United States Patent

[11] **3,588,893**

[72] Inventor **Edward W. Mc Closkey**
271 Alpine St., Apt. 4, Pasadena, Calif. 91106

[21] Appl. No. **770,581**
[22] Filed **Oct. 25, 1968**
[45] Patented **June 28, 1971**

[54] **APPARATUS FOR DETECTING AND LOCATING A FIRE AND FOR PRODUCING AT LEAST ONE CORRESPONDING INTELLIGENCE-CARRYING OUTPUT SIGNAL**
21 Claims, 29 Drawing Figs.

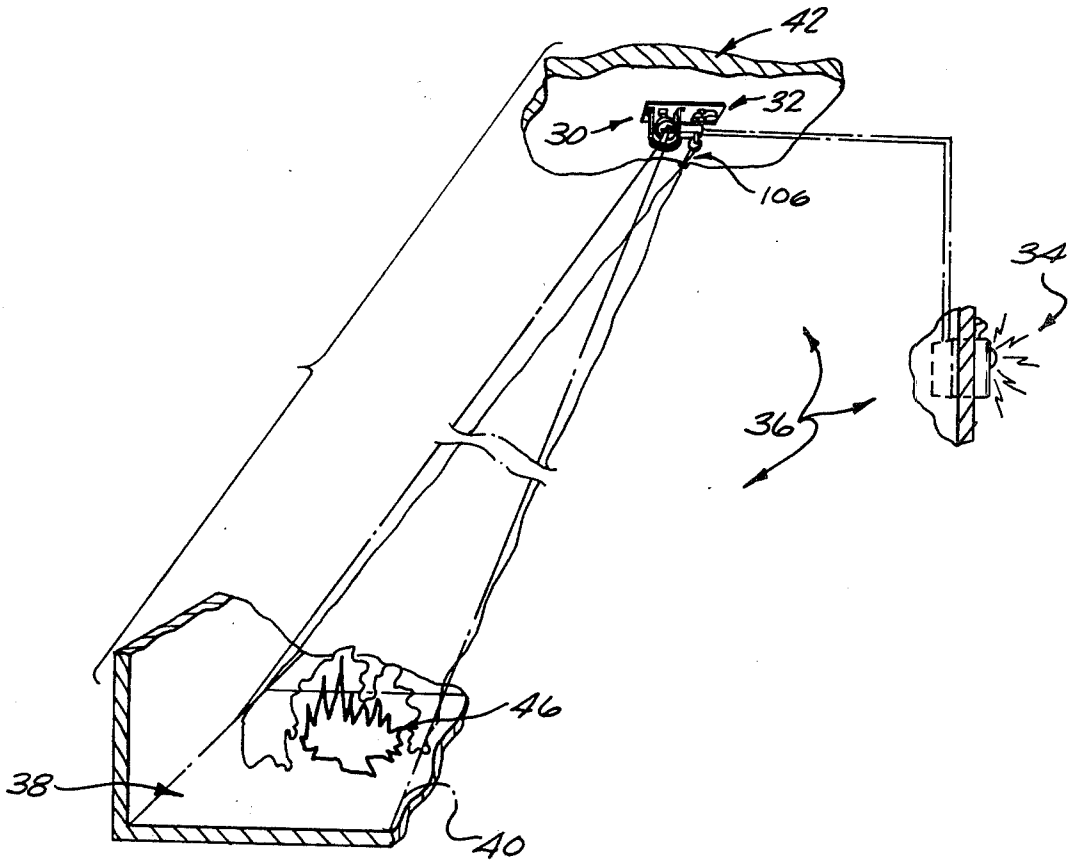
[52] U.S. Cl. 340/418
[51] Int. Cl. G08b 17/00
[50] Field of Search 340/418, 227, 228, 228.1, 237, 289, 222; 169/19, 23, 2

[56] **References Cited**
UNITED STATES PATENTS

3,229,770	1/1966	Harvey	169/19
3,235,860	2/1966	Vassil	340/228
3,488,492	1/1970	Niksarian	250/43.5

Primary Examiner—Robert L. Richardson

ABSTRACT: An apparatus for detecting and locating a fire and for producing at least one corresponding intelligence-carrying output signal (or a plurality thereof) indicating the detection and presence of a fire in an area under surveillance by the apparatus, an the location of the fire, and, in one preferred form, effectively causing the operation of appropriate fire extinguishing means in the precise location which will result in most effectively extinguishing the fire. In one preferred form, the apparatus will also operate one or more warning alarm producing means, located either locally or remotely, in a manner providing information as to the exact location of the fire. In one form this may be done without any special wiring other than the conventional, already present AC power lines.



