Dec. 12, 1933. F. KUNC 1,939,215

PHOTO ELECTRIC KEYING HEAD

Filed May 24, 1933 4 Sheets-Sheet 1

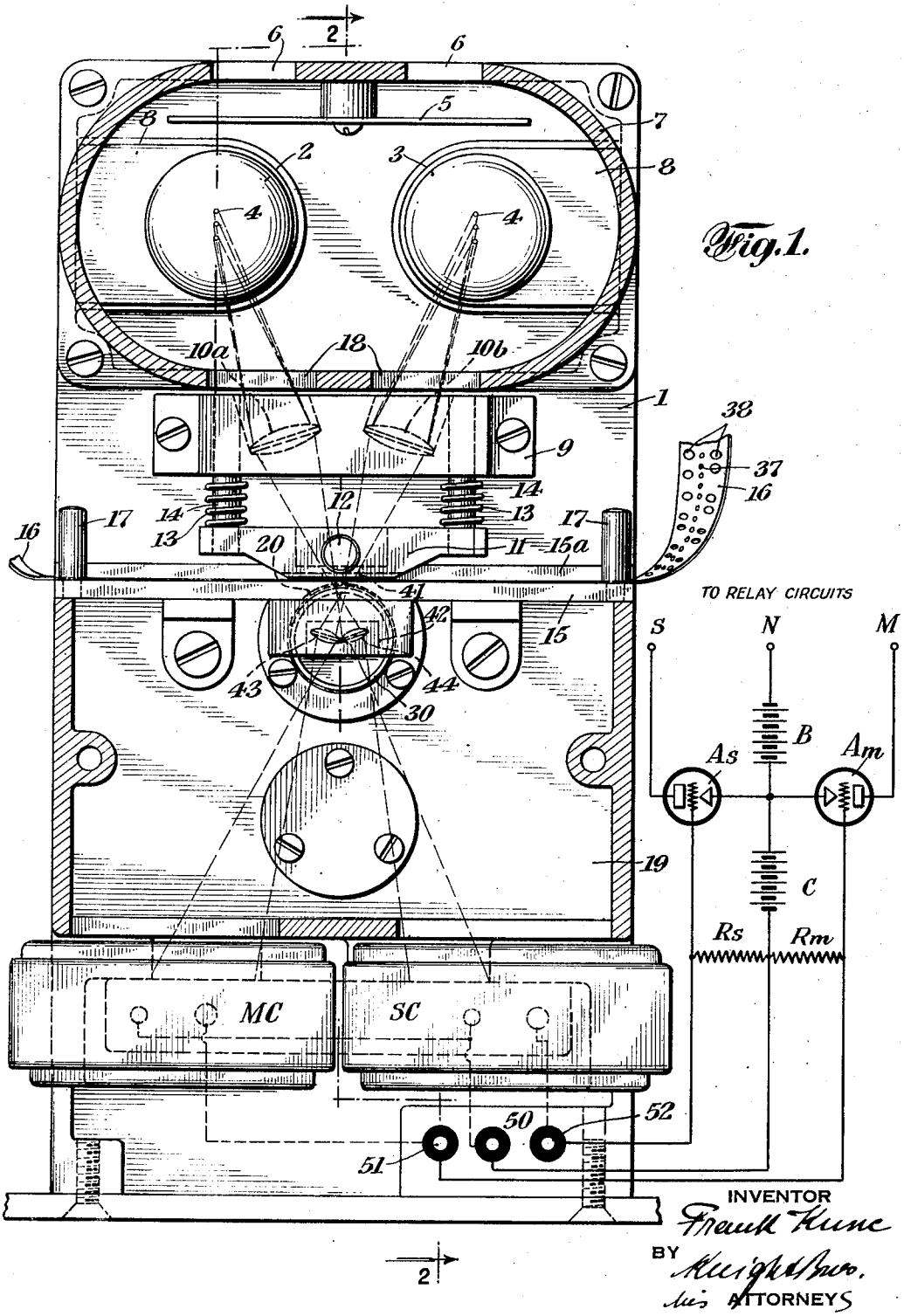

Fig. 1.

