Jan. 3, 1939. H. P. BOSWAU 2,142,106

SIGNALING SYSTEM AND GLOW LAMPS THEREFOR

Filed May 9, 1934 5 Sheets-Sheet 1

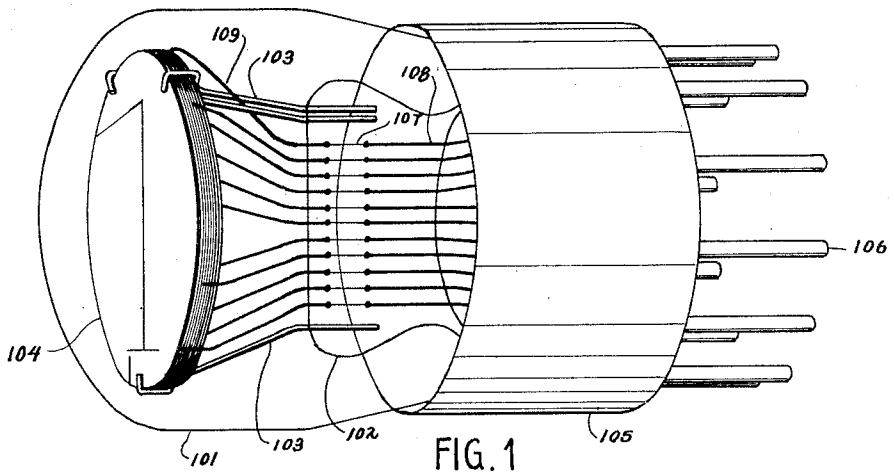

FIG. 1

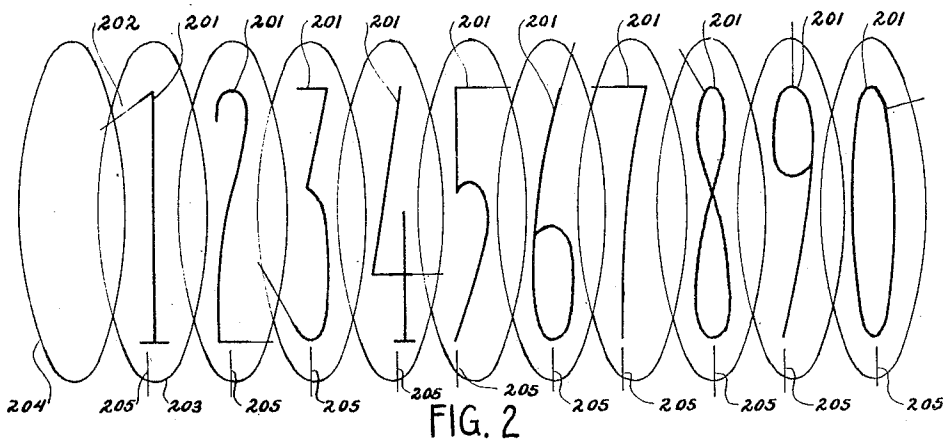

FIG. 2

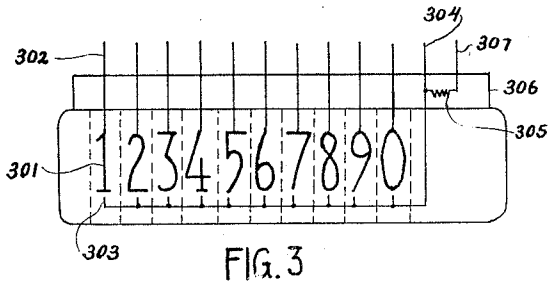

FIG. 3

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SIGNALING SYSTEM AND GLOW LAMPS THEREFOR

