

Feb. 11, 1947.

M. MORRISON

2,415,702

PHOTOELECTRIC SCANNING DEVICE

Original Filed Nov. 20, 1943 3 Sheets-Sheet 1

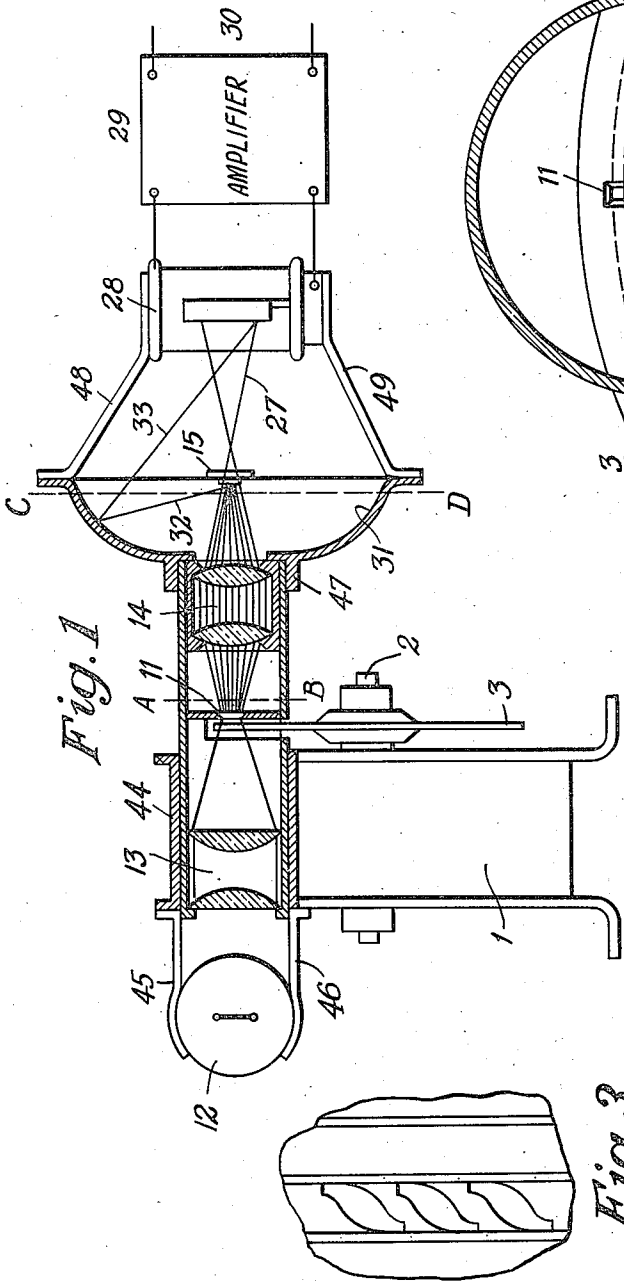


Fig. 2

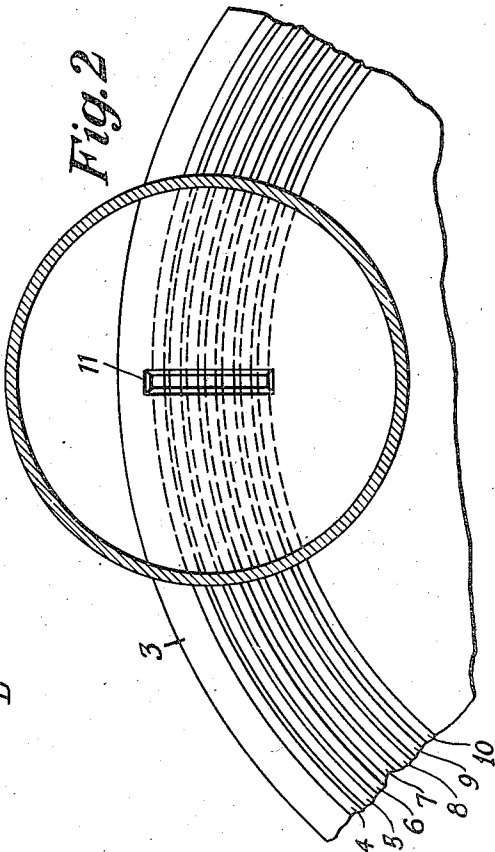
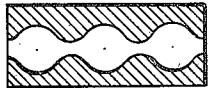
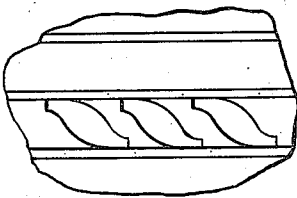


Fig. 3



INVENTOR
Maurice Morrison

Feb. 11, 1947.