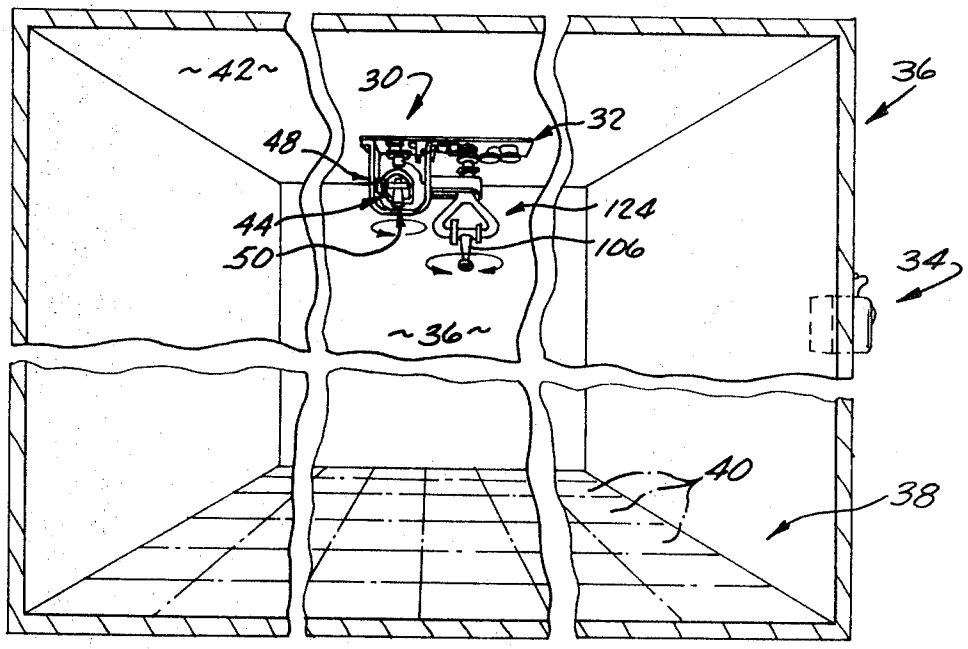


FIG. 1

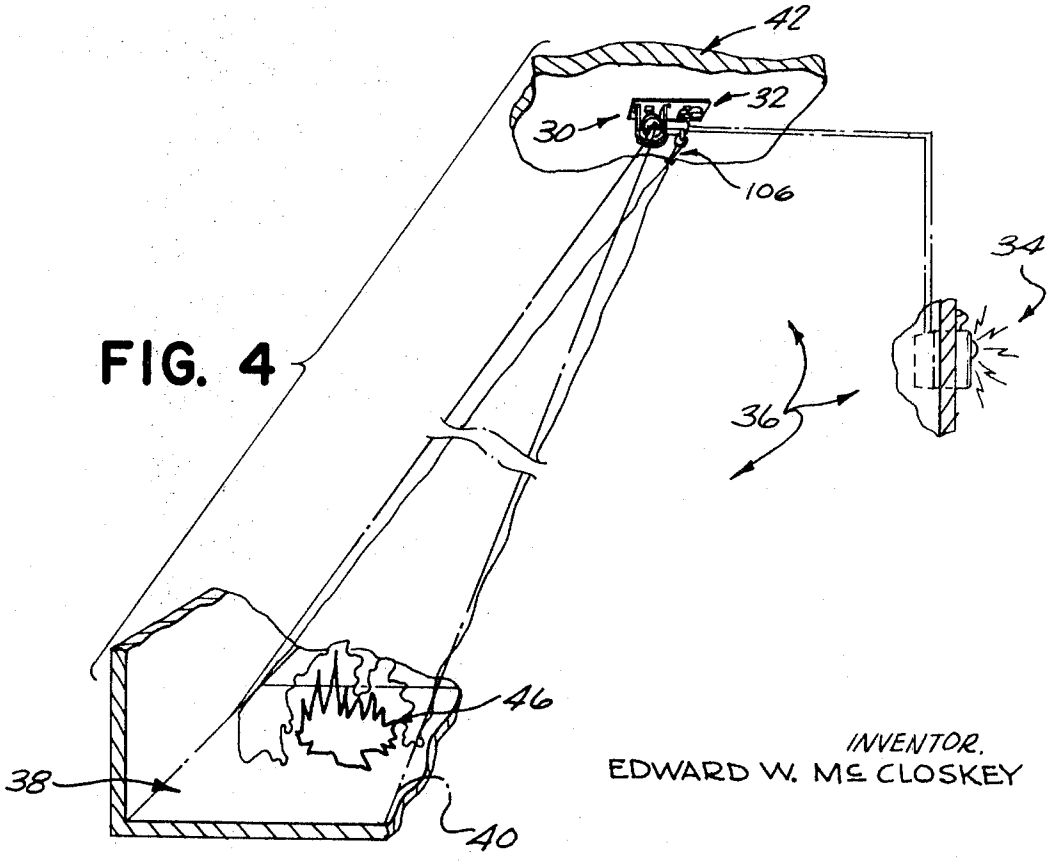


FIG. 4

INVENTOR.
EDWARD W. MS CLOSKEY

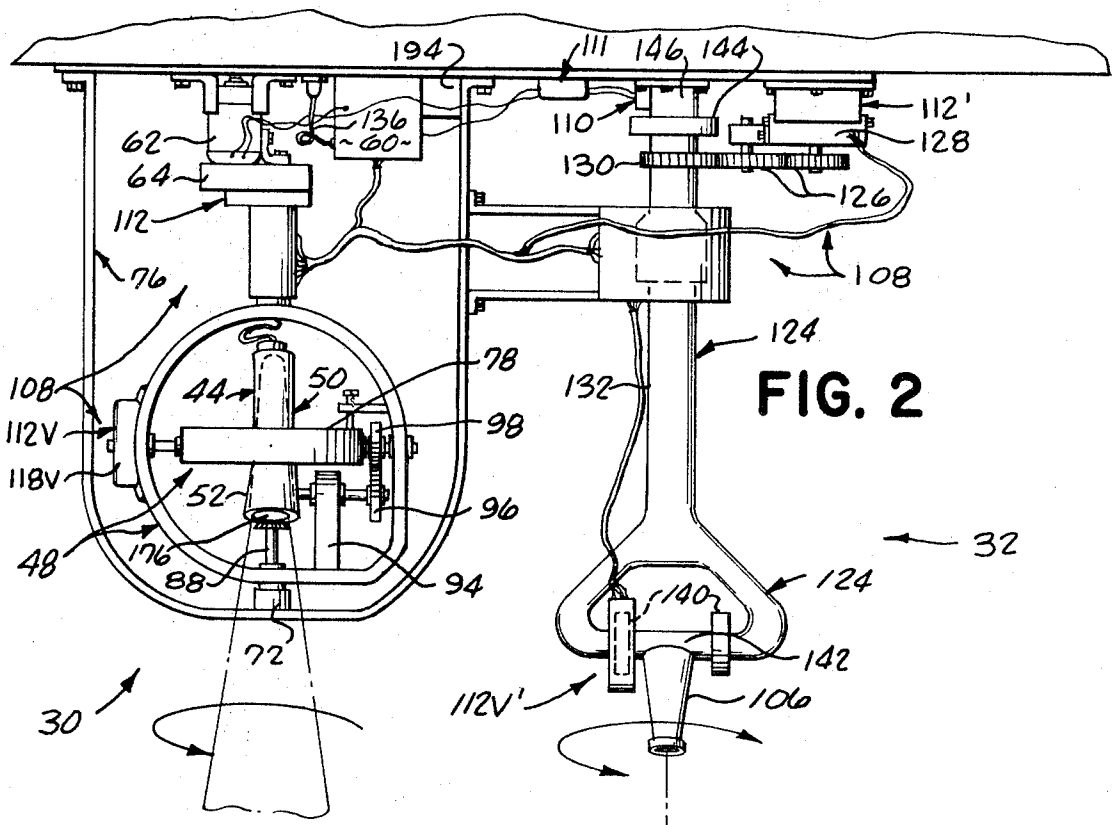


FIG. 2

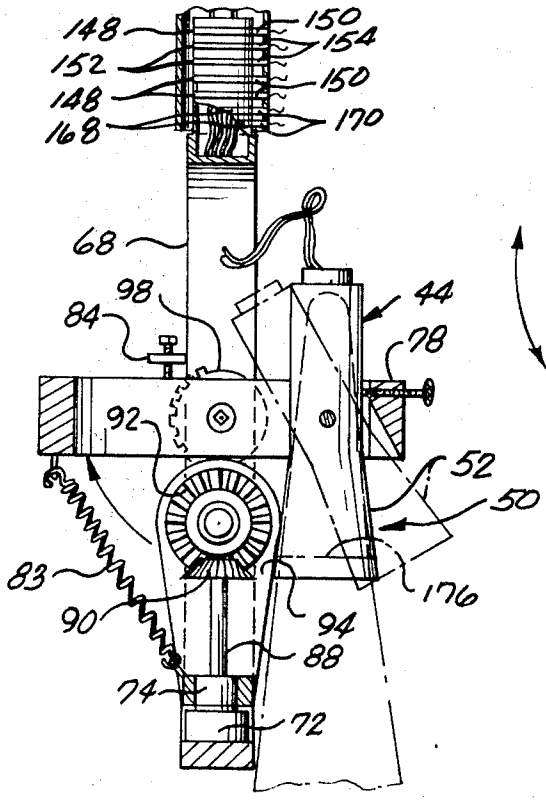


FIG. 6

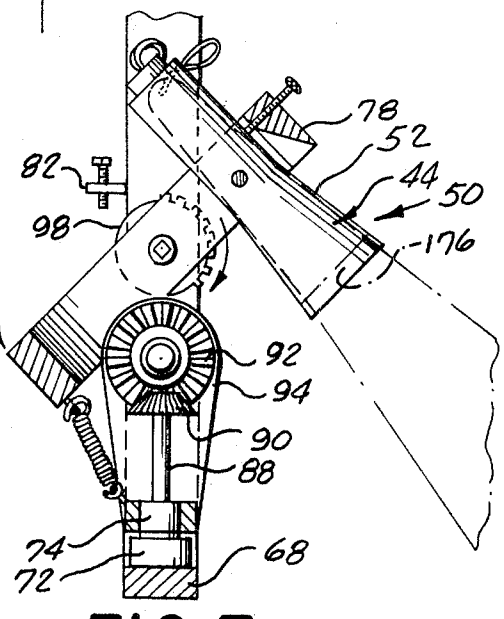


FIG. 7

INVENTOR.
EDWARD W. McCLOSKEY

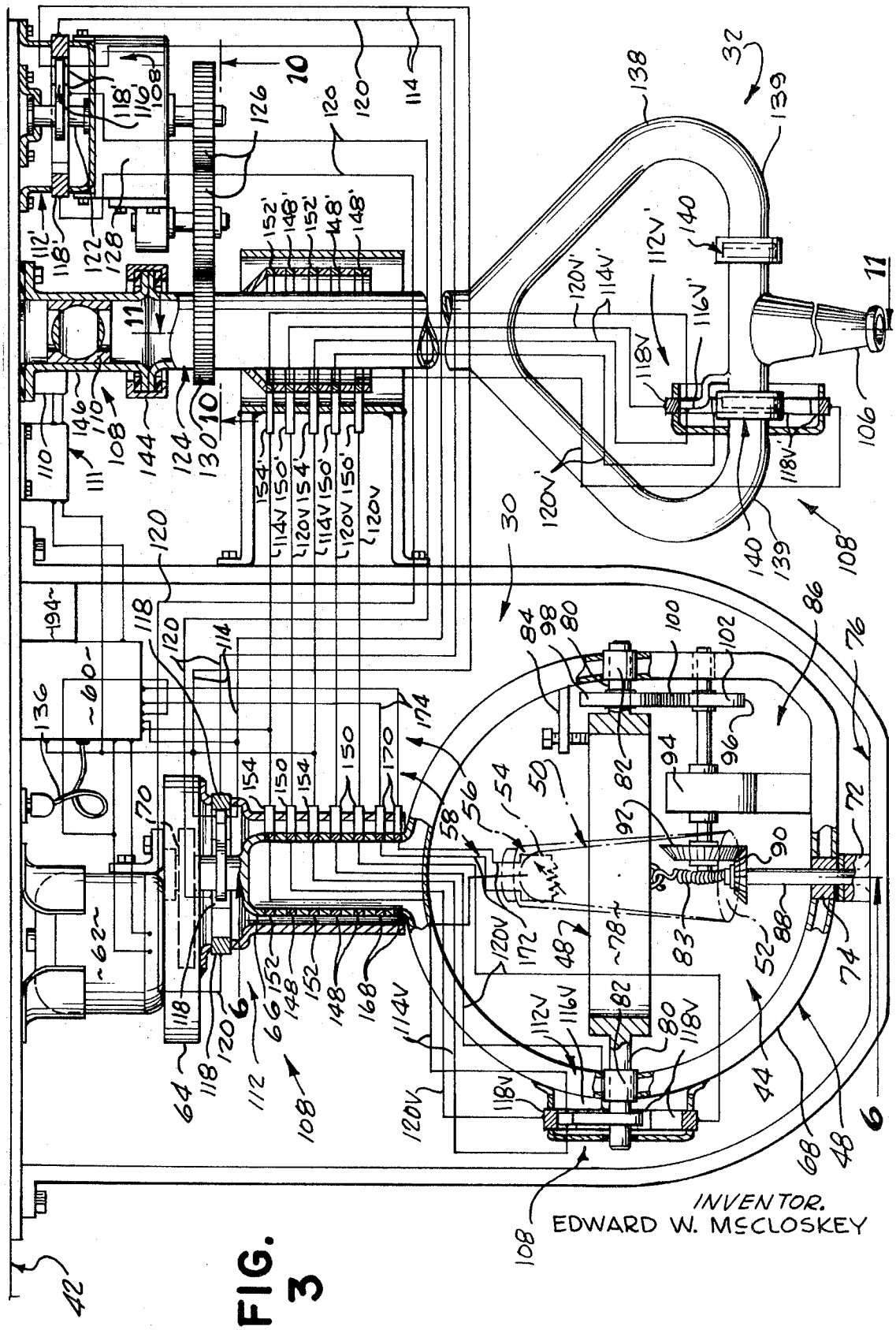


FIG. 3

INVENTOR.
EDWARD W. MCCLOSKEY

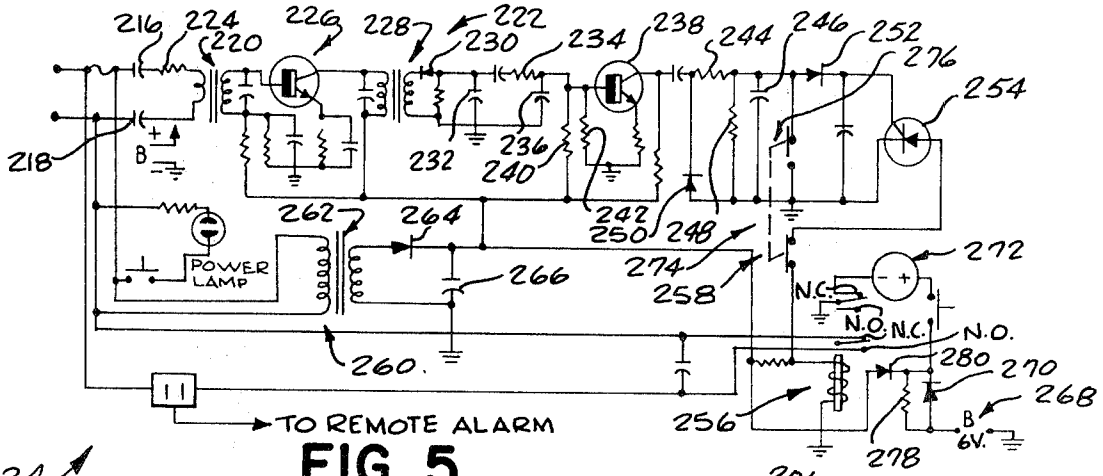


FIG. 5

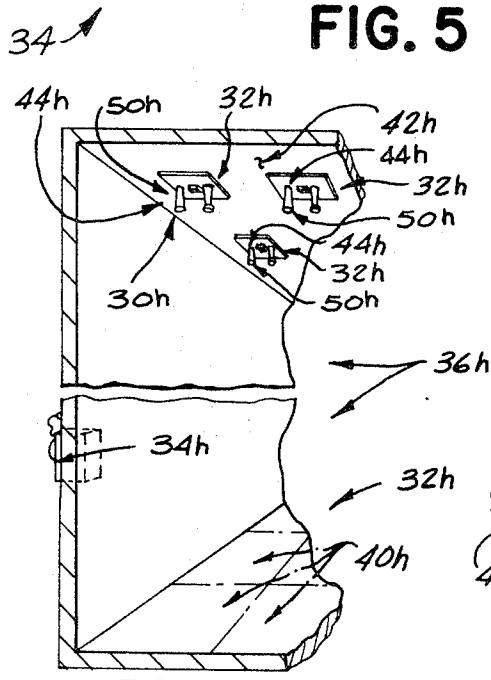


FIG. 21

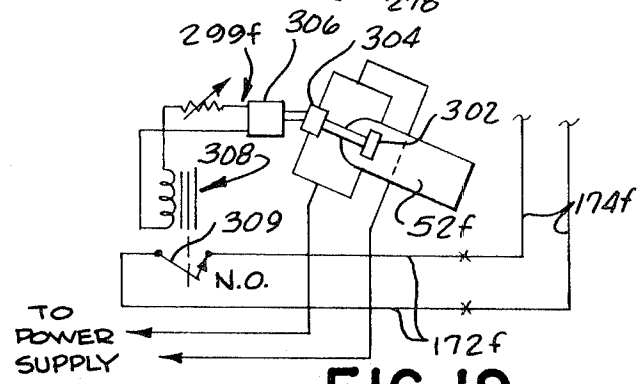


FIG. 19

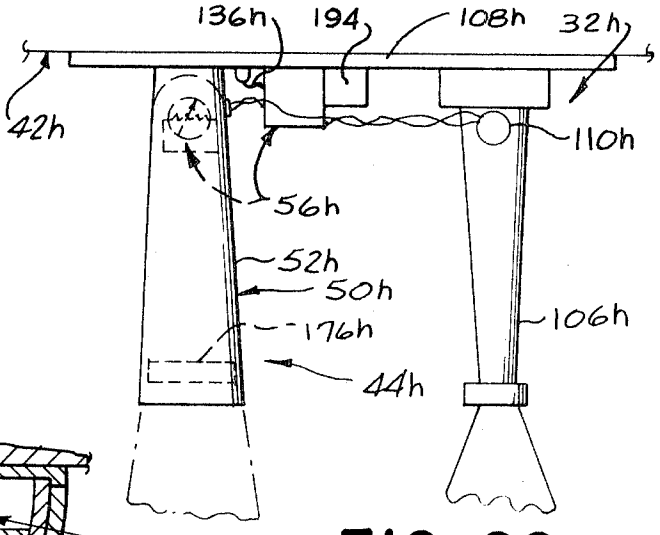
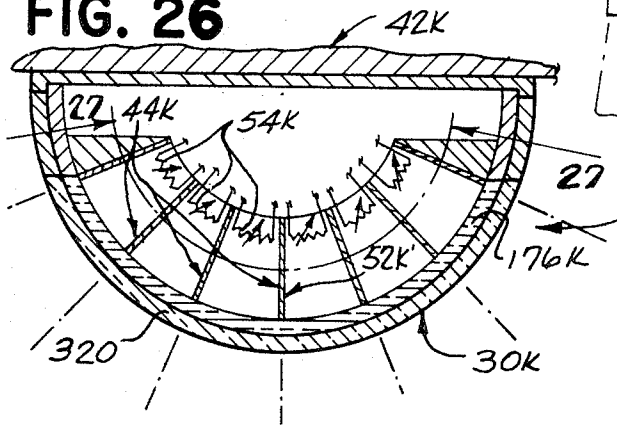


