Sept. 13, 1932. R. W. ARMSTRONG 1,877,547

ARRANGEMENT FOR OPENINGS IN SCANNING DISK MULTIPLE CARDIOID

Filed May 28, 1930 2 Sheets-Sheet 1

Fig. 1.

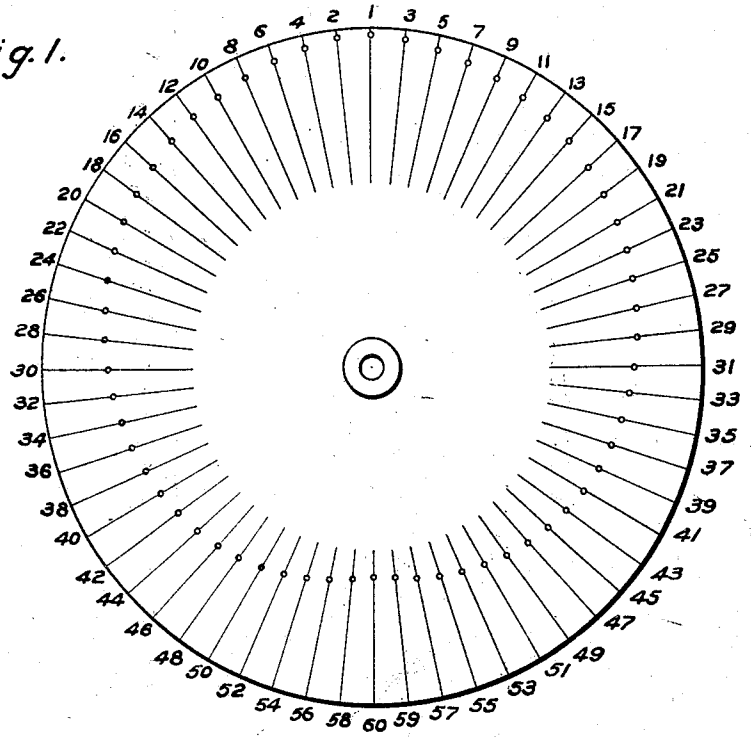
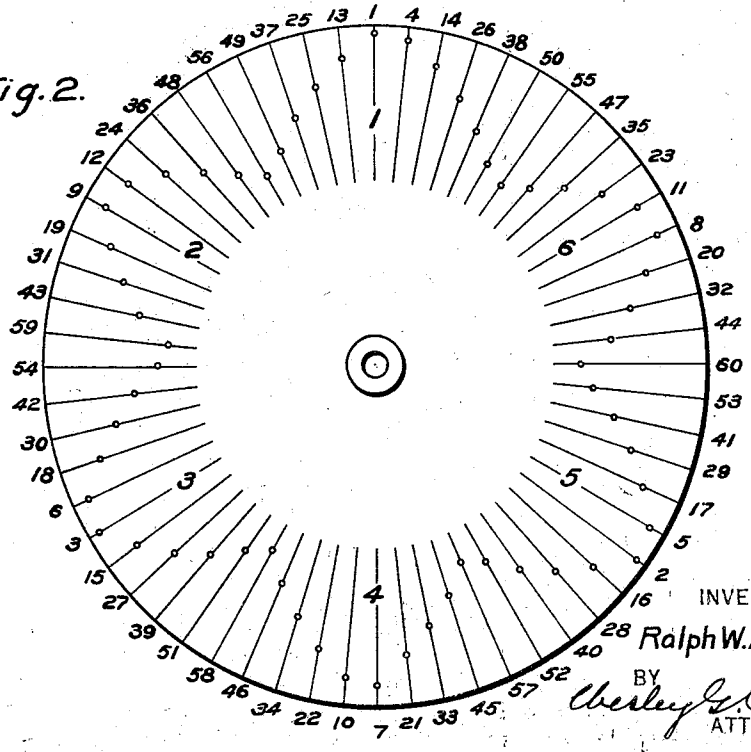


Fig. 2.



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Filed May 28, 1930 2 Sheets-Sheet 2

Fig. 3.