M. MORRISON

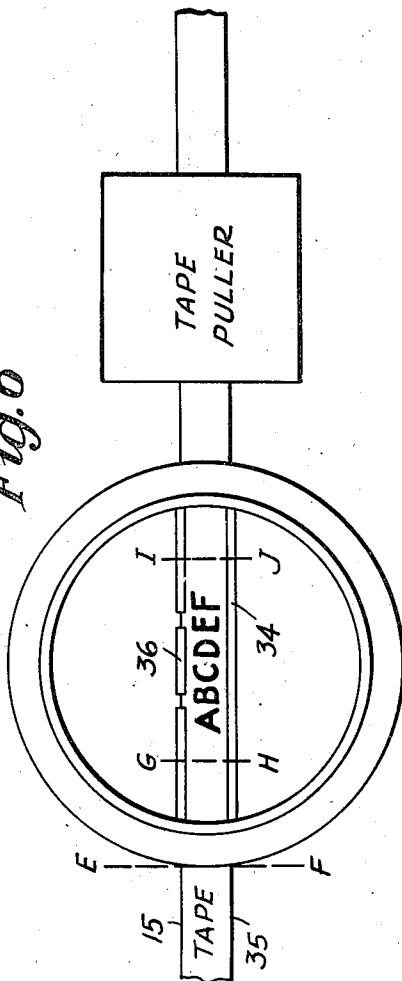
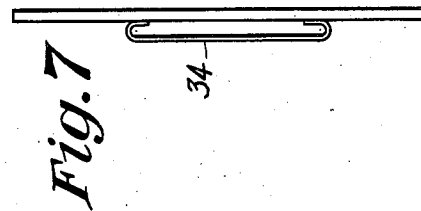
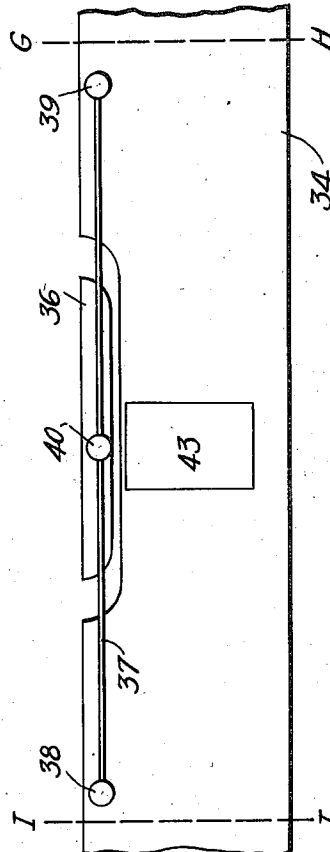
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Fig. 6



INVENTOR

Montford Morrison

Feb. 11, 1947.

