

Aug. 19, 1947.

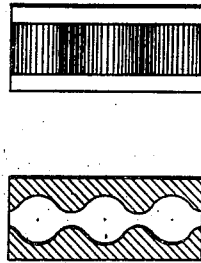
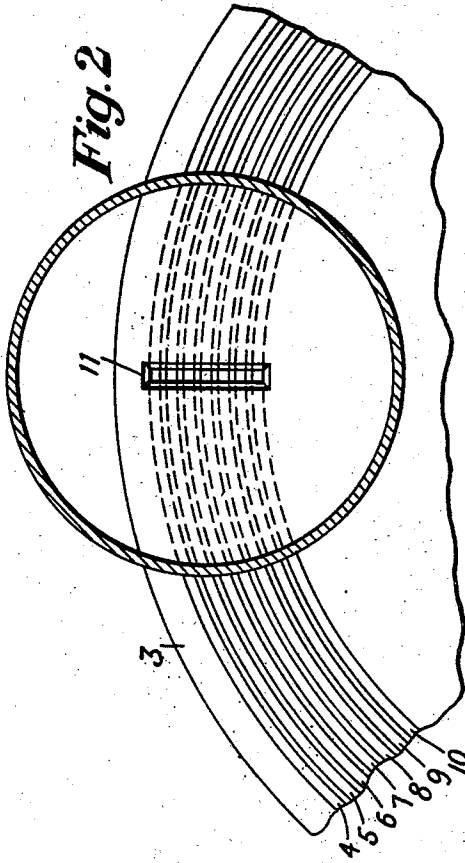
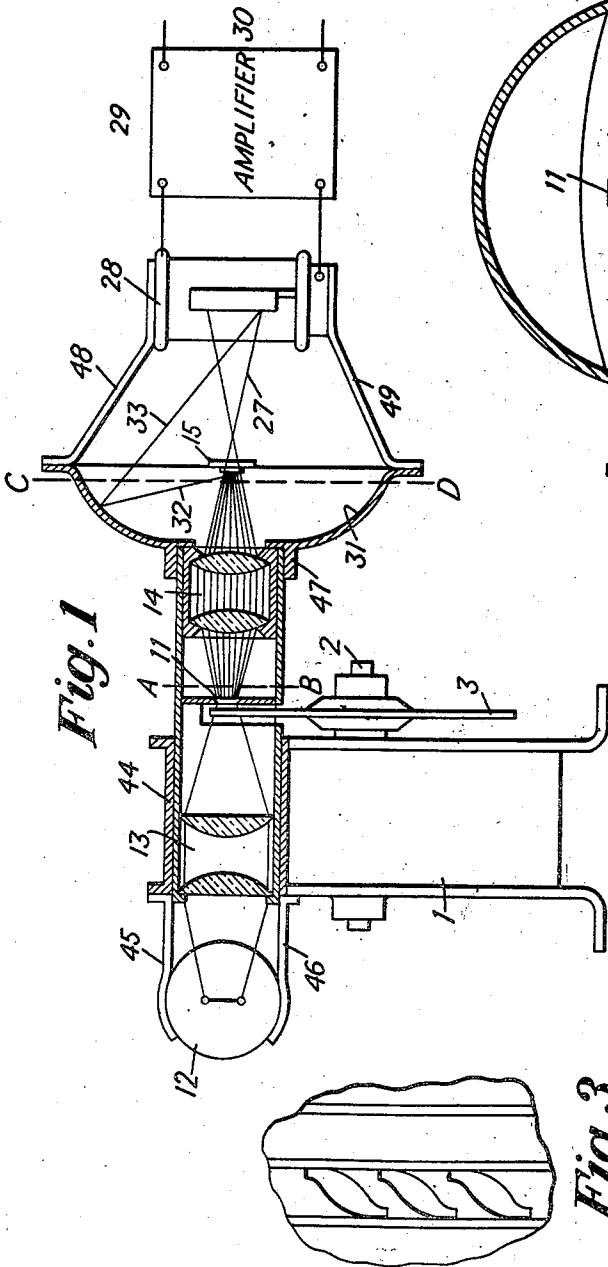
M. MORRISON

2,425,950

SIGNAL TRANSMISSION DEVICE

Filed June 12, 1945

3 Sheets-Sheet 1



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Aug. 19, 1947.

