June 14, 1932.

C. D. FAHRNEY

1,862,743

TELEVISION

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Fig. 1.

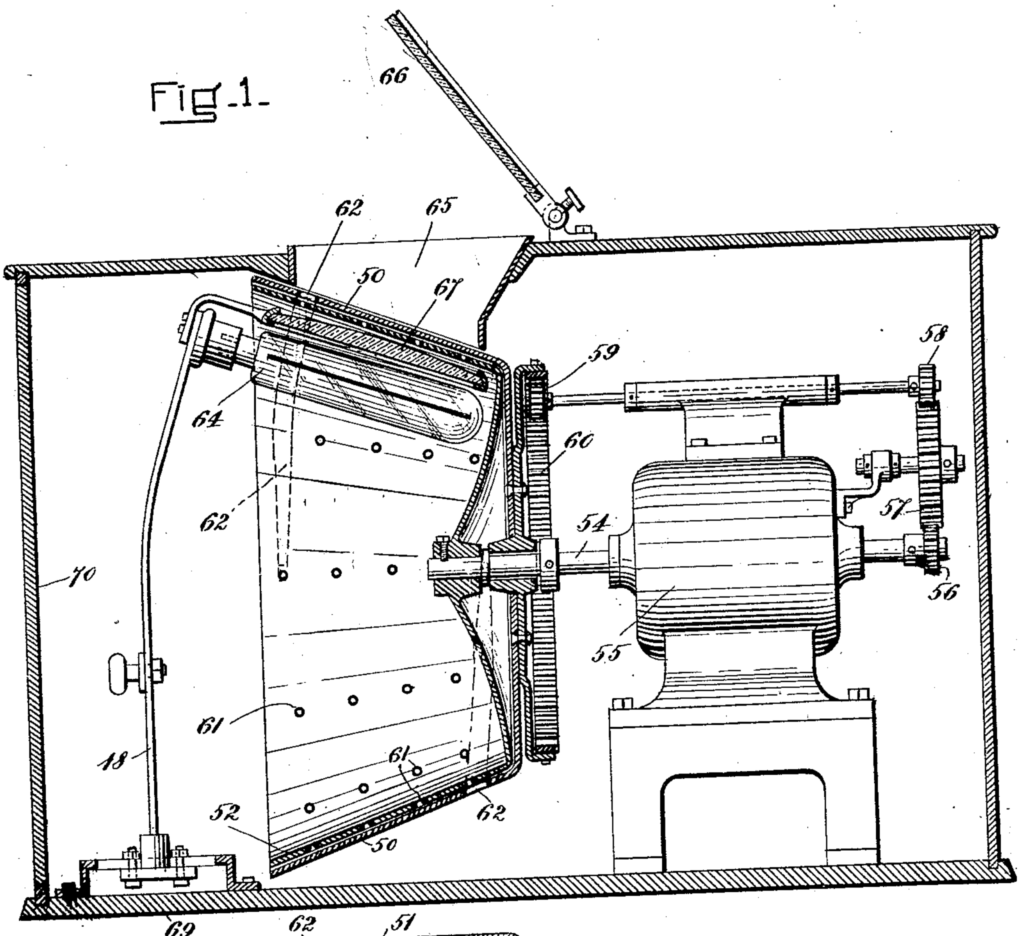

Fig. 2.

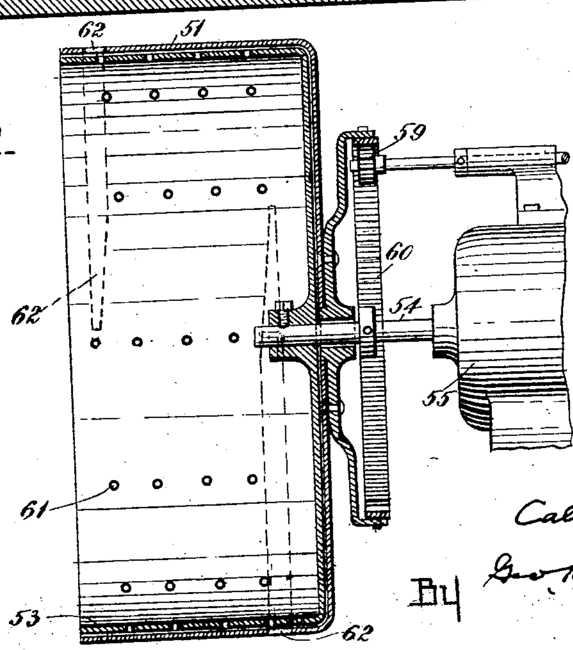

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Fig. 3.