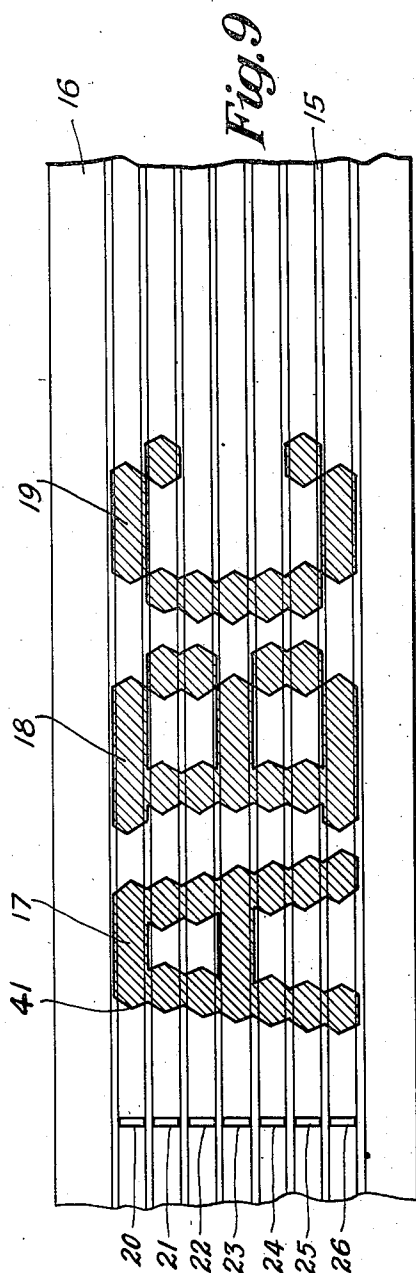
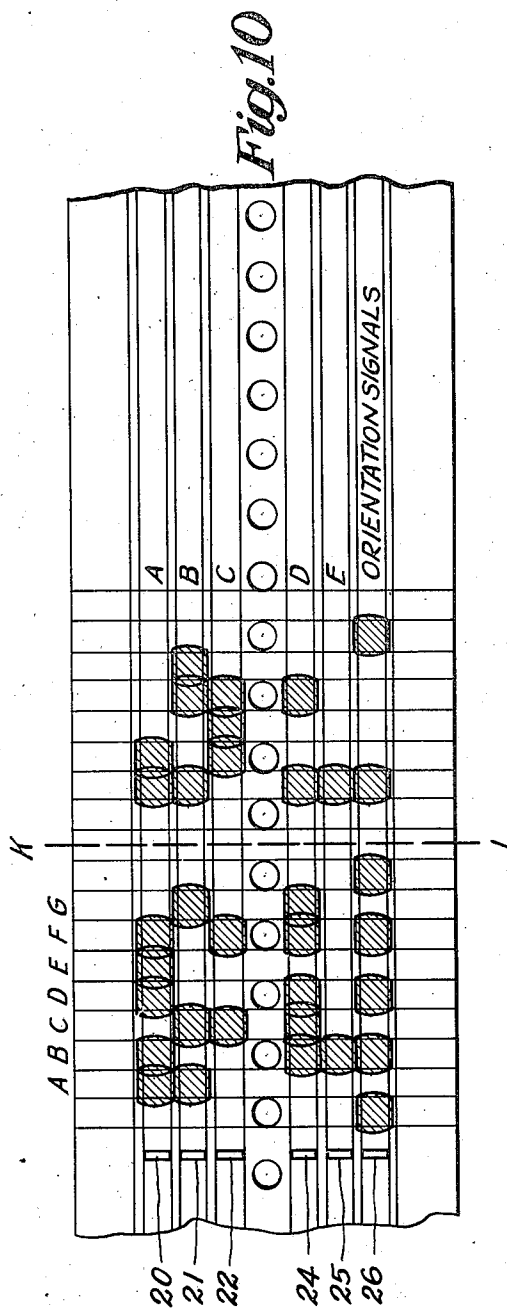
M. MORRISON

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PHOTOELECTRIC SCANNING DEVICE

Original Filed Nov. 20, 1943

3 Sheets-Sheet 3



INVENTOR
Morrison

UNITED STATES PATENT OFFICE

2,415,702

PHOTOELECTRIC SCANNING DEVICE

Montford Morrison, Upper Montclair, N. J.

Original application November 20, 1943, Serial No. 511,088. Divided and this application April 20, 1944, Serial No. 531,895

5 Claims. (Cl. 178-7.6)

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This invention relates to systems of telegraphic transmission in which optical pick-up of the signals is used, and relates in particular to such systems employing carrier currents.

The present application is a division of application Serial No. 511,088, filed November 20, 1943.

The present application discloses subject matter claimed in my co-pending applications S. N. 496,903, filed July 31, 1943, and S. N. 497,347, filed August 4, 1943.

