

Oct. 8, 1946.

G. L. BUSH

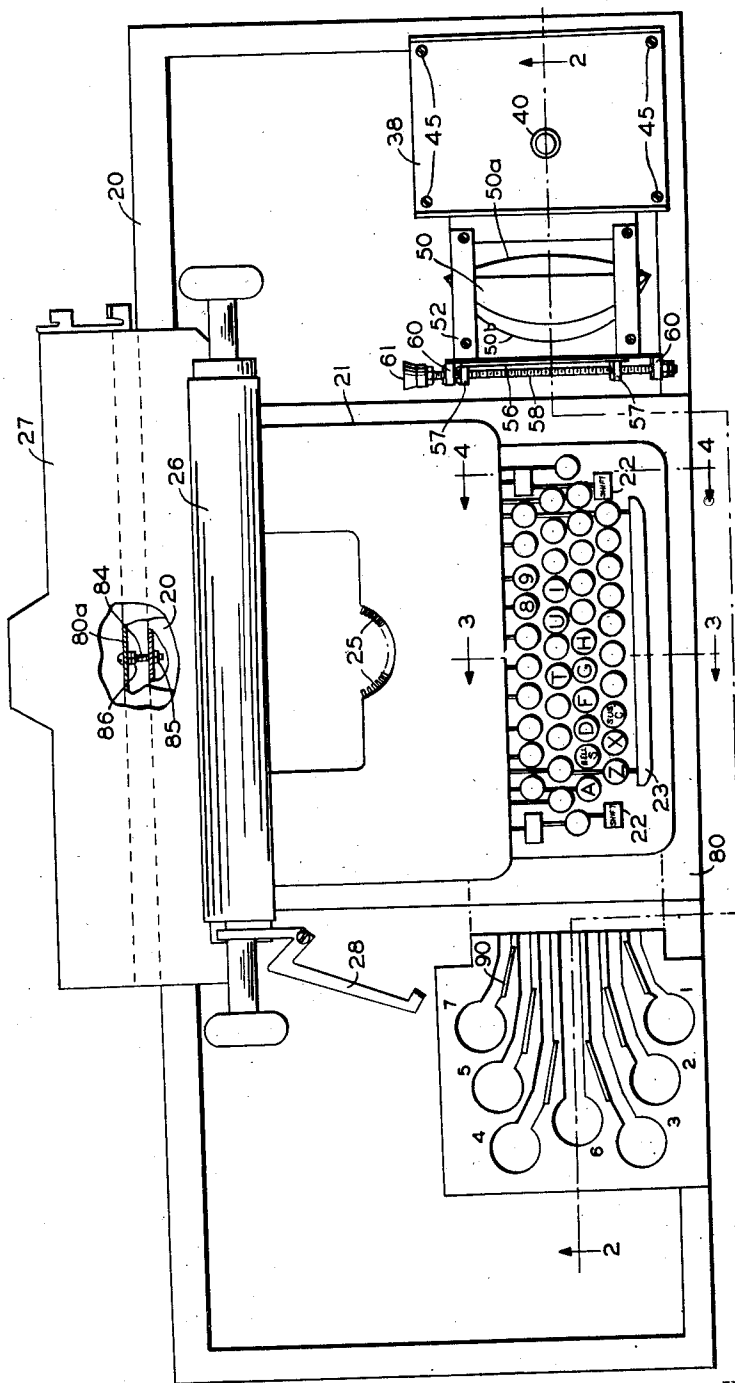
2,408,754

PHOTOELECTRIC TRANSMITTING TYPEWRITER APPARATUS

Filed July 27, 1944

6 Sheets-Sheet 1

Fig. 1



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FIG. 6

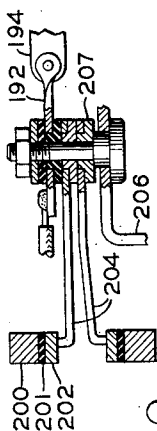
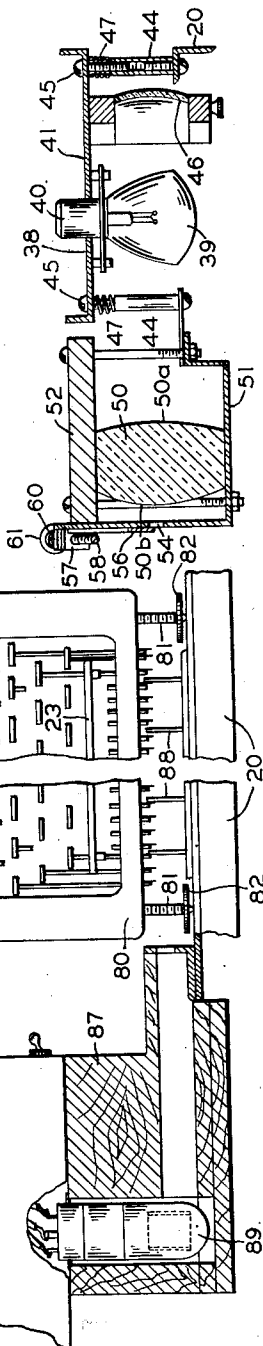
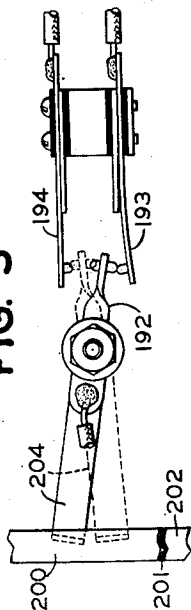