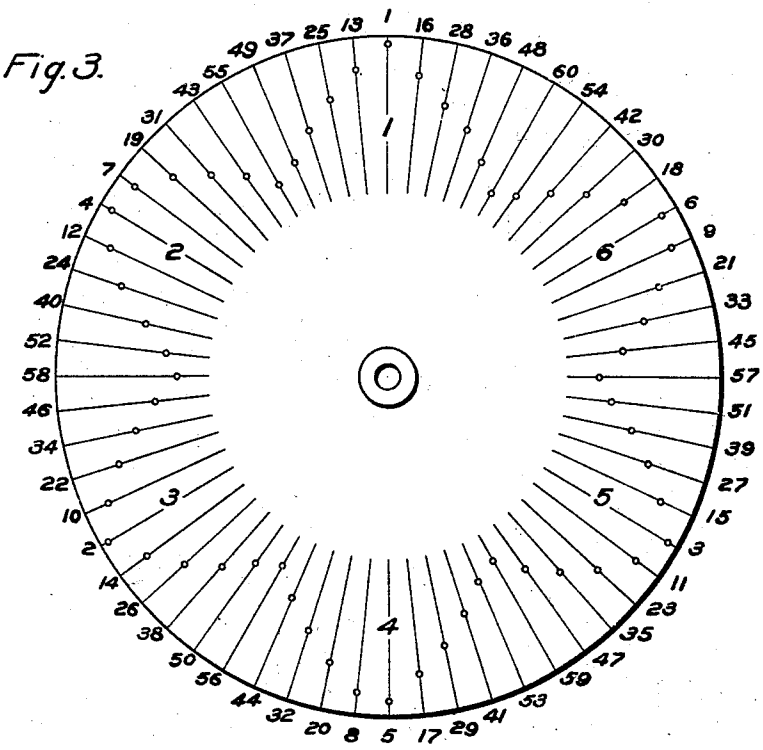
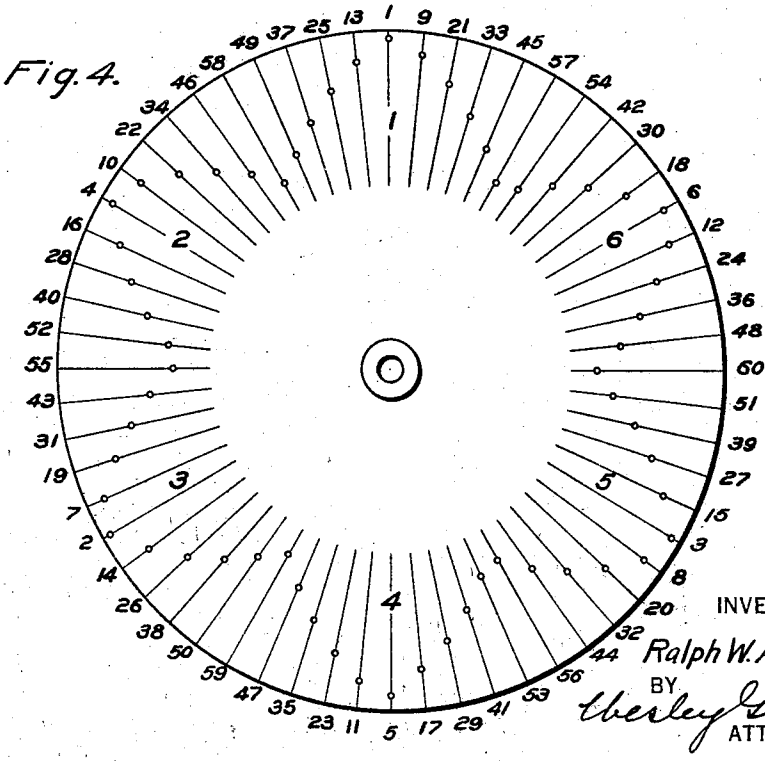


Fig. 4.



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UNITED STATES PATENT OFFICE

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ARRANGEMENT FOR OPENINGS IN SCANNING DISK-MULTIPLE CARDIOID

Application filed May 28, 1930. Serial No. 456,321.

My invention relates to television systems and more particularly to methods of scanning and means whereby such methods may be efficiently practiced.

In television systems constructed and arranged according to the prior art, scanning is generally accomplished through the use of such instrumentalities as rotating disks, vibrating mirrors or the like which are designed to cause a light beam to pass over the subject to be televised in a predetermined manner. Insofar as I am aware, whichever instrumentality is utilized, the predetermined manner of scanning takes place in one direction only; that is, the beam of light may be caused to traverse horizontal elements of the subject, beginning with an element at the top of the subject, travelling downwardly to the bottom element and then repeating the operation.

