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(54) **LOCALIZED AUTOMATIC FIRE EXTINGUISHING APPARATUS**

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(*) Notice: This patent is subject to a terminal disclaimer.

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(22) Filed: **Jan. 2, 2002**

Related U.S. Patent Documents

Reissue of:

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Issued: **Aug. 20, 1996**
Appl. No.: **08/158,989**
Filed: **Nov. 30, 1993**

U.S. Applications:

(63) Continuation of application No. 09/137,960, filed on Aug. 20, 1998, now Pat. No. Re. 37,493.

(51) **Int. Cl.**
G08B 17/12 (2006.01)

(52) **U.S. Cl.** **340/578**; 169/61; 250/339.15; 250/342

(58) **Field of Classification Search** .... 340/578; 250/342, 339.15, DIG. 1; 169/61
See application file for complete search history.

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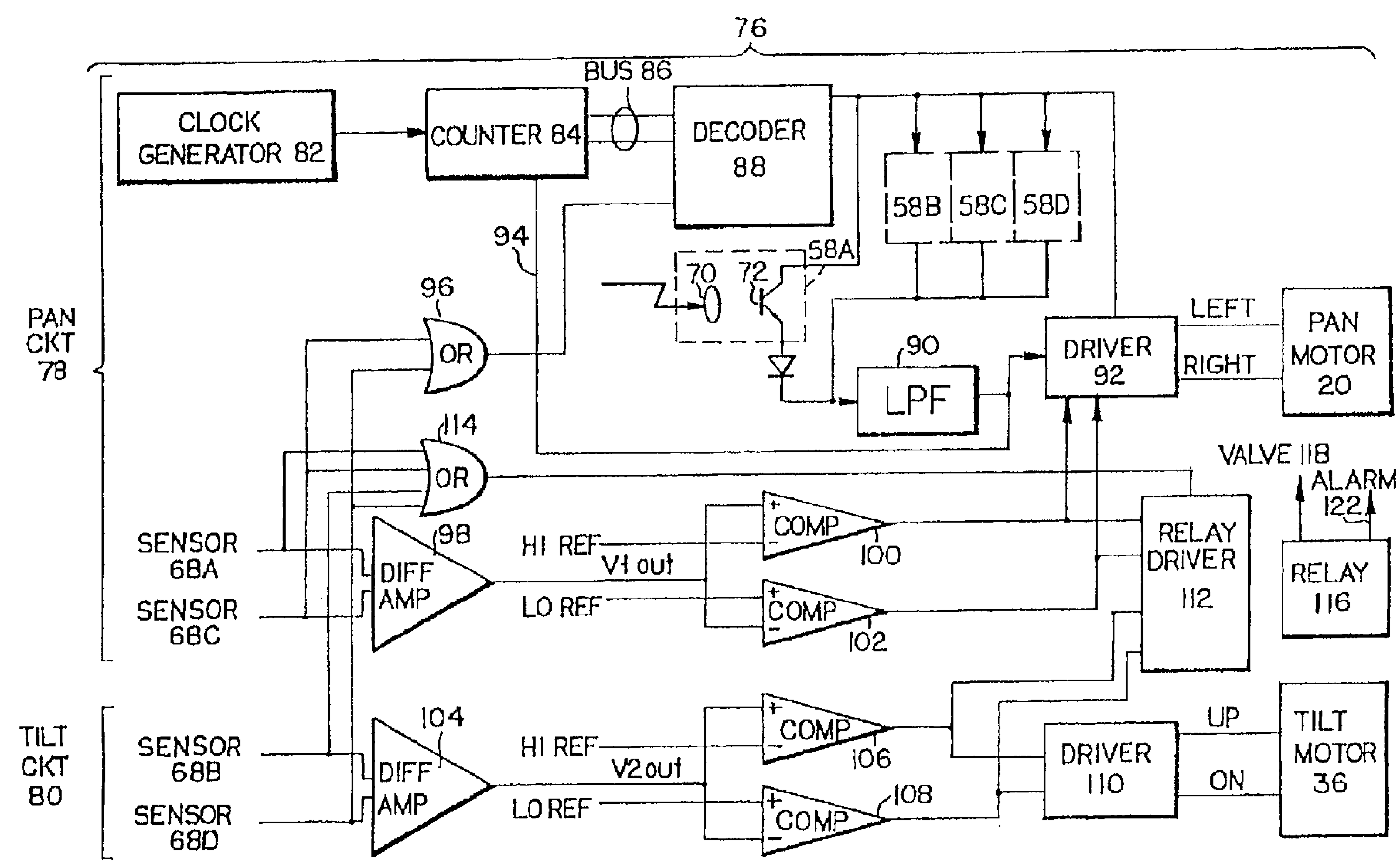
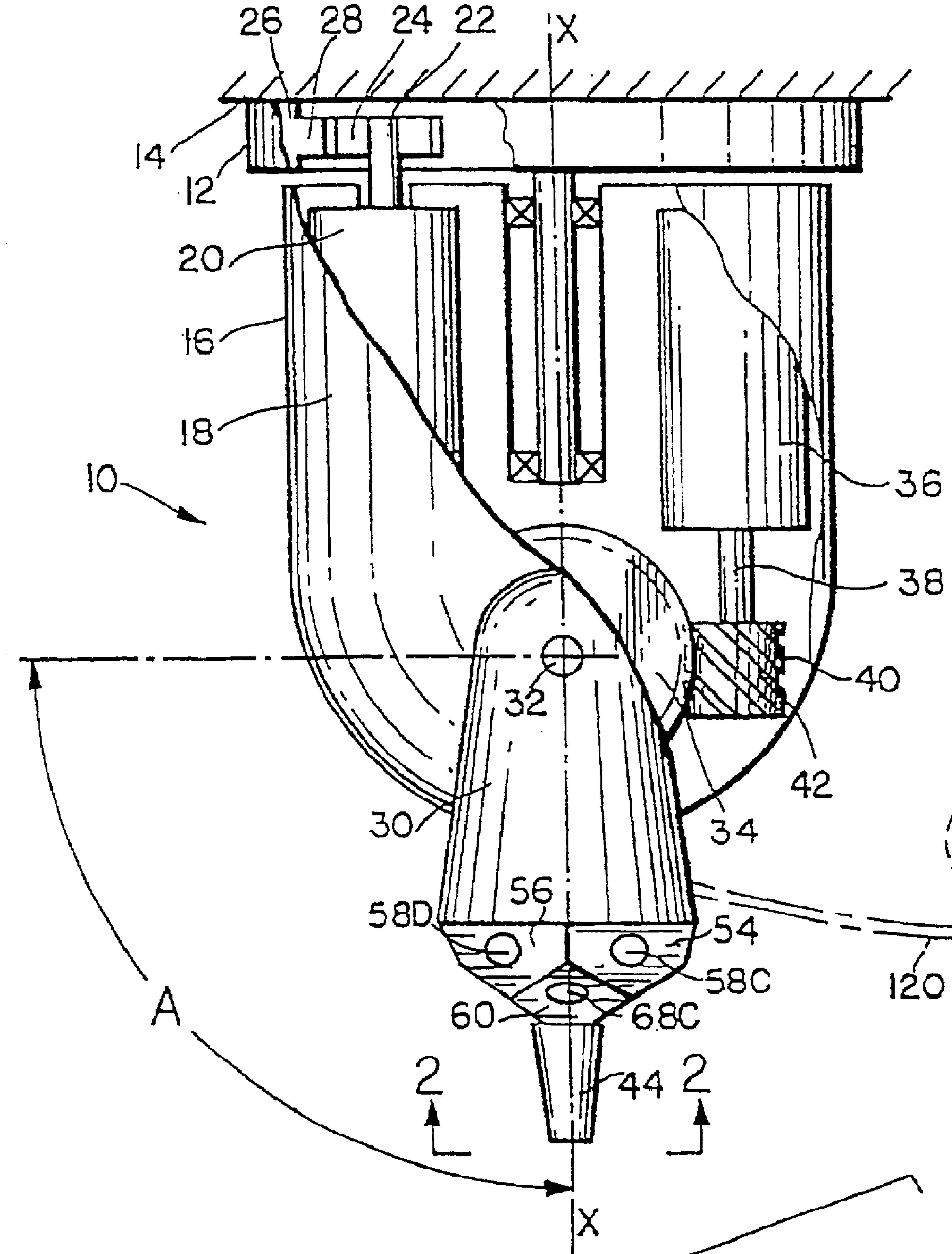
(57) **ABSTRACT**