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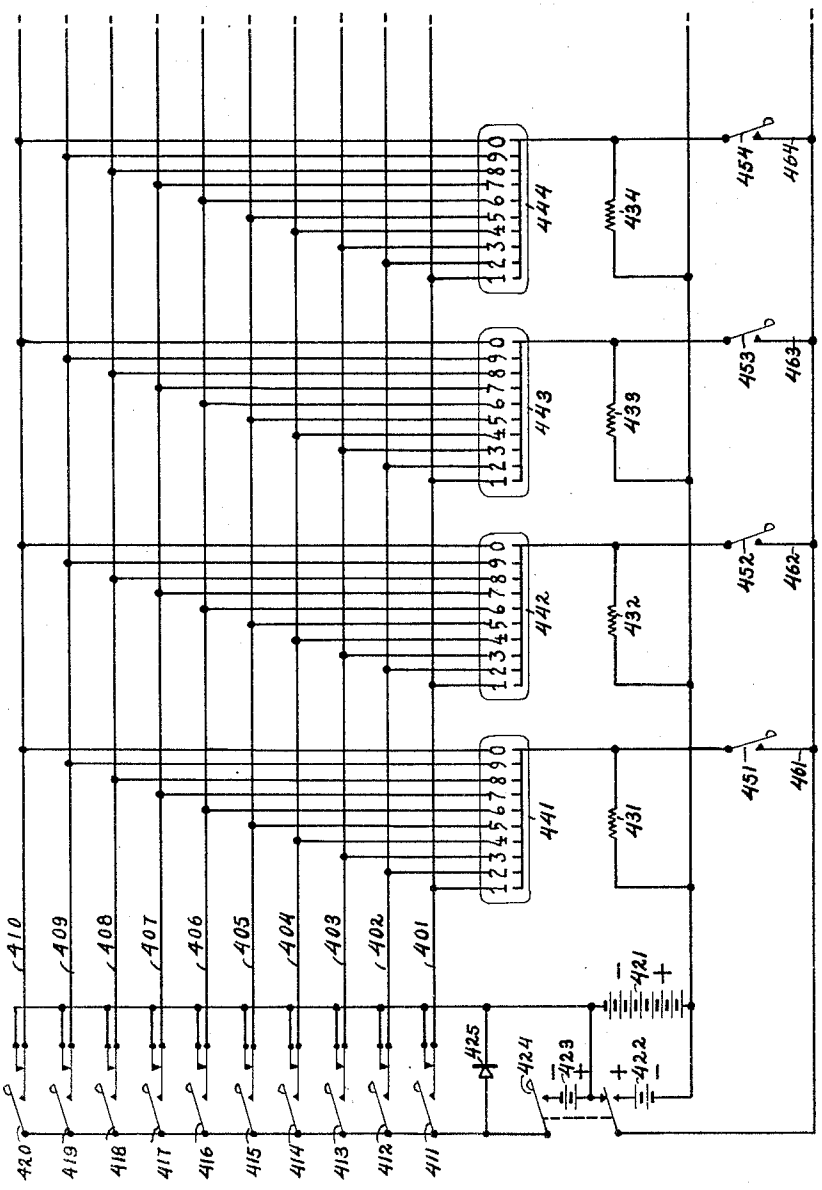

FIG. 4

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SIGNALING SYSTEM AND GLOW LAMPS THEREFOR

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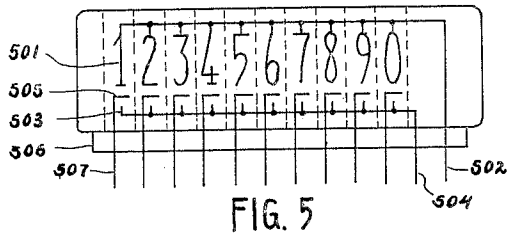