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PHOTO ELECTRIC KEYING HEAD

Filed May 24, 1933 4 Sheets-Sheet 2

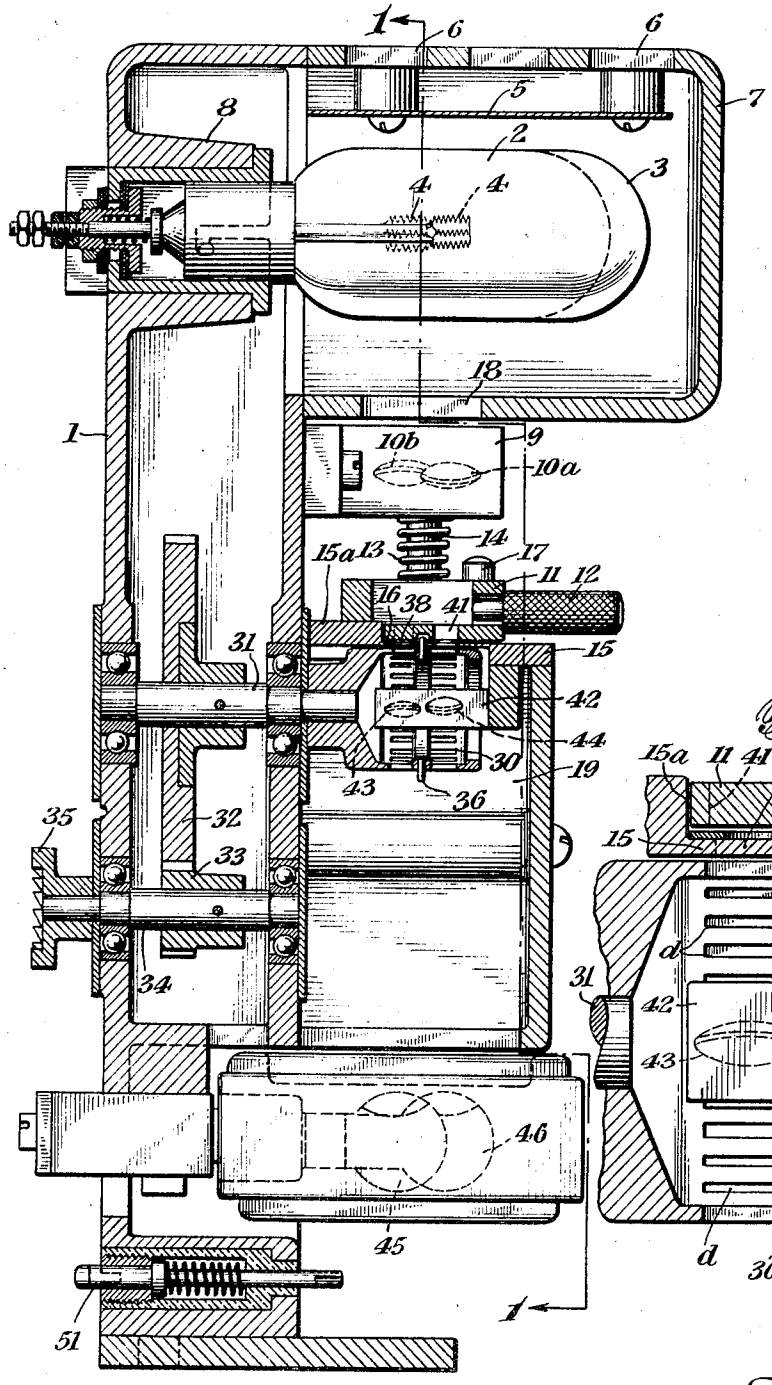

Fig. 2.

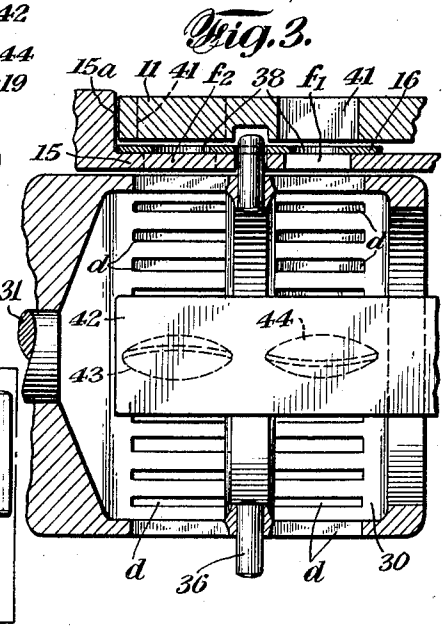

Fig. 3.

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PHOTO ELECTRIC KEYING HEAD

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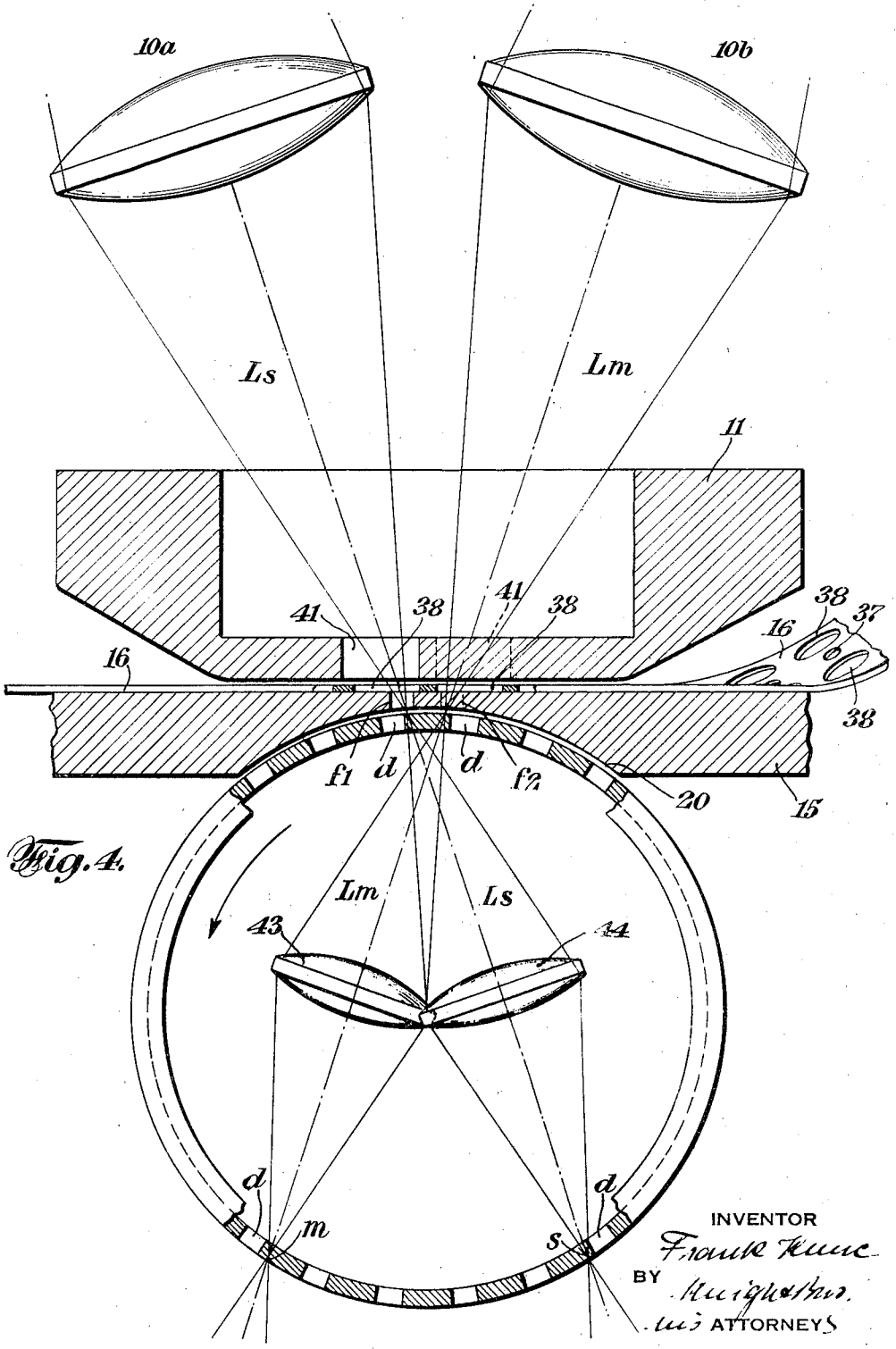

Fig. 4.

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PHOTO ELECTRIC KEYING HEAD

Filed May 24, 1933 4 Sheets-Sheet 4

Fig. 5a.

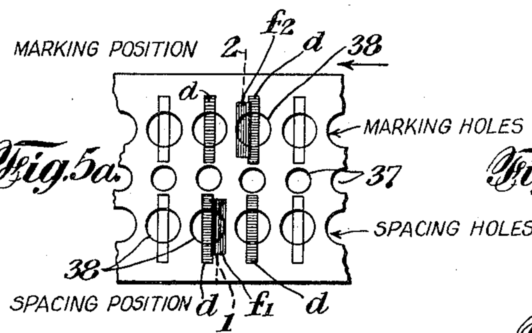


Fig. 6a.

