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VISUAL ALARM SYSTEM

2,859,431

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2 Sheets-Sheet 1

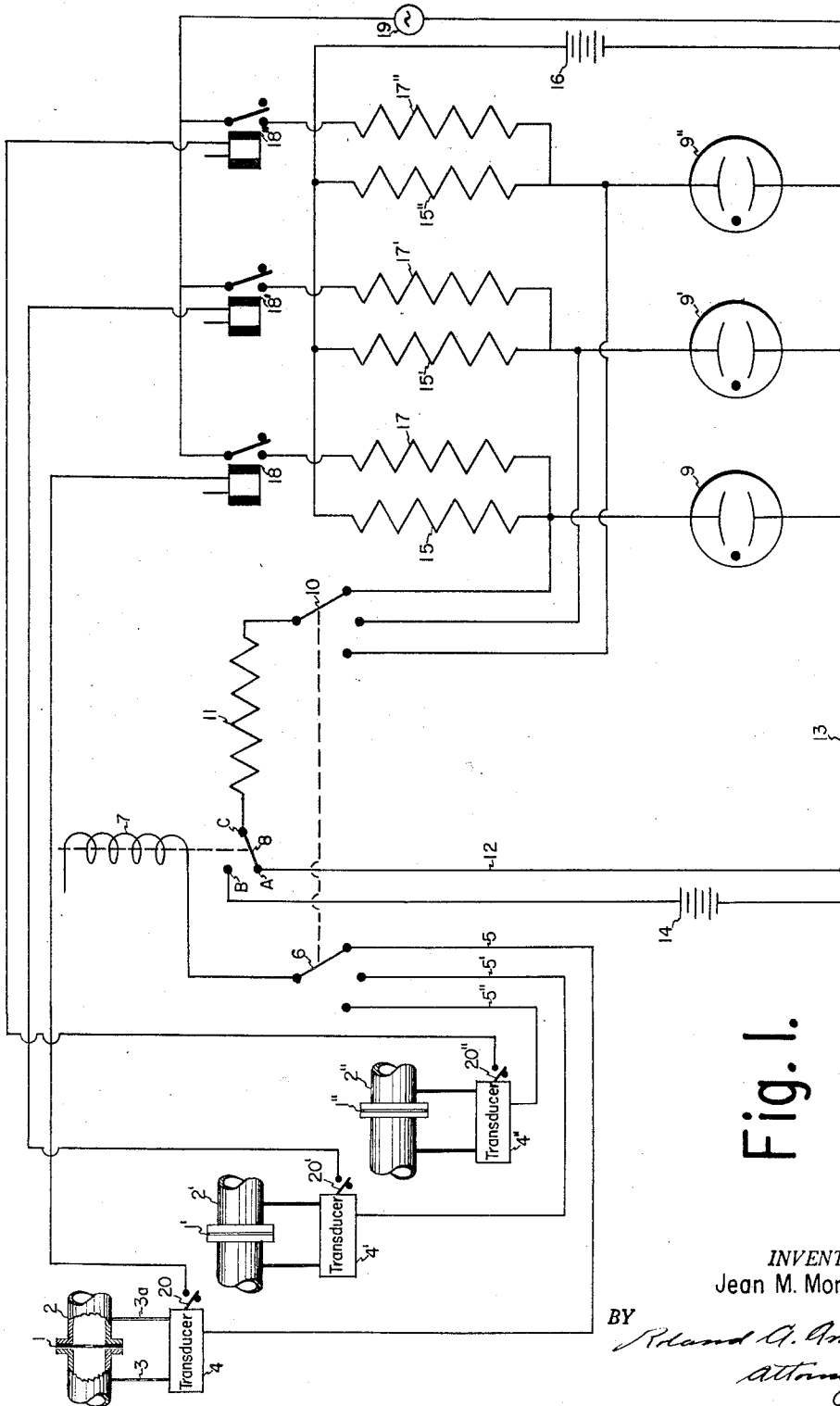


Fig. 1.

