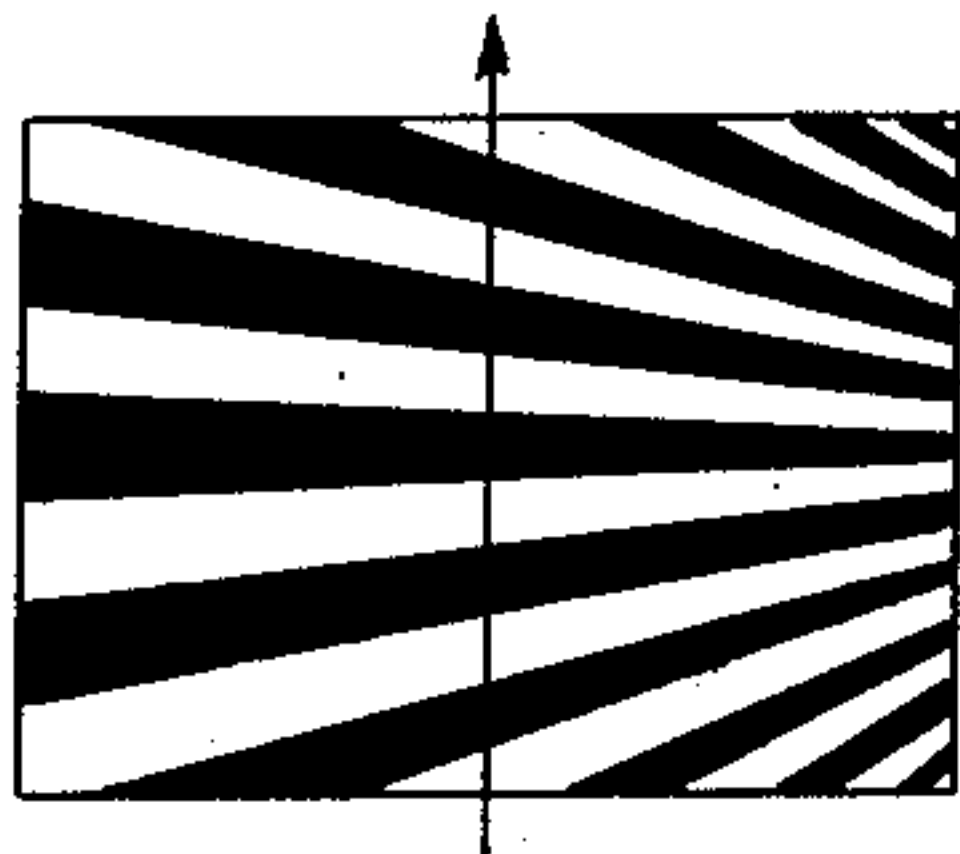


FIG. 3

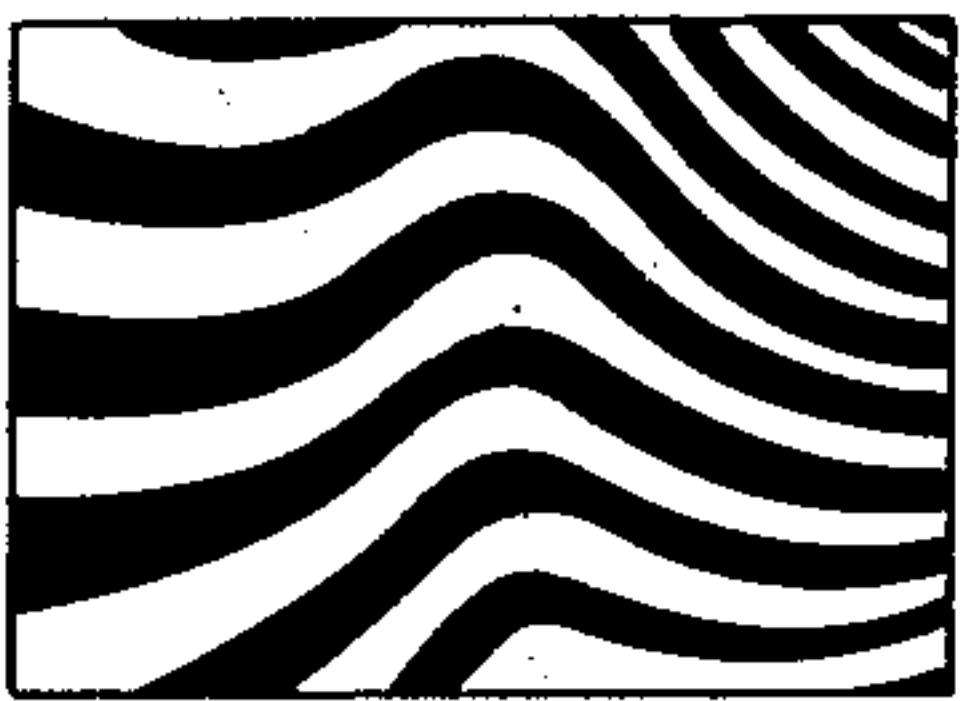