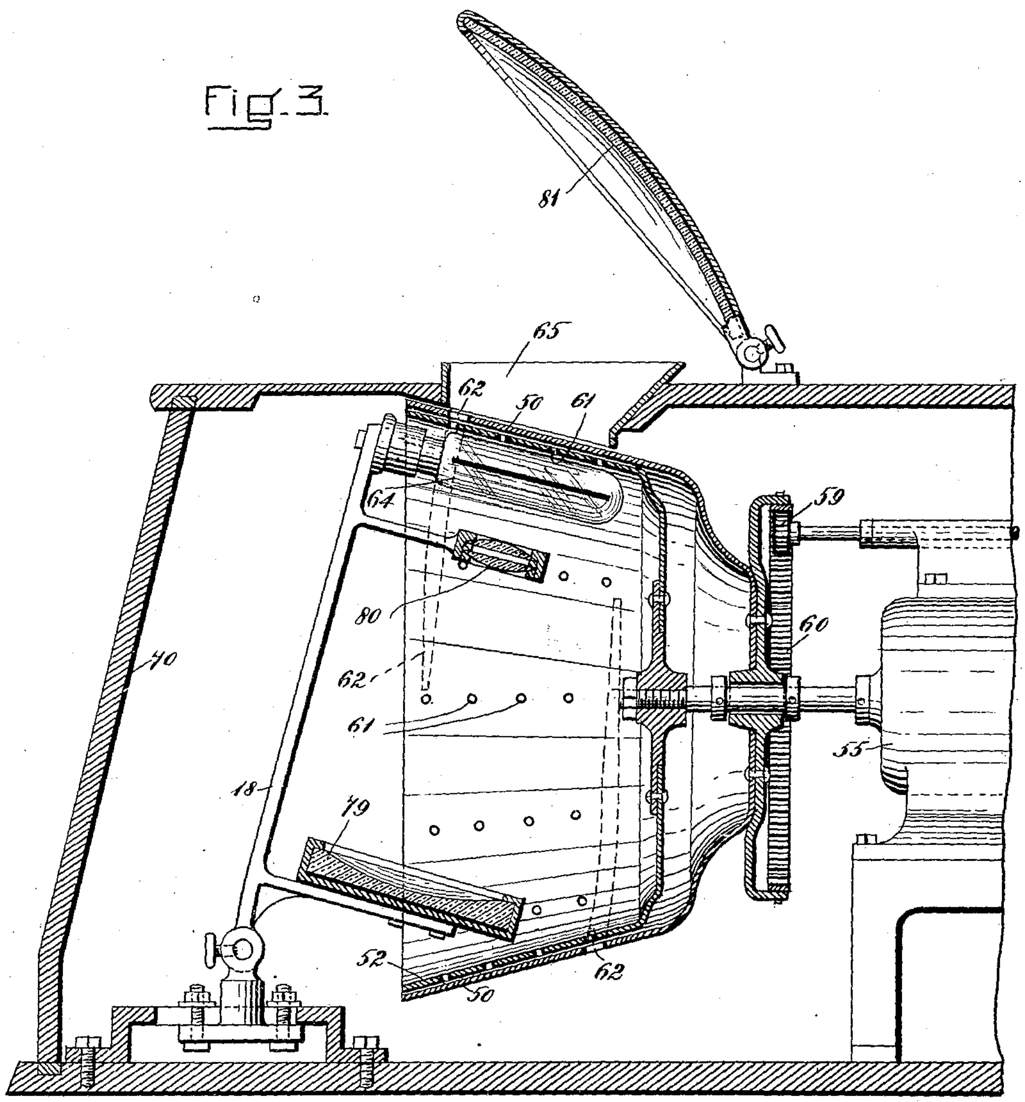

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Fig. 4.

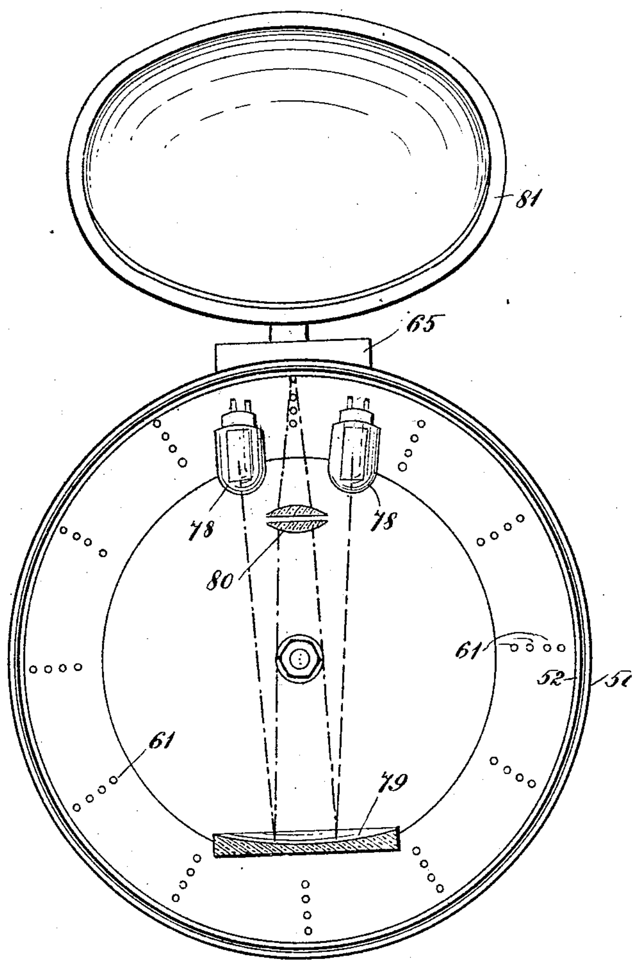

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Fig. 5.

