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(54) **DIGITAL SITUATION INDICATOR**

DIGITAL ZUSTANDSANZEIGER

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Description

Field of the invention

[0001] The present invention relates to a digital situation indicator, especially a personal monitoring and alarm system as defined in the preamble of claim 1.

Background of the invention

[0002] When entering a burning building, firefighters wear breathing apparatus consisting of an air tank, regulator, facemask and pressure gage. Typically, firefighters work in dense smoke, where the visibility may be only a few inches.

[0003] Firefighters carry a personal alert safety system (PASS) device, which activates an audible alarm, if they stop moving. The PASS device has a "Pre-Alert" stage, which allows the firefighter a pre-specified number of seconds to move or to shake the PASS device, before the alarm is activated. In addition to the PASS device, firefighters need to know certain information about their constantly changing situation in order to safely and efficiently perform their work.

[0004] At minimum, firefighters need to know at all times, how much air is remaining in their tank. The pressure of the air tank will only tell part of the story. Two firefighters with identical pressure gage readings may each have a different number of minutes of air time remaining, depending on their respective rates of air consumption. The rate of air consumption varies from firefighter to firefighter according to size, physical conditioning, and metabolic rate. The rate of air consumption also can change from minute to minute for an individual firefighter depending on the intensity of the physical work being performed, stress, and other factors. Therefore, the firefighter needs to know both the air pressure and its equivalent in number of minutes remaining, at any given time.

[0005] For safety reasons, the firefighter also needs to know the ambient temperature, its time-dependent effect on his or her cumulative heat stress level, and whether flashover conditions are impending. Before opening a door inside a burning building, the firefighter needs to know whether there is a raging fire on the other side. During so-called "mop-up" operations after the fire has been extinguished, firefighters typically have to use axes to inspect inside walls, to ensure that no hidden fires exist.

[0006] DE-A-19822142 discloses a system for supervising user, such as a fireman, who carries respiratory equipment. The respiratory equipment carrier wears a mobile part which is connected to compressed air breather to assess and transfer data via a wireless connection to a remote base station, or a central station. The mobile part is connected by a cord to earphones or a loudspeaker at the helmet of the respiratory equipment carrier such that the mobile device is able to give an audible spoken notification on the remaining air pressure, or an audible spoken alarm.

[0007] WO-A-93/03465 discloses a display located on the computer/sensor unit which is attached to firefighter's air cylinder hose.

[0008] US-A-5886822 discloses that head mounted image displays may be used in helmets, goggles and eyeglasses.

[0009] Firefighters wear thick gloves, carry axes and water hoses, and need their hands free to be able to perform their work. Gages that attach to the air hose and hang from the firefighter's side are inconvenient to continuously pick-up and, in dense smoke, are almost impossible to read. When brought up to the facemask, the gage is too close for the firefighter's eyes to focus. For this reason, an elementary display system has recently been invented, consisting of a series of Light Emitting Diodes (LEDs) mounted inside the facemask. The drawback to this approach is that the LEDs provide much less information than gages provide.

[0010] A helmet-mounted display system such as those used by military jet fighter pilots, which projects data onto the visor of the helmel, would offer firefighters a possible solution. However, the cost of a single helmet could absorb an annual budget. The cost to equip all firefighters worldwide would be staggering.

[0011] The incident commander (IC) is in charge of all firefighters at the scene of the fire. Each firefighter gives the IC a personal accountability tag (PAT) upon arrival at the scene. The IC keeps track of the firefighters by the use of a unit identification pad (UIP) and a large marker board. The drawback is that once the firefighters are inside the fire, the IC has no method of knowing how much air each firefighter has left, what temperature the firefighters are operating in, what is their heal stress level or PASS device status.

[0012] Firefighters, welders and warfighters are just examples for possible users of digital situation indicator of the invention. This kind of indicators can be utilised in many fields where personal monitoring and alarming are essential.

[0013] Information systems, for example for divers, are known in the art. These systems include sensor modules, different kinds of display modules and also modules to send and receive data between the said modules. This kind of systems have been shown for instance in US patent specifications 5503145, 5301668 and 5617848.

[0014] These systems are, however, restricted in their properties and thus a system of the present invention brings quite many new, effective properties for improving the usefulness and safety of the system.

Summary of the invention

[0015] A primary object of the present invention is to provide a digital situation indicator, especially a personal monitoring and alarm system that will overcome the shortcomings of the prior art devices. Another object of the invention is to provide a new digital situation indicator.

[0016] The invention is characterized by the features defined in claim 1. The dependent claims describe preferred embodiments of the invention.

[0017] The situation indicator SI of the invention offers a digital heads-up display HUD solution with a multitude of new features. The SI offers a truly digital, very easily legible HUD, at a cost no more expensive than the existing technology.

[0018] The SI system has three separate units:

Sensor Module SM for monitoring desired data,
Heads-Up Display HUD mounted in the facemask F of the operating person, and Incident Commander Module ICM at a distance from the operating person.

[0019] The sensor module may contain a pressure sensor, ambient temperature sensor, infrared (IR) temperature sensor, an "SOS" Button and an integrated PASS device. A microprocessor anelyses the sensor data and computes air time remaining in minutes, heal stress level, and impending flashover danger. The sensor module transmits sensor and computed data to both the HUD and the ICM. The communication between the parts is wireless such as radio frequency (RF) communication.

[0020] The sensor module may also contain a amperage sensor. The sensor module transmits sensor and computed data to the HUD using wireless communication, such as RF communication.

[0021] The heads-up display incorporates a miniature, transflective LCD display unit with electro-luminescent panel backlighting, and optical enhancement means consisting of an achromatic doublet lens, optimized to correct for on-axis spherical and chromatic aberrations. The optics is designed for extra long eye relief, and the HUD is positioned in the facamask so that it does not restrict the firefighter's forward field of view.

[0022] With the SI system, before opening a door inside a burning building, the firefighter can point the IR sensor with a laser beam at the door, press the IR sensor button and read the temperature of the door on the HUD. During "mop-up" operations after the fire has been extinguished, the firefighter can scan the walls with the IR sensor to ensure that no hidden fires exist.

[0023] The incident commander module consists of a self contained, portable, one-piece computer module, with backlit LCD display, louch screen or flex-membrane keypad, and RF transceiver. The ICM receives data transmissions from the sensor module. The ICM can also transmit text messages to the firefighler. Once the firefighter is inside the fire, the ICM tracks each firefighter's situation, including elapsed time in the fire, air pressure, air time remaining in minutes, ambient temperature in the fire, heat stress level and PASS device status.

[0024] The advantages of the invention are, among the other things, the following:

the SI system is a compact and versatile system for a user and, effective communication between different parts of the **SI** system, a user has clear and concise information for use,

it is possible to follow a user with his/her sensor module inside the fire or equivalent work and communicate, if necessary.

Brief description of the drawings

[0025] A preferred embodiments of the invention are presented in the following with reference to the attached drawing in which:

Fig. 1 shows a schematic block diagram of the sensor module according to the first embodiment of the invention,

Fig. 2 shows a schematic block diagram of the sensor module according to another embodiment of the invention,

Fig. 3 shows a schematic block diagrem of the sensor module according to another embodiment of the invention,

Fig. 4 shows a block diagram of the heads-up display,

Fig. 5 shows a block diagram of the incident commander module,

Fig. 6 shows a perspective view of the sensor module attached to an air tank, Fig. 7 shows more closely the sensor module,

Fig. 8 shows a mask with the heads-up display,

Fig. 9 shows a welders helmet with the heads-up display,

Fig. 10 shows more closely the heads-up display as perspective view,

Fig. 11 shows examples of information which can be presented in the heads-up display according to the first embodiment of the invention,

Fig. 12 show example of information which can be presented in the heads-up display according to another embodiment of the invention,

Fig. 13 shows examples of information which can be presented in the heads-up display according to another embodiment of the invention,

Fig. 14 shows a perspective view of the incident commander module,

Fig. 15 shows a flow diagram of the Flashover Warning Alarm software according to the first embodiment of the invention,

Fig. 16 shows a flow diagram of the Cumulative Heat Stress Level calculating software according to the first embodiment of the invention, and

Fig. 17a and 17b show a flow diagram of the Motion Sensor software according to the first embodiment of the invention.

Description of the preferred embodiment

[0026] Digital situation indicator SI for firefighters - system highlights:

- Pressure sensor -senses pressure remaining in the air tank of the firefighter;
- Computes minutes of air time remaining at firefighter's current consumption rate;
- Ambient température sensor - senses ambient temperature;
- Flashover warning alarm - warns of impending flashover danger;
- Computes heal stress level, in "degree-minutes";
- Integrated Personal Alert Safety System PASS device;
- Infrared (IR) sensor, activated by the push of a button - detects fire and/or high temperatures behind closed doors and inside walls;
- Visible light LASER to show where IR sensor is pointed;
- "SOS" button - transmits emergency signal to ICM and activates audible alarm;
- Service records datalogger - records sensor module service and maintenance information in non-volalile memory.