FIG. 2



FIG. 5



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FIG. 3A

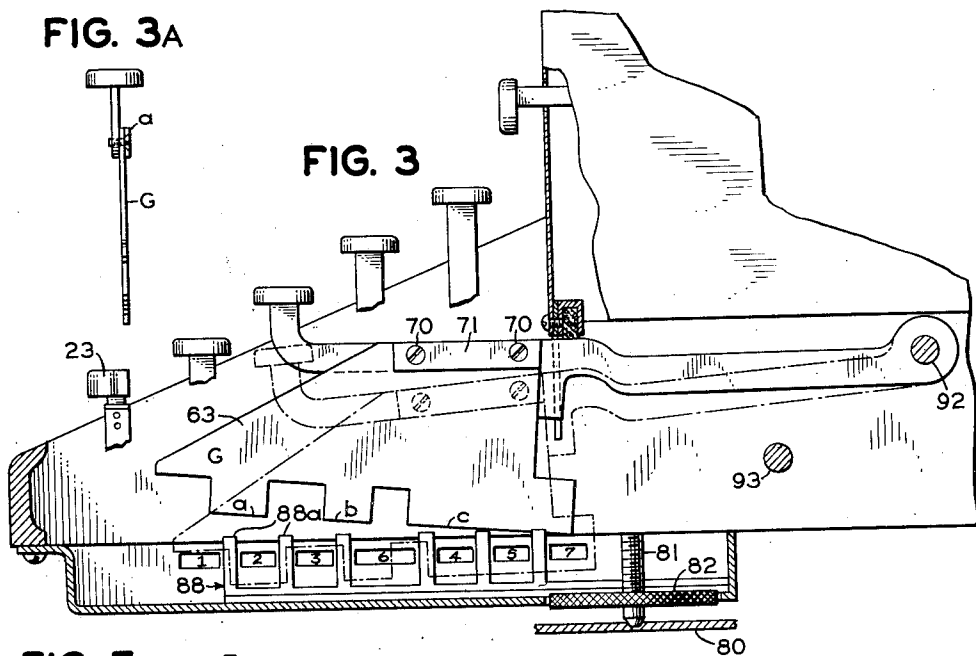


FIG. 7

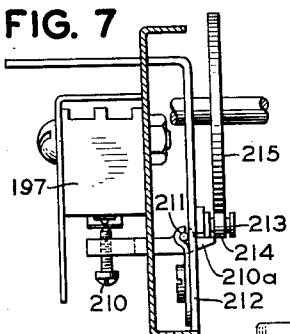


FIG. 4

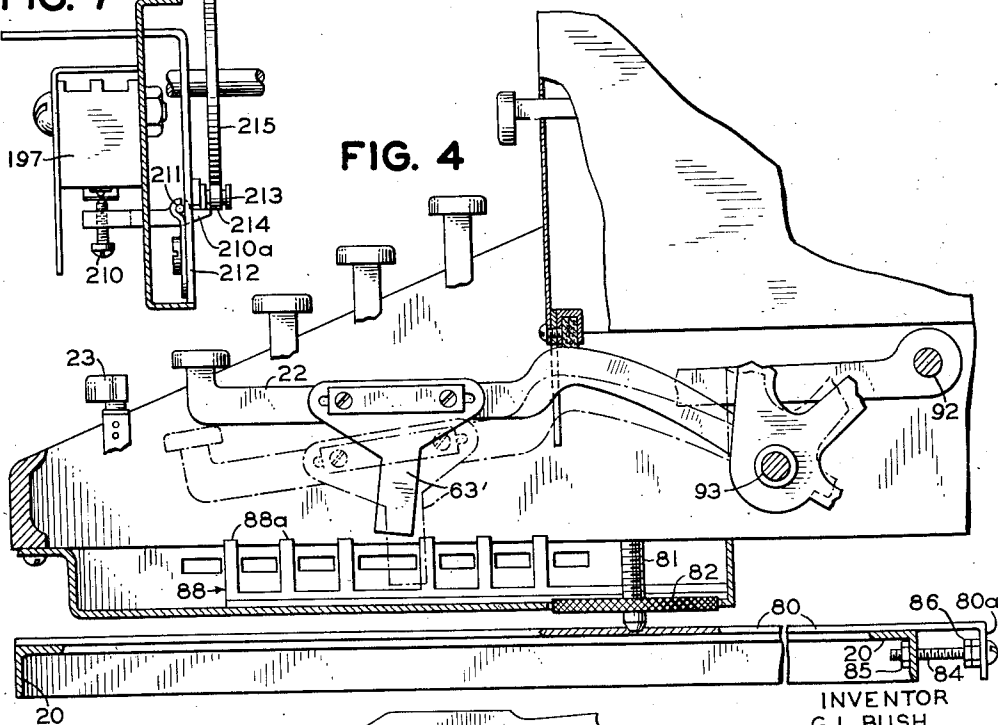
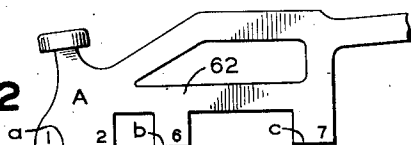


FIG. 12



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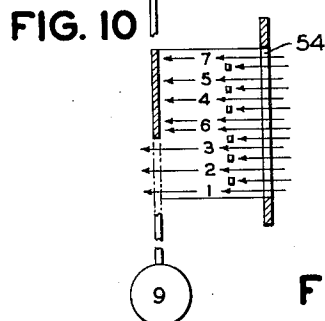
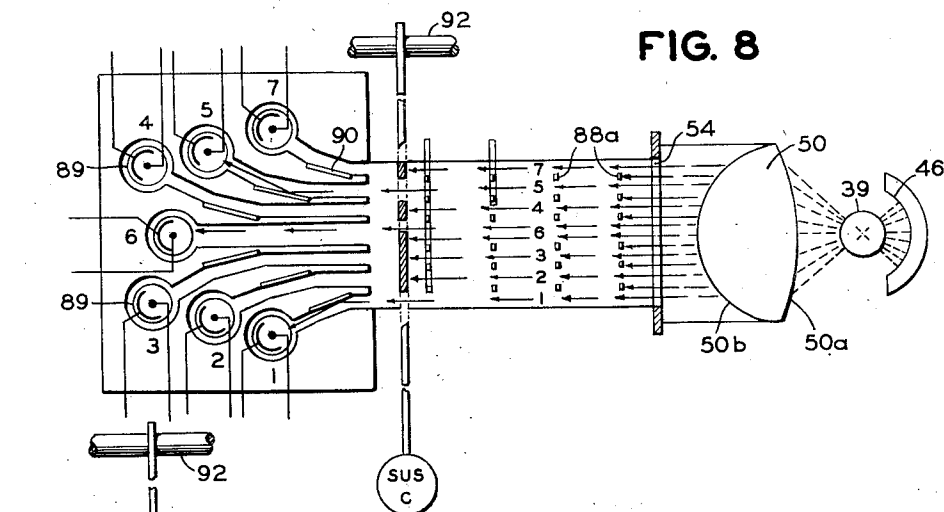


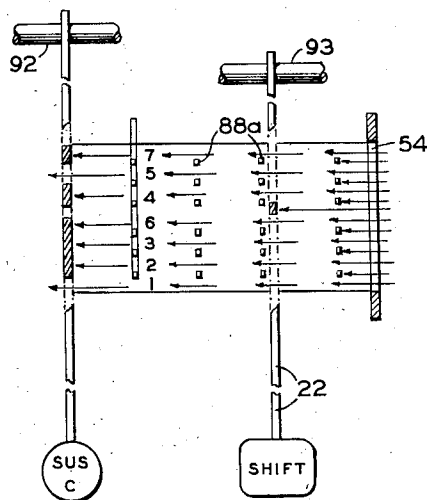
FIG. 11

CHAR- ACTER ON KEY	1	2	3	6	4	5	7
ST	+	+	+	+	+	+	+
A-2	+	+	+	+	+	+	+
K	+	+	+	+	+	+	+
Q	+	+	+	+	+	+	+
1	+	+	+	+	+	+	+
U	+	+	+	+	+	+	+
7	+	+	+	+	+	+	+
/	+	+	+	+	+	+	+
A-J	+	+	+	+	+	+	+
W	+	+	+	+	+	+	+
2	+	+	+	+	+	+	+
A	+	+	+	+	+	+	+
X	+	+	+	+	+	+	+
REP	+	+	+	+	+	+	+
F	+	+	+	+	+	+	+
Y	+	+	+	+	+	+	+
6	+	+	+	+	+	+	+
BELL	+	+	+	+	+	+	+
CM	+	+	+	+	+	+	+
B	+	+	+	+	+	+	+
D	+	+	+	+	+	+	+
Z	+	+	+	+	+	+	+
FP	+	+	+	+	+	+	+
E	+	+	+	+	+	+	+

CHAR- ACTER ON KEY	1	2	3	6	4	5	7
3	+	+	+	+	+	+	+
WEA	+	+	+	+	+	+	+
V	+	+	+	+	+	+	+
SUS	+	+	+	+	+	+	+
C	+	+	+	+	+	+	+
P	+	+	+	+	+	+	+
0	+	+	+	+	+	+	+
I	+	+	+	+	+	+	+
8	+	+	+	+	+	+	+
G	+	+	+	+	+	+	+
R	+	+	+	+	+	+	+
4	+	+	+	+	+	+	+
A-3	+	+	+	+	+	+	+
L	+	+	+	+	+	+	+
.	+	+	+	+	+	+	+
M	+	+	+	+	+	+	+
N	+	+	+	+	+	+	+
H	+	+	+	+	+	+	+
SP	+	+	+	+	+	+	+
EM	+	+	+	+	+	+	+
O	+	+	+	+	+	+	+
9	+	+	+	+	+	+	+
T	+	+	+	+	+	+	+
5	+	+	+	+	+	+	+
SH	+	+	+	+	+	+	+