FIG. 4

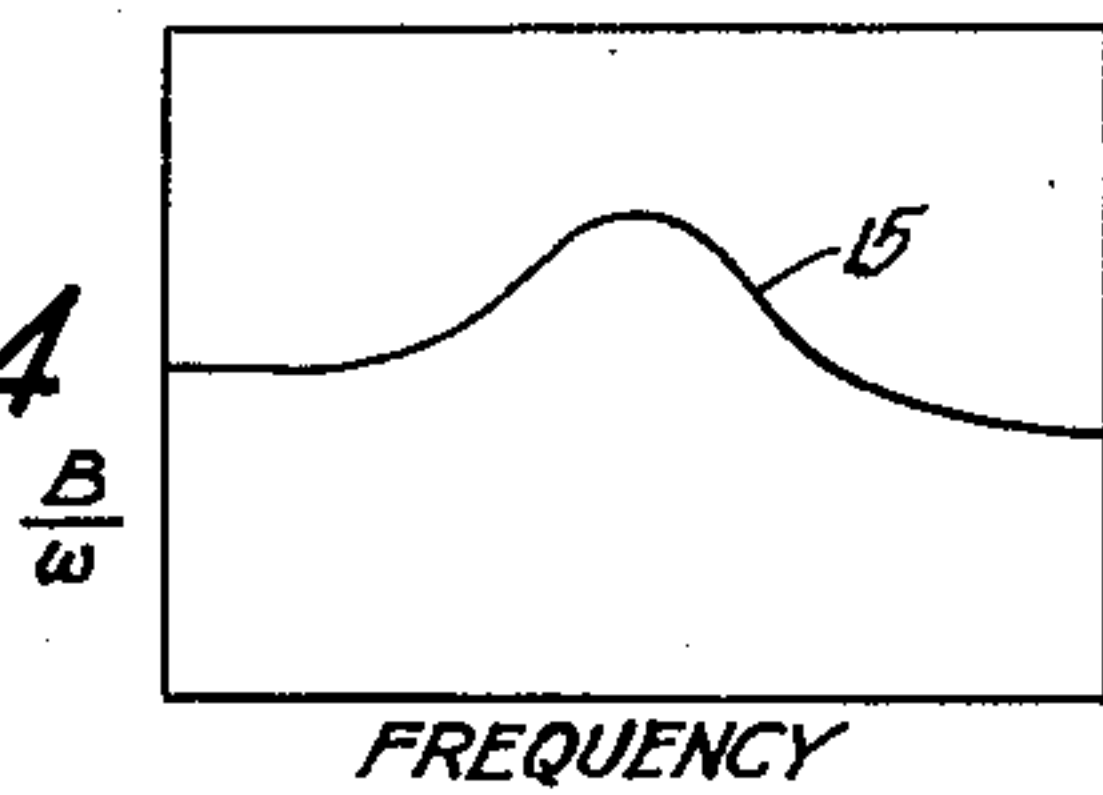


FIG. 5

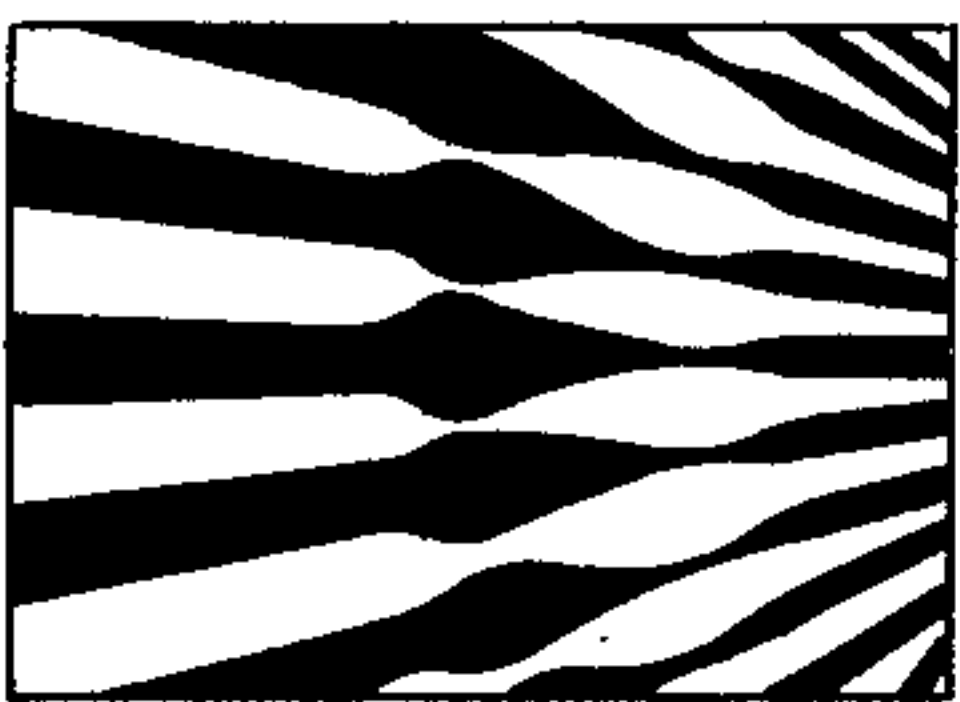