An automated fire extinguishing apparatus includes a turret with a nozzle connected to a water supply. A plurality of sensors are used to detect a fire monitored by the apparatus. The signals from the sensors are used to aim the nozzle toward the fire and to initiate water ejection therefrom. After the fire is extinguished the water is turned off.

28 Claims, 3 Drawing Sheets

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118
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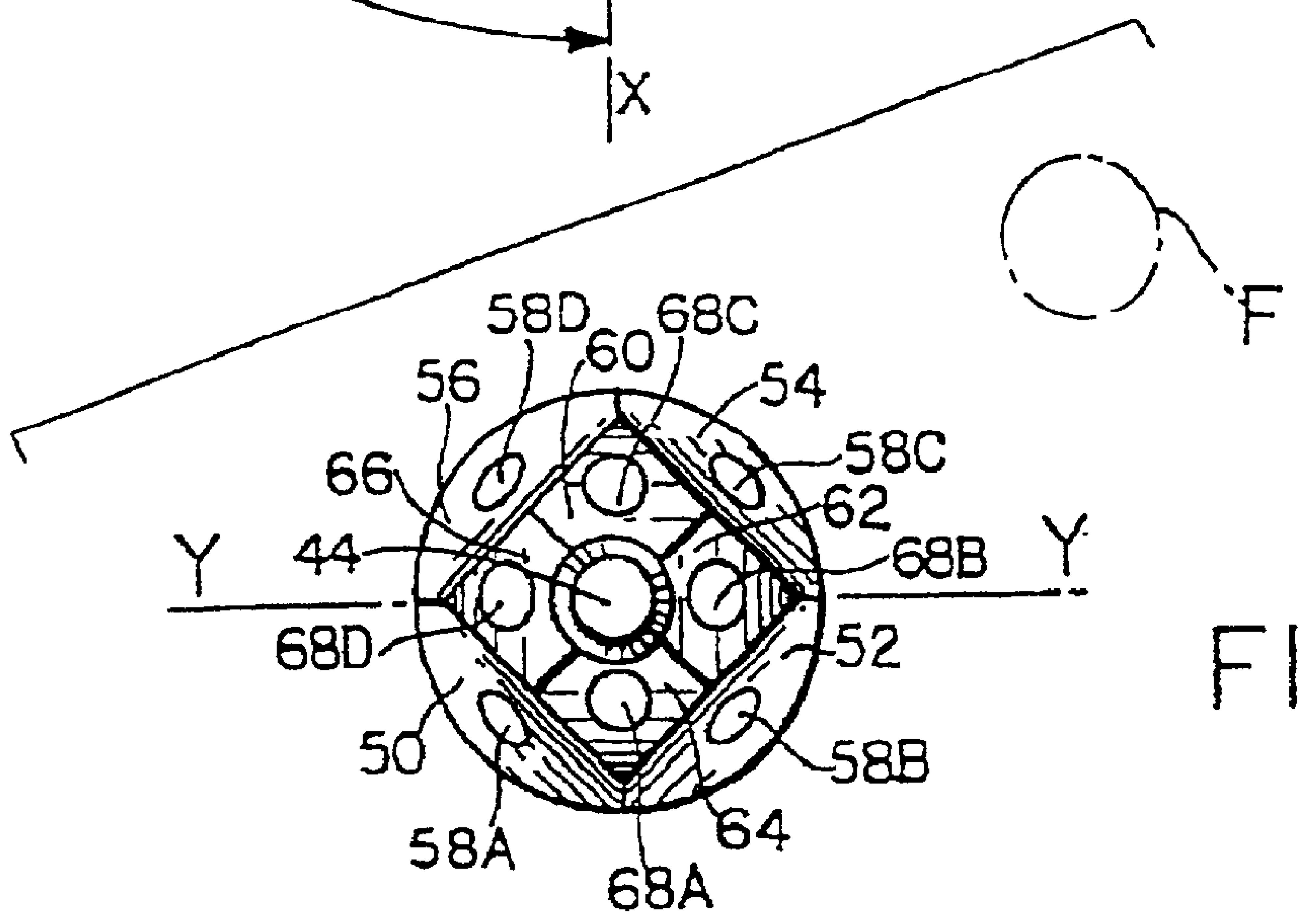
58D
54
58C
120
A
60
68C
2
44
2
X