BY

FIG. 9



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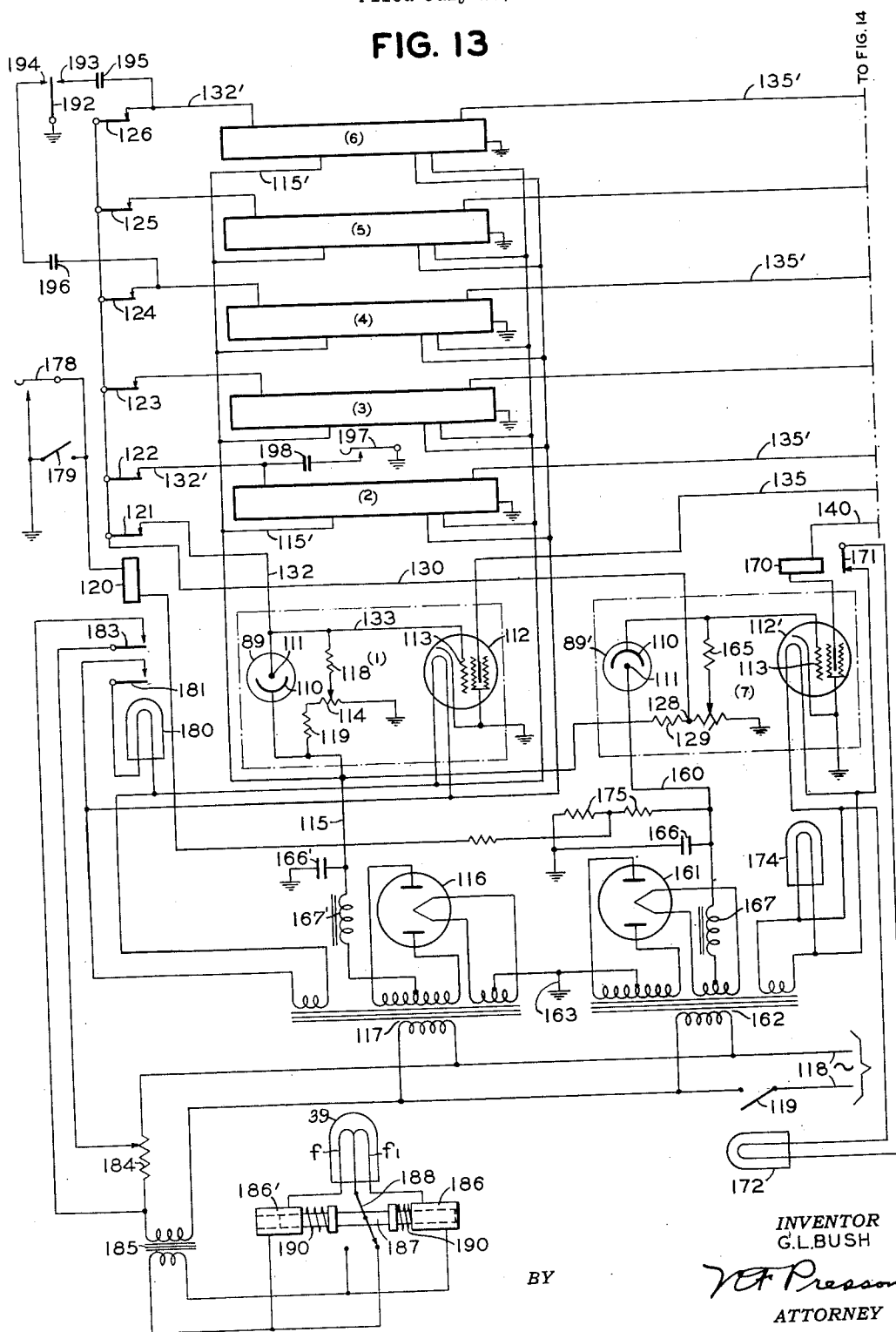
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FIG. 13



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UNITED STATES PATENT OFFICE

2,408,754

PHOTOELECTRIC TRANSMITTING
TYPEWRITER APPARATUS

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Application July 27, 1944, Serial No. 546,832

17 Claims. (Cl. 178—79)

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This invention relates to photoelectric transmitting typewriter apparatus and control circuit therefor, and more particularly to such apparatus whereby a conventional typewriter may be employed to generate permutation code telegraph signals, which signals may be transmitted either directly to receiving and printing apparatus or to perforator or other storage apparatus for subsequent retransmission of messages.

Various types of photoelectric transmitters have heretofore been proposed, but these have been subject to certain disadvantages, among which are that such devices do not have the same keyboard touch and manner of operation as a conventional typewriter; they require transmitting distributors and therefore a predetermined cadence of operation of the typewriter keys is required to be maintained; and in general have not proved acceptable for use in offices or other places where it is desirable that anyone who is familiar with the operation of a typewriter may transmit telegraph signals. One of the chief disadvantages of the use of telegraph keyboard transmitting equipment heretofore employed is that skilled operators are required to operate such devices in which a particular cadence and manner of operation is required. Thus, even though a great many persons are able to use typewriters, they are not sufficiently skilled in the use of telegraph transmitting apparatus, and usually it is necessary to employ trained operators for this purpose.

One of the objects of the invention is photo-electrical transmitting typewriter apparatus which employs the conventional typewriter and has the same keyboard touch and manner of operation as a typewriter, and in which no particular cadence or special skill is required for transmitting telegraph permutation code signals.

Another object is a transmitting typewriter which may be employed either as an ordinary typewriter for producing original and carbon typewritten copies or as a telegraph transmitter for transmitting permutation code signals, and which may be used for both purposes simultaneously.

Another object is transmitting typewriter apparatus of the character disclosed in which the conventional line feed operations of the typewriter are employed for transmitting line feed telegraph page printer signals.

Another object is a device of the character disclosed in which the conventional carriage return movements of a typewriter carriage are caused

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to transmit carriage return telegraph printer signals.

A further object is a transmitting apparatus of the character disclosed in which the upper case and lower case characters are transmitted by means of telegraph impulses generated by the operation of typing upper and lower case characters on a conventional typewriter.

Still another object is photoelectric typewriter transmitting apparatus in which if one of the typewriter keys, or the space bar or shift lever, is held depressed, inadvertently or otherwise, this does not affect the proper transmission of the character or functional signal represented by such operation, and in which notwithstanding continued depression of such keys, space bar or shift lever, only one character or functional signal corresponding thereto will be transmitted.

An additional object is means whereby the depression of a second typewriter key prior to release of a prior typewriter key by the operator or typist will not cause a garbled signal to be transmitted or otherwise interfere with the proper transmission of character signals, and in which the inadvertent depression of two or more typewriter keys simultaneously will not cause an improper signal to be transmitted.

A further object of the invention includes suitable tape feed-out control means whereby the signals generated by the typewriter and punched in a perforated tape may readily be advanced out of the tape perforator and into position to be transmitted by a tape transmitter associated therewith in a manner to prevent any lag in the transmission of a complete message after operation of the typewriter keyboard has ceased.

A still further object is an improved control circuit arrangement for perforating telegraph tape in accordance with the characters transmitted by the typewriter and in which reverte control by the tape perforator insures that the perforation of any character is completed before the system is reset for the reception of another character by the perforator.