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3 Sheets-Sheet 2

Fig. 6

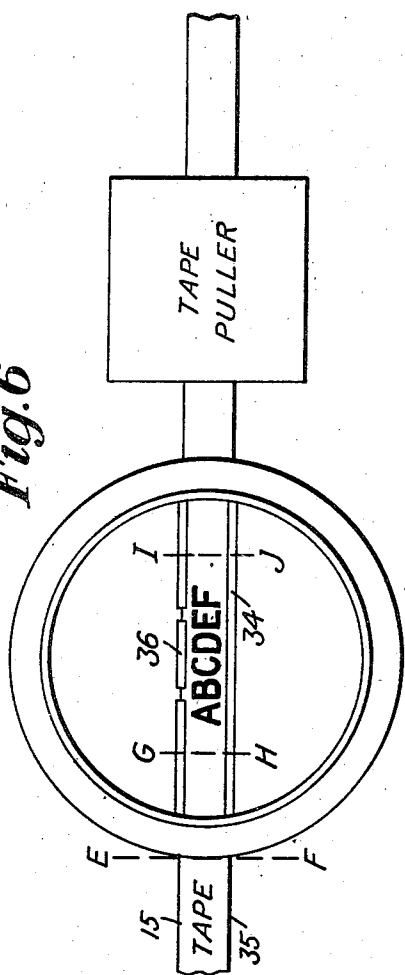


Fig. 7

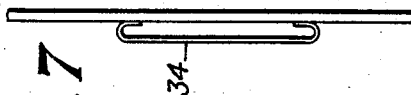
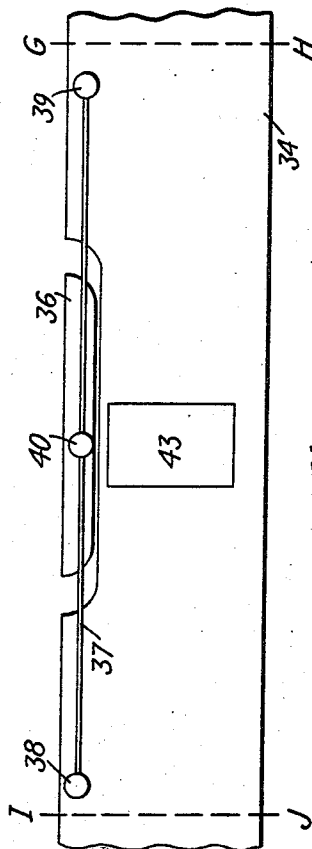