FIG. 5

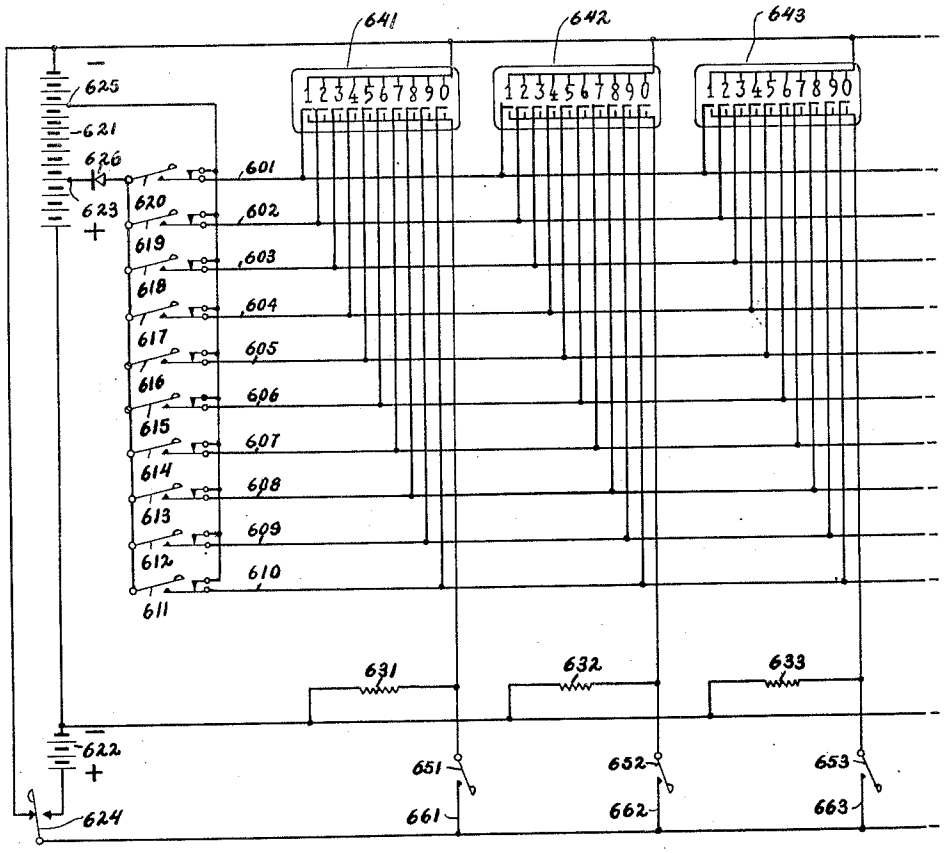

FIG. 6

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SIGNALING SYSTEM AND GLOW LAMPS THEREFOR

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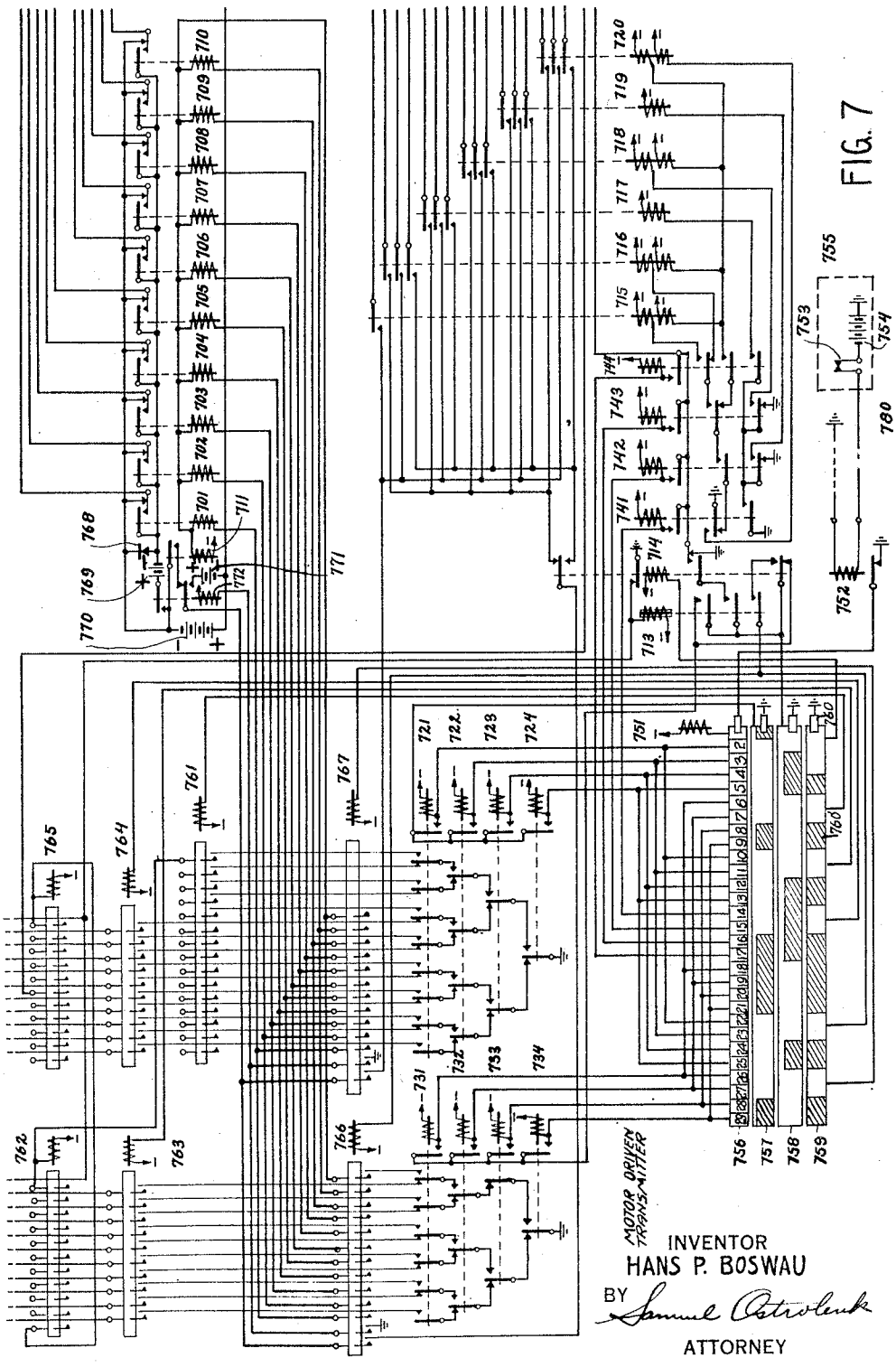