Further objects and advantages of the invention will be apparent from the following detailed description, taken in connection with the accompanying drawings showing one illustrative embodiment of the invention, in which:

Fig. 1 is a top plan view of a conventional typewriter and associated photoelectric signal generating apparatus controlled by the keyboard of the typewriter in accordance with the invention;

Fig. 2 is a front sectional view in elevation, taken along the line 2—2 of Fig. 1;

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 1, illustrating the operation of the key lever for the letter G;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 1, illustrating the shift lever operation;

Fig. 5 is a detail of certain parts for automatically transmitting telegraph printer carriage return and blank signals;

Fig. 6 is a side view of the mechanism shown in Fig. 5;

Fig. 7 is a detail of certain elements employed for automatically transmitting telegraph printer line feed signals;

Fig. 8 is a diagrammatic view showing the condition of the photocell activating light channels which obtains when transmitting the letter C;

Fig. 9 illustrates the condition of the activating light channels for the transmission of the upper case character or symbol SUS on the "C" key lever, by employing the shift lever in combination therewith;

Fig. 10 illustrates the condition of the activating light channels for the transmission of a digit, for example, the digit 9;

Fig. 11 is a chart showing permutations of code elements which may be used when a six-unit telegraph code is transmitted;

Fig. 12 is a detail of the "A" key lever, showing one arrangement of light shutters employed;

Figs. 13 and 14 show an electrical transmitting and control circuit employed with the typewriter keyboard, and a perforator circuit for recording in a telegraph tape the signals transmitted by the typewriter keyboard; and

Fig. 15 is a diagrammatic representation of a transmitting and recording system together with retransmission apparatus.

Briefly, in the preferred embodiment disclosed herein the photoelectric typewriter translates the key depressions on a modified standard typewriter into six-unit permutation code signals for transmitting to another location the characters being typed on the typewriter. A series of seven light beams are selectively interrupted by coded shutters attached to the typewriter key levers. Each of the seven light beams is adapted to control an associated photoelectric cell which is in circuit with a grid-controlled rectifier, such as a Thyatron tube, for the purpose of recording on a relay, printer magnet or tape perforator trip latch magnet whether the associated light beam has been interrupted. Six of the photoelectric circuits represent the six marking and spacing code elements respectively of the six-unit code, and a seventh or universal photoelectric circuit prevents the operating or transmitting cycle from being repeated should a key be held depressed. The shutters on all the key levers except the shift lever interrupt the seventh light beam. The light beam which represents the sixth element of the code is wider than the others, and is completely interrupted by depression of any one of the figures keys since the figures signals always have the sixth element of the code. The Thyatron grid circuits are arranged, as hereinafter described in detail, so that each of the six code element Thyatrons fires when the associated light beam is interrupted, whereas the seventh Thyatron normally is fired and is extinguished when its plate circuit is opened upon the recordation of a character by the recorder above-mentioned, and is prevented from refiring so long as the seventh light beam is interrupted. The shutters on those letter keys

which do not have the same code elements as a figure signal partially interrupt the sixth light beam, but not enough to allow the associated Thyatron to fire. The light shutter on the shift lever interrupts the part of the sixth light beam which is not interrupted by the shutters on the letter key levers. When it is desired to transmit upper case characters, the concurrent depression of the shift key and any letter key will completely interrupt the sixth light beam and introduce a sixth unit in the code.

Referring now to Figs. 1 to 4 of the drawings, the essential parts of the apparatus are mounted on a suitable base, such as an angle iron framework 20. Adjustably supported on the framework is a conventional typewriter 21 having a keyboard which includes various upper and lower case character key levers, shift levers 22 and a space bar 23. Each of the character key levers, as is well known, may be depressed to actuate one of the type bar members 25 against a sheet of paper which passes around the platen 26 when a message is being typed on the machine, the platen being mounted on a traveling carriage 27 in known manner. The usual carriage return and line space lever 28 is employed to return the carriage to the left after a line has been typed and also to give the proper line spacing.

Mounted on the framework 20, at the right hand side of the typewriter 21, is a housing 30 which, as shown in Fig. 2, contains an exciter lamp 39 that is mounted in a pre-focus socket 40 to insure that when an exciter lamp is replaced, the lamp filament will remain in the same position with respect to the optical system and thus not require readjustment of the system. The pre-focus socket is carried by a plate 41 which is mounted by means of spacers 44 on the framework. In order to provide for vertical adjustment of the plate 41, four screws 45 (of which two are seen in the figure) are threaded into the spacers or studs 44, resilient coil springs 47 around the screws serving to hold the plate 41 at its four corners in its adjusted position. The position of the source of light relative to the optical system also may be adjusted in a horizontal direction since the plate 41 may be tilted, by proper adjustment of the screws 45, so as to compensate for any horizontal deviation as well as any vertical deviation.

Secured to the plate 41 is a spherical reflector 46 which serves to concentrate the source of light from the filament of exciter lamp 39 and produce a uniform source of light for application to a lens 50. The surface 50a of the lens adjacent to the exciter lamp 39 is generally spherical, whereas the other surface 50b of the lens has a parabolic configuration thereby to project horizontal parallel rays of light through an elongated aperture 54 in the lens supporting chassis 51. The lens is suitably clamped in position by members 52 of wood or other suitable resilient material, and the elongated aperture 54 is adjustable in extent by means of an outer plate 56 which has secured thereto threaded ears or nuts 57, Fig. 1, which receive a threaded rod 58, the rod passing through bearings 60, whereby as the handle 61 of the adjusting rod is rotated, the threaded portion of the rod causes lateral movement of the nuts 57 and plate 56. The rod 58 is mounted at an angle with respect to the horizontal so that lateral movement of the plate 56 will vary the height of the rectangular light aperture 54 and thus closely control the thickness of the rectangular beam of light which is projected

in a horizontal plane beneath the typewriter keyboard.

In the illustrative embodiment shown in the drawings the photoelectric apparatus is arranged to translate the key depressions on a modified standard typewriter into a six-unit code for transmitting the message. The six-unit code is employed to avoid the necessity of sending shift and unshift signals when there is a change from upper to lower case or vice versa, but it will be understood that the apparatus may be employed to send signals comprising any other number of code units depending upon the nature of the information and the purpose for which the apparatus is to be employed. In the embodiment disclosed seven light beams, $\frac{3}{8}$ of an inch by $\frac{1}{4}$ of an inch in cross-section, are formed by a plane of light $\frac{1}{4}$ of an inch in height, and are interrupted selectively by coded shutters either formed integral with or attached to the typewriter key levers so as to depend therefrom. As heretofore stated, six of the photoelectric circuits respectively represent the six elements of the six-unit code; the seventh or universal circuit prevents the operating cycle from being repeated when a key or the space lever bar is held operated, and the shutters on all the levers except the shift lever interrupt the seventh beam when the levers are depressed.

Each of the key levers of the typewriter has either formed integral therewith or secured thereto a light-gate or plate, such as plate 62 shown in Fig. 12, with depending shutters such as *a* and *b* which are coded to produce the marking and spacing elements of a six-unit code. In the key lever of the figure, which is coded for the letter A, it will be seen that the shutters are spaced and arranged to block the light beams corresponding to code elements 1 and 2 and a portion of element 6. Each of the other key levers of the typewriter, including the space bar and shift levers, have light shutters depending therefrom in accordance with the code chart of Fig. 11. The various characters shown in the code chart are those which are desirable for air traffic service, and it will be understood that the characters may be changed in any desired manner depending upon the type of service for which the typewriter unit is to be employed. From Fig. 11 it will be noted that seven keys produce two characters each, these being A—2, K; A—I, J; BELL, S; CM, B; WEA, B; SUS, C; and A—3, L. The remainder of the keys produce only one character, irrespective of whether the shift lever is depressed or not. If desired, each of the keys can be arranged to transmit selectively upper and lower case characters depending upon whether the shift lever is operated or unoperated. Fig. 3 shows how the light shutters may be attached to the conventional key lever; in this figure the plate 63 has shutters representing the character G, and which provide spacing code elements 1 and 3, and marking code elements 2, 4, 5 and a portion of 6 when the key lever is depressed to the position indicated by the dot-and-dash lines. The plate 63 may conveniently be secured by means of screws 70 and a strap 71 to the conventional key lever, as indicated in Fig. 3a. Where the shutters are applied to the conventional key lever, they preferably are composed of a thin sheet of a light metal, such as aluminum, in order not to change the usual touch of the typewriter keys. Such shutters can also be made of plastic or other material which has suffi-

cient rigidity and is opaque to the passage of light.