FIG. 6

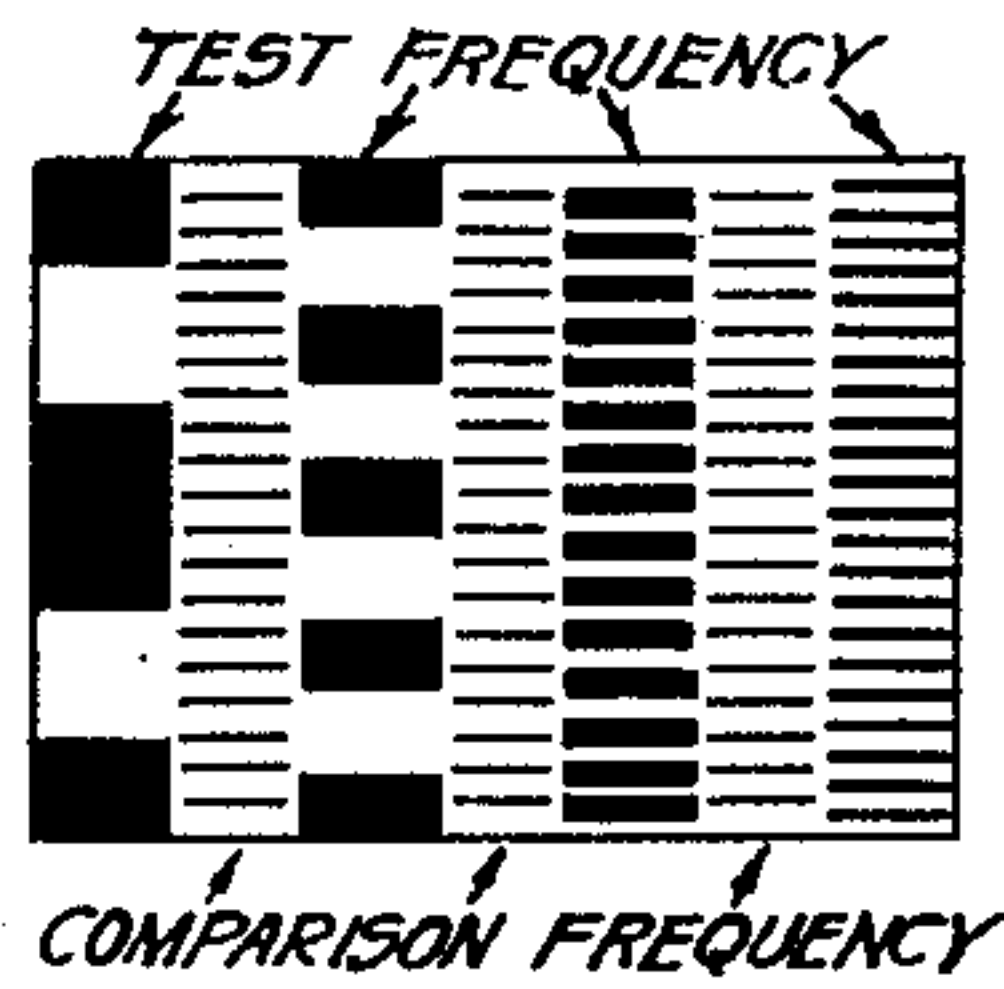
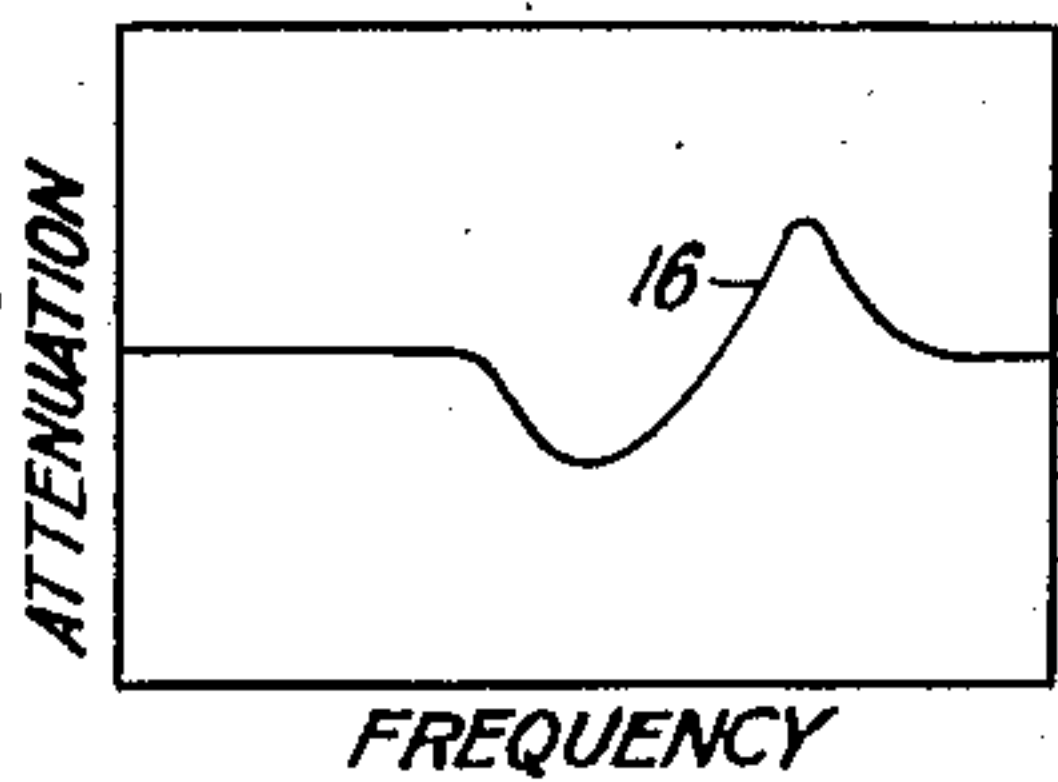


