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FIG. 6

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# UNITED STATES PATENT OFFICE 

# 2,142,106 <br> SIGNALING SYSTEM AND GLOW LAMPS THEREFOR 

Hans P. Boswau, Galion, Ohio<br>Application May 9, 1934, Serial No. 724,687<br>10 Claims. (Cl. 177-353)

This invention relates to signaling devices and more specifically to glow lamp indicators for selectively signaling numerals, letters or other characters or symbols.
One object of the present invention is to provide a signaling device which is capable of selectively displaying one of a plurality of characters in substantially the same space.

Another object is to provide a signaling device 0 for selectively displaying one of a plurality of characters in which the character to be displayed is selected by means of a momentary selecting impulse whereupon the selected character is maintained on display as long as desired by the 5 inherent characteristics of the indicator without requiring holding circuits externally of the signaling device.

A further object of the invention is to provide a control circuit for the above-mentioned sig2) naling device which requires but one individual control wire for each of a large number of signaling devices.

Other objects will appear in the following description taken in conjunction with the accom-

Fig. 1 illustrates one embodiment of the glow lamp indicator;

Fig. 2 shows certain parts of the gaseous discharge glow indicator in exploded fashion;

Fig. 3 shows the internal circuit connections of the glow lamp indicator;

Fig. 4 shows the fundamental operating and control circuits for a plurality of glow lamp indicators;

Fig. 5 shows the internal circuit connections of an alternative embodiment of the glow lamp indicator:

Fig. 6 shows the fundamental operating and control circuits for the alternative embodiment;
Fig. 7 shows an application of the glow lamp indicator and control circuit to a stock quotation system, illustrating the selecting equipment reauired on a subscriber's premises; and

Fig. 8 shows the equipment required for one 5 stock in the stock quotation system.

In the well-known space discharge devices or glow lamps a pair of metallic electrodes are sealed within a glass bulb filled with neon, mercury, sodium or cther suitable gases at a definite very low pressure. When a unidirectional (direct current) potential is applied to the electrodes and gradually increased, the glow discharge will set in at a certain definite potential called an "irniting potential". The luminous glow discharge is produced by negative electrons and pos-
itive gas ions and takes place within a certain small distance from the exposed surface of the cathode or negative electrode, which appears to be surrounded or coated with a thin film of light. This film of light follows the contours of the cathode surface in all details.

When the potential is further increased, the glow discharge becomes somewhat brighter. When the potential is gradually reduced, the glow discharge is maintained down to a potential considerably below the igniting potential, until at a certain definite minimum potential the discharge ceases.
If an intermediate potential somewhere between the igniting and minimum potential is applied to the electrodes, there will be no glow discharge, but if the potential is momentarily raised to or above the igniting potential and thereafter reduced to the intermediate potential, the discharge will be started by the igniting potential and thereafter be maintained by the intermediate potential until the potential is reduced to or below the minimum potential. This characteristic of the glow lamp makes it possible to control the starting and stopping of the glow discharge by means of brief momentary impulses of high and low potentials, with the lamp normally connected to an intermediate potential
Thus, the glow lamp may be lighted by the application of an igniting impulse and thereafter remains lit, until the potential is reduced momentarily below the minimum potential. This feature offers a means to control glow lamps without external holding relays or other means for keeping the lamp circuit closed when it is desired to have the lamp glow.
The fact that the exposed parts of the cathode of a glow lamp are entirely surrounded by a thin film of luminous discharge may be utilized to display any desired character by means of properly shaped cathodes. A cathode consisting of a wire shaped in the form of the numeral 1 will, when ignited, produce a luminous outline of the numeral 1, and similarly any other desired character may be formed.
In the present invention these two characteristics of the glow lamps are utilized as follows: In Fig. 1 the glass bulb $10!$ is filled with a suitable gas, such as neon, at the required pressure. The glass foot 102 has fused into it a number of supports 103, which hold the disk assembly 104 near the forward part of the bulb. The disk assembly 104 consists of eleven very thin disks of glass, stacked one behind the other with a small separation between adjacent disks. In the in-
terstices between the disks the electrodes are arranged in the shape of fine metal wires, the cathodes being shaped in the form of the ten numerals $1,2,3,4,5,6,7,8,9$, and 0 , while the anodes are short pieces of wire near the lower part of each cathode. The anodes do not glow, and those parts of the cathode wires which are not desired to glow are covered by a suitable insulation, such as enamel.
The bulb is mounted in a base 105 provided with external terminals 106. The connections from the terminals to the electrodes are made by means of connecting wires 188 and 109 , and are carried through the glass foot 102 in a well15 known manner by means of short connectors 101 made of metal having the same coemcient of expansion as glass.
Fig. 2 shows the disk assembly $104 \ln$ an exploded view to illustrate the ten cathodes 201 and 20 ten anodes 205. Each of ten glass disks 203 has the wires 201 and 205 forming the electrodes cemented to its surface in a suitable manner. The lead out wires, such as 202, which are not desired to glow, are covered with suitable insulation.

These ten disks with an additional front cover disk 204 are then stacked one upon the other, the wire electrodes serving to separate the disks from each other so as to permit access of the gas fllling 30 to the electrodes. After the disks are assembled, the interstices between them may be sealed in a suitable manner around the periphery to prevent interference from one electrode to another. A small aperture may be left at one point of the 5 periphery by leaving out the sealing operation at this point, to provide communication with the main gas chamber formed by the glass bulb 101.

When the bulb 101 is subsequently exhausted and then filled with gas at the proper pressure, 0 the exhausting and filling process extends through this communicating aperture to the ten gas chambers formed by the eleven glass disks 203 and 204. The communicating aperture may be filled with a suitable sealing material which permits the air and gas to permeate during the exhausting and fllling operation. After these operations are completed and the bulb 181 is sealed off, the sealing material in the communicating aperture may be rendered impervious to 0 the gas by suitable procedures, such as heating by means of electronic bombardment, for the purpose of completely sealing the ten gas chambers from each other and from the main gas chamber formed by the bulb 101.
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The entire disk assembly is very thin. If, for example, each glass disk is 0.008 inch thick and the electrode wires have a diameter of 0.002 inch, the assembly 104 is altogether only 0.108 inch thick. As a result, the rearmost cathode 0 , when glowing, will be easily discernible through the ten disks in front, and the other nine cathodes in the shape of the numerals 1 to 9 will not obscure the glow surrounding the cathode to a noticeable degree, inasmuch as the cathodes are only
650.002 inch in diameter while the glow discharge appearing on both sides of the glowing cathode is approximately 116 inch wide.