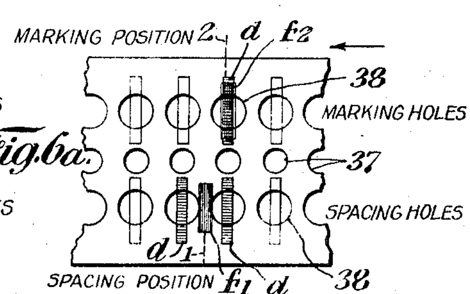


Fig. 5

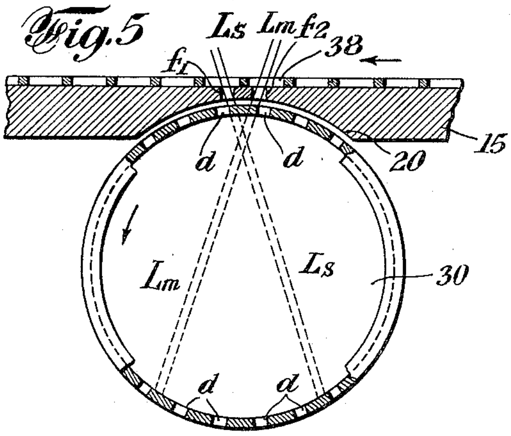


Fig. 6.

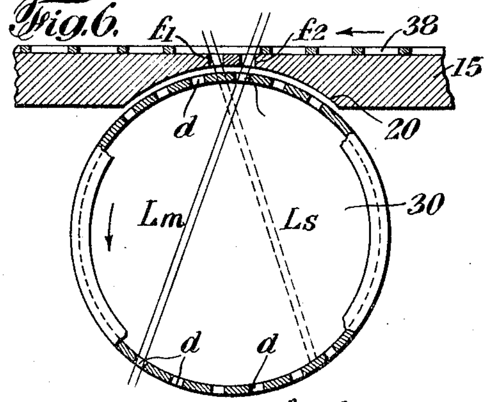


Fig. 8a

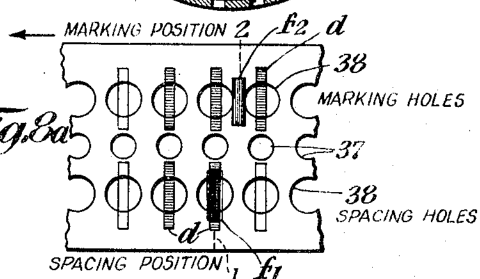


Fig. 7a

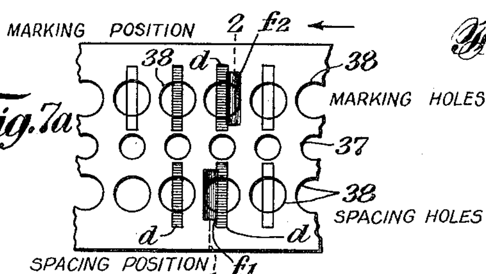


Fig. 8.

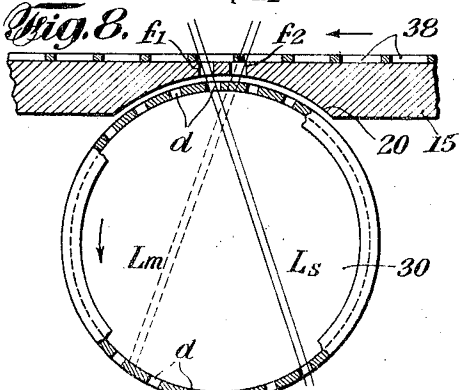
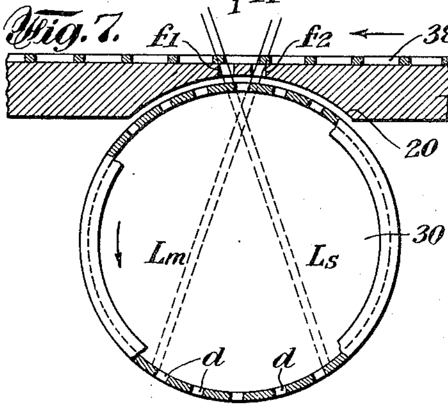


Fig. 7.



INVENTOR

Frank Kunc

BY

[signature]

his ATTORNEYS

Patented Dec. 12, 1933 1,939,215

UNITED STATES PATENT OFFICE

1,939,215

PHOTO-ELECTRIC KEYING HEAD

Frank Kunc, New Rochelle, N. Y., assignor to H. O. Boehme, Inc., New York, N. Y., a corporation of New York

Application May 24, 1933. Serial No. 672,566

18 Claims. (Cl. 178—17)

My invention relates broadly to the precise control of a light beam by means of perforations in a tape, travelling across the path of the beam. In particular my invention relates to keying heads principally used for telegraphic purposes, and in which the current impulses to be transmitted are controlled by certain well-known combinations of holes, punched into a tape. In this particular art this control operation by the hole combinations was heretofore exerted by way of mechanical contact elements controlled in their movements by the hole combinations. Attempts have been also made in the past to control beams of light—acting in turn upon photo-electric cells—directly by aforementioned hole combinations by using the tape perforations to permit the beam of light to strike the photo cell when a tape perforation passes the path of the beam, and to shut the beams off the cell by the unperforated tape portions.

With this mode of direct tape control of a light beam certain disadvantages arise which have heretofore resulted—especially at the modern high operating speeds of the tape, such as 200 words per minute and over—in lack of a clear definition of the individual impulses of which the individual signal characters, such as dots and dashes, are composed. This is largely due to the fact that in the accepted conventional forms of perforated tape, used throughout the world, the individual perforations of which the signal character is composed are spaced so close together in a signal character that the unperforated portion between adjacent holes amounts to less than the diameter of the individual perforations. Practical reasons make such close spacing advisable. This results, however, with the direct control of light beams by such perforations in overlapping of the beam effects of adjacent perforations upon the photo cell, especially when two beams are used, one for "marking", the other for "spacing", and it thus precludes a definite interruption of the beams between two immediately succeeding perforations, so that several distinctly separate current impulses cannot be produced by the control action of the photo cell in the transmitter circuit. So far as I am aware this problem has not been solved sufficiently satisfactory by the prior art to permit even reasonably high transmission speeds.

In addition, while the holes in the tape are punched with mechanical punching apparatus, the wear and tear of such appaartus and the contraction and expansion of the paper tape due to varying weather conditions, introduce slight defects in the spacing, which manifest themselves as considerable irregularities at high transmitting speeds, desirable at the present day. Also this problem has not been solved in a satisfactory manner, so far as I am aware, and is a problem which alone would cause difficulties even if the standard spacing of the tape perforations were wider than stated hereinabove.