FIG. 7

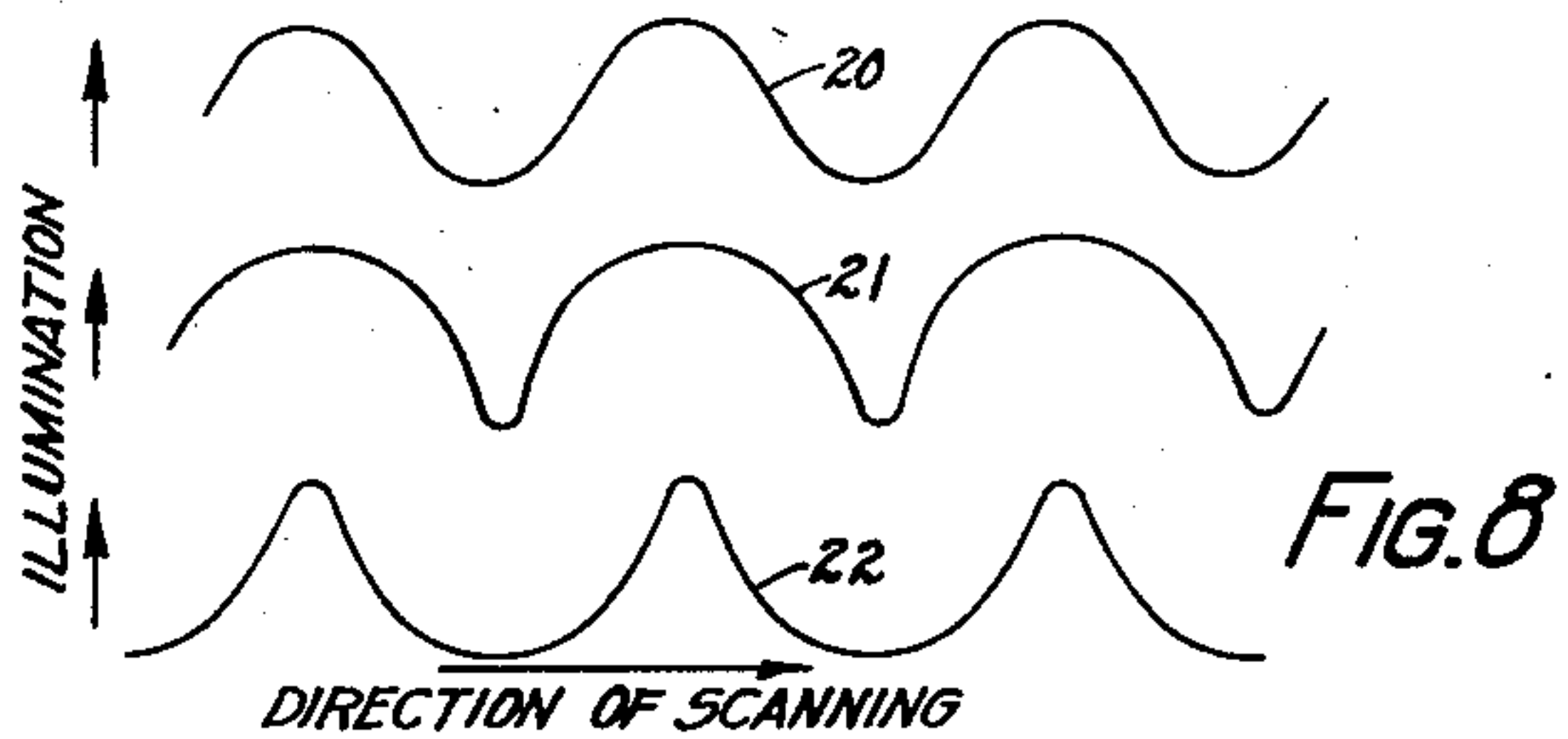


FIG. 8

FIG. 9

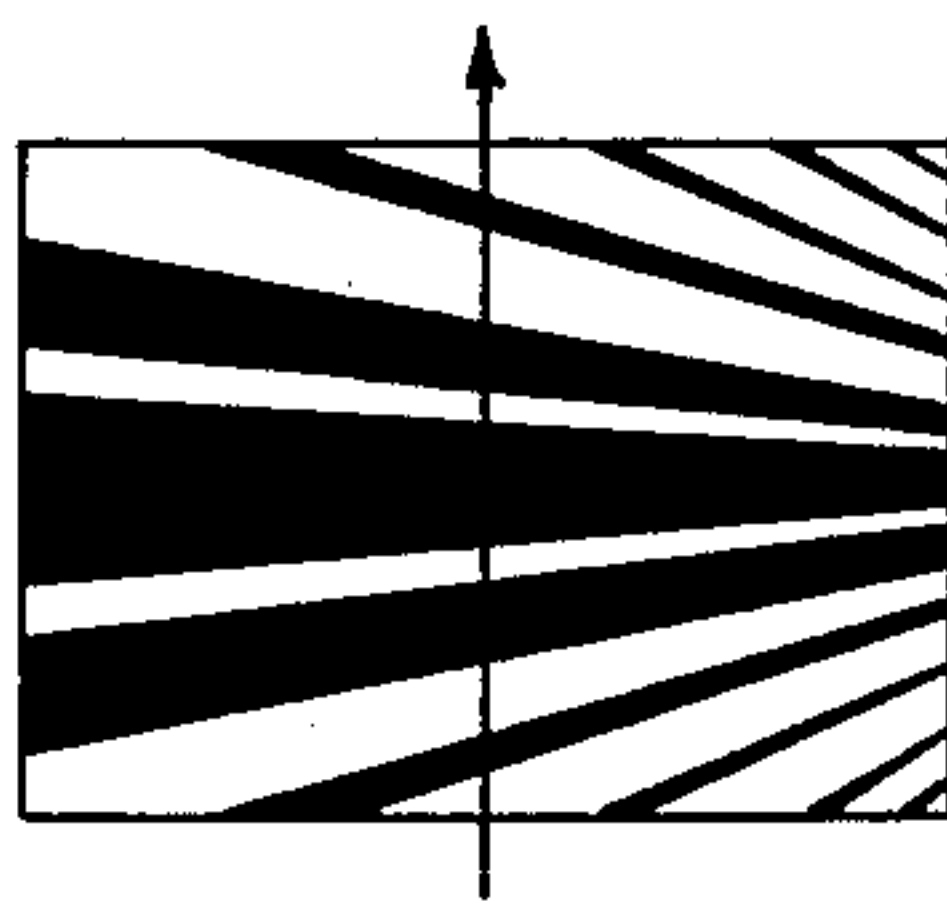


FIG. 10

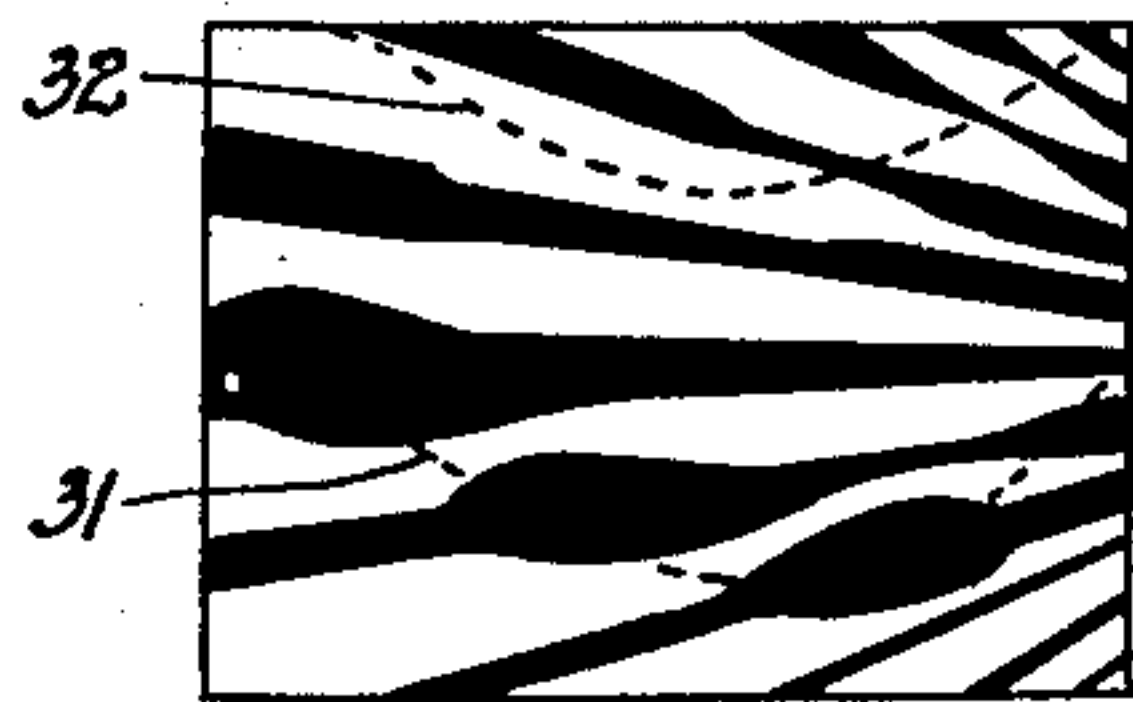
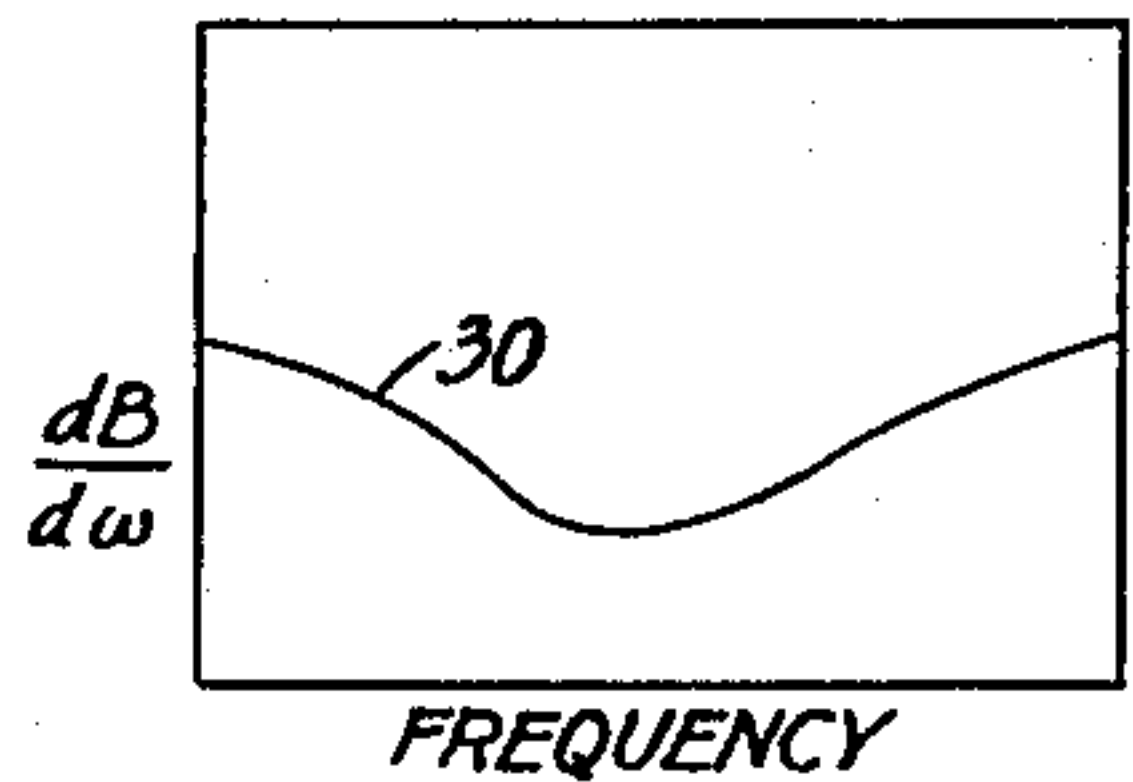


FIG. 11



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UNITED STATES PATENT OFFICE.

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TESTING TELEVISION AND LIKE SYSTEM.

Application filed June 22, 1927. Serial No. 200,702.

This invention relates to electrical testing, and aims particularly to facilitate investigation of transmission properties of television and telephotographic systems.

5 In accordance with the invention a special design is transmitted over the system and the distortion in the reproduction at the receiver noted. This gives a rapid test of the overall characteristics, especially
10 when used with television systems. For example, a design may be used which causes the signal sent to the transmission channel connecting the television transmitter and the television receiver to be a sine wave of constant amplitude and of frequency constant
15 for any line element of the design or picture but different for different line elements. In the case in which the design is scanned in successive straight parallel lines, the design
20 may be a set of alternate black and white converging bands which will extend across the field.

If there is phase distortion due to different phase delay at the various frequencies, it
25 will be apparent in the received picture by relative displacements of given tone values or intensities along the line elements corresponding to the different frequencies, respectively.