Viewed from the front of the bulb, therefore, any one of the ten cathodes, when glowing, will
70 appear in approximately the same place. In this manner, any one of the ten numerals may be displayed by causing the corresponding cathode to glow.

Fig. 3 shows the connections inside the bulb, 301 75
nals 302, the ten anodes 305 belng connected to terminal 304. A resistance 205 may also be mounted in the base 383 and connected to terminals 304 and 307.

It will be obvious from the foregoing description of the characteristics of the glow lamp that if a potential between the minimum and igniting potential is applied between the common anode and all ten cathodes, any one of the ten numerals may be displayed by the momentary application of the igniting potential to the corresponding cathode. This initiates the glow discharge at the selected cathode which is then maintained by the intermediate potential after the igniting potential is removed while all other cathodes will remain dark, since the discharge of these cathodes had not been initiated by the application of the igniting potential. To extinguish the glowing cathode, the potential of this cathode, or of all cathodes, is momentarlly reduced to a value below the minimum potential or to zero. Thereafter, any other cathode may be caused to glow by momentarily applying to it the igniting potential.

Thus the described glow lamp may be used to display any one of the ten numerals at will, and it will be obvious that, instead of ten numerals, letters or any other desired characters may be displayed by giving the cathodes the required shape, and that the construction is not limited to ten characters, but permits the use of a larger or smaller number of different characters.

In the arrangement described above, one control wire is required for each cathode or character to be displayed. Where a large number of glow lamp indicators are required to display the desired information, the number of control wires becomes considerable, and to reduce the necessary number of control wires to one individual wire per glow lamp indicator and a number of common control wires corresponding to the number of characters in each lamp, the invention makes use of the control circuit shown in Fig. 4.

In this circuit all cathodes corresponding to the numeral 1 are connected to the common wire 401 and similarly the cathodes 2 to 9 and 0 are connected to common wires 402 to 408 and 418 , respectively. Each of these ten wires is connected over a break contact of the ten number keys 411 to 429 to the negative pole of the battery 421 , which supplies the intermediate potential. The anodes of each of the glow lamps are connected through resistances 481 to 434 to the positive pole of the battery $\mathbf{4 2 1}$. In this manner intermediate potential is applied to all cathodes.

If it is desired to light, for example, numeral 1 of glow lamp 44!, the key 451 associated with this lamp is operated, thereupon number key 411 and then the common sending key 424. When key 451 is operated, all ten pairs of electrodes of glow lamp 411 are short-circuited from the anodes of lamp 441 over make contact of key 451, break contact of key 424, break contacts of the ten keys 411 to 420, wires 401 to 418, to the ten cathodes of lamp 44. This has no result if all lamps are dark and will not affect any of the other lamps, such as 442, 443, 444, etc., which all remain connected to battery 421. Upon operation of key 41I, cathodes I of all lamps 441, 442, etc. are disconnected from the negative pole of battery 421 at the break contact of key 411 and connected over the make contact of this key and rectifler 425 to the negative pole of battery 421 . This has no effect upon any of the lamps, as the cathodes remain connected to the negative pole of
battery 421 and the rectifier 425 inserted in the circuit does not change the potential.

When the key 424 is operated, auxiliary battery 423 is connected in parallel with rectifier 425,

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 thus in effect placing battery 423 in series with battery 421 and thereby raising the potential on cathodes I on wire 401 to a value higher than the intermediate potential but not quite high enough to ignite the cathodes. This circuit is traced 10 from cathodes I of glow lamps 441 to 444 over wire 401, make contact of operated key 411, thence in parallel through rectifier 425 and through upper make contact of key 424 and battery 423 to battery 421 , through battery 421 and resistances15431 to 434 to the anodes of glow lamps 441 to 444. Rectifier 425 serves to prevent short circuiting battery 423 . At the same time the short-circuit on lamp 441 is opened at the break contact of key 424 and auxiliary battery 422 is connected
20 in series with battery 421 over key 451 to lamp 441 only. This circuit is traced from cathode I of glow lamp 441 over wire 401, make contact of operated key 411 , thence in parallel through rectifier 425 and through upper make contact of key 25424 and battery 423 to battery 421 , through battery 421 , and thence in parallel through resistance 431 and through battery 422, lower make contact of key 424 wire 461 and make contact of key 451 to the anodes of glow lamp 441 . Battery 30422 is of such potential that its addition to the potential of battery 421 is not quite sufficient to reach the igniting potential. At cathode 1 of lamp 441, however, the potential applied is that of batteries 421, 422 and 423 added together and
35 this is higher than the igniting potential, so that cathode I of lamp 441 is ignited. Cathodes 1 of all other lamps have impressed upon them the potential of battery 421 plus that of battery 423 , which remains below the igniting potential, so
40 that none of these cathodes will begin to glow. Cathodes 2 to 9 and 0 of lamp 441 have impressed upon them the potential of battery 421 plus that of battery 422, which is below the igniting potential, so that no one of these cathodes will begin
$1 ;$ to glow. The only cathode where the igniting potential is reached is cathode 1 of lamp 441 where the additional potentials of both auxiliary batteries 422 and 423 are added to that of battery 421. Consequently cathode I of lamp 441 is the 60 only one that will light.

After this cathode is lighted, first key 451 and then keys 411 and 424 are released. The release of key 451 removes the additional potential of battery 422 from lamp 441, but cathode I of this
55 lamp remains illuminated through batteries 421 and $\mathbf{4 2 3}$ in series. This circuit is the same as that described above for connecting battery 423 in series with battery 42 I . When keys 111 and 424 are released, auxiliary battery 423 is also removed 60 from the circuit, but cathode 1 of lamp 441 remains lit, inasmuch as the potential of battery 421 is above the minimum potential and is sufficient to maintain the glow discharge. The circuit for cathode I of lamp 441 is traced from this cathode ire 401, normaly closed contact of key 411 battery 421, resistance 431 to the anodes of lamp 441. The control circuit is now back to normal and cathode I of lamp 441 is lit.