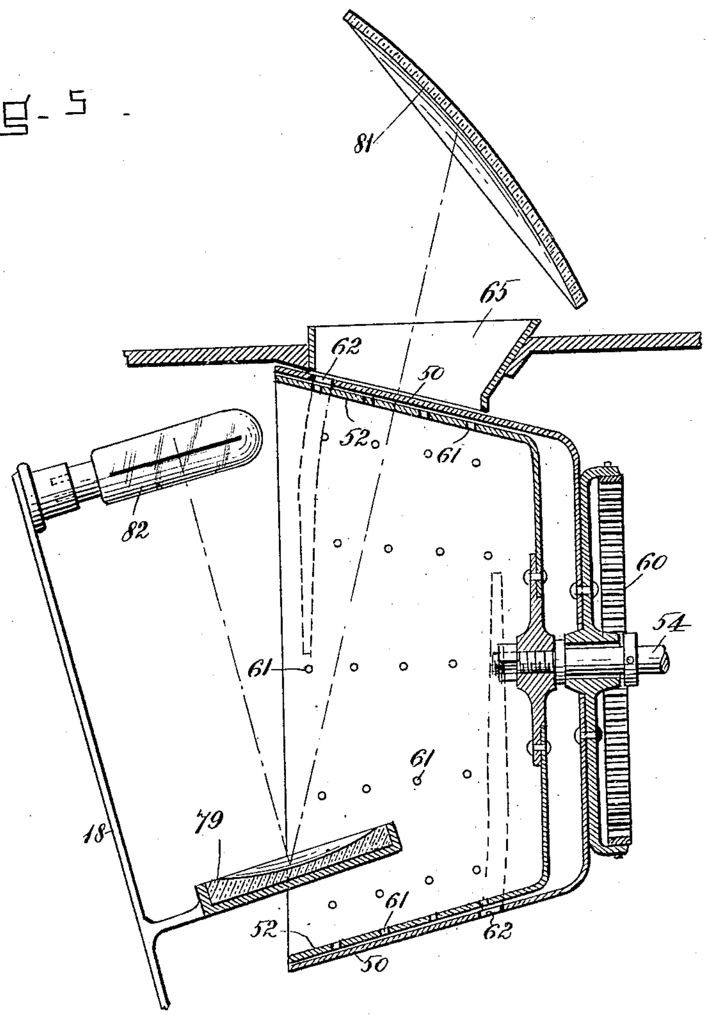

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Fig-6-

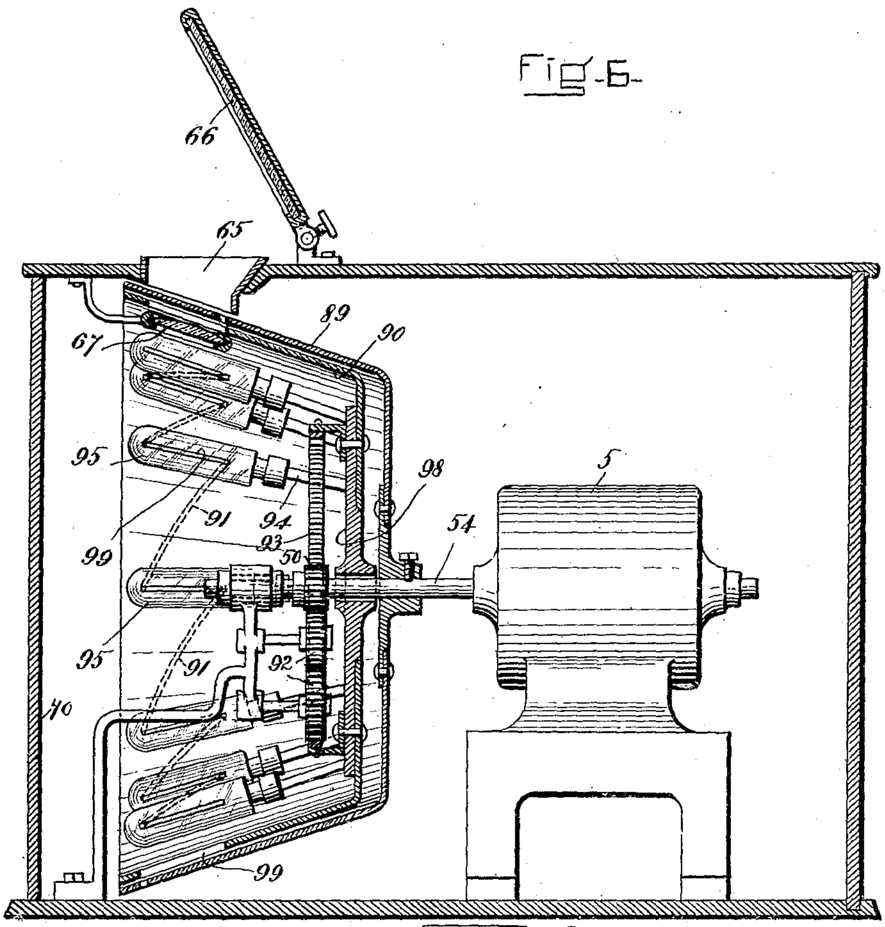

Fig-7-

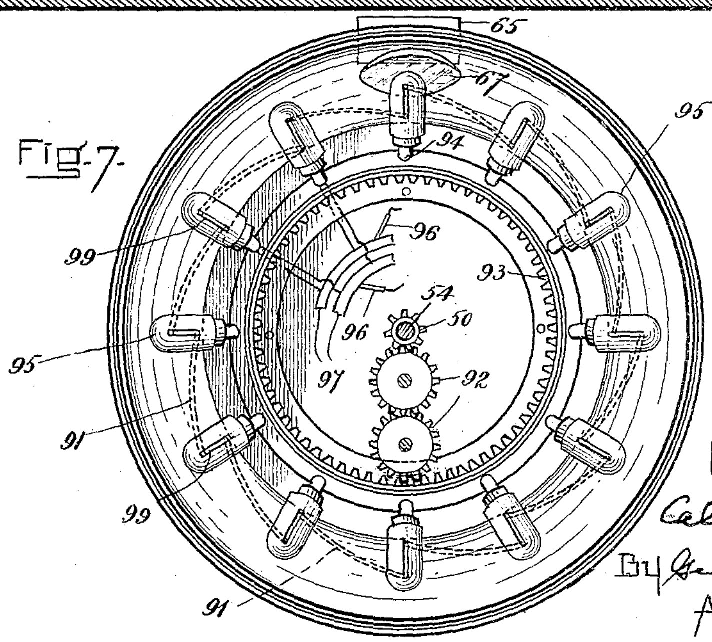