[0027] The sensor module SM in accordance with one embodiment of the invention, as shown in Fig 1, has the following parts and features:

- Sensor module SM scans all sensor readings and transmits updated sensor data to both HUD and ICM, preferably every 3 seconds;
- Pressure sensor 1- senses air pressure in the air tank 2 (Fig. 6) ;
- Control unit, such as microprocessor 3, tracks firefighter's rate of air consumption, then computes air time remaining in minutes at current consumption rate;
- Ambient temperature sensor 4 - senses ambient temperature;
- Flashover warning alarm - software analyses sensor data and detects, when ambient conditions are appropriate for impending flashover. Microprocessor 3 transmits flashover warning to both HUD and ICM, and/or activates audible alarm 5.

[0028] The operation of the flashover warning software is described in the flow chart of the Fig. 15. First the pre-specified alarm limits and the ambient temperature TA are read and the real time clock is started. Then the ambient temperature is stored in to the memory as a function of time and the rate of increase of ambient temperature is calculated. After this the ambient temperature is compared to the pre-specified alarm limit and if the ambient temperature is lower than the limit, the program returns to the beginning.

[0029] If the ambient temperature is higher than pre-specified alarm limit, the rate of increase of ambient temperature is compared to the pre-specified alarm limit. If the rate of increase of ambient temperature is lower than the limit, the program returns to the beginning. If the rele of increase of ambient temperature is higher than the pre-specified alarm limit, a flashover warning is displayed in the HUD. A flashover warning is also transmitted to tha incident commander module;

- Microprocessor 3 records firefighter's duration in high temperatures and compules cumulative heal stress level, in "degree-minutes". Software includes computelion for rehabilitation (Rehab) time as well as multiple tank 2 usage. The operation of the cumulative heat stress level program is described in the flow chart of the Fig. 16. First the pre-specified alarm limits and the ambient temperature TA are read and the real time clock is sterted. Then the ambient temperature is stored in to the memory as a function of time and the cumulative heat stress level is calculated. After this the cumulative heat stress level is displayed in the HUD.

If the cumulative heal stress level is higher than the pre-specified alarm limit, a heat stress warning alarm is activated and an alarm message is transmitted to the incident commander module. If the cumulative heat stress level is lower than the pre-specified alarm limit program returns to the beginning;

- Integrated personal alert safety system "PASS" device, including: - Motion sensor 6 to detect absence of motion by firefighter; - Vibrator 7 and/or audible alarm 5 to alert firefighter of "Pre-Alert" condition; - Transmitter 8 to transmit "Pre-Alert" condition data to HUD and ICM; -Audible alarm 5, activated after a pre-specified number of seconds of absence of motion.

[0030] The operation of the motion sensor program is described in the flow chart of the Fig. 17a and 17b, First the pre-specified alarm limits and the motion sensor are read and the real time clock is started. Then the motion is stored in to the memory as a function of time. If the motion slops, time period of zero motion is calculated.

[0031] If the time period of zero motion is shorter than the pre-specified limit, program returns to the beginning. Otherwise a countdown timer and a vibrator alarm are activated. Simultaneously zero motion warning and countdown timer data is displayed in the HUD. A zero motion warning is also transmitted to the incident commander module.

[0032] After this the motion sensor is read again. If motion is detected, the countdown timer is reset and a all clear messaga is transmitted to the incident commander module, and the program returns to the beginning. Otherwise the countdown timer is checked, and if there is still time left, motion sensor is read again. If countdown timer has reached zero, an audible alarm is activated and an alarm message is trensmitted to the incident commander module.

- Infrared (IR) sensor 9, activated by the push of a button 10 (Fig. 9) - detects infrared radiation emitted from closed doors and walls (and therefore fire and/or high temperatures behind closed doors and inside walls) ;
- Visible wavelength coaxial LASER 11 (Fig. 7) to show with its beam 11a where IR-sensor 9 is pointed;
- SOS-button 20 - activates audible alarm and transmits signal to ICM;
- Radio frequency (RF) receiver 12 - receives text messages from ICM and forwards them to HUD;
- Service records datalogger - records sensor module service and maintenance information in non-volalile memory 13;
- "Automatic On" feature - activated upon opening of air tank regulator valve;
- Optional button (s) 14 to allow firefighter to input his/her identification code.;
- Optional "Black Box" datalogger - records all sensor data during fire, with automatic "Time Slamping",
- Optional emergency locator transmitter (ELT), activated by PASS device or SOS-button.

[0033] The sensor module SM is attached to the pressure gage hose 15 of the air tank 2 as shown in Fig. 4. The sensor module SM has a connector 16 to the pressure hose 15, a housing 17 for the electronic circuitry (shown in Fig. 1) of the sensor module SM , RF antenna 18, IR-sensor and ambient temperature sensor in their housing 19, a waterproof switch 10 for IR-sensor 9 (Fig. 1), a laser 11 and SOS-button 20.

[0034] The heads-up display HUD is an optielectric, night-readable display which is mounted in a facemask F of the firefighter, as shown in Fig, 8 and Fig. 9. The heads-up display module HUD, as shown in Fig. 4, has the following parts and features:

Control unit such as a microprocessor 24, display 21, preferably electro-luminescent backlit 22, miniature digital LCD display or equivalent;

• Use of optical enhancement to create an easily legible digital display, which can be located inside the facemask as shown in Fig. 8 as an example - specifically, an achromatic doublet lens 22, optimized to correct for on-axis spherical and chromatic aberrations, with extra long eye relief, positioned so as not to restrict the firefighter's forward field of view;

• RF receiver 25 for receiving data from the sensor module SM;

• Housing 23 into which the display 21 and the lens 22 are fixed;

The display 21 in accordance with one embodiment of the invention is arranged to function as following indicators:

- Pressure indicator - indicates pressure remaining in air tank;
- Time remaining indicator - indicates air time remaining in minutes, at current consumption rate;

Ambient temperature indicator- displays ambient temperatures (compare Fig. 11) :

- Heat stress indicator - displays firefighter's cumulative heat stress level;
- Flashover warning indicator - alerts firefighter of impending flashover danger;
- Infrared temperature indicator- displays infrared temperature of object that IR-sensor is pointed towards, whenever IR-sensor button is pushed (compare Fig. 8) ;
- PASS device condition indicator - alerts firefighter of "Pre-Alert" PASS condition;

[0035] The display in accordance with another embodiment of the invention is arranged to function as following indicators:

- amperage indicator - indicates pressure remaining in air lank;

[0036] The display in accordance with another embodiment of the invention is arranged to function as following indicators:

- CWA indicator - indicates consentration of CWA in the surrounding and changes the color of the display depending the situation;
- Time remaining indicator - indicates remaining operating time in minutes at current CWA consentration;

Furthermore, the heads-up display module has:

- "Sleep mode" -provides "Automatic On" feature and prolonged battery life;
- Optional two-way RF voice communication between firefighter and incident commander.

[0037] The incident commander module ICM of one embodiment of the present invention provides the incident commander, who is commanding the operation, with real-time sensors data on all firefighters in the interior of the building or equivalent. The incident commander module ICM as shown in Fig. 5 and Fig. 14, has the following parts and features:

- Control unit such as a microprocessor 26;
- RF Transceiver 27, which receives continuous RF sensor data transmissions from up to 128 firefighters, specifically from the firefighter's sensor modules SM;
- Display 28 such as backlit LCD display, indicates the following for each firefighter:
  - Elapsed time inside the fire;
  - Pressure in air bank;
  - Air time remaining in minute;
  - Ambient tempereture reading;
  - IR sensor reading;
  - Heat stress level;
  - Flashover warning;
  - PASS device status, including "Pre-Alert" condition;
- Receives "SOS" transmission and identifies firefighter in trouble;
- Transmits text messages by means of the RF transceiver 27 to any selected firefighter or to all firefighters;
- Illuminates "Service" icons, to indicate when upcoming service is due for ICM, HUDs or sensor modules;
- "Black Box" datalogger built into ICM; - records each firefighter's situation in real-lime, as it occurs; records any firefighter's "SOS" transmission in real-time, as it occurs; - records the ICM's text messages in real-time, as they occur; - records all service and maintenance records on each device; automatically adds "Time/Date Stamp" to all records.
- Field programming capacity - enables ICM to download identification codes and other information to non-volatile memory in sensor modules and HUDs;
- Optional two-way RF voice communication between firefighter and incident commander.