If it is desired to extinguish cathode I of lamp
70441 and to light cathode 2 of this lamp in its stead, first key 451 is operated and then keys 412 and 424. The operation of key 451 , as described above, short-circuits lamp 441, thereby extinguishing cathode I of this lamp. The subsequent
the discharge of cathode 2 of lamp 441 in the above described manner. Thus it will be evident that any desired cathode of any of the lamps may be lighted at will by means of the operation of the proper keys. The operation of the common keys has no effect upon any lamp whose individual key, such as 451, 452, etc., is not operated. In the case described above, it is to be noticed that the potential of battery 421 plus that of battery 423 is impressed upon control wire 401 when keys 411 and 424 are operated. This potential is still below the igniting potential, and cathodes I of all lamps where this cathode is dark, remain dark. In those lamps where this cathode happens to be lit, the additional potential will cause a slight brightening of the glow, but has no other effect upon their operation. It will be noticed that keys 411 to 420 are provided with make-before-break contacts, so that the operation of these keys never interrupts the battery circuit.
It is possible to control several lamps at the same time by operating several of the keys 451, 452 etc. before the keys 411 to 420 and 424 are operated. In this case the same numeral will be displayed on all the lamps which are controlled simultaneously. It is not possible to light erroneously more than one cathode in each lamp inasmuch as the value of the series resistances 431, 432 etc. is such that the combined voltage drop occasioned by two or more cathodes glowing at the same time brings the potential across the electrodes to a value below the minimum potential. In such a case all the cathodes of the lamp in question are extinguished as soon as the sending keys are released.

It will be obvious that this method of control can be applied to an unlimited number of lamps. Besides the common control wires 401 to 410 , the number keys 411 to 421 , the sending key 424, the batteries 421,422 and 423, and the rectifier 425 , each lamp requires one individual control key, such as 451, 452, etc., one resistance such as 431, 432, etc., and one individual control wire such as 461, 462, etc. It will be obvious to those skilled in the art that relay contacts may be substituted for the keys without affecting the method of operation.
In the well-known grid glow lamp a third electrode, the so-called grid, is interposed between the cathode and anode. When a negative bias potential is applied to this grid, the result is an increase of the potential required for igniting the discharge. When the grid bias is gradually reduced, the discharge sets in at a certain definite value. Thereafter the grid bias may be increased again without affecting the discharge, since the negative grid attracts a space charge of positive ions from the glow discharge, which effectively neutralizes the grid. This principle may also be used for the present invention. Fig. 5 shows the internal circuit of a glow lamp indicator using this principle. The mechanical construction is substantially the same as illustrated in Figs. 1 and 2. Electrically, however, all cathodes 501 are connected to a common terminal 502, while the anodes 503 are connected to terminal 504. Ten gr:ds 505 are interposed between the cathodes and anodes and connected individually to ten terminals 501. A potential below the igniting value impressed upon terminals 502 and 504 will not cause the discharge to start. The ten grids 505 are normally connected to a negative grid bias potential. To start the discharge at any one of the cathodes, its corresponding grid bias is lowered to a point where the discharge will set in.

Thereafter, the grid bias may be returned to its normal value without affecting the discharge that has set in. In the actual construction of the glow lamp indicator, the grids may take the form of a 6 short plece of wire interposed between the cathodes and anodes.
The contrul circuit shown in Fig. 6 for the grid giow lamp indicator is similar in principle to that shown in Fig. 4 for the ordinary glow lamp indi0 cator, the only changes being those made necessary by the characteristics of the grid control principle. The cathodes of all lamps 641, 642, etc. are connected to the negative pole of battery 621 and the anodes through individual resistances 5 631, 632 etc. to the positive pole of the same battery.
Battery 621 supplies a potential sufficient to maintain the glow discharge after it has once set in, but insufficient to initiate the glow' dis0 charge.

Grids I of all lamps 641, 642, etc. are connected to the common control lead 601, and the other grids 2 to 9 and 0 similarly to control wires 602 to 610 . All ten wires 601 to 610 are connected to 620 break contacts of the associated keys 611 to 620 to point 625 of the main battery 621, this point being near the negative pole and thus impressing a negative grid blas upon all grids.

In order to light cathode 1 of lamp 641, for 0 example, first the control key 651 associated with this lamp is operated and then the common control key 611 associated with grids 1 and the sending key 624. The operation of key 651 short-circuits the lamp 641 from the anodes over make breat of key break contact of key 624 to the cathodes. This short-circuit extinguishes any cathode of lamp 631 that may be lit at this time without affecting any of the other lamps. When key 611 is operated, the grid bias on grids 1 of all lamps 641, 642 , etc. is disconnected from point 625 near the negative pole of the main battery 621 and connected to point 623 which is nearer the positive pole of this battery.
Keys 611 to 620 are provided with make-beforebreak contacts to prevent interruptions of the battery circuit. Rectifler 626 serves to prevent short-circuits between points 623 and 625 during the time while the make and break contacts of keys 611 to 620 are both closed.

Although the operation of key 611 changes the bias on grids I of all lamps, this change does not affect any of the lamps as long as their individual control keys 651 etc. are in the normal position.
65 In some of these lamps cathode I may be dark and in others it may be glowing, depending upon preceding control operations. In the lamps whose cathode I is dark, this cathode will remain dark, because the voltage of the main battery 621
60 is insufficient to start a discharge even with reduced grid bias. On the other hand, in the lamps where cathode $I$ is glowing, the discharge is not affected by changes in grid bias, so that these cathodes will continue to glow.
When key 624 is operated, the short-circuit on lamp 641 is opened at the break contact of key 624 and the anodes of lamp 641 are connected to the auxiliary battery 622 which is in series with the main battery 621 and raises the potential on the ten pairs of electrodes in lamp 641 to a value which in itself is not sufficient to initiate the discharge on those electrodes whose grid has the normal negative grid bias from point 625 of the main battery. However, where the increased po-

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 tential on the anodes and the reduced grid biasfrom point 823 of the main battery come together, that is, at anode 1 , the comblned effect of the increased potential on the lamp and the lowered grid blas is to cause the discharge to set in. As a result, the discharge sets in at cathode I of lamp 641.

When key 651 is released, the increased potential on lamp 641 is removed and this lamp now receives its potential over resistance 631 from the main battery 621 . This potential is sufficient to maintain the discharge irrespective of the value of the grid bias. The release of keys 611 and $\mathbf{6 2 5}$, whereby the grid bias is restored to its normal value, therefore has no further effect upon the discharge at cathode I of lamp S4I.
In a similar manner ail other numerals in any of the lamps may be displaye at will by proper operation of the contro keys. If it is desired to extinguish a lamp without lighting a new number, it is only necessary to operate the associated individual control key, such as 451, 452, etc. or 651 , 652 etc., whereby the associated lamp is shortcircuited in Figs. 4 and 6.