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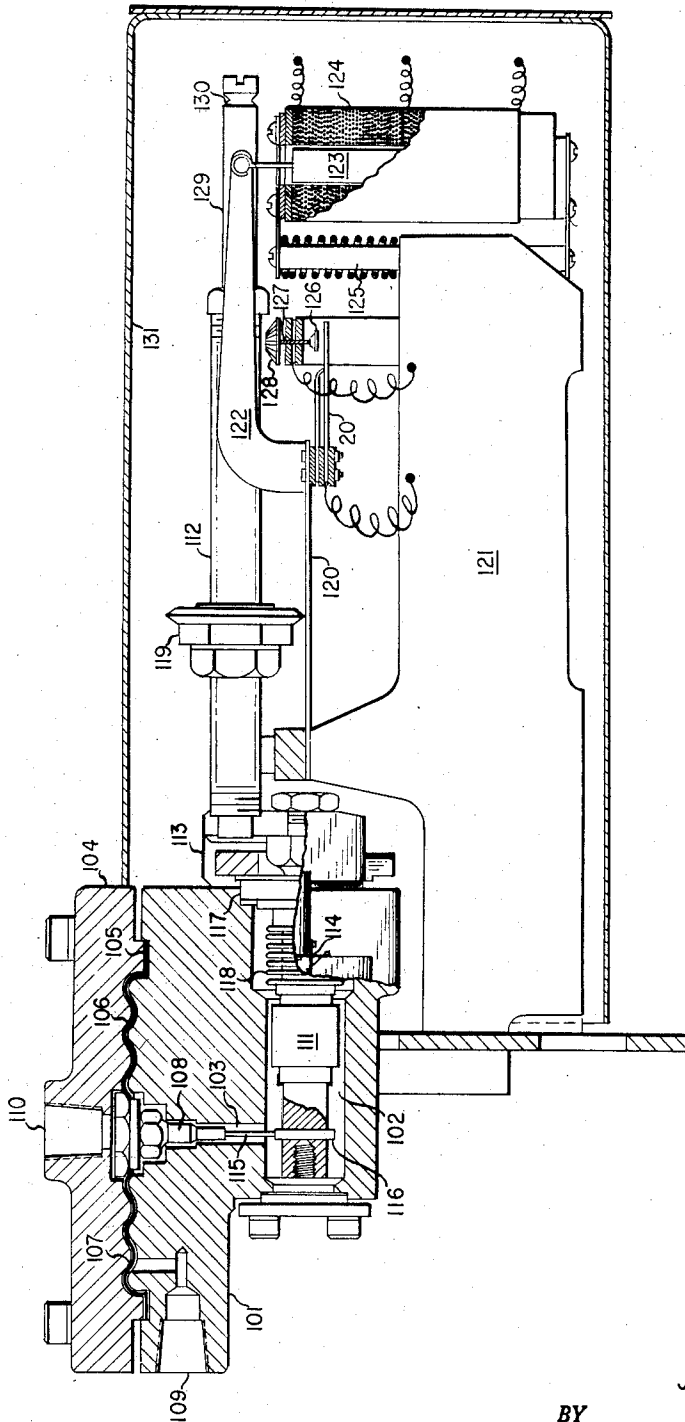


Fig. 2.

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VISUAL ALARM SYSTEM

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5 Claims. (Cl. 340—324)

The present invention relates in general to industrial instrumentation and more particularly to a new and improved multi-sensor visual alarm system adapted to provide a discrete pair of alarms for each sensor.

In industrial instrumentation it often becomes desirable to sense a particular process variable at a multiplicity of different points. Frequently it is sufficient merely to secure an alarm when the value of the variable at the particular point exceeds a predetermined limit. For instance, in a neutronic reactor comprising several hundred parallel liquid coolant channels it is important that the operator be given a prompt minor alarm for each particular channel in which the coolant flow rate is then below a chosen "caution" level, and that a prompt major alarm be given for each channel in which the rate falls below a selected still-lower "crucial" level. In each channel such flow rate may be sensed with an orifice to provide a corresponding pressure signal, which signal may be converted with a simple transducer to a corresponding quantitative electric signal for telemetering to the control room or other alarm station; the transducer may also be adapted to close a limit switch to provide a separate on-off signal whenever the pressure signal falls below the "crucial" level.

One object of the present invention is to provide a new and improved alarm system responsive to such signals from a multiplicity of "sensors"—i. e., sensing means—and adapted to give a visual indication, by means of electric light, of minor and major alarm signals received from each sensor.