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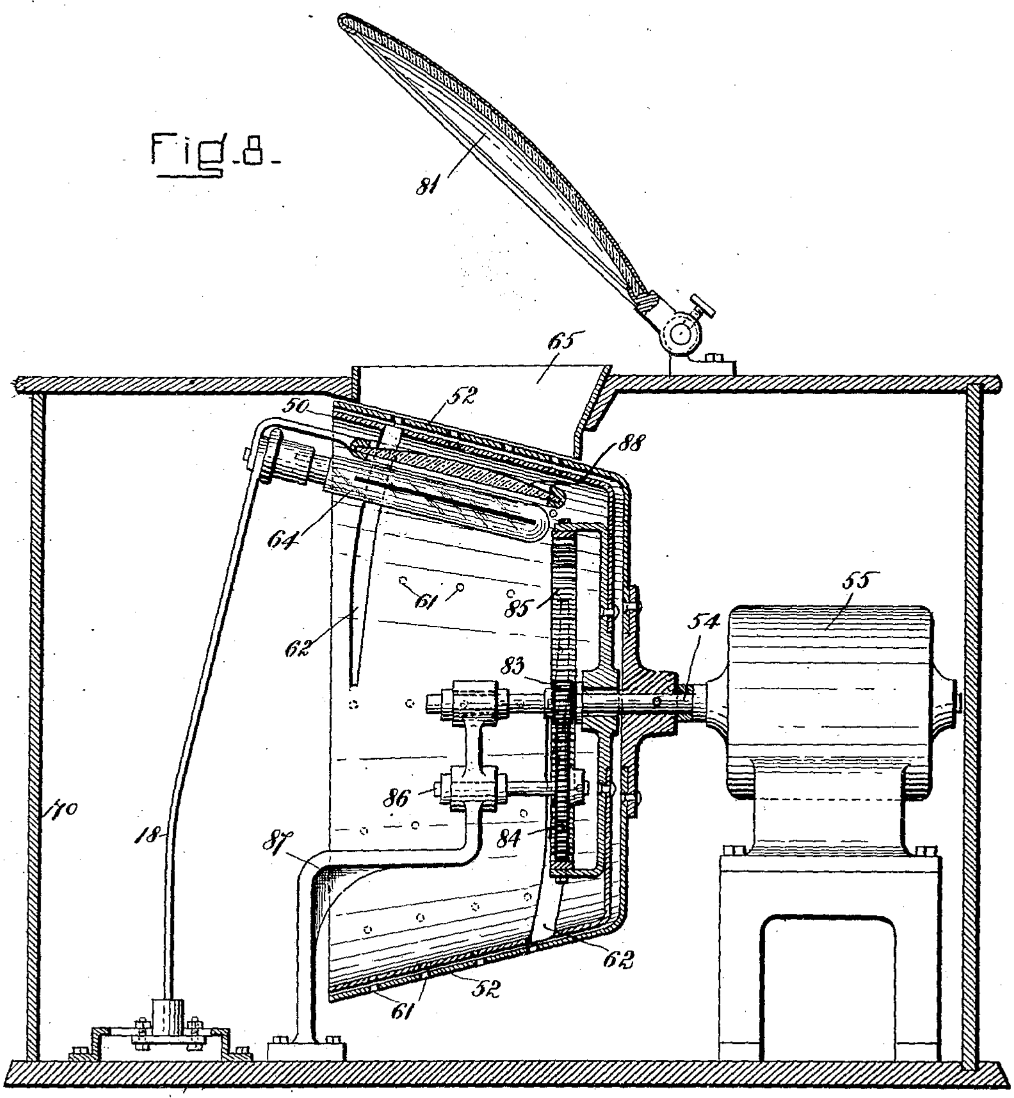
Fig. 8.



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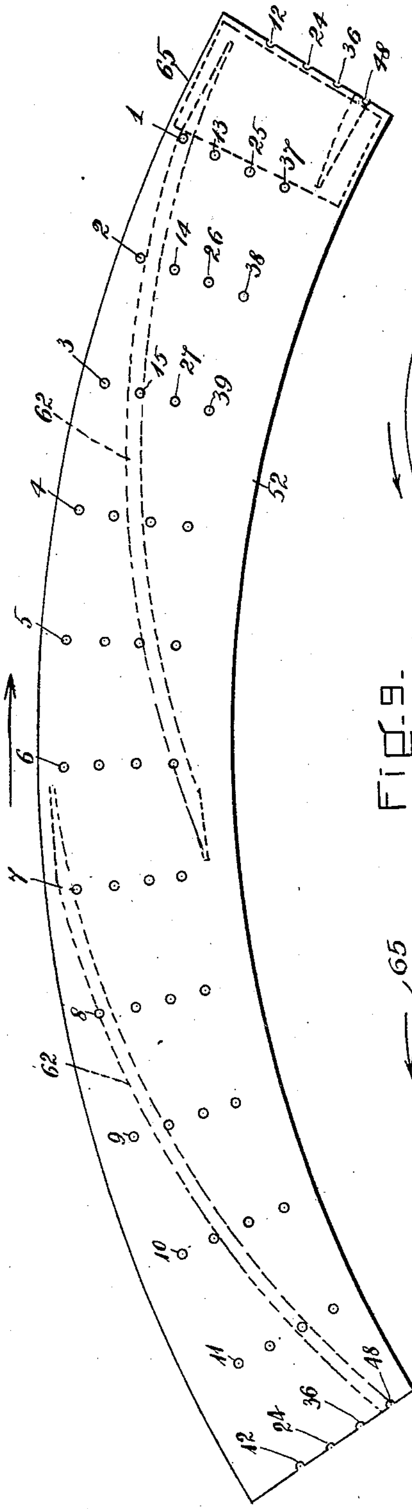

FIG. 9.