Figs. 7 and 8 illustrate the application of the new glow lamp indicator to a stock quotation system, although it will be understood that the principle of this invention is by no means limited to stock quotation systems, but may be used to advantage in any system where it is necessary to display information by numerals, letters or any other characters or symbols. It will also be understood that the new glow lamp indicator may be constructed in any desired shape or size up to the largest dimensions. The circuit shown in Figs. 7 and 8 makes use of the method of control shown in Flg. 4, but it will be understood that it may be modifled to the method of control shown in Fig. 6 by any one skilled in the art.
The stock quotation system illustrated is arranged for a maximum of 1500 different stocks, giving for each stock the hundreds, tens and units digits and fractions (in eighths) of the closing price of the preceding day, and the tens and units digits and fractions (in eighths) of theopening, highest, lowest and last price of the current day. It is capable of transmitting two quotations per second or 120 quotations per minute with the customary speed of telegraphic transmission over the line. Contrary to well-known stock quotation systems in use at the present time where the speed of transmission is governed chiefly by the time required for sending the necessary number of impulses into the mechanical indicators, the stock quotation system disclosed herein is limited in speed only by the transmission over the line, the local control of the new glow lamp indicators being accomplished practically instantaneously without recourse to a varying number of impulses.
In the system shown, first the desired stock is selected by transmitting the hundreds, tens and units digits identifying the stock, next a code is transmitted to select the range, i. e. the close, open, high, low or last price or any desired combination thereof, and finally the tens and units digits and the fractions of the price are transmitted. The transmission is performed on the startstop principle by means of a four unit code, that is, each digit is represented by four line impulse spaces and the selected number is identified by the absence, called "marking current", or presence, called "spacing current", of line current during each of these four spaces. The codes used are shown in the following table, but it will be understood that any other combination of
four-unit codes may be employed. In the table a dash represents a spacing pulse, while a marking pulse is indicated by a numeral designating which of the four impulse spaces is occupied by the

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| Code No. | Marking pulses |
| :---: | :---: |
| 1 | 1-. |
| 3. | -2-- |
| 4. | -3- |
| 5 -. | 1-3. |
| 7... | -23: |
| 8 | --4 |
| 9 | 1--4 |
| 10. | -2-4 |
| 11. | 12-4 |
| 12 | $\bigcirc-34$ |
| 14 | -234 |
| 15 | 1234 |

Before going into a detailed description of the sequential operations which occur in a code transmission, the various apparatus used in my invention and their functions will be described.
The transmitter shown diagrammatically at 755 in Figure 7 consists essentially of a battery 754 and a transmitting contact 153 actuated by a motor driven tape or key board and distributor (not shown) for transmitting code combinations of impulse conditions to select a stock at a remote receiving point and thereafter indicate its quotation thereat. Any one of a number of well known types of transmitters, such as a key or tape operated, may be used, for example a transmitter of
35 the type shown in the patent to Kleinschmidt, No. 2,010,158, dated August 6, 1935, but inasmuch as they do not form a part of this invention, no specific illustration thereof need be given.
The transmitter 155 is connected over the line
40 780, broken to illustrate that it extends to a remote point, where the receiving apparatus comprising my novel stock quotation system is located. Connected at the receiving end in this line is a relay 152 which is arranged to operate 45 its armature in response to the received code combination of impulse conditions.
To transmit the code combination, the transmitter distributor is released for a cycle of operations and a start impulse is transmitted which
60 functions to release a clutch (not shown) on the receiver, releasing the recelving distributor for a cycle of operations. The transmitting and receiving distributors rotate in synchronism with each other through one revolution. Thereafter o distributors are stopped at a normal nonoperating position by the disengagement of the clutch and remain at rest until the next transmitting impulse.
The line relay 152, located at the receiving 60 end, operates in response to the start impulse to control the operation of the clutch magnet 751. Clutch magnet 15I, upon its energization, releases the clutch referred to above to permit the distributor brushes to wipe over the rings 156, 757, 758 153 to be rotated by their motor through a single revolution in a manner well-known in the art.
During the rotation of the brushes, code combinations of impulses are received in synchronism
70 with the brushes so that a new impulse condition is received as the brushes engage successive segments, each code combination comprising four impulse conditions as described above, although either more or less impulse conditions may be
the number of selections to be made, as will be well understood by those skilled in the art.
The first code combination received is arranged to make a "hundreds" selection. The next code combination received is arranged to make a "tens" selection, and the last, a "units" selection.
This completes the selection of the stock whose quotation is to be given and there then follows a code combination indicating the range or type of selection such as last, low, high, etc. Following this, further code combinations are received to indicate the actual quotation of the stock and range.
The code combinations are all received over the segments of distributor ring 756. Thus the first code combination in making the "hundreds" selection is received while the distributor brush moves over the segments 2 to 5 of ring 156, to the left of the segment on which the brush is shown at rest. The selection set-up on the relays $\mathbf{7 2 1}$ - $\mathbf{7 2 4}$ is thereupon held locked by reason of the brush of ring 751 being on a conducting portion at this time.
Immediately after the receipt of the first code combination, the brush 760 moves from an insulating portion to a conducting segment on the ring 159 and energizes the relay 161. The particular selection set-up on the relays 721-124 is thus transferred to a particular one of the "hundreds" group selecting relay 162. Although only one "hundreds" selection relay 762 is shown, ii will be obvious that there may be as many of thiese "hundreds" selection relays as the possible code combinations set up by the relays 121-124.

While this transfer for making the "hundreds" group selection takes place, the brush, wiping over the segments of the distributor ring 756, has also passed over the first two segments of the next code combination, namely, segments 6 and 7 , and as the brush 760 moves into engagement with the insulating segment 760, the remaining two impulses of the second code are received for selectively energizing relays 131 to 734, which function similar to tile relays $721-124$ to receive and relay the received codes. The two sets of code-receiving relays $\mathbf{1 2 1 - 1 2 4}$ and 13i-134 provide an overiap to insure full use of line time but, as shown, only a partial overlap is necessary, due to the fact that the actual indicating device is substantially instantaneous in its operation and only the transfer of the set-up on the selecting relays consumes time, necessitating a partial overlap.

Thus, prior to the end of the receipt of the second code combination, the brush wiping over distributor 751 moves into engagement with an insulating segment opening the locking circuits of relays $\mathbf{1 2 1}-\mathbf{7 2 4}$ so that these relays are restored and prepared to receive a new code combination. It will be noted that this occurs immediately after the brush 760 has transferred the set-up of relays 72i-124 to select the "hundreds" group relay 762.

During the receipt of the second code combination, the brush of ring 758 is in engagement with the conducting portion of the ring for providing a locking circuit for the selectively energized relays 731-134.