FIG. 1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58D
68C
60
56
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58C
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68B
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52
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58B
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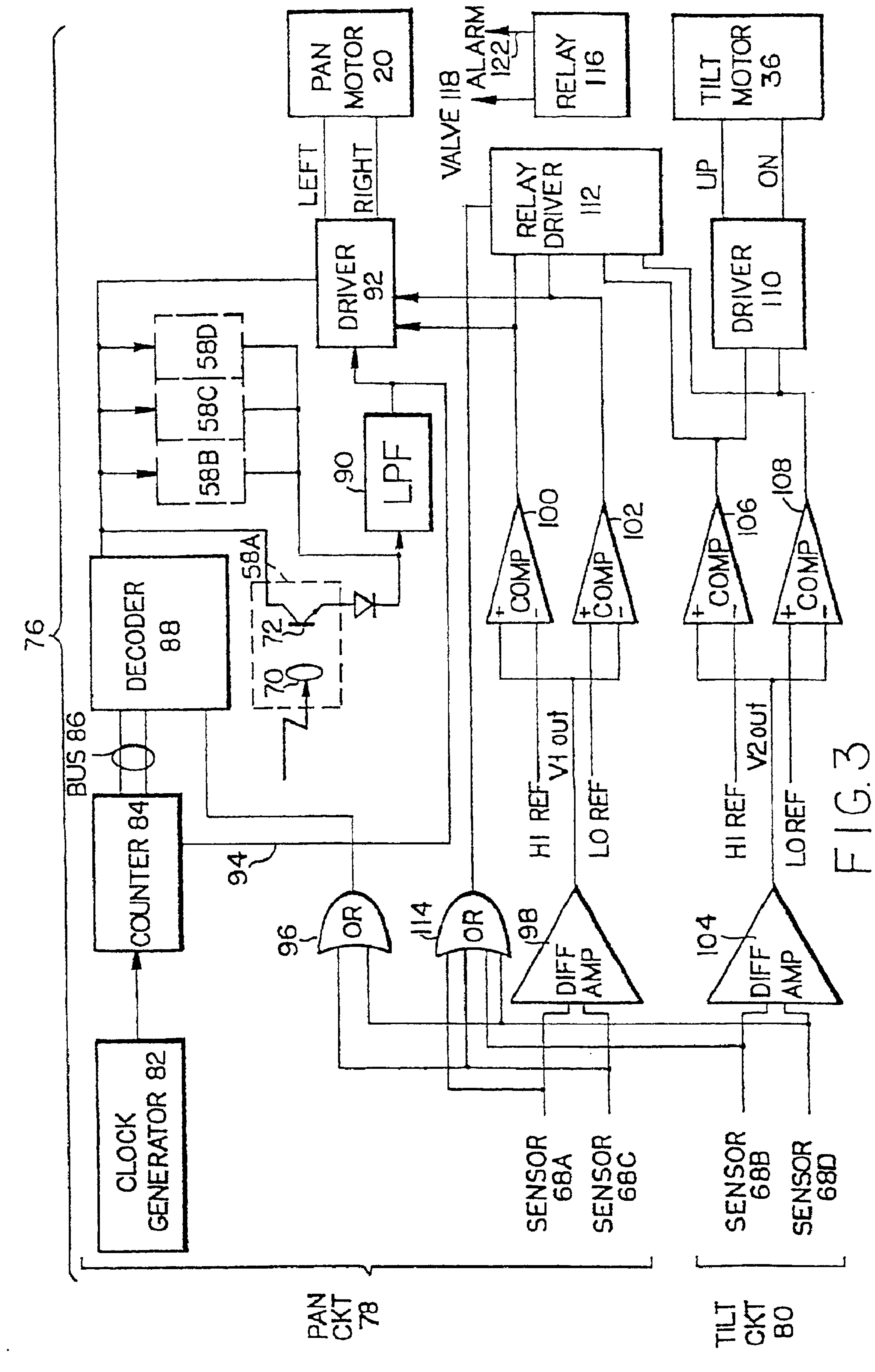
58A
68A