Claims

1. A digital situation indicator, especially a personal monitoring and/or alarm system, wherein the situation indicator (SI) has three separate units:

a sensor module (SM) for monitoring desired data having sensors (1, 4, 6, 9; 32) for monitoring conditions in connection with the operating person and a control unit (3) for analyzing the data collected;

a heads-up display module (HUD) mounted in a facemask (F) or helmet of the operating person for displaying the data;

an incident commander module (ICM) at a distance from the operating person, for providing the incident commander with real-time sensors data on each operating person in the operating area;

whereby the modules are arranged to communicate with each other,

and having wireless communication means (8, 12, 27) in said modules (SM, HUD, ICM) for sending and receiving data between the sensor module (SM) and the heads-up display (HUD) module of the operating person and further between the sensor module and the incident commander module (ICM),

sensor module (SM) further comprising

- a flashover warning alarm for analyzing sensor data and detecting, when ambient conditions are appropriate for impending flashover,
- means for computing cumulative heat stress level and heat stress warning alarm;
- personal alert safety system (PASS) having motion sensor (6) and alarm (5; 7);
- SOS button (20); and
- radio frequency transceiver (8, 12) for transmitting sensor data, computed data and alarms to the heads-up display (HUD) module and/or an incident commander module (IGM) and receiving messages from the incident commander module (ICM); and

the incident commander module (ICM) further comprising

- a control unit such as a microprocessor (26),
- a radio frequency transceiver (27) for receiving sensor data transmissions and SOS transmissions from the fire fighters, especially from their sensor modules (SM) and for transmitting messages to any selected fire fighter or to all fire fighters and
- display (28) for indicating information from the fire fighters.

2. A digital situation indicator according to claim 1, **characterized in that** the sensor module includes an infrared temperature sensor (9) for detecting fire and/or high temperature behind closed doors and inside walls and a visible fight laser (11) to show with its beam where the sensor (9) is pointed.

3. A digital situation indicator according to claim 2, **characterized in that** the infrared temperature sen-

sor (9) has a switch (10) such as a button for activating the sensor.

4. A digital situation indicator according to any of claims 1 - 3, **characterized in that** the sensor module (SM) has an emergency locator transmitter (ELT) activated by personal alert safety system (PASS) or SOS button (20).

5. A digital situation indicator according to claim 1, **characterized in that** the sensor module (SM) is attachable to the pressure gage hose (15) of an air tank (2).

6. A digital situation indicator according to any of claims 2 - 5, **characterized in that** the sensor module has two housings (17, 19) connected to each other, where the first housing (17) is for the electronic circuitry and the second housing (19) is or the coaxially arranged infrared temperature sensor (9) and laser (11) and further for the IR sensor activating switch (10) and SOS-button (20).

7. A digital situation indicator according to claim 1, **characterized in that** the heads-up display (HUD) module has a control unit such as a microprocessor (24), a display, preferably electro-luminescent backlit (22) miniature, digital liquid crystal display (21), and optical enhancement means, specifically an achromatic doublet lens (22), optimized to correct for on-axis spherical and chromatic aberrations, which display (21) is positioned in a facemask or a helmet.

8. A digital situation indicator according to claim 7, **characterized in that** the display (21) is arranged to function as the following indicators:

- pressure indicator for indicating pressure remaining in the air tank;
- time remaining indicator for indicating air remaining in minutes at current consumption rate;
- ambient temperature indicator for displaying ambient temperatures;
- heat stress indicator for displaying fire fighter's cumulative heat stress level; - flashover warning indicator for alerting the fire fighter of impending flashover danger;
- personal alert safety system (PASS) device condition indicator for alerting the fire fighter of pre-alert condition; and
- infrared temperature indicator for displaying infrared temperature of the object that the infrared temperature sensor (9) is pointed towards.

9. A digital situation indicator according to any of preceding claims 1 - 8, **characterized in that** the heads-up display (HUD) module has a two-way radio frequency voice communication between any of the fire fighters and an incident commander by means of the incident commander module (ICM).

10. A digital situation indicator according to any of preceding claims 1 - 9, **characterized in that** the incident commander module (ICM) is arranged to transmit text messages by means of the transceiver (27) to any selected fighter or to all the fighters.

11. A digital situation indicator according to claim 1, **characterized in that** the display (28) of incident commander module (ICM) is arranged to indicate the following information for each fine fighters:

- elapsed time inside the fire;
- pressure in the air lank and air remaining in minutes;
- ambient temperatura reading;
- heat stress level;
- flashover warning;
- status of the personal alert safety system (PASS) device; and
- reading of the infrared temperature sensor (9)

and for each war fighter:

- elapsed time under chemical warfare agent;
- chemical warfare agent concentration in the surroundings;
- current dosage of chemical warfare agent; and
- remaining operating time in minutes.

12. A digital situation indicator according to any of preceding claims 1 - 11, **characterized in that** the incident commander module (ICM) has a datalogger which is arranged to record the following information

- each fighter's situation in real-time, as it occurs;
- any fighter's SOS transmission on real-time, as it occurs;
- all service and maintenance records on each device; and
- automatically to add time/date stamp to all records.

13. A digital situation indicator according to any of preceding claims 1 - 12, **characterized in that** the incident commander module (ICM) has field programming capacity, which enables the ICM to download identification codes and other information from the incident commander module (ICM) to the sensor module (SM) and the heads-up display (HUD) module of the fighter.

Patentansprüche

1. Ein digitaler Zustandsanzeiger, insbesondere ein persönliches Überwachungs- und/oder Alarmsy-

stem, wobei der Zustandsanzeiger (SI) drei getrennte Einheiten aufweist:

ein Sensormodul (SM) zum Überwachen gewünschter Daten mit Sensoren (1, 4, 6, 9; 32) zum Überwachen von Zuständen in Verbindung mit der Person im Einsatz und einer Kontrolleinheit (3) zur Analyse der gesammelten Daten;
ein Blickfeldanzeigen-(HUD)-Modul in einer Gesichtsmaske (F) der Person im Einsatz montiert zum Zeigen der Daten;
ein Einsatzleitermodul (ICM) in einem Abstand von der Person im Einsatz, um den Einsatzleiter mit echtzeitlichen Sensordaten über jede Person im Einsatz in dem Einsatzbereich zu versehen;
wobei die Module angeordnet sind, miteinander zu kommunizieren, und
drahtlose Kommunikationsmittel (8, 12, 27) in den besagten Modulen (SM, HUD, ICM) zum Senden und Empfangen von Daten zwischen dem Sensormodul (SM) und dem Blickfeldanzeigen-(HUD)-Modul der Person im Einsatz und weiterhin zwischen dem Sensormodul und dem Einsatzleitermodul (ICM),
wobei das Sensormodul (SM) weiterhin Folgendes aufweist

- einen Flashover-Warnungs-Alarm, um Sensordaten zu analysieren und zu erfassen, wann die Umgebungsbedingungen für einen bevorstehenden Flashover reif sind,
- Mittel zur Berechnung eines kumulativen Hitzebelastungsniveaus und einen Warnungsalarm für Hitzebelastung;
- ein persönliches Alarm-Sicherheits-System (PASS) mit einem Bewegungssensor (6) und einem Alarm (5; 7);
- einen SOS-Knopf (20); und
- ein Radiofrequenz-Sende-Empfangsgerät (8, 12) zum Übermitteln von Sensordaten, berechneten Daten und Alarmen an ein Blickfeldanzeigen-(HUD)-Modul und/oder ein Einsatzleitermodul (ICM) und zum Empfangen von Mitteilungen von dem Einsatzleitermodul (ICM); und

das Einsatzleitermodul (ICM) weiterhin Folgendes aufweist

- eine Steuereinheit wie zum Beispiel einen Mikroprozessor (26),
- ein Radiofrequenz-Sende-Empfangsgerät (27) zum Empfangen von Sensordatenübermittlungen und SOS-Übermittlungen von den Feuerwehrmännern, insbesondere von ihren Sensormodulen (SM), und zum Übermitteln von Mitteilungen an einen beliebigen gewählten Feuerwehrmann oder an alle Feuerwehrmänner und
- einen Anzeiger (28) zum Zeigen von Information von den Feuerwehrmännern.

2. Ein digitaler Zustandsanzeiger gemäß dem Patentanspruch 1, **dadurch gekennzeichnet, dass** das Sensormodul einen Infrarot-Temperatursensor (9) zum Entdecken eines Feuers und/oder einer hohen Temperatur hinter geschlossenen Türen und innerhalb von Wänden und einen Laser (11) mit sichtbarem Licht, um mit seinem Strahl zu zeigen, worauf der Sensor gerichtet ist, aufweist.

3. Ein digitaler Zustandsanzeiger gemäß dem Patentanspruch 2, **dadurch gekennzeichnet, dass** der Infrarot-Temperatursensor (9) einen Schalter (10) wie zum Beispiel einen Knopf zum Betätigen des Sensors aufweist.

4. Ein digitaler Zustandsanzeiger gemäß einem der vorhergehenden Patentansprüche 1 - 3, **dadurch gekennzeichnet, dass** das Sensormodul (SM) einen Notfall-Lokalisierungs-Transmitter (ELT) aufweist, der durch das persönliche Alarm-Sicherheits-System (PASS) oder den SOS-Knopf (20) aktiviert wird.