It is the purpose of the present invention to overcome these defects.

The idea underlying the solution of these problems is the use of a fixed aperture diaphragm and a plurality of movable apertured diaphragms, spaced apart very exactly at the minimum standard spacing distance between two adjacent perforations in the tape, which latter diaphragms are movable past the fixed aperture conjointly with the tape, so that a perforation in the tape, whenever it occurs, is in registry with a movable aperture and must travel with it past the fixed aperture. In this manner the light beam is free to pass through this control device and through a perforation only by way of portions of a movable aperture, which register with the fixed diaphragm aperture. Especially if the fixed and the movable apertures are in the tape travel direction slightly narrower than a perforation, it becomes immaterial for the precise timing of the light beam flashes, whether one or the other perforation is slightly off the precise spacing, since the beam flashes, if a perforation is at all present, are determined by the overlapping of the fixed aperture with a movable aperture.

In particular by the arrangements constituting the subject matter of the present invention I have, as practical demonstrations with a full size apparatus have proven, attained the following objects:

a. A precise definition of the individual light beam flashes upon the photo cell, and thus non-interference between two light beams when controlled by the closely spaced perforations of existing conventional forms of perforated tape;

b. More rapid turn-on and cut-off of the light beam and its increased concentration upon the photo cell after it has passed the tape perforations;

c. Avoidance of the effect of ordinary unavoidable irregularities in the tape perforations (such as slightly irregular spacing) upon the precise control of the light beam.

As a result of these improvements I have been able to considerably increase the transmission speed of photo-electric keying heads and the

preciseness of the signal characters at low and high operating speeds.

My invention is illustrated in the accompanying drawings in which—

Fig. 1 represents a front elevation of the apparatus, partly in section on line 1—1 in Fig. 2.

Fig. 2 represents a sectional side elevation on the section line 2—2 in Fig. 1.

Fig. 3 represents an enlarged view of the light control drum 30 in Fig. 2, partly in section.

Fig. 4 represents in more or less diagrammatical form a still further enlarged section through the light control drum of Fig. 3, at right angles to the drum axis, showing in addition the condenser lens system and its optical effects.

Figs. 5, 6, 7 and 8 are diagrammatic representations of different phase relations between the slots in the light control drum, the holes in the perforated tape and the fixed slots during the advance of the tape to bring about the desired light beam control in accordance with the configuration of the tape perforations, and

Figs. 5*a*–8*a* show plan views of perforated tape portions and the several slots, corresponding respectively with the phase relations shown in Figs. 5–8.

Referring to Figs. 1 and 2, 1 is the casing in which the entire mechanism is housed. In the upper part of the casing a chamber is provided with a removable cap 7 which contains two incandescent lamps 2 and 3 preferably of a type which has several parallel concentrated filaments, for instance three as shown at 4 in Figs. 1 and 2. The purpose of this type filament will be explained later. These lamps are mounted in bosses 8 provided on the back wall of the casing, and are positioned so that they protrude into the removable housing 7. Besides, they are arranged so that one stands further ahead of the other, as shown in Fig. 2 so that the filaments of the lamps are offset a certain distance as shown in Fig. 2. Removable casing 7 is provided at the top with ventilation holes 6 across which a light baffle plate 5 extends to prevent light from being thrown through these holes to the outside. The lower portion of casing 7 is provided with two windows 18 through which the light beams emanating from these filaments can be projected to the outside. Below casing 7 is arranged the condenser lens frame 9 which contains the two condenser lenses 10*a* and 10*b* and which are positioned so that for instance 10*a* receives the light from lamp 2 and 10*b* the light from lamp 3. Referring again to the filaments 4 of these lamps it is preferable to have more than one concentrated filament, for instance three as shown, and to have these filaments positioned so that their light projection onto their respective condenser lens forms a band of uninterrupted width, the width of the band being equal to the width of the projection of the three filaments. Condenser lens frame 9 has windows at the bottom through which the condensed light emanates and through which it is thrown onto certain definite portions of the tape track 15 which runs across the front of housing 1 as shown in these figures. On tape track 15 travels the perforated tape 16, the rear portion of track 15 being slightly raised as shown at 15*a* so that the tape is guided at one side by this raised portion. At the other side the tape is guided by pins 17, one being mounted at either end of track 15. The tape is held yieldingly to the central portion of track 15 by means of presser foot 11 guided by two pins 14, and controlled by springs 13. By means of a handle 12 presser foot can be raised for the purpose of inserting the tape.

Below tape track 15 is arranged the drum housing 19 which contains a slotted drum 30 mounted on a shaft 31, journalled in the two walls of housing 1 as shown, and which carries between the two walls a gear wheel 32 meshing with gear wheel 33 on shaft 34 also journalled in housing 1, the latter shaft protruding to the outside where it is provided with a clutch element 35 by which it can be coupled with a motor or other power drive.

The detailed construction of drum 30 and the adjacent portions of track 15 are shown in greatly enlarged scale in Fig. 3. In this figure the tape is shown inserted between presser foot 11 and track 15. As is well-known, the perforated tapes used for this purpose are provided with central uniformly spaced perforations 37 which serve for feeding the tape through the apparatus in which it is used. As is further shown in Fig. 1 the larger perforations 38 near the outer edges of the tape are the perforations of which the different signal characters are composed. Through these perforations the light beams from the condenser lenses aforementioned are thrown, and for this purpose the lenses 10*a* and 10*b* are focused so that each lens projects the image of the three filaments of its appertaining lamp onto one row of perforations. It will now appear clearly why the filaments of the two lamps are laterally offset as shown in Fig. 2. They are offset the distance which the two rows of perforations 38 are spaced apart on tape 16.

Referring now again to Fig. 3, track 15 is provided with a central slotted portion through which the sprockets 36 provided on drum 30 protrude so that they may engage the central row of perforations 37 of the tape, and thus feed the tape forward (in Fig. 1 from the right to the left). Presser foot 11 is provided with two windows 41, one of them being shown in dotted lines in Fig. 3 through which the light beam projected by the appertaining condenser lens is projected onto the tape portions on which the signal character holes are punched. In Fig. 3, two oppositely disposed punchings 38 are shown in cross-section. They register with the respective windows 41, which latter are very much larger than the tape perforations. Drum 30 is provided on its circumference with two peripheral rows of axially directed slots *d*, one row being arranged on either side of the sprocket row. The centers of these rows are spaced apart the distance of the two character hole rows 38 on the tape, and the slots of each row equal in number and are in axial alinement with the sprockets so that there is a pair of alined slots provided for each sprocket, and so that each slot is diametrically alined with the signal perforations of its appertaining tape row, whenever they occur. Drum 30 is mounted so that its periphery comes very close to the underside of tape track 15 without touching it, the latter being adapted at its underside at that point to the contour of the drum, as shown at 20 in Figs. 1 and 4. In tape track 15 are provided above the rotation axis of drum 30 two fixed narrow slots *f*1, *f*2, each extending in the direction of the drum axis as shown in Figs. 2 and 3. These slots are, however, not in axial alinement with one another, but are slightly offset in the direction of the tape travel, the offset being less than the peripheral spacing distance between two drum slots *d*. The reason

for this offset will appear from Figs. 5–8 and 5*a*–8*a* to which I shall now refer.