FIG. 22

FIG. 26



INVENTOR.
EDWARD W. McCLOSKEY

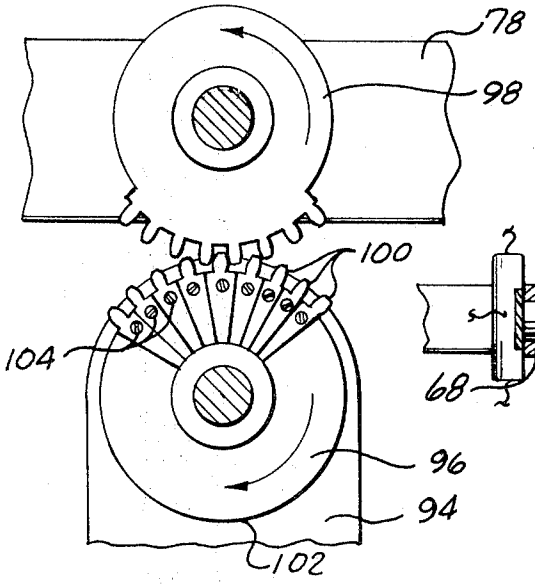


FIG. 9

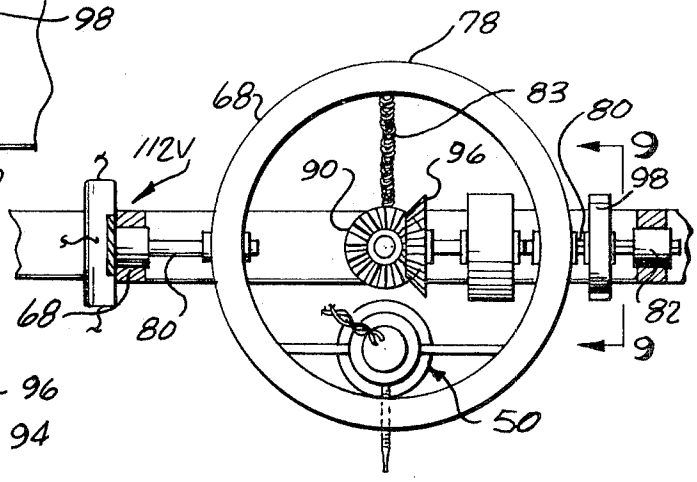


FIG. 8

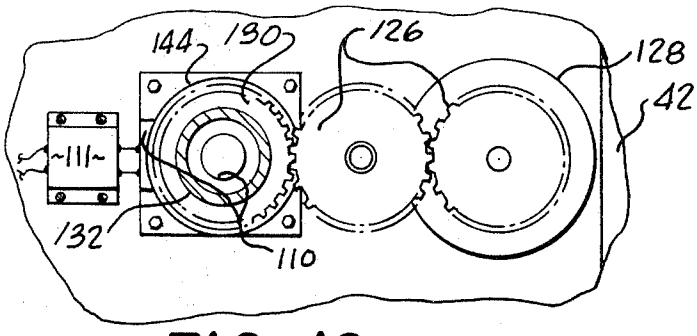


FIG. 10

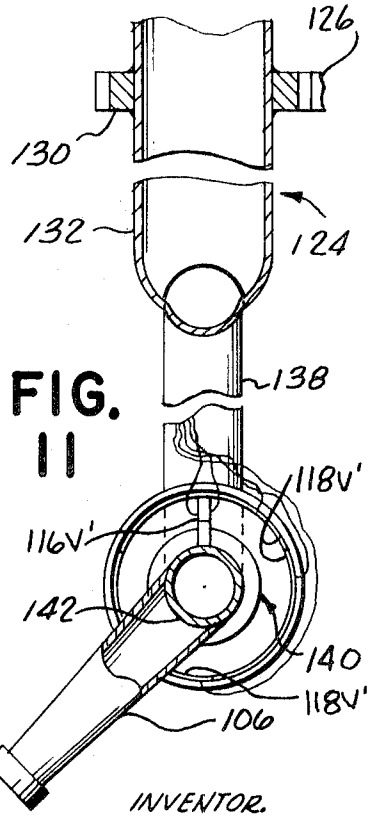


FIG. 11

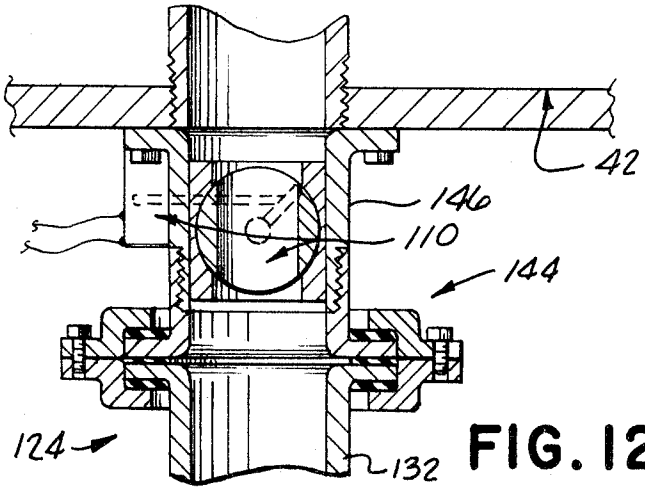


FIG. 12

INVENTOR.
EDWARD W. McCLOSKEY

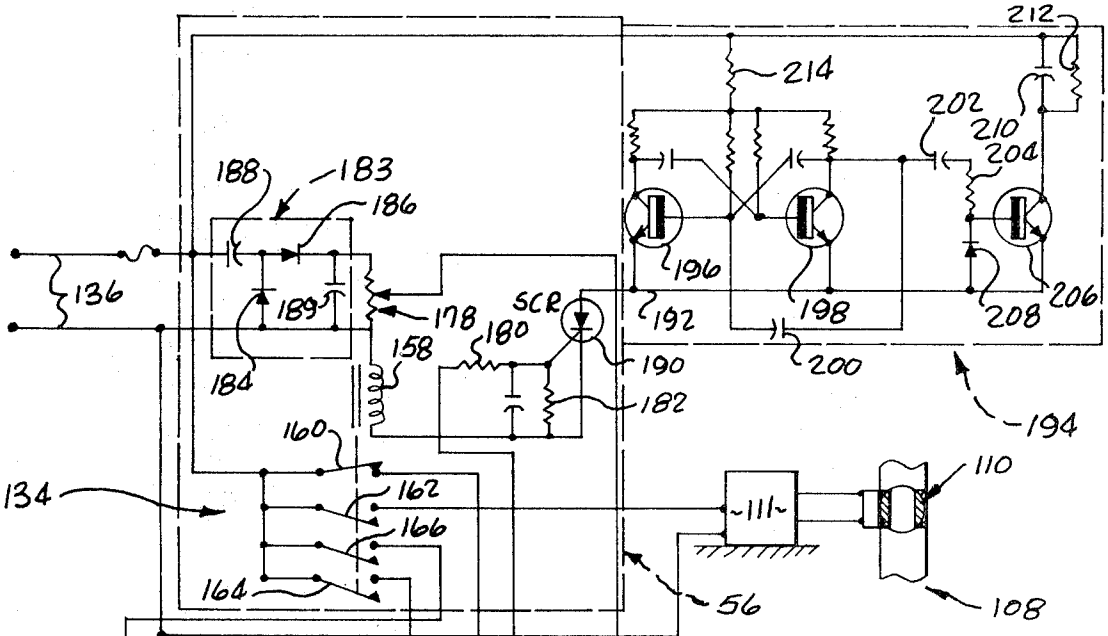


FIG. 13

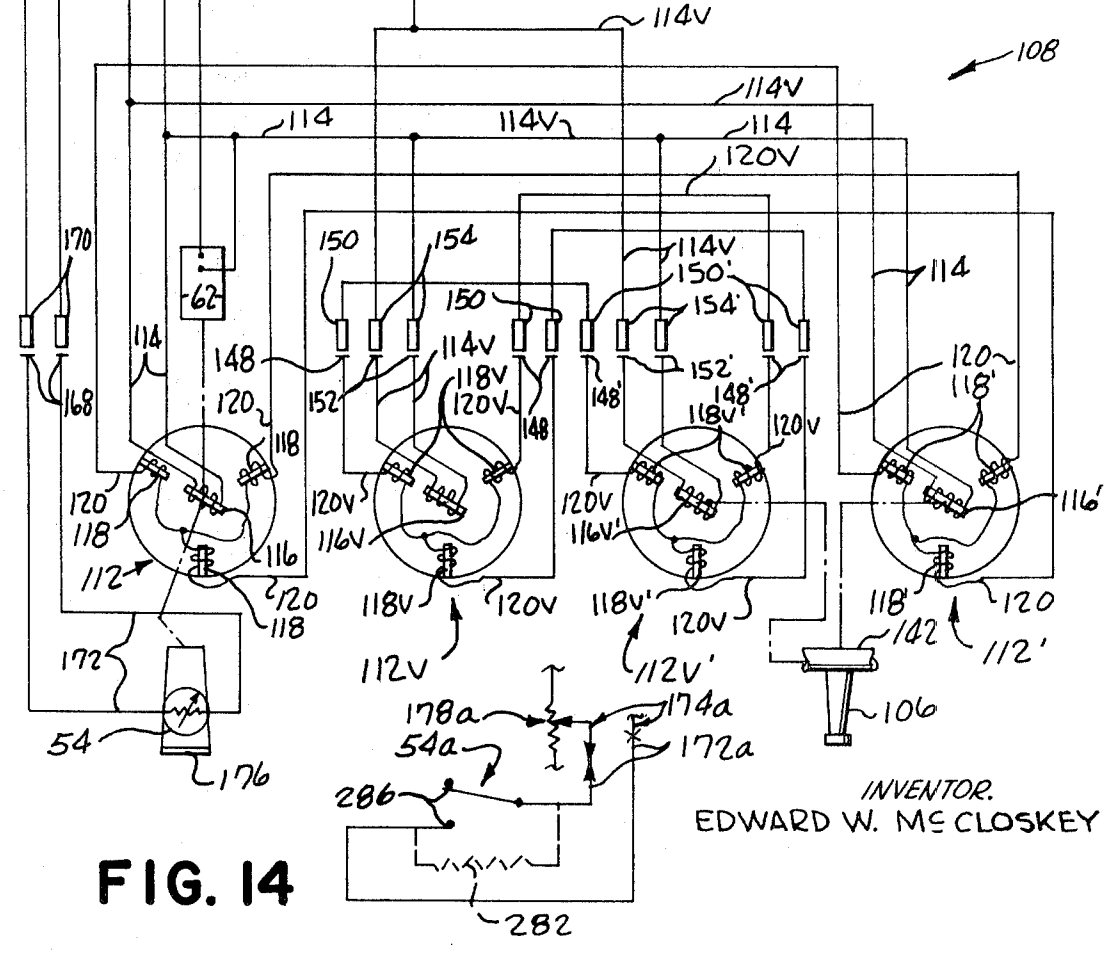


FIG. 14

INVENTOR.
EDWARD W. McCLOSKEY

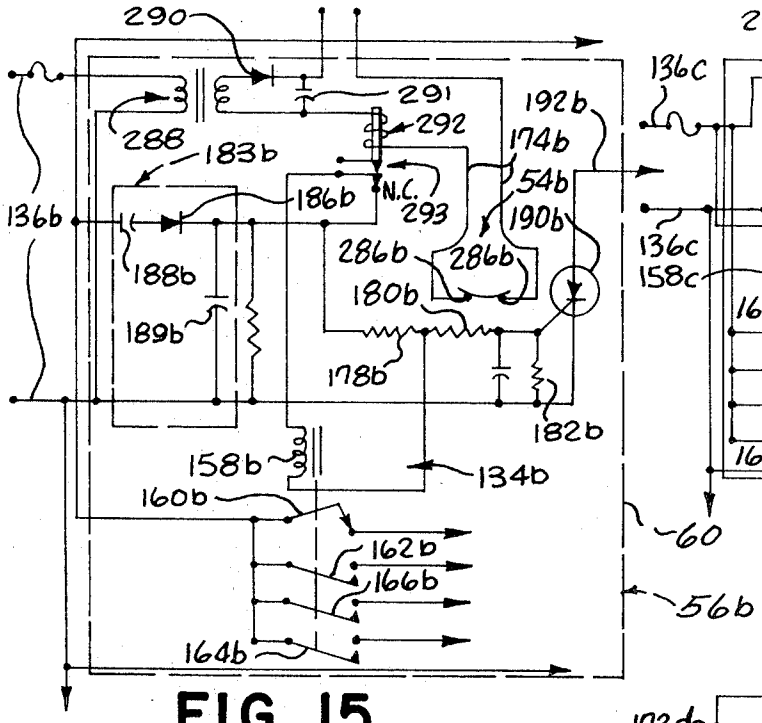


FIG. 15

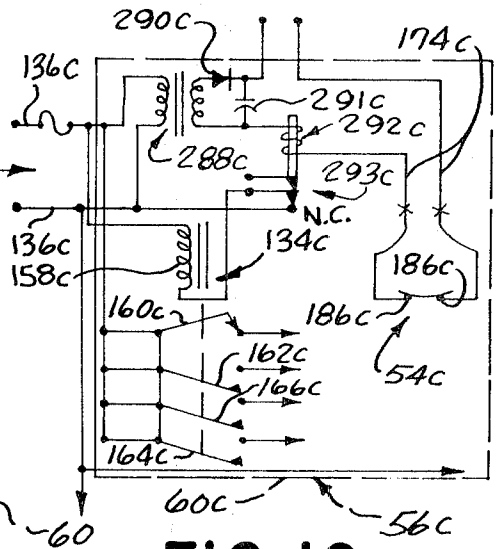


FIG. 16

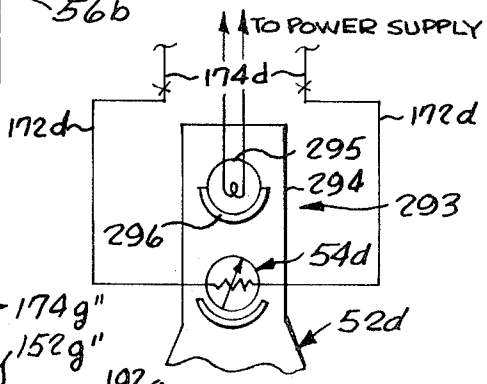


FIG. 17

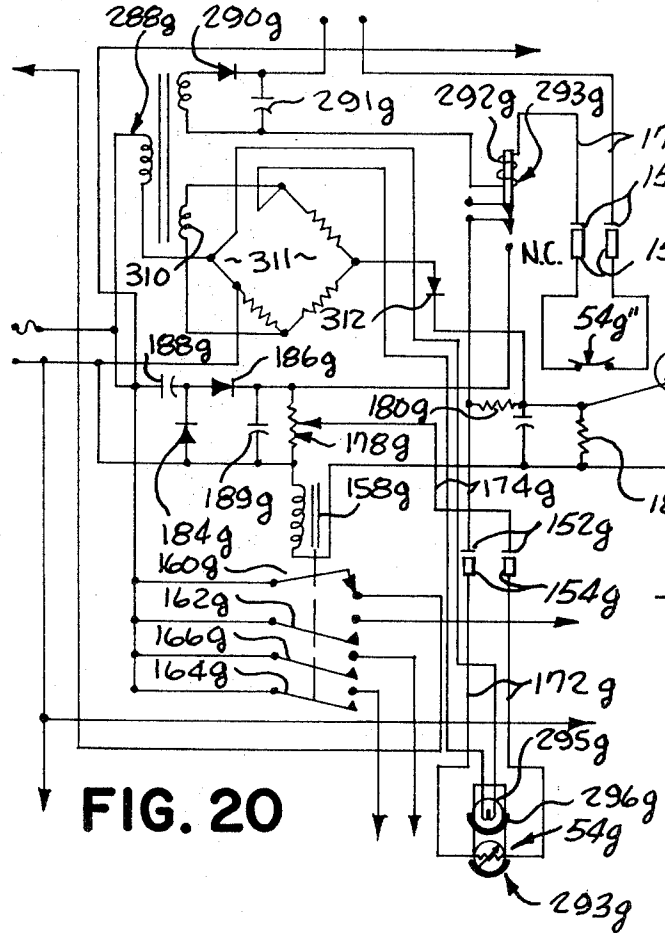


FIG. 20

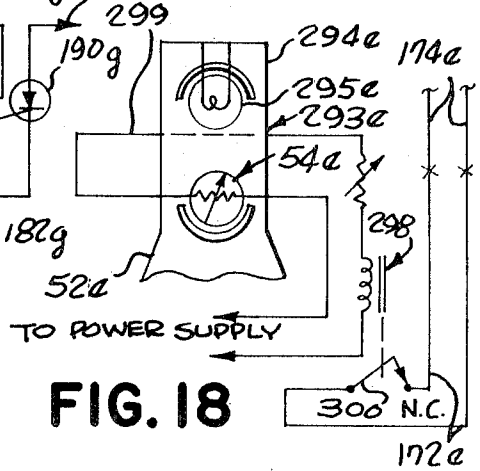


FIG. 18

INVENTOR.
EDWARD W. McCLOSKEY

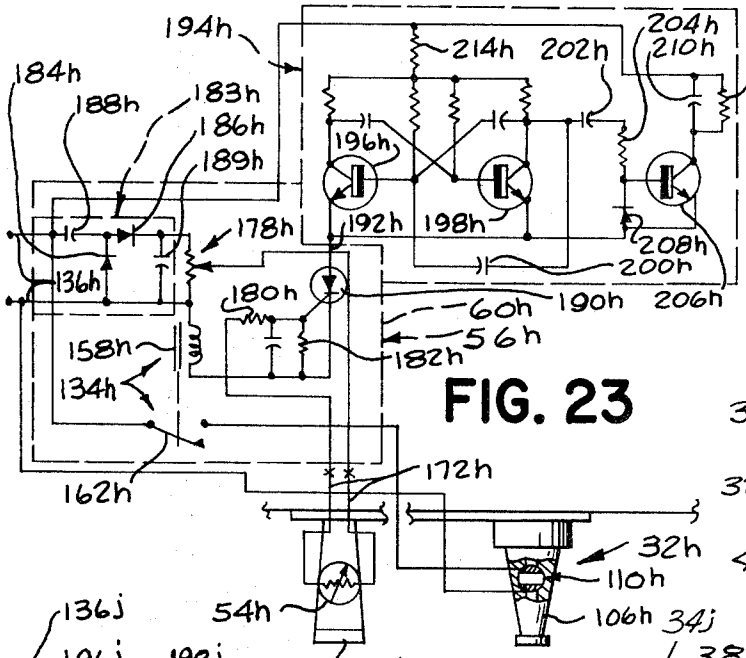


FIG. 23

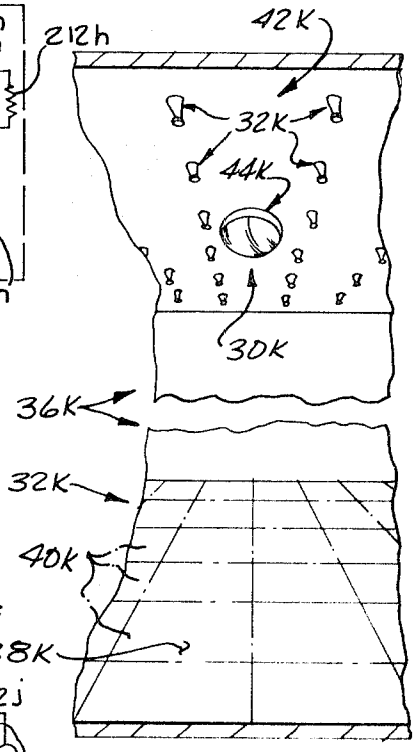


FIG. 25

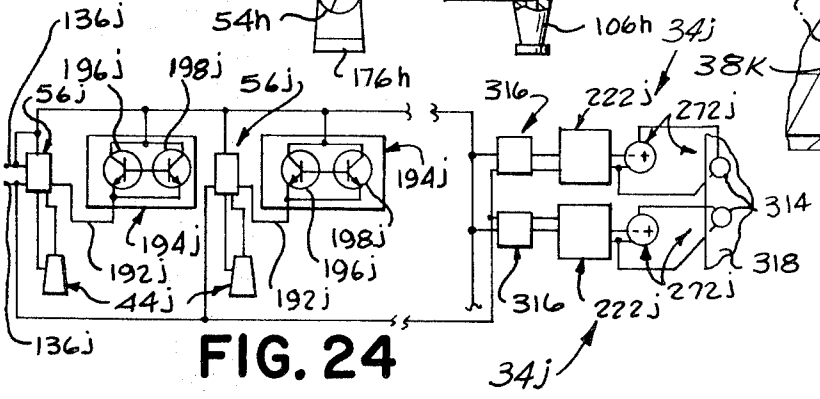


FIG. 24

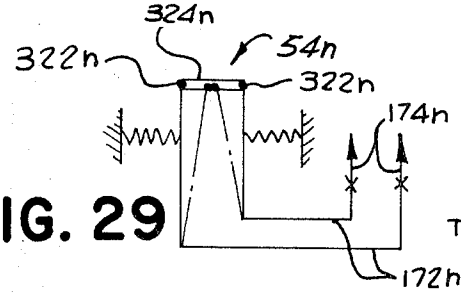
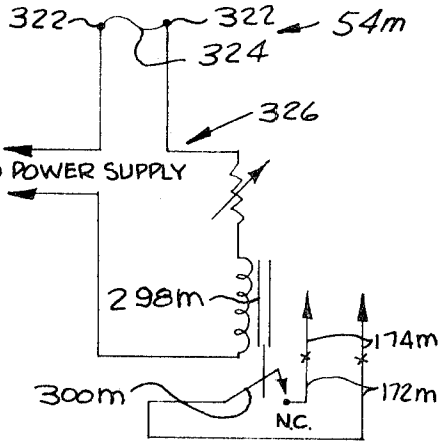


FIG. 29

FIG. 28



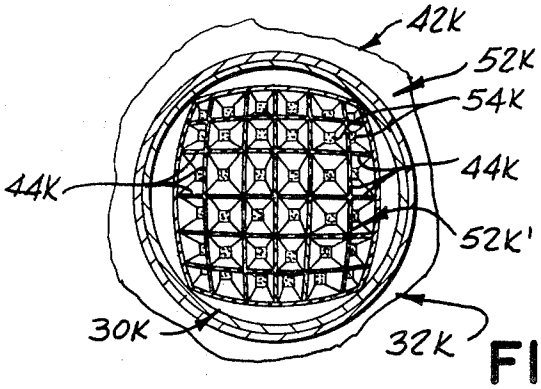


FIG. 27

INVENTOR.
EDWARD W. McCLOSKEY

APPARATUS FOR DETECTING AND LOCATING A FIRE AND FOR PRODUCING AT LEAST ONE CORRESPONDING INTELLIGENCE-CARRYING OUTPUT SIGNAL

Generally speaking, the present invention comprises apparatus for detecting and locating a fire and producing at least one corresponding output signal for specifically located fire extinguishing purposes and/or for alarm producing purposes of either a general or a specific-location-indicating type and which includes fire sensing means adapted to be positioned with respect to multiple area portions of a relatively large area (usually a plan view area, such as the floor area of a large warehouse, storage building, factory building, or other comparable structure) in a manner such as to selectively sense a fire in any of said multiple area portions in a manner both detecting such a fire and also determining the location thereof with respect to such multiple area portions—that is, detecting the fire and determining which of said multiple area portions contains the fire. The fire sensing means includes fire responsive effective output signal producing transducer means adapted to provide an intelligence-carrying output signal (which is intended to include the meaning of such an output signal in one or more portions throughout this application) in response to the detection and location of the fire by the fire sensing means mentioned above, with said signal carrying intelligence indicating both the detection and presence of the fire and exactly which one of the multiple area portions contains the fire.

In one preferred form of the invention, fire extinguishing means is provided (usually adjacent to the fire sensing means, although not specifically so limited in all forms of the invention) and is adapted to selectively and correlatedly spray a fire extinguishing fluid (usually water, although not specifically so limited in all forms of the invention) primarily and almost exclusively into a particular one of such multiple area portions in which the fire sensing means has detected and located a fire. In this preferred general form of the invention, correlation and control means is also provided and is effectively coupled with respect to the intelligence-carrying output signal mentioned above produced by the fire responsive output signal producing transducer means and also is effectively coupled with respect to the fire extinguishing means mentioned above and includes effective servomotor means for operating said fire extinguishing means (which is intended to include one or more portions) in a selective, correlated manner whereby to cause the activation thereof and the emission of a fire extinguishing fluid such as that mentioned above therefrom, primarily and almost exclusively into that particular one of such multiple area portions of a large area under surveillance by the apparatus in which a fire has been located by the previously mentioned fire sensing means in the manner briefly referred to hereinabove whereby to cause selective extinguishing of the detected and located fire substantially without operating the fire extinguishing means in a manner such as to emit such a fire extinguishing fluid into others of such multiple area portions in which such a fire has not been located by the previously mentioned fire sensing means.

Also, in the preferred general form of the invention referred to in the preceding paragraph, the output signal producing transducer means of the fire sensing means may be said to effectively comprise, or to be effectively provided with, effective fire cessation responsive means adapted, in response to the extinction of such a previously detected and located fire, to cause the cessation of the corresponding intelligence-carrying output signal and the corresponding cessation of operation of, or the effective inactivation of, the corresponding correlation and control means controlling the operation of the correlated portion of said fire extinguishing means so that the emission and direction of such a fire extinguishing fluid onto a particular area where a fire has existed will cease immediately after the fire has been extinguished.

Also, in one preferred general form of the invention, the intelligence-carrying output signal (in one or multiple portions thereof) is effectively coupled (usually by way of an output signal transmitting means) to one or more warning alarm signal producing means, which may be located locally or remotely or both, and adapted to produce one or more types of perceptible warning alarm signals whenever such a fire has been detected and located.

In one preferred form of the invention, the coupling of such an output signal transmitting means of the surveillance apparatus with respect to a remote warning alarm signal producing means may be by way of the conventional AC power lines provided in virtually all buildings, or the like, where the apparatus of the present invention may be provided for fire detection and surveillance purposes.

Also, in one preferred form of the invention, the warning alarm signal producing means may include a plurality of individual and distinct portions, each corresponding to a different output signal transmitting means taking a different intelligence-carrying output signal portion corresponding to a different portion of the fire sensing means and effectively correlated with respect to the surveillance thereby of a different one of the multiple area portions of the relatively large area under surveillance by the complete apparatus, such as the floor area within a warehouse or the like, so that any particular portion of the warning alarm signal producing means will be activated and energized in correspondence with the detection and location by the surveillance apparatus of a fire in that particular multiple area portion of the complete large area under surveillance by the apparatus, thus in effect, causing the warning alarm signal producing means to provide to a remote viewer precise information as to the location of a detected fire within such a warehouse or other building. The type of output signal or signals produced by the warning alarm signal producing means may comprise audibly perceptible signals, visibly perceptible signals, a combination of both at one or more stations or locations, or any other perceptible type of warning alarm signal or signals.

The fire sensing means of the apparatus of the present invention may comprise a single fire sensing means unit or portion actually moved in a scanning pattern with respect to the relatively large area made up by the assembly of multiple area portions previously mentioned so that each individual multiple area portion is at some time correlated with and effectively under surveillance by the fire sensing means, or the fire sensing means may include a plurality of fire sensing means portions which provide an effective but static type of scanning of each of the multiple area portions, such as floor regions of a warehouse or the like by being individually directed onto and maintaining surveillance over only the corresponding individual and different ones of such multiple area portions, and the expression "fire sensing means" is intended to broadly include both of these meanings.

Also, the same situation prevails with respect to the fire responsive effective output signal producing transducer means of the fire sensing means—that is, it may comprise a single such transducer means actually scanningly moved over each of the multiple area portions or may comprise a plurality of such transducer means portions each effectively maintaining surveillance over only its own different individual multiple area portion of the relatively large floor plan area under surveillance by the complete apparatus, and each such fire responsive transducer means may take a number of different forms.

In one such form the fire responsive means comprises a circuit condition altering heat responsive means adapted to abruptly and substantially change the magnitude of impedance of an associated electric circuit in response to the reception of heat (usually primarily in the form of infrared radiation although it may also include heat received by convection or conduction in certain forms thereof) in excess of a predetermined magnitude.

In another form, the fire responsive means may comprise a circuit condition altering smoke sensing and responsive means adapted to substantially change the magnitude of impedance

of an associated electric circuit in response to the reception of smoke (such as that produced by a fire) which produces a predetermined optical density and/or reflectivity change and a corresponding optical change in the passage and/or reflection of light with respect to a quantity of air carrying such smoke therein.

In a further form of the invention, the above-mentioned fire responsive means may comprise a circuit condition altering fire-caused acoustical vibration-responsive means selectively tuned to receive acoustical vibrations characteristic of and effectively produced as a result of a fire and adapted to effectively substantially change the magnitude of impedance of an associated electric circuit (or other electrical characteristic thereof) in response to the reception of fire-caused acoustical vibrations in excess of a predetermined magnitude.

Also, it should be noted that the above-mentioned smoke sensing form of fire responsive means may be combined with any of the different heat responsive means or with the fire-caused acoustical vibration responsive means, or various other combinations of such transducer means, all within the broad scope of the present invention.

With the above points in mind, it is an object of the present invention to provide a novel surveillance apparatus of the character referred to hereinbefore adapted to maintain a relatively large area under constant surveillance and to virtually immediately detect and locate a fire and to provide an output signal carrying information indicating the detection of such a fire and the exact location thereof, and wherein said output signal may be employed for a variety of different purposes such as for causing an appropriate and selective and limited-extent fire extinguishing action of fire extinguishing means in a manner such as to do a minimum of damage of adjacent areas which do not contain such a fire while positively extinguishing the actual detected and located fire and also which may be employed for providing either a local or a remote or both types of warning alarm signal and, in certain forms of the invention, a warning alarm signal providing exact information as to the location of the detected fire. The novel surveillance apparatus of the present invention has any or all of the advantage referred to herein and includes any or all of the features referred to herein, generically and/or specifically, and individually or in combination, and is of relatively simple, inexpensive construction adapted for manufacture with a minimum of tooling and therefore of capital costs and with a minimum of production per unit cost and is also adapted for initial installation in a building at the time that it is built or for subsequent installation and does not require that lengths of auxiliary wire be mounted at inconvenient and conspicuous locations in order to connect the surveillance portion of the apparatus and the warning alarm signal producing means portion of the apparatus by reason of the fact that the conventional AC power wiring normally found in virtually all buildings today may be employed for this purpose. These advantages facilitate the widespread and large-scale manufacture, sale, and use of the invention for the purposes referred to herein or for any other substantially functionally equivalent purposes.

Further objects are implicit in the detailed description which follows hereinafter (which is to be considered as exemplary of but not specifically limiting the present invention), and said objects will be apparent to persons skilled in the art after a careful consideration of the detailed description which follows hereinafter, and all such implicit objects are intended to be included and comprehended herein as fully as if particularly and specifically pointed out herein.

For the purpose of clarifying the nature of the present invention, several exemplary embodiments of the invention are illustrated in the hereinbelow-described figures of the accompanying drawings and are described in detail hereinafter.

FIG. 1 is a fragmentary, perspective view illustrating one exemplary embodiment of the invention in a somewhat diagrammatic, schematic form wherein it comprises a single surveillance unit substantially centrally positioned within a warehouse or other building at a position adjacent to or a short distance below the ceiling thereof, and wherein it is adapted to maintain a substantially complete surveillance over the entire, relatively large floor area of the building and, of course, of a plurality of similar multiple area portions comprising said relatively large floor plan area. In this exemplary first form of the invention, this is accomplished by actual physical scanning movement of the surveillance unit so as to sequentially maintain under surveillance various portions of the complete floor plan area, and of the individual multiple area portions thereof, during the course of the scanning movement of the surveillance unit. Also, this view shows, in a somewhat diagrammatic and schematic manner a correlated fire extinguishing means which is of the same general type—that is, a type adapted to be capable of being moved so as to direct the emission nozzle thereof toward any particular one of the multiple area portions of the large floor plan area of the building in which the surveillance unit has detected and located a fire. This view also shows on the remote outside wall of the building a single representative one of one or more warning signal producing means adapted to be activated by the detection and location of a fire within the building by the surveillance unit. In this view, the building is shown as being empty (although normally in the case of a warehouse numerous materials would be positioned therein). This is done for the sake of convenience and clarity so that the representative multiple area portions of the complete, relatively large floor plan area of the building can be seen, as indicated by the phantom line division of the complete floor surface area into a plurality of such multiple area portions, which division it should be understood is entirely imaginary and arbitrary, and in connection with this it should further be understood that, optionally, such multiple area portions are changeable as to size, number, shape, etc. It should be clearly understood that the relative size of the complete building, the ceiling thereof, the walls thereof, the floor thereof, and in particular the size of the multiple area portions of the floor of the building and the distance of each of same from the surveillance unit and the fire extinguishing means, are greatly minimized relative to the actual size of the showing of said surveillance unit and said fire extinguishing means. In other words, the surveillance unit and the fire extinguishing means are shown grossly enlarged relative to all other dimensions in FIG. 1, and this is done for space saving reasons. It is important that this be understood since otherwise it might lead to the assumption that a substantial "parallax" error of the type referred to hereinafter will exist, when actually such is very largely not the case when the real physical relatively greatly reduced size and lateral spacings of the surveillance unit and fire extinguishing means relative to all of the other dimensions of the buildings shown in FIG. 1, which actually exist, are taken into consideration.

FIG. 2 is a view of a fragmentary and very largely diagrammatic and schematic nature illustrating the actual structure of certain portions of the surveillance unit shown in FIG. 1 and of the fire extinguishing unit shown in FIG. 1 and also shows the external physical appearance of one exemplary form of fire sensing means, fire extinguishing means, correlation and control means effectively coupling the fire sensing means and fire extinguishing means and physical details of the actual mounting of the fire sensing means for actual physical scanning movement so as to maintain the entire warehouse floor surface under sequential scanning surveillance and physical details of the mounting of the fire extinguishing means in a manner such as to be adapted to be moved so as to be directed toward and aligned with a fire which has been detected and located by the scanningly moving fire sensing means of the surveillance unit.

FIG. 3 is a view similar in many respects to FIG. 2 but is of a somewhat fragmentary, partially broken away and, in certain cases, sectional nature, and is drawn to a much larger scale than FIG. 2. Certain portions of the apparatus are removed completely in FIG. 3 so that the electrical circuitry and interconnections of the apparatus can be more clearly seen and un-

derstood. In this view, the fire responsive transducer element of the complete fire responsive effective output signal producing means, which element is carried by the scanning receiver and adapted to be moved in a scanning pattern thereby, is shown, but the remaining part of said complete fire responsive effective output producing transducer means which is not carried by the scanning receiver but which is effectively connected thereto by relatively rotatable slip ring and contact brush means, is not shown in full specific detail but is shown substantially in block diagrammatic form since the interior electrical schematic detail thereof is better shown in FIG. 13. In this view, the master vertical planar movement synchro carried by the surveillance unit and the corresponding slave vertical planar movement synchro carried by the fire extinguishing means and the master horizontal planar movement synchro carried by the surveillance unit and the corresponding slave horizontal planar movement synchro carried by the fire extinguishing means are all shown in very fragmentary electrical schematic form from a viewing position perpendicular to the axis of rotation of the rotor of each of same and thus the details of said four synchros are not fully shown in this view but are fully shown in electrical schematic form in FIG. 13. FIG. 3 shows the apparatus in some portion of its normal repetitive scanning cycle of operations of the surveillance unit and all portions of the apparatus are correspondingly shown.

FIG. 4 is a fragmentary, largely diagrammatic and schematic view, generally similar to FIG. 1, but illustrates the apparatus when a fire has been detected and located in any particular one of the multiple area portions of a warehouse floor such as shown in FIG. 1, and all portions of the apparatus are correspondingly shown. It should be noted that in this FIG., which is somewhat more fragmentary than FIG. 1, the surveillance unit and the fire extinguishing means and a particular one of the plurality of multiple floor area portions having a fire which has been detected by the surveillance unit, and which is in the process of being extinguished by the fire extinguishing means, are drawn much more nearly in their proper size ratios than in the showing of FIG. 1 and that this clearly illustrates the fact that there is a minimal "parallax" error which is substantially corrected by the spreading action of the fire extinguishing liquid emitted by the fire extinguishing means and, therefore, necessarily less detail of the surveillance unit and fire extinguishing means is shown in this view, because they are drawn to a much smaller relative scale, and much less of the building is shown, since it and the floor and, in particular, the multiple floor area portions thereof, are drawn to a much larger relative scale, thus necessitating a very fragmentary showing thereof.

