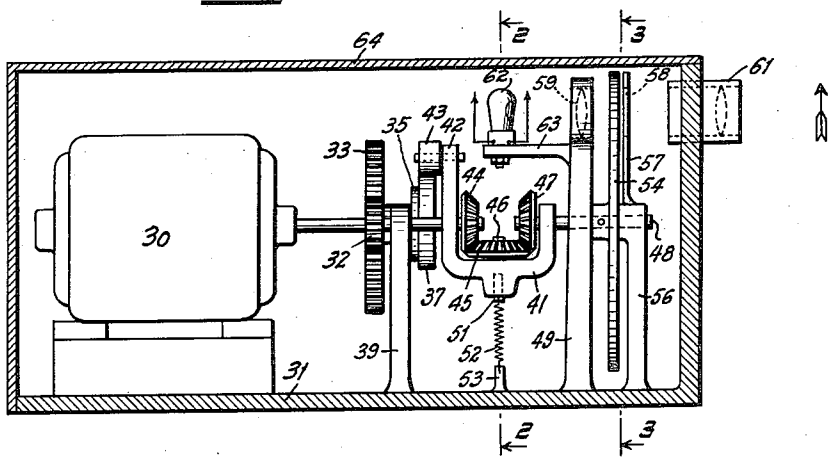
May 23, 1933. J. H. HAMMOND, JR 1,910,540

SECRET TELEVISION

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Fig. 1



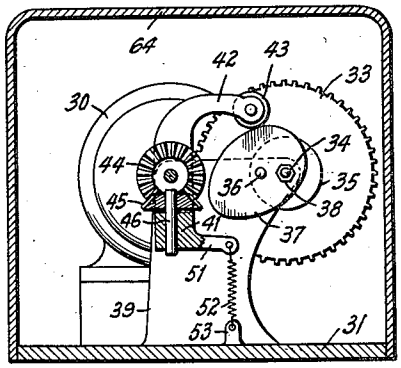




Fig. 2

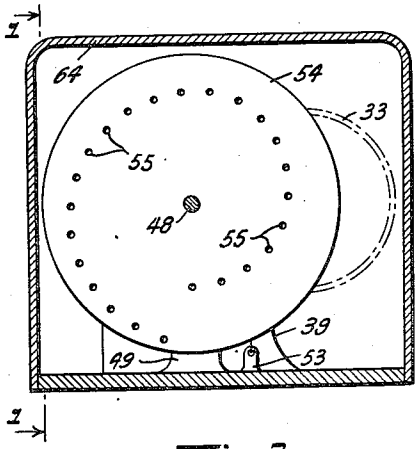



Fig. 3

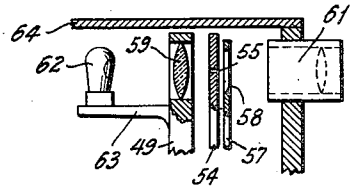



Fig. 4

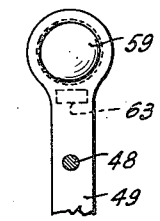



Fig. 5

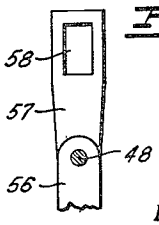



Fig. 6

INVENTOR.

BY John Hays Hammond, Jr.,
Albert M. Austin
ATTORNEY.

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Fig. 7

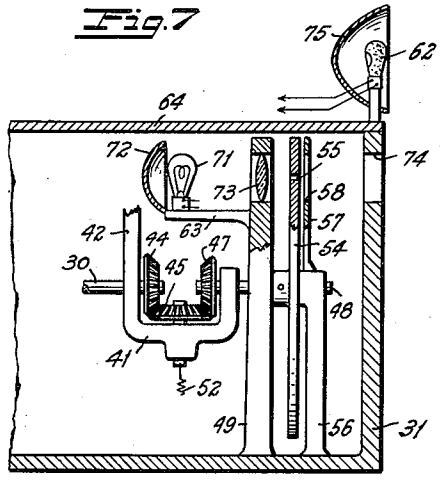
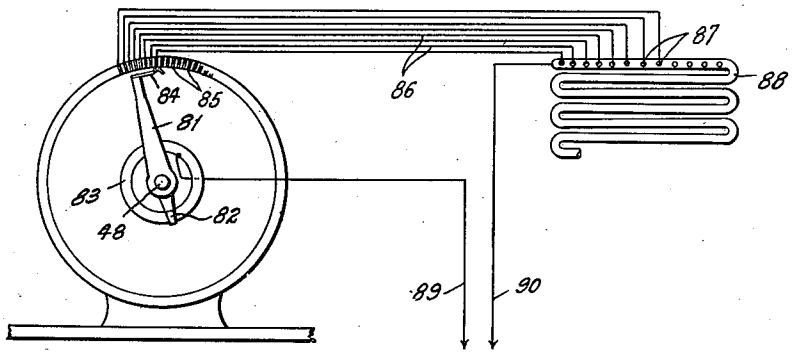



Fig. 8



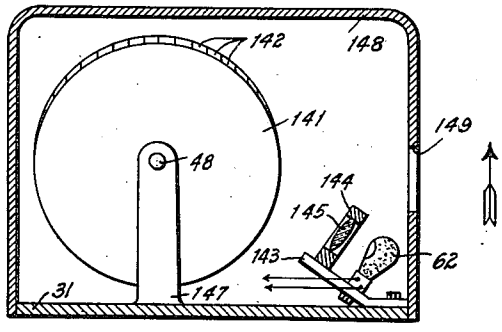




Fig. 16

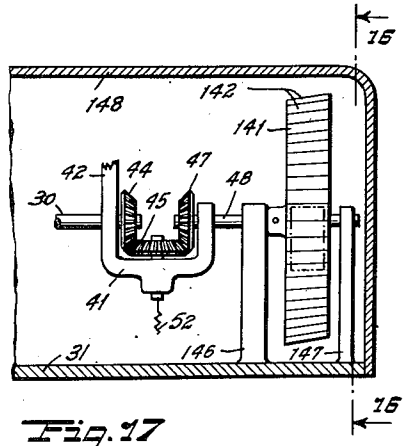



Fig. 17

INVENTOR.
John Hays Hammond, Jr.
BY
Albert M. Austin
ATTORNEY.

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Fig. 9

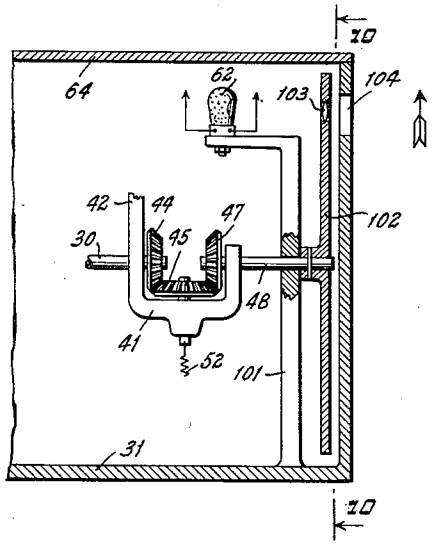



Fig. 10

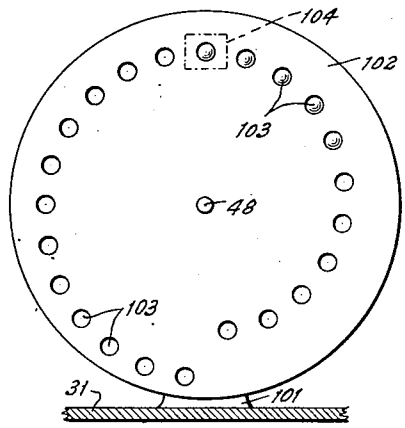



Fig 11

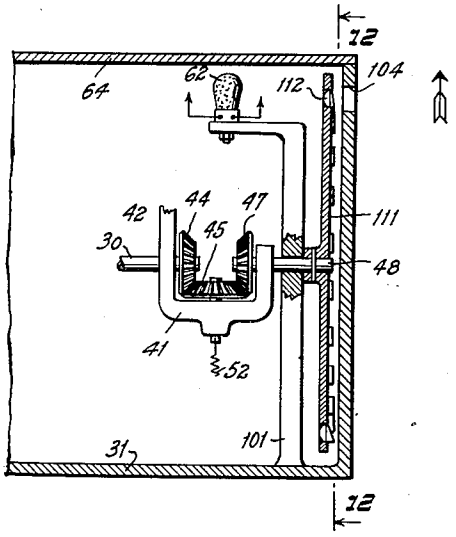
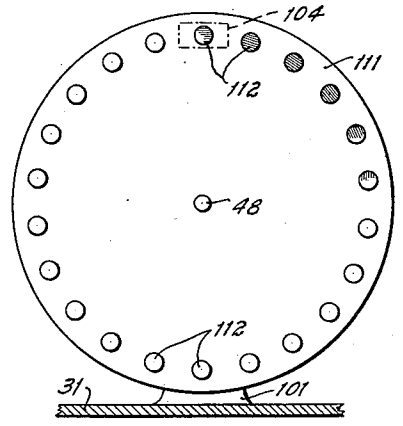



Fig. 12




INVENTOR.