The typewriter is adjustable, forwardly or backwardly, with respect to the supporting frame 20 and the optical system, since it is carried by a plate 80 of sheet metal which is slidably mounted, as shown in Fig. 3, on the angle iron structure 20. The typewriter is adjustably supported on plate 80 by means of four leveling screws 81, the lower tapered ends of which are received in recessed portions in plate 80. By turning the knurled knob 82 of each leveling screw, the typewriter may be raised or lowered at any of four points to level the same and to adjust its vertical position relative to the optical system. In order to adjust the typewriter forwardly or backwardly, any convenient means may be employed for moving the plate 80, such for example, as a threaded screw 84 which passes through a flanged portion 80a of the plate and is threaded into the frame member 20, whereby rotation of the screw 84 will cause the plate 80 to slide along on the frame structure 20 until the correct position is attained, after which a lock nut 85 maintains the desired adjustment. Two lock nuts 86 on the screw 84 cooperate with the head of the screw to engage the portion 80a of the plate 80 for effecting the adjustment.

The rectangular beam of light which issues through the aperture 54 is divided into seven light channels 1 to 7 by means of comb members 88, Fig. 3, which have upstanding baffles or plates 88a that define the respective light channels. As shown in Fig. 8, four of these combs are provided in the embodiment disclosed, the straight arrows between the baffles in the figure indicating the channels of light. The channel of light corresponding to code element 6 is a wider channel, as indicated by the two arrows in this channel, and this channel is split by the operation of certain of the shutters so as to interrupt a part of the sixth light beam in accordance with the code set forth in Fig. 11. The seven channels of light are selectively cut off from seven photocells 89, numbered 1 to 7 in Figs. 1 and 8, by the action of the shutters attached to and forming a part of the key levers. As seen in Fig. 1, the housing 87 which contains the photocells 89 is mounted on the framework 20, at the left hand side of the typewriter, and as indicated in Fig. 2, the supporting and enclosing structure for the photocells may comprise a block of wood or other suitable material for optically and electrically isolating the photocells from each other. Deflecting plates 90, shown in Figs. 1 and 8, are inserted in light channels 1, 2, 3, 4, 5 and 7 in order to deflect and direct the light beams to the photocells. These plates may comprise any suitable deflecting surface which is placed at the proper angle, and preferably comprise a first surface mirror in which the reflecting surface is on the top face of the mirror. A preferred mirror coating is sublimated aluminum.

Referring again to Fig. 8 it will be seen how the various light beams are interrupted when the typewriter key bearing the designations SUS, C is depressed. It will be seen that the shutters on this key lever permit light channels 1 and 5 to pass freely, and permit a portion of the light of channel 6 to pass, but block light channels 2, 3, 4 and 7. Referring to the chart in Fig. 11 it will be observed that when the letter C is to be transmitted, at which time the shift lever is not depressed, the marking signal code elements would be 2, 3, 4 and a portion of 6, whereas if the shift

lever is also depressed to provide the upper case character SUS, code elements 2, 3, 4 and all of 6 will be obtained. A portion only of the light of channel 6 is cut off when the lower case C is selected because the associated Thyatron tube of circuit 6 should not fire at this time, and thus sufficient light is left on the photocell to prevent firing of the Thyatron. The reason for this arrangement is so that if the shift lever is depressed, as shown in Fig. 4, without the concurrent depression of another key lever, photocell 6 will remain energized because only a portion of its light channel is cut off, and no registration of the depression of the shift lever will be obtained. However, if any other key with a shutter, such as shown in Fig. 3, which covers the other half of the sixth light channel is depressed and the shift lever concurrently depressed to the position indicated by dot-and-dash lines in Fig. 4, then it is desired to block the light from photocell 6 in order to introduce the sixth element of the code.

Fig. 9 illustrates the condition when the key lever C is depressed and the shift lever also is depressed. Each of the character levers of the keyboard is hingedly mounted on a common shaft 92, whereas the two shift levers, one on each side of the machine, are mounted on a common rock shaft 93, whereby the shift signal may be introduced from either side of the keyboard. In this figure it will be noted that the code elements of Fig. 8, namely, the light channels 2, 3, 4 and all of 6 are blocked, thereby causing these marking code elements to be inserted in the signal transmitted. Fig. 10 illustrates the condition when one of the numeral keys is depressed, for example, numeral 9, in which case all of the light of channel 6 is blocked by the key lever alone, thereby to insert a sixth marking element in the signal transmitted.

In the arrangement diagrammatically shown in Fig. 15 the signals generated by the photoelectric circuits are applied to a tape perforator, from which the signals are retransmitted automatically as the tape passes through a tape transmitter. As indicated at 100 in the figure, suitable switch or plug connections may be provided so that the signals can be transmitted either to a multiplex type of printer or the perforator, or to both simultaneously. The tape between the perforator and tape transmitter is caused to control a tight tape switch or auto-stop 101, whereby when the loop of tape between the perforator and the transmitter becomes depleted, the tape transmitter will automatically be stopped in known manner, for example, as in the Dixon Patent No. 1,192,171. The tape transmitter in conjunction with the transmitting distributor transmits the six-unit permutation code telegraph signals over a telegraph line to a printer or other receiving apparatus at the distant end.

Referring to Figs. 13 and 14, there is shown a preferred circuit arrangement for generating and storing permutation code telegraph signals. Each photoelectric signal circuit 1 to 6 and the universal circuit 7, Fig. 13, comprises, in the specific embodiment disclosed, a suitable photoelectric tube 89 of the vacuum type identified in the trade as No. 929. Such a photocell comprises a caesium coated plate element 110 and a vertical electrode 111, the emission taking place from the plate 110 to the electrode 111 and being varied in accordance with the amount of light falling upon the cell. Preferably, and as shown, the

photocell is operatively connected with a grid-controlled gas-filled rectifier 112, such as a Thyatron of the type known in the trade as No. 2051. The bias on the grid 113 of the Thyatron is adjustable from 0 to -13 volts by a potentiometer 114 which is connected by conductor 115 to a source of negative current comprising a full wave rectifier 116 powered from a transformer 117 that is connected to a source of alternating current 118 when the switch 119 is closed. The potentiometer is connected to grid 113 through a grid bias resistor 118 which in this circuit is of the order of five megohms. The adjustable resistance portion 114 of the potentiometer is in the present instance of the order of 3000 ohms, and this connected in series with a resistance 119 of the order of 60,000 ohms.

The No. 7 or universal photoelectric circuit, shown in the lower right hand portion of Fig. 13, is different from the code element circuits 1 to 6 in that the Thyatron 112' is fired when light falls on the phototube 89'. The plate circuit of this Thyatron includes conductor 140 and the relay PR, Fig. 14, which is normally operated and through its armature and make contact 139 holds the direct current power supply 148 on the code element tube circuits 1 to 6 through a common relay CR, conductors 141 and 145, and the manually closed switch 146. When a key lever is depressed, a certain combination of trip latch magnets 136 on the perforator, and the common relay CR will operate. The common relay upon operating closes, through its armature and contact 156, the operating circuit for the perforator punch solenoid PM. The perforator may be of any suitable type known in the art; various details of such a perforator are disclosed in Hoover et al. Patent No. 1,851,838, issued March 29, 1932. At the end of its stroke a contact 143 on the punch solenoid PM opens the plate circuit, comprising conductor 140, relay PR, and conductors 142 and 145, to the No. 7 or universal photoelectric circuit, and the Thyatron 112' will go out. This releases the PR relay, which removes through its make contact 139 the power supply to the plates of the code element circuits 1 to 6, and the Thyatrons in those circuits also are extinguished. When contact 139 closes and the key lever is up, the universal photoelectric circuit will fire and reestablish the power supply to the code element circuits. If the key lever is held depressed, the release of the punch magnet PM will reestablish the universal photoelectric circuit, but the Thyatron 112' of circuit 7 will not fire because the light from its phototube is shut off. This circuit will remain de-energized until the key lever is released, when light falling on the photo tube will again fire the Thyatron.