Immediately after the receipt of the last of 70 these impulses of the second code combination, the brush 160 moves into engagement with a conducting segment on the ring 759 and provides an energizing circuit for the transfer relay. 163 which transfers the selection set-up on the
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relays 731 - 134 to select the "tens" group selecting relay 765. Although one such tens selecting relay is shown, it will be obvious that the number of such selecting relays may again be equal to the number of selections that may be made by relays 131-134 times the number of "hundreds" selection relays. Moreover, although the transfer relay 163 is shown as providing connections only to the "hundreds" relay 162, it will
10 be obvious that multiple connections are provided through this relay to all the other "hundreds" group relays.

While this transfer takes place, the third code combination is being received over the distributor segment 756. to selectively energize relays 12i-124 in accordance with a "units" selection. During this time the brush of ring 151 is on a conducting segment so as to provide a locking circuit for these relays, and during the latter half of this interval the brush of ring 158 is on an insulating portion for releasing the lock of relays $131-134$ which by this time have transmitted their setting to the "tens" selecting relay. the third code combination is recelved while the brush of distributor 756 is passing over segments 10 to 13 . Following the recelpt of the third code combination which makes a units selection, a circuit is completed over the arma-
30 tures of relays 121-124 and through an armature of the "tens" relay 165 to the relay 850 which controls the glow lamps of the selected stock. This occurs following the energization of the transfer relay 164 which is energized immediately after the receipt of the code combination when brush 760 moves into engagement with the fourth conducting segment of ring 159. Here again, although circuits are shown extending from the armatures of relays 164 to the tens relay 165, it will be understood that multiple circuits are provided to all the other tens relays employed in my system.

Following the selection of the relay 850 individual to the particular stock quotation to be quoted, it is necessary to transmit a further code combination to determine which of the ranges of quotations is to be transmitted. This is accomplished while the distributor brush is passing over the fourth group of distributor segments 14 to 17 distributor ring 156. Relays 141-144 are selectively energized during this interval and selectively control the energization of relays $715-120$ which are individual to the particular range. Relays $115-120$ over their ar; matures, control energizing circuits for the glow lamps individual to the respective ranges such as close, open, high, low, etc.

At this point not only has an individual stock been selected, but the particular glow lamps for to the range which is to be transmitted have also been selected. There follow code combinations to indicate the quotation of the selected stock and range. This occurs while the brush of distributor 156 passes over the fifth, sixth and ments 18 to 21,22 to 25 , and 26 to 29.

As the brush passes over the segments 18 to 20, relays 131 to 134 are selectively energized in accordance with the tens quotation of the
70 selected stock. At this time a locking circuit is provided in these relays over the brush of distributor 158 which is passing over a conducting portion thereof. Immediately following the receipt of the code, brush 760 moves into engage75 ment with the next to the last conducting seg-
ment of ring 158 and completes an energizing circuit for the relay 168 which transfers the selective set-up of the relays 181-184 to select a relay $181-710$. There are ten such relays to enable the selection of the numerals $1-9$ and 0 .
The next succeeding code selectively energizes relays 121-124 as the brush of distributor 156 passes over the segments 22 to 25 . Immediately following this selection, the distributor brush 760 passes into engagement with the last conducting segment of the ring 158, completing an energizing circuit for the transfer relay 161 which again transfers the set-up of the relays 121-124 to the relays 101-110. Following the energization of these relays and just before the distributor is brought to rest at normal position, relay 114 is energized which provides a multiple energiang circuit for relay 166 to make the final transfer of the fractions selection.
When the code for the "tens" quotation is received, relay 714 being at this time de-energized, the glow lamp for the "tens" quotation of the particular selected stock and of the particular range is energized over the uppermost armature of the selected relays 116-120. When the "units" quotation code is received, the circult for the "units" glow lamp is energized over the middle armature of the selected relays 116-120 and finally, when the "fractions" quotation code is received, the "fractions" glow lamp of the selected stock and range is energized over the lowermost armatures of the selected relays 116-120, and in each instance the numeral in the glow lamp selected to illuminate is determined by the particular unit relays $\mathbf{7 0 1 - 1 / 4}$ which is energized.
As shown, the armature of the relay 115 extends only to one relay because this is the range relay for the hundreds digit appearing in the close position only. The range code hundredsNo. 14-marking pulses 234 -selects range relay 115 which controls the lighting of the hundreds lamp in the close position. For purposes of simplicity the hundreds lamp in the other positions is omitted.
A detalled description of the operation will now follow.
Normally the line relay 152 at the receiver is energized over the line, sending contact 152 and battery 184. When a quotation is to be transmitted, the sender opens the contact 153 momentarily for the purpose of starting the recelving distributor. Line relay 162 releases and energizes the clutch 181 over the first segment of distributor ring 758 and its associated brush, and break contact of line relay 752 . The distibutor rings 156 to 158 are shown developed as straight lines, but it will be understood that they are actually arranged in circular form so that the last segment is adjacent to the first.

When clutch 751 is energized, it couples the driving motor (not shown) with the brushes 186 which thereupon rotate over the distributor rings 168 to 159 in synchronism with the sender until one revolution is completed. As the top brush passes off the first segment of distributor ring 158 , the circuit of clutch 151 is opened, but the clutch is kept engaged by mechanical means untll one revolution is completed.
For purposes of illustration it will be assumed in the following that stock No. 1516 is to be selected. Hundreds code 15 as shown above, is represented by marking current on the line during all four impulse spaces. Accordingly, line relay 752 is deenergized while the brushes pass-over the next four segments of distributor ring 156. As 7
the brush passes over the first of these segments with the line relay 152 de-energized, a circuit is closed for relay 121 over the segment of ring 156, its associated brush and break contact of 6. line relay 152. Relay 121 operates over this circuit and locks over its own make contact. distributor ring 151 and its associated brush. The line relay being de-energized during the next three impulse spaces, relays 122, 123 and 724 are similarly operated and locked.

Relays 721 to 724 and also 731 to 734 are so adjusted that their locking contact closes first before any of the other contacts are antuated. Thus it is not necessary that these relays are completely operated during the brief interval while the brush passes over the associated segment, it being sufficient to close the locking contact whereupon the relay is fully operated over the holding circuit. The relay 121 with the largest number of contacts is on the first segment, so that it may fully operate during the next three segments.

While the transmitter sends the next four impulse spaces for the tens digit of the stock number, the selection registered on the four relays .121 to 724 is translated into the operation of the corresponding hundreds selection relay in the following manner:

As the brushes pass from the last of the hun30 dreds selection segments, a circuit is closed for relay 761 over a segment of distributor ring 159. Relay 761 operates, in turn closing a cir cuit for one of the hundreds selection relays, depending upon the position of the four register relays 121 5 to 124. In the present case, all four of these relays are operated, closing a circuit for hundreds selection relay 762 over make contact of relay 761, and make contacts of relays 121, 122, 123 and 124. Relay 762 operates and locks over its own make contact and break contact of relay 714.

