

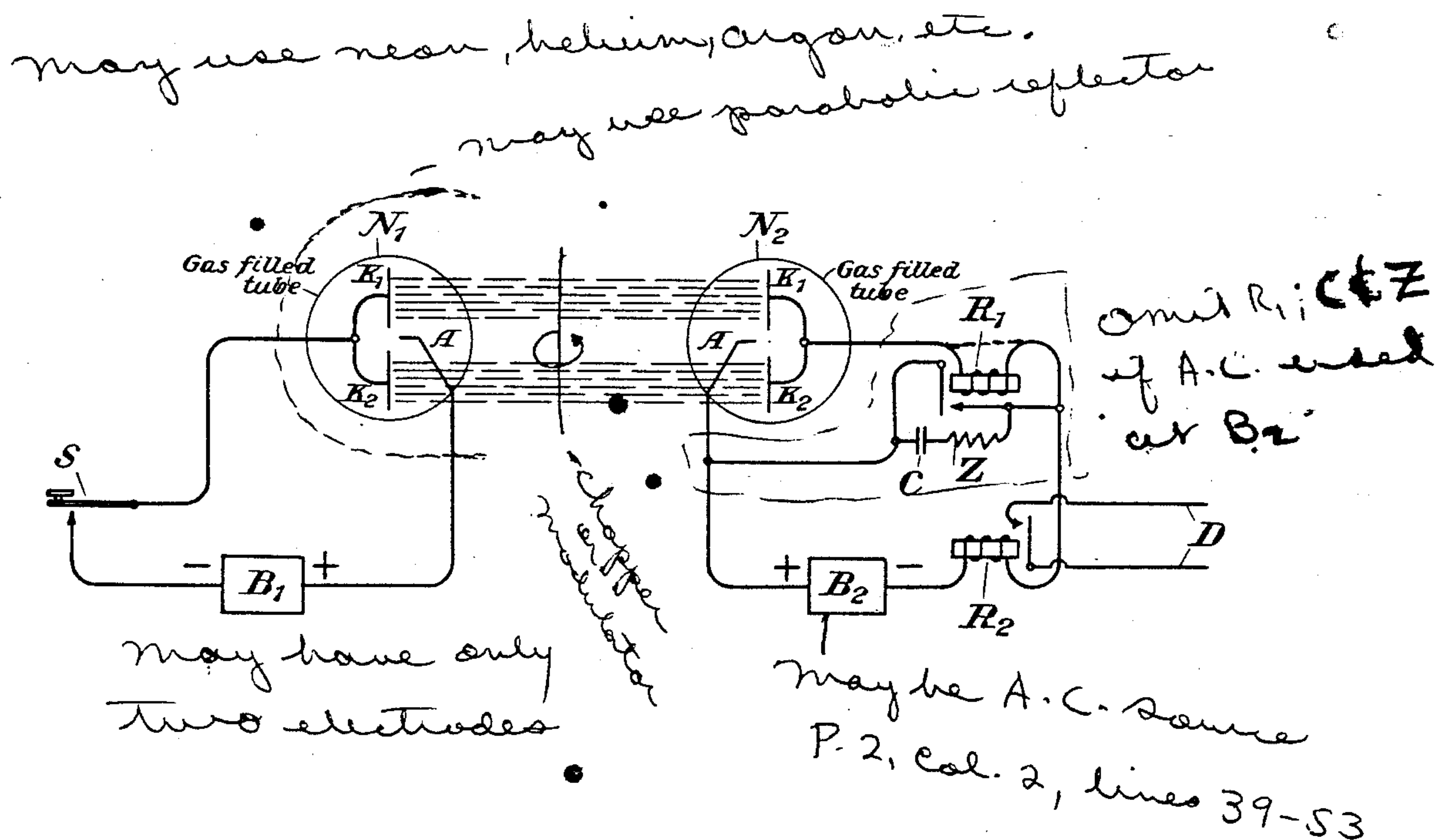
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SIGNALING SYSTEM EMPLOYING GLOW DISCHARGES

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Potential across electrodes of N_2 normally insufficient to ionize gas therein. Ultra-Violet rays transmitted from N_1 in conjunction with potential B_2 is sufficient to ionize gas in N_2 permitting current to flow therein causing relay R_2 to operate to send signal out on D . Relay R_1 then operates to remove potential from electrodes N_2 causing it to become de-ionized.