Among the objects of the invention are; to provide a simple and efficient means for generating a large number of accurately-fixed carrier frequencies; to provide a simple and effective means for modulating the light, used in the optical pick-up system, into sinusoidally varying beams before the beams are employed in the pick-up operation; to provide means for the simultaneous application of a plurality of scanning beams to a single signal copy to be transmitted; to provide means for use of both the transmitted and the reflected light from the signal copy, in the optical pick-up system; to provide means for the transmission of Baudot and other similar codes to receiving stations not equipped with synchronized apparatus; to provide means for the transmission of Baudot and other codes under conditions which greatly reduce the errors of reception, due to interference; to provide a method of telegraph transmission directly from a plain letter text without requiring synchronism at the receiving station; and to provide a modification for letters, numerals and other signal characters used in telegraph transmission, which reduces the bandwidth of the transmission frequencies required and reduces the interchannel interference in the receiving circuit-filters.

Further and other objects will be obvious from the specification when read in connection with the accompanying drawings, and the scope of the invention is set forth in the claims hereto.

In the drawings:

Fig. 1 is a partial section of one embodiment of the invention used as a transmitter; Fig. 2 is an enlargement of a section of Fig. 1, taken at the plane marked A—B in that figure and looking west; Figs. 3, 4 and 5 are enlargements of different modifications of the circular tracks shown in Fig. 2; Fig. 6 is a section of Fig. 1 taken at the plane C—D of that figure and looking east, and with a tape-puller added for clearness; Fig. 7 is an enlargement of a fragmentary view of Fig. 6 taken at the plane E—F and looking east, and which shows the channel form of guide for the transmission tape; Fig. 8 is a rear view of that

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part of the tape channel shown in Fig. 6, between the dotted lines G—H and I—J; Fig. 9 is an enlargement of the tape shown in Fig. 6; and Fig. 10 is a form of transmission tape used for Baudot and other similar codes.

In Fig. 1, 1 is a constant speed motor which may be of any form whatever, and its function is to revolve the shaft 2 at a highly constant speed. This may be a small synchronous motor directly applied to a constant frequency alternating-current system; it may be a synchronous motor driven alternating-current derived by amplification from a tuning fork oscillator; or, preferably, it may be of the highly constant speed form driven directly from a direct-current source, as described in my co-pending patent application filed July 28, 1943, Serial No. 496,389.

Onto shaft 2 is mounted a plate 3, which may be constructed in a variety of forms. The construction of plate 3 will be better understood from Fig. 2 which is a fragmentary enlargement thereof. Plate 3 may be constructed of a photographic film, or preferably, a photographic plate, in which latter case there is a freedom from shrinkage. Plate 3 is provided with a series of light tracks, indicated by 4, 5, 6, 7, 8, 9 and 10. These light tracks, in the case of a photographic plate or film, are formed in the same way that light-sound tracks are formed on motion picture film, which results in either a variable width form, shown in Fig. 4, or a variable density form, shown in Fig. 5. The light tracks, 4, 5, 6, 7, 8, 9 and 10 on plate 3, Fig. 2, are separated by a radial space less than the radial width of the said tracks.

These light tracks in reality form frequency tracks for the generation of carrier-current frequencies, in the same sense that the sound tracks on motion picture film serve for the generation of sound frequencies.

The light tracks produced on plate 3 are formed into continuous circular paths.

These light tracks, or carrier-current frequency tracks, revolve continuously behind a slit 11, Figs. 1 and 2, which slit is sufficiently narrow to provide substantially sinusoidal variation in the total light flux that is permitted to be transmitted by means of the combined action of the revolving carrier frequency track and the stationary slit, as will be appreciated by those skilled in the art to which this invention appertains. In some cases, instead of a photographic plate, I may use a thin metal opaque plate provided with perforations, such as shown in Fig. 3, and which provides the same character of light flux modulation, but the pattern of the perforation is modified so

as to permit more metal to be retained between perforations, thereby retaining considerable strength in the metal plate.