Fig. 8



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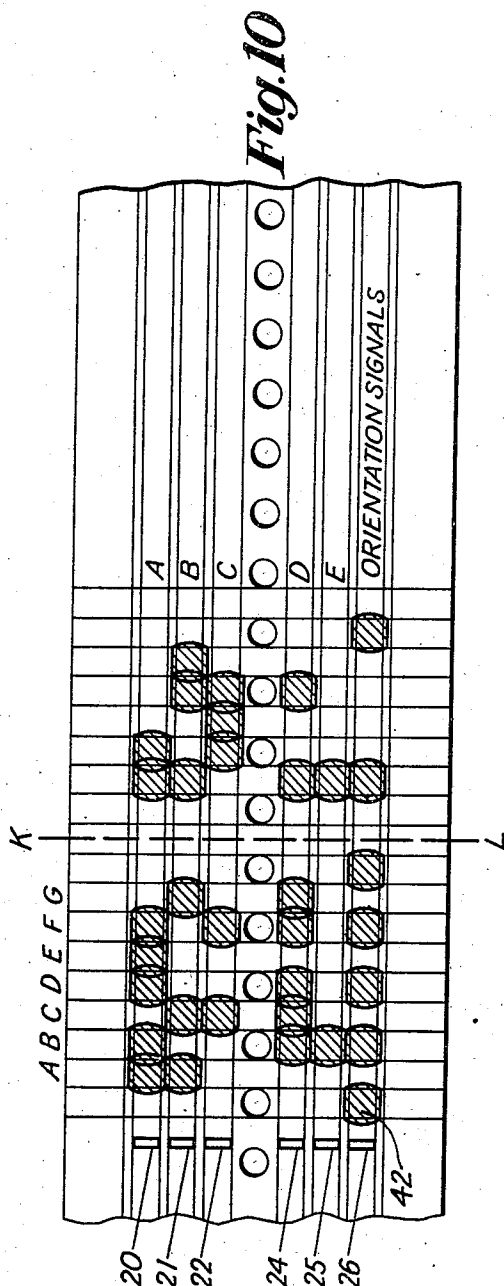
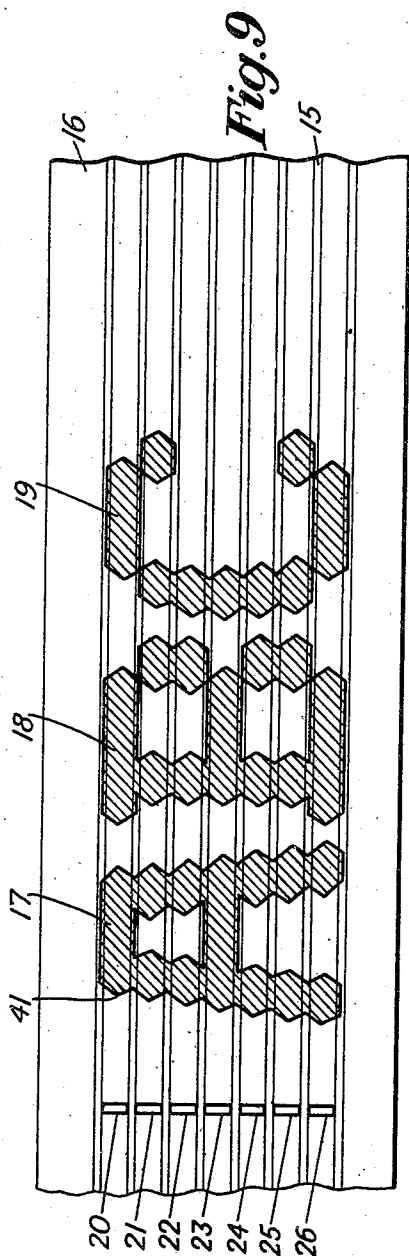
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Filed June 12, 1945

3 Sheets-Sheet 3



INVENTOR.

Montford Morrison

UNITED STATES PATENT OFFICE

2,425,950

SIGNAL TRANSMISSION DEVICE

Montford Morrison, Upper Montclair, N. J.

Application June 12, 1945, Serial No. 599,007

5 Claims. (Cl. 250—41.5)

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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 continuation in part of application Serial No. 496,903, filed July 31, 1943, which issued as Patent No. 2,380,666.

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 band-width of the transmission frequencies required and reduces the interchannel interference in the receiving circuit-filters.

A prime requirement of multi-channel carrier-current telegraph transmission systems is that the transmission currents of the different channels be so formed that they are capable of separation in the receiving circuit filters. This means that the transmitted signals must be modulated upon waves which are free of harmonic components lying within the transmission band of frequencies employed in the system. The fundamental carrier wave-forms must be substantially entirely free of all harmonics of the fundamental, beginning with the second and extending through a considerable range of harmonics thereafter. In systems employing a single photoelectric cell for signal translation, the above-stated purity of wave form is critical to operative usefulness. See the article by Cruickshank, in the British Institution of Electrical Engineer's Journal, July 1929, "Voice-frequency telegraphs."