At the receiving end of such system, a similar scanning device must be employed, with the result that this uni-directional scanning method presents to the eye of an observer a water-fall effect, as the beam of light at the receiving end travels downwardly, in translating the transmitted impulses of the televised subject, to produce the image of the same. The above effect is very undesirable, as it impairs the detail and visibility of received pictures.

It is, accordingly, one object of my invention to provide an improved scanning method to be followed at either the transmitting or the receiving end of a television system to eliminate the water-fall effect referred to above.

Another object of my invention is to provide a scanning means whereby the above method may be put into practice.

Additional objects will be disclosed in the following description of my invention.

I have discovered that excellent results may be obtained by a scanning procedure which comprises the scanning of the subject in a non-sequential fashion and the changing of the direction of scanning. For example, I might scan alternate horizontal elements of the subject in succession, from top to bottom, and then, instead of following the usual procedure of repeating the operation, I contemplate scanning the unscanned elements of the subject in reverse order, that is, from the bottom to the top of the subject. In this manner, I break up the uni-directional scanning sequence of adjacent elements of a televisioned subject, these being the chief causes of the water-fall effect.

My improved method may be applied to any of the scanning devices referred to above which, of course, may be modified for the purpose. In the scanning arrangement utilizing vibrating mirrors, it is apparent that the relative motions of the mirrors may be so adjusted as to accomplish scanning according to my improved method.

As another means whereby my method may be put into use, I have provided a scanning device of the disk type, wherein the scanning elements are so arranged as to accomplish the desired result. An arrangement of scanning elements very suitable for the purpose comprises a cardioid arrangement made up of two spirals or multiples thereof, running in opposite directions. Assuming a light source to be casting a light beam on the upper portion of the disk, the effect of the cardioid arrangement of scanning elements will be to cause the subject to be scanned by a series of horizontal light lines from top to bottom and then in reverse direction from bottom to top.

Various species of disks of this type are disclosed in the accompanying drawings wherein:

Figure 1 represents a simplified embodiment of my scanning device.

Figs. 2, 3 and 4 represent modifications thereof.

Referring more particularly to Fig. 1, I have illustrated a scanning disk of 60 scanning elements, in the form of a single cardioid, comprising a pair of spirals running in opposite directions. The scanning elements of one spiral are so spaced from the edge of the disk as to scan alternate scanning elements on a subject, the scanning elements comprising the other spiral being so spaced from the edge as to scan the remaining elements. Employing the arrangement dis-

closed in Fig. 1, it will be apparent that substantially no two adjacent picture elements will be scanned successively, and various elements will be scanned at equal time intervals. The above condition, or conditions approximating them, are essential in the accomplishment of the desired results for, whenever a plurality of adjacent subject elements are successively scanned, a light flutter or the aforementioned waterfall effect will be the result.

I have found that improved results may be secured by the use of a disk, wherein the arrangement of the scanning elements comprises a plurality of oppositely directed spirals, as illustrated in Fig. 2. The particular spacing of the elements is obtained through a mathematical relationship derived from the species disclosed in Fig. 1, the results of which may preferably be modified in an arbitrary manner to obtain more efficient operation.

If "n" equals the number of cardioids comprising the arrangement of scanning elements on the disk, then the scanning elements on the single cardioid disk determined by the progression 1, $n+1$, $2n+1$, etc., 2, $n+2$, $2n+2$, etc., will determine the order of scanning of the "n" cardioid disk.

As an illustration, let it be assumed that it is desired to construct a six cardioid 60 scanning element disk. To determine the order in which the scanning elements should appear thereon, the above mathematical progression is applied to the single cardioid arrangement of Fig. 1. For example, $n+1$ equals 7. The 7th scanning element on the single cardioid disk is element 13. Therefore, element 13 will follow the scanning element 1. In like manner, $2n+1$ equals 13, which corresponds to the scanning element 25 on the single cardioid. Therefore, element 25 will follow element 13. Developing the above calculations, the following order of scanning is obtained:

1, 13, 25, 37, 49, 60, 48, 36, 24, 12—7, 19, 31, 43, 55, 54, 42, 30, 18, 6—3, 15, 27, 39, 51, 46, 34, 22, 10, 9, 21, 33, 45, 57, 52, 40, 28, 16, 14—5, 17, 29, 41, 53, 56, 44, 32, 20, 8—11, 23, 35, 47, 59, 38, 26, 14, 2.