FIG. 7

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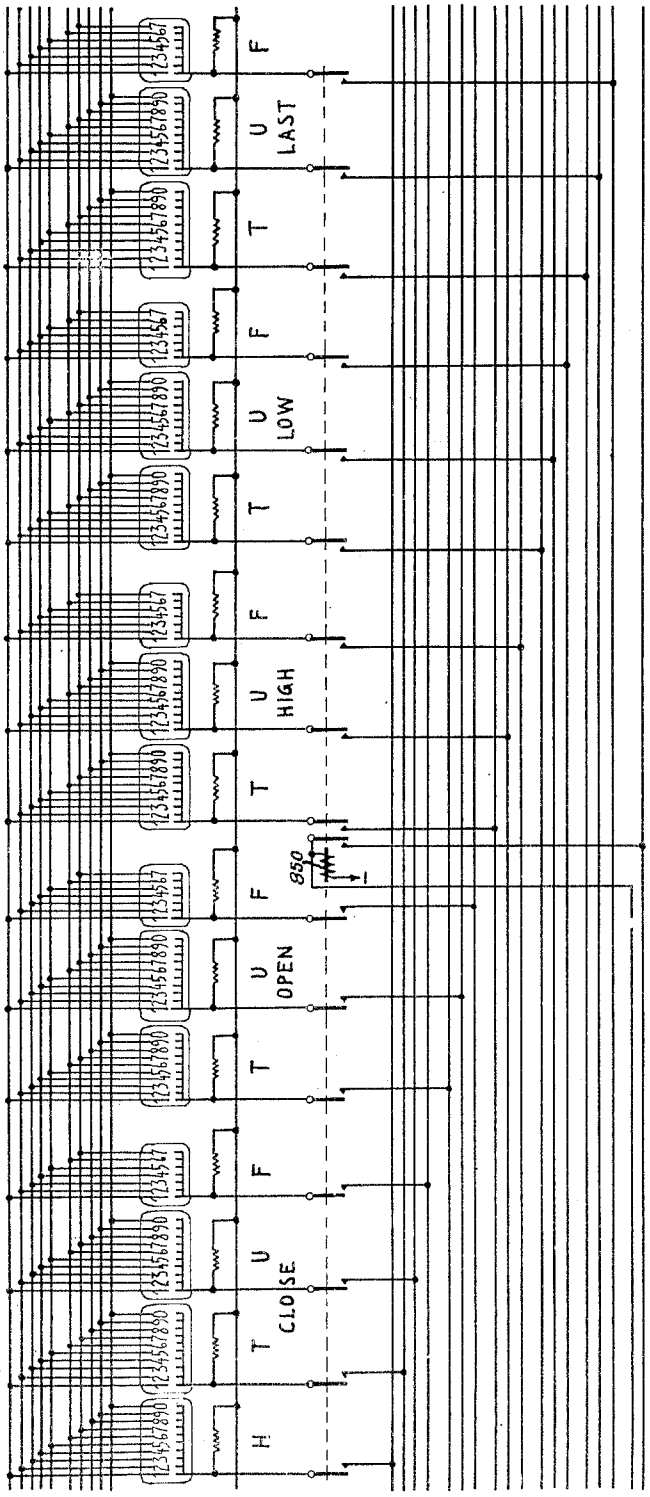

FIG. 8

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Patented Jan. 3, 1939

2,142,106

UNITED STATES PATENT OFFICE

2,142,106

SIGNALING SYSTEM AND GLOW LAMPS THEREFOR

Hans P. Boswau, Galion, Ohio

Application May 9, 1934, Serial No. 724,687

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 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 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 signaling 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 accompanying drawings in which:

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 required on a subscriber's premises; and

Fig. 8 shows the equipment required for one 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 other 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 "igniting potential". The luminous glow discharge is produced by negative electrons and positive 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 **101** 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 108 and 109, and are carried through the glass foot 102 in a well-known manner by means of short connectors 107 made of metal having the same coefficient of expansion as glass.