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It is well known in the art of harmonic analysis of waves, that any wave, made up of discontinuous impulses of uni-polar half sine-waves, is not the equivalent of any continuous complete sine-wave, but rather is the equivalent of one which contains a fundamental sine-wave of the periodicity of the impulses, plus a high amplitude second harmonic and a succeeding series of harmonics of substantial, but decreasing amplitudes, having frequencies which lie within the transmission band of useful carrier-current telegraph systems. This is particularly true for the lower frequency carrier fundamentals in voice frequency carrier telegraph systems—the systems pertinent to the present case.

Such wave-forms therefore, are unusable as fundamental carrier frequencies, where channel separation is required to attain reception of transmitted signals.

Where photoelectric generators are employed to produce fundamental carrier frequencies, the modulating device employed in these generators must be such that it does not produce any harmonic components of the fundamental frequency that lie within the transmission band, as such harmonic components penetrate into the filter circuits adjacent to the fundamental filter circuit, preventing effective channel separation.

Several prior patents have disclosed photoelectric generators employing revolving opaque discs with openings therein described as light modulators having "sinusoidal" openings therein and producing "sinusoidal" variations in the flux.

A first structure which may be said to represent a pioneer patent in the photoelectric generator field employs an opening having the form of a half-sinusoid, but fails to teach how such an opening can be made to produce a complete sine wave of generated current and it is obvious that no such wave can be produced by such a structure.

A second structure is believed to be the first patent, to disclose a light modulating disc of opaque material having a plurality of concentrically arranged rows of sinusoidal openings therein. These openings do in fact produce sinusoidal light modulations in the particular structure disclosed. However, the disclosed modulating disc requires a plurality of cooperating slits and therefore, under any set of objective operational conditions, the modulated beam has a lateral sweeping motion added to the light flux modulation. This structure cannot be made to produce sinusoidal modulations with a stationary slit or so function with a stationary beam. It

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is not disclosed as a photoelectric signal pick-up system, nor is it obvious that it could be used as such.

A third structure utilizes a light modulating system employing a transparent glass or Celluloid disc without openings therein, but with sinusoidal traces formed thereon.

A fourth structure comprises a disc like that of the second structure applied to an optical system like that of the third structure providing a stationary modulated beam, which combination permits its use as a scanning means in a photoelectric signal pick-up system. This fourth structure employs discrete openings of the exact form of a half-sinusoid in an opaque disc, which openings are described as "sinusoidal." While such openings may be said to be partly sinusoidal in character, they cannot be modified by extension to be completely sinusoidal in form, as is critical to the objectives of his disclosure under the requirements set forth, *supra*.

An attempt to make the openings of the fourth structure completely sinusoidal would result in destroying his disc by cutting it into ring-shaped pieces. For this reason the disc of the second structure applied to the optical system of the third structure cannot be made to produce completely sinusoidal light modulations, as required for carrier-current telegraph systems.

The inventor of the fourth structure suggests in his specification, that a modulating disc may be made of transparent material by a photographic or other process and that his modulating annuli may vary sinusoidally and have a minimum modulation dimension greater than zero. This suggestion, if carried out with the form of the modulation openings shown in his disc and described to be sinusoidal, would not result in a completely sinusoidal modulation. A form of structure which would, under these processes, produce sinusoidal modulations, is, however, disclosed in the form of the third structure.

However, neither the inventor of the third nor of the fourth structure teaches how such a structure may result in openings in the modulating disc. It is well known that photographic processes applied to photo sensitive coatings on translucent discs do not result in openings in the discs. The inventor of the fourth structure does not teach how discrete openings of any form may be made in a modulator to function to provide completely sinusoidal modulations of luminous flux.

The present invention involves the provision of discrete openings in an opaque rotatable modulator formed to produce luminous flux modulations that are completely sinusoidal within the band of transmission frequencies used in the carrier system employed, and particularly within the operational frequency response of the translation photo electric cell.

While the inventor of the third structure illustrates a transparent light modulating disc having a plurality of concentric areas, each area constituted to sinusoidally modulate the light directed thereon, and a source of light with a cylindrical lens system for concentrating the light from the source into a line, he does not disclose how completely sinusoidal luminous flux modulations could be attained by discrete openings in opaque material.