These figures constitute pairs such as 5, 5*a*, 6, 6*a* and so forth, showing diagrammatically, in sectional elevation and in plan view respectively, the relation of the appertaining slots *d* and *f* to the momentarily appertaining signal perforations 38 in the tape. In Figs. 5*a*—8*a* the drum slots *d* are horizontally hatched and the fixed track slots *f*1 and *f*2 are vertically hatched. One row of signal perforations 38 constitutes what is commonly termed the "marking" holes, the other row the "spacing" holes. Reference is made in this connection to the U. S. Patent No. 1,858,511 of May 17, 1932, to Knopp and Kunc, in which these terms in their relation to the control of the transmission circuit are explained in detail, so that this explanation may be omitted from the present specification. It may be shortly stated, however, that in such tape controlled signal transmission the control effects upon the transmitting circuit exerted by two transversely oppositely disposed signal perforations in the tape should not be simultaneous but successive. That same rule applies also in the present case. For this reason the fixed slots *f*1, *f*2 are spaced apart in the tape travel direction less than the spacing of slots *d*, so that the two light beams may not be flashed through the slots into the interior of drum 30 simultaneously but successively. The timing of the light passage is as follows.

Referring first to Figs. 5 and 5*a*, it will be noted that the relative positions of the drum 30, slots *f*1, *f*2 and the tape perforations 38 are such (see Fig. 5) that when the marking light beam L*m* enters slot *f*2 through a marking perforation 38 which has partly uncovered that slot (see Fig. 5*a*), the beam is still prevented from entering the drum, because at that time drum slot *d* has not yet registered with slot *f*2. It is located to the right of slot *f*2 and about to uncover the latter. Likewise, the spacing beam L*s* is shut off the drum 30, because drum slot *d*, moving together with a spacing perforation 38, present at that point has just passed slot *f*1. Thus no light at all can enter the drum interior. In Fig. 5 the two light beams L*m* and L*s* are therefore indicated within the drum by dotted lines.

As the drum revolves and moves the tape further in the direction of the arrow into the position shown in Fig. 6, drum slot *d*, shown in Fig. 5*a* about to register with marking slot *f*2, has now registered with the latter, as shown in Fig. 6*a* by the combined vertical and horizontal hatching, and the marking beam L*m* can now enter drum 30, through perforation 38 and slots *f*2 and *d*, as shown in full lines in Fig. 6. The drum slot *d* of the spacing row has in Fig. 6*a* moved still further to the left away from slot *f*1, and the next succeeding drum slot *d*, bisecting the next succeeding tape perforation 38, has not yet arrived at slot *f*1. Therefore, the spacing beam L*s* is still cut off the interior of drum 30, which is indicated by dotted lines.

As drum 30 revolves further and moves the tape in the direction of the arrow into the position shown in Fig. 7, drum slot *d* of the marking row has moved past and close to the left of slot *f*2 (see Fig. 7*a*) and therefore just cut off beam L*m* from the drum interior. The beam is, accordingly, indicated by dotted lines in Fig. 7. At the same time the spacing drum slot *d*, shown in Fig. 6*a* a distance to the right of slot *f*1, has now moved close to the right of slot *f*1 in Fig. 7*a*, but does not yet register with it. Therefore, at this phase spacing beam L*s* is still cut off the drum interior and is also shown dotted.

In the last phase of the cycle, shown in Figs. 8 and 8*a* the marking drum slot *d*, shown in Fig. 7*a* close to the left of slot *f*2 has in Fig. 8*a* moved further away from that slot and the next succeeding marking drum slot *d* with its appertaining perforation 38 is still far away from slot *f*2. Therefore, marking beam L*m* cannot enter the drum. But at the same time, the spacing drum slot *d* close to the right of slot *f*1 in Fig. 7*a*, has in Fig. 8*a* registered with that slot, and therefore a spacing light beam L*s* can enter drum 30, which is indicated in full lines in Fig. 8. Now a new cycle commences with a phase relation shown in Figs. 5 and 5*a*.

From the foregoing description and from Figs. 5–8 it will appear that the marking and spacing beams enter drum 30 alternately at sharply defined time intervals and for sharply defined time periods, assuming in the present showing in Figs. 5*a*–8*a* that continuous rows of marking and spacing perforations 38 happen to be punched in the tape. If, according to the signal character one or several perforations should be omitted in one or the other row no light can pass through the fixed slot *f*1 or *f*2 when a drum slot *d* registers with it, the tape paper being sufficiently opaque to shut the light beam off drum 30. It will be further noted from Figs. 5*a*–8*a*, which show fairly accurately the relative proportions of the widths of slots *f*1, *f*2 and *d* to the size of a tape perforation, that only a comparatively narrow diametrical zone of a perforation is used for actual light transmission. Thus, the actual light transmitting areas of the perforations, as Figs. 5*a*–8*a* show, are spaced quite far apart, sufficient to permit the sharply defined shutting off of one beam before the other beam is allowed to flash.

How important this double control by two slots *d* and *f* of each light beam is for the precise beam flashing may be easily seen for instance from Fig. 6*a*. If we assume in this figure the absence of the drum slots and if we assume that for instance fixed slot *f*1 be even much narrower than it is shown, the round edges of a perforation would nevertheless only very gradually admit light through the slot, and shut it off very gradually, and thus would only gradually energize and de-energize the photo cell, and commence immediately with the next perforation to gradually re-energize the cell without producing uniform, well defined periods during which the cell is fully energized or de-energized. It would besides be difficult, if not impossible with this form of tape perforation to operate two cells by two beams so that when one cell is energized the other is de-energized. Further, the sharp definition of the beam flashes is increased by the straight edges of the two cooperating slots *d* and *f*, which admit much more rapidly the full strength beam for a given tape speed than round hole shutter openings.