FIG. 5 is a fragmentary view of a largely diagrammatic and schematic nature of the warning signal alarm signal producing means shown physically in FIG. 1.

FIG. 6 is an enlarge, fragmentary, sectional view, taken substantially along the plane and in the direction indicated by the arrows 6–6 of FIG. 3 and shows certain details of the gimbal-type double ring mounting of the fire sensing means of the exemplary first form of the invention which is a part of the apparatus for causing the actual physical scanning movement thereof. This view shows the apparatus in one part of a scanning cycle just prior to the completion of one complete scanning of the entire warehouse floor area.

FIG. 7 is a fragmentary view, generally similar to FIG. 6, but effectively comprises an operatively succeeding view illustrating the change of position of various portions of the apparatus after one complete scanning of a complete floor plan area of the warehouse of FIG. 1 is accomplished when it is desired for the apparatus to return to a starting position for repeating the entire scanning operation again. The structure bringing about this return of the apparatus to an initial scanning position is clearly illustrated in this view.

FIG. 8 is a top view, partly in section, taken in a direction and on a plane substantially transverse to that of FIG. 6.

FIG. 9 is an enlarged, fragmentary, partly broken away and partly sectional view of the partial gear bringing about vertical, line-by-line, arcuate movement of the scanning means during a plurality of horizontal scanning sweeps thereof, and is taken primarily in a direction generally indicated by the arrows 9–9 of FIG. 8.

FIG. 10 is a partially broken away and somewhat diagrammatic and schematic view, taken in the direction of the arrows 10–10 of FIG. 3, of portions of the fire extinguishing means and of the correlation and control means coupled mechanically thereto and electrically with respect to the surveillance unit so that the fire extinguishing means when activated to emit fire extinguishing fluid will be directed exactly toward a fire which has been detected and located by the surveillance unit or, more particularly, the fire sensing means thereof.

FIG. 11 is an enlarge, fragmentary view substantially transverse to the plane of FIG. 10, taken substantially in the direction of the arrows 11–11 of FIG. 3, and further illustrates the detailed structure of the correlation and control means and of the mounting of the fire extinguishing means to bring about the direction thereof exactly toward a fire detected and located by the surveillance unit.

FIG. 12 is a somewhat enlarged, fragmentary view of just the extreme upper stationary pipe portion of the fire extinguishing means and of a control valve adapted to be operated by the correlation and control means so as to emit a fire extinguishing fluid when a fire has been detected and located by the surveillance unit, and this view shows said control valve in temporarily open position for such emission of fire extinguishing fluid (usually water, although not specifically so limited).

FIG. 13 is an enlarged, fragmentary, and somewhat diagrammatic interior view of one exemplary form of fire responsive transducer means of the fire sensing means and shows it as comprising a particular type of circuit condition altering heat responsive means wherein heat is received in the form of infrared radiation by passing it through an infrared filter and directing it onto an infrared responsive photosensitive means taking the form of a photocell or a light responsive effective resistor or the like for abruptly altering the resistance thereof in response to the reception thereby of infrared radiation. This view also includes an electrical schematic of the various elements of the correlation and control means shown either structurally or in somewhat electrically incomplete form in FIG. 3.

FIG. 14 is a fragmentary view very similar to a small portion of FIG. 13 but illustrates a very slight modification of the type of heat responsive means wherein heat may be received in the form of infrared radiation or by convection or by conduction, or any combination thereof, and wherein the actual heat responsive means comprises an effective, normally open switch means or other electric circuit condition altering means normally having a very high resistance or impedance and adapted, in response to the reception of any form of heat or any combination of forms of heat in excess of a predetermined magnitude, to effectively close the circuit in a manner abruptly and greatly reducing the resistance or impedance thereof. In the example illustrated, this is shown as comprising a thermostatic element providing actual physical movement of at least one end thereof although not specifically so limited.

FIG. 15 is a fragmentary, diagrammatic, electrical schematic view of a modified form of fire sensing means with the remainder of the apparatus removed for reasons of drawing simplification and clarity. In this modification, the circuitry is differently arranged and the heat responsive means is of substantially the same type as that illustrated in FIG. 14 but is of a normally closed type adapted to open when heat in excess of a predetermined magnitude is received thereby.

FIG. 16 is another fragmentary, diagrammatic, electrical schematic view of a further modified form of the fire sensing means and is very similar to the FIG. 15 form thereof except for the fact that in this modification the intelligence-carrying output signal is somewhat different and does not include a portion adapted to activate a transmitter means for activating a remote warning alarm signal producing means such as that shown in FIGS. 1 and 5, and therefore this circuit is somewhat

simpler than that shown in FIG. 15 which is adapted to activate such a transmitter means.

FIG. 17 is a view of a portion of a modified form of fire sensing means having a different type of fire responsive means which, in this view, comprises a smoke responsive means adapted to abruptly and substantially change the magnitude of impedance of the associated circuit in response to the reception of smoke producing a predetermined optical reflectivity change and a corresponding optical change in the reflectivity of light from smoke particles in the air and onto a photocell or a light responsive resistor. In other words, this fire responsive means may be used in lieu of the heat responsive means shown in the first form of the invention with the same associated circuitry and interconnections.

FIG. 18 is a view very similar to FIG. 17 but merely illustrates a slightly modified form of the smoke sensing and responsive means comprising the fire responsive means wherein it is responsive to a predetermined change in optical density and a corresponding optical change in the passage of light through a quantity of air carrying the smoke between the light source and the photocell or light sensitive resistor.

FIG. 19 is a view similar to FIGS. 17 and 18 but illustrates a further modification of the fire responsive means wherein it comprises a circuit condition altering fire-caused acoustical vibration-responsive means selectively tuned to receive acoustical vibrations characteristic of and effectively produced as a result of fire. The modified form thereof is shown in this view as having a directional input means comprising a directional parabolic sound receiving reflector and focus-located microphone fed through a tuned band-pass filter so as to operate a relay which corresponds to the light responsive resistor or photocell of the first form of the invention and which otherwise is connected to the same type of associated circuitry in substantially the same manner.

FIG. 20 is a fragmentary, electrical schematic view, generally similar to FIG. 3, but illustrates a modified form of the invention wherein the heat responsive means of the FIG. 3 form of the invention is modified from the specific form thereof shown individually in FIG. 13 to the smoke responsive form thereof shown individually in FIG. 17, and wherein an additional heat responsive means of the type shown in FIG. 15 is associated therewith and wherein the corresponding combination of electrical circuitry is also associated together, thus making the device responsive to heat and/or to smoke.

FIG. 21 is a greatly reduced size, fragmentary, somewhat schematic and diagrammatic, perspective view generally similar to FIG. 1 but illustrating a modified arrangement wherein the fire sensing means has a number of physically separated and differently mounted portions, each carried underneath the warehouse ceiling in a manner such as to overlie its own individual one of the multiple area portions of the warehouse floor area and wherein the fire extinguishing means also comprises a plurality of portions physically spaced apart and each mounted adjacent to its correlated fire sensing means portion in overlying relationship with respect to its correlated and underlying particular one of the multiple area portions comprising the complete floor plan area of the warehouse.

FIG. 22 is an enlarged, fragmentary view similar to FIG. 2 of the first form of the invention, and illustrates a typical pair of one of the fire sensing means portions and a corresponding and correlated one of the fire extinguishing means portions of the plurality of each of same comprising, in the first case, complete fire sensing means and, in the second case, complete fire extinguishing means, and in this view said two units are shown largely physically.

FIG. 23 is a view generally similar to FIG. 3 of the first form of the invention, but illustrates in an electrical schematic manner the two exemplary units shown physically in FIG. 22, it being understood that the transmitter associated with each heat sensing means portion will operate the common warning alarm signal producing means.

FIG. 24 is a fragmentary, diagrammatic, schematic view generally similar to FIG. 23, but illustrates a slight modification wherein the transmitter associated with each different heat sensing means portion provides a distinctively different transmission signal fed through the conventional AC power lines to a corresponding one of a plurality of different receivers associated with a corresponding plurality of different warning alarm signal producing means portions and is separated out or selected by the correlated one thereof so that only one warning alarm signal producing means portion will be activated by any particular heat sensing means portion which has detected a fire in its particular one of the multiple area portions comprising the complete warehouse floor. This view shows both a representative number of different heat sensing transmitter means and the corresponding plurality of warning alarm signal producing means portions and is taken to be representative of any desired number thereof.

FIG. 25 is a view generally similar to FIGS. 1 and 21, but illustrates a slightly different arrangement which is of the multiple portion-type illustrated in FIG. 21, but wherein all of the fire sensing means portions are assembled together into one centrally positioned, effectively unitary, wide angle, composite surveillance unit actually composed of a plurality of individual fire sensing means having a common wide angle input to the different fire responsive means contained therein and corresponding in number to the number of multiple area portions of the complete warehouse floor. The fire extinguishing means is still of the multiple portion-type illustrated in FIG. 21, and each of said portions is still located substantially the same as illustrated in the FIG. 21 form of the invention, and each is correlated with its corresponding fire sensing means portion of the centrally assembled, wide angle, composite surveillance unit and is electrically connected thereto in substantially the same manner as clearly illustrated in FIG. 21 relative to that form of the invention.

FIG. 26 is an enlarged, diagrammatic and somewhat schematic view taken substantially along the plane and in the direction indicated by the arrows 26–26 of FIG. 25 and illustrates the fact that the composite, effectively assembled surveillance unit of this modified form of the invention has a common infrared filtered input comprising a wide angle lens which focuses infrared radiation received from each individual one of the multiple area portions of the warehouse floor onto a corresponding one of a plurality of laterally assembled small heat responsive means, each of which is similar to the exemplary one illustrated in connection with the first form of the invention, which together effectively comprise a multiple area portion replica locating grid composed of the plurality of such fire responsive means.

FIG. 27 is an enlarged, fragmentary view taken substantially along the plane and in the direction indicated by the arrows 27–27 of FIG. 26 and clearly shows in front elevation the multiple area portion replica locating grid referred to in the description of the preceding figure.

FIG. 28 is a fragmentary view illustrating a modified form of heat responsive means substitutable in lieu of any of the other heat responsive or fire responsive means shown in the illustrations of the various other forms of the invention. In this view it is shown as a normally closed circuit arrangement having two conventional electrical connector elements provided with an electrically conductive heat responsive burnout membrane therebetween adapted to be melted away and/or burnout in response to the reception of heat in excess of a predetermined magnitude whereby to effectively open an auxiliary circuit whereby to cause a relay to close an associated circuit.

FIG. 29 is a view generally similar to FIG. 28 but illustrates a burnout-type of heat responsive means analogous to that shown in FIG. 28 but of a normally open circuit-type wherein there are two electrically conductive contact elements effectively biased toward each other but normally separated by a nonconductive heat responsive burnout membrane adapted, in response to the reception of heat in excess of a predetermined magnitude, to be melted or burned out and to thus

allow the electrical contacts biased toward each other to close an associated circuit.

One exemplary and nonspecifically limiting first form of the invention is illustrated in FIGS. 1—13 inclusive and, generally speaking, may be said to comprise apparatus for detecting and locating a fire and for producing at least one corresponding output signal (which is intended to mean an individual output signal or a plurality of output signal portions) which, in the preferred exemplary and nonspecifically limiting first form of the invention illustrated in FIGS. 1—13 inclusive is employed for correlatedly operating a fire extinguishing means in an optimum manner such that a fire extinguishing fluid will be directed more or less precisely and specifically onto the detected and located fire and not into other nearby regions where no such fire is present. Also, the output signal, in the exemplary but nonspecifically limiting first form of the invention illustrated in FIGS. 1—13 inclusive, operates a warning alarm signal producing means so as to provide a warning alarm signal producing means so as to provide a perceptible alarm at one or more locations, either local or remote, so that the detection and location of the fire will become known to the appropriate personnel at the very beginning of such a fire, who may take such other appropriate action as may be necessary to aid in extinguishing the fire even though the fire extinguishing means of the apparatus of the present invention is intended to accomplish this fully in a completely automatic manner.

In the exemplary but nonspecifically limiting first form of the invention illustrated in FIGS. 1—13 inclusive, the apparatus generally includes three distinct major portions, the first of which is designated generally by the reference numeral 30 and which may be said to comprise a surveillance unit, the second of which is indicated generally by the reference numeral 32 and which may be said to comprise the above-mentioned fire extinguishing means, and the third of which comprises the above-mentioned warning signal producing means, such as is generally designated by the reference numeral 34.

The surveillance unit, generally designated at 30 in the exemplary first form of the invention, is adapted to maintain an actual physical scanning-type of surveillance of a relatively large spacial region between same and a relatively large floor area at the bottom of said spacial region, such as the floor of a warehouse or the like, of the type generally designated by the reference numeral 36 in FIG. 1, although it should be understood that the building 36 may be any type of building and is not limited to a warehouse specifically. It will be noted that, in the exemplary first form of the invention illustrated, the warehouse 36 has a relatively large floor space area such as is generally designated by the reference numeral 38, which may be said to effectively be formed of or made up of a plurality of similar multiple area portions, several representative individual ones of which are individually indicated by the reference numeral 40. The multiple area portions 40 in FIG. 1 are indicated as being defined by phantom lines, and this is done in order to make it completely clear that there are no such real physical lines and that they are imaginary, and that the breaking up of the complete warehouse floor surface area 38 into a plurality of multiple area floor portions 40 is a convenience for use in considering the surveillance and actual scanning thereof by the surveillance unit 30, which is carried at a substantially central position (although it may be located elsewhere if the scanning pattern is correspondingly modified) immediately below a ceiling 42 of the warehouse so that it can maintain surveillance of virtually the entire interior region defined within the warehouse walls between the surveillance unit 30 and the plurality of multiple area portions 40 of the complete warehouse floor surface 38. In this connection, it should be clearly noted that a simpler way of considering of referring to the spacial regions maintained under surveillance by the surveillance unit 30 is to define them or to refer to them in terms of the lower terminal surface of said spacial regions which is largely defined by the warehouse floor 38 and the multiple area portions 40 thereof, although in those instances where it is desired to also maintain surveillance of upper portions of sidewalls of the warehouse, the projected bottom terminal area of the region under surveillance would necessarily be somewhat larger than the actual warehouse floor 38, but even where this type of complete scanning of the warehouse walls is desired, it is merely necessary to consider the relatively large area 38 as being extended beyond the actual warehouse floor to an extent such as to include in the scanning region all upper sidewall portions of the warehouse which it is desired to be included therein. Any reference hereinafter to the so-called relatively large area 38 comprised of multiple area portions 40 is to be broadly construed in the light of the foregoing statement.

The surveillance unit, generally designated by the reference numeral 44, which is adapted to be actually physically scanningly moved in a horizontal 360° rotative sweeping movement, with each succeeding 360° circular sweeping movement being progressively deflected in a vertical planar direction or manner so that the entire plurality of multiple area portions 40 will be sequentially scanned and effectively viewed by the fire sensing means 44 in a manner such as to selectively sense a fire which may occur in any of such multiple area portions 40 in a manner both detecting such a fire and also determining the location thereof with respect to such multiple area portions 40. In other words, the fire sensing means 44 will, by reason of its scanning movement, also acquire exact location information as to exactly which of the multiple area portions 40 contains such a fire, such as is indicated generally at 46 in the fragmentary view comprising FIG. 4.

The fire sensing means of the exemplary first form of the invention generally designated at 44, is of an actual physical scanning-type as referred to above and, therefore, includes what might be termed a gimbal-type of double ring mounting means, such as is generally designated by the reference numeral 48, which permits the above-described type of actual physical scanning movement along two mutually perpendicular planes (i.e., a substantially horizontal plane as far as movement is concerned, although downwardly angularly directed, and a plane substantially perpendicular thereto) of the scanning receiver means, generally designated by the reference numeral 50, which comprises a directional input means 52 (which may be a parabolically shaped infrared receiver and reflector means in one exemplary form of the invention) and which further includes a fire responsive transducer element 54 of a complete fire responsive effective output signal transducer means, generally designated by the reference numeral 56, which is adapted to have the infrared radiation or heat received by the relatively angularly narrow directional input means 52 effectively focused thereupon to effectively alter the condition of an associated circuit, such as is indicated at 58, in a manner which will cause the remaining or output signal producing portion 60 of the complete fire responsive effective output signal producing transducer means 56 to provide an intelligence-carrying output signal (in one or more such output signal portions) in response to the detection and location of a fire by the complete fire sensing means 44, with the fire sensing means 44 also providing intelligence indicating, in addition to the detection and presence of such a fire, the actual physical location thereof with respect to the previously mentioned multiple floor area portions 40. The detailed structure of the complete fire responsive effective output signal producing transducer means 56 will be described hereinafter.

The fire sensing means, generally designated by the reference numeral 44, also is provided with scanning motor means 62, which drives a first reduction gearing means 64, the output of which in turn drives a hollow shaft 66 which is connected to the outermost ring member 68 of the gimbal-type double ring mounting means designated generally at 48, and rotates said outermost ring member 68 around a vertical axis. Said outer ring member 68 is provided with appropriate bearings 70 and 72, in the first case both rotatively and vertically mounting and positioning the hollow shaft 66, and in the

second case rotatably and vertically mounting and positioning a second hollow shaft 74 at the opposite end of the outer ring member 68. Either or both of said bearing members 70 and 72 may be connected to suitable mounting structure such as is indicated generally at 76 for attachment of the entire surveillance unit 30 to the ceiling 42. The other or inner ring member 78, in one preferred form of the invention, actually only comprises a partial ring and is pivotally mounted with respect to the first ring member 68 for rotation around a substantially horizontal axis perpendicular to the vertical axis of rotation of the first ring member 68.

In the example illustrated, this is provided by having aligned opposite side portions of the inner ring member 78 provided with outwardly directed stud members 80 which extend through rotary sleeve members 82 carried by corresponding adjacent portions of the outer ring member 68, although the rotative mounting arrangement can be positionally reversed or otherwise modified provided that the proper mounting of the inner ring member 78 with respect to the outer ring member 68 for rotation around a horizontal axis of rotation is achieved, and all such arrangements are intended to be included and comprehended within the broad scope of the present invention.

It will be understood that an appropriate portion of the inner ring member 78 mounts (preferably adjustably) the previously mentioned scanning receiver means 50, and means is provided for causing the inner ring member 78 to move through a predetermined vertical planar arcuate extent so as to correspondingly move the directional input means 52 of the scanning receiver 50 in a manner much less than, but correlated with respect to, the corresponding horizontal rotary movement provided thereto by the corresponding rotary movement of the outer ring member 68 during scanning operation of the complete gimbal-type double ring mounting structure 48 of the fire sensing means generally designated at 44.

In the example illustrated in the first form of the invention, said means for correlating a vertical planar arcuate movement of the direction input means 52 of the scanning receiver 50 with the horizontal arcuate movement thereof in an appropriate scanning manner comprises a return biasing spring 83 and a positionally adjustable threaded stop member 84, arranged for use in vertically arcuately returning the entire inner ring member 78 and the directional input means 52 of the scanning receiver 50 to an initial starting position after completion of one complete scanning cycle. Said means also includes the positive vertical movement driving means generally designated by the reference numeral 86, which includes a nonrotating, vertically directed stub shaft 88 fixedly carried by the surveillance unit 30 at a location below the bearing 72 and the hollow shaft 74 and extending upwardly therethrough into a position within the outer ring member 68 and exactly coaxial with the vertical axis of rotation thereof and terminating with a small bevel gear 90 which drives a much larger right angle bevel gear 92 which is coupled to a second reduction gearing means 94 which in turn drives a partial spur gear 96 which drives a sector-shaped gear 98 directly coupled to an offset portion of the inner ring member 78. It should be clearly noted that the partial driving spur gear 96 has peripheral gear teeth 100 around only a portion of the circumference thereof and has a radially inwardly recessed, nontoothed return slide portion 102.