Another object is to provide such a system of marked simplicity wherein both the minor and major alarms from a particular source are discretely indicated upon only a single electric bulb.

A further object is to provide such a major-minor alarm system affording ready adjustability of the selected general limit of quantitative signal level beyond which the minor alarm for any sensor point should result.

Still another object is to provide for prompt extinguishment of each major and each minor alarm indication upon disappearance of its critical event, but in any case only after retention of each minor alarm indication, once given, for an adequate period for visual correlation with indications from other sensor points.

Additional objects will become apparent hereinafter.

In accordance with the present invention, a new and improved alarm system for the purpose comprises, in its essence, a gas-filled diode glow bulb having the characteristic that, with sufficient impressed potential, conduction can take place in either direction between its electrodes but in either event a visible gas glow is induced only at that electrode then serving as the cathode. Each signal received from its corresponding sensor and exceeding the pre-selected "caution" level and thus warranting indication of a minor alarm is adapted to trigger the impression of a D. C. potential across the diode bulb sufficient to produce unidirectional conduction between the diodes; and induced gas glow at only one electrode, lighting the

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bulb rather dimly, constitutes the minor alarm indication. In parallel fashion, each signal from the corresponding sensor warranting indication of a major alarm is adapted to trigger the impression of an A. C. potential across the diode bulb sufficient to produce bi-directional conduction; the induced gas glow is then at both electrodes, lighting the bulb discernibly more brightly to constitute the major alarm indications thus greatly simplifying and minimizing the necessary alarm indicator array.

In further accordance with this invention, the unidirectional-bidirectional system is refined by combination therewith of resort to a gas bulb having the superadded characteristic that the applied D. C. potential required to commence unidirectional conduction is substantially greater than that required to maintain conduction once started. A source of continuing D. C. potential great enough to sustain but not initiate unidirectional conduction is then continually impressed across each such bulb. Then, once unidirectional conduction is initiated upon receipt of a minor alarm signal, the bulb remains dimly lit regardless of whether the superimposed D. C. initiating potential is removed. In multi-sensor application, such arrangement affords utilization of a single monitor to scan the telemetered signal from each sensor in turn, and to actuate the impression of a momentary D. C. initiating potential across its corresponding bulb in the event that the particular signal exceeds the pre-selected minor alarm level; all bulbs so lit remain dimly lit as the monitor passes on to scan other sensors in the cycle. In each instance where the monitor does not actuate impression of a D. C. initiating potential, though, it simply short-circuits the particular bulb momentarily, thereby extinguishing it if lit. Thus a bulb, once dimly lit, will remain so for at least one full cycle of the monitor, so as to afford ample visual correlation with the state of all other bulbs, before extinguishment. Whatever be the immediate state of minor alarm indication, though, it remains susceptible all the while to be overridden by any major alarm whereupon the bulb is lit brightly by A. C. conduction and remains so for so long as the major alarm persists.

Not only does the resort to a single monitor for controlling the multiplicity of bulbs represent marked economy of apparatus, but it also advantageously affords a single place where a solitary adjustment is all that is needed to alter the setting of the minor alarm signal threshold affecting all bulbs.

A preferred embodiment is illustrated in the appended drawings.

In the drawings,

Fig. 1 is a schematic diagram of the instant alarm system as applied to signals from a representative three sensing elements.

Fig. 2 is a detailed elevation, partially cut-away and cross-sectioned, of the mechanism of the transducer employed in the Fig. 1 system for converting quantitative pressure signals to corresponding electrical signals.