The light beams thus admitted to the interior of drum 30 could be allowed to pass diametrically through it and out through those slots *d* located then at the lower portion of the drum, as diagrammatically indicated in Figs. 5–8, so as to strike the appertaining photo cell 45 or 46, disposed in optical alinement in the bottom of casing 1 (see Fig. 2). Such a direct passage would, however, have the disadvantage that each beam would pass through several of the slots *d* of its appertaining slot row. This will be understood

in view of the earlier statement that the condenser lenses 10*a* and 10*b* focus in the appertaining fixed slots *f*1 and *f*2, so that each light beam would spread in drum 30, and only those portions which happen to be in proper alinement with some of the lower slots *d*, could reach the photo cell. In this manner only certain portions of the photo cell would be energized at the time, and before these beam portions could sweep over the entire cell area, the beam flash would be terminated by the coaction of the upper slots *d* and *f*1, *f*2 just described. Besides, only a fraction of the total available amount of beam light entering the drum could emanate from it and be useful for energization. The rest would be lost within the drum.

To overcome this, a set of projecting lenses 43, 44 is provided in the interior of drum 30, one lens in optical alinement with each beam. As will be seen from Figs. 1, 2, 3 and 4, a projecting lens frame 42 is arranged in the interior of drum 30 (which is open at the right hand end, Fig. 2, for that purpose). This frame is mounted on the underside of track 15, and contains the two projecting lenses 43 and 44, each of sufficient size to encompass the entire appertaining beam spreading in the drum (see Fig. 4). Lenses 43 and 44 are designed so that they focus in the lower drum periphery and thus within the lower drum slots *d*, when the latter pass the focus. In this manner the entire amount of light of each beam is thrown out of drum 30, the photo cells being located at a focal distance at which the entire light cone emanating from a lower slot *d* will simultaneously and uniformly illuminate the desired area portion of the cell.

Besides the aforedescribed conservation of all of the available beam light and its effective application to a cell, this arrangement has the following additional advantage. As will be noted from Fig. 4, no light can emanate from the lower portion of drum 30, unless a lower slot *d* is located at the lower focal point of a beam at the time when the upper drum slot *d* registers with the appertaining fixed slot *f*1, *f*2 respectively. In Fig. 4 the phase relation of the shutter slots, represented in greatly enlarged scale, is that which prevails in Figs. 5, 5*a*. The left hand upper drum slot *d* has just passed fixed slot *f*1, and the right hand upper drum slot *d* is just about to register with fixed slot *f*2, so that neither beam can enter drum 30. The optical alinement of lenses 43 and 44 is such that the beam L*m* would focus at that time at the point *m* and beam L*s* at the point *s* of the lower drum wall, at which points no slots *d* appear at that time; the focal point *s* has just been passed by the right hand lower slot *d*, just as the upper focal point of that beam has been passed by an upper slot *d*, which shuts it off. Similarly, left hand lower slot *d* is just about to arrive at lower focal point *m*, the same as the corresponding upper right hand slot *d* is about to register with its fixed slot *f*2 to admit beam L*m* to the drum. Thus each beam is simultaneously controlled at two points, and the diameter of the drum can be easily chosen so, with respect to the drum slot spacing fixed by the tape hole spacing, that the starting and the stopping of the beam flashes occurs precisely, and instantaneously for all practical purposes.

This beam control arrangement is used as follows:

The two photo-electric cells may be connected in circuit in any suitable manner, conventional with this type of signal transmission. For instance the connection may be as shown in Fig. 1. One cell, denoted with MC may respond to the light flashes produced by the marking holes of the tape and the other cell denoted with MS may respond to the flashes produced by the spacing holes of the tape. The cathodes of these cells are connected in Fig. 1 to the common terminal 50, which is electrically directly connected to casing 1 and thus represents the ground of the circuit. The anode of cell MC is connected to insulated terminal 51, and the anode of cell MS to insulated terminal 52. These terminals are connected respectively to the grids of amplifier tubes A*m* and A*s*. The photo cells used are of the potential generating type. The common cell terminal 50 is connected to the filaments of the amplifiers. Across the grid-filament circuits of these tubes are connected respectively the resistances R*m* and R*s*. A biasing battery C, common to both grid circuits is dimensioned so, that normally, i. e. with no photo cell current flowing, no plate current can flow in the amplifier tubes. When for instance photo cell MC is energized by a marking beam flash, produced in the manner described, the potential at the ends of resistance R*m* varies, and the grid of tube A*m* is sufficiently positively charged to cause an output current impulse to flow by way of output terminals M—N through a conventional hold-over relay circuit (not shown). When cell MS is energized by a spacing beam flash, the grid of tube A*s* becomes more positive and causes an output current impulse to flow by way of output terminals S—N through another portion of the conventional hold-over relay circuit.

I claim:

1. Means for controlling the effect of a light beam, directed upon a photo-electric cell, by perforations in a tape, comprising a tape having a longitudinal row of perforations spaced at a fixed minimum distance or at multiples thereof, a fixed apertured diaphragm having its aperture disposed in the path of the beam and in line with said perforation row, means for positively feeding the tape past said window, said feeding means having apertures spaced equal to said minimum spacing of said perforations, so as to pass said fixed aperture coincidentally with a perforation occurring in the tape, whereby the light beam is permitted to strike the cell through a perforation only by way of portions of a movable aperture, which register with the aperture of said fixed diaphragm.

2. Means for controlling the effect of a light beam upon a photo-electric cell by perforations in a tape, comprising a tape having a longitudinal row of perforations spaced at a fixed minimum distance or at multiples thereof, a fixed apertured diaphragm disposed in the path of the beam and in line with said perforation row, means for positively feeding the tape past said aperture, said feeding means having apertures spaced equal to the minimum spacing of said tape perforations so as to pass said fixed aperture coincidentally with a perforation occurring in the tape, the fixed aperture and the movable apertures being in the tape feeding direction narrower than the tape perforations, whereby the light beam is permitted to strike said cell through a perforation only by way of portions of a movable aperture which register with said fixed aperture.

3. In a photo-electric keying head, means for controlling the effect of a light beam on a photo

cell, comprising a tape containing perforations spaced at a fixed minimum distance or multiples thereof, and representing the signal characters to be keyed, a tape track and means for positively feeding the tape over the track, and a photo cell disposed beyond said feeding means in line with said beam, said track having a transverse slot disposed in the path of the light beam and of said perforations, said feeding means having slots extending transversely to said tape and being spaced equal to said minimum perforation spacing so as to travel in registry with a perforation past said track slot, whereby the light beam is permitted to strike said cell through a perforation only by way of portions of a movable slot, which register with said track slot.