The arrangement of the structure described immediately above for causing appropriate horizontal planar and vertical planar correlated but lesser magnitude scanning movement of the directional downwardly angularly inclined input means 52 of the scanning receiver 50 is such that energization of the motor means 62, which is the normal condition thereof when the surveillance unit 30 is energized and which only becomes inoperative when a fire is detected and located as will be described in greater detail hereinafter, drives the first reduction gearing 64, which in turn drives the first-mentioned hollow shaft 66 which is directly connected to the upper end of the first-mentioned ring member 68 which, therefore, is rotated around a vertical axis of rotation at a constant horizontal scanning rate determined by the initial r.p.m. of the motor 62 and the extent of the output-to-input reduction provided by the reduction gearing means 64 which, in certain forms of the invention, may be of a controllably adjustable-type if desired.

The rotation of the outer ring member 68 provided in the immediately previously described manner, causes the entire offset assembly carried by the inner ring member 78 and comprising driven large bevel gear 92, the second reduction gearing 94, and the partial spur gear 96, to rotate around the vertical axis of rotation of the outer ring member 68 and, more importantly, to rotate around the fixed small bevel gear 90 which is in engagement with the edge of the large bevel gear 92, thus causing the large bevel gear 92 to be rotated at a reduced rate compared to the rate of rotation of the outer ring member 68. This reduced rate of rotation of the bevel gear 92 is further reduced by the second reduction gearing 94 so that the partial spur gear 96 is driven in a manner synchronized an correlated with the rotation of the outer ring member 68 around its vertical axis of rotation but at a very much lesser rate of rotation.

The greatly reduced rate of rotation of the partial spur gear 96 causes greatly reduced corresponding rotary movement of the sector gear 98 fixedly carried by the offset portion of the inner ring member 78 and thus causes the inner ring member 78 to be angularly rotated in a vertical plane through an arcuate extent vertical planar deflection correlated with but very much less than the corresponding rate of horizontal arcuate rotary movement of the outer ring member 68, and since the scanning receiver 50 moves in precisely the same manner as the offset portion of the inner ring member 78 carrying the partial gear 98, it is correspondingly arcuately moved in a vertical plane in a manner correlated with its horizontal arcuate movement, although of much lesser magnitude, in precisely the desired scanning manner.

As soon as the directional input means 52 of the scanning receiver 50 has moved to the extreme desired extent of its vertical planar arcuate deflection, such as would occur immediately following the position of the apparatus as shown in FIG. 6, the peripheral toothed portion 100 of the partial gear 96 becomes disengaged from the teeth of the sector gear 98 and the recessed, nontoothed return of the slide portion 102 of the partial gear 96 moves into opposition to the toothed sector gear 98 and allows the return biasing spring 83 to reverse the direction of vertical planar arcuate movement of the inner ring member 78 and of the scanning receiver 50 back to its initial starting position for the repetition of the scanning cycle as soon as the partial gear 96 has rotated sufficiently to again oppose the partial peripheral gear toothed portion 100 thereof to the sector gear 98 and again drivingly engage same for repeating the vertical planar arcuate deflection cycle of operations described above. This return of the apparatus to its initial starting position is best shown in FIG. 7, and in connection therewith it should be noted that the extent of the return movement provided by the return biasing spring 83 can be adjustably controlled by the adjustable stop means 84, and also the extent of the opposite extreme of the vertical planar arcuate deflection of the inner ring member 78 and of the scanning receiver 50 can be adjusted by removing individual portions of the partial exterior peripheral gear teeth 100 which are separate from the inner body thereof and are fastened thereon by threaded fastener means 104 in a plurality of individual, arcuately adjacent, arcuate gear tooth elements.

The exemplary first form of the invention also includes the previously mentioned fire extinguishing means generically designated by the reference numeral 32 and having a directional nozzle means or the like, such as indicated at 106, adapted to controllably emit a fire extinguishing fluid (usually water, although not specifically so limited) toward any particular one of the multiple area portions 40 (which is to be construed as including intervening space volume portions also) in which a fire has developed and has been detected and

located by the surveillance unit 30. In other words, the nozzle means 106 of the fire extinguishing means 32 is adapted to be directed toward exactly the same multiple area portion 40 as that toward which the directional input means 52 of the scanning means 50 is directed when a fire is detected and located thereby. At all other times, the nozzle 106 remains motionless and does not move through a continuous sequence of scanning movements as does the directional input means 52 of the scanning receiver 50 of the surveillance unit 30.

The movement of the nozzle 106 so as to be directed toward the same multiple area portion 40 as the directional input means 52 of the scanning receiver 50 only occurs when the complete fire responsive effective output signal producing transducer means 56 produces an output signal indicating the detection and location of such a fire as will be explained hereinafter. This is accomplished through the use of correlation and control means, generally designated by the reference numeral 108, which includes servomotor means for operating a correlated portion of the fire extinguishing means 32 in a selective correlated manner whereby to cause activation thereof, by the opening of a normally closed solenoid openable control valve means such as is indicated generally by the reference numeral 110 and which is actually a part of said correlation and control means 108. The opening of the normally closed solenoid openable control valve means 110 is preferably slightly delayed by time delay means indicated in block diagrammatic form at 111 allow the repositioning of the nozzle 106 to be completed before the valve 110 opens, which, of course, causes the emission of a fire extinguishing fluid, such as water or the like, and does so through the nozzle 106 which is directed at that particular one of the multiple area portions 40 which contains a fire which has been detected and located by the surveillance unit 30.

The correlation and control means, generally designated by the reference numeral 108, also comprises a rotatable horizontal master positioning synchrorotary motor means, indicated generally at 112, which also has its rotor 116 driven by the output of the reduction gearing 64, which is driven by the driving motor 62, and thus it will be understood that the rotor 116 of the master positioning synchrorotary motor means 112 moves in exact correspondence with the rotation of the previously mentioned outer ring member 68 of the scanning means, and thus may be referred to as a horizontal master positioning synchrorotary motor means.

It should be noted that there are two input leads 114 to the rotor 116 of the horizontal master positioning synchro 112 and that there are three symmetrically arranged field windings 118 disposed about the rotor 116 and each having a pair of leads, one of which is connected to the next field winding 118 and the other of which extends to a position exterior of the synchro 112 as indicated at 120. Thus, exterior of the synchro 112 there are two rotor leads 114 and three field leads 120, and these are adapted to be correspondingly connected to the similar rotor winding 116' and to the similar field windings 118' of the corresponding and correlated horizontal slave positioning synchrorotor means, generally designated by the reference numeral 112', which has an output shaft 122 effectively connected to a horizontally rotary pipe portion, indicated generally at 124, of the fire extinguishing means 32 which is adapted to rotate around a vertical axis of rotation in a manner similar to the ring member 68 of the surveillance unit 30. In the example illustrated, this is accomplished by mounting the slave synchro 112' so that the output shaft 122 thereof drives spur gears 126 through reduction gearing 128 in a manner such that the extent of rotative movement imparted by the spur gears 126 to a similar laterally adjacent spur gear 130 coupled to the rotary tube portion 132 of the horizontally rotatable structure 124 produces exactly corresponding rotation thereof when energized to that of the rotor 116 of the horizontal master synchro 112 and the corresponding rotation of the first ring member 68 of the surveillance unit 30.

The three field winding output leads 120 from the master synchro 112 connect to the corresponding field windings 118' of the slave synchro 112'. However, the two leads 114 connected to the master synchrorotor 116 are not normally connected to the slave synchrorotor means 116' until such time as a previously open relay switch 166 of a composite relay indicated generally at 134 is closed as a consequence of the scanning receiver 50 of the surveillance unit 30 detecting and locating a fire in a particular one of said multiple area portions 40 and causing the production by the complete fire responsive effective output signal producing transducer means 56 of an output signal in a manner which will be described hereinafter. Whenever this occurs and the previously open relay switch 166 is temporarily closed for the duration of the detected and located fire, and leads 114 are connected from the AC input terminals 136 to both the master synchro rotor 116 and the slave synchrorotor 116', and this in the manner of such synchro positioning motors, causes the rotor 116' of the slave synchro 112' to rotate until it assumes exactly the same angular rotative position as that of the rotor 116 of the master synchro unit 112, which of course corresponds to the position of the outer ring member 68 and the scanning receiver 50 of the surveillance unit 30.

Of course, the rotation of the slave rotor 116' of the slave synchro 112' will thus cause the rotation of the complete horizontal rotary assembly 124 of the fire extinguishing means 32 until the nozzle 106 is directed exactly toward that particular one of the multiple area portions 40 which contains the fire which has been detected and located by the directional input means 52 of the scanning receiver 50 of the surveillance unit 30. At precisely this same time, energization of the relay 134 closes another relay switch 162, which causes electrical energy from the AC input terminals 136 to also be connected to the previously mentioned solenoid operated control valve 110 to open same.

It should be noted that, in the exemplary arrangement illustrated, the previously mentioned horizontally rotary pipe structure 124 of the fire sensing means 32 actually comprises the upper rotary inlet pipe or tube portion 132 and a bifurcated or yoke-shaped pipe portion 138 terminating at the bottom in two inwardly directed, aligned pipe ends 139 which carry rotary liquidtight couplings, such as indicated generally at 140, rotatively connected to a corresponding inner pipe member 142 which, in turn, is connected to the previously mentioned nozzle 106.

The upper inlet tube or pipe portion 132 is connected through another liquidtight rotary bearing means 144 to an upper, nonrotatable pipe portion 146 which is adapted to be fastened to the ceiling 42 of the warehouse 36 and to pass therethrough and to be connected to a suitable source of fire extinguishing fluid under pressure, such as to a water main or the like, although not specifically so limited.

It should be clearly noted that the two liquidtight rotary couplings generally indicated at 140 and the single liquidtight coupling, generally indicated at 144, may each be of a similar type adapted to allow free axial rotation of the aligned parts while maintaining a complete liquidtight communication of the corresponding pipe portions, and since such structures are well known in the art and do not touch upon the real inventive concept of the present invention, the detailed interior construction thereof is not shown. Incidentally, the solenoid openable control valve 110 which has been previously referred to as effectively controlling fluid emission from the nozzle 106 is not physically carried by the nozzle 106 in the exemplary form of the invention illustrated but is effectively in control thereof. Actually, it is carried in the fixed pipe portion 146, which is a more convenient location therefor since it will not then move, with the consequent electrical connection problems which would arise from such movement.

The previously mentioned correlation and control means indicated generally at 108 also includes, in addition to the horizontal master and slave synchros 112 and 112' carried, respectively, by the surveillance unit 30 and the fire extinguishing means 32, vertical planar master and slave synchromotor means of identical construction to the horizon-

tal movement master and slave synchromotor means 112 and 112', and therefore a detailed description of such vertical planar movement master and slave synchro means will not again be repeated.

In order to correlate the previous description of the horizontal master and slave synchromotors 112 and 112' with the corresponding identical parts of the vertical planar movement master and slave synchros, similar parts of the latter are designated by the same reference numerals, followed by the letter V, however —meaning that parts bearing the same reference numerals as those of the horizontal movement master and slave synchros 112 and 112' are identical in structure thereto but comprise corresponding parts of the vertical planar movement master and slave synchros 112V and 112V'. This is true of all of the corresponding parts.

In the case of the vertical planar movement master synchro 112V, it should be noted that its rotor 116V is effectively coupled to the inner ring member 78 at an axial location, while the remainder of the vertical planar movement master synchro 112V is coupled to the outer ring member 68, and thus relative vertical pivotal movement of the inner ring member 78 with respect to the outer ring member 68 will cause corresponding relative rotation of the master synchrorotor 116V with respect to the remainder of said master synchro 112V, and of the slave synchrorotor 116V' with respect to the remainder of the slave synchro 112V', by reason of the electrical connection thereof as a consequence of the energization of the previously mentioned relay 134 and the closure thereby of another relay switch 164 to electrically connect the master and the slave rotor leads 114V between the master synchrorotor 116V and the slave synchrorotor 116V'; it being understood that the three field windings 118V and 118V', respectively, are already connected through the three sets of leads 120V passing through three of the corresponding sliprings 148 separately and insulatingly carried by the hollow drive shaft 66 and through corresponding brush means 150 and through corresponding brush means 150' engaging corresponding sliprings 148' exteriorly carried in an insulated manner by the rotatable tube means 132 of the fire extinguishing means 32 and connected therefrom to the corresponding three field windings 118V'.

The connection of the master and slave synchrorotors 116V and 116V' by the rotor leads 114V occurs, as mentioned above, when the previously mentioned relay switch 164 is closed and this occurs through the other two sliprings 152 spacedly and insulatingly carried by the hollow shaft 66 and cooperating with corresponding contact brushes 154 and through the corresponding pair of brushes 154' engaging the corresponding pair of sliprings 152' exteriorly carried in an insulated manner by the rotatable tube means 132 of the fire extinguishing means 32 and connected therefrom to the corresponding two rotor windings 116V'. This of course causes the rotor 116V' of the slave synchro 112', to be effectively attached in driving relationship to the entire inner tube portion 142 of the fire extinguishing means 32 around a horizontal axis of rotation thereof because of the fact that an exterior part of one of the rotary couplings 140 physically carries the slave synchrorotor 116V' around the exterior thereof while the remaining and field carrying portion of the vertical planar movement synchro 112V' is attached to the adjacent inwardly directed pipe end portion 139 of the bifurcated yoke part 138 of the horizontally rotary pipe structure 124.

Thus, whatever position the directional input means 52 of the scanning receiver 50 is in when it detects a fire will automatically be transmitted as a result of closure of the corresponding relay switches 166 and 164 (comprising parts of relay 134 operated by energization of relay coil 158) to the two slave synchros 112' and 112V' of the fire extinguishing means 32, and will cause them to immediately rotate until the nozzle 106 is directed exactly toward the fire which has been detected and located by the surveillance unit 30 and at that time, also in response to energization of relay coil 158 to operate composite relay 134, the normally closed solenoid openable control valve 110 of the fire extinguishing means 32 is temporarily opened for the duration of the fire and a fire extinguishing fluid, such as water or the like is emitted directly onto the fire until it is extinguished, at which time the directional input means 52 of the scanning receiver 50 no longer detects the previous fire and therefore no intelligence-carrying output signal is produced by the complete fire responsive effective output signal producing transducer means 56 of the complete fire sensing means 44 and the relay 134 becomes effectively deenergized and the solenoid operable control valve 110 of the fire extinguishing means 32 closes and the driving motor 62, which had been deenergized only during the duration of the fire in a manner which will be described immediately hereinafter, is again reenergized and the actual physical scanning movement of the fire sensing means 44 of the surveillance unit 30 beings again.

As pointed out above, when a fire is detected and located by the fire sensing means 44 and the previously described sequence of operations begins, the energization of the previously mentioned relay 134 under the control of the transducer means 56 deenergizes the motor 62 during the duration of the fire for precisely the same period of time as the temporary opening of the solenoid openable control valve 110 of the fire extinguishing means 32 occurs. In other words, whenever the motor 62 is on, the fire extinguishing means 32 is inoperative, and whenever the fire extinguishing means 32 is operative the motor 62 is deenergized.

The previously mentioned composite relay 134, which is under the control of the output signal producing portion 60 of the fire responsive effective output signal producing transducer means 56, actually comprises, in the example illustrated, a single energizing relay coil 158 operating a plurality of sets of relay contacts including normally closed relay contacts 160 connecting the AC terminals 136 to the motor 62, normally open relay contacts 162 connecting the AC terminals 136 to the solenoid-openable control valve 110, normally open relay contacts 164 connecting the AC terminals 136 to the vertical planar master synchro 116V and also to the slave synchrorotor 116V', and another, normally open set of contacts 166 connecting the horizontal master synchrorotor 116 to the horizontal slave synchrorotor 116'.

Said fire responsive effective output signal producing transducer means 56 in the exemplary first form of the invention includes the previously mentioned transducer element 54 carried at the effective focus of the directional input means 52 of the scanning receiver means 50 which is connected by means of two wires and two additional sliprings 168 carried by the hollow shaft 66 and engaged by two corresponding exterior brushes 170 through the extended leads 172 to the corresponding two leads 174 of the remaining output signal producing portion, indicated generally at 60, of the complete fire responsive effective output signal producing transducer means 56 which is also a part thereof.

The transducer means indicated generally at 56 is based primarily upon the transducer element 54 which may comprise a photocell or a light responsive resistor normally having a very high resistance, perhaps of the order of 1 to 3 megohms or the like, although not specifically so limited, and which, when subjected to infrared radiation, has its resistance very greatly reduced. In the example illustrated, the directional input means 52 is provided with an infrared filter means 176 adapted to substantially completely exclude all visible light and to pass only infrared radiation. Thus, obviously, the light responsive transducer element 54 will respond only to infrared radiation received thereby and in response to the receipt of such infrared radiation in excess of a predetermined magnitude it will very quickly change the magnitude of impedance or resistance of the associated circuitry connected thereto and including the variable resistor or rheostat 178, which is a sensitivity control, and the two resistors 180 and 182.

The AC input voltage from the AC input terminals 136 is effectively fed into a half-wave voltage doubler power supply 183, which includes the diodes 184 and 186 and the two

capacitors 188 and 189, and which functions to halfway rectify and double the approximately 117 volts conventionally supplied at the AC input terminals 136 so that the voltage fed to the sensitivity control rheostat 178, taking into account the small losses which occur, is approximately 325 volts DC.

The voltage across the infrared responsive resistor 54 is determined by the setting of the sensitivity variable resistor or rheostat 178 and since the resistance of the infrared responsive resistor 54 is extremely high when little or no infrared radiation is received thereby there is little current flow through the series circuit connecting same and the sensitivity controlling rheostat 178 and the two resistors 180 and 182 connected in a controlling manner with respect to the gate of the silicon controlled rectifier gate 190, and thus said silicon controlled rectifier is normally nonconductive.

However, as the resistance of the infrared responsive resistor 54 decreases because of the increased reception of infrared radiation because the scanning means 50 has detected and located a fire, more current flows through the associated circuit including the sensitivity controlling rheostat 178 and the resistor 180 (which is a current limiter used to protect the silicon controlled rectifier gate from damage) and the other resistor 182 (which is a gate controlling resistor). Increased current flow through the gate controlling resistor 182 sets up a positive voltage on the gate of the silicon controlled rectifier 190 and triggers it into conduction.

Pulsating DC voltage is then applied through the output lead 192 to the transmitter, indicated generally by the reference numeral 194, for the production of an alarm transmission signal which can be fed through the conventional AC power line to one or more warning alarm signal producing means, either local or remote or both, such as the exemplary one generally designated by the reference numeral 34, for causing same to be operated coincident with the detection and location of a fire by the surveillance unit 30. The details of the transmitter 194 of the warning alarm signal producing means 34 will be described hereinafter.

At the same time that the circuit associated with the infrared radiation responsive resistor 54 has its resistance greatly lowered because of the detection and location of the fire, the increased current in said circuit passes through the previously mentioned relay coil 158 of composite relay 134 and causes operation of all of the plurality of sets of relay contacts 160, 162, 164, and 166 previously described herein for the purposes also previously described herein, which of course bring about the cessation of operation of the main driving motor 62, thus the locking of the directional input portion 52 of the scanning receiver 50 on the detected and located fire, the activation of the two slave synchros 112' and 112V' of the fire extinguishing means 32 so as to cause it to move until the nozzle 106 is also directed toward the fire which has been detected and located by the surveillance unit 30, and the activation of the normally closed, solenoid openable control valve 110 of the fire extinguishing means 32 so that a fire extinguishing fluid such as water or the like will be directed onto the detected and located fire, which state of conditions will continue until the fire has been extinguished, at which time the infrared radiation impinging upon the infrared radiation responsive resistor 54 becomes greatly reduced or eliminated substantially entirely and the resistance thereof greatly increases, resulting in greatly decreased current flow through the corresponding circuitry and through the relay coil 158 which is thus effectively deenergized in a manner which allows it to respond to its normal spring biasing so as to be operated in a manner which will change the relative positions of all of the various sets of relay contacts 160, 162, 164, and 166 of relay 134. This will, of course, deenergize the valve 110 and shut off the fire extinguishing fluid or water emitted by the fire extinguishing means 32, disconnect the slave synchrorotors 116' and 116V' of the fire extinguishing means 32 from AC power and the corresponding rotors 116 and 116' of the master synchros 112 and 112V of the surveillance unit 30, and will also reenergize the main driving scanning motor 62 and again initiate scanning operation of the surveillance unit 30 until another fire is detected and located or until the complete device is deenergized by disconnecting it from the AC power source 136, either by pulling the plug out of the electrical receptacle or female outlet or by pulling the switch, or otherwise.