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SIGNALING SYSTEM EMPLOYING GLOW DISCHARGES

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This invention relates to signaling systems. More particularly, this invention relates to signaling systems employing light rays for the transmission of signals. Still more particularly, this invention relates to signaling systems employing the luminous discharge of gas filled tubes for the transmission of signals.

It is well known that when a voltage exceeding a predetermined value is impressed across the spaced electrodes enclosed within an envelope of, for example, glass, the envelope being filled with a gaseous medium such as neon, argon, helium, or the like, the gas within the envelope will become ionized and a discharge will occur. When such a discharge occurs, it will be accompanied by a luminous effect which will be quite pronounced in the space bridging the electrodes.

It is one of the objects of this invention to produce a luminous discharge between the electrodes of a gas filled tube, radiate the rays of the luminous discharge and then convert the received rays into currents which will correspond to those used in producing the luminous discharge.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing showing one embodiment of the invention merely for the purpose of illustration.

Referring to the drawing, the reference characters N_1 and N_2 represent two gas filled tubes each having an envelope of a transparent material such as glass, and each enclosing a gaseous medium which may be neon, argon or helium gas, or a combination of these gases and hydrogen or mercury vapor, or any other gas which when ionized will become luminous. These gas filled tubes N_1 and N_2 , although they appear to be closely spaced in the drawing, may, however, be separated by great distances.

Each of these tubes includes two or more electrodes, three electrodes being illustrated, however, merely by way of example. Two of these electrodes may be called cathodes K_1 and K_2 , and the third electrode an anode A. The two electrodes K_1 and K_2 may be connected to each other, as shown. The tube N_1 may be considered as located at the transmitting station or in the transmitting circuit of a signaling system, and the tube N_2 may be considered as part of the receiving apparatus of the system which may or may not be at a distant point.

The anode A and the conductor common to the cathodes K_1 and K_2 of the tube N_1 are connected to a series circuit which includes a source of potential designated B_1 and a key designated S.

The source B_1 is preferably one capable of producing a direct voltage which is greater than the voltage required to ionize the gas within the tube N_1 and break down the gaps between either or both of the electrodes K_1 and K_2 and the anode A.

When the key S is operated so as to close its associated contact, the source B_1 will then transmit a direct voltage of large magnitude which will become impressed directly between both of the electrodes K_1 and K_2 and the anode A. In response to this impressed voltage of large magnitude, both of the gaps between the anode A and the electrodes K_1 and K_2 will be simultaneously broken down and both of these gaps will exhibit glow discharges which are luminous. The luminous rays may include infra red rays and ultra violet rays and other rays whether luminous or non-luminous and, of course, if the glow is of violet color, the transmitted rays will for the most part be composed of the ultra violet portion of the spectrum.

At the receiving station it will be seen that the electrodes K_1 and K_2 of the tube N_2 are connected together and the common conductor is connected in series with a circuit which includes the winding of a vibrating relay designated R_1 , the winding of an operating relay designated R_2 , a source of potential designated B_2 , and the terminal of the tube N_2 which is connected to the anode A of that tube. The armature and contact of the vibrating relay R_1 are connected in a circuit which directly shunts the parallel discharge gaps of the tube N_2 and the series winding of the vibrating relay R_1 . The armature and contact of the vibrating relay are also shunted by a condenser C of large capacity and an impedance Z of small magnitude, both of which are connected in series relationship. The armature of the operating relay R_2 and its contact are connected to a circuit D and they control the flow of current through that circuit.

The source B_2 may be one of direct voltage such as may be produced by a storage battery and the voltage of this source is of itself insufficient to properly ionize the gas within the tube N_2 so as to break down the gaps between either of the electrodes K_1 and K_2 and the anode A of the tube N_2 . However, when the luminous rays emanating from the electrodes and gas within the tube N_1 associated with the transmitting circuit are transmitted through the envelope of the tube N_2 to the electrodes K_1 and K_2 of the tube N_2 , the gas within the tube N_2 will become instantly ionized. This will result in a reduction of

impedance between anode A and cathodes K₁ and K₂ from a substantially infinite value to a finite and low value. This reduction in impedance from an open circuit to a closed circuit condition results in a current flow from the source B₂ through the circuit including the winding of the operating relay R₂, the winding of the vibrating relay R₁, and either or both of the electrodes K₁ and K₂ of the tube N₂ and its anode A. The armatures of both relays R₁ and R₂ will be attracted so as to close their associated contacts. Upon the closure of the contact of the relay R₂, the circuit D will become operated.