Referring to Fig. 1, three orifices, 1, 1', 1'', in respective pipe lines 2, 2', 2'', have their individual high and low pressure taps 3, 3a, connected to respective transducers 4, 4', 4'', each adapted to convert the quantitative difference in pressure between said taps connected thereto to a corresponding electrical potential signal upon its respective signal telemetering conductors 5, 5', 5''. The three signal conductors 5, 5', 5'', are adapted to be selectively connected one at a time, through a first stepping switch 6, of a pair of ganged stepping switches, to a monitor comprising a spring-loaded solenoid 7, actuating a single-pole double-throw toggle relay 8. The toggle relay 8, is provided with throw terminals "A" and "B" and a pole terminal "C". A first, second and third neon-filled diode glow bulb 9, 9', 9'', each for

serving a respective one of said three transducers 4, 4', 4'', is each adapted to have its first terminal selectably connected one at a time, through the second stepping switch 10, of said ganged pair, and then through a confluent loading resistor 11, to the pole terminal "C" of the toggle relay 8. Each neon bulb characteristically admits of conduction in either direction between its electrodes resulting in a visible gas glow being induced only at that electrode then serving as the cathode, and requires an applied potential to initiate conduction there-through substantially greater than that to maintain conduction once started; more specifically, such a bulb, currently available commercially, employed in this instance is identified as "NE-96" as produced by General Electric Company,¹ which has a D. C. initiation potential threshold approximating 135 ± 10 volts, and emits an orange cathode glow upon conduction. The ganging of the stepping switches 6, 10, is such that a selection of one of the conductors 5, 5', 5'', with the first stepping switch 6, results in concomitant selection of its corresponding one of the neon bulbs 9, 9', 9'', by the second stepping switch 10. From throw terminal "A" of the toggle relay 8, leads an unobstructed conductor 12, directly to a common junction conductor 13, to which the remaining, second terminal of each of the glow bulbs 9, 9', 9'', is connected; throw terminal "B" is connected through a first source of D. C. potential (ca. 155 volts) 14, to the junction conductor 13. Also connected to said first terminal of each of the glow bulbs 9, 9', 9'', is a respective individual D. C. loading resistor 15, 15', 15''; the several series combinations of one bulb and its respective resistor are connected in parallel and commonly served by a permanently-connected second source of D. C. potential (ca. 90 volts) 16, of the same polarity, respecting the bulbs 9, 9', 9'', as the first source of D. C. potential 14. Further connected to said first terminal of each of the glow bulbs 9, 9', 9'', is a respective individual A. C. loading resistor 17, 17', 17'', in series with a respective individual major alarm relay 18, 18', 18''; the several series combinations of one bulb and its respective resistor and relay are connected in parallel and commonly served by a permanently-connected source of A. C. potential (ca. 115 volts, 60 cycles) 19. Each major alarm relay 18, 18', 18'', is actuated in on-off fashion, by a respective limit switch 20, 20', 20'', upon its corresponding transducer 4, 4', 4'', adapted to be closed whenever the major alarm threshold is exceeded there.

In operation, the glow bulbs 9, 9', 9'', are normally unlit, the toggle relay 8, is normally thrown to its "A" terminal, and the limit switches 20, 20', and 20'', and major alarm relays 18, 18', 18'', are normally open. The ganged stepping switches 6, 10, are progressively advanced in unison from one selectable terminal to the next in a continuing repetitive cycle; these are preferably driven mechanically for uniform, automatic operation. With the toggle relay 8, in its normal "A" position, the selection, by the second stepping switch 10, of each glow bulb 9, 9', 9'', in turn, simply short-circuits the particular bulb through the second stepping switch 6, confluent loading resistor 11, unobstructed conductor 12, and common junction conductor 13, thereby leaving the bulb unlit. However, in the event that the quantitative electrical signal being received by the solenoid through the first stepping switch 6, from the selected one of the conductors, say 5, exceeds the minor alarm threshold value for which the monitor has been pre-set, the toggle relay 8, is then drawn into its "B" position by the solenoid 7. This connects the first source of D. C. potential 14, across the corresponding bulb 9, through the confluent loading resistor 11, and the second stepping switch 10; the impressed potential is in itself sufficient to initiate conduction, whereupon the pertinent bulb 9, commences