FIG. 2



76
PAN MOTOR 20
LEFT
RIGHT
ALARM 122
RELAY 116
VALVE 118
RELAY DRIVER 112
TILT MOTOR 36
UP
ON
DRIVER 92
58D
58C
58B
LPF
90
DRIVER 110
DECODER 88
58A
72
70
COMP
100
102
106
108
BUS 86
COUNTER 84
V1 out
HI REF
LO REF
V2 out
94
OR
96
114
98
DIFF AMP
104
CLOCK GENERATOR 82
SENSOR 68A
SENSOR 68C
SENSOR 68B
SENSOR 68D
PAN CKT 78
TILT CKT 80

FIG. 3

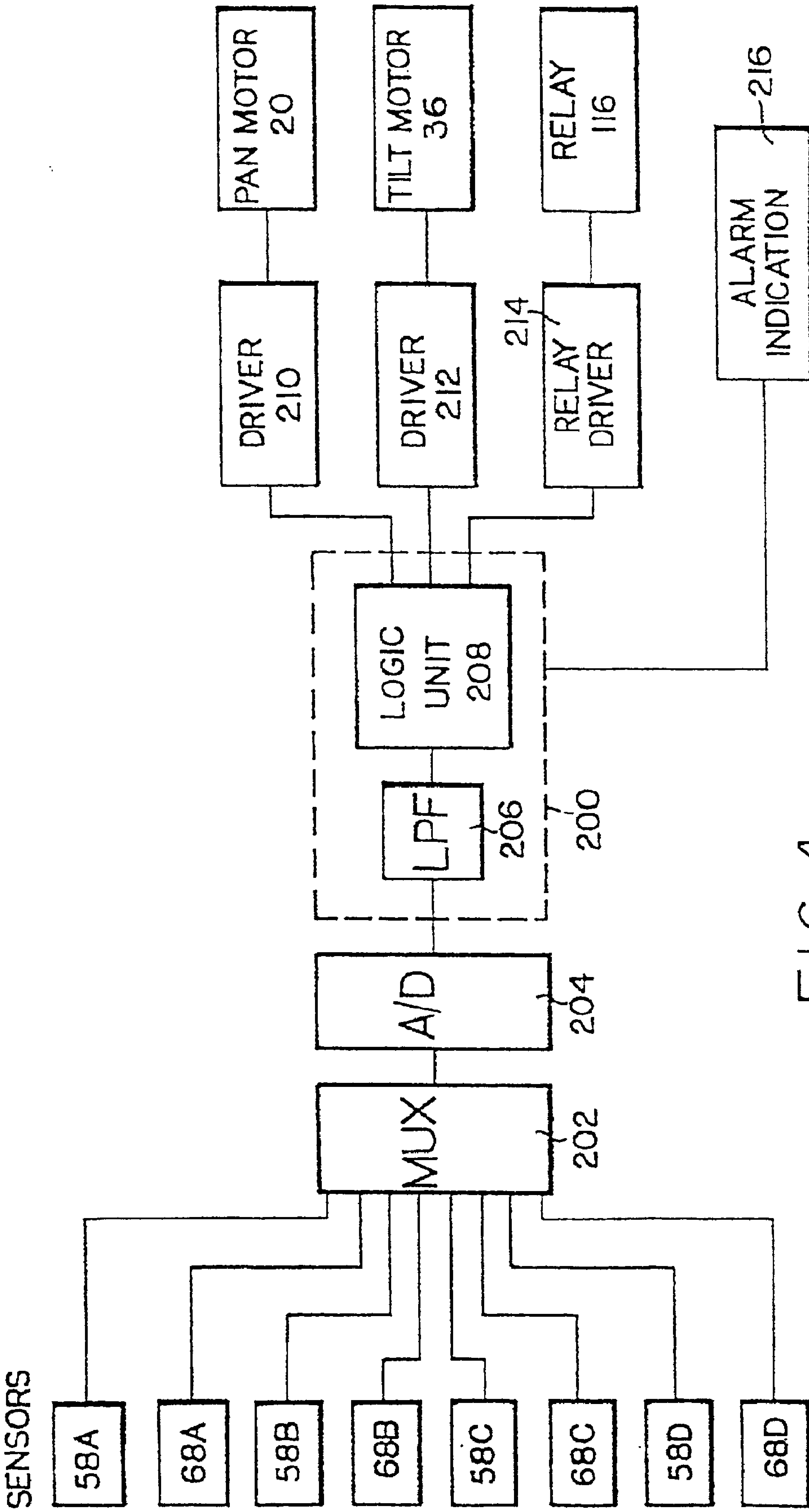

PAN MOTOR
20
TILT MOTOR
36
RELAY
116
216
ALARM
INDICATION
DRIVER
210
DRIVER
212
214
RELAY
DRIVER
LOGIC
UNIT
208
LPF
206
200
A/D
204
MUX
202
SENSORS
58A
68A
58B
68B
58C
68C
58D
68D

FIG. 4

LOCALIZED AUTOMATIC FIRE EXTINGUISHING APPARATUS

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

CROSS-REFERENCE TO RELATED APPLICATION

This reissue application is a continuation of U.S. patent application Ser. No. 09/137,960, filed Aug. 20, 1998, now U.S. Pat. No. RE 37,493, which was a reissue of U.S. Pat. No. 5,548,276, which resulted from U.S. patent application Ser. No. 08/158,989.