The transmitter 194 normally receives no input signal by way of the lead 192 but, as previously described, whenever the infrared radiation responsive resistor 54 receives a substantial amount of infrared radiation as a result of the detection and location of a fire, the silicon control rectifier 190 produces a pulsating DC voltage applied through the lead 192 across the transmitter 194 which functions to generate an output alarm transmission signal adapted to be transmitted over the conventional wall-mounted AC power lines to any other wall outlet or the like where the alarm unit 34 is connected to any other wall outlet or the like where the alarm unit 34 is connected to the AC power lines and where the alarm transmission signal will be received, detected, and/or demodulated, and caused to operate a perceptible alarm signal means which will produce an audible alarm, a visible alarm, or any combination thereof at one or more locations.

The above-mentioned application of a pulsating DC voltage through the lead 192 across the transmitter 194, which effectively comprises a multivibrator of an emitter-coupled type, causes the transistors 196 and 198 to generate a carrier wave or signal which may be of any suitable frequency such as 50 kilocycles, for example, and which may be very precisely attained through the use of a trimmer capacitor 200 which allows minute frequency adjustments of the output of the multivibrator.

The transmitter output is coupled by way of a capacitor 202 and resistor 204 to the base of a switching transmitter 206. The diode 208 protects the base of the switching transistor 206 by limiting negative voltage peaks. When the transmitter 194 is turned on, the switching transistor 206 switches off and on at a rate, in the example described, of 50 kilocycles. One end of an output circuit comprising a parallel-connected capacitor 210 and a resistor 212 is connected to one side of the AC line connected to one of the AC input terminals 136 and the other end of said output circuit 210—212 is connected to the collector of the switching transistor 206. When said switching transmitter 206 switches, its collector-to-emitter resistance is very low, in effect placing the capacitor 210 and parallel-connected resistor 212 across the AC power line, through the silicon controlled rectifier 190 which is, of course, also conducting at that time.

The transmitting multivibrator portion of the complete transmitter 194 is connected to one side of the AC line through another resistor 214. The emitters of the transistors 196 and 198 are connected to the anode of the silicon controlled rectifier 190.

When the silicon controlled rectifier 190 conducts, it turns on the multivibrator by supplying it with 60-cycle pulsating DC voltage rectified from the AC power source terminals 136 which is, of course, the same as the AC line from which said AC power source terminals 136 are supplied, usually by way of a male and female plug wall or ceiling connection.

The switching transistor 206 connects the output capacitor 210 and the output resistor 212 in parallel across the AC line on alternating half cycles of the 60-cycle modulating voltage, thus producing a 50-kilocycle radiofrequency carrier wave signal modulated by these half cycles at a 60cycle rate. The resultant wave form of the output transmission signal so produced is a 50-kilocycle modulation of alternating half cycles of the 60-cycle voltage on the AC line —in other words, a burst of 50-kilocycle signal transmitted 60 times per second. Since the 50-kilocycle signal is not transmitted continuously but only on alternate half cycles of the 60-cycle AC line voltage, the output transmission signal consists of a 50-kilocycle signal pulse modulated by 60 cycles from the AC line, and this can be transmitted over the conventional wall or ceiling mounted AC power lines without in any way interfering with the operation thereof or of any other equipment plugged into

the AC power line except one or more warning alarm signal producing means of the general-type indicated at 34, each of which may be said to comprise input coupling capacitors 216 and 218 connected to a 50-kilocycle input filter transformer, indicated generally at 220, thus providing appropriate input to the complete receiver unit, generally designated by the reference numeral 222 and doing so through the conventional AC power line. The resistor 224 helps to match the filter transformer 220 to the power line.

The alarm transmission signal, after having been received by the AC input terminals of the receiver 222 and having passed through the input filter transformer 220, has most of the 60-cycle AC component removed by the time the 50-kilocycle burst signal arises at the base of the transistor 226. This transistor amplifies the signal which is then fed to 50-kilocycle output filter transformer 228. In the secondary circuit of said output filter transformer 228, diode 230 detects the negative half of the signal and a capacitor 232 filters out the 50-kilocycle carrier, leaving only 60-cycle modulated pulse wave form. Frequencies above approximately 60-cycles cycles are removed by an integrator including the resistor 234 and the capacitor 236 and the resulting 60-cycle signal is fed to the base of a transistor 238.

When no signal is present at the transistor 238, it is held at saturation by a base-bias voltage divider including the resistors 240 and 242. When a signal is received, however, it lowers the conducting point of transistor 238 and increases its collector voltage, causing the transistor to conduct and pass the pulse. Following this amplifier, the signal is fed to an integrator comprising the resistor 244 and the capacitor 246, whose time constant is very low. Hence, several 60-cycle pulses are required to charge the capacitor 246. Resistor 248 discharges any noise or static signals which tend to charge the capacitor 246, and diode 250 limits any negative voltage which might discharge the capacitor 246.

When capacitor 246 is fully charged, diode 252 conducts, turning on the silicon controlled rectifier 254 which then conducts and effectively shorts the positive end of the relay, indicated generally at 256 to ground through the switch 258 and the anode-cathode circuit of the silicon controlled rectifier 254.

Normally the alarm unit itself which actually produces the perceptible output alarm is plugged into the AC line and there may be one or more such alarm units operated from the receiver, either locally or remotely. The power supply means generally designated by the reference numeral 260 and including the transformer 262, the diode 264, and the capacitor 266, furnishes a normal 16 volts DC for the transistors and energizes the relay 256, thus making the normally open contacts thereof. Hence, the alarm circuit including the battery, indicated generally at 268 and the diode 270, is open and the alarm does not sound.

When the silicon controlled rectifier 254 conducts, however, as a result of receiving the previously mentioned type of alarm transmission signal originally produced by the transmitter 194 as a result of the detection and location of a fire, the silicon controlled rectifier 254 shorts out the positive end of the coil of the relay 256 to ground, deenergizing the relay and causing the normally closed contacts to make or move to the alternate positions thereof. With the alarm circuit closed, the alarm transducer (which may be of any well-known type such as a bell, a siren, or any other suitable type, which is indicated diagrammatically by the reference numeral 272), produces a very high amplitude output audible signal which can be heard at great distances. However, the actual alarm 272 may be one or more lights of either a steady state or intermittently flashing-type, or any combination thereof, with an audible alarm, and there may be any desired number of either or both types of alarms located at one or more locations, either local or remote.

After an alarm signal has been received and the appropriate corrective action has occurred (in other words, the originally detected and located fire has been extinguished, either by the fire extinguishing means 32 or by auxiliary fire extinguishing operations or both), the receiver 222 is restored to its standby condition by pushing the composite reset switch 274 which operates both the previously mentioned switch 258 in a manner such as to open the circuit from the silicon controlled rectifier 254 to the coil of the relay 256 and also operates the other switch portion 276 in a manner closing same so as to discharge the capacitor 246, which prevents the diode 252 and the silicon controlled rectifier 254 from conducting until another transmission signal is received by the receiver 222.

Power for the alarm transducer 272 is furnished by the battery 268, which is trickle-charged from the AC power line through the resistor 278 and the diode 280. If power to the receiver fails, voltage to the coil of the relay 256 is cut off, causing the normally closed relay contacts to make. The alarm would then sound to indicate the power loss. Any number of external alarms may be used with the receiver 222 and may be connected to auxiliary socket means which supplies the 117 volts AC and may be switched by another set of contacts on the relay 256 if desired.

It should be noted that the heat responsive transducer element 54 has been referred to hereinbefore as comprising a photocell or a light responsive resistor normally having a very high resistance, perhaps of the order of 1 to 3 megohms or the like, although not specifically so limited, and which, when subjected to infrared radiation, has its resistance very greatly reduced.

It has also been referred to hereinbefore as being provided with an infrared filter means 176 adapted to substantially exclude or greatly attenuate all visible light and to pass substantially only infrared radiation. This should be construed broadly since actually the photocell or infrared radiation responsive resistor 54 may be of a type responsive to a broad spectrum of radiation in the infrared and visible light regions which thus requires the infrared filter means 176 to exclude other forms of radiation which might cause the operation of the apparatus in an undesired manner simulating the detection and location of a fire when actually only conventional visible light is received by the directional input means 52. However, alternatively, the photocell or infrared radiation responsive resistor 54 may be of a type which inherently, by reason of the characteristics of the photocell or infrared radiation responsive resistor 54 itself, is responsive to infrared radiation and has little or no response to visible light. Either type of arrangement or any other substantially functionally equivalent arrangement may be employed in lieu of the specific exemplary but nonlimiting arrangement illustrated in the first form of the invention, and all such equivalent arrangements are intended to be included and comprehended within the broad scope of the present invention.

FIG. 14 is a fragmentary view similar to a very small portion of FIG. 3 or of FIG. 13, but illustrates a very slight modification of the type of heat responsive means shown at 54 in FIGS. 3 and 13, which is adapted to be connected to the circuitry of the first form of the invention as shown very fragmentarily in FIG. 13 and as shown somewhat more completely in FIG. 3. Because this view does illustrate a modification, parts which are similar to those of the first form of the invention are designated by similar reference numerals, followed by the letter *a*, however.

In the FIG. 14 modification, it should be noted that the actual transducer element 54*a* comprises a type of heat responsive means which is not responsive only to infrared radiation but which is responsive to the reception of any form of heat in any of several different ways such as by way of infrared radiation, convection, conduction, or any combination thereof, and wherein the actual heat responsive element 54*a* comprises an effective normally open switch means which optionally may be shunted by a very high resistance as indicated at 282, with said normally open switch element effectively comprising a thermostatic switch element, also indicated by said reference numeral 54*a*, made up of at least two joined, dissimilar metals having very substantially different temperature coefficients of

expansion and having one end fixed and the other end freely movable in the direction of the arrow indicated by the reference numeral 284 in response to the reception of heat of a predetermined extent which will effectively close the contacts 286 of the heat responsive switch 54*a* and maintain it closed as long as said heat is received by the thermostat switch element 54*a*. This will, of course, close the same analogous circuit through the sensitivity control 178*a* as that previously described at 178 in the first form of the invention and will cause similar operation of the remainder of the apparatus of the first form of the invention, which is adapted to be connected to the thermostatic switch 54*a* in precisely the same manner as its connection to the infrared radiation responsive photocell or resistor 54 of the first form of the invention, whereby to cause all of the same sequence of events to follow production of the output signal as that described hereinbefore in connection with the first form of the invention when the infrared radiation responsive photocell or resistor 54 received sufficient infrared radiation to cause a substantial lowering of the resistance thereof, and it is believed unnecessary to again detail all of the sequence of consequent actions of the overall apparatus.

It should be noted that the thermostatic switch element 54*a* may assume a variety of different physical configurations such as of longitudinal dual strip form having two strips of different metals having different thermal coefficients of expansion joined together; it may comprise a bimetallic disc-shaped structure of a type well-known in the art or any of a number of other possible physical configurations wherein the differential thermal expansion produces actual physical switch-closing movement of switch contacts. Also, a separate thermally responsive actuator operating a nonthermally responsive switch may be employed in lieu of the arrangement illustrated and may comprise, in this case, merely a single thermally expansive material coupled in actuating relationship with respect to the switch arm and adapted to change its physical dimensions sufficiently in response to the reception of a predetermined amount of heat to move the switch arm into contact-closing relationship. All such functionally equivalent arrangements are intended to be included and comprehended herein.

FIG. 15 is another fragmentary, diagrammatic, electrical schematic view of a modified form of the fire sensing means of the first form of the invention as is perhaps best shown in FIG. 3 fragmentarily in FIG. 13, with the remainder of the apparatus removed for reasons of drawing simplification and clarity. Because this is a modification, parts which are similar to those of the first form of the invention are designated by similar reference numerals, followed by the letter *b*, however.

In the FIG. 15 form of the invention, a heat responsive thermostatic type element is designated by the reference numeral 54*b* and is normally physically positioned such as to maintain the contacts 286*b* in circuit closing relationship and is only adapted to open same in response to the reception of heat in excess of a predetermined amount. In this modification, supply voltage for the normally closed thermostatic switch 54*b* is furnished by a step down input transformer, generally designated by the reference numeral 288, which, for example, may cause its secondary to provide approximately 6.3 volts which is rectified by rectifier means 290 and filtered by capacitor means 291.

The normally closed thermostatic switch element 54*b* may be in series with one or more other heat sensors, either of a similar type or of a functionally equivalent type so as to provide a plurality of spaced heat sensors if desired, functionally equivalent to the thermostatic element 54*b* shown in FIG. 15, and all in series with the coil of a relay, indicated generally by the reference numeral 292, which is normally energized by current flow through the circuit when no fire has been located and detected by the apparatus.

The thermostatic element 54*b*, or any other such remote series-connected heat sensing means of a functionally equivalent type as referred to above, may be of the fixed temperature type adapted to detect and open the associated circuit in response to a high temperature (usually at about 133° F., although not specifically so limited). When such a high temperature is detected by the closed thermostatic switch arm 54*b*, comprising the heat responsive means in the FIG. 15 modification of the invention, or by any other functionally equivalent heat responsive means, either remote or local, connected in series therewith, current to the relay coil 292 is interrupted. The normally closed lower pair of contacts 293 of FIG. 15 (which have been held open by the flow of current through the relay coil 292 until the reception of such a high temperature by the thermostatic switch arm 54*b* and the opening thereof in response thereto) then close, applying sufficient voltage across the gate protecting resistor 180*b* and the gate controlling resistor 182*b* to gate the silicon controlled rectifier 190*b* into conducting relationship which, in turn, will turn on a transmitter, such as that shown at 194 in the first form of the invention, and adapted to be connected to the silicon controlled rectifier 190*b* in precisely the same manner as in the first form of the invention.

All portions of the half-wave rectifier voltage doubler power supply 183 of the first form of the invention are also employed in this modification as indicated at 183*b*, although the sensitivity control 178 of the first form of the invention is replaced in this modification by a high resistance 178*b* sufficient to prevent the gating of the silicon controlled rectifier 190*b* until the contacts of the relay 292 close in response to the detection and location of a fire in the manner described above. The operation of the rest of the circuitry of the FIG. 15 modification of the invention is substantially the same as that of the first form of the invention and therefore will not again be repeated.

In the FIG. 15 modification of the invention, it should be noted that the coil of the relay 158*b* is differently placed in the circuit so as to be energized when the normally closed contacts of the relay 292 are allowed to close from their previously held open relationship when the thermostatic switch arm 54*b* opens in response to the detection and location of a fire and thus deenergizes the relay coil 292. This, of course, causes the relay coil 258*b* and all of the associated relay switch means similar to those shown at 160, 162, 164, and 166 in the first form of the invention to operate in the same manner as previously described in connection with the first form of the invention and therefore not again described in detail in the FIG. 15 modification thereof.

FIG. 16 is another fragmentary, diagrammatic, electrical schematic view very similar to FIG. 15, but illustrating a very slight modification thereof wherein the silicon controlled rectifier 190*b*, the resistors 180*b*, 182*b*, and 178*b*, and the complete half-wave rectifying voltage doubler power supply 183*b* common to both the first form of the invention and the FIG. 15 modification, are eliminated entirely. In this modification, parts similar to those of previously described forms of the invention are designated by similar reference numerals, followed by the letter *c*, however.

It will be noted that, in the FIG. 16 modification, the normally closed thermostatic switch arm or disc 54*c* which effectively comprises the heat responsive element of this modification of the invention, functions in substantially the same manner as the corresponding thermostatic switch element 54*b* of the FIG. 15 form of the invention and is connected in similar circuitry. This is also true to the relay 292*c*. However, it should be noted that the coil of relay 292*c* merely functions to operate a relay coil 158*c* similar to that shown at 158 in the first form of the invention and for substantially the same purposes, which are not again described at this point. Indeed, if desired, in this modification of the invention, the relay 292*c* may actually merge with, and effectively replace and comprise, the relay coil 158 of the first form of the the invention, and the disclosure of FIG. 16, taken in conjunction with this description, is intended to be construed broadly enough to cover such an arrangement.

The major difference of this modification to the invention is that, while all of the fire detection, locating, and extinguishing apparatus functions substantially the same in the FIG. 16 form of the invention as it does in the first form of the invention, no transmission signal is provided and no remote warning alarm signal producing means is provided, and complete reliance may be made upon the fire extinguishing operation of the apparatus for fire protection purposes, and if a warning alarm is desired, an independent alarm device of any of several well-known types may be employed for this purpose. In other words, this is a simplification of the FIG. 15 form of the invention.

FIG. 17 is a fragmentary view of a portion of another modified form of fire sensing means having a different type of fire responsive means adapted to be connected in circuitry substantially the same as that illustrated in the first form of the invention as is perhaps best shown in FIG. 3 and fragmentarily in FIG. 13, but which is not adapted to directly respond to heat but to the reception of smoke whereby to produce a predetermined optical reflectivity change and a corresponding optical change in the reflectively of light from smoke particles in air sampled by the surveillance unit and onto a photocell or light responsive resistor. In this exemplary form of the invention, parts which are similar to those of the first form of the invention are designated by similar reference numerals, followed by the letter *d*, however.

It will be noted that the heat responsive resistor or photocell 54*d* comprises a part of a complete smoke responsive means 293 including a small chamber, such as indicated generally and somewhat diagrammatically at 294, which has an illumination lamp 295 effectively partially masked by a mask or remotely directed reflector, such as is indicated at 296, in a manner such as to normally not directly emit any light so as to impinge directly upon the light responsive photocell or light responsive resistor 54*d*. Thus, normally, the light responsive resistor 54*d* is effectively dark although it is open to ambient air within a warehouse such as that shown at 36 in the first form of the invention, and as soon as the air within the warehouse overlying a particular one of the multiple area portions, such as shown at 40 in the first form of the invention, rises through the input means 52*d* and into the interior passage of the open-ended chamber 294, the smoke will flow past the mask 296 and will reflect a certain amount of light emitted by the lamp 295 back onto the light responsive resistor or photocell 54*d*, which will thus have a sudden great reduction in resistance and will correspondingly modify the associated circuitry in precisely the same manner as all of the associated circuitry of the first form of the invention, all of which is to be understood to be connected to the FIG. 17 modification of the invention, which merely illustrates a replacement for the particular fire responsive element shown at 54 in the first form of the invention by the smoke responsive means 293 shown in the FIG. 17 modification of the invention. Therefore, all of the rest of this modification is to be understood as being similar to the first form of the invention and is therefore not again described in detail.

FIG. 18 is a view very similar to FIG. 17 but merely illustrates a slightly different form of smoke sensing and responsive means wherein it is responsive to a predetermined change in optical density and a corresponding optical change in the passage of light through a quantity of air carrying smoke rather than to the reflectivity change produced by smoke in the air as disclosed in the FIG. 17 form of the invention. Portions of the FIG. 18 form of the invention structurally of functionally similar to the FIG. 17 form or to any of the other forms of the invention previously described are designated by similar reference numerals, followed by the letter *e*, however.

In the FIG. 18 modification, it will be noted that there is no mask such as that shown at 296 in FIG. 17, positioned between the illumination lamp 295*e* and the light responsive resistor or photocell 54*e*. Instead, light is emitted directly from the lamp 295*e* toward and onto the photocell or light responsive resistor 54*e*, and, indeed, the rear portion of the lamp may be masked or provided with a reflector if desired in order to avoid wasted light. In this case, smoke in air positioned between the lamp 295*e* and the light responsive resistor or photocell 54*e* is adapted to produce a change in optical density so as to reduce the amount of light impinging on the photocell and to thus increase its resistance rather than reduce its resistance in the manner of the previously described forms of the invention. Thus, in this modification, the auxiliary circuitry extending from the photocell 54*e* normally has a relatively low resistance and is not directly connected to the remainder of the circuitry of the first form of the invention as a direct substitute for the infrared radiation responsive resistor 54, but, instead, is merely connected to the power supply and to the coil of a relay 298 which holds open a normally closed switch 300 connected to the rest of the previously described circuitry in the same manner as that of the light responsive resistor 54*d* of FIG. 17 of the infrared radiation responsive resistor 54 of the first form of the invention so that reception of a certain amount of smoke within the chamber 294*e* causes the photocell 54*e* to substantially increase in resistance whereby to effectively deenergize the relay 298 and to allow the normally closed switch arm 300 to close the associated circuitry in the same manner as the reception of heat in the first form of the invention effectively greatly reduces the impedance of the infrared radiation responsive photocell or resistor 54 and thus increases current in the associated circuitry. Thus, the remainder of the apparatus connected to this modified form of the invention functions in precisely the same way as in the first form of the invention which has been previously described in detail and which will not again be repeated at this point.