An important requirement in the economic structure and economic operation of a carrier-current telegraph system is the "line time" per channel required to transmit a single signal character. Since the period of time and the

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number of channels required to transmit a single character are determining factors in the cost of message transmission, the smaller the number of channels required to transmit a signal character, the less will be the cost of the transmission apparatus, and the greater will be the possibility of transmitting more than one character at a time within a given band of transmission frequencies, in a multi-channel optical signal pick-up carrier telegraph transmission system.

The prior art systems of optical pickup for telegraph transmission, which are pertinent to the category of the present invention, are substantially all random scanning facsimile systems. The present invention strictly is not such a system.

Facsimile systems are those which have a scanning beam or scanning beams which are small enough and which scan a sufficient number of lines per inch to pick up a facsimile signal of any form encountered by random scanning. Another distinguishing feature of facsimile systems is that they scan the entire area of the support on which the signal characters are recorded. Lindenblad, *supra*, is an example of a random scanning facsimile system in that he scans the entire width of the tape, illustrating 12 channels to cover the entire width.

By the employment of the present invention for message transmission, a great saving is attained in the number of modulated scanning beams required in the transmitter, the number of channels required in the transmission circuit and the number of separation filters required in the receiver.

By reducing the number of such circuit elements required to transmit a single character, many improvements are attained:

(a) The cost of the entire system is reduced.

(b) The width of the band of transmission frequencies may be reduced.

(c) The fewer the number of channels, the more easily interchannel interference may be reduced. (See Patent No. 2,370,985.)

(d) With a given transmission band width, the fewer the number of channels the greater may be the frequency separation between channels, resulting in less expensive separation filters.

(e) Greater frequency separation between channels permits higher transmission speed, reducing the line time, thus reducing the cost of transmission.

(f) By reducing the channels required to transmit a single character to a minimum and retaining a normal channel frequency spacing, it is possible to transmit two characters simultaneously within a normal voice frequency band, thereby doubling the transmission efficiency.

In the present invention the signal characters, which may be letters, figures or other characters, are delineated, each by a combination of areas, each area lying within a predetermined single scanning track. A multiplicity of parallel scanning tracks is employed such that a single transit of all the tracks completely determines the identifying characteristic of the signal character.

The number of unitary areas and therefore the number of scanning tracks employed, is determined by the typographic quality of the characters that is acceptable under the circumstances.

This method differentiates from the prior art in that it completely avoids random scanning. Random scanning requires station terminal equipment and transmission circuit time for

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scanning operations which results in no pick-up of signal intelligence. By eliminating this wastage, important improvements in the art are attained.

Any photoelectric pick-up system which modulates the light beam before the scanning operation, requires that the carrier frequency response of the photoelectric cell come within the limits of the wave form, set forth supra. The present invention involves a rotatable modulator having discrete openings providing such wave forms.

By providing signal characters formed by the composition of a definite number of unitary areas which all lie within predetermined scanning tracks, and by providing a scanning operation in which the scanning beams are constrained to these tracks, double scanning of a single elementary area is avoided and therefore double circuit signals in the receiver are avoided. It is appreciated by those skilled in the art that in the case of random scanning, a single longitudinal character element may come within the path of two scanning beams, resulting in a double width line in the receiving recorder. This is particularly important where a minimum number of channels are employed to scan a single signal character. In the prior art where random scanning is practiced, this effect is minimized by the very large number of scanning transits employed for a single character and the accompanying very small area scanned.

Gildermeister, German Patent 527,176, (1931), discloses a definite number of carrier channels per character, but proposes scanning by unmodulated beams of light, with frequency modulation by separate modulators after signal modulation, separate photoelectric cells and separate coupling circuits for transmission. While the device is complex, it does not teach nor require sinusoidal transmission frequency modulations, because the separate output circuits may be separately filtered to produce sinusoidal output currents.

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 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 by alternating-current derived by amplification from a tuning fork oscillator; or, preferably, it may be of the highly constant speed form

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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-cut-off 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 the 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 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 area 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—, 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.