Immediately after the armature of the vibrating relay R₁ has closed its contact, a shunt path will be established around electrodes A to K₁ and K₂ of tube N₂ and the winding of the vibrating relay R₁. The current then transmitted from source B₂ through the winding of the relay R₂ will become substantially increased and the increased current will retain the armature of the relay R₂ in its operated position. While the armature of relay R₁ remains on its contact, the tube N₂ will cease to glow. The armature of the vibrating relay R₁ will release and cause the associated contact to become opened. Current will then flow from the source B₂ through two parallel paths. One of these parallel paths will include the condenser C and the impedance Z, causing the condenser C to become charged. The other path will include the anode A of the tube N₂ and its two electrodes K₁ and K₂ and the winding of the vibrating relay R₁. If no luminous light rays are transmitted from the tube N₁ in the transmitting circuit to the tube N₂ in the receiving circuit, the vibrating relay will fail to return its armature to its closed position and immediately thereafter the armature of the operating relay R₂ will become released. If, however, rays emerging from the transmitting station do reach the tube N₂ of the receiving station, further ionization of the gas within the tube N₂ will occur and the winding of the vibrating relay R₁ will again attract its armature and close its associated contact. Hence the armature of the relay R₂ will remain closed against its contact, maintaining the circuit D closed.

When the winding of the vibrating relay R₁ causes the release of its armature, there will be produced across its contacts and hence across the elements A and K₁ and K₂ of the tube N₂ a voltage "kick" of large magnitude. This kick is produced by the decay of the magnetomotive flux in relay R₂ and may of itself be sufficient, when combined with the potential of the source B₂, to ionize the gas within the tube N₂, especially between electrodes A and K₁ and K₂ within tube N₂. In order to eliminate the possibility of this occurrence, the condenser C and the impedance Z are interposed in the circuit, as shown, the impedance Z being one of comparatively small magnitude so that it may easily absorb the voltage transmitted therethrough toward the condenser C. It will be noted that the source B₂ may be one of direct current voltage and that the gaps within the tube N₂ will become discharged only when the rays emerging from the transmitting tube N₁ reach the tube N₂. As long as the tube N₂ receives rays of light, the relay R₁ will vibrate its armature at a high speed and the circuit D will remain closed by the armature and contact of the relay R₂. Just as soon as these emerging rays disappear, however, the gas within the tube N₂ will become deionized and the circuit

D will be opened at the contact of the armature of the relay R₂.

So it will be seen that the key S at the transmitting station or in the transmitting circuit may be operated to create luminous discharges between the electrodes in the gas of the tube N₁ for predetermined intervals of time in accordance with signals. These signals will be accompanied by the transmission of correspondingly interrupted luminous rays which will impinge upon the electrodes of the tube N₂ at the receiving station. Hence the circuit of the winding of the relay R₂ will be opened and closed for corresponding intervals of time, thereby controlling the transmission of current through the circuit D.

The gas filled tube N₁ need not include three electrodes as shown; it may include but two electrodes forming only one gap between which a luminous discharge will occur when the voltage across the electrodes of the gap exceeds a predetermined value and, in fact, it may include an external electrode (not shown). Similarly, the tube N₂ may include but two electrodes upon which the rays emerging from the transmitting station are impinged so as to aid in thoroughly ionizing the gas within the tube N₂ and thereby reducing the impedance within the tube N₂ from a very high and practically infinite value to a very low and almost negligible value.

The tube N₁ may have the gap between its electrodes located at or near the foci of a parabolic reflector (not shown) which will direct the transmission of the emerging rays accurately to the electrodes of the tube N₂. Inasmuch as the parabolic reflector is not a necessary element of the system, and inasmuch as any other ray-directing device may be used instead, none has been shown in the drawing.