A common property of the light tracks illustrated in Figs. 3, 4 and 5, is that with an appreciable slit width the light-flux is never completely cut off in any of these three forms, the fact being obvious on inspection of the figures. The perforated pattern illustrated in Fig. 3 represents an important improvement in the art and constitutes a perforated structure which in fact may produce sinusoidal modulations of the light-flux without complete cutoff, it being appreciated by those skilled in the art the impracticability of perforations producing complete cutoff. Those skilled in the art fully appreciate the important factor in having a no-cutoff light-modulation to provide the proper photocell bias. The perforations shown in Fig. 3 are formed such that the effective optical thickness of the plate at the boundary of the apertures is less than the minimum dimension of the aperture. The area scanned is substantially rectangular in form, having one dimension constant in all cases.

Returning to Fig. 1, 12 is a so-called exciter lamp, of a conventional variety, such as used in standard 35 mm. motion picture optical sound systems; 13 represents a conventional set of condensing lenses which focuses the light onto the revolving carrier frequency light tracks, in a manner somewhat similar to the way in which the light is focused on sound track in a motion picture film; the difference being that in a motion picture film, the image of the slit employed is focused on the sound track, whereas in the present case the light is first focused on the carrier frequency light track, then passes through the slit in a multiplicity of beams varying in periodicity in light-flux modulation representing the periods of the different frequencies of carrier-current used. This multiplicity of modulated light beams is illustrated by the lines diverging from slit 11, which pass through a projection lens system 14, which accurately focuses each beam onto a desired part of the tape 15, which is shown in its edgewise position in the figure.

The slit 11 is beveled to a dimension having an optical depth less than the minimum width of the slit. It will be appreciated by those skilled in the art that illuminated slits may be regarded as light sources and are at times so referred to herein.

An enlarged section of tape 15 is shown in Fig. 9, which comprises a translucent paper support 16, onto which specially-designed characters 17, 18 and 19 are printed. These characters are preferably printed on both sides of the translucent support 16. This double printing increases the opacity of the characters and thereby improves the quality of the optical pick-up.

The rectangles 20 to 26 represent the images of the combined slit and carrier frequency tracks, as projected upon the tape 15, Fig. 1.

These images, 20 to 26 inclusive, vary in total flux sinusoidally with the period equal to that of the carrier frequency of a telegraph channel which these frequencies represent in the output circuit, as will be hereinafter more fully described. That is, each rectangle varies in total flux in such a way, if the light represented by this image were fed directly to a photoelectric cell, unmodulated carrier current would be developed in the photocell circuit. As the tape 15 with the characters 17, 18 and 19 is pulled into the field of these light beams, modulation is produced by the absorption of light by the opaque characters, as will be understood by those skilled in the art.

Returning to Fig. 1, the seven light beams fall upon the tape 15 which is moving in the vertical direction to the plane of the paper, and as the white translucent paper passes through the light beams, some light is transmitted directly through the paper, as indicated by lines 27 and photocell 28, which forms a part of the amplifier circuit 29, having an output 30.

31 is a concave reflecting surface, and the tape 15 is so located with reference to the focus of the surface 31 that a considerable amount of the light is reflected back along such lines as 32, and is also directed to the photocell 28 along lines such as 33.

By such a structure the photocell 28 receives light by direct transmission through the paper tape 15 and also, by reflection, from the surface of the paper, providing a high efficiency in the optical system.

Exciter lamp 12 may be fixed to the optical barrel structure 44 by supports 45 and 46. Optical barrel 44 supports the reflector 47 which, in turn, has mounted upon it supports 48 and 49 supporting the photoelectric cell 28, forming an articulated integral optical structure which is conjoined to the stator of the motor 1.

As tape 15 moves across the paths of the various light beams, modulations in accordance with the character of the opaque configurations on the tape are produced in the currents of the photocell 28.

Referring to Fig. 6, which is Fig. 1 taken at the plane C—D and looking east, this shows the location of the characters facing the optical system.

Fig. 7 is a fragmentary view of Fig. 6 taken at the dotted line E—F and looking east, and shows the channel 34, Figs. 6 and 7, through which the tape is pulled, and in Fig. 6, a tape puller is indicated for clearness.