With further reference to the openings shown in Fig. 3, and their operative function in the system shown in Fig. 1, it is well known in the art that photoelectric cells, of the type commonly employed in optical pick-up systems for facsimile transmission, have a very pronounced limitation in the frequency response thereof. It is well known that this frequency response begins to fall off sharply in the upper audio range and becomes ineffective at several times this range.

This photoelectric cell frequency response limitation is not necessarily a disadvantage in facsimile systems employing luminous flux carrier frequencies obtained by mechanical modulation, since the over-all limitations of all factors necessarily employed in such systems, limit practically operative systems to the audio frequency range in the optical pick-up employed.

So long as the luminous flux frequency modulations produced by the openings shown in Fig. 3 does not contain any low order harmonics of the fundamental carrier frequency (such as the second, third, fourth or fifth, et cetera), higher order harmonics, if present, automatically fall outside the range of the transmission frequency band, in practical systems, and ultra-high order harmonics fall within the ineffective frequency response of the photoelectric cell.

Therefore, it is obvious that the amount of overlapping employed (if any) in the openings

shown in Fig. 3, depends upon the width of the optical slit and the frequency response of the photoelectric cell employed.

If the slit width employed is of the order of a value found in common practice in the audio frequency reproduction art (say 0.001"), the adjacent ends of the openings in Fig. 3 can be overlapped any amount which is insufficient to produce a modulation impulse having a duration within the effective range of the frequency of the photoelectric cell employed. In common practice, this overlapping may be advantageously of the order shown in the figure, since for useful frequencies in the audio range produced by the openings in the figure, the duration of the impulse, produced by the percentage overlapping shown, would be too short for effective frequency response by cells commonly employed in the art.

If the duration of the impulse represents a frequency outside of the effective frequency response of the photoelectric cell, obviously this frequency is outside of the transmission band of the system.

There is a distinct advantage, when using slits of the width given above, to have some overlapping of the modulating openings because less accuracy is required in the alignment of the optical system to provide completely sinusoidal luminous flux modulations. This is due to the fact that the frequency response of the cell applies to durations of absence of luminous flux as well as does it apply to durations of presence of luminous flux.

Where no overlapping of the openings is employed with a 0.001" slit, a high degree of optical system alignment accuracy is required to prevent the duration of cut-off to the minimum required to be outside the frequency response of the cell. Some overlapping has the effect of reducing the accuracy required.

However, with slits of a width of the order of several times that of the value mentioned, no overlapping of the openings may be required, since the extra width of the slit provides the continuity of the completely sinusoidal modulation of the luminous flux, within the frequency response of the photoelectric cell.

It is well known in the photoelectric cell art, as applied to facsimile transmission, that the frequency responses of cells commonly employed in this art, begin to fall off in the upper audio frequency range and become ineffective for frequencies substantially above this range. This characteristic applies to periods of absence of luminous flux as well as to periods of presence of luminous flux, as is well known in the art. The expression "sinusoidal within the operating frequency response of said cell" is used herein to mean that any additions to, subtractions from, or modifications of, the luminous flux causing the completely sinusoidal carrier currents generated, is of a frequency order too high for the photoelectric cell employed to modulate any such deviations present, upon the generated wave.

The expression "alphabetic characters" as used herein, is hereby defined to include numerals.

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

What I claim is:

1. A photoelectric generator of continuously periodically varying electric currents comprising a photoelectric cell, a light source transmitting a continuous stationary beam of luminous flux to said cell, a stationary member of opaque material embracing an optical slit, said slit being

located in said beam with the effective plane of the limiting aperture thereof oriented at a right-angle to the direction of said beam, a traveling member associated with said stationary member and having opaque surface embracing rotatable discrete openings therein formed into a continuous series having a circuitous path and modulated dimensions transverse to said path, adjacent openings in said series extending along said path to register simultaneously with said slit, said circuitous path intercepting said beam of said luminous flux in a direction transverse to the longitudinal direction of said slit, said luminous flux transmitted to said cell passing through both said slit and said openings, and the instantaneous values of said dimensions registering through said slit varying within the operational frequency response of said cell as a complete sine-curve with the rational displacements of said discrete openings under continuous operation, whereby the luminous flux from said source to said cell transmitted through said slit and said discrete openings by conjoint action thereof varies within the operational frequency response of said cell as a full sine wave and has quantitative values limited by the product of said width and said instantaneous values, within said operational response.