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention pertains to an automatic fire extinguishing apparatus, and more particularly to an apparatus which locates a fire in a room and directs a stream of water or other agent from a nozzle at the fire for extinguishing it.

2. Description of the Prior Art

Automatic sprinkler installation are common in both residential and commercial establishments and are frequently mandated by local fire codes. However these sprinkler installations consist merely of a plurality of water nozzles set off by mechanical heat sensors. Because these types of heat sensors are slow and inefficient, by the time the fire is detected it has usually spread over a large area causing injuries and property damage before it is extinguished. Additionally, a fire is much more difficult to extinguish after it has spread then at its inception. Fire detectors are also known which detect a fire by using a heat and/or light sensors. However these types of detectors are used commonly merely to set off fire alarms and not to extinguish the fire itself. U.S. Pat. Nos. 3,665,440; 3,493,953; 3,689,773 and 3,824,392 show various state of the art detectors.

OBJECTIVES AND SUMMARY OF THE INVENTION

In view of the above-mentioned disadvantages of the prior art, it is an objective of the present invention to provide an apparatus which can quickly identify and extinguish a fire before it has a chance to spread.

A further objective is to provide an apparatus which can accurately pinpoint and extinguish a fire whereby the fire extinguishing activity is restricted only to the immediate vicinity of the fire thereby reducing damage.

A further objective is to provide a fire extinguishing apparatus which is reliable yet inexpensive.

Other objectives and advantages of this invention shall become apparent from the following description.

Briefly, the fire extinguishing apparatus constructed in accordance within invention contains a turret mounted to oversee a preselected area or room, and a plurality of sensors for sensing a fire. The apparatus also includes nozzle means disposed on the turret, and aiming means coupled to said sensors for aiming said nozzle means toward a fire detected by the sensors. An extinguishing agent is then ejected toward the fire by the nozzle means. After the fire has been extinguished, the flow of the extinguishing agent to the nozzle means is disrupted.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a side elevational view of a fire extinguishing apparatus constructed in accordance with this invention;

FIG. **2** shows a bottom view of the apparatus head showing the arrangement of the sensors and spray nozzle;

FIG. **3** shows a block diagram of one embodiment of the control circuit for the apparatus of FIGS. **1** and **2**; and

FIG. **4** shows a block diagram of an alternate embodiment of the control circuit.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, and more particularly FIGS. **1** and **2**, an apparatus **10** constructed in accordance with this invention includes a base **12** mounted on a ceiling **14** and a turret **16**. The turret **16** includes a generally cylindrical housing **18** open at the top. A motor **20** secured inside housing **18** is used to rotate the turret **16** about a vertical axis X—X. For this purpose, motor **20** has a shaft **22** terminating in a toothed gear **24**. Base **12** is provided with a stationary ring **26** having radially inwardly extending teeth **28**. Teeth **28** engage gear **24** so that as the shaft **22** is turned by motor **20**, the turret **18** rotates with respect to the base.

An arm **30** is mounted on housing **18** by a horizontal shaft **32**. Shaft **32** also supports a toothed gear **34** disposed inside housing **18**. Also within housing **18** there is provided a second motor **36** with a shaft **38** and a gear **40**. Importantly, gear **40** has teeth **42** disposed at an angle and engaging the toothed wheel **34** such that as the gear **40** is turned by motor **36**, it causes a gear **34** and arm **30** to turn about shaft **32**.

At the tip of arm **30** there is provided a nozzle **44**. Initially the arm **30** is positioned so that the nozzle **44** is pointed straight down as indicated in FIG. **1**. This position of the nozzle is referred to as the initial or rest position. The gear **34** is arranged so that as the motor **36** rotates, the wheel **34** causes the arm **30** and nozzle **44** to turn about shaft **32** in a preselected direction. Thus, as motor **36** is activated, the nozzle **44** turns in a vertical plane Y—Y passing through the center of turret **16** as shown in FIG. **2**.

As previously mentioned, turret **16** is rotatable in either direction by any arbitrary angle about a vertical axis X—X by motor **20**. In this manner, nozzle **44** can be directed in any direction by rotating the housing **18** in a panning movement and then or simultaneously tilting the nozzle about shaft **32**.

Arm **30** is formed with a plurality of flat surfaces which may be arranged in different patterns as required. For example, as shown in FIG. **1**, the arm **30** may be provided with two set of surfaces. One set of four surfaces **50**, **52**, **54**, **56** is disposed at an angle of about 20° with respect to a vertical plane and arranged around nozzle **44**. Each of these surfaces **50**–**56** is provided with an infrared scan sensor **58**. Radially inwardly of surfaces **50**–**56** there is provided a second set of surfaces **60**, **62**, **64**, **66** disposed at about 70° with respect to a vertical plane. Each of the surfaces **60**–**66** is provided with a seek sensor **68** angularly offset from the scan sensors **58** by 45°. Sensors **66** and **58** thus form a two-dimensional array around nozzle **44** as seen in FIG. **2**.