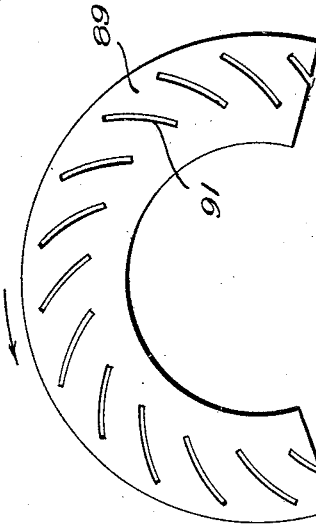

FIG. 12.

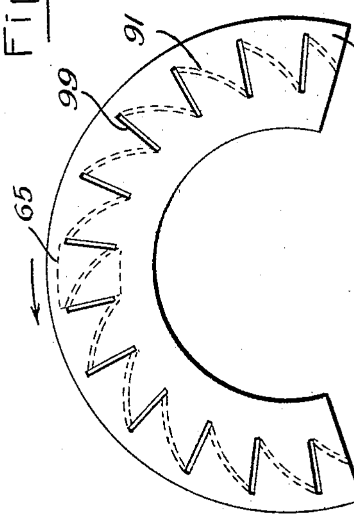

FIG. 11.

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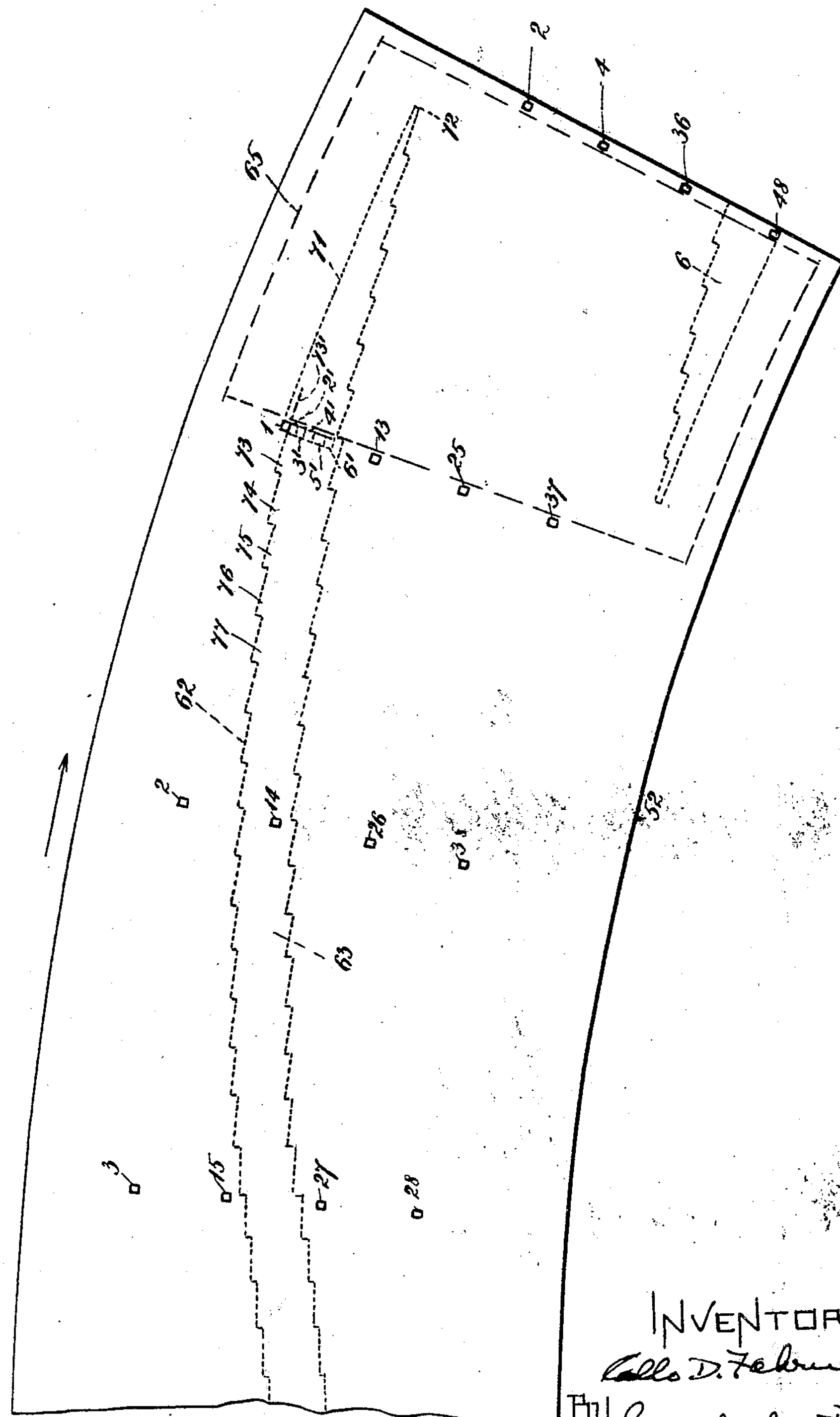
FIG-10.



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Patented June 14, 1932 **1,862,743**

UNITED STATES PATENT OFFICE

CALLO D. FAHRNEY, OF CAMBRIDGE, MASSACHUSETTS

TELEVISION

Application filed March 11, 1929. Serial No. 345,978.