4. In a photo-electric keying head, means for controlling the effect of a light beam on a photo cell, comprising a tape containing perforations spaced at a fixed minimum distance or multiples thereof, and representing the signal characters to be keyed, a tape track and means for positively feeding the tape over the track, and a photo cell disposed beyond said feeding means in line with said beam, said track having a transverse slot disposed in the path of the light beam and of said perforations, said feeding means having slots extending transversely to said tape and being spaced equal to said minimum perforation spacing so as to travel in registry with a perforation past said track slot, all of said slots being in the tape feeding direction narrower than a tape perforation, whereby the light beam is permitted to strike said cell through a perforation only by way of portions of a movable slot, which register with said track slot.

5. In a photo-electric keying head, means for controlling the effect of a light beam on a photo cell, comprising a tape containing perforations spaced at a fixed minimum distance or multiples thereof, and representing the signal characters to be keyed, a tape track and a drum disposed tangentially to said track and having means for positively engaging said tape for feeding it over said track, and a photo cell disposed beyond said drum in line with said beam, said track having a transverse slot disposed adjacent to said drum in the path of the light beam and of said perforations, said drum having axially directed slots in its peripheral wall, spaced equal to said minimum perforation spacing and registering with said perforations so as to travel in registry with a perforation past said track slot, whereby the light beam is permitted to strike said cell through a tape perforation only by way of portions of a drum slot, which register with said track slot.

6. In a photo-electric keying head, means for controlling the effect of a light beam on a photo cell, comprising a tape containing perforations spaced at a fixed minimum distance or multiples thereof, and representing the signal characters to be keyed, a tape track and a drum disposed tangentially to said track and having means for positively engaging said tape for feeding it over said track, and a photo cell disposed beyond said drum in line with said beam, said track having a transverse slot disposed adjacent to said drum in the path of the light beam and of said perforations, said drum having axially directed slots in its peripheral wall, spaced equal to said minimum perforation spacing and registering with said perforations so as to travel in registry with a perforation past said track slot, the track slot and the drum slots being in the tape feeding direction narrower than a tape perforation, whereby the light beam is permitted to strike said cell through a tape perforation only by way of portions of a drum slot, which register with said track slot.

7. In a photo-electric keying head, means for controlling the effect of a light beam on a photo cell, comprising a tape containing perforations spaced at a fixed minimum distance or multiples thereof, and representing the signal characters to be keyed, a tape track and a drum disposed tangentially to said track and having means for positively engaging said tape for feeding it over said track, and a photo cell disposed beyond said drum in line with said beam, said track having a transverse slot disposed adjacent to said drum in the path of the light beam and of said perforations, said drum having axially directed slots in its peripheral wall, spaced equal to said minimum perforation spacing and registering with said perforations so as to travel in registry with a perforation past said track slot, whereby the light beam is permitted to strike said cell through a tape perforation only by way of portions of a drum slot, which register with said track slot, said light beam being directed at a suitable angle with respect to said track, so that after passing through a registering drum slot it will pass through a drum slot located substantially diametrically opposite to said registering drum slot before it reaches the photo cell.

8. In a photo-electric keying head, means for controlling the effect of a light beam on a photo cell, comprising a tape containing perforations spaced at a fixed minimum distance or multiples thereof, and representing the signal characters to be keyed, a tape track and a drum disposed tangentially to said track and having means for positively engaging said tape for feeding it over said track, and a photo cell disposed beyond said drum in line with said beam, said track having a transverse slot disposed adjacent to said drum in the path of the light beam and of said perforations, said drum having axially directed slots in its peripheral wall, spaced equal to said minimum perforation spacing and registering with said perforations so as to travel in registry with a perforation past said track slot, the track slot and the drum slots being in the tape feeding direction narrower than a tape perforation, whereby the light beam is permitted to strike said cell through a tape perforation only by way of portions of a drum slot, which register with said track slot, said light beam being directed at a suitable angle with respect to said track, so that after passing through a registering drum slot it will pass through a drum slot located substantially diametrically opposite to said registering drum slot before it reaches the photo cell.

9. In a photo-electric keying head, means for controlling the effect of a light beam on a photo cell, comprising a tape containing perforations spaced at a fixed minimum distance or multiples thereof, and representing the signal characters to be keyed, a tape track and a drum disposed tangentially to said track, and having means for positively engaging said tape to feed it over said track, and a photo cell disposed beyond said drum in line with said beam, said track having a transverse slot disposed adjacent to said drum, in the path of said perforations, means for focusing a beam of light upon said track slot, said drum having axially directed slots in its peripheral wall, spaced equal to said minimum perforation spacing and registering with said perfora-

tions, so as to travel in registry with a perforation past said track slot, the track slot and the drum slots being in the tape feeding direction narrower than a tape perforation, whereby the light beam is permitted to enter the interior of said drum through a tape perforation only by way of portions of a drum slot, which register with said track slot, a projecting lens mounted in the drum interior and designed and directed to focus the entire light beam entering the drum upon one of the drum slots disposed substantially diametrically opposite a drum slot in registry at the time, for directing the entire beam simultaneously upon the entire area of the photo cell, and for precisely timing the occurrence and duration of beam flashes upon the cell by the two oppositely disposed and oppositely moving drum slots.

10. Means for controlling the effect of two light beams respectively upon two photo-electric cells by perforations in a tape, comprising a tape having two parallel rows of transversely alined perforations spaced in each row a fixed minimum distance or multiples thereof, a fixed apertured diaphragm disposed in the path of each beam and in line with the appertaining perforation row, means for positively feeding the tape past said fixed apertures, said feeding means having apertures for each perforation row, spaced apart the minimum spacing of said tape perforations, so as to pass the appertaining fixed aperture coincidentally with a perforation occurring in the tape, said fixed apertures being spaced apart in the tape feeding direction less than said minimum perforation spacing so that when one fixed aperture registers with a perforation of one row, the other fixed aperture is located between adjacent perforations of the other row, whereby each light beam is permitted to strike its cell through a perforation of its appertaining row only by way of portions of a movable aperture which register with the appertaining fixed aperture, and whereby one light beam is interrupted when the other light beam strikes its cell.

11. Means for controlling the effect of two light beams respectively upon two photo-electric cells by perforations in a tape, comprising a tape having two parallel rows of transversely alined perforations spaced in each row a fixed minimum distance or multiples thereof, a fixed apertured diaphragm disposed in the path of each beam and in line with the appertaining perforation row, means for positively feeding the tape past said fixed apertures, said feeding means having apertures for each perforation row, spaced apart the minimum spacing of said tape perforations, so as to pass the appertaining fixed aperture coincidentally with a perforation occurring in the tape, said fixed and said movable apertures being in the tape feeding direction narrower than the tape perforations, and said fixed apertures being spaced apart in the tape feeding direction less than said minimum perforation spacing so that when one fixed aperture registers with a perforation of one row, the other fixed aperture is located between adjacent perforations of the other row, whereby each light beam is permitted to strike its cell through a perforation of its appertaining row only by way of portions of a movable aperture which register with the appertaining fixed aperture, and whereby one light beam is interrupted when the other light beam strikes its cell.