5. Ein digitaler Zustandsanzeiger gemäß dem Patentanspruch 1, **dadurch gekennzeichnet, dass** das Sensormodul (SM) an einen Druckmessgeräteschlauch (15) eines Luftbehälters (2) befestigt werden kann.

6. Ein digitaler Zustandsanzeiger gemäß einem der vorhergehenden Patentansprüche 2 - 5, **dadurch gekennzeichnet, dass** das Sensormodul zwei mit einander verbundene Gehäuse (17, 19) aufweist, wobei das erste Gehäuse (17) für die elektrischen Schaltkreise und das zweite Gehäuse (19) für den koaxial angeordneten Infrarot-Temperatursensor (9) und den Laser (11) und weiter für den, den Infrarot-Sensor betätigenden Schalter (10) und den SOS-Knopf (20) vorgesehen ist.

7. Ein digitaler Zustandsanzeiger gemäß dem Patentanspruch 1, **dadurch gekennzeichnet, dass** das Blickfeldanzeigen-(HUD)-Modul eine Steuereinheit wie zum Beispiel einen Mikroprozessor (24), einen Anzeiger, vorzugsweise eine elektro-luminiszente hintergrundbeleuchtete (22) Miniaturausgabe, einen digitalen Flüssigkristallanzeiger (21), und optische Verbesserungsmittel, im Besonderen eine achromatische Doubletten-Linse (22), optimiert, sphärische und chromatische Aberrationen innerhalb der Achse zu korrigieren, welcher Anzeiger (21) in einer Gesichtsmaske oder einem Helm platziert ist, aufweist.

8. Ein digitaler Zustandsanzeiger gemäß dem Patentanspruch 7, **dadurch gekennzeichnet, dass** der Anzeiger (21) angeordnet ist, als folgende Indikatoren zu funktionieren:

- Druckanzeiger, um den in dem Luftbehälter verbleibenden Druck anzuzeigen;
- Anzeiger der verbleibenden Zeit, um die verbleibende Luft in Minuten bei der gegenwärtigen Verbrauchsrate anzuzeigen;
- Anzeiger der Umgebungstemperatur, um Umgebungstemperaturen anzuzeigen;
- Anzeiger der Hitzebelastung, um das kumulative Hitzebelastungsniveau des Feuerwehrmannes anzuzeigen;
- Anzeiger einer Flashover-Warnung, um den Feuerwehrmann über eine bevorstehende Flashover-Gefahr zu alarmieren;
- ein Zustandsanzeiger des persönlichen Alarm-Sicherheits-System-(PASS)-Gerätes, um den Feuerwehrmann über einen Vor-Alarm-Zustand zu alarmieren; und
- Infrarot-Temperaturanzeiger zum Zeigen einer Infrarot-Temperatur des Objektes, auf das der Infrarot-Temperatursensor (9) gerichtet ist.

9. Ein digitaler Zustandsanzeiger gemäß einem der vorhergehenden Patentansprüche 1 - 8, **dadurch gekennzeichnet, dass** das Blickfeld-anzeigen-(HUD)-Modul eine Zweiweg-Radiofrequenz-Stimmenkommunikation zwischen einem Beliebigen der Feuerwehrmänner und einem Einsatzleiter mit Hilfe des Einsatzleitermoduls (ICM) aufweist.

10. Ein digitaler Zustandsanzeiger gemäß einem der vorhergehenden Patentansprüche 1 - 9, **dadurch gekennzeichnet, dass** das Einsatzleitermodul (ICM) angeordnet ist, SMS-Botschaften mit Hilfe des Sende-Empfangsgeräts (27) an einen beliebigen gewählten Feuerwehrmann oder an alle Feuerwehrmänner zu übermitteln.

11. Ein digitaler Zustandsanzeiger gemäß dem Patentanspruch 1, **dadurch gekennzeichnet, dass** der Anzeiger (28) des Einsatzleitermoduls (ICM) angeordnet ist, die folgende Information für jeden Feuerwehrmann zu zeigen:

- verstrichene Zeit innerhalb des Feuers;
- Druck im Luftbehälter und verbleibende Luft in Minuten;
- Umgebungstemperaturanzeige;
- Niveau der Hitzebelastung;
- Flashover-Warnung
- Status des persönlichen Alarm-Sicherheits-System-(PASS)-Geräts; und
- Anzeige des Infrarot-Temperatursensors (9) und für jeden Krieger:
  - verstrichene Zeit des einem Kampfstoff der chemischen Kriegsführung Ausgesetztseins;
  - Konzentration des Kampfstoffes der chemischen Kriegführung in der Umgebung;
  - gegenwärtige Dosis des Kampfstoffes der chemischen Kriegführung; und
  - verbleibende Einsatzzeit in Minuten.

12. Ein digitaler Zustandsanzeiger gemäß einem der vorhergehenden Patentansprüche 1 - 11, **dadurch gekennzeichnet, dass** das Einsatzleitermodul (ICM) ein Datenerfassungssystem aufweist, das angeordnet ist, folgende Information aufzuzeichnen

- Zustand eines jeden Kriegers in Echtzeit, beim Aufkommen;
- SOS-Übermittlung eines beliebigen Kriegers in Echtzeit, beim Aufkommen;
- alle Versorgungs- und Wartungsaufzeichnungen für jedes Gerät; und
- das automatische Hinzufügen von Zeit/Datum-Stempeln zu allen Aufzeichnungen.

13. Ein digitaler Zustandsanzeiger gemäß einem der vorhergehenden Patentansprüche 1 - 12, **dadurch gekennzeichnet, dass** das Einsatzleitermodul (ICM) eine Feldprogrammierkapazität aufweist, die es dem ICM erlaubt, Identifikationskode und andere Information von dem Einsatzleitermodul auf das Sensormodul (SM) und das Blickfeldanzeigen-(HUD)-Modul des Kriegers herunterzuladen.

Revendications

1. Indicateur de situation numérique, en particulier système d'alarme et/ou de contrôle personnel, l'indicateur de situation (SI) comportant trois unités distinctes :

un module capteur (SM) destiné à contrôler des données souhaitées,
possédant des capteurs (1, 4, 6, 9, 32) destinés à contrôler les conditions en rapport avec la personne en service et une unité de commande (3) destinée à analyser les données collectées ;
un module d'affichage frontal (HUD) monté dans un masque facial (F) ou casque de la personne en service pour afficher les données ;
un module gestionnaire d'incident (ICM), situé à une certaine distance de la personne en service, pour donner au gestionnaire d'incident des données de capteurs en temps réel sur chaque personne en service dans la zone d'intervention ;
moyennant quoi les modules sont conçus pour communiquer les uns avec les autres,
et comportant des moyens de communication

sans fil (8, 12, 27) dans lesdits modules (SM, HUD, ICM) pour envoyer et recevoir des données entre le module capteur (SM) et le module d'affichage frontal (HUD) de la personne en service et de plus entre le module capteurs et le module gestionnaire d'incident (ICM),
le module capteur (SM) comprenant en outre

- une alarme d'avertissement d'embrasement pour analyser des données de capteurs et détecter le moment où les conditions ambiantes sont appropriées à un embrasement imminent ;
- un moyen destiné à calculer le niveau de stress thermique cumulé et d'alarme d'avertissement de stress thermique ;
- un système de sécurité d'alerte personnel (PASS) possédant un capteur de mouvement (6) et une alarme (5 ; 7) ;
- un bouton SOS (20) ; et
- un émetteur-récepteur à radiofréquence (8, 12) destiné à transmettre des données de capteurs, des alarmes et des données calculées au module d'affichage frontal (HUD) et/ou au module gestionnaire d'incident (ICM) et à recevoir des messages provenant du module gestionnaire d'incident (ICM) ; et

le module gestionnaire d'incident (ICM) comprenant en outre

- une unité de commande telle qu'un microprocesseur (26),
- un émetteur-récepteur à radiofréquence (27) destiné à recevoir des transmissions de données de capteurs et des transmissions SOS en provenance des pompiers, en particulier en provenance de leurs modules capteurs (SM) et à transmettre des messages à tout pompier sélectionné ou à tous les pompiers sélectionnés et
- un écran d'affichage (28) destiné à indiquer des informations en provenance des pompiers.

2. Indicateur de situation numérique selon la revendication 1, **caractérisé en ce que** le module capteur comprend un capteur de température infrarouge (9) destiné à détecter un incendie et/ou une température élevée derrière des portes fermées et des cloisons intérieures et un laser à lumière visible (11) pour montrer, grâce à son faisceau, vers quel endroit pointe le capteur (9).

3. Indicateur de situation numérique selon la revendication 2, **caractérisé en ce que** le capteur de température infrarouge (9) comporte un commutateur (10) tel qu'un bouton pour activer le capteur.