BY John Hays Hammond, Jr.,

Albert M. Austin

ATTORNEY

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Fig. 13

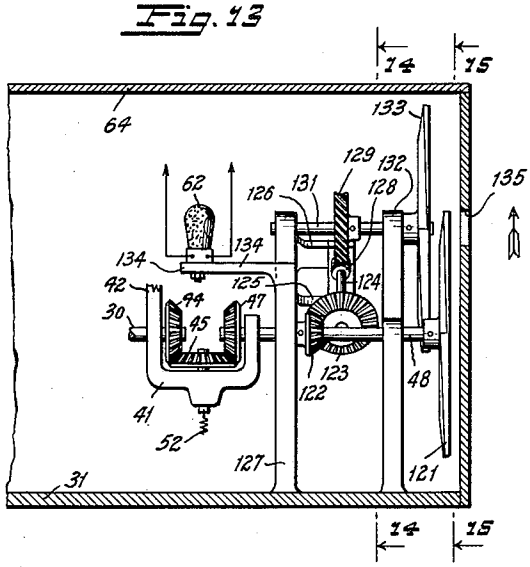



Fig. 14

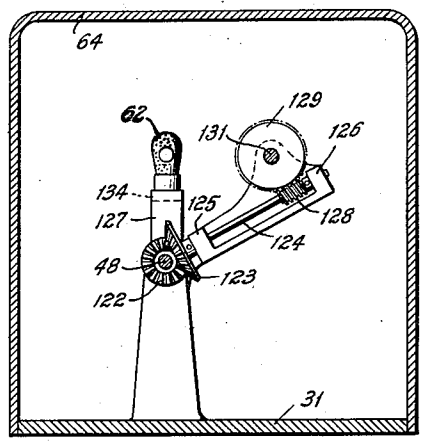



Fig. 15

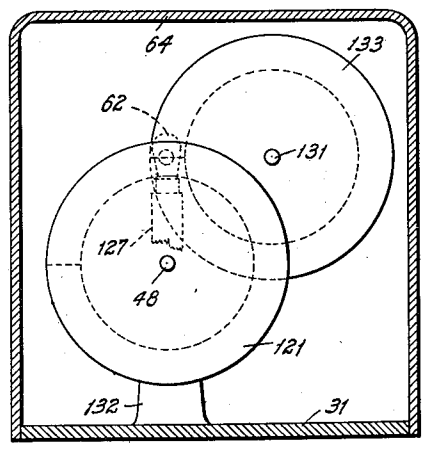



Fig. 15 A

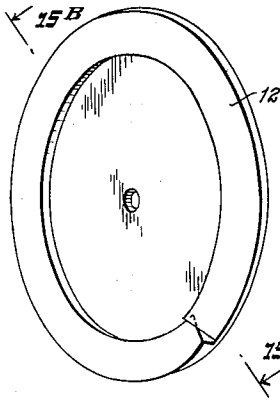



Fig 15 B




INVENTOR.

BY John Hays Hammond, Jr

Albert M. Austin

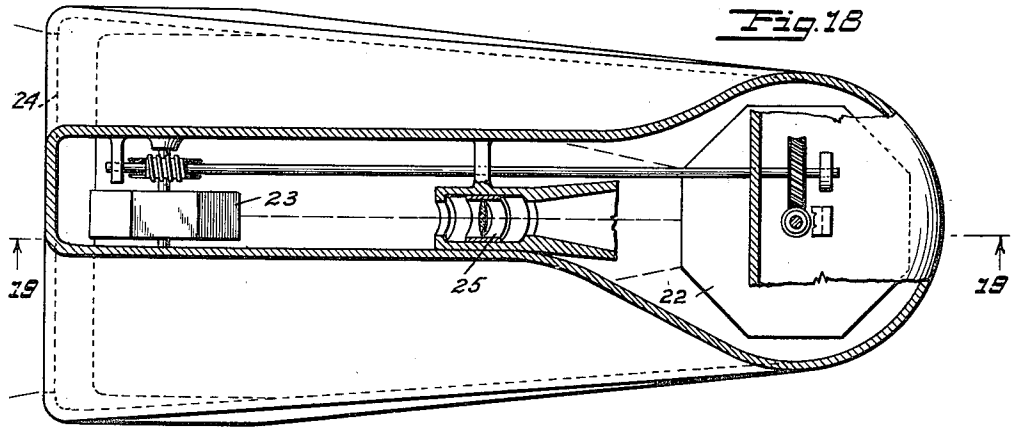
ATTORNEY

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Fig. 18



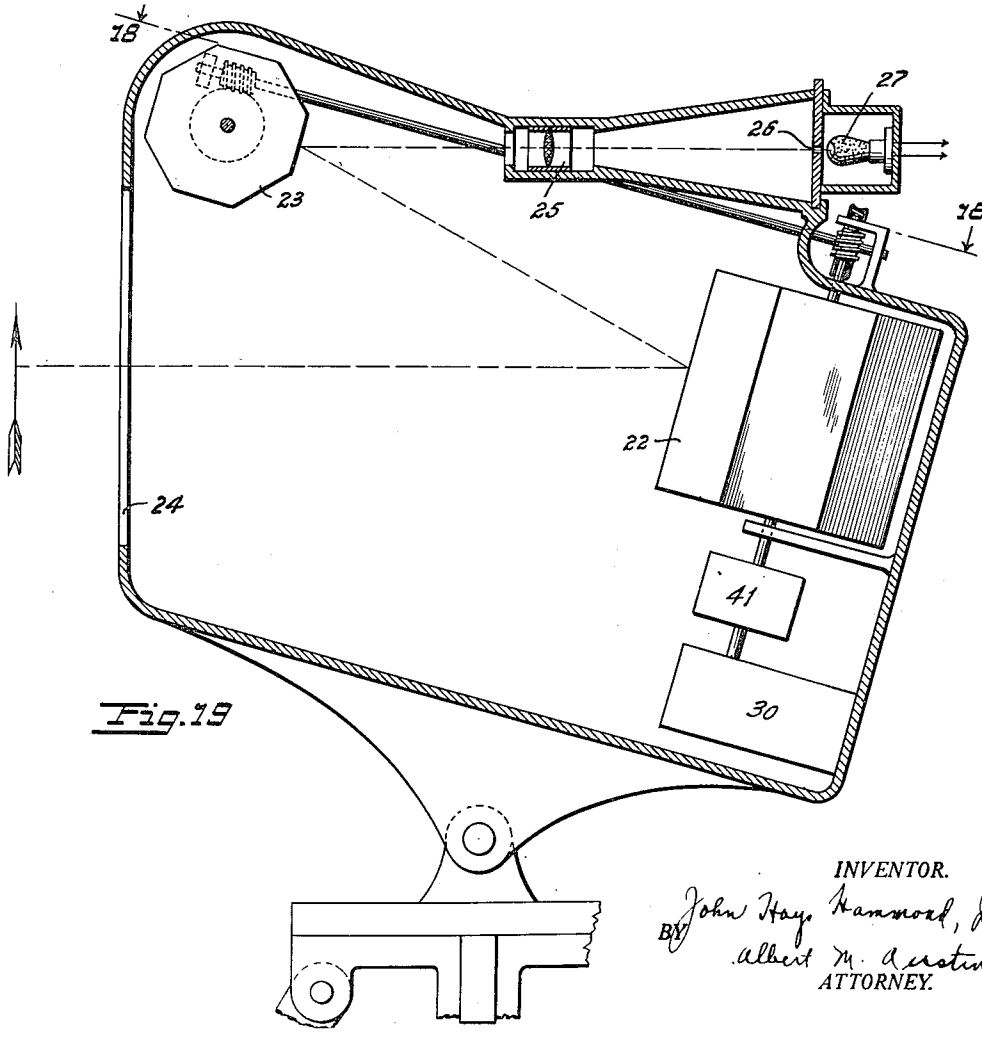




Fig. 19

INVENTOR.
BY John Hays Hammond, Jr.
Albert M. Austin
ATTORNEY.