Only one hundreds selection relay 162 is shown, but it will be obvious that in reality one such relay is provided for every hundred stocks, or a total of 15 for 1500 stocks, each being connected to one of the 15 contacts of relay 761. If a code other than No. 15 is transmitted, the four relays 121 to 724 will be operated in a different combination, resulting in the operation of a different hundreds selection relay when relay 761 is energized.
Two segments after the hundreds code is transmitted, the brushes of distributor rings 157 and 759 pass off their segments with the result that the holding circuit for relays $\mathbf{7 2 1}$ to $\mathbf{7 2 4}$ is opened at ring 757 and the circuit of relay 761 at ring 759. All these relays release.

Meanwhile the top brush has been passing over the tens segments of distributor ring 156, causing the registration of the selected tens digit upon the four relays 131 to 134, overlapping in part, the time during which the hundreds relay 721 to 124 are still locked.

In the present case, the tens digit is I, corresponding to marking current on the line during CJ the first of the four impulse spaces only. As a result, the line relay 752 is de-energized while the brush passes the first of the tens segments, but energized while the brush passes over the next three segments. Consequently relay 731 70 will be operated, while relays 132, 133 and 734 remain de-energized. Relay 131 locks over its own make contact, break contact of relay 714 and distributor ring 158.

After the tens selection line impulses are com75 pleted, a circuit is closed over distributor ring 159
for relay 763, which connects the contacts of relays 131 to 134 to the windings of the tens selection relays, resulting in the operation of the proper one of these relays. In the present example, the circuit closed by the register relays 731 to 734 leads to tens selection relay 765, from winding of 165 over make contact of hundreds selection relay 162, make contact of relay 763. make contact of relay 131 and break contacts of relays 132, 133 and 734. Relay 765 locks over its own make contact and break contact of relay 114. Two segments later, the circuit of relay 163 and the locking circuits of relays 131 to 134 are opened at distributor ring 158 and 759, causing these relays to release.
Only one tens selection relay $\mathbf{1 6 5}$ is shown, but it will be obvious that in practice one such relay is provided for every ten stocks, or a total of 150 relays for 1500 stocks. Which of these relays operates depends upon the previously energized hundreds selection relay and upon the position of register relays 731 to 134.
Meanwhile, in partial overlapping time relation, the top brush has been passing over the next four segments of distributor ring 756, which are connected to register relays 121 to 124. As a result the units stock selection digit is registered on these four relays. In the present example the units digit is 6, represented by marking current during the second and third impulse space. Consequently relays $\mathbf{1 2 2}$ and $\mathbf{7 2 3}$ are operated and locked while relays 121 and 124 remain de-energized.
After the units selection is transmitted, the brush of distributor ring 759 closes a circuit for relay 164. This relay operates and closes a circuit for the selection relay 850 of the selected stock, shown in Fig. 8, from its winding over make contacts of relays 165 and 764, break contact of relay 721, make contacts of relays 122 and 723, and break contact of relay 124. Relay 850 locks over its own make contact and break contact of relay 114. Only one stock selection relay 850 is shown, but it will be obvious that one such relay is provided for each stock whose prices are to be indicated. Which of these stock selection relays operates depends upon the previously operated hundreds and tens selection relay and the position of register relays 721 to 724.
If desired, the number of stocks may be increased to $15 \times 15 \times 15=3375$, without increasing the transmitting time. To accomplish this, relays 731-734 are equipped with the same contact arrangement as relays 121 to 124 and five make contacts are added to relays 162, 763, 164 and 765 and the number of tens selection relays is raised to 225 .
Two segments later, on distributor ring 156, the circuit of relay 764 and the holding circuit of relays 121 to 724 are opened at distributor rings 151 and 759 , causing these relays to release.
Meanwhile and in partial time overlapping relation, the top brush has been passing over the four range selection segments of distributor ring 156, registering the desired range. The range determines upon which indicators the subsequent price quotation is to be registered, that is, either close, open, high, low or last price. In addition, there are the ranges high and last together used when the last price also sets a new high, similarly low and last together, when the last price also sets a new low, unison used to set the first price of the day, when open, high, low and last are obviously the same, hundreds used to set the hundreds digit of the closing price of the preced-
ing day, which is not repeated on the other ranges open, high, low and last. A further range is wipe-out which sets all indicators of one stock at the same time, used to restore the indicators to 5 normal at the beginning of the day. The codes used for these various ranges are as follows:


For purposes of illustration it will be assumed the following that the range low and last is to be transmitted. This code calls for marking current during the first and second segment, resulting in the operation of relays 141 and 142 as the top brush passes over the corresponding segments of distributor ring 756, while relays 143 and 744 remain de-energized. Relays 741 and 142 lock over their own make contacts and break contact of relay 714 and close circuits for relays 719 and 720, the former over make contacts of relays 742 and 141, the latter over make contact of relay 741 . Relays 719 and 120 prepare circuits for the glow lamp indicators "low" tens units fractions and "last" tens units fractions shown on Fig. 8, thereby insuring that the subsequent price transmission will be registered upon these glow lamp indicators. The other ranges select the other indicators in a similar manner by means of relays 715 to 720 , depending upon which of the four range register relays 141 to 744 are energized during the range transmission.

Following the range transmission, the top brush passes over the next four segments of distributor ring 156 during which time the tens digit of the price is transmitted and registered upon the four relays 731 to 734 in the above described manner. Assuming that the tens digit of the price is 2 , represented by marking current during the second impulse space, only relay 732 will be energized during the transmission. After the transmission of the tens digit of the price is completed, a circuit is closed by distributor ring $\mathbf{7 5 9}$ for relay 766, whereby the selection registered on relays 131 to 734 is transferred to one of the ten control relays 701 to 710 . In the instance under con-

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 tact of relay 765 , break contact of relay 731 contact of relay 732 and break contacts of relays 133 and 134. The make-before-break contact of relay 702 corresponds to key 412 in Fig. 4.60 At the same time relay 711 , which is in series with all the relays 701 to 710 , has operated, closing at its make contact circuits for short-circuiting the tens glow lamp indicators previously selected by the operation of the stock selection and
65 range relays. In the present example, this circuit is traced from the anodes of lamps "Iow tens" and "last tens" in Fig. 8, over make contacts of relay 850, to Fig. 7 and there over make contacts of the operated range relays 119 and 120,
70 break contact of relay 114, make contact of relay 766, break contact of relay 712, make contact of relay 711 and break contacts of relays 101, 703 and 110 to cathodes 1,3 to 9 and 0 of the above-mentioned glow lamps. Relay 102 being
i.) operated, the short circuit for cathodes 2 is traced
from make contact of relay 111 over rectifler 188 and make contact of relay 112 to cathodes 2.