4. Indicateur de situation numérique selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** le module capteur (SM) comporte un émetteur de localisation d'urgence (ELT) activé par le système de sécurité d'alerte personnel (PASS) ou le bouton SOS (20).

5. Indicateur de situation numérique selon la revendication 1, **caractérisé en ce que** le module capteur (SM) peut être attaché au tuyau (15) à manomètre d'une bonbonne à air (2).

6. Indicateur de situation numérique selon l'une quelconque des revendications 2 à 5, **caractérisé en ce que** le module capteur comporte deux logements (17, 19) reliés à l'un à l'autre, le premier logement (17) étant destiné aux circuits électroniques et le second logement (19) étant destiné au capteur de température infrarouge (9) et au laser (11) agencés de façon coaxiale et en plus au commutateur d'activation de capteur IR (10) et au bouton SOS (20).

7. Indicateur de situation numérique selon la revendication 1, **caractérisé en ce que** le module d'affichage frontal (HUD) comporte une unité de commande, telle qu'un microprocesseur (24), un écran d'affichage, de préférence un écran d'affichage (21) numérique à cristaux liquides, miniature, rétroéclairé électroluminescent (22), et un moyen d'amélioration optique, spécifiquement une lentille doublet achromatique (22), optimisé pour corriger les aberrations chromatiques et sphériques sur l'axe, ledit écran d'affichage (21) étant positionné dans un masque facial ou un casque.

8. Indicateur de situation numérique selon la revendication 7, **caractérisé en ce que** l'écran d'affichage (21) est conçu pour fonctionner comme les indicateurs suivants :

- indicateur de pression destiné à indiquer la pression restant dans la bonbonne à air ;
- indicateur de temps restant destiné à indiquer l'air restant en minutes à la vitesse de consommation en cours ;
- indicateur de température ambiante destiné à afficher les températures ambiantes ;
- indicateur de stress thermique destiné à afficher le niveau de stress thermique cumulé du pompier ;
- indicateur d'avertissement d'embrasement destiné à alerter le pompier d'un danger d'embrasement imminent ;
- indicateur d'état de dispositif de système de sécurité d'alerte personnel (PASS) destiné à alerter le pompier d'un état de pré-alerte ; et

- indicateur de température infrarouge destiné à afficher la température infrarouge de l'objet vers lequel pointe le capteur de température infrarouge (9).

9. Indicateur de situation numérique selon l'une quelconque des revendications 1 à 8, **caractérisé en ce que** le module d'affichage frontal (HUD) a une communication vocale à radiofréquence bidirectionnelle entre l'un quelconque des pompiers et un gestionnaire d'incident au moyen du module gestionnaire d'incident (ICM).

10. Indicateur de situation numérique selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** le module gestionnaire d'incident (ICM) est conçu pour transmettre des messages textes au moyen de l'émetteur-récepteur (27) à tout pompier sélectionné ou à tous les pompiers.

11. Indicateur de situation numérique selon la revendication 1, **caractérisé en ce que** l'écran d'affichage (28) du module gestionnaire d'incident (ICM) est conçu pour indiquer les informations suivantes pour chaque pompier :

- temps passé dans l'incident ;
- pression dans la bonbonne à air et air restant, en minutes ;
- lecture de température ambiante ;
- niveau de stress thermique ;
- avertissement d'embrasement ;
- état du dispositif de système de sécurité d'alerte personnel (PASS) ; et
- lecture du capteur de température infrarouge (9) et pour chaque combattant ;
- temps passé en présence d'agent de guerre chimique ;
- concentration d'agent de guerre chimique dans les environs ;
- dosage en cours d'agent de guerre chimique ; et
- temps d'intervention restant, en minutes.

12. Indicateur de situation numérique selon l'une quelconque des revendications 1 à 11, **caractérisé en ce que** le module gestionnaire d'incident (ICM) possède un enregistreur de données qui est conçu pour enregistrer les informations suivantes :

- la situation de chaque pompier en temps réel, comme elle se présente ;
- transmission SOS de tout pompier en temps réel, comme elle se présente ;
- tous les enregistrements de service et d'entretien sur chaque dispositif ; et
- l'ajout automatique de marques heure/date à tous les enregistrements.

13. Indicateur de situation numérique selon l'une quelconque des revendications 1 à 12, **caractérisé en ce que** le module gestionnaire d'incident (ICM) a une capacité de programmation sur le terrain, qui permet à l'ICM de télécharger des codes d'identification et d'autres informations depuis le module gestionnaire d'incident (ICM) vers le module capteur (SM) et le module d'affichage frontal (HUD) du pompier.

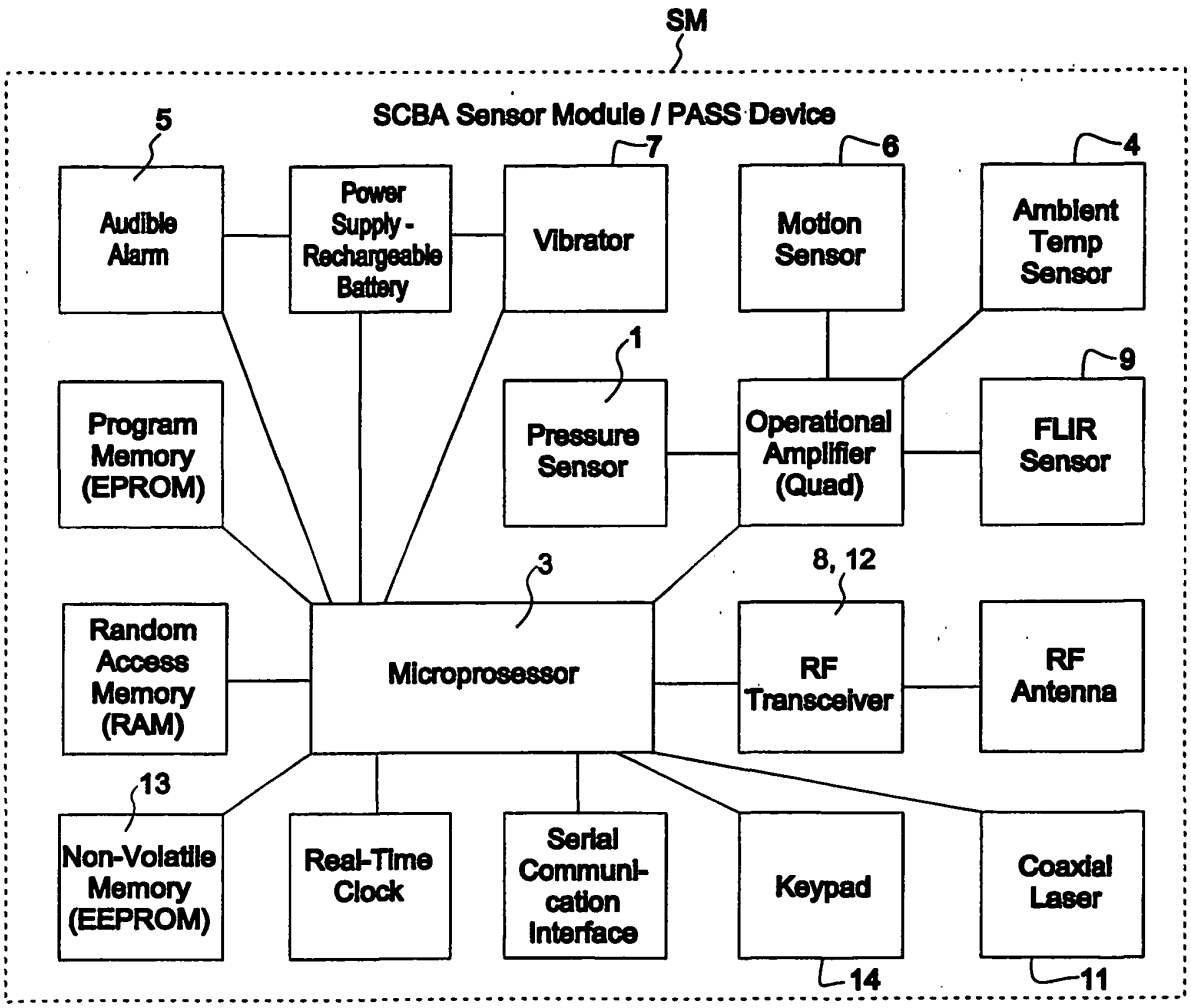

SM
SCBA Sensor Module / PASS Device
5
Audible Alarm
Power Supply - Rechargeable Battery
7
Vibrator
6
Motion Sensor
4
Ambient Temp Sensor
1
Pressure Sensor
Operational Amplifier (Quad)
9
FLIR Sensor
Program Memory (EPROM)
3
Microprosessor
8, 12
RF Transceiver
RF Antenna
Random Access Memory (RAM)
13
Non-Volatile Memory (EEPROM)
Real-Time Clock
Serial Communi-cation Interface
Keypad
14
Coaxial Laser
11