May 23, 1933. J. H. HAMMOND, JR 1,910,540

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Fig. 20

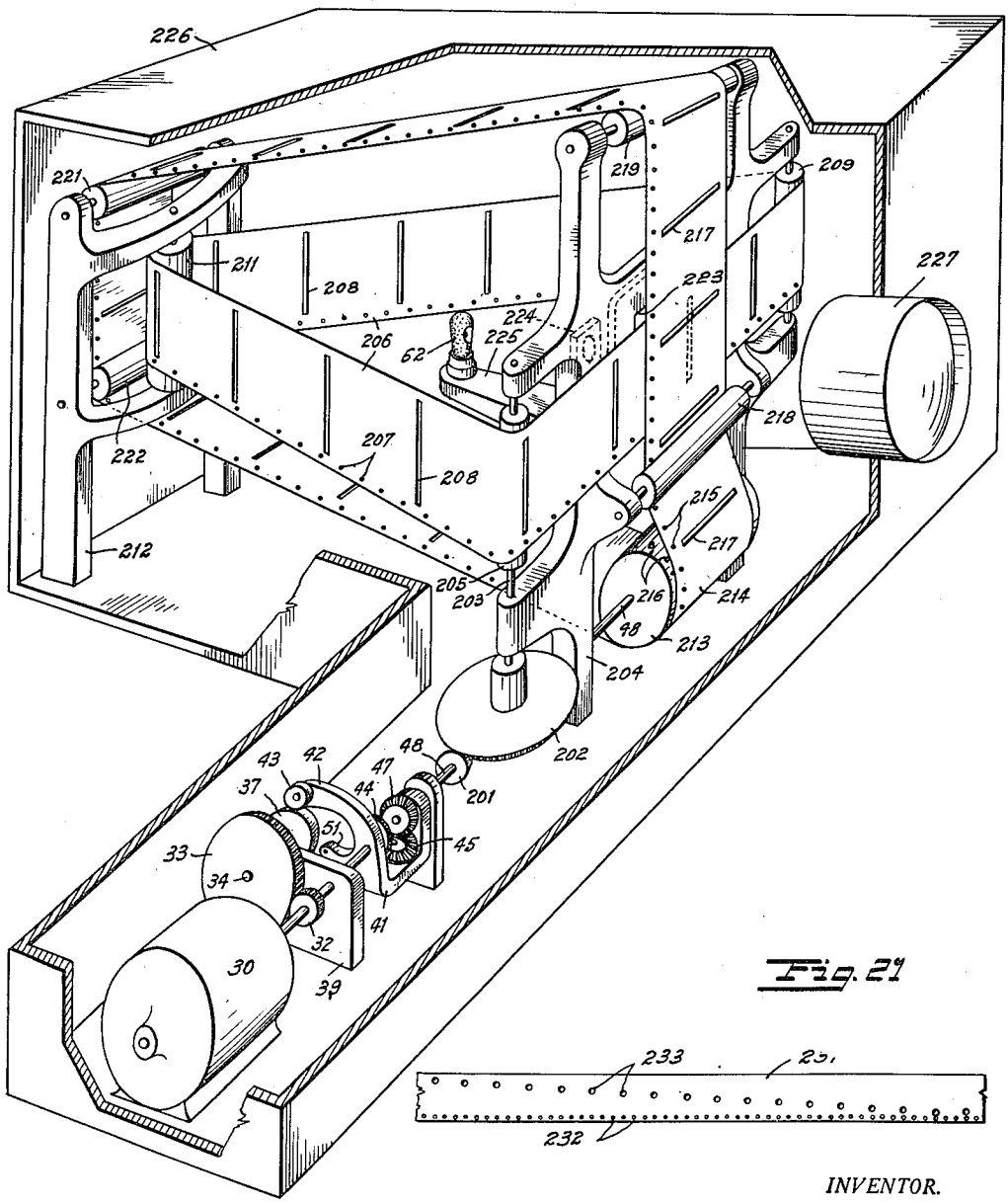



Fig. 21




INVENTOR.

BY John Hays Hammond, Jr.

Albert M. Austin

ATTORNEY

May 23, 1933. J. H. HAMMOND, JR 1,910,540

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Fig. 22

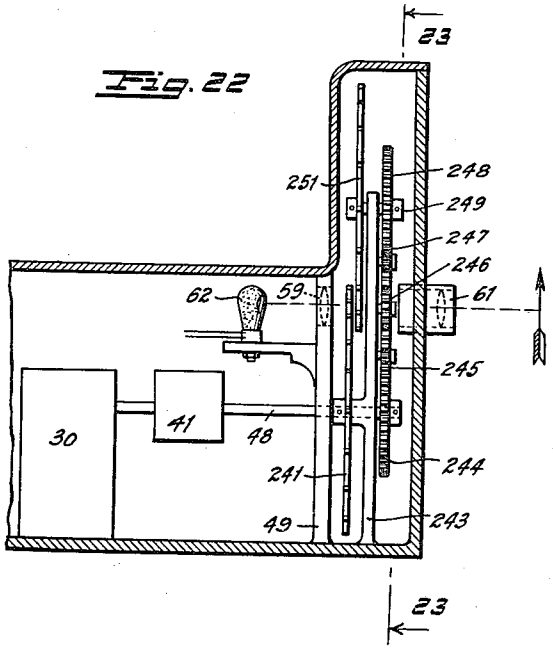



Fig. 23

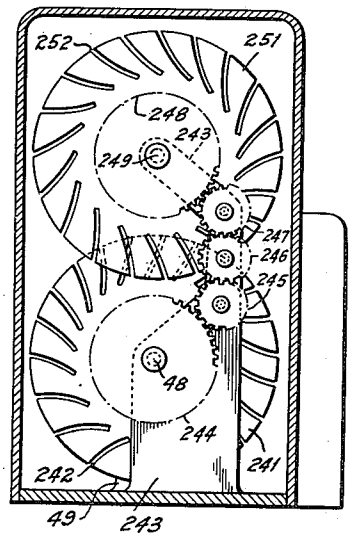



Fig. 30

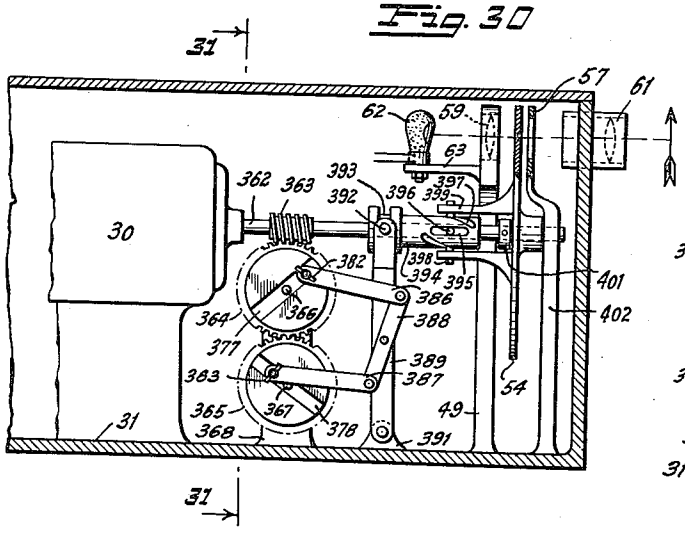
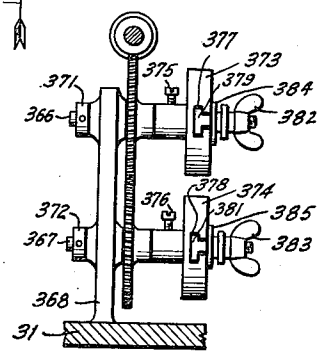



Fig. 31




INVENTOR.

BY John Hays Hammond, Jr.