The characters ABCDEF, etc., are accurately located on tape 15 with reference to the lower side 35 of the tape 15. The channel 34, Fig. 6, is provided with a gentle spring actuated member 36, Figs. 6 and 8.

Referring to Fig. 8, this is a fragmentary view of the part of the channel 34 which lies between the dotted line G—H and I—J, and the member 36, Figs. 6 and 8, is a loose channeled part held by a fine spring 37, which is fixed to pins 38 and 39 on a channel part 34 and to a loose member 36 by pin 40. 43 is an opening in the channel 34 to permit the transmission of light at this location.

The function of this member 36 is to keep the tape 15 pressed against the lower side of the channel 34, keeping the characters accurately located with reference to the modulated light beams.

Referring to Fig. 9, I prefer to modify the configurations of the letters and characters in such a way as to reduce the rate-of-change in the light modulation produced by the character. As the character moves into the light image, instead of striking a parallel line, I prefer to use a graduated area such as shown in 41 which reduces the rate-of-change, as will be understood by those mathematically equipped in the art of optical light pick-ups.

This reduced rate-of-change provided by the configurations of the characters at the pick-up thresholds, reduces the inter-channel interference in any receiving circuit which may be employed in connection with this system of transmission and further simplifies the receiving filter structures. This reduced rate-of-change further eliminates the necessity of employing a multiple

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periodic band-pass filter network in the transmission circuit, which would provide the same result in the output of the transmission circuit as this said reduced rate-of-change, but at a much higher cost and with a greatly increased bulk of structure, but such a network may be employed in an embodiment of this invention if and when desired.

Returning to Fig. 1, the reflecting surface 31 has an active reflecting area greater than the effective photo-sensitive working area of the cathode of photoelectric cell 28, and therefore the flux gathered by the surface 31 and reflected to the cathode cell 28, is in fact concentrated upon the cathode of photocell 28, which fact follows from the specifications of the structures. In other words, the light-flux per unit area falling on the cathode of photocell 28, which said flux is received upon it by reflection from surface 31, is greater in value than the light-flux per unit on the surface 31, which said flux is received upon it by reflection from the tape 15. Further, the surface 31 is so formed and disposed with reference to the cathode of photocell 28 that substantially all the flux received by the surface 31 is reflected to the cathode of tube 28, except a small amount which is cut off by the tape 15 and its partially surrounding support 34, Figs. 6 and 7. This support 34 is made as narrow as practicable, in the direction of the width of the tape and in preferred forms the maximum width of the support 34 in this said direction, Figs. 6, 7 and 8, is less than twice the width of the tape 15.

Fig. 10 shows the embodiment of my invention as characterized by a tape operated in the place of the tape shown in Fig. 9, used for the purpose of transmitting Baudot code signals and signals by other similar codes. In this case, instead of transmitting a complete character in a single channel, I may employ five simultaneous channels represented by the light images 20, 21, 22, 24 and 25, providing the five units required for the code. The light image 26 provides an orientation frequency which goes out with the code signals and may be recorded simultaneously at receiving stations, and later the message decoded without the use of synchronism during reception.

In Fig. 10, to the left of the dotted line K—L, is shown such a transmission copy for the letters A—G, inclusive.

Of course, Baudot code may also be transmitted by such a system, using only one channel for a complete character, such as shown at the right of the line K—L, and at the same time employing orientation signals, such as 42, at the beginning of each character. The use of these orientation signals also obviates the necessity of using a synchronism at the receiver at the time of reception, and the message may be decoded later by the use of these orientation signals. These Baudot signal dots may be supplied with boundary lines functioning as modulation modifiers, as will be understood by those skilled in the art, and as illustrated in the figure. Equal unit codes may be transmitted under this invention with perforated feed holes, as illustrated, and printed signal characters, the units of which may overlap if and when desired, as shown in Fig. 10.

The use of five simultaneous channels for the transmission of Baudot code, reduces the interference effect upon the signals, since all of the interference is applied to all the signals of one character at the same time. Where only one unit is sent at a time, the interference effect is differ-

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ent for different units of a single character, which is conducive to errors.

Having described one embodiment of the invention, the scope thereof is set forth in the claims hereunder.