Fig. 1

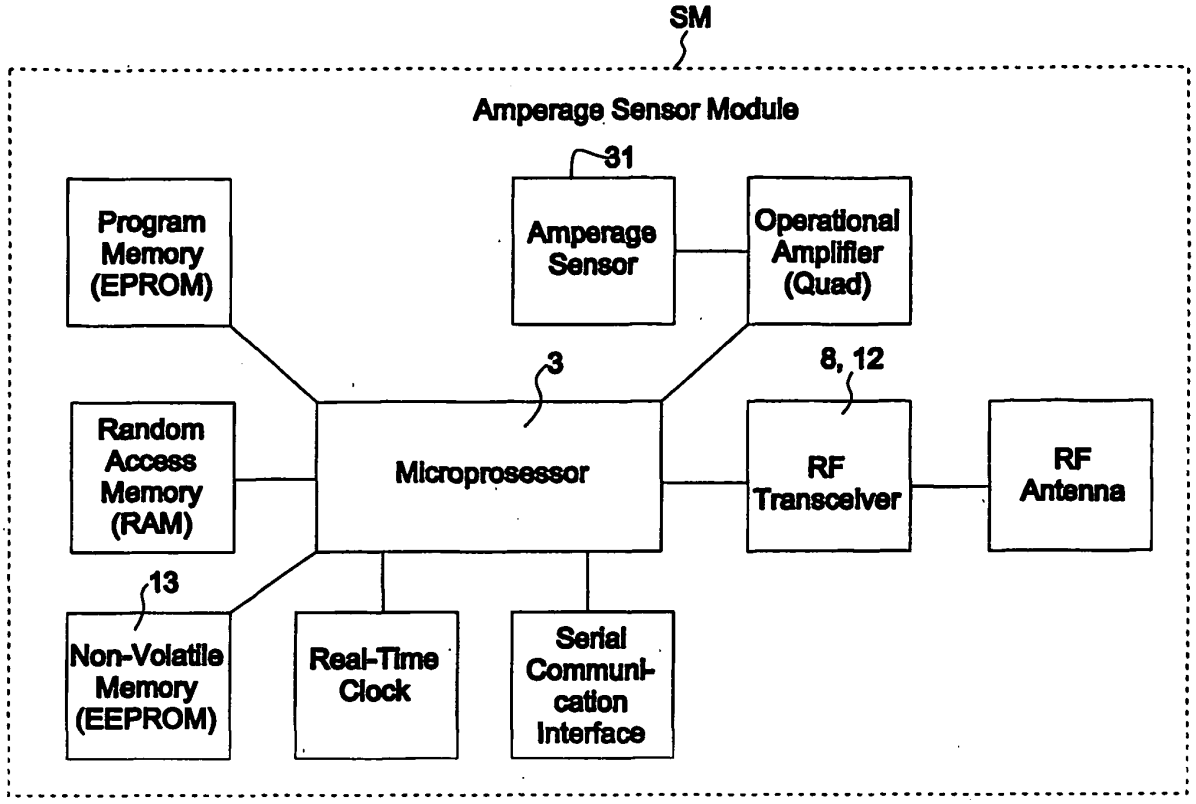

SM
Amperage Sensor Module
31
Program Memory (EPROM)
Amperage Sensor
Operational Amplifier (Quad)
3
8, 12
Random Access Memory (RAM)
Microprosessor
RF Transceiver
RF Antenna
13
Non-Volatile Memory (EEPROM)
Real-Time Clock
Serial Communi-cation Interface

Fig. 2

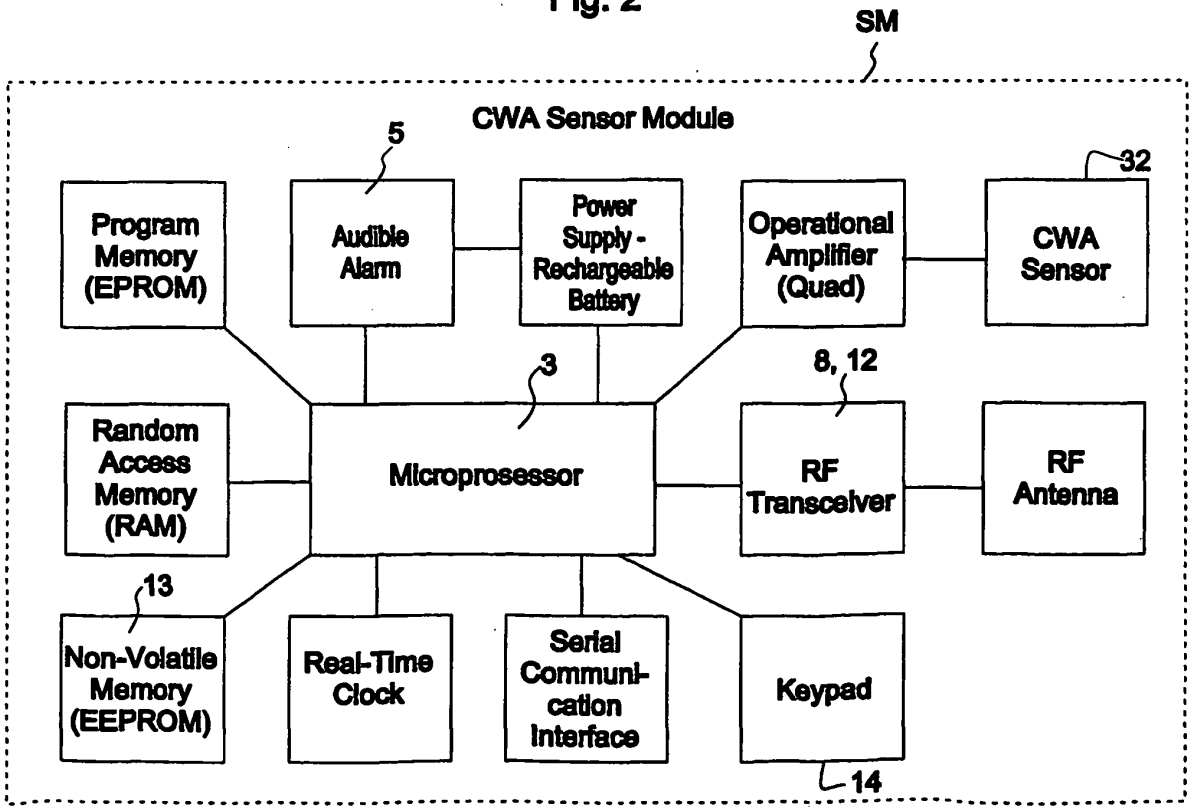

SM
CWA Sensor Module
5
32
Program Memory (EPROM)
Audible Alarm
Power Supply - Rechargeable Battery
Operational Amplifier (Quad)
CWA Sensor
3
8, 12
Random Access Memory (RAM)
Microprosessor
RF Transceiver
RF Antenna
13
Non-Volatile Memory (EEPROM)
Real-Time Clock
Serial Communi-cation Interface
Keypad
14