Relay 711 in turn closes a circuit for relay 112, whose contacts correspond to key 424 in Fig. 4. Relay 112, being of the ordinary telephone type, requires several milli-seconds for operating. During the interval after relay 111 operates and before relay 172 operates, the cathodes which may be glowing in lamps "low" tens and "last" tens are extinguished over the abovedescribed short-circuit. The interval is more than long enough to accomplish this, inasmuch as the lighting as well as the extinguishing of glow lamps takes place in a fraction of a milli-second.

When relay 112 operates, the short-circuit is opened at the break contact of this relay, battery 111 connected between the main battery 110 and the anodes of lamps "low" tens and "last" tens and battery 769 placed in parallel with rectifier 168. As explained above, this results in starting the discharge on those cathodes where the two additional potentials come together, that is, cathodes 2 of lamps "low" tens and "last" tens.

Two segments later, distributor ring 159 opens the circuit of relay 765, which in turn releases relays 702, 711 and 712 . At the same time the holding circuit for relays 131 to 134 is opened by distributor ring 158, causing the release of relay 132. When relay 165 releases, the additional potential from battery 111 is removed from lamps "low" tens and "last" tens, but the discharge is maintained as described above in connection with FMg. 4.
Meanwhile the units digit of the price has been registered on relays 121 to 724. After the transmission of this digit is completed, distributor ring 159 closes a circuit for relay 767. If the units digit be 8, corresponding to marking current during the fourth impuise space, relay 124 will be energized at this time. As a result, the operation of relay 761 closes a circuit for relay 108 over make contact of relay 161, break contacts of relays 121, 122 and 123, and make contact of relay 124. Relay 711 operates in series with relay 108 and closes the short-circuit for lamps "low" units and "last" units over make contacts of relays 850 119, 120 and 167, break contact of relay 112, make contact of relay 711 , break contacts of relays 701 to 107 and 109 to 110 to cathodes 1 to 1 and 9 and 0 , as well as over make contact of relay 108 and rectifier 168 to cathodes 8 . Subsequently relay 112 operates and causes the starting of the discharge on cathodes 8 of lamps "low" units and "last" units. Two segments later, the circuit of relay 767 is opened by distributor ring 159, causing this relay and relays 708,711 and 112 to release in succession. At the same time the holding circuit of relay 124 is opened by distributor ring 151, causing the release of this relay. In this manner the selected units digit 8 is registered on the lamps "low" units and "last" units.
Meanwhile the fractions diglt of the price has been registered on the four relays 131 to 134. Assuming the fractions digit to be 7, represented by marking current during the first three impulse spaces, relays 131, 132, and 733 are energized during the fractions selection. After the fractions selection is completely transmitted, the brushes of the distributor pass from the last segment back to the first and thereupon the clutch is mechanically disengaged, thus stopping the rotation of the brushes. If the sender is ready for the transmission of the next quotation, the clutch will be immediately energized again and the fractions digit will be registered upon the lamps "low" fractions

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and "last" fractions while the hundreds digit of the next stock selection is transmitted over the line. If the sender pauses before transmitting the next quotation, the brushes remain on the segment mitted. In either case the fractions digit is registered on the lamps as follows:
When the brushes return to the first segment, a clrcuit over ring 759 is closed for relay 714 which perates, in turn closing a circuit for relay 166 over make contacts of relays 713 and 114, distributor ring 158 and its associated brush. Slow releasing relay 713 is normally energized over a break contact of relay 114. Relay 766 closes cirthe ten relays $\mathbf{7 0 1}$ to $\mathbf{7 1 0}$. In the present example, relay 707 is operated over make contacts of relays 186, 131, 132 and 133 and break contact of relay 134. Relay 111 operates in series with relay 107, described operations, including the extinguishing of lamps "low" fractions and "last" fractions, the operation of relay 172 and the starting of the discharge on cathodes 1 of lamps "low" fractions and "last" fractions over make contacts of relays $850,719,120,114,166$, 112, batteries 111 and $\mathbf{1 1 0}$, make contacts of relays 112, battery 169, make contact of relay 701 to cathodes 1.
When relay 714 operates, the holding circuit of 0 relays 162 and 765 is opened, causing the release of these relays or of whichever hundreds and tens stock selection relays may be energized at this time.

At the same time the circuit of slow-releasing relay 113 is opened, but this relay remains operated for a certain period due to its slow-releasing feature.

The holding circuit of relays 741 to 144 and of the stock selection relay, such as 850, is trans40 ferred by relay 114 from direct ground to ground over the make contact of slow-releasing relay 113, distributor ring 158 and its associated brush. The holding circuit of relays 731 to 734 is maintained over a make contact of relay 713. These relays 5 therefore remain operated for the time being.

If the next quotation is immediately following, relay 713 has not sufficient time to release. As the brushes pass from the second segment, the holding circuit for relays 131 to 134, 741 to 144, 5 166, and stock selection relay 850 is opened by distributor ring 758, causing all these relays to release. A segment and a half later, the circuit of relay 114 is opened by distributor ring 759, causing this relay to release as well, thereby 55 restoring the fractions control circuit to normal and closing the circuit for relay 713.
If the sender pauses before transmitting the next quotation, the brushes remain on the first segment and relay 714 stays operated long enough to release of the latter opens the holding circuits of relays 131 to 134, 141 to 144, 766 and stock selection relay 850 at make contacts of relay 713. All these relays release, restoring the entire circuit
65 to normal, with the exception of relay 114 which stays operated until the next quotation is transmitted.
If it is desired to extinguish a lamp without lighting a new numeral, code 11 is transmitted, causing the operation of relay 111 direct without operating one of the relays 101 to 710 . As a result, the short-circuit for the lamps is closed but no circuit set up to light another numeral. The circuit for relay $1 / 1$ is traced over make conts tact of relay 166, 131, 132, break contact of relay

133 and make contact of relay 134 or over make contacts of relays 181, 121, 122, break contact of relay 123 and break contact of relay 124.