Fig. 2 shows the disk assembly 104 in an exploded view to illustrate the ten cathodes 201 and 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 filling 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 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, 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 filling operation. After these operations are completed and the bulb 101 is sealed off, the sealing material in the communicating aperture may be rendered impervious to 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.

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 0 to a noticeable degree, inasmuch as the cathodes are only 0.002 inch in diameter while the glow discharge appearing on both sides of the glowing cathode is approximately 1/16 inch wide.

Viewed from the front of the bulb, therefore, any one of the ten cathodes, when glowing, will 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 being the ten cathodes, connected to ten terminals 302, the ten anodes 303 being connected to terminal 304. A resistance 305 may also be mounted in the base 306 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 momentarily 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 409 and 410, respectively. Each of these ten wires is connected over a break contact of the ten number keys 411 to 420 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 431 to 434 to the positive pole of the battery 421. In this manner intermediate potential is applied to all cathodes.

If it is desired to light, for example, numeral 1 of glow lamp 441, 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 441 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 410, to the ten cathodes of lamp 441. 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 411, cathodes 1 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 rectifier 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, thus in effect placing battery 423 in series with battery 421 and thereby raising the potential on cathodes 1 on wire 401 to a value higher than the intermediate potential but not quite high enough to ignite the cathodes. This circuit is traced from cathodes 1 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 resistances 431 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 in series with battery 421 over key 451 to lamp 441 only. This circuit is traced from cathode 1 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 424 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 422 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 this is higher than the igniting potential, so that cathode 1 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 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 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 1 of lamp 441 is the 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 1 of this lamp remains illuminated through batteries 421 and 423 in series. This circuit is the same as that described above for connecting battery 423 in series with battery 421. When keys 411 and 424 are released, auxiliary battery 423 is also removed 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 1 of lamp 441 is traced from this cathode over wire 401, normally 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 1 of lamp 441 is lit.

If it is desired to extinguish cathode 1 of lamp 441 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 1 of this lamp. The subsequent operation of keys 412 and 424 thereupon initiates 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 1 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 grids 505 are interposed between the cathodes and anodes and connected individually to ten terminals 507. 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 short piece of wire interposed between the cathodes and anodes.

The control circuit shown in Fig. 6 for the grid glow lamp indicator is similar in principle to that shown in Fig. 4 for the ordinary glow lamp indicator, 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 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 discharge.

Grids 1 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 through 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 bias upon all grids.

In order to light cathode 1 of lamp 641, for 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 contact of key 651, individual control lead 661, 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-before-break contacts to prevent interruptions of the battery circuit. Rectifier 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 1 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. In some of these lamps cathode 1 may be dark and in others it may be glowing, depending upon preceding control operations. In the lamps whose cathode 1 is dark, this cathode will remain dark, because the voltage of the main battery 621 is insufficient to start a discharge even with reduced grid bias. On the other hand, in the lamps where cathode 1 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 potential on the anodes and the reduced grid bias from point 623 of the main battery come together, that is, at anode 1, the combined effect of the increased potential on the lamp and the lowered grid bias is to cause the discharge to set in. As a result, the discharge sets in at cathode 1 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 625, whereby the grid bias is restored to its normal value, therefore has no further effect upon the discharge at cathode 1 of lamp 641.

In a similar manner all other numerals in any of the lamps may be displayed at will by proper operation of the control 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 651, 652, etc. or 651, 652 etc., whereby the associated lamp is short-circuited 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 Fig. 4, but it will be understood that it may be modified 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 the opening, 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 start-stop 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 marking pulse.

Code No.	Marking pulses
1	1 - - -
2	- 2 - -
3	1 2 - -
4	- - 3 -
5	1 - 3 -
6	- 2 3 -
7	1 2 3 -
8	- - - 4
9	1 - - 4
10	- 2 - 4
11	1 2 - 4
12	- - 3 4
13	1 - 3 4
14	- 2 3 4
15	1 2 3 4

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 **753** 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 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 **755** is connected over the line **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 **752** which is arranged to operate 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 functions to release a clutch (not shown) on the receiver, releasing the receiving distributor for a cycle of operations. The transmitting and receiving distributors rotate in synchronism with each other through one revolution. Thereafter the two distributors are stopped at a normal non-operating position by the disengagement of the clutch and remain at rest until the next transmitting impulse.