Fig. 3

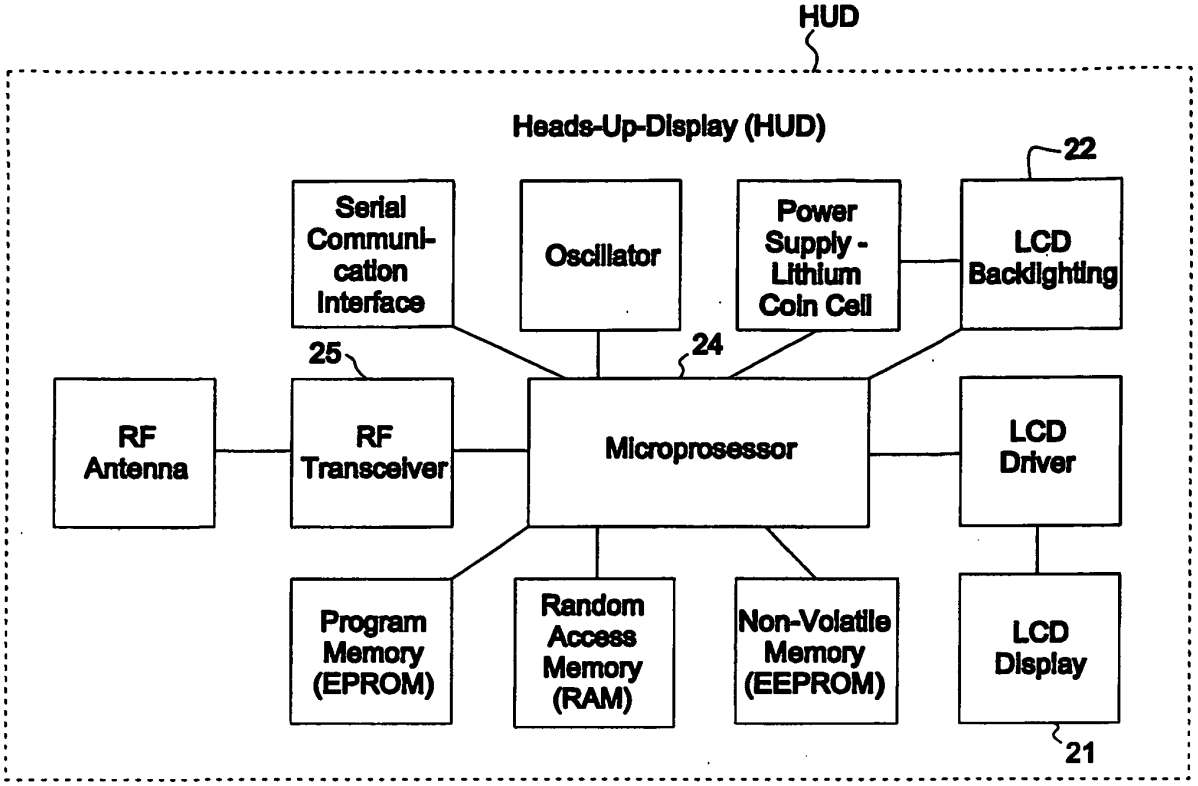

HUD
Heads-Up-Display (HUD)
22
Serial Communi-cation Interface
Oscillator
Power Supply - Lithium Coin Cell
LCD Backlighting
25
24
RF Antenna
RF Transceiver
Microprosessor
LCD Driver
Program Memory (EPROM)
Random Access Memory (RAM)
Non-Volatile Memory (EEPROM)
LCD Display
21

Fig. 4

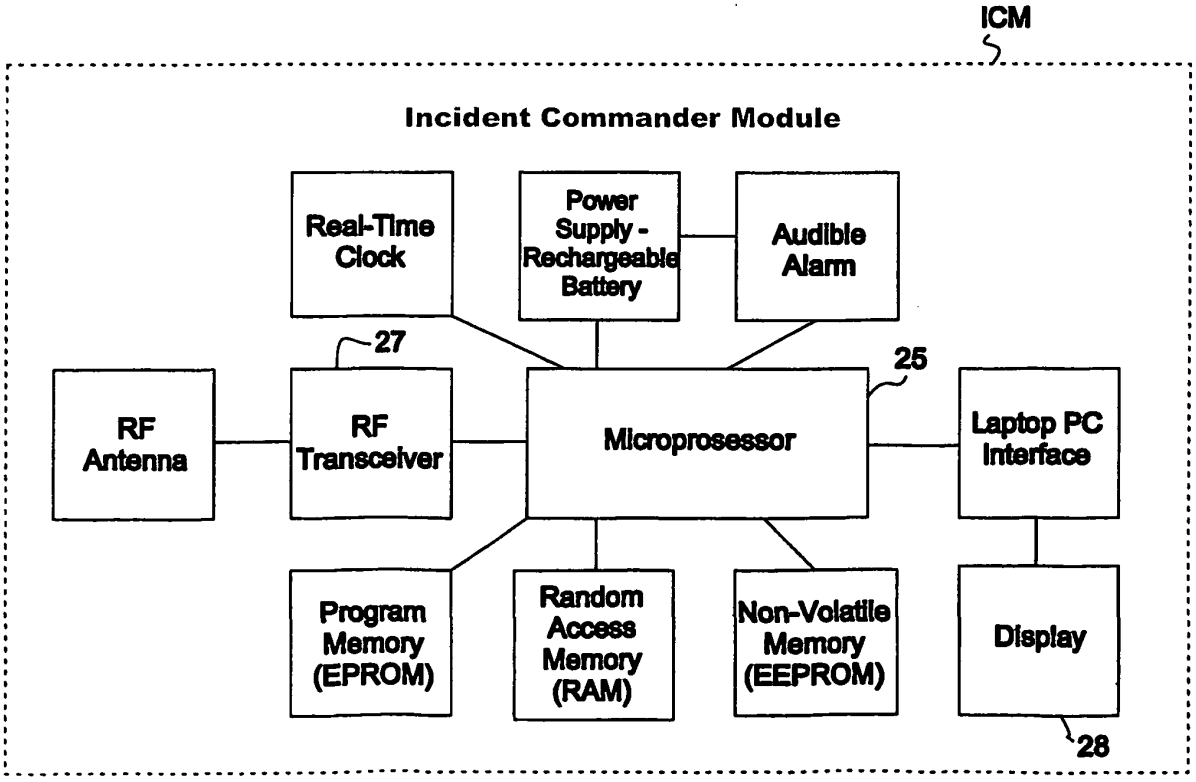

ICM
Incident Commander Module
Real-Time Clock
Power Supply - Rechargeable Battery
Audible Alarm
27
25
RF Antenna
RF Transceiver
Microprosessor
Laptop PC Interface
Program Memory (EPROM)
Random Access Memory (RAM)
Non-Volatile Memory (EEPROM)
Display
28