The scanning order obtained by the mathematical method outlined above serves to break up the scanning sequence followed by the scanning arrangements of the prior art and also serves to change the direction of scanning; that is, the horizontal light lines travel upwardly as well as downwardly, all tending to eliminate the light effects referred to above. It will be noted, however, that certain of the adjacent scanning lines in the above order, i. e., 1 and 2, 10 and 9, 4 and 5, 55 and 54, follow successively thereby, to a small degree, tending toward the production of local light flutter. To overcome this I resort to arbitrary means and interchange the locations of the above elements to more widely separated positions in the order of scanning, thereby obtaining an arrangement as follows:

1, 13, 25, 37, 49, 56, 48, 36, 24, 12—9, 19, 31, 43, 59, 54, 42, 30, 18, 6—3, 15, 27, 39, 51, 58, 46, 34, 22, 10—7, 21, 33, 45, 57, 52, 40, 28, 16, 2—5, 17, 29, 41, 53, 60, 44, 32, 20, 8—11, 23, 35, 47, 55, 50, 38, 26, 14, 4.

Fig. 2 of the drawing represents a cordioid disk embodying the above scanning arrangement.

Various other methods of schemes may be devised for forming the multiple cardioid scanning arrangements, practically all of which depend upon some arbitrary factor to obtain the most efficient results. In addition to the method outlined above, I have found the following scheme to produce very good results. For a 6 cardioid 60 hole disk, I arbitrarily let the cardioid elements, 1, 2, 3, 4, 5, and 6 of Fig. 3 begin with scanning elements 1, 4, 2, 5, 3 and 6, respectively, so that consecutively numbered elements are separated by one-third the circumference. I then space the successive elements by steps of 12 scanning lines for the left-hand spirals. By averaging the successive numbers of preceding left-hand spirals, I can determine the order of the scanning elements comprising the right-hand spirals. The following scanning order is obtained as a result of utilizing the above scheme:

1, 13, 25, 37, 49, 55, 43, 31, 19, 7—4, 16, 28, 40, 52, 58, 46, 34, 22, 10—2, 14, 26, 38, 50, 56, 44, 32, 20, 8—5, 17, 29, 41, 53, 59, 47, 35, 23, 11—3, 15, 27, 39, 51, 57, 45, 33, 21, 9—6, 18, 30, 42, 54, 60, 48, 36, 24, 12.

Scanning elements 12 and 13, 24 and 25, which appear close together in the above order, may be shifted to obtain improved results. For example, 16 and 12 might be interchanged and 28 and 24 might be reversed as to position. The resultant scanning order is embodied in the disk disclosed in Fig. 3.

Another scheme which I have worked out for obtaining an efficient scanning disk is to arbitrarily assign elements 1, 4, 2, 5, 3, 6 as the starting elements of the cardioids 1, 2, 3, 4, 5 and 6, respectively, of Fig. 4 and elements 58, 55, 59, 56, 60 and 57 as the terminating elements of the cardioids and then I decrease the intermediate elements in steps of 12 scanning lines to obtain the following scanning order:

1, 13, 25, 37, 49, 58, 46, 34, 22, 10—4, 16, 28, 40, 52, 55, 43, 31, 19, 7—2, 14, 26, 38, 50, 59, 47, 35, 23, 11—5, 17, 29, 41, 53, 56, 44, 32, 20, 8—3, 15, 27, 39, 51, 60, 48, 36, 24, 12—6, 18, 30, 42, 54, 57, 45, 33, 21, 9.

It will be apparent that various other mathematical or arbitrary schemes may be resorted to, to obtain an arrangement of scanning elements for breaking up the sequence of scanning and altering the direction of scanning of the scanning arrangements of the

prior art and, therefore, while I have disclosed my invention in great detail, I do not desire to be limited except insofar as shall be necessitated by the prior art and the appended claims.

I claim as my invention:

1. The method of scanning a picture in a television system comprising scanning certain of the picture elements throughout the whole picture in one direction and thereafter scanning the other elements in another direction.

2. The method of scanning a picture in a television system comprising scanning non-adjacent elements of the picture throughout the whole picture in one direction and thereafter scanning the remaining elements in the opposite direction.

In testimony whereof, I have hereunto subscribed my name this 22nd day of May 1930.

RALPH W. ARMSTRONG.