The principal object of the present invention is to provide a television receiving system, by means of which a relatively large picture will be reproduced by means of a comparatively small and compact scanning apparatus. Other objects of my invention are to provide the scanning apparatus with an improved reflector and with a more efficient picture-receiving surface than those now in use. A further object of my invention is to provide means for increasing the amount of light transmitted through the scanning apertures to the picture-receiving surface. Other objects of my invention will hereinafter appear in the detailed description of the specific embodiments of my invention which I have employed to illustrate the principles thereof.

With the foregoing objects in view, my invention comprises, as its salient features, two rotating surfaces of revolution, such as two concentric cones or two concentric drums, provided with co-operating light-transmitting apertures, together with means for rotating said members in the same direction at different speeds or in opposite directions. The lamps, the luminosity of which is varied by the incoming current, neon lamps for example, may be stationary, or may rotate with one of said surfaces of revolution. In cases where the said lamps are stationary I may employ one such lamp placed either directly behind the window of the apparatus, or placed behind and forwardly of the same; or alternatively, since there is a limitation to the size of such lamps, I may use two neon lights placed behind and on either side of the window, together with a reflector such as a concave mirror whereby the light rays are directed to the window, with or without the interposition of a ray-concentrating means, such as a lens.

My invention contemplates also the use of a concave mirror as a picture-receiving surface.

My invention consists further in the parts and combination of parts hereinafter more fully described and set forth in the appended claims.

Various illustrative embodiments of my invention are shown in the drawings which accompany and form a part of this specification, but it is to be understood that said drawings are merely illustrative and are not to be regarded as restrictive.

In the drawings—

Figure 1 is a longitudinal central section of a television-receiving apparatus embodying my invention;

Fig. 2 is a similar fragmentary view of a modification;

Fig. 3 is a central longitudinal section of a television-receiving apparatus in which two lamps placed on either side of the window are employed;

Fig. 4 is a front view of the apparatus shown in Fig. 3;

Fig. 5 is a central section of a further modification in which the lamp is placed behind and forwardly of the window;

Fig. 6 is a central section of a modification in which the lamps rotate with one of the co-operating scanning members;

Fig. 7 is an end view of the apparatus shown in Fig. 6;

Fig. 8 is a similar view of a further modification in which the relative positions of the scanning members are reversed from those shown in Fig. 1;

Fig. 9 is a development on a smaller scale of the conical scanning members shown in Fig. 1;

Fig. 10 is a fragmentary view showing a development on a larger scale of the scanning members shown in Fig. 1;

Fig. 11 is a development of the inner scanning member shown in Fig. 6, and

Fig. 12 is a development of the outer scanning member which co-operates therewith.

In the particular drawings selected for illustrating the principle of my invention, 50 represents one of two co-operating scanning members, shown in the present instance as a cone, although as indicated at 51 in Fig. 2, this member may be a surface of revolution of another form, such as a cylinder. The co-operating scanning member is a cone 52 concentric with the cone 50 in Fig. 1 and the cylinder or drum 53 in Fig. 2. The inner member 52 is mounted on and rotates with the shaft 54 of the motor 55, while the outer member is mounted loosely on said shaft and is rotated in the same direction as the inner member but at a lower speed, the gearing 56, 57, 58 and the pinion 59 meshing with the annular gear 60, which is rigidly attached to the member 50, serving to drive the latter at a lower rate of speed than the member 52.

The cone 52 is provided with a plurality of perforations 61 which may be circular, as shown, or rectangular, as indicated in Fig. 10, and said perforations are arranged spirally around the periphery of the cone forming in the present instance four spiral convolutions, the perforations of the several spires being arranged in four rows, each along a generatrix of said surface. In the present instance, I show forty-eight perforations forming four spirals of twelve perforations each, although it will be understood that I do not limit myself in this manner. The arrangement of the perforations in the cylinder 53 is identical with that above described in connection with the cone 52. The cone 50 is provided with two light-transmitting apertures, shown, in the present instance, as the slots 62, each extending approximately one-half way around the periphery of said cone in a diagonal direction and arranged to co-operate successively with the perforations 61. The relative position of the said perforations and slots is shown in Fig. 9 which is a development of the two cones 50, 52.

The preferred design is shown in Fig. 10 in which the perforations are rectangular, preferably square, and the slots each consist of a plurality of contiguous rectangular sections 63, each displaced along a generatrix of the cone by a distance equal to the width of one of the perforations. A source of light, the luminosity of which is capable of being varied by changes in the received current, such for example as a neon light in lamp 64, is provided for transmitting light through the apertures formed when the perforations and slots are in register and, as shown in Fig. 1, said lamp is placed behind the window 65 through which the transmitted light passes and impinges upon the picture-receiving surface 66, a lens 67 being interposed between said lamp and window if desired. The lamp is supported by the adjustable bracket 68 and the casing 69 in which the above described apparatus is housed may be provided with a sliding door 70.

The motor 55 being synchronized with the motor which drives the transmitting scanning-disc the changes in luminosity of the lamp effected by variations in the electrical energy transmitted by wire or by radio waves will vary the light units transmitted to the picture-receiving surface 66 as the slots register successively with the perforations in the inner cone, and thereby compose the picture which was analyzed at the sending station by the scanning transmitter.

Referring to Figs. 9 and 10 which show the relation between the slots and perforations in more detail than can be indicated in Fig. 1, the cones 50 and 52 are assumed to be rotating in the direction of the arrows placed above said Figs. 9 and 10, respectively, and the inner perforated cone, in the present instance, has a speed of rotation eight times higher than that of the outer slotted cone. The perforation 48 has just passed beyond the window located in dotted lines at 65, and the perforation 1 is about to enter the field of said window. When the perforation 48 was within the window, it was in register with the lower end of the lefthand slot 62 and light was being transmitted through said perforation 48 and slot.