FIG. 19 is a view similar to FIGS. 17 and 18 but illustrates a further modification of the fire responsive means wherein it comprises a circuit condition altering fire-caused acoustical vibration-responsive means selectively tuned to receive acoustical vibrations characteristic of and effectively produced as a result of a fire and thus functioning to produce an output signal in a manner functionally equivalent to that of the transducer element 54 of the first form of the invention. Parts which are functionally or structurally substantially equivalent to those of previously described forms of the invention are designated by similar reference numerals, followed by the letter *f*, however.

In the FIG. 19 modification, the directional input means 52*f* effectively comprises a directional parabolic sound receiving reflector provided with an acoustoelectric transducer or microphone located at the focus of the parabolic sound receiving reflector 52*f* and designated by the reference numeral 302, which is adapted to produce an electrical output fed through an electrical amplifier indicated in block diagrammatic form of 304 and a tuned band-pass filter means indicated in block diagrammatic form at 306 which is tuned so as to reject all frequencies but a particular band of frequencies correlated with the audible output of a detected and locate fire. The filtered electrical signal is then fed from the tuned band-pass filter 306 into a relay coil 308 which closes a normally open switch arm 309 connected to the associated electrical circuitry in substantially the same manner as the switch arm 300 shown in FIG. 18 (except that FIG. 19 shows a normally open switch arm 309 adapted to be closed when the relay coil 308 is energized) and thus adapted to cause operation of all of the rest of the circuitry of the first form of the invention whenever the relay switch arm 309 closes in substantially the same manner as that caused by reception of infrared radiation by the infrared responsive resistor 54 of the first form of the invention, and therefore the operation of all of the rest of the similarly connected apparatus is not again described in detail.

Incidentally, it should be noted that the acoustical vibration responsive means provided by the untuned microphone 302 and the tuned band-pass filter 306 may be modified by the provision of a substantially functionally equivalent arrangement wherein the acoustical input is tuned, such as by having a

variable volume chamber connected to the microphone and adapted to be tuned in an acoustical band-pass manner, in which case the electrically tuned band-pass filter 306 may be eliminated. All such functionally equivalent arrangements are intended to be included and comprehended within the scope of the present invention.

FIG. 20 is a view effectively comprising the FIG. 17 modification of the invention in combination with the FIG. 15 modification of the invention, and parts which are substantially equivalent, structurally or functionally, to previously described forms of the invention are designated by similar reference numerals, followed by the letter *g*, however.

It should be noted that in FIG. 20 both a smoke responsive means 293*g* and a heat responsive means 54*g'* are provided, in the first case in the manner of the FIG. 17 form of the invention (which is basically the first form of the invention having the infrared radiation responsive means replaced by a smoke responsive means), and in the second case by a normally closed thermostatic switch arm 54*g'* connected identically to the thermostatic switch arm 54*b* of FIG. 15. However, one additional feature is provided and comprises an additional secondary winding 310 of the common power supply transformer 288*g* corresponding to that shown at 288 in FIG. 15, which provides supply voltage for the smoke detector lamp 295*g* by connecting the lamp 295*g* as one leg of a bridge circuit, indicated generally by the reference numeral 311, which has three other resistances connected in the three other legs thereof and with all of said resistances and the resistance of the smoke detector lamp 295*g* being such that the bridge 311 is normally substantially balanced so that only a very small current flows through the diode 312. This residual current is too small to provide sufficient voltage drop across the resistor 182*g* to gate the silicon control rectifier 190*g* into on condition. Thus, the bridge 311 normally performs no function until such time as the smoke detector lamp 295*g* burns out or is removed from its socket. When this occurs, the balance of the bridge 311 is upset and current flow increases from the bridge through the diode 312 and the gate controlling resistor 182*g* and back to the bridge. As before, the voltage drops across the gate controlling resistor 182*g* gates on the silicon controlled rectifier 190*g* which then applies pulsating DC voltage to a transmitter, such as that shown at 194 in the first form of the invention, whereby to produce an alarm transmission signal in the same manner as that described in detail hereinbefore in connection with the first form of the invention and therefore not repeated at this point.

Because two different types of fire responsive means, comprising the heat responsive thermostatic member 54*g'* and the smoke responsive means 293*g* are employed, it is necessary that both of these be positioned to correspondingly receive heat and smoke, respectively. In one form, this may be done by mounting the heat responsive means 54*g'* in a scanning receiver means similar to that shown at 50 of the first form of the invention in a manner described in detail hereinbefore, while the smoke receiving means 293*g* may be separately mounted. In another form the smoke detecting means 293*g* may be mounted along with the heat sensing means 54*g* in a scanning receiver means such as that shown at 50 in the first form of the invention, and where such an arrangement is employed such that each of the two fire responsive means is carried for scanning movement, and additional pair of sliprings 152*g''* and an additional pair of brushes 154*g''* engaging same may be employed, and such an arrangement is illustrated in FIG. 20.

The arrangement of the FIG. 20 modification of the invention is such that either the reception of excessive smoke or of excessive heat will cause the production of an output signal and the operation of the relay coil 158*g*, whereby to lock the surveillance unit onto a detected and located fire, cause the operation of the fire extinguishing means in a manner directed exactly toward the detected and located fire and to produce a perceptible alarm at one or more locations, either locally or remotely, all in the manner previously described in detail in connection with the first form of the invention.

It should be noted that in all of the forms of the invention wherein actual physical scanning movement of the surveillance unit, such as that shown at 30 in the first form of the invention, for example, occurs, a very small amount of what is known as j"parallax" may exist — that is, a very slight error in the directioning of the nozzle means 106 of the fire extinguishing means 32 would occur if it is directed exactly the same in a parallel manner to the directing of the directional input means 52 of the canning receiver means 50. This type of very slight parallax error is a direct function of the base line distance between the scanning receiver 50 and the nozzle 106 of the fire extinguishing means and is an inverse function of the distance from each of same to a detected fire such as that shown at 46 in FIG. 4. Thus, reduction in the ratio of said base line distance with respect to the actual distance to a detected fire will greatly reduce such parallax error to a degree such that normally the diverging or spreading of the fire extinguishing water or other fluid sprayed by the nozzle 106 toward the fire 46 will completely overcome any such very slight parallax error which, incidently, is normally of a very small magnitude in a customary installation of the apparatus of the present invention and thus does not normally require any special correction thereof. However, in the event that the relative size of a warehouse or other building, such as that shown at 36 in the first form of the invention, is insufficient with respect to the size of the surveillance unit 30 and the fire extinguishing mean 32 to produce a sufficient parallax error minimization to allow the spreading effect of the sprayed fire extinguishing fluid to substantially completely overcome same in the manner referred to above, it is possible to incorporate parallax error computing and correcting means, certain types of which are well-known in the art, into any portion of the correlation and control means 108 so as to bring about a corresponding corrective effect on the positioning of the nozzle 106, and all such arrangements are intended to be included and comprehended within the broad scope of the present invention.

It is also possible to closely associate and/or effectively combine the mounting structures mounting the surveillance unit 30 and the fire extinguishing means 32 of the illustrative first form of the invention, for example, so that the scanning receiver 50 and the tip of the nozzle 106 will be very closely physically positioned with respect to each other and this can be done in such a way that the scanning movement of the scanning receiver 50 is still permitted by such modified mounting without moving the nozzle means 106 until a fire has been detected and located, or it can be arranged on a composite single scanning mounting means so that they are both scanningly moved simultaneously and thus can have a virtually common mounting. This latter type of arrangement, of course, would not require the horizontal planar movement master and slave synchros 112 and 112', nor the vertical planar movement master and slave synchros 112V and 112V', and thus would provide an electrically somewhat simpler structure. All of these arrangements including closely associated mountings, common mountings, independent driving arrangements, and common driving arrangements for the scanning means 50 of the surveillance unit 30 and the nozzle 106 of the five extinguishing means 32 are intended to be included and comprehended within the broad scope of the present invention.

FIGS. 21—23 illustrate a modified form of the invention, and parts which are structurally or functionally substantially equivalent to those of previously described forms of the invention are designated by similar reference numerals, followed by the letter *h*, however.

In the FIGS. 21—23 form of the invention, the surveillance unit or means corresponding to that shown at 30 in the first form of the invention and the fire sensing means 44*h* include a number of physically separated an differently mounted portions, each also being designated by the reference numeral 44*h* and each carried underneath the warehouse ceiling 42*h* in a manner such as to overlie its own individual one of the multiple area portions 40*h* of the warehouse floor area 38*h*. Also, in this modification of the invention, the fire extinguishing means generally designated by the reference numeral 32*h* also com-

prises a plurality of portions physically spaced apart and each mounted adjacent to its correlated fire sensing means portion 44*h* in overlying relationship with respect to its correlated and underlying particular one of the multiple area portions 40*h* comprising the complete floor plan area 38*h* of the warehouse 36*h*. Each of the said fire extinguishing means portions is also generally designated by the reference numeral 32*h*.

The major difference of this modification of the invention is the fact that each fire sensing means 44*h* is no longer of an actual physical scanning-type involving actual physical scanning movement of the type described in detail in connection with the first form of the invention but, instead, is of what might be termed a static, effective scanning-type since each fire sensing means portion 44*h* has it s directional input means 52*h* adapted to cover substantially only its own particular underlying correlated one of the multiple area portions 40*h* of the warehouse floor 38*h*.

Thus, it can be said that the plurality of different fire sensing mean portions 44*h* maintain all of said small multiple area portions 40*h* under surveillance and thus provide what might be termed a static-type of effective scanning thereof with the output signal produced by each fire sensing means portion 44*h* cooperating with the corresponding correlation and control means 108*h* controlling the corresponding or correlated fire extinguishing means portions 32*h* in a manner which may be said effectively to provide information indicating the detection and also the location of a fire since it will only be a fire contained in a particular underlying multiple area portion 40*h*, or the region between same and a fire sensing means portion 44*h*, which will activate that particular one of said fire sensing means portions 44*h* and cause it to produce an output signal whereby to bring about the operation of the corresponding, normally closed solenoid openable controllable valve 110*h* of the corresponding fire extinguishing portion 32*h* so that the fire extinguishing fluid (usually water) will be directed downwardly onto the detected and located fire only in that particular multiple area portion 40*h* of the warehouse floor 38 which actually contains the fire.

Thus, in this modification, there are no master and slave synchros similar to those shown at 112, 112', 112V, and 112V', there is no driving motor similar to that shown at 62 in the first form of the invention and, consequently, there are no sliprings such as those shown in the first form of the invention and no rotary gimbal type double ring mounting structure such as that shown at 48 in the first form of the invention.

In the FIGS. 21—23 modification of the invention, each of the directional input means 52*h* is directed downwardly in a manner such as to as nearly as possible cover only its own particular multiple area portion 40*h* and to do this in a nonmoving manner. All the rest of the structure of each pair of fire sensing means portion 44*h* and each fire extinguishing means portion 32*h*, and the interconnection thereof by the correlation means in the above-mentioned manner without the intervention of the pair of master and slave synchromotors, is such as to bring about substantially the same sequence of operations as that described hereinbefore, in connection with the first form of the invention, with the exception of those steps referring to structural elements which have been eliminated from each such pair of units in this modification of the invention. In other words, the relay coil 158*h* in this modification operates only one set of contacts 162*h* which control the normally closed solenoid openable control valve 110*h* of the corresponding correlated fire extinguishing means portion 32*h*.

In this modification of the invention, the output signal carried by lead 192*h* of each heat sensing means portion 44*h* may be connected to its own individual transmitter such as the exemplary one shown at 194*h* or they may all be connected to a common single such transmitter and may operate one or more local or remote warning alarm signal producing means such as the representative ones shown at 34*h*.

Apart from the elimination of the actual physical scanning movement producing means for the heat sensing means and the provision of master and slave synchromotor means to cause the fire extinguishing means to actually physically move to an identical orientation to the fire sensing means, the FIGS. 21—23 modification of the invention functions substantially the same as the first form of the invention and may employ any of the different types of fire responsive means illustrated in FIGS. through 20 or any combination thereof. In particular, it should be noted that the smoke detector-type of modification of the fire responsive means illustrated in two different forms of FIGS. 17 and 18 and in the combination form of FIG. 20 is particularly adaptable to this form of the invention since smoke generally rises directly upwardly from a fire and in the actual physical scanning first form of the invention illustrated it takes longer for smoke to reach the surveillance unit than in the FIGS. 21—23 form of the invention unless actual suction means such as a small fan is provided, which is intended to be included and comprehended within the scope of the present invention for use in the actual physical scanning forms of the invention or in any of the other forms of the the invention.

FIG. 24 is a fragmentary, diagrammatic, schematic view generally similar to FIG. 23, but illustrates a very slight modification wherein parts which are structurally or functionally similar to previously described forms of the invention are designated by similar reference numerals, followed by the letter *j*, however. In this modification, each fire sensing means 44*j* is adapted to feed through a transmitter 194*j*, in response to its individual detection and location of a fire, a distinctly different transmission signal because the multivibrator portion comprising the transistors 196*j* and 198*j* and associated circuit elements produce a distinctively different carrier wave or signal, although it is also possible to arrange a different modulating signal modulating the same carrier wave or frequency for each fire sensing means 44*j*. In any event, the arrangement is such that a distinctly different alarm transmission signal is adapted to be fed from the transmitter 194*j* in response to the detection by any different one of the plurality of fire sensing means 44*j* so that corresponding correlated receivers, such as shown somewhat fragmentarily and diagrammatically at 222*j*, will receive the appropriate and correlated one of the alarm transmission signals only by reason of having a correspondingly differently tuned and selective input band-pass filter means, such as is indicated generally by the reference numeral 316. Thus, only the proper receiver 222*j* corresponding to the particular fire sensing means 44*j* which has detected and located a fire in its underlying multiple area portion of a warehouse floor will be activated and will cause its corresponding alarm signal producing transducer means 272*j* to produce a perceptible alarm which will indicate to a viewer at a remote location precisely the location of the detected and located fire since, in addition to the audible alarm 272*j*, a corresponding panel indicated at 318 carrying a plurality of individual fire location indicating lamps 314 will be energized in a manner such as to cause only the proper location indicating one of the lamps 314 to light up.

FIGS. 25—27 illustrate an arrangement similar to the form of the invention illustrated in FIGS. 21—23, and parts which are structurally or functionally substantially equivalent to previously described forms of the invention are designated by similar reference numerals, followed by the letter *k*, however.

In the FIGS. 25—27 modification, it will be noted that all of the fire sensing means portions 44*k* are effectively assembled together into one centrally positioned, effectively unitary, wide-angle, composite surveillance uniting 30*k* carried at a central position by the warehouse ceiling 42*k* in a manner similar to the surveillance unit 30 of the first form of the invention, but in this case being of a static, effectively scanning-type generally similar in many respects to that disclosed in the FIGS. 21—23 modification of the invention wherein each of said fire sensing means portions 44*k* does not actually move but remains stationary. However, it should be noted that, in this modification, each of said fire sensing means portions 44*k* has a common, wide-angle, directional input means 52*k* and has a plurality of individual but closely laterally adjacent fire responsive means 54*k* so assembled with respect to each other

and with respect to the common, wide-angle, directional input means, which includes a lens 320, as to cause each individual fire responsive means 54*k* to have imaged thereon substantially only its particular individual one of the plurality of multiple area portions 40*k* of the warehouse floor 38*k*. In other words, this arrangement is functionally equivalent to that shown in the FIGS. 21—23 form of the invention with the only difference being that each of the plurality of fire sensing means 44*k* has been moved into laterally assembled relationship so as to comprise an effectively unitary, centrally positioned surveillance unit 30*k*, and that all of the fire responsive means 54*k* have been moved into laterally adjacent assembled relationship whereby to effectively comprise a multiple area portion replica locating grid of said plurality of fire responsive means 54*k*. Also, in this form of the invention, the common, wide-angle, directional input means 52*k* has a common infrared filter means 176*h* rather than individual infrared input filter means 176*h* as shown in the FIGS. 21—23 form of the invention. However, in this modification, each of the fire extinguishing means portions 32*k* is still substantially the same as in the FIGS. 21—23 form of the invention, and the entire apparatus illustrated in the FIGS. 25—27 form of the invention, and the operation thereof, is identical to that previously described in connection with the FIGS. 21—23 form of the invention and, therefore, will not be repeated at this point. It should be noted that the showing of the lens 320 in FIG. 26 is not to be construed as showing its actual physical structure but as being merely a diagrammatic or representative showing of any of a variety of different types of lenses which may be employed for this purpose and which may comprise a common unitary lens having any type of front and/or rear lens surfaces, either curved at the front, curved at the rear, or both, and either having a common curvature for the complete lens or a plurality of individual different curvatures for each of a plurality of lens portions each adapted to focus infrared radiation on its own individual infrared radiation responsive means 54*k*. Also the lens diagrammatically indicated at 320 may comprise a plurality of individual lens elements or facets, each cooperable for focusing infrared radiation on its own individual one of the plurality of infrared radiation responsive resistors 54*k* of the complete multiple area portion replica locating grid formed by the plurality of said infrared radiation responsive resistor means 54*k* as is perhaps best shown in FIG. 27. Also, another type of lens having a plurality of lens surface portions arranged in a series of laterally adjacent ridges and sometimes referred to as a lenticular lens may be employed as the lens means 320. Also, it should be noted that the lens 320 may actually merely comprise an infrared radiation transmissive cover having little or no infrared radiation refracting effect whatsoever, and in this case the directional aspect of each of the directional walls 52*k* provides the means for limiting the effective field of view of each individual different one of the infrared radiation responsive means 54*k* to its own multiple area floor portion of a warehouse or building floor similar to those shown at 40*k* in FIG. 25. Also, if desired, the lens 320 may be eliminated entirely, which thus causes said switch 300*m* to function in exactly the same manner as infrared radiation responsive resistor 54 of the first form of the invention, and the switch 300*m* is adapted to be connected to the rest of the apparatus and associated circuitry and to function in substantially the same manner as the disclosure of the first form of the invention when the infrared radiation responsive resistor 54 is exposed to radiation and has its resistance greatly reduced. Therefore, the rest of the associated circuitry and structure will not again be repeated in FIG. 28, since it is understood that it is similarly connected. The auxiliary circuit 326 may be appropriately connected to either the AC power supply terminals or the half wave rectified DC voltage doubler supply disclosed in the first form of the invention and may be provided with appropriate sensitivity controlling rheostat means if desired. The heat responsive member or membrane 324 may be metallic and comprise a thermally fusible and meltable link or it may be made of plastic of any of various kinds provided with conductive means, such as conductive particles of graphite, metal, or the like, imbedded therein, and arranged to melt the plastic matrix at a predetermined temperature, or any other substantially functionally equivalent arrangement may be employed in lieu of the specific heat responsive burnout member or membrane 324 illustrated in FIG. 28.

FIG. 29 is a view similar to FIG. 28 and also to the first form of the invention as best illustrated in FIGS. 3 and 13, and parts which are structurally or functionally similar to the previously described forms of the invention are designated by similar reference numerals, followed by the letter *n*, however.

The FIG. 29 modification illustrates a reversed arrangement analogous to a comparison of FIG. 18 to FIG. 17, which illustrated a reversed arrangement. In other words, in FIG. 29, a burnout-type of heat responsive member or membrane 324*n* is also employed but it is of a type which is normally nonconductive and, upon burning out at a predetermined temperature or upon the reception of a predetermined amount of heat, effectively allows the contacts 322*n*, which are normally biased toward each other, to move into contact with each other and to effectively close the associated circuitry in a manner functionally equivalent to the closing of the corresponding circuit associated with the infrared radiation responsive resistor 54 of the first form of the invention and thus causes all of the rest of the apparatus of the first form of the invention, which is to be similarly connected to the modified form in FIG. 29, to operate in the same manner as that previously described in detail and therefore not repeated at this point.