The scan and seek sensors **58**, **68** are each arranged and constructed to monitor a solid cone directed along an axis normal to the respective surfaces **50**–**56**, **60**–**66** through the room or area being monitored by device **10**. The sensors which may be either infrared photodetectors or pyroelectric ceramic sensors, generate electrical signals corresponding to the radiated energy sensed by the respective sensor in the solid cone. The scan and seek sensors are used to detect a fire in the room or area monitored by device **10** and to aim nozzle **44** through the motors **20** and **36** toward the fire. Details of the sensors **58**, **68** and how they are interconnected is shown in FIGS. **3** and **4**. As seen in FIG. **3**, sensor **58**A consist of an infrared filter **70** and an phototransistor **72**. Light passing to phototransistor **72** is filtered by the infrared filter **70** to eliminate ambient light. Each of the other sensors **58**B, **58**C, **58**D, **68**A, **68**B, **68**C and **68**D are formed of similar filters and phototransistors which have been omitted herein for the sake of clarity. Sensors **58**A, **58**B, **58**C and **58**D cooperate to monitor the room or area of device **10** and when a fire is detected to pan the turret **16** generally toward said fire. For this purpose, inside housing **18** an electronic circuit **76** is provided consisting of a pan circuit **78** and a tilt circuit **80**. The pan circuit includes a clock generator **82** for generating clock signals at predetermined intervals. The clock signals are fed to a counter **84** which in response increments a count on a parallel bus **86**. Preferably, the counter is set to count from 1 to N where N is the number of scan sensors **58** (in this case four). The bus **86** feeds the count to a decoder **88** which in response activates the scan sensors **58**A, **58**B, **58**C and **58**D one at a time in sequence. The output of each sensor **58**A–**58**D is fed to a low pass filter **90**. Low pass filter **90** is used to filter the signals from the sensors to eliminate false signals generated by hot objects within the field of sensors. More particularly, it is known that the light intensity produced by fires is not constant but it flickers because of various physical parameters in a frequency range of about 5–30 Hz. Thus, low pass filter **90** is used to eliminate signals outside this range, such as for example a 60 Hz signal produced by a standard incandescent lamp.

The filtered signal from the filter **90** is fed to a driver **92** which is also connected to the decoder **88** so that the driver **92** can identify the sensor which has produced the signal received from the filter. Based on these received signals, driver **92** then drives the pan motor **20** either to the clockwise or counterclockwise as required to generally orient the housing **16** toward the fire. While the motor **20** is driven in response to a signal from one of the scan sensors, the counter is disabled through a line **94** also connected to the output of filter **90**.

The seek sensors **68** provide signals similar to the sensors of the scan sensors. If necessary, these signals may also be filtered as described above.

The pan motor **20** continues moving the housing **16** until one of the seek sensors disposed in plane Y—Y (i.e. sensor **68**B or **68**D) also senses the fire. For this purpose, the output of sensors **68**C and **68**D are fed to an OR gate **96**. When either of these sensors detects the fire, the signal output from sensor **96** disables the decoder **88**, which in turn stops motor **20** through driver **92**. At this point the seek sensors take over the operation of aiming the nozzle **44**. Because of the panning motion of motor **20**, the turret **16** has been rotated so that the fire is somewhere ahead of either sensor **68**B or **68**D. At this point, the nozzle **44** casts a shadow which occults the fire from one or two of the seek sensors **168**. The turret **16** and arm **30** are now moved around by the four seek sensors **68** until this shadow is eliminated and hence the nozzle is aimed at the fire. For this purpose the outputs of sensors **68**A and **68**C are fed to a differential amplifier **98** which in response generates an analog signal having an amplitude proportional to the difference between these two sensor outputs. The output of amplifier **98** V**1**out is fed to two comparators **100**, **102**. Comparators **100**, **102** determine if the amplifier output is outside a preselected range determined by two voltage signals HI REF and LO REF used as references signals by comparators **100** and **102** respectively. If the output V**1**out is above the preselected range, comparator **100** generates an output which is fed to driver **92** and used to drive motor **20** in one direction. If V**1**out is below said range, comparator **102** generates a signal which is fed to driver **92** to drive a motor **20** in the opposite direction. In this manner the pan motor **20** is used to align the nozzle quickly with one of the sensors **68**A, **68**C.

As can be seen from FIG. **3**, a similar arrangement is used for the tilt circuit **80**. For this circuit, the outputs of sensors **68**B, **68**D are fed to a differential amplifier **104**. The output V**2**out of amplifier **104** is fed to two comparators **106**, **108** for comparing this output to another preselected range. If V**2**out is above this range, comparator **106** activates a driver **110** which in response turns the tilt motor **36** in one direction. If the output V**2**out is below the preselected range, comparator **108** generates a signal for driver **110** for driving the tilt motor **36** in the opposite direction until the output of comparator **108** falls within the second preselected range.

In this manner the four seek sensors **68** cooperate to pan the housing **16** and tilt arm **30** until the nozzle is directed toward the fire. When the four seek sensors generate approximately equal outputs, i.e. none of them are occulted by the nozzle **44**, the output of comparators **100**–**108** are the same. These four outputs are fed to a relay **112** driver. Relay driver also receives an input from an OR gate **114** to indicate that at least one of the sensors **68** A–D is high, i.e. a fire has actually been detected. When the signals to driver **112** indicate that a fire has been detected and that the nozzle **44** has been properly aimed, the driver **112** activates a relay **116**. Relay **116** then opens a valve **118** (FIG. **1**) for pumping water or another fire extinguishing agent into nozzle **44** through a hose **120**.