to glow dimly. As the second stepping switch 10, advances to other positions in its cycle, the initiated dim glow of the pertinent bulb 9, is maintained by the second source of D. C. potential 16, which impresses a potential through pertinent individual D. C. resistor 15, sufficient to maintain unidirectional conduction although insufficient to initiate it. In each succeeding monitor cycle in which the signal from the pertinent conductor 5, remains above the minor alarm threshold, the resulting "B" position of the toggle relay 8, will reimpress the first source of D. C. potential 14, upon pertinent bulb 9, thus assuring that the same remains at least dimly lit. In the first monitor cycle in which the pertinent signal no longer exceeds the minor alarm threshold, the resulting "A" position of the toggle relay 8, short-circuits the pertinent bulb 9, thus extinguishing its dim light. At any time, a particular transducer, say 4', may detect a major alarm event and operate to close its limit switch, say 20', and consequently to close the corresponding major alarm relay, say 18', thereby connecting the source of A. C. potential 19, across corresponding bulb 9', through its A. C. loading resistor 17'; this immediately lights that bulb 9', brightly, regardless of whether or not it had already been dimly lit, to remain so until the cessation of the major alarm event whereupon the limit switch 20' and relay 18', will open. The several loading resistors are designed to curb excessive current through the glow bulbs and to attenuate the potentials sufficiently that spurious conduction of other bulbs does not ensue because of the alternative current paths through the network; for the circuit illustrated, a suitable set of elements is as tabulated in Table I below.

TABLE I

Circuit elements

First source of D. C. potential 14	155 volts.
Second source of D. C. potential 16	90 volts.
Source of A. C. potential 19	115 volts, 60 cycles.
Glow bulb, "NE-96," 9 ("NE-17" substantially identical)	62,500 ohms (with associated external resistance).
Confluent D. C. resistor 11	27,000 ohms.
Individual resistors (D. C. circuit) 15	18,000 ohms.
Individual resistors (A. C. circuit) 17	27,000 ohms.

Referring to Fig. 2, the transducer (reference numeral 4 in Fig. 1) comprises, from the mechanical standpoint, a stationary, high-pressure housing 101, defining a lower, horizontal, open-mouthed, cylindricform cavity 102, and a central, vertical, open-topped cylindricform well 103, extending upward therefrom. A cover block 104, surmounts, and is bolted to, the high-pressure housing 101; the juxtaposed horizontal surfaces of that block and housing form a pressure-tight seal 105, around their mating peripheries, but are interiorly spaced apart so as to define a thin, horizontal, circularly-corrugated, discal chamber 106, therebetween, communicating with the open top of said vertical well 103. A similarly circularly-corrugated fluid-impervious, metal, slack diaphragm 107, loosely disposed within the discal chamber 106, is sealed around its outer periphery within said seal 105, and is further sealed at its center to the upper portion of a vertical cylindricform plunger 108, retained in vertically slidable relationship within the vertical well 103. A high-pressure inlet port 109, in the high-pressure housing 101, communicates with the interspace formed in the discal chamber 106, below the diaphragm 107. A low-pressure inlet port 110, in the cover block 104, communicates with the interspace above the diaphragm 107.

A horizontally-disposed lever of the first order, comprising a slender force arm 111, extending in through the wider mouth of said cylindricform cavity 102, and a load arm 112, extending externally away from the high-pressure housing 101, is provided with an integral bifurcated yoke 113, loosely astraddle the exterior of the high-pressure housing 101, the pair of tips of which are coaxially hinged to said high-pressure housing 101, each by a respective cross-spring pivot 114, thereby establishing the fulcrum. The force arm is kinematically linked

¹ Lamp Division, Nela Park, Cleveland 12, Ohio.

to the plunger 108, through a push rod 115, and a collar 116. A bushing 117, and a circumferentially-corrugated bellows 118, provide a flexible fluid-tight seal for the egress of the force arm 111, through the mouth of the cylindric cavity 102. A major portion of the length of the load arm 112, has the form of a threaded rod upon which a circumferentially sharp-ridged nut 119, is run. Below and generally parallel with said load arm 112, a thin, flat, resilient leaf spring 120, is cantilevered from a stationary baseplate 121, toward the extremity of that arm; in planform the spring 120, is substantially an extremity-converging trapezoid. The sharp ridge of the nut 119, remains in essentially point contact with the longitudinally-median upper surface of the spring 120, throughout the length of its run.