As soon as the perforation 48 passes beyond the window, the perforation 1 in register with the upper end of the righthand slot 62 passes into the window and light from a neon lamp is transmitted therethrough. As soon as the perforation 1 passes without the field of the window the perforation 2 will pass within the same and will be in register with the righthand slot 62, and so on until the perforations 2, 3, 4, 5 and 6 have swept by the window, each being successively in register with a different portion of the righthand slot 62 in its passage thereacross, whereupon the identical action takes place with respect to the perforations 7 to 12, respectively, and the lefthand slot 62, the aforesaid action taking place in one complete revolution of the cone 52. On the second revolution the perforations 13 to 24 pass across the window, sweeping the two slots successively, and on the next two revolutions of the cone, the perforations 25 to 36 and 37 to 48, respectively, pass across the window and sweep the said slots.

Referring particularly to Fig. 10, it will be noted that the end portions of the two slots overlap a distance equal, approximately, to seven-eighths of the width of the window, and also that the square perforation 1 in the cone 52 which, as aforesaid travels eight times faster than the cone 52, is in register with the upper righthand end of the slot 62 in its passage across the window, the upper boundary 71 of the righthand end of said slot being the arc of a circle formed by the intersection of said cone and a plane normal to the axis thereof. When the perforation 1 has just passed without the window and the righthand end 72 of the slot is under the righthand boundary of said window, the rectangular section 73, which in length is equal to one-eighth of the width of the window, is partly within the latter, as indicated by the dotted line 73′, and the perforation 2 has just come into register with the lefthand end of said section, being at this instant about to enter the field of the window as indicated by 2′. In like manner, the perforation 3 is in register with the section 74 just before it enters the field of the window, as indicated at 3′. The positions of the perforations 4, 5 and 6 as they are about to enter the field of the window successively are shown at 4′, 5′ and 6′, respectively, the said perforations being in register, respectively with the sections 75, 76 and 77 of the slot 62 as they successively pass across the window.

It will now be apparent that by means of the foregoing construction I am enabled to produce with a comparatively small and compact scanning apparatus, a much larger picture than could be composed by the scanning discs now in use. Specifically, by means of a cone 52 having its larger base twelve inches in diameter, and provided with forty-eight holes arranged as shown, and a concentric slotted disc 50 rotating at one-eighth the speed of the perforated disc, I am enabled to compose a three inch square picture, using perforations of approximately one-sixteenth inch in diameter, whereas if a scanning disc were employed to produce a picture of that size, such disc would have to be forty-eight inches in diameter and have forty-eight perforations arranged in a single spiral, each perforation being one-sixteenth inch in diameter. A standard scanning disc of the type now generally in use in television reception and provided with forty-eight perforations arranged in a single spiral, each perforation being one-thirty-second inch in diameter, will produce a picture only one and one-half inches square.

By means of the present invention, I am enabled to use one-sixteenth inch perforations which permit the transmission of more light than the standard twenty-four inch disc apparatus with one thirty-second inch perforations. Manifestly, a forty-eight inch disc would be prohibitively large and while a three inch square picture could be produced on a twenty-four inch disc by reducing the number of perforations from forty-eight to twenty-four, the resulting picture would lack detail.

The relative speeds of the two cones are determined by the number of rows of perforations and the number of slots. If it were possible to use a single slot extending all the way around the cone, the ratio of the speed of the perforated cone to that of the slotted cone would be four to one; in the present instance it is eight to one, and if four slots equally spaced around the cone were used, such ratio would be sixteen to one. Thus the ratio of the speed of the perforated member to that of the slotted member is the ratio of the product of the number of rows of said perforations by the number of slots to unity.

Where the surfaces of revolution which form the co-operating scanning members are cones, as in Fig. 1, the standard disc transmitter may be used, but where, as in the case of Fig. 2, such surfaces of revolution are cylinders or drums, a drum transmitted must be employed. The operation of the apparatus shown in Fig. 2 is identical with that above set forth in Fig. 1.

There being at present a limitation to the size of suitable lamps for use in television-receiving apparatus, I have devised means for increasing the amount of light transmitted through the scanning members which consists in using a plurality of lights, one or more being placed on either side of the window, together with means for directing the light thereto.

In Figs. 3 and 4 I have illustrated a receiving system in which two such lights 78, 78 are employed, one on either side of the window 65, although of course it is to be understood that a number of lights connected in multiple may be placed on either side of the window. The light emanating from said lamps is directed by any suitable reflector such as the concave mirror 79 to the window, and if desired a lens 80 may be interposed between said reflector and window. The light-receiving surface shown in Figs. 3 and 4 is a concave or magnifying mirror 81, although it will be understood of course that the plane surface 66 shown in Fig. 1 may be used with the apparatus illustrated in Fig. 3, and conversely, and in general that such concave or magnifying mirror may be employed in any of the several embodiments of my invention.

In Fig. 5 the lamp 82 is not placed directly behind the window 65, but is located behind and forwardly of the same, and the light from said lamp is directed to the window by the reflector 79.

The operation of the apparatus shown in Figs. 3, 4 and 5 will be readily understood from the foregoing detailed description of the operation of the system shown in Fig. 1.

In Fig. 8, the two co-operating scanning members 50 and 52 are made to rotate in opposite directions by mounting the outer member 52 to rotate with the shaft 54, and by mounting the inner member 50 loosely on said shaft and connecting it therewith by the pinion 83, carried by and rotating with said shaft, the gear 84 and the annular gear 85 by which said inner member is carried, a suitable bracket 86 being provided to support the outer end of the shaft 54 and the stud 87 which carries the gear 84.