Albert M. Austin

ATTORNEY

May 23, 1933. J. H. HAMMOND, JR 1,910,540

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Fig. 24

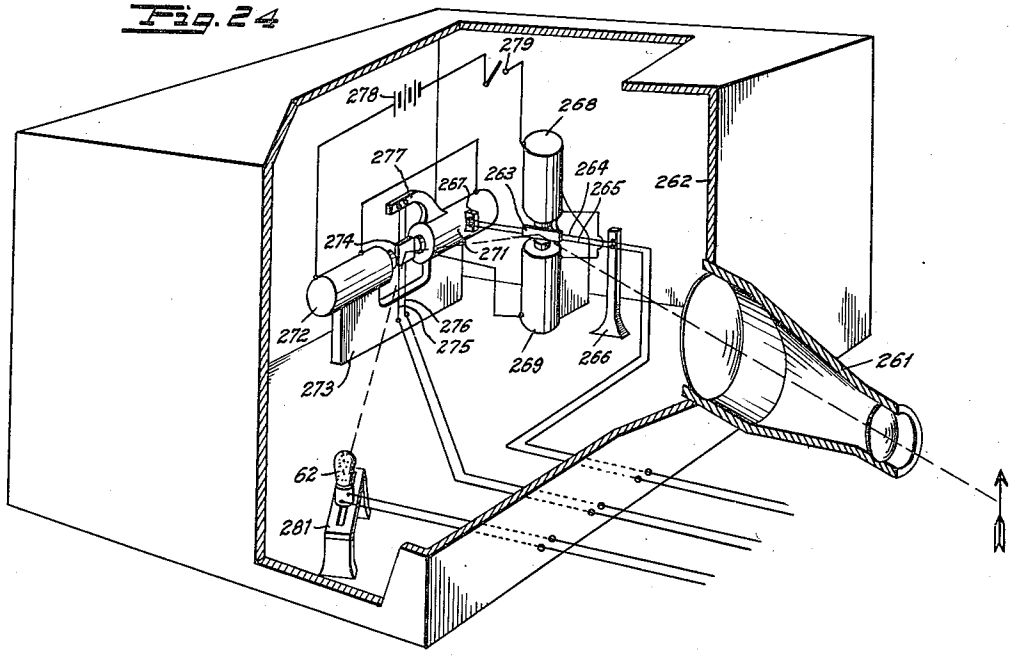
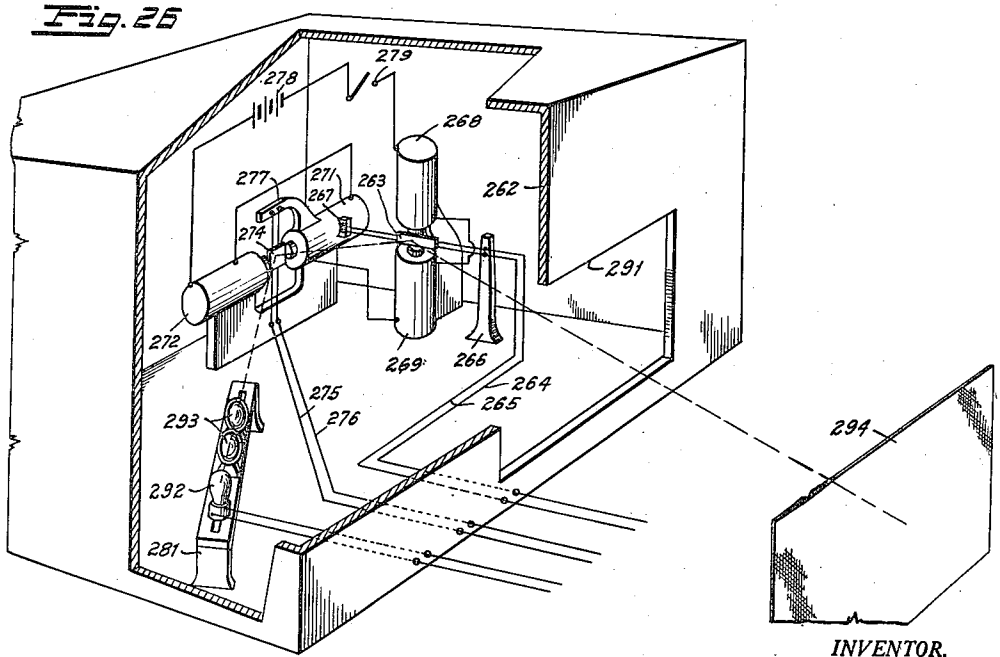



Fig. 26




INVENTOR.

BY John Hays Hammond, Jr.

Albert M. Austin

ATTORNEY

May 23, 1933. J. H. HAMMOND, JR 1,910,540

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Fig. 27

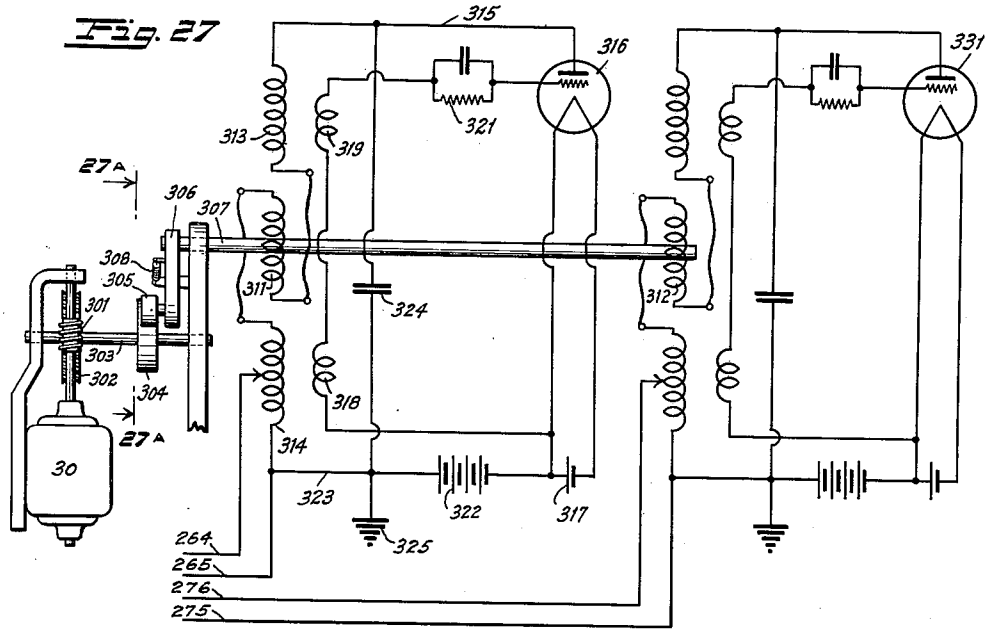



Fig. 27A

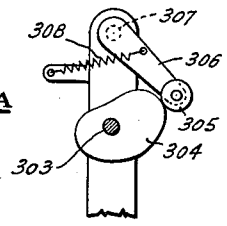
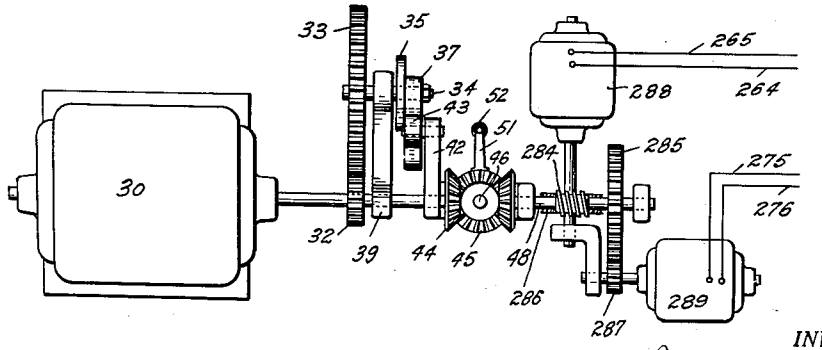



Fig. 25




INVENTOR.

BY John Hays Hammond, Jr.

Albert M. Austin

ATTORNEY.

May 23, 1933. J. H. HAMMOND, JR 1,910,540

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Fig. 28

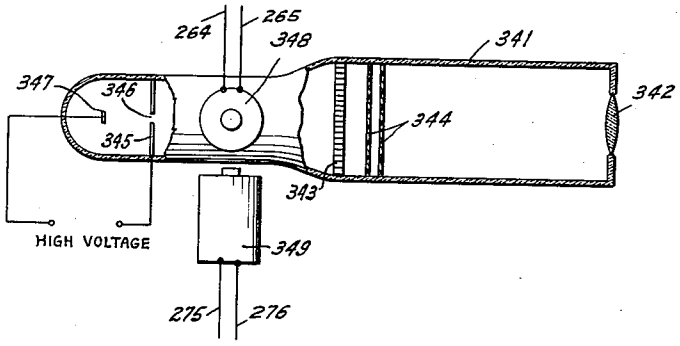
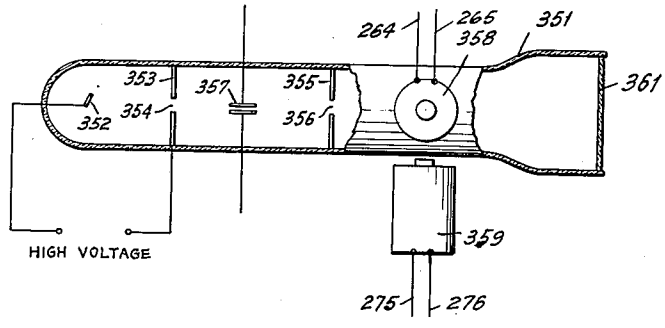



Fig. 29




INVENTOR.