The operation of the device is evident from the above-description. Suppose a fire breaks out in a zone F. The fire is first detected by scan sensor **58**B. In response to an output from this sensor, the pan circuit **78** of FIG. **3** activates the pan motor **20** causing the turret **16** to turn counterclockwise until the fire comes into the view of seek sensor **68**B. At this point the scan sensors **58** are disabled and the four seek sensors **68** take over. Sensors **68**A, **68**C continue the panning until the plane Y—Y of the housing is passing through zone F. At the same time, the sensors **68**B, **68**D tilt the nozzle upward until it is pointed at the fire zone F. Once the aiming of the nozzle is completed, the relay **116** activates valve **118** and an agent is directed by the nozzle at the fire zone F. Relay **116** also generates a fire alarm signal on alarm line **122**. If the sensors no longer detect a fire, the relay **116** is disabled by driver **112** and valve **118** is closed.

Thereafter the device **10** is checked and serviced as required, the nozzle is re-oriented in the downward position, and the device is once again ready for operation.

In order to insure that the device operates properly, the scan sensors are arranged so that at least the field of vision of sensors **58**A, **58**B as well as sensors **58**C and **58**D overlap respectively to eliminate dead zones, i.e. zones in which a fire cannot be detected.

Of course the number of scan or seek sensors may be increase or decreased. Additionally, instead of the discrete circuitry shown in FIG. **3**, a microprocessor based circuit may also be used, as shown in FIG. **4**. In this Figure, the eight sensors **58**A–D, **68**A–D are scanned sequentially by a microprocessor **200** through a multiplexer **202** and an analog-to-digital converter **204**. The sensor outputs may be filtered either by using analog filtering, or within the microprocessor, using a software implemented digital filter

206. This filtering is performed to separate signals due to a fire from other infrared sources as discussed above. A logic unit **208** monitors the sensor outputs. The fields of the sensors are overlapped so that a fire zone F is indicated by the respective output of three sensors. These outputs are used by the logic unit to determine the location of the fire zone and to pan the turret **16** toward the fire zone through a driver **210** and simultaneously to tilt the arm through a driver **212**. After the nozzle has been aimed, the logic unit activates a driver **214** to energize relay **116**. A fire alarm indication **216** is separately energized by logic unit **208**.

Obviously numerous modifications may be made to this invention without departing from its scope as defined in the appended claims.

I claim:

[**1**. A fire extinguishing apparatus comprising:

a turret mounted in a preselected area;

sensor means for detecting a fire;

nozzle means mounted on said turret, said nozzle means being arranged and constructed to eject a fire extinguishing agent; and

aiming means coupled to said sensor for aiming said nozzle means toward said fire when said fire is detected by said sensor means;

wherein said sensor means includes a first set of sensors having optical axes disposed at a first angle with respect to a vertical line and a second set of axis disposed at a second angle with respect to said vertical line.]

[**2**. The extinguisher of claim **1** wherein said turret is rotatable.]

[**3**. The apparatus of claim **2** wherein said aiming means includes means for rotating said turret about a vertical axis.]

[**4**. The apparatus of claim **3** wherein said nozzle means is rotatable with respect to a horizontal axis.]

[**5**. The apparatus of claim **1** wherein said first set of sensors alternate with respect to said second said of sensors.]

[**6**. The apparatus of claim **1** wherein said sensor means is mounted on said turret for concurrent movement with said nozzle means.]

[**7**. A fire extinguishing apparatus comprising;

a housing rotatable about a first axis;

a nozzle supported by said housing;

sensor means for sensing a fire;

aiming means for aiming said nozzle toward said fire; and

water supply means coupled to said sensor means for supplying water to said nozzle when said fire is sensed;

wherein said sensor means comprises a plurality of sensors arranged in an array around said nozzle.]

[**8**. The apparatus of claim **7** wherein said nozzle is rotatable about a second axis normal to said first axis.]

[**9**. The apparatus of claim **7** wherein said sensor means is mounted on said housing and is coupled to said nozzle for concurrent movement therewith.]

[**10**. The apparatus of claim **7** wherein said nozzle is constructed and arranged to occult said fire from some of said sensors when said nozzle is not aimed toward said fire.]

[**11**. The apparatus of claim **7** wherein each of said sensors comprises an electrical element, and a field of vision, said electrical element generating an electrical signal when said fire is in the field of vision of the corresponding sensor.]

[**12**. The apparatus of claim **11** further comprising filtering means for filtering a frequency of said electrical signals to differentiate said fire from other heat sources.]

[**13**. A fire extinguishing apparatus comprising:

a housing disposed in a preselected area;

nozzle means for selectively directing water at a fire;

a plurality of sensor means mounted on the nozzle means, each said sensor monitoring a portion of said area to generate a sensor signal when a fire is detected; and

aiming means coupled to each said sensor means for aiming said nozzle toward said fire.]

[**14**. The apparatus of claim **13** wherein said housing is rotatable about a vertical axis and said nozzle is mounted on said housing.]

[**15**. The apparatus of claim **14** wherein said nozzle means is rotatable about a horizontal axis.]

[**16**. The apparatus of claim **15** wherein said nozzle means and said sensors are mounted on an arm.]

[**17**. The apparatus of claim **16** wherein said aiming means includes a pan motor for panning said housing about said vertical axis in response to signals from said sensors.]

[**18**. The apparatus of claim **17** further comprising a tilting motor for tilting said nozzle means with respect to said horizontal axis in response to signals from said sensors.]

19. A method for detecting a location of a fire within a predetermined area, said method comprising the acts of:

(a) monitoring infrared energy within the predetermined area;

(b) filtering out the infrared energy not within a predetermined frequency range to produce filtered energy signals;

(c) determining existence of a fire within the predetermined area based on the filtered energy signals;

(d) determining a location of the fire within the predetermined area when said determining (c) determines the existence of the fire; and

(e) directing a nozzle of a fire extinguishing apparatus to the location of the fire,

wherein the location of the fire is an x-y location, and

wherein said directing (e) directs the nozzle of the fire extinguishing apparatus to the x-y location of the fire by moving the fire extinguishing apparatus in both an x-direction and a y-direction.