30 Amplitude distortion would be apparent from varying contrast from line element to line element of the received picture, throughout the range of line elements corresponding to different frequencies, respectively.

35 Other objects and aspects of the invention will be apparent from the following description and claims.

Figure 1 is a block diagram of a television system; Fig. 2 is a conventional type of
40 representation of a design for creating desired testing currents in the system; Fig. 3 shows conventionally a character of image produced from the original design shown in Fig. 2 under conditions in the system which
45 are indicated by the diagram constituting Fig. 4; Fig. 5 shows conventionally a character of image produced from the original design shown in Fig. 2 under conditions in the system which are indicated by the diagram constituting Fig. 6; Fig. 7 shows conventionally another original design for creating
50 desired testing currents in the system; Fig. 8 is a set of curves indicating operating conditions which may be desired in the test; Fig. 9 shows conventionally a third original

design for creating desired testing currents in the system; and Fig. 10 shows conventionally a character of image produced from the pattern of Fig. 9 under conditions in the system which are indicated by the diagram
60 constituting Fig. 11.

Any desired type of picture transmission or television system may be used in the practice of the invention. Fig. 1 indicates a television system which may be so used. Preferred forms of television systems are disclosed in the copending applications of Frank Gray, Serial No. 181,538, filed April 6, 1927, and J. W. Horton, Serial No. 181,570, filed April 6, 1927. In Fig. 1 the television transmitting apparatus 1 at a sending station and the television receiving apparatus 2 at the receiving station are connected by a wire or radio transmission channel 3. All of these parts of the system may be, for
75 example, such as those disclosed in the Gray application just mentioned.

To quickly test overall transmission characteristics of the system a picture may be transmitted over the system which will give,
80 for the signal transmitted to the line, a sinusoidal current of constant amplitude and of a frequency which is constant for any line element of the picture scanned but changes slightly as each new line element across the
85 picture is scanned. The picture may be, for example, of the general type conventionally indicated in Fig. 2, wherein the upwardly pointing arrow indicates the direction of scanning. In the figure, the changes from
90 black to white are sudden; but it is to be understood that in the test design actually transmitted, the changes are gradual, and such as to give a pure sine wave and not the square wave which would result if the
95 changes from black to white were sudden. This statement holds for all of the test designs described herein.

If there is overall phase distortion in the system due to different phase delay at the
100 various frequencies, at the receiving end of the system the successive line elements of the image will not line up in phase, but will be out of phase, for example, as indicated in Fig. 3 wherein the frequencies near the middle of the frequency range are retarded
105 along the time axis, relative to the higher and lower frequencies. The deviation at each frequency will be proportional to the phase delay B/ω at that frequency. The
110

quantity ω is 2π times the frequency in cycles per second, and the quantity B is the phase change, in radians of angle, experienced by the sinusoidal signal wave due to transmission through the system.

The phase delay can be plotted roughly against frequency from the appearance of the image. This has been done in Fig. 4, wherein the graph 15 corresponds with Fig. 3. If the phase delay were uniform for all of the frequencies represented by the various line elements of the picture, the graph 15 would be a horizontal straight line.

If there is amplitude distortion, the successive line elements of the picture will show a varying contrast throughout the range of frequencies, for example, as indicated in Fig. 5, the contrast being greatest for those frequencies attenuated the least. The variation in contrast has been conventionally shown by widening the black lines to indicate increased contrast, and narrowing them to indicate decreased contrast. The attenuation-frequency curve 16 corresponding to Fig. 5 is roughly shown in Fig. 6. The attenuation test is useful for showing the general trend of the attenuation throughout the frequency range, and is sensitive to sharp irregularities in the attenuation.

With regard to phase delay measurements as described above in connection with Figs. 3 and 4, sharp deviations (that is, within a short frequency range) in the phase delay are easily observed, but gradual deviations over a large frequency range are more difficult to see.

The method of the delay test may be modified, with resulting increase of accuracy, by using a design such as that conventionally indicated in Fig. 7 instead of the design of Fig. 2. The direction of scanning is the same as in Fig. 2. The design of Fig. 7 is such that in transmitting the sine waves a standard comparison frequency is alternated each time with the testing frequency. With this design a gradual deviation in the delay may be more easily detected. If the same range of frequencies is to be kept, the interval between successive frequencies can be maintained small by increasing the size of the design.

The succession in frequencies can be so taken that the length of a line element of the picture corresponds to an integral number of cycles, thus avoiding any discontinuity in going from one line element to the next, except when the frequency change occurs. This eliminates the obscuring effect of the transients which would be caused by these discontinuities.