BY John Hays Hammond, Jr.

Albert M. Austin

ATTORNEYS.

Patented May 23, 1933 1,910,540

# UNITED STATES PATENT OFFICE

JOHN HAYS HAMMOND, JR., OF GLOUCESTER, MASSACHUSETTS

## SECRET TELEVISION

Application filed July 3, 1929. Serial No. 375,679.

The invention relates in general to the transmission of intelligence, and more particularly, to a system for secretly transmitting pictures.

According to a preferred form of the invention a picture may be distorted at the transmitting station according to a predetermined law and transmitted by radio or other transmitting medium in its distorted form. At the receiving station the distorted picture is received and by proper devices which make use of the predetermined law by which the picture was distorted, the picture is restored to its original appearance. In this way the likeness or facsimile of the original picture is transmitted and yet it is impossible for one to receive a true likeness of the original picture if he does not know the law by which the picture was distorted.

One method for distorting the picture is to vary the rate of scanning according to some predetermined law. In other words, instead of scanning the picture in the ordinary manner, it is scanned irregularly. The variation in the scanning rate may be accomplished by direct mechanical connection to the scanning disc or other mechanical scanning device, or it may be accomplished by suitable force directly upon the scanning rays, both at the transmitting and receiving ends of the system.

The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which

Fig. 1 shows the side elevation of the system as applied to the type of the television apparatus developed by Dr. Alexanderson at the General Electric Company.

Fig. 2 is a cross section taken on line 2—2 of Fig. 1.

Fig. 3 is a section taken on line 3—3 of Fig. 1.

Fig. 4 is a fragmentary view of the side elevation of part of the apparatus.

Fig. 5 is a detail showing the lens used in the apparatus.

Fig. 6 is a detail showing the aperture for defining the extent of the picture.

Fig. 7 shows a fragmentary side elevation of a modified form of this system.

Fig. 8 shows the system as applied to the method developed by the Bell Telephone Laboratories.

Fig. 9 is a side elevation of the system as applied to a rotating disc using a spiral system of lenses.

Fig. 10 is a sectional view taken on the line 10—10 of Fig. 9.

Fig. 11 is a side elevation of the system as applied to a rotating disc using lenses set at varying angles.

Fig. 12 is a sectional view taken on line 12—12 of Fig. 11.

Fig. 13 is a side elevation of the system applied to the Jenkins system of prismatic discs.

Fig. 14 is a section taken on line 14—14 of Fig. 13.

Fig. 15 is a section taken on line 15—15 of Fig. 13.

Fig. 15—A is a perspective showing the construction of the prismatic discs in the apparatus of Fig. 13.

Fig. 15—B is a section taken on line 15B—15B of Fig. 15—A.

Fig. 16 is a side elevation of the system using a plurality of rotating mirrors set at varying angles.

Fig. 17 is a section taken on line 17—17 of Fig. 16.

Fig. 18 is a side elevation of the system using two rotating sets of mirrors.

Fig. 19 is a plan view taken on line 19—19 of Fig. 18.

Fig. 20 is a perspective view of the system using two moving belts.

Fig. 21 shows a belt which may be used to

take the place of the two belts shown in Fig. 18.

Fig. 22 is a side elevation of the system as applied to two rotating discs provided with curved slots.

Fig. 23 is a section taken on line 23—23 of Fig. 22.

Fig. 24 is a perspective view of the system using two vibrating mirrors mounted at right angles to each other.

Fig. 25 shows the two generators used for supplying current to the mechanism shown in Fig. 24;

Fig. 26 is a perspective view of the receiver used in connection with Fig. 24;

Fig. 27 is a diagrammetic view of an alternate system for producing the currents used in connection with Fig. 24;

Fig. 27—A is a section taken on line 27A—27A of Fig. 27;

Fig. 28 shows a system as applied to a cathode ray tube;

Fig. 29 is a receiver for the system shown in Fig. 28 using a Braun tube;

Fig. 30 is similar to Fig. 1, but using a different method for varying the speed of the disc; and

Fig. 31 is a section taken on line 31—31 of Fig. 30.

In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Like reference characters denote like parts in the several figures of the drawings.

In the form of invention shown in Figures 1–6, a motor 30 is mounted on a base 31. On the shaft of the motor 30 is secured a pinion 32, which meshes with a gear 33. This gear is secured to a shaft 34, to the other end of which is attached a plate 35, which is provided with a pin 36. Fitting over the shaft 34 and the pin 36 is a cam 37, which is held securely in place by means of a nut 38. The shaft of the motor 30 and the shaft 34 have bearings in a bracket 39.

Loosely mounted on the end of the shaft of the motor 30 is a yoke in form of a U-shape member 41 which is provided with an arm 42 on the end of which is mounted a roller 43, which engages the face of the cam 37. Secured to the end of the shaft of the motor 30 is a bevelled gear 44, which meshes with a second bevelled gear 45, which is loosely mounted on a stud 46 carried by the member 41. The bevelled gear 45 meshes with a third bevelled gear 47, which is secured to a shaft 48 which has a bearing in a bracket 49.

The member 41 is provided with an extension 51 to which is attached one end of a spring 52, the other end of which is secured a lug 53 forming part of the base 31. Secured to a shaft 48, is a scanning circular disc 54 which is provided with a plurality of small openings 55 arranged in the form of a spiral on the face of this disc. The outer end of the shaft 48 is supported by a bracket 56. Mounted on the top of this bracket is a plate 57 provided with a rectangular opening 58 (see Figure 6).

Mounted in the bracket 49 is a lens 59. In front of the plate 57 is mounted a lens system 61 which focuses the light received by it upon the plane of the disc 54. The lens 59 then tends to focus the light which passes through this disc upon a photoelectric cell 62, which is mounted on a projection 63 of the bracket 49. The whole apparatus is covered by a casing 64.

The receiving apparatus of this system is similar to the transmitter except that suitable light such as a neon tube takes the place of the photoelectric cell 62. This tube is lighted from amplified current received from the photo-electric cell 62 which has been transmitted either by wire or wireless to the receiving apparatus in any well known manner.

In the operation of the form of the invention shown in Figures 1–6, the motors 30 at the transmitter and receiver are run at exactly the same speed by any form of synchronization which may be found suitable for the purpose. The motor at the transmitter drives the disc 54 through the differential gears 44, 45 and 47 at such a rate that the disc makes more than 16 revolutions per second. At the same time, the pinion 32 drives the gear 33, which in turn rotates the cam 37. This causes the arm 42 to be oscillated about the axis of the motor shaft 30. As this arm is integral with the member 41, the latter will be oscillated in the same way. This oscillation will, by means of the differential action of the bevelled gears cause the disc 54 to be alternately accelerated and decelerated with respect to the uniform speed of the motor 30. This cycle of acceleration and de-celeration will be determined by the shape of the cam 37 and the ratio of the gears 32 and 33.

The light from the external scene which is focused by the lens system 61 on the plane of the disc 54 is allowed to pass through the holes 55 in this disc as it rotates and is focused upon the photoelectric cell 62. It is thus seen that the image which is focused on the disc 54 is scanned by the holes 55, thus each point of this image is successively focused upon the cell 62. The current from this cell is amplified by any suitable means and transmitted either by wire or radio to the receiving apparatus, where it is again amplified and where it controls the light emitted from the variable light sources which replaces the photoelectric cell 62 in the receiver. The light from this lamp is then passed through the lens 59 which forms it

into a parallel beam, and the holes 55 scan this beam in a manner similar to the way the holes 55 in the transmitter scan the image of the scene focuses on the disc 54. The light in the receiver which passes through the holes 55 is then projected by a suitable projector corresponding to the lens system 61 in the transmitter, upon a screen, thus reproducing the scene at the transmitter.

It is necessary that the two motors 30 of the transmitter and the receiver be run at exactly the same speed and be in exactly the same phase of relationship with each other so that the accelerations and de-celerations caused by the two identical cams 37 will produce similar cycles of acceleration and deceleration in both the transmitter and receiver discs 54.