20. A method as recited in claim 19, wherein said determining (d) of the location of the fire is performed using the filtered energy signals.

21. A method as recited in claim 19, wherein said method further comprises:

(f) supplying fire extinguishing agent through said nozzle when the fire is sensed; and

(g) ceasing the supply of the fire extinguishing agent through said nozzle when the fire is no longer sensed by said sensors,

wherein following said ceasing (g), said method is again ready to locate another fire by repeating said acts (a) through (g).

22. A method as recited in claim 21, wherein said determining (d) of the location of the fire and said directing (e) of the nozzle to the location of the fire are performed simultaneously.

23. A method as recited in claim 19, wherein said determining (d) of the location of the fire and said directing (e) of the nozzle to the location of the fire are performed simultaneously.

24. A method as recited in claim 22, wherein the fire extinguishing apparatus includes a plurality of sensors positioned around the nozzle, and the sensors detect the infrared energy.

25. A method as recited in claim 24, wherein said determining (d) of the location of the fire finds the location of the fire by balancing the infrared energy received from the sensors.

26. A method as recited in claim 22, wherein said method further comprises:

(f) supplying fire extinguishing agent through said nozzle when said fire is sensed; and

(g) ceasing the supply of the fire extinguishing agent through said nozzle when said fire is no longer sensed by said sensors.

27. A method as recited in claim 26, wherein following said ceasing (g), said method is again ready to locate another fire by repeating said acts (a) through (g).

28. A method for detecting a fire within a predetermined area, comprising:

(a) sensing infrared energy within the predetermined area;

(b) converting the infrared energy into electrical signals;

(c) filtering the electrical signals to produce filtered electrical signals which correspond to a fire;

(d) detecting the presence of a fire within the predetermined area based on the filtered electrical signals; and

(e) moving a fire extinguishing nozzle so as to point to the fire detected in said detecting (d),

wherein said detecting (d) detects a location of the fire, and

wherein the location of the fire is an x-y location, and wherein said moving (e) moves the fire extinguishing nozzle to the x-y location of the fire by moving the fire extinguishing apparatus in both an x-direction and a y-direction.

29. A method as recited in claim 28, wherein said sensing (a) senses infrared energy in a predetermined area, and wherein said filtering (c) filters signals in the frequency range of 5–30 Hz.

30. A method of claim 28, wherein said detecting (d) comprises comparing the filtered electrical signals with a predetermined threshold level.

31. A method of claim 28, wherein said sensing (a) monitors a plurality of infrared sensors, and wherein said detecting (d) comprises determining location of a fire based on the filtered signals from the plurality of the infrared sensors.

32. A method as recited in claim 28, wherein said method further comprises (f) releasing a fire extinguishing agent towards the fire via the fire extinguishing nozzle.

33. A method of claim 28, wherein said method further comprises:

(f) supplying fire extinguishing agent through the nozzle when the fire is sensed; and

(g) ceasing the supply of the fire extinguishing agent through the nozzle when the fire is no longer sensed by said sensors.

34. A method as recited in claim 33, wherein following said ceasing (g), said method is again ready to locate another fire by repeating said acts (a) through (g).

35. A method as recited in claim 28, wherein said detecting (d) of the location of the fire and said moving (e) of the nozzle to the location of the fire are performed simultaneously.

36. A method as recited in claim 35, wherein a plurality of sensors are positioned around the nozzle, and the sensors detect the infrared energy.

37. A method as recited in claim 36, wherein said detecting (d) of the location of the fire finds the location of the fire by balancing the infrared energy received from the sensors.

38. A method as recited in claim 36, wherein said method further comprises:

(f) supplying fire extinguishing agent through the nozzle when the fire is sensed; and

(g) ceasing the supply of the fire extinguishing agent through the nozzle when the fire is no longer sensed by said sensors.

39. A method as recited in claim 38, wherein following said ceasing (g), said method is again ready to locate another fire by repeating said acts (a) through (g).

40. A method as recited in claim 38, wherein said sensing (a) senses infrared energy in a predetermined area, and wherein said filtering (c) filters signals in the frequency range of 5–30 Hz.

41. A method of claim 38, wherein said detecting (d) comprises comparing the filtered electrical signals with a predetermined threshold level.

42. A method as recited in claim 34, wherein said sensing (a) senses infrared energy in a predetermined area, and wherein said filtering (c) filters signals in the frequency range of 5–30 Hz.

43. A method of claim 34, wherein said detecting (d) comprises comparing the filtered electrical signals with a predetermined threshold level.

44. A method as recited in claim 28, wherein the predetermined area is an area of a structure.

45. A method as recited in claim 44, wherein the area is a room and the structure is a building.

46. A system, comprising:

a fire detector that detects a location of a fire within a predetermined area, said fire detector monitors infrared energy within the predetermined area, filters out the infrared energy not within a predetermined frequency range to produce filtered energy signals, determines existence of a fire within the predetermined area based on the filtered energy signals, and determines a location of the fire within the predetermined area when the existence of the fire has been determined; and

a fire extinguishing agent that supplies fire extinguishing agent toward the location of the fire when the existence of the fire has been determined and ceases supply of the fire extinguishing agent toward the location of the fire when the existence of the fire is no longer detected.

* * * * *