It will be noticed from Fig. 13 that the photocell 89' associated with the Thyatron of the universal circuit 7 is oppositely poled with respect to the photocells 89 of the code element circuits 1 to 6. Element 111 of the photocell 89' of circuit 7 is connected by conductor 160 to the cathode of a full wave rectifier 161, the rectifier being powered from a transformer 162 connected to the alternating current source 118. The plate circuit of the rectifier 161, which is its negative pole, is connected to ground at 163, and this causes the element 111 of the photocell to be positive relative to the ground 163. The circuit to the grid 113 has two paths to the power supply, one through the grid bias resistor 165 to an adjustable tap on the voltage divider 129 to pro-

duce the normal bias, and another path through the phototube 89' to the rectifier 161 for the positive power supply. With no light on the phototube the adjustable grid bias is set to prevent the tube from firing. Light falling on the phototube produces a current in the grid bias resistor 165 in such a direction that its voltage drop subtracts from the normal bias and the resultant voltage on the grid is less than the normal bias and the tube will fire.

A filter condenser 166 and an inductance 167 are connected in the cathode circuit of rectifier 161, and a similar condenser 166' and inductance 167' are connected in the anode or plate circuit of rectifier 116, for smoothing purposes.

When no transmission is taking place a relay 120, which is deenergized at this time, applies through its armatures and break contacts 121 to 126 and conductors 132 and 132', negative biasing potential to the photoelectric circuits 1 to 6. This biasing potential is obtained from the point 128 on voltage divider 129 of the photoelectric circuit 7, through the conductor 130, armature and contact 121 and conductors 132 and 133 to the grid 113. Each of the six code element tubes 112 of circuits 1 to 6 has a similar bias maintained thereon when transmission is not taking place. When light to any of the phototubes of circuits 1 to 6 is cut off by a shutter on a given key lever, the voltage across the associated grid bias resistor 118 will disappear, reducing the bias on the grid of the associated Thyatron, i. e., tube 112, to a fixed value (less than two volts) and the tube 112 will fire. The negative bias applied to the grid of tube 112 is produced by a fixed bias from the voltage divider which comprises resistances 119 and 114, plus the voltage drop across resistance 118 when current is flowing through the phototube 89 and resistance 118 and a portion of resistance 114 to ground. When light is not falling on phototube 89, as when a key lever is depressed, the voltage drop across resistance 118 is reduced to a low value, and the fixed bias from the voltage divider causes the tube 112 to fire; when light is falling on tube 89, as when no key lever is depressed, the voltage drop across resistance 118 plus the fixed bias is sufficient to prevent the tube 112 from firing. In the case of phototube 89 in circuit 6, the total amount of light allowed to fall on the tube is greater in order that the blocking bias on tube 112 may be maintained even though approximately one-half of the light is cut off, as when a lower case character lever alone is depressed or when the shift lever alone is depressed. The plate supply for the tubes is obtained over the conductor 135 or 135' in series with a perforator trip latch relay 136, Fig. 14, conductor 137, winding of common relay CR, armature and make contact 139 of relay PR (which is normally energized), conductors 141 and 145, switch 146 (which is closed when the device is in operation) and conductor 147 to a source of direct current supply at 148.

The current in the plate circuit of each of the code element tubes 112 depends on the requirements of the registering mechanism, and in the case of a tape perforator of the character disclosed should not exceed approximately 375 mills. To limit the current in this circuit to the proper value, padding resistances 154 are inserted in the circuits.

Once the universal circuit tube 112' is fired, its plate circuit will remain energized until opened at armature 143 by the energization of perforator

punch magnet PM which opens the positive power supply to the plate of the No. 7 circuit at the end of its cycle. The relay CR, which is in series in the common power supply circuit to the code registering circuits 1 to 6 of the perforator, operates when any of the circuits are energized, the punch magnet PM being operated by an armature and make contact 156 of relay CR. At the end of the punch magnet stroke, the contact 143 opens the positive power supply lead, and the trip latches 136 on the perforator are reset on the release stroke of the punch magnet in known manner. When the punch magnet releases, due to a space charge condition in the tube, a resistance 150 of the order of one megohm maintains a slight potential on the plate of the Thyatron 112' during the open circuit interval, but not sufficient to maintain an arc in the tube. This prevents the occurrence of a space charge condition which might cause the tube to fire when the circuit is reclosed. Similarly, the circuit comprising conductor 151 and resistance 150' maintains a slight potential on the plates of the code element Thyatrons 1 to 6 during the open circuit interval of armature 139 of relay PR to prevent the occurrence of a space charge condition which might cause the tubes to fire when the circuit is reclosed.

In the plate circuit of the Thyatron tube of circuit No. 7, a relay 170, Fig. 13, controls at its armature and break contact 171 the energizing circuit for a signal lamp 172. When transmission is taking place the relay 170 alternately is operated and released and this causes lamp 172 to flash, thereby to indicate to the operator that the circuit is transmitting, one flash of the lamp being obtained for each character sent.

A pilot light 174 is connected across a secondary of the transformer 162 and lights to give a visual indication of the fact that switch 119 is closed and that alternating current power is being applied to the tube circuits.

Across the output of the rectifier 161 is a constant load impedance 175 to provide for better voltage regulation of the rectifier; this output resistance also operates as a voltage divider thereby to apply operating current of desired voltage to the relay 120. In the circuits of rectifiers 116 and 161 the transformers 117 and 162 are of the step-up type thereby to provide a higher voltage for the operation of the phototubes 89 which operate satisfactorily with approximately 350 volts, whereas relay 120 does not require such a high operating voltage, and hence by means of the voltage divider 175, the operating voltage applied to the relay may be of the order of 120 volts.

Provision is made so that the typewriter may be used without transmitting to the line, and when it is thus used for local typing, the Thyatrons in the code element circuits are prevented from firing by a fixed bias well above -2 volts being placed on their grids through the break contacts 121 to 126 of the relay 120. Connected in the operating circuit of the relay is a foot switch 178 and also a manually operable switch 179, whereby the relay may be controlled either by the foot of the operator or by manually closing the switch 179. When the relay 120 is operated by either of the switches on the control panel, the fixed grid biases are removed and a lamp 180 is operated through a circuit including an armature and make contact 181 of relay 120, which indicates that the equipment is set up for line transmission. The exciter lamp 39 prefer-

ably is operated at reduced voltage when line transmission is not being effected, and for this purpose the relay 120 has an armature and make contact 183 bridged across an impedance, for example, a resistance 184, which is in the primary circuit of the exciter lamp transformer 185. When relay 120 is energized, the resistance is shorted out to bring the lamp up to operating brilliancy. This arrangement prolongs the life of the lamp when line transmission is not in service.