It will be noted that the relative position of the perforated and slotted members is the reverse of that shown in Fig. 1, although it will be understood of course that in this embodiment of my invention, as well as that shown in Fig. 1, the slotted member may be outside the perforated member. In like manner, it is immaterial whether the slotted member of Fig. 1 be disposed outside the perforated member, as shown, or inside the same insofar as the actual production of the picture is concerned, but under certain circumstances it may be preferable to have said slotted member arranged inside the perforated member when both members rotate in the same direction and at different speeds.

In the case of Fig. 8, the scanning member at the *transmitting* station must be rotated oppositely to that of the scanning member used to transmit to the receiving apparatus shown in Fig. 1; and in such case the light units will travel across the window or frame from the bottom up instead of from the top down. In Fig. 8 I have indicated a lens 88 interposed between the lamp and the window.

In order to further increase the size of the received picture and also to make it possible to reduce the size of the lamp without loss in transmitted light and thereby effect a saving of electrical energy, I have devised a receiving system in which a plurality of lamps are carried by and rotate with the more slowly moving of the two co-operating scanning members. One embodiment of this system is shown in Figs. 6 and 7 in which the outer or more rapidly rotating scanning member 89, herein shown as a cone, is mounted on and rotates with the shaft 54 and the inner co-operating member 90 is loosely mounted on said shaft and rotated oppositely to that of the member 89 by the pinion 91, spur gears 92 and annular gear 93, the latter being secured to the member 90 in any suitable manner. Brackets 94 attached to and rotating with the inner member 90 carry relatively small neon lamps 95, herein shown as twelve in number, and said lamps are energized by current supplied through the brushes 96 which make contact with the rings 97 carried by, but insulated from, the plate 98 to which the annular gear and cone 90 are secured. The cone 90 is provided with a plurality of slots 99, herein shown as twelve, one for each lamp and said slots are arranged along generatrices of the cone in the present instance, each lamp being disposed directly behind one of said slots with its plate substantially parallel thereto. The co-operating cone 89 has a plurality of arcuate slots 91 which are so disposed, as indicated in Fig. 11, that the respective ends of each said slot terminates at the inner and outer ends of two of the contiguous apertures 99. The arrangement is such that when the two scanning members are rotating in the direction indicated by the arrows in Figs. 11 and 12, the speed of rotation of the outer member 89 with respect to the inner member 90 must be such that one of the arcuate slots will traverse one of the slots 99 in the time required by the latter to move a distance equal to its own width, so that as the slots 99 move successively across the window, each being swept as aforesaid by one of the arcuate slots, the variable light values transmitted through those portions of the respective pairs of apertures 91, 99 which are in register will pass through the window and impinge upon the mirror 65, thereby forming or composing the picture analyzed and sent out at the transmitting station.

It is to be understood of course that the analyzing apparatus at the transmitting station must conform to the receiving apparatus shown in Figs. 6 and 7, insofar as the co-operating light-transmitting apertures are concerned, that is to say, such analyzer must consist of two discs or two cones, or two other co-operating surfaces, provided respectively with light-transmitting apertures conforming in shape and arrangement with those used in the receiving system.

In the system shown in Fig. 1 in which a single stationary light is used, the perforations which for convenience of representation are somewhat exaggerated are in the present instance only one forty-eighth of the width of the window, and even if a lamp were used having a plate as wide as the window, only one forty-eighth of its area would be effective in transmitting light through two registering apertures. However, in the system of Fig. 6, small lamps each having a long narrow plate can be used, the dimensions of such plate being substantially co-extensive with a slot 99, and in this manner the cost both of the lamps and of the current necessary to energize the same is greatly reduced. In addition to this advantage, a comparatively large picture may be made with a relatively small and compact apparatus.

The length of the picture will be that of one of the slots 99 and the width thereof will be equal to the distance between two such slots, and thus it will be seen that by properly correlating the dimensions and positions of the slots with the rotational speeds of the respective co-operating members, a picture can be formed larger than that possible with the apparatus of Fig. 1, other things being equal, and also that a picture equal to that made by the apparatus of Fig. 1 can be formed by the system of Fig. 6 more economically because, as above explained, smaller lamps consuming less energy may be used.

Having thus described various illustrative embodiments of my invention without however limiting the same thereto, what I claim and desire to secure by Letters Patent is:—

1. In a television receiving apparatus, the combination of a pair of drums one located within the other and both rotatable on parallel axes, the surface of one drum having a plurality of circumferentially spaced light-transmitting apertures arranged in a plurality of spirals, and the surface of the other drum having a plurality of light-transmitting slots, and means to rotate said drums at

such relative speed that said slots cooperate with successive spirals of apertures.

2. A television receiving apparatus comprising in combination a surface of revolution provided with a plurality of rows of perforations each arranged along a generatrix of said surface, the said perforations being disposed around the said surface in such manner as to form a plurality of spirals, a co-operating concentric scanning member provided with a plurality of slots, and means for rotating said surfaces in the same direction at relatively different speeds, the ratio of the speed of the perforated member to that of the slotted member being the ratio of the product of the number of rows of said perforations by the number of said slots to unity.

3. In a television receiving apparatus, scanning members provided with co-operating light-transmitting apertures, a window, a lamp disposed behind said window, and a magnifying mirror for receiving the light transmitted through said apertures when in registration.

In testimony whereof, I have hereunto subscribed my name this 5th day of March, 1929.

CALLO D. FAHRNEY.