It will be impossible for a receiving apparatus not having the proper cam 37 or a receiver of conventional form with a disc 54 mounted directly on the shaft of the motor 30 to pick up the impulses sent out from the transmitter and form them into a picture, as the cycle of acceleration and de-celeration produced in the transmitter disc 54 would cause the received picture to be distorted or scrambled so that it would be merely a blur upon the screen. It is therefore necessary that both the transmitter and receiving apparatus be provided with identical cams 37, as otherwise the pictures cannot be received properly.

In the modified form of the invention shown in Fig. 7 the photo-electric cell 62 is replaced by a powerful projector lamp 71. Mounted behind this lamp is a reflector 72. The light from the lamp and the reflector passes through a lens 73 and thence through the holes 55 in the disc 54 and passes through an aperture 74 in the casing 31. The photo-electric cell 62 in this case is mounted at the focus of a parabolic reflector 75, which is mounted on the top of the casing 64.

The operation of this system is similar to that already described, except that the light from the lamp 71 passes through the lens 73 and the holes 55 in the rotating disc 54, which cause small beams of light to be projected through the aperture 74 and on to any desired subject, such, for example, a person's face which it is desired to transmit. The light reflected from this object is then received by the photo-electric cell 62, the current from which is then amplified, as already described. This system, therefore, must be used in a dark room so that only the light reflected from the subject is received by the photo-electric cell. In practice it is usual to have a number of these cells connected in parallel and located around the aperture 74. The receiving apparatus in this system is exactly similar to that already described.

In Fig. 8 is shown a type of receiving apparatus which may be used in place of that shown in connection with Figs. 1 to 3. In this system the shaft 48 is provided with an arm 81, which is insulated therefrom and which carries a brush 82 which engages a circular contact segment 83. On the other end of the arm 81 is mounted a contact spring 84 which engages a large number of contact segments 85. These are connected by a plurality of conductors 86 to terminal points 87 located in large neon tube 88. The commutator 83 and the end of the neon tube 88 are connected to two conductors 89 and 90, which are connected to a suitable source of voltage which is varied proportionally to the energy received, and is thus proportional to the intensity of the light received by the photo-electric cell 62.

In the operation of this system the shaft 48 of the receiver follows the motion of the disc 54 of the transmitter as already described and as the arm 81 rotates the brush 84 engages successively the segments 85. As it does so, it will connect the terminals 87 in succession with the conductor 89 and as each one is connected it will cause a glow in the neon tube which will be proportional to the received current at that instant, thus the light at that point will be proportional to the light received by the transmitter from the point of the scene being transmitted. It will thus be seen that there will be produced in the glass tube 88 an image of the scene being taken up by the transmitter. This will be true as long as the two run in synchronism and the cycle of oscillation produced by the cams 37 are the same, and in phase with each other.

In the system shown in Figs. 9 and 10, the end of the shaft 48 is supported by a bracket 101 on the top of which is mounted the photo-electric cell 62. Secured to the end of the shaft 48 is a disc 102 which carries a plurality of small lenses 103. These lenses are arranged on a spiral as shown in Fig. 10. An aperture 104 is provided in the casing in line with the photo-electric cell 62. As these lenses pass behind the aperture 104 they focus the light from various parts of the scene upon the photo-electric cell 62, so as to cause this to be illuminated successively by the light from every point of the scene.

This transmitter may be used in connection with the type of receiver shown in Figs. 1 to 3, or it may be used in a receiver similar to the transmitter shown in Figs. 9 and 10, in which the photo-electric cell 62 is replaced by a variable light source as already described.

In the system shown in Figs. 11 and 12, a disc 111 is mounted on the end of the shaft 48, and is provided with a plurality of small lenses 112, which are mounted circularly on the disc, but each individual lens is mounted at a slight angle to the axis of the shaft 48, so that as these lenses pass in front of the aperture 104, they will cause the light from

every point of the scene to be focused on the photo-electric cell 62. The system, in other respects, is similar to that described in Figs. 9 and 10.

In the system shown in Figs. 13, 14, 15, 15—A and 15—B, the shaft 48 carries a prismatic disc 121 which is of the type used by Jenkins in his picture transmission systems. Secured to the shaft 48 is a bevelled pinion 122 which meshes with a bevelled gear 123, mounted on a shaft 124 which has bearings 125 and 126 carried by a bracket 127. To the other end of the shaft 124 is secured a worm 128 which meshes with a worm-wheel 129. This worm-wheel 129 is mounted on a shaft 131, which has bearings in the brackets 127 and 132. To the end of the shaft 131 is secured a second prismatic disc 133, which is similar in construction to the prismatic disc 121.

The photo-electric cell 62 is mounted on an arm 134, which forms part of the bracket 127. The photo-electric cell 62 is located in line with the axis formed by the intersection of the two center lines of the prismatic rings 121 and 133. An opening 135 is located in front of this axis. In the operation of this system the prismatic disc 121 is rotated at the speed of a shaft 48, and the prismatic disc 133 is rotated at a much slower speed through the gear reduction 122—123 and 128—129. These two discs, as they rotate, cause the light to be picked up from each point of the field and focused upon the photo-electric cell 62.

In the receiver a similar construction is used except that the photo-electric cell 62 is replaced by a variable light source and optical system as described in connection with Figs. 1 to 3. In this way the discs 121 and 133 at the transmitter and receiver are run at the same speed, and are varied in speed at the same time and by the same amount, so that the image produced at the receiver will be a reproduction of that seen at the transmitter.

In the system shown in Figs. 16 and 17, the shaft 48 carries a drum 141, on which is mounted a plurality of small mirrors 142, each of which is mounted at a slightly different angle. Mounted on a bracket 143 is an adjustable frame 144, in which is mounted a lens system 145, which focused the light from the mirror 142 on the photo-electric cell 62, which is adjustably mounted on a bracket 143. The shaft 48 is supported by brackets 146 and 147 from the base 31. A case 148 covers the apparatus, and is provided with an opening 149 which allows the light from the external scene to fall on the mirrors 142.

In the operation of this system the shaft 48 is driven in a manner similar to that described in connection with Figs. 1 to 3, and the light from the external scene passes through the opening 149 and falls upon the rotating mirrors 142 from which it is reflected to the lens system 145, and focused upon the photo-electric cell 62. As each mirror passes in front of the opening 149, it takes the light from successive points on a vertical line of the scene, and focuses it on the photo-electric cell 62. As the normal through the center of each mirror passes through a different point on the axis of rotation of the drum 141, the light reflected by the successive mirrors to the lens 145 will be from successive vertical lines of the scene, and in this way each point of the scene will be swept over during one rotation of the drum 141. The receiver will be of similar construction, except that the photo-electric cell and lens 145 will be replaced by a fluctuating source of light and a suitable optical system for focusing this light upon the mirrors 142.

Figs. 18 and 19 show a system using two rotating mirrors with their axes at right angles to each other. The two sets of mirrors 22 and 23 of Fig. 18 are rotated at different speeds, 22 running at a high speed and 23 at a much slower speed. The light from the scene which passes through the opening 24 is reflected from the faces of the rapidly rotating mirror 22 to the faces of the slowly rotating mirror 23, and thence to the optical system 25 which focuses the light upon the hole 26 through which it passes to fall upon the photo-electric cell 27, which in this case would be the same as the photo-electric cell 62 of Figure 1.

In the operation of this system the light is picked up successively from various points of the scene by means of these two rotating mirrors, so that each time one face of the mirror 22 passes in front of the opening 24 it will reflect the light from the points of a horizontal line to one face of the mirror 23. The next face of the mirror 22, as it passes in front of the opening 24 reflects light from the points of the next line below of the scene as the mirror 23 has moved through a slight angle, while a new face, 22, has moved into position. In this way, light from every point of the scene is successively focused on the photo-electric cell, from which it is transmitted as already described, to the receiving apparatus which is similar to that shown in Fig. 18 except that the photo-electric cell and the hole 26 are replaced by a fluctuating source of light and a suitable optical system for focusing this light upon the mirrors and thence upon the screen.

In the system shown in Fig. 20, the motor 30 and variable speed mechanism connected therewith are the same as that shown in Figs. 1 to 3. In this case, the shaft 48 is provided with a bevelled pinion 201, which meshes with a bevelled gear 202. This gear is

mounted on a shaft 203 which has a bearing in a frame-work 204. Secured to the shaft 203 is a roller 205 over which passes an endless belt 206, which is provided with perforations 207, which engage pins not shown on the roller 205. The roll 206 is also provided with transverse slots 208. This belt passes over two other rollers 209 and 211 which are supported in the frame 204 and a secondary frame 212.