Neither the source B₁ nor B₂ need be of direct voltage. The source B₂ may be replaced by an alternating voltage or an interrupted direct voltage. If one of the latter is employed at the source B₂, it will be unnecessary to include the vibrating relay R₁, the condenser C and the impedance Z in the circuit. When the latter elements are eliminated, the winding of the operating relay R₂ will be connected in series with the electrodes of the tube N₂ and the source B₂ of alternating potential or interrupted direct potential. In the latter arrangement, the gas within the tube N₂ will become deionized immediately after rays emerging from the transmitting station fail to reach the tube N₂.

One of the features of this invention is the use of a gas filled tube at a transmitting station which, when impressed with a sufficiently high voltage, will produce a luminous glow and, when the rays of this glow are transmitted to a similar gas filled tube and impressed upon the electrodes of the latter tube with sufficient intensity, will cause a prompt breakdown of the gap or gaps within the latter tube. It will be understood that a lens of, for example, the convex type, may be interposed between the tubes N₁ and N₂ for the purpose of concentrating the emerging light directly between the electrodes of the tube N₂.

While other types of tubes which do not include a gaseous medium may be employed for a light source, a gas filled tube is preferred in this invention for the reason that an illumination builds up or dies out with great speed. In other words, the high voltage impressed upon the electrodes of a gas filled tube will very quickly transform the darkened space between the electrodes of the

tube into one of substantial luminosity and vice versa.

The arrangement disclosed in this application represents a substantial advance in the art in that the operation of the relays or other associated electrical translating devices may be made to take place without the use of amplifying devices intervening between the gas tube N₂ which is responsive to light and the associated electrically operated translating devices. This is principally due to the current carrying capacity of the gas filled tube which is very considerable, i. e. several amperes or more.

The operation of the gas filled tube employed in this invention differs from all known light-controlled tubes in that it employs no heated cathode; it requires no amplifiers; it has an infinite impedance when in the non-operating condition; it requires no resistance networks carrying currents at any or all times, nor does it depend upon voltage drop changes taking place in these resistances to produce operation of the associated electrical translating devices; nor does it depend on an electromotive force generated by the tube itself to operate an amplifying device, for it includes no such device; and, furthermore, it draws absolutely no current when in the non-operated condition.

The arrangement of this invention is particularly applicable for the transmission of signals from a circuit of the type connected to tube N₁, which may assume considerable potential above ground, to a circuit of the type connected to tube N₂ which it is desired shall not assume substantial voltage above ground. Such a situation arises when it is proposed to transmit current from a power circuit into a telephone circuit, or vice versa, where it becomes difficult and expensive to couple the power line and the telephone line for the transmission of signals between them and avoid these large potentials in the telephone line. This is especially true when there is a fault on the power line and the apparatus associated with the power line may be impressed with several hundreds or even thousands of volts above that of the telephone circuit. Thus the operation of the well-known protectors on the telephone circuit will be avoided and the transmission from the power circuit to the telephone circuit may be continued without interruption during these periods when, as just stated, faults exist on the power circuit. It is obvious therefore that if the potentials applied to the telephone circuit assumed values in excess of that required to operate the protectors associated therewith, the circuit would be disabled at a time when it would be most needed. One of the purposes, therefore, of the arrangement of this invention is to enable signaling over the power and telephone systems without danger of damage to the telephone apparatus and without the expense of cumbersome insulating transformers which may, moreover, make signaling through the system with direct current virtually impossible.

It will be understood that a key S need not be employed at the transmitting station or in the transmitting circuit. If the potential of the source B₁ is applied directly between the electrodes of the tube N₁, producing a continuous luminous discharge between the electrodes of the tube N₁, it will then be possible to interpose between the tubes N₁ and N₂ any well-known form of shutter (not shown) which is either mechanically or electrically operated. The movement of

the shutter will in that case produce the interruptions in the transmitted light which will correspond to the desired signals.

Inasmuch as the tubes N₁ and N₂ may be separated from each other by considerable distances, and inasmuch as the circuits of these tubes are separate and distinct from each other and require no physical connection therebetween, the glow discharge in the gas of the tube N₁ may be produced by lightning voltages or voltages from high voltage power systems which may, in fact, be many thousands of volts above ground potential. These very large voltages caused by lightning or power surges, for example, will break down the gap or gaps of the tube N₁ and later operate the relay R₂ at the receiving circuit in the manner already described hereinabove. Thus these large voltages caused by lightning, for example, may be employed to control the transmission of extremely low voltages transmitted through the circuits of the tube N₂, and they may similarly control small voltages or currents transmitted through the circuit D.