To the extremity of the leaf spring 120, is affixed an extension tab 122, from the end of which depends a powdered-iron slug 123, axially disposed in vertically translatable relationship as an armature within a vertical, center-tapped, helical, electrical, induction coil 124, mounted upon said baseplate 121. Precise initial vertical positioning of the coil 124, with respect to the baseplate 121, is afforded by its mounting through a vertical, helical-spring-opposed adjustment bolt 125. Also affixed to the extremity of the leaf spring 120, in electrically-insulated relationship, is a resilient flap-strip limit switch 20, adapted to make electrical contact with its "closed" terminal 126, whenever the extremity of the leaf spring 120, is permitted sufficient elevation by the load arm 112, and its nut 119. The terminal 126, is mounted upon the baseplate 121, through a vertical adjustment screw 127, surmounted by a graduated knob 128. An extremity extension 129, upon the load arm 112, is provided with a circumferential groove 130, from which standard weights (none shown) may be hung manually in periodic adjustment and checking of quantitative response. An outer protective housing 131, envelops the exposed movable components.

In operation of the transducer, a differential pressure is impressed across the diaphragm 107, by introducing the higher pressure through the high-pressure inlet port 109, and the lower through the low-pressure port 110. As the diaphragm 107 is thereby forced upward, the attached plunger 108, and in turn the push rod 115, the collar 116, and the extremity of the force arm 111, are urged upward also. Pivoting upon each cross-spring pivot 114, through the yoke 113, the load arm 112, is consequently forced downward, progressively depressing with its nut 119, the leaf spring 120, until the restorative force produced therein counterbalances the force upon the diaphragm 107. The depression of the extremity of the leaf spring 120, results, through the extension tab 122, in corresponding depression of the armature 123, in the center-tapped coil 124, quantitatively varying the respective impedances of the two halves of the coil on either side of the center tap. Whenever the differential pressure across the diaphragm 107, decreases to the preselected major alarm threshold level, the leaf spring 120, raises the limit switch 20, into electrical contact with the terminal 126.

The fluid at the higher pressure introduced through the high-pressure port 107, fills the entire cylindric well 103, and the cylindric cavity 102, but is contained by the circumferentially-corrugated bellows 118, and its bushing 117. Adjustment of the position of nut 119, along the load arm 112, changes the effective length of the cantilever spring 120, as well as of the load arm 112, thereby changing the pressure range of response; the trapezoidal planform affords finer adjustments as the range is narrowed. The two halves of the center-tapped induction coil 124, are adapted to serve as two arms of an impedance bridge; the precise unbalance of impedance resulting from the relative displacement of the armature 123, from the null position, as a quantitative signal, is readily convertible into a corresponding level of direct-

current potential upon a telemetering conductor, say 5 (in Fig. 1). Mechanically changing the vertical position of the null point of the coil 124, as afforded by the helical-spring-opposed adjustment bolt 125, adjusts the sensitivity of the response for a particular portion of the range. The major alarm threshold level is set by adjusting the screw 127, with its graduated knob 128.

Upon expansion of the basic illustrated arrangement to a production model of 144 glow bulbs serving a like number of sensors, it was found that, commensurate with reasonable mechanical wear and performance of the stepping switches and other commercial components, all 144 points could satisfactorily be scanned in about 2½ minutes, representing a scanning rate approximating one point per second.

While this invention has been described with particular reference to such application, it may be appreciated that the minor and major alarm signals indicated upon a single bulb need not necessarily derive from the same sensor or sensed parameter, so long as it is desired that the major alarm indication is to override and mask out the minor. Too, the system is in no wise restricted to multiple-bulb arrays; it is beneficially applicable to a single-bulb system indicating only one minor and one major alarm. Other variations and applications of the hereinbefore-disclosed means will become apparent to those skilled in the art. It is, therefore, to be understood that all matters contained in the above description are illustrative only and do not limit the scope of the present invention.

What is claimed is:

1. An alarm system for visually indicating receipt of any major alarm signal and, separately, receipt of any minor alarm signal in the absence then of a major alarm signal, which comprises a gas-filled diode glow tube characteristically admitting, upon impression of sufficient potential, of electrical conduction in either direction between its electrodes attended by a visible gas glow induced only at that electrode then serving as the cathode, means responsive to each received significant major alarm signal by activating the impression of an alternating-current potential across said bulb sufficient to produce bi-directional conduction therethrough, thereby inducing gas glow at both electrodes of said bulb and thus producing a relatively bright light constituting the major alarm indication, and means responsive to each received significant minor alarm signal by activating the impression-current potential across said bulb sufficient to produce unidirectional conduction therethrough, thereby inducing gas glow at only one of said electrodes and thus producing a relatively dim light, discernible in the absence of a major alarm indication on said bulb, constituting the minor alarm indication.