The line relay **752**, located at the receiving end, operates in response to the start impulse to control the operation of the clutch magnet **751**. Clutch magnet **751**, upon its energization, releases the clutch referred to above to permit the distributor brushes to wipe over the rings **756**, **757**, **758** and **759** 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 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 used for each code combination, depending upon 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 **756**, to the left of the segment on which the brush is shown at rest. The selection set-up on the relays **721**—**724** is thereupon held locked by reason of the brush of ring **757** 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 **759** and energizes the relay **761**. The particular selection set-up on the relays **721**—**724** is thus transferred to a particular one of the "hundreds" group selecting relay **762**. Although only one "hundreds" selection relay **762** is shown, it will be obvious that there may be as many of these "hundreds" selection relays as the possible code combinations set up by the relays **721**—**724**.

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 **731** to **734**, which function similar to the relays **721**—**724** to receive and relay the received codes. The two sets of code-receiving relays **721**—**724** and **731**—**734** provide an overlap 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 **757** moves into engagement with an insulating segment opening the locking circuits of relays **721**—**724** 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 **721**—**724** 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**—**734**.

Immediately after the receipt of the last of these impulses of the second code combination, the brush **760** moves into engagement with a conducting segment on the ring **759** and provides an energizing circuit for the transfer relay **763** which transfers the selection set-up on the

relays 731—734 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 731—734 times the number of "hundreds" selection relays. Moreover, although the transfer relay 763 is shown as providing connections only to the "hundreds" relay 762, it will 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 721—724 in accordance with a "units" selection. During this time the brush of ring 757 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 758 is on an insulating portion for releasing the lock of relays 731—734 which by this time have transmitted their setting to the "tens" selecting relay.

The third code combination is received while the brush of distributor 756 is passing over segments 10 to 13. Following the receipt of the third code combination which makes a units selection, a circuit is completed over the armatures of relays 721—724 and through an armature of the "tens" relay 765 to the relay 850 which controls the glow lamps of the selected stock. This occurs following the energization of the transfer relay 764 which is energized immediately after the receipt of the code combination when brush 760 moves into engagement with the fourth conducting segment of ring 759. Here again, although circuits are shown extending from the armatures of relays 764 to the tens relay 765, 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 756. Relays 741—744 are selectively energized during this interval and selectively control the energization of relays 715—720 which are individual to the particular range. Relays 715—720 over their armatures, 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 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 756 passes over the fifth, sixth and seventh group of segments, comprising the segments 18 to 21, 22 to 25, and 26 to 29.

As the brush passes over the segments 18 to 20, relays 731 to 734 are selectively energized in accordance with the tens quotation of the selected stock. At this time a locking circuit is provided in these relays over the brush of distributor 758 which is passing over a conducting portion thereof. Immediately following the receipt of the code, brush 760 moves into engagement with the next to the last conducting segment of ring 759 and completes an energizing circuit for the relay 766 which transfers the selective set-up of the relays 731—734 to select a relay 701—710. There are ten such relays to enable the selection of the numerals 1–9 and 0.

The next succeeding code selectively energizes relays 721—724 as the brush of distributor 756 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 759, completing an energizing circuit for the transfer relay 767 which again transfers the set-up of the relays 721—724 to the relays 701—710. Following the energization of these relays and just before the distributor is brought to rest at normal position, relay 714 is energized which provides a multiple energizing circuit for relay 766 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 716—720. When the "units" quotation code is received, the circuit for the "units" glow lamp is energized over the middle armature of the selected relays 716—720 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 716—720, and in each instance the numeral in the glow lamp selected to illuminate is determined by the particular unit relays 701—710 which is energized.

As shown, the armature of the relay 715 extends only to one relay because this is the range relay for the hundreds digit appearing in the close position only. The range code hundreds—No. 14—marking pulses 234—selects range relay 715 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 detailed description of the operation will now follow.