It will be evident that the arrangement of this invention may be used for counting the number of objects or devices which may pass in the path between tubes N₁ and N₂. The passage of each object or device will operate the relay R₂ and close the circuit D. In such an arrangement the relay R₂ may be a counting relay or, if desired, the circuit D may be connected to a counting relay or any other well-known counting device without the use of amplifying devices intervening between the tube responsive to light and the electrically operated translating devices.

While this invention has been disclosed as embodied in certain specific forms which may be deemed desirable, it is understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the appended claims.

What is claimed is:

1. The combination of two gas filled tubes each having two electrodes, a key, a source of potential connected in series with said key and the two electrodes of one of said tubes, the operation of said key applying the potential of said source to the two electrodes of the latter tube and producing a glow discharge therebetween, a second source of potential, and a relay, the winding of which is connected in series with said second source of potential and the two electrodes of the other of said tubes, the luminous rays emanating from the first of said tubes being impressed upon the electrodes of the second of said tubes and substantially reducing the impedance between the electrodes of the second tube.

2. In a signaling system, the combination of a first gas filled tube having a plurality of electrodes, means for creating a luminous discharge between the electrodes of said first tube in accordance with signals, a second gas filled tube having a plurality of electrodes, means for impressing the rays emerging from the luminous discharge of the first gas filled tube upon the electrodes of the second gas filled tube and reducing the impedance between the latter electrodes from that corresponding to an open circuit condition to a very low impedance, and a circuit including the winding of a vibrating relay connected in series with the electrodes of the second gas filled tube for periodically removing all potential from the electrodes of the second tube, said circuit also including a current consuming

Shutter continuous operation

translating device which is operated in accordance with the impedance changes of the second gas filled tube.

3. The method of signaling with apparatus including a pair of gas filled tubes each having a pair of electrodes, which consists in intermittently producing a luminous discharge between the electrodes of one of the gas filled tubes in response to signals, transmitting the intermittently produced rays of the luminous discharge to the electrodes of the other gas filled tube, reducing the impedance between the electrodes of the latter gas filled tube from that corresponding to an open circuit value to a very low value in response to these transmitted rays, and detecting the signals determined by the intermittent impedance changes of the latter tube.

4. The method of signaling by reducing the impedance between the electrodes of a gas filled tube from that corresponding to an open circuit condition to a very low value, which consists in transmitting to said electrodes and through the space between said electrodes such rays of the spectrum as are produced within the tube itself if a voltage equal to the breakdown value of the tube is impressed across its electrodes, the transmission being interrupted in accordance with signals, and detecting the signals determined by the intermittent changes in impedance of the tube.

5. The combination of first and second gas filled tubes each of which includes two spaced electrodes, each tube having the property such that when a voltage exceeding the breakdown value of the tube becomes impressed across its electrodes a luminous discharge will occur therebetween, means for producing in accordance with signals a luminous discharge between the electrodes of one of the tubes, means for periodically

supplying potential to the electrodes of the first gas-filled tube in accordance with said signals, and means for transmitting the rays emerging from the first gas filled tube to the electrodes of the second gas filled tube for assisting the breakdown of the gap between the electrodes of the second gas filled tube.

6. The method of signaling with a pair of gas filled tubes, each having a pair of spaced electrodes, which consists in producing a luminous discharge between the electrodes of one of the gas filled tubes, interrupting this luminous discharge in accordance with signals, transmitting the rays of the luminous discharge and impressing said rays upon the electrodes of the other gas filled tube, reducing the impedance between the electrodes of the latter gas filled tube from that corresponding to an open circuit condition to a negligible value in response to the transmitted rays, and detecting the signals determined by the alternate impedance changes within the latter gas filled tube.

7. The combination of two similar gas filled tubes each having two electrodes between which a glow discharge may occur when a voltage impressed upon said electrodes exceeds a predetermined value, said tubes being adjacent to each other, means for producing in accordance with signals a glow discharge between the electrodes of one of said tubes, the emergent rays of said glow discharge being impressed upon the electrodes of the other tube for reducing its impedance from that corresponding to an open circuit condition to a low value, and a current consuming signal detector operatively connected to the electrodes of the latter tube to reproduce the signals.

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