2. A photoelectric generator of continuously periodically varying electric currents comprising a photoelectric cell, a light source transmitting a continuous stationary beam of luminous flux to said cell, a stationary member of opaque material embracing an optical slit, said slit being located in said beam with the effective plane of the limiting aperture thereof oriented at a right-angle to the direction of said beam, a continuously traveling member associated with said stationary member and having an extended surface embracing rotatable discrete openings therein formed into a continuous series having a circuitous path, said circuitous path intercepting said stationary beam of luminous flux in a direction transverse to the longitudinal direction of said slit, said luminous flux transmitted to said cell passing through both said slit and said openings, the sum dimension of said openings registering through said slit varying within the operating frequency response of said cell sinusoidally with the travel of said traveling member, and said discrete openings being formed and oriented to prevent complete cut-off of said flux through said slit for a period of time operatively responsive by said cell.

3. A photoelectric generator of continuously periodically varying electric currents comprising a photoelectric cell, a light source transmitting a continuous stationary beam of luminous flux to said cell, a stationary member of opaque material embracing an optical slit, said slit being located in said beam with the effective plane of the limiting aperture thereof oriented at a right-angle to the direction of said beam, a continuously traveling member associated with said stationary member and having an extended surface embracing rotatable discrete openings therein formed into a continuous series having a circuitous path, said circuitous path intercepting said stationary beam of luminous flux in a direction transverse to the longitudinal direction of said slit, said luminous flux transmitted to said cell passing through both said slit and said openings, the sum

dimension of said openings registering through said slit varying within the operating frequency response of said cell sinusoidally with the travel of said traveling member, and said discrete openings being formed and oriented to include parts of two of said openings registering through said slit at a single instant of time of travel of said traveling member.

4. A photoelectric generator of continuously periodically varying electric currents comprising a photoelectric cell, a light source transmitting a continuous stationary beam of luminous flux to said cell, a stationary member of opaque material embracing an optical slit, said slit being located in said beam with the effective plane of the limiting aperture thereof oriented at a right-angle to the direction of said beam, a continuously traveling member associated with said stationary member and having an extended surface embracing rotatable discrete openings therein formed into a continuous series having a circuitous path, said circuitous path intercepting said stationary beam of luminous flux in a direction transverse to the longitudinal direction of said slit, said luminous flux transmitted to said cell passing through both said slit and said openings, the sum dimension of said openings registering through said slit varying within the operating frequency response of said cell sinusoidally with the travel of said traveling member, and the adjacent ends of successive openings being spaced laterally with reference to the longitudinal direction of travel of said traveling member.

5. A photoelectric generator of continuously periodically varying electric currents comprising a photoelectric cell, a light source transmitting a continuous stationary beam of luminous flux to said cell, a stationary member of opaque material embracing an optical slit, said slit being located in said beam with the effective plane of the limiting aperture thereof oriented at a right-angle to the direction of said beam, a continuously traveling member associated with said stationary member and having an extended surface embracing rotatable discrete openings therein formed into an continuous series having a circuitous path, said circuitous path intercepting said stationary beam of luminous flux in a direction transverse to the longitudinal direction of said slit, said luminous flux transmitted to said cell passing through both said slit and said openings, the sum dimension of said openings registering through said slit varying within the operating frequency response of said cell sinusoidally with the travel of said traveling member, and the adjacent ends of successive openings being spaced laterally and overlapped longitudinally with reference to the direction of travel of said traveling member.

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Certificate of Correction

Patent No. 2,425,950.

August 19, 1947.

MONTFORD MORRISON

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Column 11, line 5, claim 1, after the word "having" insert *an*; line 19, same claim, for "rational" read *rotational*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of September, A. D. 1947.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.