The exciter lamp 39, as will be seen from Fig. 13, preferably is of the double filament type having filaments f and f' , whereby if one filament should go out, the other filament is available for operating the apparatus. It is desirable that in the event of one filament going out, the other filament will be cut in automatically. This is effected by causing the energizing circuit for each of the filaments to pass through a solenoid coil 186 or 186', the two solenoid coils having a plunger or core 187 mounted therein, the core operating a switch 188 to either of two closed circuit positions. In the event that one of the filaments, for example f , should go out in service, the energizing circuit of solenoid 186 will also be opened, and the core 187 caused to move to the left by the action of a compressed helical spring 187', and this actuates a switch 188 to close the circuit of filament f through contact 189. When either of the electromagnets 186 or 186' is deenergized, the spring member 190 of the solenoid which is deenergized will cause the solenoid core and the switch blade 188 controlled thereby to be actuated towards the other magnet and thus cause the switch blade to close the circuit through the other solenoid. The core 187 and switch blade 188 may be moved manually to one position or the other when starting the apparatus in operation.

At the upper left hand portion of Fig. 13 there is shown a switch element 192 which is operable to apply ground either to a contact 193 or contact 194, the switch element being operated by movement of the typewriter carriage as follows. As the typewriter carriage is manually returned to its starting position, after a line has been typed, the switch blade element 192 engages contact 194 and applies ground through condenser 196 to the grid of the Thyatron in photoelectric circuit 4. This ground causes the voltage of the grid of the Thyatron to be momentarily brought below the firing grid bias of the tube and the tube will fire and introduce the code for a telegraph printer carriage return signal in the transmission. The condenser 196 is employed to insure that only one carriage return signal will be transmitted for each carriage return operation of the typewriter since the ground supplied through contact 194 to the grid of the tube only persists long enough to charge the condenser 196. When the condenser is charged, the grid bias of the tube is again brought to the fixed bias as determined by the adjustable resistor 114. At the end of the return stroke of the carriage, the carriage reverses and moves the switch element 192 to contact 193, and causes the Thyatron in photoelectric circuit 6 to fire in the same manner as the closure of contact 194 to cause photoelectric circuit 4 to fire. This introduces a blank character in the transmission which allows the carriage on the receiving printer to be completely restored before the transmission of the first message character in the next line.

A grounded switch blade 197 associated with

the No. 2 photoelectric circuit is operative to transmit a telegraph printer line feed signal automatically as the platen of the typewriter is manually rotated by the carriage return and line feed lever. This circuit has a condenser 198 which operates generally in the manner of condensers 195 and 196 heretofore described to insure that only one signal will be transmitted for each line feed operation.

Figs. 5 and 6 of the drawings illustrate a simple form of mechanism for automatically transmitting the carriage return signal and succeeding blank signal. On a conventional typewriter there are tabulator rods such as the rods 200, or such rods may be provided. To these rods are secured insulating strips 201 which carry metal contact strips 202 with which sliding spring contact members 204 coast. The outer bent ends of the members 204 engage the metal conducting strips 202 with sufficient frictional force so that as the typewriter carriage is moved in either direction, the frictional engagement of the members 204 with the strips 202 will cause the switch member 192 to be rotated out of engagement with one of the contact springs 193 and into engagement with the other contact spring 194, and vice versa. The contact pileup arrangement for effecting this is best seen in Fig. 6, the pileup being carried by a bracket member 206 rigidly supported by the typewriter frame in place of the tabulator mechanism. The contact pileup is arranged about the pivot member 207 which is received within an opening in the bracket member 206, so that the entire contact pileup pivots to the extent shown in Fig. 5 to control the circuits of contacts 193 and 194 respectively. By means of the foregoing, the carriage return signal and space signal immediately following the carriage return signal are automatically inserted by the manual operation of returning the carriage of a typewriter by the carriage return and line feed lever.

A suitable line feed switch device for automatically inserting a line feed is shown in Fig. 7 of the drawings. The switch 197, which preferably is a micro-switch of a type well known in the art, is operated by a lever 210 pivoted at fulcrum 211 to the end plate 212 of the typewriter carriage. The shorter arm 210a of the lever bears against a mounting 213 for a jockey roller 214 which in the typewriter is employed for maintaining the platen in any adjusted line position. The jockey roller 214 which rides on the line feed ratchet 215 of the typewriter is moved upwardly and downwardly whenever the carriage return and line feed handle is operated, and each time the line feed ratchet is moved one tooth, the jockey roller assembly depresses the end 210a of the lever 210 and causes closure of switch 197, thereby causing the transmission of a line feed signal in the manner hereinbefore described with respect to photoelectric circuit 2 of Fig. 13. By this arrangement, the number of line feed signals transmitted depends upon the spacing between lines since there is one signal transmitted for each tooth of the line feed ratchet during operation thereof. At the receiving end, therefore, the lines of the subject matter when recorded on a page printer are spaced in accordance with the lines of the subject matter as typewritten on the transmitting machine.

Referring again to Fig. 3 of the drawings, the plate member 63 which carries the light shutters a , b , c has a configuration such that after any of the typewriter keys has been depressed, upon release of the key the various light channels 1 to

6 of the code circuits will be uncovered by the light shutters before the seventh or universal light channel is uncovered. The reason for this is that if the universal light channel were uncovered at the same time or prior to the other light channels, a false character might be transmitted on the release of the key lever, depending on which of the code light channels were not uncovered sufficiently to maintain the blocking bias on the code element Thyratrons before the No. 7 Thyatron refires. However, by preventing the No. 7 light channel from becoming uncovered until the six code element channels are uncovered, this prevents the inadvertent transmission of an improper signal since there is not sufficient light on No. 7 photocell to refire its Thyatron until all the code element photocells have sufficient light falling thereon to maintain the proper blocking bias on their associated Thyratrons. The angular disposition of the light shutters relative to the horizontal, and the manner in which they are caused to pivot with the key levers, obviates the transmission of a false character.

The light shutters are arranged so that they do not interrupt the various light channels until the key lever has been depressed by the typist or operator to within approximately $\frac{1}{8}$ of an inch of its final travel when the typewriter keys are struck. This insures that if two or more keys are struck concurrently or simultaneously, the key levers will strike each other and wedge at a point such that no signal will be transmitted. This prevents the transmission of a garbled signal in the event that two or more keys are concurrently depressed, since it is only the last $\frac{1}{8}$ of an inch of travel of the type bar levers which is effective to control the light channels.

Various modifications of the apparatus and circuit arrangements shown, and various equivalents or substitutes for the devices illustrated, will readily occur to those versed in the art without departing from the spirit or scope of the present invention. The disclosure, therefore, is for the purpose of illustrating the principles of the invention which is not to be regarded as limited except as indicated by the scope of the appended claims.

What is claimed is:

1. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated the light beams are permutably interrupted depending upon the character represented by said key lever, and a plurality of signal generating devices respectively controlled by said photocells for producing marking or spacing pulses depending upon which of said photocells are activated by said light beams.

2. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely

across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated the light beams are permutably interrupted depending upon the character represented by said key lever, and means comprising a plurality of gas-filled discharge tubes having control electrodes controlled by said photocells for producing marking or spacing pulses depending upon which of said photocells are activated by said light beams.

3. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated the light beams are permutably interrupted depending upon the character represented by said key lever, means comprising a plurality of gas-filled discharge tubes having control grids respectively controlled by said photocells for producing marking and spacing pulses respectively depending upon whether said tubes are fired or extinguished, and grid biasing means for preventing said tubes from firing when their associated photocells are activated by said light beams and for causing the tubes to fire when the light beams are interrupted by said light shutters.

4. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, the characters including letters and figures, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated, the light beams are permutably interrupted depending upon the character represented by said key levers, said light shutters being arranged so that one of said light beams is completely interrupted by actuation of the figures keys to insert a codal element in addition to those employed for letters characters, and a plurality of signal generating devices respectively controlled by said photocells for producing marking and spacing pulses representative of letters or figures depending upon which of said photocells are activated by said light beams.

5. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, the characters including letters and figures, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated, the light beams are permutably interrupted depending upon the char-

acter represented by said key lever, said light shutters being arranged so that one of said light beams is only partially interrupted by actuation of the letters keys, but is completely interrupted by actuation of the figures keys thereby to insert a codal element in addition to those employed for letters characters, and a plurality of signal generating devices respectively controlled by said photocells for producing marking and spacing pulses representative of letters or figures depending upon which of said photocells are activated by said light beams.

6. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers and a shift lever, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers and said shift lever whereby when a key lever is actuated, the light beams are permutably interrupted depending upon the character represented by said key lever and the position of said shift lever, said light shutters being arranged so that one of said light beams is not completely interrupted by actuation of a character key or the shift lever but is completely interrupted by concurrent actuation of a character key and the shift lever thereby to insert an additional codal element when the shift lever is actuated, and a plurality of signal generating devices respectively controlled by said photocells for producing marking and spacing pulses representative of shift and unshift characters depending upon which of said photocells are activated by said light beams.

7. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated the light beams are permutably interrupted depending upon the character represented by said key lever, means comprising a plurality of gas-filled discharge tubes having control electrodes respectively controlled by said photocells for firing the tubes to produce coded pulses depending upon which of said photocells are activated by said light beams, a recording device responsive to said coded pulses, means controlled by said device for extinguishing said tubes when a recording operation has been effected, and means including certain of said light shutters on the key levers and an auxiliary photocell controlled thereby for preventing repeated firing of said tubes when a key lever is held actuated.

8. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely beneath said key

levers and respectively associated with said photocells for activating the same, coded light shutters depending from the key levers whereby when a key lever is depressed the light beams are permutably interrupted depending upon the character represented by said key lever, means comprising a plurality of gas-filled discharge tubes having control electrodes respectively controlled by said photocells for firing the tubes to produce coded pulses depending upon which of said photocells are activated by said light beams, a recording device responsive to said coded pulses, means controlled by said device for extinguishing said tubes when a recording operation has been effected, and means for preventing repeated firing of said tubes when a key lever is held depressed, comprising certain of said light shutters on the key levers, an auxiliary photocell controlled thereby, a gas-filled discharge tube having a control electrode connected to the auxiliary photocell, and means controlled by said tube for preventing the other tubes from refiring until after said depressed key lever has been released.

9. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely beneath said key levers and respectively associated with said photocells for activating the same, coded light shutters depending from the key levers whereby when a key lever is depressed the light beams are permutably interrupted depending upon the character represented by said key lever, means comprising a plurality of gas-filled discharge tubes having control electrodes respectively controlled by said photocells for firing the tubes to produce coded pulses depending upon which of said photocells are activated by said light beams, a recording device responsive to said coded pulses, means controlled by said device for extinguishing said tubes when a recording operation has been effected, and means for preventing repeated firing of said tubes when a key lever is held actuated, comprising certain of said light shutters on the key levers, an auxiliary photocell controlled thereby, a gas-filled discharge tube having a control electrode connected to the auxiliary photocell, and relay means in the anode circuit of said tube for controlling the anode circuits of the other tubes to prevent them from refiring until after said depressed key lever has been released.

10. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated the light beams are permutably interrupted depending upon the character represented by said key lever, means comprising a plurality of gas-filled discharge tubes having control electrodes respectively controlled by said photocells for firing the tubes to produce coded pulses depending upon which of said photocells are activated by said

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light beams, a tape perforator having a punch operating device and responsive to said coded pulses for storing the signals in a tape, and switch means controlled by said punch operating device for extinguishing said tubes when a perforating operation has been effected.

11. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated the light beams are permutably interrupted depending upon the character represented by said key lever, means comprising a plurality of gas-filled discharge tubes having control electrodes respectively controlled by said photocells for firing the tubes to produce coded pulses depending upon which of said photocells are activated by said light beams, a tape perforator having a punch magnet and responsive to said coded pulses for storing the signals in a tape, and switch means controlled by said punch magnet for extinguishing said tubes when a perforating operation has been effected.

12. Photoelectric typewriter apparatus for transmitting permutation code telegraph printer signals having marking and spacing codal elements, comprising a typewriter having a traveling carriage and a line space lever and a keyboard with an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated the light beams are permutably interrupted depending upon the character represented by said key lever, a plurality of gas-filled discharge tubes having control electrodes respectively controlled by said photocells for producing marking or spacing pulses depending upon which of said photocells are activated by said light beams, and a control electrode biasing circuit including a switch actuated by manual operation of the line space lever for causing said tubes to generate a printer line feed signal.

13. Photoelectric typewriter apparatus for transmitting permutation code telegraph printer signals having marking and spacing codal elements, comprising a typewriter having a traveling carriage and a keyboard with an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated, the light beams are permutably interrupted depending upon the character represented by said key lever, a plurality of gas-filled discharge tubes having control electrodes respectively controlled by said photocells for producing marking or spacing pulses depending upon which of said photocells are activated by said light beams, and

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a control electrode biasing circuit including a switch actuated by manual return of the typewriter carriage for causing said tubes to generate a printer carriage return signal.

14. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means comprising an exciter lamp for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated the light beams are permutably interrupted depending upon the character represented by said key lever, means comprising a plurality of gas-filled discharge tubes having control grids respectively controlled by said photocells for producing marking and spacing pulses respectively depending upon whether said tubes are fired or extinguished, means controlling a source of current for applying a voltage to operate said exciter lamp when the apparatus is transmitting signals, and a control circuit including a relay for causing said lamp to operate at reduced voltage when transmission is not being effected.

15. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing codal elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated, the light beams are permutably interrupted depending upon the character represented by said key levers, a plurality of grid-controlled gas-filled discharge tubes respectively controlled by said photocells whereby the tubes are fired selectively to produce marking and spacing pulses depending upon which of said photocells are activated by said light beams, recording apparatus responsive to said pulses for recording permutation code signals in accordance therewith, means controlled by said recording apparatus and operative upon each recording operation temporarily to disconnect the plate current supply for the tubes to extinguish the same, and means for applying a potential to the plates of the tubes to prevent the occurrence of a space charge condition which might cause the tubes to fire when their plate current supply is again connected.

16. Photoelectric typewriter apparatus for transmitting permutation code signals having marking and spacing elements, comprising a typewriter keyboard having an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means comprising an exciter lamp for producing separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated the light beams are permutably interrupted depending upon the character represented by said key lever, a plurality of

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space discharge signal generating tubes respectively controlled by said photocells for producing marking or spacing pulses depending upon which of said photocells are activated by said light beams, said exciter lamp having at least two light-emitting filaments each of which when energized will activate said photocells, a source of current supply for said lamp, switch means for connecting the current to any of said filaments, and electromagnetic means in circuit with said filaments and automatically operative when a filament burns out to actuate said switch means to connect another of said filaments to said current supply.

17. Photoelectric typewriter apparatus for transmitting permutation code telegraph printer signals having marking and spacing codal elements, comprising a typewriter having a traveling carriage and a keyboard with an assembly of character key levers, a plurality of photocells respectively corresponding to the codal elements of the permutation signals, means for producing

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separate light beams passing transversely across said key levers and respectively associated with said photocells for selectively activating the same, coded light shutters projecting from the key levers whereby when a key lever is actuated, the light beams are permutably interrupted depending upon the character represented by said key lever, a plurality of gas-filled discharge tubes having control electrodes respectively controlled by said photocells for producing marking or spacing pulses depending upon which of said photocells are activated by said light beams, a control electrode biasing circuit including a switch actuated by manual return of the typewriter carriage for causing said tubes to generate a printer carriage return signal, and a non-printing signal immediately following the carriage return signal to provide sufficient time for a carriage return operation at a receiving printer.

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