It should be noted that the present invention is directed primarily to the inventive concept comprising the provision of means for detecting and locating a fire in a relatively large region (usually within a building of any of various different types) and to cause correlated operation of fire extinguishing means in a specifically directed and localized manner so that only the area containing the fire will be subjected to the fire extinguishing fluid, liquid, chemical, or other means, and even this will terminate automatically as soon as the fire has been extinguished. This, plus the provision of a general alarm, or various different remote alarms of either a general type or of a type indicating the specific location of the fire and, in one preferred form, the provision of such an alarm which utilizes the conventional AC power lines for the transmission to the remote alarm signal producing means location of an alarm transmission signal, comprise the basic features of the present inventive concept in various different degrees of scope and particularlity.

In other words, the invention is not specifically limited to the various different exemplary forms of the apparatus shown in the drawings as exemplifying various different nonspecifically limiting forms of the invention. These are to be construed as exemplary only, and it is to be clearly understood that any other substantially functionally or structurally equivalent means may be employed in lieu thereof.

For example, the representative type of actual physical scanning apparatus shown in the first form of the invention illustrated in FIGS. 1—13 exemplifies this principle of the invention quite well but is not intended to limit the invention to that particular type of scanning means only. Actually, virtually any type of scanning means may be employed in lieu thereof, and all such are intended to be included and comprehended herein.

For example, one of the many different types of modifications which the scanning means may take may comprise a structure similar to the double ring gimbal-type mounting structure shown at 48 in the first form of the invention which is mounted in a position 90° displaced around a horizontal axis from that shown in the first form of the invention so that the outer ring 68 normally rotates around a horizontal axis rather than a vertical axis and during a portion of each scanning movement will sweep across a corresponding length of an underlying rectangular warehouse floor or the like, with the other ring 78 being adapted to progressively deflect the

scanning sweep in a width direction of the underlying warehouse floor so that a regular rectangular scanning pattern of a type fully comparable to that of a television picture or the like will be produced and will exactly cover and maintain surveillance over a rectangular warehouse floor, irrespective of the ratio of length to width or vice versa. Of course, this type of arrangement means that a full 360° sweep of the outer ring 68 would not be required, and it would only need to sweep through an arcuate angle such as to cover the length of the warehouse floor, and at each end of such a sweep it might be provided with partially toothed gear driving means and biasing spring or other return means to disengage the scanning motor from the outer ring member 68 to allow it to return to its initial scanning position in substantially the same manner as that previously described in connection with the inner ring member 78, the driven gear 98, the partial driving gear 96 provided with the nontoothed portion 102, the biasing spring 83 and the adjustable stop means 84. Structure of this type or of any functionally equivalent type may be employed for causing the rotation of the outer ring member 68 to be of a limited arcuate extent and, upon reaching its terminal point, to automatically become disengaged and return to its starting point, and all such arrangements are intended to be included and comprehended within the road scope of the present invention, and the words, "horizontal," "horizontal planar," "vertical," and/or "vertical planar" used throughout this application, are to be broadly construed as exclusive of such modified scanning arrangements. Also, more than one scanning means may be appropriately arranged to maintain surveillance over different portions of the complete warehouse floor.

Also, it should be noted that the invention is not limited to the exemplary type of correlation and control means shown in the exemplary first form of the invention illustrated in FIGS. 1—13 as comprising a scanning driving motor driving the scanning means and a pair of master synchromotors carried by the driven scanning means and controlling the positioning of a similar pair of slave synchromotors which correspondingly control the positioning of the fire extinguishing means. This apparatus illustrates the principle of such correlation and control means quite well, but it should be clearly understood that the invention is not specifically limited thereto and that various other functional or structural substantially equivalent arrangements are contemplated and may be employed in lieu thereof and are intended to be included and comprehended within the broad scope of the present invention. Also, in this connection, it should be noted that if the fire extinguishing means is substantially larger and heavier than the scanning means, the slave synchros may be either larger or may have their signals suitably amplifier for controlling larger slave synchros or they may merely comprise small pilot units adapted to control much larger servo units for properly positioning a fire extinguishing means of considerably larger mass than the scanning means.

It should also be noted that in the first form of the invention illustrated in one nonspecific, nonlimiting version in FIGS. 1—13, the movement of the scanning means and of the directional input means 52 in what might be termed a vertical planar direction away from a true vertical, downwardly directed relationship directly over the center of the warehouse floor, is also correlated with an increase in distance that the fire extinguishing fluid emitted by the fire extinguishing means 32 toward a detected and located fire must travel, and therefore an additional means may be correlated with the vertical planar movement master synchro 112V or the corresponding slave synchro 112V', or any of the parts of either the scanning unit or the fire extinguishing means 32 which move in said direction may be correlated with such an additional means which will be operable for controlling the available pressure at the nozzle 106 and thus the length of the emitted stream of fire extinguishing fluid so as to compensate for variations of the distance from the nozzle 106 to a detected and located fire. This may be done by having such vertical planar movement of said structural elements control a rheostat or the like for producing an electric current variation controlling the operation of a pressure reducing valve or pressure producing means cooperating with the fire extinguishing fluid adapted to be emitted by the fire extinguishing means nozzle 106, or various other means may be employed, such as means changing the configuration of the emitting aperture of the nozzle 106 so as to cause the fire extinguishing fluid to be ejected an appropriate distance for reaching a detected and located fire.

Also, it should be noted that the various types of fire responsive means specifically illustrated in various different FIGS. of the drawings and specifically described herein are not to be construed as specifically limiting the invention thereto but are merely exemplary of a considerably greater number of such devices which may be employed in the apparatus of the present invention and within the scope hereof.

For example, virtually any type of fixed temperature fire responsive means may be employed in lieu of those shown in the drawings and specifically described herein, as may types of fire responsive means based upon the reception of a predetermined quantity of heat as distinguished from the reaching of a predetermined temperature. This is also true of the employment of fire responsive means which do not primarily respond to just the reaching of a fixed temperature or to the receipt of a predetermined quantity of heat, but which responds to the rate of rise of temperature and which normally employs, in one form, an expansible gas or fluid operating a diaphragm or piston type of actuator and having a controllable vent whereby a rapid rise in temperature will cause a corresponding rapid increase in the volume of the gas or fluid, which will be drained off at a lesser rate through the predetermined vent and thus exert a pressure determined by these two factors on the diaphragm or piston actuator and cause a corresponding output operation which can open or close a switch in any of the arrangements of the present invention described and illustrated hereinbefore. This type of arrangement, of course, will provide no actuation if the rate of temperature rise is small enough so that the exhausting of the heated gas through the vent equals the rate of volumetric expansion thereof. This type of heat responsive means is considered significant because virtually any fire will produce a rapid rise in temperature which is not normally produced by any other type of condition.

It is also possible to provide a combined rate of temperature rise and/or fixed temperature (or fixed quantity of heat) responsive means in a single composite unit which may be employed in lieu of any of the specifically disclosed fire responsive means shown in the FIGS. of the drawings illustrating various exemplary forms of the present invention.

Additionally, it should be noted that various other types of smoke responsive means may be employed, including certain types based upon the variation in ionization of air produced by the presence of smoke therein. This may be employed directly or may be employed in a differential manner by having a pair of ionization gauges, one of which is sealed from ambient atmosphere and any smoke which may be contained therein, and the other of which is open to ambient atmosphere and to any smoke which may be contained therein, and to then effectively measure the difference in ionization produced by the two guages, which can best be done by measuring the differential current flow, voltage, and/or resistance or impedance produced thereby which can be effectively employed to operate a relay or switch which will function as a replacement for any of the fire responsive means disclosed in the various forms of the present invention.

It is possible to employ, in lieu of any of the specifically disclosed fire responsive means of the present invention, another type of fire responsive means taking the form of a smoke sensitive means which measures the extent of smoke presence in an air sample by measuring the acidity thereof with a pH meter, and as pointed out hereinbefore air samples for the measurement of the smoke content thereof can be allowed to enter the sampling device merely as a result of normal convection or can be positively aspirated thereinto by positive aspiration or suction means, and all of these arrangements are intended to

be included and comprehended within the broad scope of the present invention.

The forms of the invention illustrated employing burnout members or membranes may actually be made of metallic material adapted to melt or effectively burn away at a predetermined temperature or may comprise a plastic or other matrix member alone in the nonconductive form thereof and with suitable conductive material therein in the conductive form thereof, adapted to melt or burn away when the predetermined temperature is reached. Either of these forms, in the conductive versions thereof, may be similar to the arrangement illustrated in FIG. **28** or, in the nonconductive versions thereof, may be similar to the exemplary but nonspecifically limiting form in FIG. **29**. It should be noted that the physical arrangement of the parts may be widely varied within the broad scope of this teaching. For example, in one form, a type of fire sensitive insulated wire or cable may be employed as the effective switch and may comprise a pair of electrically conductive wires exteriorly insulated around the assembly thereof but separated from each other only by such a temperature sensitive burnout membrane of a nonconductive-type, and which is adapted to definitely burn out or melt away at a predetermined temperature and to thus allow the constrained pair of electrically conductive wires to touch each other and to close an associated electric circuit. This type of arrangement makes it possible to actually extend the fire responsive means along any line region where such a fire sensitive cable can be mounted. For example, such a fire responsive cable could be laid in an alternating, reversed or crisscross pattern substantially traversing the complete area of that portion of the ceiling of a warehouse directly overlying its particular multiple area portion of the complete warehouse floor surface and could be conducted to the rest of the output signal producing portion of the fire sensing means such as is shown at **56** in the first form of the invention to produce an appropriate signal.

It should also be noted that the fire responsive means may take another form wherein it comprises means responsive to ultraviolet radiation such as is very often present during the initial stages of electrical arc and spark-caused fires and for use wherever such a fire is attended by excessive emission of ultraviolet radiation.

Also, it should be noted that the various forms of fire extinguishing means disclosed in the FIGS. of the drawings may be arranged to emit water, various fire extinguishing fluids and/or chemicals including foam-producing chemicals and the like, or combustion-inhibiting chemicals or the like, or various liquids such as that known as "light water" or the like, which have a greater effectiveness in extinguishing fire than does conventional water. All such arrangements are intended to be included and comprehended within the broad scope of the present invention.

It should be understood that the FIGS. and the specific description thereof set forth in this application are for the purpose of illustrating the present invention and are not to be construed as limiting the present invention to the precise and detailed specific structure shown in the FIGS. and specifically described hereinbefore. Rather, the real invention is intended to include substantially equivalent constructions embodying the basic teachings and inventive concept of the present invention.

I claim:

1. Apparatus for detecting and locating a fire and for producing at least one corresponding output signal, comprising at least one fire sensing means adapted to be positioned with respect to multiple area portions of a relatively large area in a manner such as to selectively sense a fire in any of such multiple area portions in a manner both detecting such a fire and also determining the location thereof with respect to such multiple area portions, each fire sensing means including fire responsive effective output signal producing transducer means and an associated circuit portion adapted to provide an intelligence-carrying output signal in response to the detection and location of a fire by said fire sensing means and carrying intelligence indicating the detection and presence of such a fire and the location thereof with respect to such multiple area portions.

2. Apparatus as defined in claim **1**, including at least one fire extinguishing means provided with and adapted to selectively and correlatedly spray a fire extinguishing fluid primarily into a particular one of such multiple area portions in which said fire sensing means has detected and located a fire; and correlation and control means effectively coupled with respect to the intelligence-carrying output signal produced by the fire responsive output signal producing transducer means and the fire extinguishing means and including servomotor means for operating a correlated portion of said fire extinguishing means in a selective correlated manner whereby to cause activation thereof and the emission of a fire extinguishing fluid therefrom primarily into a particular one of such multiple area portions in which a fire has been detected and located by said fire sensing means whereby to cause selective extinguishing of such a detected and located fire substantially without operating the fire extinguishing means in a manner such as to emit such a fire extinguishing fluid into others of such multiple area portions in which such a fire has not been detected and located by said fire sensing means.

3. Apparatus as defined in claim **2**, wherein said fire responsive output signal producing transducer means also effectively comprises effective fire cessation responsive means adapted, in response to the extinction of such a fire, to cause the cessation of the corresponding intelligence carrying output signal and the corresponding cessation of operation of the corresponding servomotor means controlling the operation of a correlated portion of said fire extinguishing means.

4. Apparatus as defined in claim **3**, including warning alarm signal producing means adapted to be effectively coupled to said fire responsive transducer means of said fire sensing means and the corresponding output signal produced thereby and responsive thereto for the production of a perceptible warning alarm signal.

5. Apparatus as defined in claim **4**, wherein said fire sensing means is provided with transmitter means coupled to an output portion thereof and adapted, and in response to the receipt of the corresponding output signal indicating that a fire has been detected and located in one of such multiple area portions, to produce an alarm transmission signal adapted to be transmitted through conventional AC power supply lines to said warning alarm signal producing means at a remote location.

6. Apparatus as defined in claim **2**, wherein said fire sensing means includes effectively directional input means effectively directed in a receiving manner with respect to a limited area region of a relatively large area formed of a plurality of such multiple area portions and being of an effective area scanning type in that the fire responsive output signal producing transducer means thereof effectively causes the output signal produced thereby to carry intelligence indicating which of a plurality of such multiple area portions said directional input means is directed toward when a fire is detected and located therein and said corresponding correlated fire responsive output signal producing transducer means is effectively activated to produce said corresponding intelligence carrying output signal.

7. Apparatus as defined in claim **6**, wherein said fire sensing means is of an actual scanning type including scanning motor means effectively scanningly moving said directional input means of said fire sensing means in an effectively sequential line-by-line area-by-area scanning movement successively sweeping across such multiple area portions of a relatively large area in a repetitive manner as long as said scanning motor means is operative.

8. Apparatus as defined in claim **7**, wherein said correlation and control means effective servomotor means comprises similarly rotatable master and slave positioning synchrorotary motor means including master unit portions thereof driven in correspondence with the actual physical scanning movement

of said directional input means and slave unit portions thereof coupled in corresponding positioning relationship with respect to said fire extinguishing means for directing same toward a particular one of such multiple area portions toward which said directional input means of said fire sensing means is directed when a fire is detected and located therein and the corresponding intelligence carrying output signal is produced by transducer means of said fire sensing means.

9. Apparatus as defined in claim 8, including coupling means effectively arranged to normally decouple said slave unit portions of said master and slave positioning synchrorotary motor means from said master unit portions thereof and operative to couple same together in response to the production by the corresponding fire responsive transducer means of the corresponding output signal in response to the detection and location of a fire by said fire sensing means.

10. Apparatus as defined in claim 6, wherein said fire sensing means is of a static effective scanning-type wherein said fire sensing means comprises a plurality of different fire sensing means portions each differently physically located in substantially overlying relationship with respect to a corresponding different one of such multiple area portions and each having a corresponding effectively directional input means portion directed toward a correlated corresponding different one of such multiple area portions and each having a corresponding different output signal producing fire responsive transducer means for producing a corresponding output signal correlated with a corresponding one of such multiple area portions whereby, when activated by the detection and location of a fire, to provide information as to which of such multiple area portions contains the fire, said fire extinguishing means also comprising a plurality of fire extinguishing means portions corresponding in number to the fire sensing means portions and being located in a correlated substantially overhead manner with respect to different ones of such multiple area portions and in a manner correlated with the corresponding fire sensing means portions.

11. Apparatus as defined in claim 10, including warning alarm signal producing means adapted to be effectively coupled to said fire responsive transducer means of said fire sensing means and the corresponding output signal produced thereby and responsive thereto for the production of a perceptible warning alarm signal, said warning alarm signal producing means comprising a plurality of different portions each corresponding to a different one of such multiple area portions of a large area being effectively scanned by the fire sensing means and being responsive to the production of a corresponding output signal produced by the fire sensing means and bearing information indicating both the detection of a fire and the location thereof in a particular one of such multiple area portions, each different one of said fire sensing means portions correlated with and effectively scanning a different one of such multiple area portions having a corresponding transmitter portion connected thereto and arranged to produce a distinctive alarm transmission signal different from the alarm transmission signal produced by others of said transmitter portions and in each case comprising a modulated different high frequency carrier signal, each of said different correlated portions of said warning alarm signal producing means correlated with corresponding different ones of such multiple area portions being effectively provided with a selective input band-pass filter means tuned to pass a different band-pass frequency corresponding to a different alarm transmission signal from a different correlated one of the transmitter portions whereby only the warning alarm signal producing means portion corresponding to the fire sensing means portion effectively scanning a particular and correlated one of such multiple area portions where a fire is detected and located will be activated so as to produce a perceptible warning alarm signal which, of course, provides information to an onlooker at the remote warning alarm signal means position as to the exact location of a detected and located fire.

12. Apparatus as defined in claim 6, wherein said fire sensing means is of a static effective scanning type and comprises a plurality of fire sensing means portions assembled together into effective closely laterally adjacent relationship as a single unit having said directional input means taking the form of a common wide angle d6rectional input means thereinto and having a plurality of said fire responsive means laterally adjacent to each other in assembled relationship appropriately positioned to selectively cover a corresponding particular and different one of such multiple area portions and together with the other laterally adjacent fire responsive means effectively comprising a multiple area portion replica locating grid of the plurality of such fire responsive means, said fire extinguishing means also comprising a plurality of fire extinguishing means portions corresponding in number to the fire sensing means portions and being located in a correlated substantially overhead manner with respect to different ones of such multiple area portions and in a manner correlated with the corresponding fire sensing means portions.

13. Apparatus as defined in claim 1, wherein said fire sensing means includes effectively directional input means effectively directed in a receiving manner with respect to a limited area region of a relatively large area formed of a plurality of such multiple area portions and being of an effective area scanning-type in that the fire responsive output signal producing transducer means thereof effectively causes the output signal produced thereby to carry intelligence indicating which of a plurality of such multiple area portions said directional input means is directed toward when a fire is detected and located therein and said corresponding correlated fire responsive output signal producing transducer means is effectively activated to produce said corresponding intelligence carrying output signal.

14. Apparatus as defined in claim 13, wherein said fire responsive means takes the form of a circuit condition altering fire-caused acoustical vibration-responsive means selectively produced as a result of a fire and wherein said directional input means comprises a directional parabolic sound receiving reflector and focus-located microphone adapted to substantially change an electrical characteristic of an associated circuit portion in response to the reception of fire-caused acoustical vibrations in excess of a predetermined magnitude.

15. Apparatus as defined in claim 13, wherein said fire sensing means is of an actual scanning-type including scanning motor means effectively scanningly moving said directional input means of said fire sensing means in an effectively sequential line-by-line area-by-area scanning movement successively sweeping across such multiple area portions of a relatively large area in a repetitive manner as long as said scanning motor means is operative.

16. Apparatus as defined in claim 1, wherein said fire responsive means takes the form of a circuit condition altering heat responsive means adapted to substantially change an electrical characteristic of an associated circuit portion in response to the reception of heat in excess of a predetermined magnitude.

17. Apparatus as defined in claim 1, wherein said fire responsive means takes the form of a circuit condition altering smoke sensing and responsive means adapted to substantially change an electrical characteristic of an associated circuit portion in response to the reception of smoke producing an optical change and a corresponding change in light impinging upon a photosensitive means comprising a part thereof.

18. Apparatus as defined in claim 1, including warning alarm signal producing means adapted to be effectively coupled to said fire responsive transducer means of said fire sensing means and the corresponding output signal produced thereby and responsive thereto for the production of a perceptible warning alarm signal.

19. Apparatus as defined in claim 18, wherein said fire sensing means is provided with transmitter means coupled to an output portion thereof and adapted, and in response to the receipt of the corresponding output signal indicating that a

fire has been detected and located in one of such multiple area portions, to produce an alarm transmission signal adapted to be transmitted through conventional AC power supply lines to said warning signal producing means at a remote location.

20. Apparatus as defined in claim **19**, wherein said warning alarm signal producing means is provided with receiver means adapted to receive said alarm transmission signal at a remote location and to convert it into a warning alarm signal means operating signal.

21. Apparatus as defined in claim **18**, wherein said warning alarm signal producing means comprises a plurality of different portions each corresponding to a different one of such multiple area portions of a large area being effectively scanned by the fire sensing means and being responsive to the production of a corresponding output signal produced by the fire sensing means and bearing information indicating both the detection of a fire and the location thereof in a particular one of such multiple area portions.