What I claim is:

1. In a photoelectric pick-up apparatus employing a source of light transmitting a beam of luminous flux to a photoelectric cell and in which said beam is transversely intercepted by a longitudinally slideable tape having signal characters embodied therein, a supporting frame surrounding said beam of luminous flux, means fixed to said frame for guiding said tape across the path of said beam, said means comprising a bar channeled in the direction of the advancement of said tape to approximately fit said tape and having an extended surface in the vicinity of said beam to fix the plane of interception of said tape with said beam, the channeling of said bar partially enclosing the side of said tape leaving said characters exposed to said beam, a concave reflecting surface surrounding said beam gathering light reflected by said tape due to said interception and redirecting said light to said cell, and said bar having a width permitting said redirected light to go around said tape to said cell without substantial interference by supporting structure for the tape.

2. In a photoelectric pick-up apparatus employing a source of light transmitting a beam of luminous flux to a photoelectric cell and in which said beam is transversely intercepted by a longitudinally slideable tape having signal characters embodied therein, a supporting frame surrounding the path of said flux, means fixed to said frame for guiding said tape across the path of said beam, said means including a member having an extended plane surface in the vicinity of said beam to support one face of said tape at the interception thereof with said beam, said member having an extended surface at a right-angle to said plane surface to fix the lateral path of said tape on said plane, under sliding operation of said tape, a concave reflecting surface surrounding said beam gathering light reflected by said tape due to said interception and redirecting said light to said cell, and said bar having a width permitting said redirected light to go around said tape to said cell without substantial interference by supporting structure for the tape.

3. In a photoelectric pick-up apparatus employing a source of light transmitting a beam of luminous flux to a photoelectric cell and in which said beam is transversely intercepted by a longitudinally slideable tape having signal characters embodied therein, a supporting frame surrounding the path of said flux, means fixed to said frame for guiding said tape across the path of said beam, said means including a member having an extended plane surface in the vicinity of said beam to support one face of said tape at the interception thereof with said beam, said member having an opening at said interception providing for the transmission of said beam through said member, said member having an extended surface at a right-angle to said plane surface to fix the lateral path of said tape on said plane, under sliding operation of said tape, a concave reflecting surface surrounding said beam gathering light reflected by said tape due to said interception and redirecting said light to said cell, and said bar having a width permitting said redirected light to go around said tape to said cell

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without substantial interference by supporting structure for the tape.

4. In a photoelectric pick-up apparatus employing a source of light transmitting a fixed local distance scanning beam of luminous flux to a photoelectric cell and in which said beam is transversely intercepted by a longitudinally slideable tape having signal characters embodied therein, a supporting frame surrounding the path of said flux, means fixed to said frame for guiding and supporting said tape longitudinally across the path of said beam, said means including a member having an extended plane surface in the vicinity of the crossing of said path by said tape fixing said focal distance, said member having a channeled surface at a right-angle to said plane surface fixing the alignment of said characters with reference to said beam, a concave reflecting surface surrounding said beam gathering light reflected by said tape due to interception thereby of said beam, and said surface redirecting said light around said tape to said cell.

5. In a photoelectric pick-up apparatus employing a source of light transmitting a fixed focal distance scanning beam of luminous flux to a photoelectric cell and in which said beam is transversely intercepted by a longitudinally slideable tape having signal characters embodied therein, a supporting frame surrounding the path of said flux, means fixed to said frame for guid-

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ing and supporting said tape longitudinally across the path of said beam at said focal distance, a concave reflecting surface surrounding said beam gathering light reflected by said tape due to interception thereby of said beam and redirecting reflected luminous flux from said surface to said cell, said means lying across the field of said reflected luminous flux, said means including a member having a surface extended longitudinally with the direction of sliding of said tape over the entire field of said reflected luminous flux to support said tape in the vicinity of the crossing of said path by said tape fixing said focal distance, and said surface extending laterally of said direction only sufficient to support and guide said tape, whereby said reflected luminous flux is intercepted in a direction transverse to said tape by said means an amount only slightly in excess of the width of said tape.

MONTFORD MORRISON.

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