On an extension of the shaft 48 is mounted a drum 213, over which passes an endless belt 214, which is provided with perforations 215, which engage pins 216 mounted on the drum 213. The roll 214 is also provided with transverse slots 217. This belt passes over two rollers 218 and 219, mounted in the frame 204 and two rollers 221 and 222, mounted in the frame 212. An opening 223 is provided in the frame 204 behind the place where the slots 208 and 217 intersect. Mounted behind this opening is a lens 224, which focuses the light which passes through the slots upon the photo-electric cell 62. This cell is adjustably mounted on an arm 225, which is carried by the frame 204.

The whole apparatus is covered by a casing 226 in the front wall of which is mounted a lens system 227, which forms an image of the outside scene on the face of the belt 214 at the place where it passes over the belt 206.

In the operation of the form of the invention shown in Fig. 20, the motor 30 is run at a constant speed, which causes the shaft 48 to run at a variable speed as already described in connection with Figs. 1 to 3. This causes the belt 214 to run at a high speed. The belt 206 is run at a low speed through the gear reduction 201—202. As each slot 217 in the belt 214 passes in front of a slot 208 in the belt 206, it will scan a line of the image formed by the lens 227 on the face of the belt 214. Each successive slot in the belt 214 will scan a different line of the image as the slot 208 in the belt 206 moves slowly across the image. In this way the image is completely scanned every time the belt 214 makes a complete revolution and a slot 208 moves across the opening 223. The light which passes through the opening formed by the intersection of the two slots is focused on the photo-electric cell 62 by means of a lens 224. The current from the photo-electric cell 62 is then amplified and transmitted by any suitable means to the receiver where it is again amplified and controls the intensity of the light source. The light is projected through a suitable lens system and is then caused to follow a zig-zag path by means of the two slots in the belts of the receiver. This light is then projected on a screen where it reproduces the scene at the transmitter.

In Fig. 21 is shown a belt 231, which may be used to replace the belt 214 in which case it is not necessary to use the belt 206. In this form of apparatus this belt 206, together with the rollers 205, 209, and 211, together with the bevelled gears 201 and 202 may be dispensed with. The belt 231 is provided with a set of perforations 232 along the edge, which are engaged by the pins 216 on the roller 213. This belt is also provided with a series of perforations 233, which run diagonally across the belt.

When this belt is moved rapidly in front of the lens 224, it scans the image of the scene produced by the lens system 227, and causes the light from each point of the scene to be focused upon the photo-electric cell 62. In this way the scene is scanned during each complete revolution of the belt 231. The receiving apparatus is similar to the transmitter except that the photoelectric cell 62 is replaced by the variable light source in a similar manner as that described in connection with the first system.

Figs. 22 and 23 show the system as applied to two slotted scanning discs. In this form of invention, the shaft 48 carries a disc 241, which is provided with curved slots 242 near the periphery. The shaft 48 is journalled in a bracket 243, and has secured to its end a gear 244. This gear meshes with the first of a train of three small gears 245, 246 and 247, the last of which meshes with a gear 248, which has one less tooth than the gear 244, The gear 248 is secured to a shaft 249, which is journalled in the bracket 243, and has mounted on its other end a disc 251, which has a plurality of curved slots 252 near its periphery.

The two sets of slots 242 and 252 intersect at a point behind the lens system 61, and in front of the lens 59. These slots are so shaped that when the two discs are rotated in the same direction, and at nearly the same speed, the disc 251 running at a slightly faster speed than the disc 241, will cause the image to be scanned so that the light from each point of the image will pass through the lens 59 and be focused on the photo-electric cell 62, and thence transmitted as already described. The receiver is similar in construction, except that the photo-electric cell and lens system are replaced by a variable intensity light and a suitable projector system, as already described with previous figures.

In the transmitting system shown in Figures 24 and 25, the lens system 261 is mounted in the front of a casing 262, and forms a small image of the external scene on a mirror 263, which is mounted on two fine wires 264 and 265. These wires are supported on one side by a bracket 266, and on the other side by a plate 267. Mounted adjacent to a mirror 263 are two electro-magnets 268 and 269. The plate 267 is mounted on one of two electro-magnets 271 and 272, which are supported on a frame 273. Between these magnets is mounted a small mirror 274, which is sup-

ported on two fine wires 275 and 276. These wires are supported from the frame 273 and a bracket 277. The windings of the magnets 268, 269, 271 and 272 are connected in series, with a battery 278 and a switch 279. The photo-electric cell 62 is slidably mounted on a base 281, and is connected to the transmitting system as previously described.

In Fig. 25 is shown the motor 30, together with the variable speed mechanism which is the same as that shown in Fig. 1, and will not be more fully described herewith. Mounted on the shaft 48 is a worm 284 and a gear 285. The worm 284 meshes with a worm wheel 286, and the gear 285 meshes with a pinion 287. The worm wheel 286 is mounted on the shaft of an alternator 288 and the pinion 287 is mounted on the shaft of a high frequency alternator 289. The out-put circuit of the alternator 288 is connected to the conductors 264 and 265.

When the motor 30 is run at a constant speed, the shaft 48 will be run at a variable speed, as described in connection with Fig. 1. This will cause the alternators 288 and 289 to run at variable speeds, the alternator 288 at a comparatively slow speed, the alternator 289 at a comparatively high speed. The alternator 288 will therefore produce a low frequency current in the wires 264 and 265, and the alternator 289 will produce a high frequency current in the wires 275 and 276. These currents, flowing through the wires, will cause the two mirrors 263 and 274 to vibrate at a low and a high frequency respectively. This double motion will cause a scanning of the scene between the two mirrors, which will reflect light successively from each point of the scene to the photo-electric cell 62.

Fig. 26 shows the receiver which is similar in construction to the transmitter, except that the lens system 261 is replaced by an opening 291, and the photo-electric cell is replaced by a variable intensity lamp 292, and a condensing lens system 293. The conductors 264, 265, 275 and 276 are connected to two alternators similar to those described in connection with Fig. 25. In the operation of this system, the two motors 30 at the transmitter and the receiver are run at the same speed, thus causing the two alternators 288 and 289 to be run at the same variable speeds, which produces alternating currents of similar frequencies in the conductors 264—265 and 275—276. This causes the two mirrors 263 in the transmitter and the receiver to vibate in synchronism at a low speed, and the two mirrors 274 at the transmitter and the receiver to vibrate in synchronism at a high speed. This causes the light from the variable intensity lamp 292 to be thrown on a screen 294, so as to reproduce the image of the scene at the transmitter.

Fig. 27 shows an alternate scheme for producing the high frequency currents supplied to the conductors. On the shaft of the motor 30 is mounted a worm 301, which meshes with the worm wheel 302 mounted on a shaft 303. Secured to this shaft is a cam 304 on the face of which rides a roller 305, which is mounted on the end of an arm 306. This arm is secured to one end of a shaft 307. The roller 305 is held in engagement with the cam 304 by means of a spring 308. Secured to the shaft 307 are two coils 311 and 312. The coil 311 rotates between two stationary coils 313 and 314. The coils 313, 311 and 314 are connected in series the other end of the coil 313 being connected by a conductor 315 to a plate of a vacuum tube 316. The filament of this tube is connected across a battery 317. One side of this battery is connected through two coils 318 and 319 and a grid leak 321 to the grid of the tube 316. One side of the battery 317 is connected to one side of a battery 322, the other side of which is connected by a conductor 323 to the coil 314. Connected between the conductors 315 and 323 is a condenser 324. The conductor 323 is connected to a ground 325. The conductors 264 and 265 are connected respectively to a tap of the coil 314 and to the conductor 323.

The coil 312 is connected in a similar manner to a second vacuum tube oscillator 331. The conductors 275 and 276 are connected in a similar manner to the conductors 265 and 264. In the operation of this form of the invention the motor 30 at the transmitter and receiver are run in synchronism, thus causing the two cams 304 to rotate at exactly the same speed. As these cams rotate the arm 306 will be oscillated in a similar manner, thus oscillating the coils 311 and 312. This will cause the frequency of the vacuum tube oscillators 316 and 331 to be varied in a similar manner, thus producing variations in the frequency of the currents supplied to the conductors 264—265 and 275—276. This will cause the transmitter and receiver to function as described with Figs. 24 to 26.