Normally the line relay 752 at the receiver is energized over the line, sending contact 753 and battery 754. When a quotation is to be transmitted, the sender opens the contact 753 momentarily for the purpose of starting the receiving distributor. Line relay 752 releases and energizes the clutch 751 over the first segment of distributor ring 756 and its associated brush, and break contact of line relay 752. The distributor rings 756 to 759 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 760 which thereupon rotate over the distributor rings 756 to 759 in synchronism with the sender until one revolution is completed. As the top brush passes off the first segment of distributor ring 756, the circuit of clutch 751 is opened, but the clutch is kept engaged by mechanical means until 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 756. As

the brush passes over the first of these segments with the line relay 752 de-energized, a circuit is closed for relay 721 over the segment of ring 756, its associated brush and break contact of line relay 752. Relay 721 operates over this circuit and locks over its own make contact, distributor ring 757 and its associated brush. The line relay being de-energized during the next three impulse spaces, relays 722, 723 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 actuated. 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 721 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 721 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 hundreds selection segments, a circuit is closed for relay 761 over a segment of distributor ring 759. Relay 761 operates, in turn closing a circuit for one of the hundreds selection relays, depending upon the position of the four register relays 721 to 724. 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 721, 722, 723 and 724. Relay 762 operates and locks over its own make contact and break contact of relay 714.

Only one hundreds selection relay 762 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 721 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 757 and 759 pass off their segments with the result that the holding circuit for relays 721 to 724 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 756, causing the registration of the selected tens digit upon the four relays 731 to 734, overlapping in part, the time during which the hundreds relay 721 to 724 are still locked.

In the present case, the tens digit is 1, corresponding to marking current on the line during 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 will be operated, while relays 732, 733 and 734 remain de-energized. Relay 731 locks over its own make contact, break contact of relay 714 and distributor ring 758.

After the tens selection line impulses are completed, a circuit is closed over distributor ring 759 for relay 763, which connects the contacts of relays 731 to 734 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 765 over make contact of hundreds selection relay 762, make contact of relay 763, make contact of relay 731 and break contacts of relays 732, 733 and 734. Relay 765 locks over its own make contact and break contact of relay 714. Two segments later, the circuit of relay 763 and the locking circuits of relays 731 to 734 are opened at distributor ring 758 and 759, causing these relays to release.

Only one tens selection relay 765 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 734.

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 721 to 724. 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 722 and 723 are operated and locked while relays 721 and 724 remain de-energized.

After the units selection is transmitted, the brush of distributor ring 759 closes a circuit for relay 764. 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 765 and 764, break contact of relay 721, make contacts of relays 722 and 723, and break contact of relay 724. Relay 850 locks over its own make contact and break contact of relay 714. 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 $15\times15\times15=3375$, without increasing the transmitting time. To accomplish this, relays 731—734 are equipped with the same contact arrangement as relays 721 to 724 and five make contacts are added to relays 762, 763, 764 and 765, and the number of tens selection relays is raised to 225.

Two segments later, on distributor ring 756, the circuit of relay 764 and the holding circuit of relays 721 to 724 are opened at distributor rings 757 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 756, 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 normal at the beginning of the day. The codes used for these various ranges are as follows:

Range	Code No.	Marking pulses
Last	1	1 - - -
Low	2	- 2 - -
High	4	- - 3 -
Open	8	- - - 4
Close	6	- 2 3 -
Hundreds	14	- 2 3 4
Low and last	4	1 2 - -
High and last	5	1 - 3 -
Unison	15	1 2 3 4
Wipe-out	10	- 2 - 4

For purposes of illustration it will be assumed in 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 741 and 742 as the top brush passes over the corresponding segments of distributor ring 756, while relays 743 and 744 remain de-energized. Relays 741 and 742 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 741, the latter over make contact of relay 741. Relays 719 and 720 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 741 to 744 are energized during the range transmission.

Following the range transmission, the top brush passes over the next four segments of distributor ring 756 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 759 for relay 766, whereby the selection registered on relays 731 to 734 is transferred to one of the ten control relays 701 to 710. In the instance under consideration, relay 702 is operated over make contact of relay 766, break contact of relay 731, make contact of relay 732 and break contacts of relays 733 and 734. The make-before-break contact of relay 702 corresponds to key 412 in Fig. 4.

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 range relays. In the present example, this circuit is traced from the anodes of lamps "low 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 719 and 720, break contact of relay 714, make contact of relay 766, break contact of relay 772, make contact of relay 711 and break contacts of relays 701, 703 and 710 to cathodes 1, 3 to 9 and 0 of the above-mentioned glow lamps. Relay 702 being operated, the short circuit for cathodes 2 is traced from make contact of relay 711 over rectifier 768 and make contact of relay 702 to cathodes 2.