From the foregoing it will be euldent how the other ranges operate and it will not be necessary to go into a detalled description of these operations. Moreover, it will be clear that any desired number of receivers may be operated simultaneously from the same sender over the same line. Other possible applications of this invention will be evident to those skilled in the art and the Invention is not limited to the applications and means shown in the foregoing description or the associated drawings except as set forth in the appended claims.
I claim:

1. An annunciator system comprising a plurality of indicator units, each comprising a plurality of indicating gaseous discharge glow devices, said devices being characterized in that a materially higher voltage is required to start a discharge therein, than is required to sustain a discharge therein, means normally applying a sustaining voltage across each of sald devices, selecting means effective for selecting desired ones of said units, means for then momentarily removing the sustaining voltage from the devices of the selected unit and again re-establishing the same, said selecting means serving after the re-establishment of said sustaining voltage to subject predetermined devices of the selected unit to a starting voltage to start discharges therein, said sustaining voltage thereafter being effective to maintain said discharges independently of the starting voltage.
2. An annunciator system comprising a plurality of indicator units, each comprising a plurallty of indicating gaseous discharge glow devices, sald devices being characterized in that a materially higher voltage is required to start a discharge therein, than is required to sustain a discharge therein, means normally applying a sustaining voltage across each of said devices, selecting means for selecting said units in predetermined order, means including said selecting means for momentarily removing the sustaining voltage from the devices of the selected unit and again re-establishing the same, said selecting means serving after the re-establishment of said sustaining voltage to subject predetermined devices of the selected unit to a starting voltage to start discharges therein, said sustaining voltage thereafter being effective to maintain said discharges independently of the starting voltage.
3. A plurality of gaseous discharge glow devices arranged in groups, said devices being characterized in that a predetermined voltage is required to start a discharge therein, means for selectively subjecting all the devices of a desired group to a portion of a starting voltage, and means for selectively subjecting a desired device of each group to a complementary portion of said starting voltage, to start a discharge in the selected device of the selected group.
4. A plurality of gaseous discharge glow devices 66 arranged in groups, said devices being characterized in that a materially higher voltage is required to start a discharge therein, than is required to sustain a discharge therein, means normally applying a sustaining voltage across each of said 70 devices, means for selectively subjecting all the devices of a desired group to a portion of a starting voltage, means for selectively subjecting a desired device of each group to a complementary portion of said starting voltage, to start a discharge in the
$\qquad$
desired device of the desired group, the discharge being maintained in said desired device independently of the starting voltage by the sustaining voltage.
5. A plurality of gaseous discharge glow devices arranged in groups, each of said devices including an anode and a cathode and being characterized In that a predetermined voltage is required to start a discharge therein, a plurality of common anode connections each connecting the anodes of all devices in one group together, a plurality of common cathode connections each connecting corresponding cathodes of all the groups together, means including said anode circuit connections for selectively subjecting all the devices in a desired group to a portion of a starting voltage, and means including said cathode circuit connections for selectively subjecting a desired device in each group to a complementary portion of said starting voltage to start a discharge in the desired device of the desired group to the exclusion of all other devices.
6. A plurality of gaseous discharge glow devices arranged in groups, each of said devices including $4-$ an anode and a cathode and being characterized in that a materially higher voltage is required to start a discharge therein, than is required to sustain a discharge therein, anode circuit connections individual for each group, individual circuit connections for each cathode, sald cathode circuit connections being multiplied to corresponding cathodes of other groups, means for normally applying a sustaining voltage across each of said devices, means including said anode circuit conin a desired group to a portion of a starting voltage, means including said cathode circuit connections for selectively subjecting a desired device of each group to a complementary portion of said 40 starting voltage to start a discharge in the desired device of the desired group, said sustaining voltage thereafter being effective to maintain said discharge independently of the starting voltage.
7. A plurality of gaseous discharge glow devices arranged in groups, said devices each including an anode, a cathode and a control grid and being characterized in that the decrease of a negative bias voltage applied to the control grid results in a decrease of the voltage required to start a discharge in the device, means normally applying a predetermined negative bias voltage to the control grids of all the devices, means for selectively applying a voltage across the anodes and cathodes of all the devices in a desired group, said last mentioned voltage being insufficient to start a discharge in the devices with said predetermined bias voltage applied to the control grids, and means for selectively decreasing said bias voltage applied to the grids of 60 a desired device of each group to start a discharge in the desired device of the desired group.
8. A plurality of gaseous discharge glow devices arranged in groups, said devices each including an anode, a cathode and a control grid and being characterized in that a materially higher voltage applied across the anodes and cathodes and a materially lower bias voltage applied to the control grid is required to start a discharge therein, than is required to sustain a discharge therein,
means normally applying a sustaining voltage across the anodes and cathodes of all devices, means normally applying a bias voltage to the control grids of all devices, means for selectively applying an increased voltage across the anodes and cathodes of all the devices in a desired group. and means for selectively decreasing the blas voltage applied to the control grids of a deslred device of each group to start a discharge in the desired device of the desired group, sald sustaining voltage thereafter being effective to maintain said discharge independently of said increased voltage across the anodes and cathodes and of said decreased blas voltage.
9. A plurality of gaseous discharge glow devices arranged in groups, said devices each including an anode, a cathode and a control grld and being characterized in that the decrease of a negative bias voltage applied to the control grid results in a decrease of the voltage required to start a discharge in the device, a common cathode circuit connection for the cathodes of all the devices, a plurality of common anode connections each connecting the anodes of all the devices in one group together, a plurality of common grid connections each connecting corresponding grids of all the devices together, means normally applying a predetermined negative blas voltage to the control grids of all the devices, means for selectively applying a voltage across the anodes and cathodes of all the devices in a desired group, said last mentioned voltage belng insufficient to start a discharge in the devices with said predetermined bias voltage applied to the control grids, and means for selectively decreasing said bias voltage applied to the grids of a desired device of each group to start a discharge in the desired device of the desired group.
10. A plurality of gaseous discharge glow devices arranged in groups, said devices each including an anode, a cathode and a control grid and being characterized in that a materially higher voltage applied across the anodes and cathodes and a materially lower bias voltage applied to the control grid is required to start a discharge therein, than is required to sustain a discharge therein, a common cathode circuit connection for the cathodes of all the devices, a plurality of common anode connections each connecting the anodes of all the devices in one group together, a plurality of common grid connections each connecting corresponding grids of all the devices together, means normally applying a sustaining voltage across the anodes and cathodes of all devices, means normally applying a bias voltage to the control grids of all devices, means for selectively applying an increased voltage across the anodes and cathodes of all the devices in a desired group, and means for selectively decreasing the bias voltage applied to the control grids of a desired device of each group to start a discharge in the desired device of the desired group, said sustaining voltage thereafter being effective to maintain said discharge independently of said increased voltage across the anodes and cathodes and of sald decreased blas voltage.

HANS P. BOBWAU.