The system shown in Fig. 28 consists of a tube 341 in one end of which is mounted a lens 342 which produces an image of the external scene upon a screen 343, which is made up of a plurality of small metallic cubes, made of some such metal as rubidium which are insulated from each other. The chamber between the lens 342 and the screen 343 is filled with a suitable gas, such as sodium vapor. Located in front of the screen 343 are two parallel screens of metallic gauze 344. The portion of the tube to the left of the screen 343 is evacuated, and contains an anode plate 345, provided with a small hole 346. Mounted in the end of the tube is a cathode 347. This cathode and the plate 345 are connected to a suitable source of high voltage of, say 100,000 volts D. C. Located

adjacent to the tube 341 are two electro magnets 348 and 349. The winding of the magnet 348 is connected to the conductors 264 and 265, and the winding of the magnet 349 is connected to the conductors 275 and 276, of either Fig. 25 or 27.

The receiver (Fig. 29) consists of a Braun tube 351. In this tube is mounted a cathode 352, which is inclined at a slight angle, and an anode plate 353 provided with a small opening 354. Across the cathode 352 and anode 353 is a source of high voltages, such as 100,000 volts, D. C. A second plate 355, provided with a small aperture 356, is mounted further down the tube. Between the two plates 353 and 355 are mounted the plates of a condenser 357. Mounted adjacent to the tube 351 are two electromagnets 358 and 359. The magnet 358 is connected by the conductors 264 and 265 to the transmitter apparatus (Fig. 28), and the magnet 359 is connected to Fig. 28 by the conductors 275 and 276. At the end of the tube 351 is mounted a fluorescent screen 361.

In the operation in the form of the invention shown in Figs. 28 and 29 the high voltage between the cathode 347 and the anode 345 produces a stream of electrons from the cathode which pass through the aperture 346 and strike the screen 343. The alternating currents passing through the magnets 348 and 349 cause the stream of electrons to be deflected from its straight course, and make it follow a zigzag course over the screen 343, thus striking successively each one of the cells of which this stream is composed. Thus each one of these cells is negatively charged each time that the electron stream passes over it. The whole screen is passed over by the electron stream in less than $\frac{1}{16}$th of a second.

The lens 342 forms an image of the external scene upon the righthand face of the screen 343. The light from the external scene falling on the cells of the screen 343 cause each one to be discharged an amount, proportional to the intensity of this light, so that as the electron stream passes over each cell the amount of electricity necessary to charge this cell to its normal potential is proportional to the intensity of light falling upon the opposite side of the cell. Due to the sodium vapor in the tube 341, this fluctuation causes a variation in potential between the metallic gauze 344 and the screen 343. This variation of potential is amplified by any suitable means, and is transmitted to the receiver either by wire or wireless, where it is again amplified and delivered to the plates of the condenser 357. In the receiver Fig. 29 a stream of electrons will pass from the cathode 352 through the opening 354 of the anode 353, and between the plates of the condenser 357 and will strike the plate 355 below the opening 356 due to the fact that the cathode 352 is slightly inclined to the vertical.

As the stream of electrons passes between the plates of the condenser 357 it will be deflected in an amount proportional to the charge on these plates, so that as the potential of the condenser is increased, a greater amount of electrons will pass through the aperture 356 and will strike the fluorescent screen 361. In this way the amount of light emitted by the fluorescent screen 361 is proportional to the number of electrons striking this screen, which is proportional to the charge on the condenser 357. This in turn is proportional to the difference of potential between the gauze 344 and the screen 343, which depends upon the intensity of illumination of each one of the individual cells of the screen 343. When the alternating currents pass through the magnets 358 and 359, they cause the electron stream to be deflected, causing it to follow a zigzag path over the screen 361, which is similar to the path followed by the electron stream over the screen 343. In this way the fluorescent screen 361 is at each point illuminated an amount proportional to the light received on the screen 353 from the external scene at that point so that there will be produced on the fluorescent screen 361 an image of the external scene viewed by the transmitter in Fig. 28.

It is necessary in this case as well as in the previous system that the alternating currents supplied to the magnets 348—349 and the magnets 358—359 be synchronized and in phase, and also be varied in a similar manner as otherwise it would be impossible for the receiver to unscramble the picture sent by the transmitter. Any system can be used for producing these alternating currents such, for example, as that shown with Figs. 25 and 27.

In Figs. 30 and 31 is shown a system similar to that shown in Figs. 1 to 3, except that a different means is used for causing the variable motion required. In this system the motor 30 is mounted on the base 31, and is provided with a shaft 362, on which is mounted a worm 363. This worm meshes with a gear 364, which meshes with a second gear 365. These two gears are secured to two shafts 366 and 367 respectively. These shafts are journalled in a bracket 368, which is mounted on the base 31. Collars 371 and 372 are secured to the shafts 366 and 367 respectively, and hold them in their proper positions. Adjustably mounted on the shafts 366 and 367 are two circular plates 373 and 374 which are secured to their respective shafts by means of set screws 375 and 376. Each plate is provided with a T slot 377 and 378, in which slide T shaped members 379 and 381. These members are threaded at their ends, and on them are screwed wing

nuts 382 and 383, which are clamped against washers 384 and 385.

Rotatably mounted on the wing nuts 382 and 383 are two levers 386 and 387, the other ends of which are pivoted to a lever 388 which is pivoted at its middle point to an arm 389 which is pivoted at its lower end to a bracket 391 which is carried by the base 31. The upper end of this arm is Y shaped, and carries two pins 392, which slide in a slot 393 provided in a sleeve member 394, which is slidably but not rotatably mounted on the shaft 362. This member is provided with two straight slots 395, in which slide a pin 396 carried by the shaft 362, and with two curved slots 397 in which slide two pins 398 carried by two brackets 399, which are secured to the perforated disc 54. This disc is loosely mounted on the shaft 362, and is held in position by means of a collar 401 pinned to this shaft. The outer end of the shaft 362 is supported by a bracket 402 on the top of which is mounted the plate 57. In front of this is mounted the lens system 61, and behind the disc 54 is mounted the lens 59 and the photo-electric cell 62. In the operation of the form of the invention shown in Figs. 30 and 31 the T shaped members 377 and 381 are located in any desired position in the slots 377 and 378 and are clamped in these positions. The plates 373 and 374 are then rotatably adjusted on the shafts 366 and 367 to any desired position and are clamped there by means of the set screws 375 and 376. The motor 30 is then started and run at a constant speed. This causes a rotation of the shaft 362, which in turn rotates the member 394 by means of the pin 396. This, in turn, causes a rotation of the disc 54 by means of the pins 398 and the brackets 399.

At the same time, the worm 363 causes a slow rotation of the plates 373 and 374, which causes the levers 386 and 387 to be moved back and forth. This in turn causes an oscillation of the lever 388, which causes the lever 389 to oscillate. This causes the member 394 to be moved back and forth along the shaft 362, which, by means of the slots 397, causes the disc 54 to be alternately accelerated and decelerated above and below the speed of the shaft 362, thus producing a motion similar to that of the disc 54 in Figs. 1 to 3.

The receiver is similar in construction to the transmitter, except that the photo-electric cell 62 has been replaced by a variable intensity light, and the lenses 59 and 61 are replaced by a suitable projector lens system. The T shaped members 379 and 381 are then located in exactly the same positions as the similar members at the transmitter, and the discs 373 and 374 are adjusted to the same relative positions as those in the transmitter. The motor 30 of the receiver is then run in synchronism with the motor at the transmitter by any suitable means and the current from the photo-electric cell 62 is amplified and transmitted to the variable intensity lamp at the receiver.

The rest of the operation of the mechanism is similar to that shown in Figs. 1 to 3.

While certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. Apparatus for the secret transmission of pictures comprising a constant speed driving element, a first bevel gear driven thereby, a second bevel gear in axial alignment with said first bevel gear, scanning means driven by said second bevel gear, a yoke, a third bevel gear mounted on said yoke and meshing with said first and second gears, a cam driven by said driving element, a follower on said yoke cooperating with said cam to oscillate said third gear about the axis of said first and second gears, whereby said scanning means is driven at an irregular speed.

2. Apparatus for secret transmission of living pictures comprising a scanning disc, means to cause said disc to scan a field and means for varying the angular speed of rotation of said disc according to a secret law, said last means including a cam of predetermined shape corresponding to the secret law.

3. Apparatus for the secret transmission of intelligence comprising a constant speed driving element, a first gear driven thereby, a second gear, a variable speed driven element driven by said second gear, transfer gearing between said gears, a cam, and means controlled by said cam for periodically shifting the position of said transfer gearing.

In testimony whereof I have hereunto set my hand.

JOHN HAYS HAMMOND, JR.