Relay 711 in turn closes a circuit for relay 772, whose contacts correspond to key 424 in Fig. 4. Relay 772, being of the ordinary telephone type, requires several milli-seconds for operating. During the interval after relay 711 operates and before relay 772 operates, the cathodes which may be glowing in lamps "low" tens and "last" tens are extinguished over the above-described 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 772 operates, the short-circuit is opened at the break contact of this relay, battery 771 connected between the main battery 770 and the anodes of lamps "low" tens and "last" tens and battery 769 placed in parallel with rectifier 768. 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 759 opens the circuit of relay 766, which in turn releases relays 702, 711 and 772. At the same time the holding circuit for relays 731 to 734 is opened by distributor ring 758, causing the release of relay 732. When relay 766 releases, the additional potential from battery 771 is removed from lamps "low" tens and "last" tens, but the discharge is maintained as described above in connection with Fig. 4.

Meanwhile the units digit of the price has been registered on relays 721 to 724. After the transmission of this digit is completed, distributor ring 759 closes a circuit for relay 767. If the units digit be 8, corresponding to marking current during the fourth impulse space, relay 724 will be energized at this time. As a result, the operation of relay 767 closes a circuit for relay 708 over make contact of relay 767, break contacts of relays 721, 722 and 723, and make contact of relay 724. Relay 711 operates in series with relay 708 and closes the short-circuit for lamps "low" units and "last" units over make contacts of relays 850, 719, 720 and 767, break contact of relay 772, make contact of relay 711, break contacts of relays 701 to 707 and 709 to 710 to cathodes 1 to 7 and 9 and 0, as well as over make contact of relay 708 and rectifier 768 to cathodes 8. Subsequently relay 772 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 759, causing this relay and relays 708, 711 and 772 to release in succession. At the same time the holding circuit of relay 724 is opened by distributor ring 757, 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 digit of the price has been registered on the four relays 731 to 734. Assuming the fractions digit to be 7, represented by marking current during the first three impulse spaces, relays 731, 732, 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

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 first segment until the next quotation is transmitted. In either case the fractions digit is registered on the lamps as follows:

When the brushes return to the first segment, a circuit over ring 759 is closed for relay 714 which operates, in turn closing a circuit for relay 766 over make contacts of relays 713 and 714, distributor ring 758 and its associated brush. Slow releasing relay 713 is normally energized over a break contact of relay 714. Relay 766 closes circuits from the contacts of relays 731 to 734 to the ten relays 701 to 710. In the present example, relay 707 is operated over make contacts of relays 766, 731, 732 and 733 and break contact of relay 734. Relay 711 operates in series with relay 707, causing the above-described operations, including the extinguishing of lamps "low" fractions and "last" fractions, the operation of relay 772 and the starting of the discharge on cathodes 7 of lamps "low" fractions and "last" fractions over make contacts of relays 850, 719, 720, 714, 766, 772, batteries 771 and 770, make contacts of relays 712, battery 769, make contact of relay 707 to cathodes 7.

When relay 714 operates, the holding circuit of relays 762 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 713 is opened, but this relay remains operated for a certain period due to its slow-releasing feature.

The holding circuit of relays 741 to 744 and of the stock selection relay, such as 850, is transferred by relay 714 from direct ground to ground over the make contact of slow-releasing relay 713, distributor ring 758 and its associated brush. The holding circuit of relays 731 to 734 is maintained over a make contact of relay 713. These relays 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 731 to 734, 741 to 744, 766, 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 714 is opened by distributor ring 759, causing this relay to release as well, thereby 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 cause the release of slow-releasing relay 713. The release of the latter opens the holding circuits of relays 731 to 734, 741 to 744, 766 and stock selection relay 850 at make contacts of relay 713. All these relays release, restoring the entire circuit to normal, with the exception of relay 714 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 711 direct without operating one of the relays 701 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 711 is traced over make contact of relay 766, 731, 732, break contact of relay 733 and make contact of relay 734 or over make contacts of relays 767, 721, 722, break contact of relay 723 and break contact of relay 724.

From the foregoing it will be evident how the other ranges operate and it will not be necessary to go into a detailed 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 said 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 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 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 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 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

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 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, said 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 connections for selectively subjecting all the devices in 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 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 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 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 said decreased bias voltage.

9. 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, 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 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 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 said decreased bias voltage.

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