The accuracy of the delay tests with the designs of Figs. 2 and 7, can be increased by using, in the receiving apparatus 2, non-linear transmission characteristics, for example, in the vacuum tubes, magnetic cir-

cuits, or receiving lamp. Referring to Fig. 8, such non-linear characteristics can be made to change a sinusoidal variation such as indicated by graph 20, corresponding with the light intensity along a line element of the design being viewed through the system, to a variation such, for example, as that indicated by graph 21 which will give sharper bands in black, or to a variation such as that indicated by graph 22 which will give sharper bands in white. The form of variation indicated by curve 22 can be obtained, for example, by employing an amplifier which amplifies high instantaneous magnitudes of signals more than the lower instantaneous magnitudes. The form of variation indicated by curve 21 can be obtained, for example, by an amplifier or network which has higher transmission efficiency for low amplitudes of signals than for the higher amplitudes. If the elements with the non-linear transmission characteristics are employed, introduction of additional phase distortion through these elements should be guarded against.

To test envelope delay ($dB/d\omega$) instead of phase delay (B/ω), still another pattern, such, for example, as that conventionally indicated in Fig. 9, can be employed. The direction of scanning is indicated by the upwardly pointing arrow. In this figure, as in Fig. 5, variation in contrast is indicated by widening the black lines to indicate increased contrast, and narrowing them to indicate decreased contrast. With this design the current sent out on the line will not be of constant amplitude, but will be modulated. That is, each line element of the picture generates a wave of constant frequency and varying amplitude, the frequency varying slightly from line element to line element, and the envelopes of all of the waves having the same frequency. The waves, as generated, have their greatest amplitudes correspond to the same relative points (namely the center points) in the line elements which produce the waves, respectively; and the waves, as generated, have their least amplitudes correspond to the same relative points (namely, the end points) in the line elements which produce the waves respectively. At the receiving end of the system, in the image, which may have some such appearance as conventionally indicated by Fig. 10, for example, the maxima or minima of the modulations will trace out the envelope delay versus frequency curve, as indicated by the dotted line graphs 31 and 32, respectively, in Fig. 10. The envelope delay versus frequency curve is drawn as a full line curve 30 in Fig. 11. This curve indicates the relative times at which the envelopes of the variations, at the receiving end of the system, due to the various line elements of the picture in Fig.

9 reach their maximum and minimum values.

In general, the accuracy of the envelope delay test is less than the accuracy of the phase delay tests. However, in those cases
5 where the phase delay varies a small amount in a very narrow frequency interval, the irregularity in the envelope delay will be much more prominent than in the phase delay. In such cases, though the accuracy of
10 the envelope delay test would be less, the sensitivity in detecting the irregularity would be greater.

What is claimed is:

1. The method of operating a wave transmission system which comprises transmitting through the system waves which differ from each other in a known regular manner as regards a characteristic common to all of them, and producing a figure from the
20 transmitted waves which is representative of them.

2. The method of operating an electro-optical system which comprises transmitting through the system waves of different frequencies, respectively, and producing from the waves transmitted a design from which frequency characteristics of the system are apparent by inspection.

3. The method of determining the relative effects which a wave transmission system produces upon a given characteristic of waves which are respectively different as regards another given characteristic, which method comprises transmitting through the
30 system, in rapid succession, waves which differ in a known regular manner as regards said second characteristic, and producing a design from the transmitted waves.

4. The method of determining overall characteristics of an electro-optical system at various frequencies which comprises transmitting through the system waves of different frequencies respectively, in rapid succession, and producing from the waves
45 transmitted a design indicative of the relative effects of the transmission upon the waves of different frequencies, respectively.

5. The method of determining frequency characteristics of a television system, which
50 comprises transmitting through the system, in rapid succession, waves the respective frequencies of which differ in a known regular manner, and producing from the transmitted waves a design from which frequency char-

acteristics of the system are apparent by 55 inspection.

6. The method of operating an electro-optical system which comprises viewing through the system a pattern which generates sine waves of constant amplitude and
60 systematically changing frequency.

7. The method of operating an electro-optical system which comprises transmitting through the system a picture containing line elements that generate sine waves which are
65 all of the same amplitude but the frequency of which changes from element to element so that the frequency change is gradual.

8. The method of operating a picture transmission system which comprises successively transmitting through the system parallel adjacent line elements of a picture, each of which generates an integral number of cycles of a wave that has a different frequency in the case of each line element. 75

9. The method of operating a picture transmission system including a sending station, a receiving station and a wave transmission channel for transmission between said stations, which method comprises transmitting from said sending station through said transmission channel sinusoidal variations of constant amplitude but of changing frequency, changing the sinusoidal variations into variations of a relatively peaked
80 wave form, and producing an image from the latter variations.

10. The method of testing a picture transmission system which comprises successively transmitting through the system line elements of a picture each of which generates a wave of constant frequency and varying amplitude, said frequency being different for different line elements.

11. The method of testing a picture transmission system which comprises successively transmitting through the system parallel adjacent line elements of a picture, each of which generates a modulated wave of different frequency, said waves as generated
100 having their greatest amplitudes correspond to the same relative points in the line elements which produce them respectively.

In testimony whereof, I have signed my name to this specification this 21st day of
June, 1927. 105

PIERRE MERTZ.