12. In a photo-electric keying head, means for controlling the effect of two light beams on photo cells, comprising a tape containing two parallel rows of transversely alined perforations, spaced apart in each row a fixed minimum distance or multiples thereof to represent the signal characters to be keyed, a tape track and means for positively feeding the tape over said track, means for focusing two light beams upon said track, one upon each perforation row, and a photo cell disposed in the path of each beam beyond said track, said track having two transverse slots, one in the path of each perforation row and in the path of each light beam, said track slots being transposed in the travel direction of the tape a distance smaller than the minimum spacing of the perforations in said rows, so that when one slot registers with a perforation of one row, the other slot is located between adjacent perforations of the other row, said feeding means having slots for each perforation row, extending transversely to said rows, the slots for each row being spaced equal to said minimum perforation spacing so as to travel in registry with the perforations of the pertaining row past the appertaining track slot, whereby each light beam is permitted to strike its cell through a perforation of its appertaining row only by way of portions of a movable slot which register with the appertaining track slot, and whereby one light beam is interrupted when the other light beam strikes its cell.

13. In a photo-electric keying head, means for controlling the effect of two light beams on photo cells, comprising a tape containing two parallel rows of transversely alined perforations, spaced apart in each row a fixed minimum distance or multiples thereof to represent the signal characters to be keyed, a tape track and means for positively feeding the tape over said track, means for focusing two light beams upon said track, one upon each perforation row, and a photo cell disposed in the path of each beam beyond said track, said track having two transverse slots, one in the path of each perforation row and in the path of each light beam, said track slots being transposed in the travel direction of the tape a distance smaller than the minimum spacing of the perforations in said rows, so that when one slot registers with a perforation of one row, the other slot is located between adjacent perforations of the other row, said feeding means having slots for each perforation row, extending transversely to said rows, the slots for each row being spaced equal to said minimum perforation spacing so as to travel in registry with the perforations of the pertaining row past the appertaining track slot, all of said slots being in the tape feeding direction narrower than a tape perforation whereby each light beam is permitted to strike its cell through a perforation of its appertaining row only by way of portions of a movable slot which register with the appertaining track slot, and whereby one light beam is interrupted when the other light beam strikes its cell.

14. In a photo-electric keying head, means for controlling the effect of two light beams on photo cells, comprising a tape containing two parallel rows of transversely alined perforations, spaced apart in each row a fixed minimum distance or multiples thereof to represent the signal characters to be keyed, a tape track and a drum disposed tangentially to said track and having means for positively engaging said tape to feed it over said track, means for focusing two light beams upon said track, one upon each

perforation row, and a photo cell disposed in the path of each beam beyond said drum, said track having two transverse slots adjacent to the tangential point of said drum, one in the path of each perforation row and in the path of each light beam, said slots being transposed in the tape travel direction a distance smaller than the minimum spacing of the perforations in said rows, so that when one slot registers with a perforation of one row, the other slot is located between adjacent perforations of the other row, said drum having two rows of axially directed slots in its peripheral wall, one row in alinement with each perforation row, the slots of each row being spaced equal to said minimum perforation spacing, and axially alined respectively with the slots of the other row so that the slots register with the perforations of their appertaining row and travel in registry with a perforation past the appertaining track slot, all of said track and drum slots being in the tape feeding direction narrower than a tape perforation, whereby each light beam is permitted to strike its cell through a tape perforation only by way of portions of a drum slot which register with the appertaining track slot, and whereby one light beam is interrupted when the other light beam strikes its cell.

15. In a photo-electric keying head, means for controlling the effect of two light beams on photo cells, comprising a tape containing two parallel rows of transversely alined perforations, spaced apart in each row a fixed minimum distance or multiples thereof to represent the signal characters to be keyed, a tape track and a drum disposed tangentially to said track and having means for positively engaging said tape to feed it over said track, means for focusing two light beams upon said track, one upon each perforation row, and a photo cell disposed in the path of each beam beyond said drum, said track having two transverse slots adjacent to the tangential point of said drum, one on the path of each perforation row and in the path of each light beam, said slots being transposed in the tape travel direction a distance smaller than the minimum spacing of the perforations in said rows, so that when one slot registers with a perforation of one row, the other slot is located between adjacent perforations of the other row, said drum having two rows of axially directed slots in its peripheral wall, one row in alinement with each perforation row, the slots of each row being spaced equal to said minimum perforation spacing, and axially alined respectively with the slots of the other row so that the slots register with the perforations of their appertaining row and travel in registry with a perforation past the appertaining track slot, all of said track and drum slots being in the tape feeding direction narrower than a tape perforation, whereby each light beam is permitted to strike its cell through a tape perforation only by way of portions of a drum slot which register with the appertaining track slot, and whereby one light beam is interrupted when the other light beam strikes its cell, said light beams being directed at a suitable angle with respect to said track, so that each beam after passing through a registering drum slot will pass through a drum slot of the same row located substantially diametrically opposite to said registering drum slot, before it strikes its cell.

16. Method of controlling a light beam directed at a photo-electric cell by the perforations in a perforated tape, consisting in continuously moving said tape conjointly with apertured diaphragms in registry with said perforations past a fixed apertured diaphragm in line with the beam, whereby the beam is permitted to strike the cell through a perforation only by way of portions of a movable aperture which register with the aperture of said fixed diaphragm.

17. Means for controlling a light beam directed at a photo-electric cell by the perforations in a perforated tape comprising a plurality of spaced movable apertured diaphragms registrable at their apertures with said perforations, a fixed apertured diaphragm having its aperture in the path of said beam, and means for positively and continuously moving said tape and said movable diaphragms conjointly and in registry with said perforations past said fixed diaphragm, whereby the beam is permitted to strike the cell through a perforation only by way of portions of a movable aperture which register with said fixed aperture.

18. Means for controlling a light beam directed at a photo-electric cell by the perforations in a perforated tape comprising a plurality of spaced movable apertured diaphragms registrable at their apertures with said perforations, a fixed apertured diaphragm having its aperture in the path of said beam, and means for positively and continuously moving said tape and said movable diaphragms conjointly and in registry with said perforations past said fixed diaphragm, the apertures of both kinds of diaphragms being in the direction of the tape movement narrower than a perforation, whereby the beam is permitted to strike the cell through a perforation only by way of portions of a movable aperture which register with said fixed aperture.

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