2. The alarm system of claim 1 wherein said gas is neon, and at least one of said means comprises an electrical relay.

3. An alarm system for visually indicating receipt of any major alarm signal and, separately, receipt of any minor alarm signal in the absence then of a major alarm signal, which comprises a gas-filled diode glow bulb characteristically admitting, upon impression of sufficient potential, of conduction in either direction between its electrodes attended by a visible gas glow induced only at that electrode then serving as the cathode and having the further characteristic that the minimum applied direct-current potential required to initiate uni-directional conduction is substantially greater than the minimum required to maintain such conduction once initiated, a source of continuing direct-current potential continually impressed across said bulb insufficient to initiate uni-directional conduction through said bulb but sufficient to sustain same once initiated, means responsive to each received significant major alarm signal by activating the impression of an alternating-current potential across said bulb sufficient to produce bi-directional conduction

therethrough, thereby inducing gas glow at both electrodes of said bulb and thus producing a relatively bright light constituting the major alarm indication, and means responsive to each received significant minor alarm signal by activating the impression, at least briefly, of a direct-current potential across said bulb sufficient to initiate uni-directional current therethrough, thereby initially inducing a gas glow at only one of said electrodes and thus producing a relatively dim light, discernible in the absence of a major alarm indication, constituting the minor alarm indication, which glow is adapted to be maintained by continuing uni-directional conduction therethrough sustained by said continually impressed source of direct-current potential.

4. An alarm system responsive to electrical signals from a multiplicity of sensing elements for providing a discrete pair of alarms for each element by visually indicating specially for each element of any major alarm signal from that element and, separately, receipt of any minor alarm signal from that element in the absence then of a major alarm signal therefrom, which comprises a multiplicity of gas-filled diode glow bulbs each characteristically admitting, upon impression of sufficient potential, of conduction in either direction between its electrodes attended by a visible gas glow induced only at that electrode then serving as the cathode and having the further characteristic that the minimum applied direct-current potential required to initiate unidirectional conduction is substantially greater than the minimum required to maintain such conduction once initiated, with each bulb corresponding to a different particular one of said sensing elements, a source of continuing direct-current potential continually impressed across each said bulb insufficient to initiate uni-directional conduction through said bulb but sufficient to sustain same once initiated, means responsive to each received major alarm signal from each particular sensing element by activating the impression of an alternating-current potential across the bulb corresponding to that element sufficient to produce bi-directional conduction therethrough, thereby inducing gas glow at both electrodes of that bulb and thus producing a relatively bright light constituting the major

alarm indication of that bulb, a first stepping switch means adapted to engage in electrically conductive relationship each individual bulb in succession in a continuing repetitive cycle, a second stepping switch means adapted to operate in unison with said first stepping switch means and to convey minor alarm signals from only that particular sensing element whose corresponding bulb is then engaged by said first stepping switch means, means responsive to each minor alarm signal conveyed by said second stepping switch means by activating the impression of a direct-current potential through said first stepping switch means and thus across only said corresponding bulb then engaged by said first stepping switch means with said potential being sufficient to initiate uni-directional conduction through that bulb, thereby initiating a gas glow at only one of the electrodes of that bulb and thus producing a relatively dim light, discernible in the absence of a major alarm indication by that bulb, constituting the minor alarm indication of that bulb, which dim glow is adapted to be maintained by continuing uni-directional conduction therethrough sustained by said continually impressed source of direct-current potential as the first stepping switch means advances in its cycle to engage the other bulbs, and means responsive to the absence of any minor alarm signal being conveyed by said second stepping switch means by activating a short-circuiting, through said first stepping switch means, of the corresponding bulb then engaged by said first stepping switch means, thereby extinguishing the bulb if already dimly lit.

5. The alarm system of claim 4 wherein said gas is neon, at least one of said responsive means is an electrical relay, and said means activating the impression of an alternating-current potential is adapted to sustain that activation throughout all periods that said major alarm signal persists.

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