Fig. 5

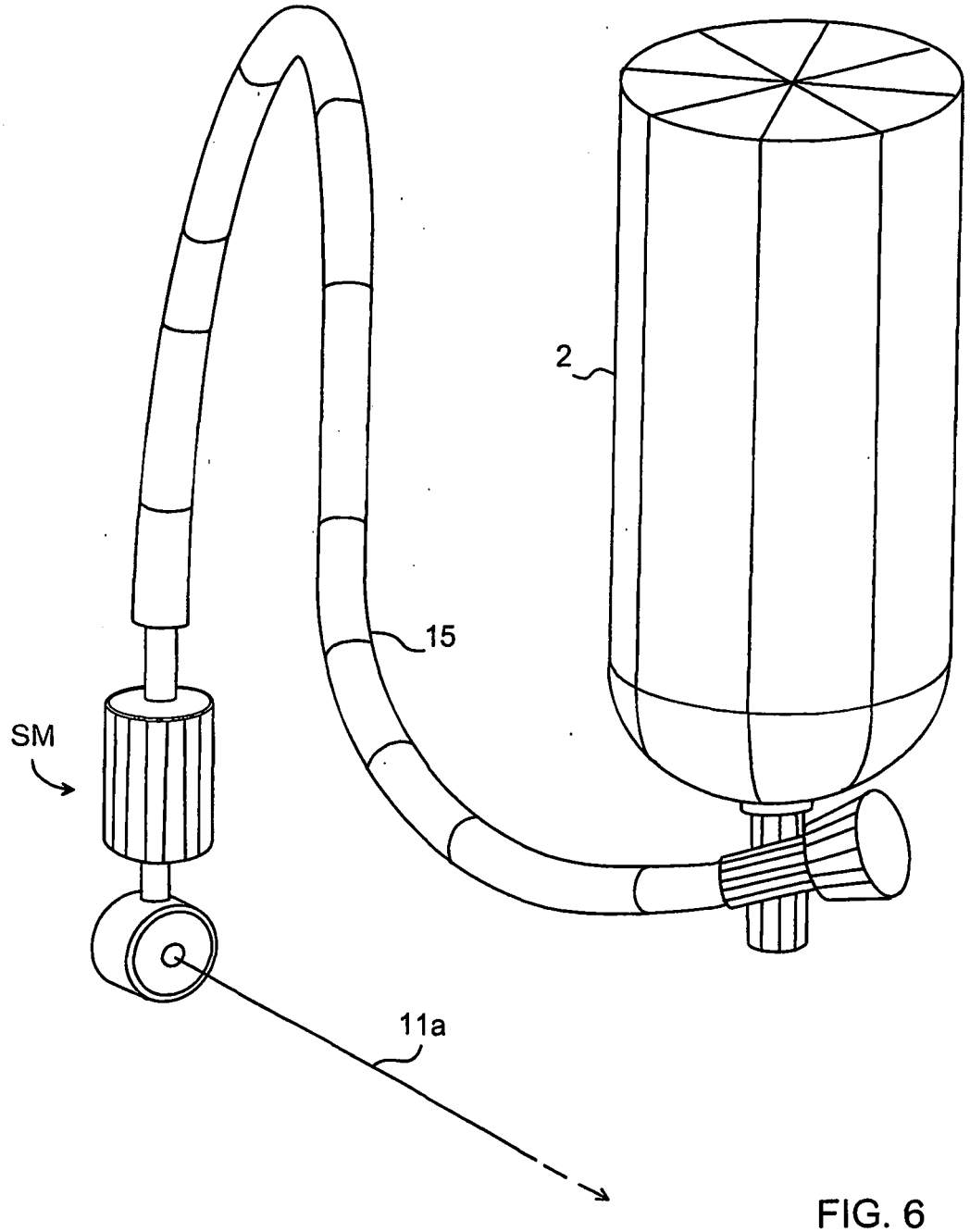


FIG. 6

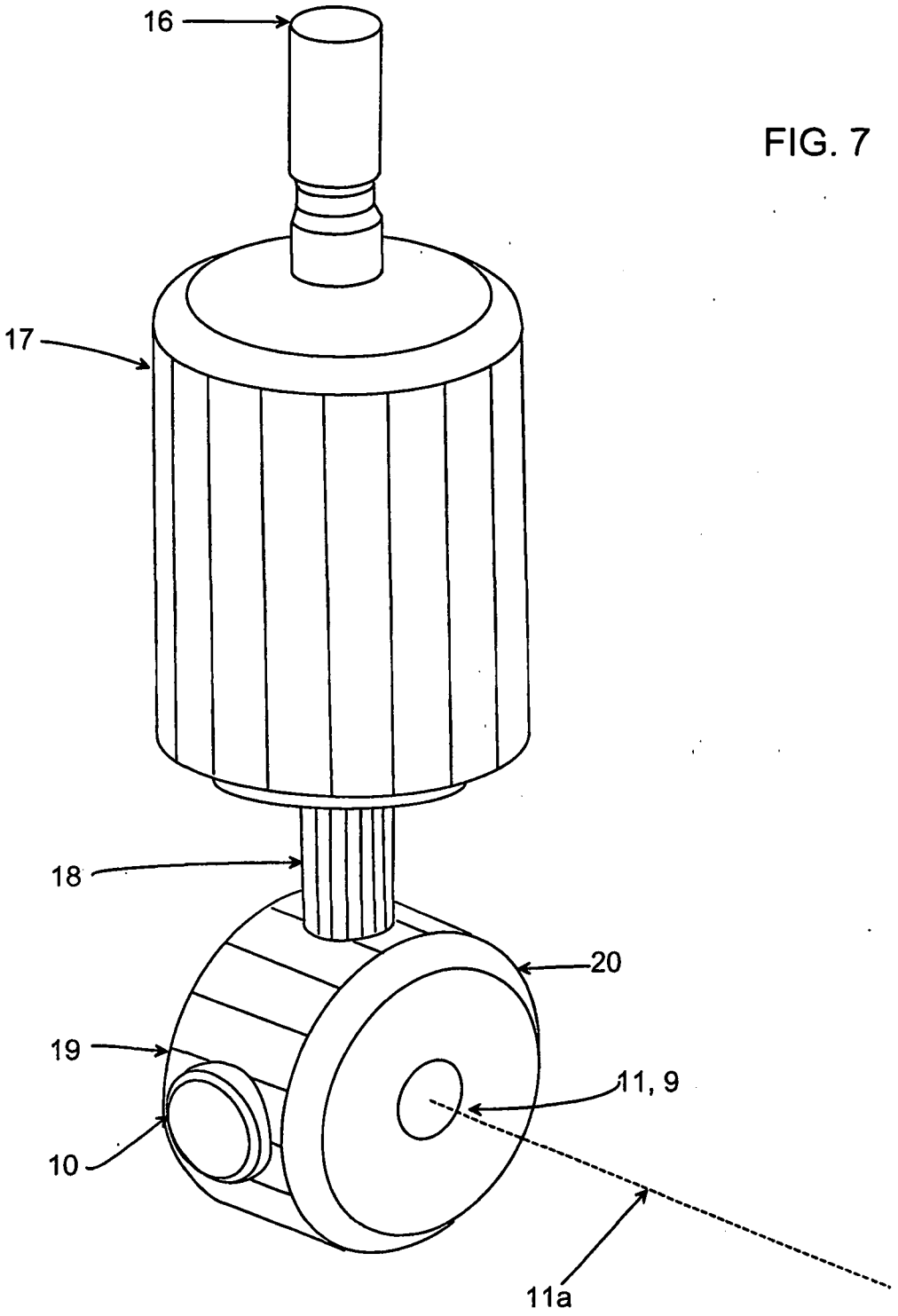


FIG. 7

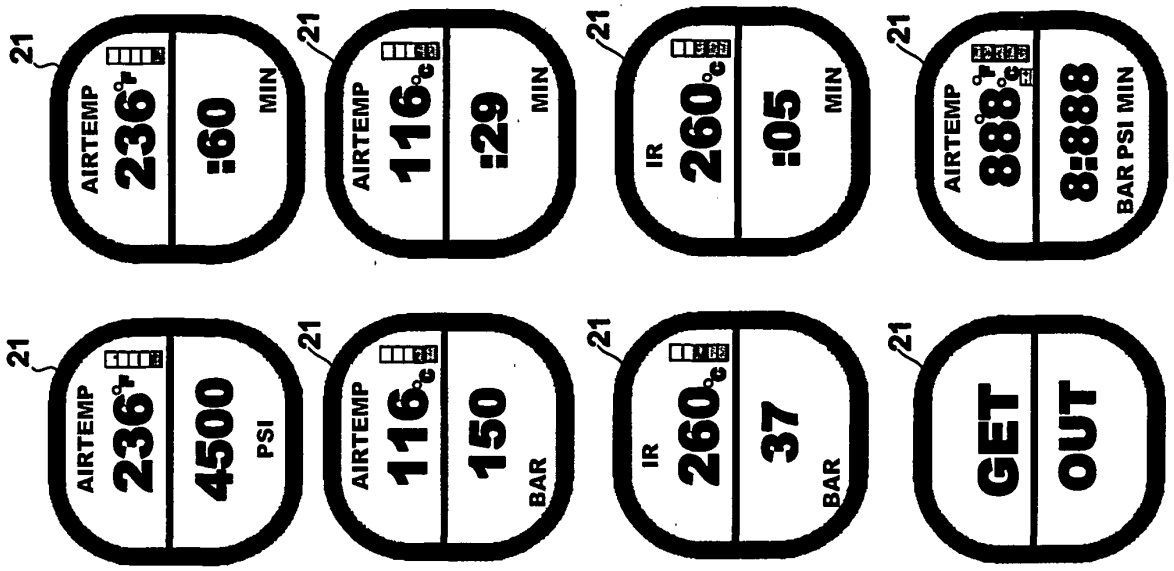

21
AIRTEMP
236°
:60
MIN
21
AIRTEMP
116°
:29
MIN
21
IR
260°
:05
MIN
21
AIRTEMP
888°
8:888
BAR PSI MIN
21
AIRTEMP
236°
4500
PSI
21
AIRTEMP
116°
150
BAR
21
IR
260°
37
BAR
21
GET
OUT

FIG. 11

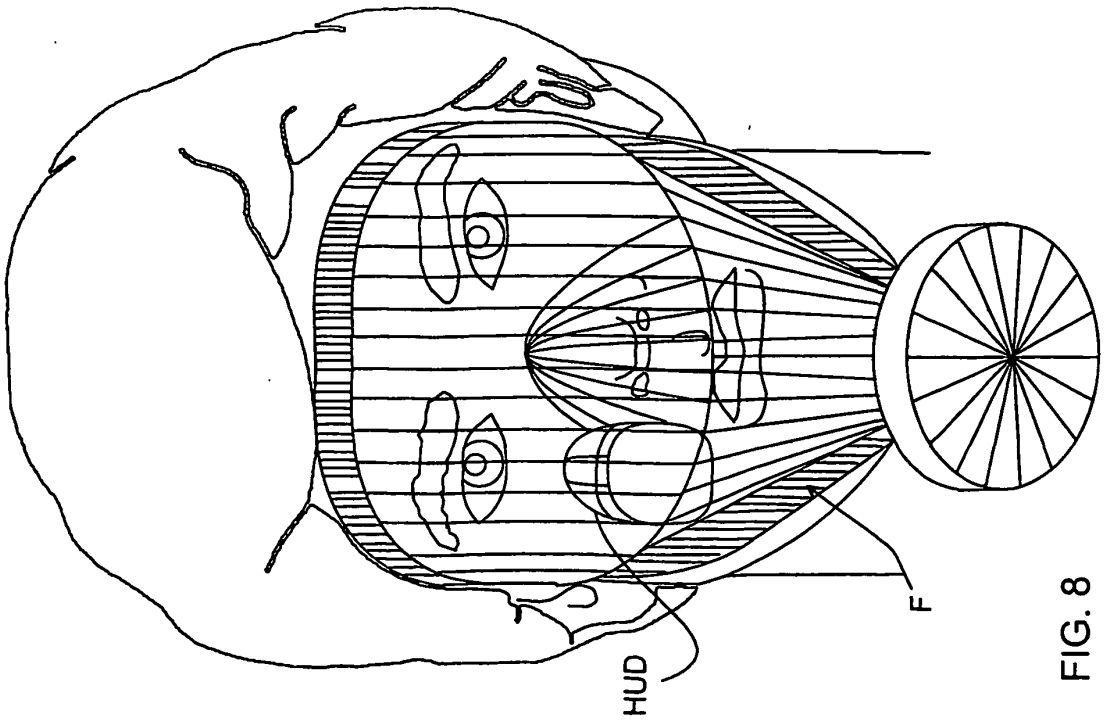

HUD
F

FIG. 8

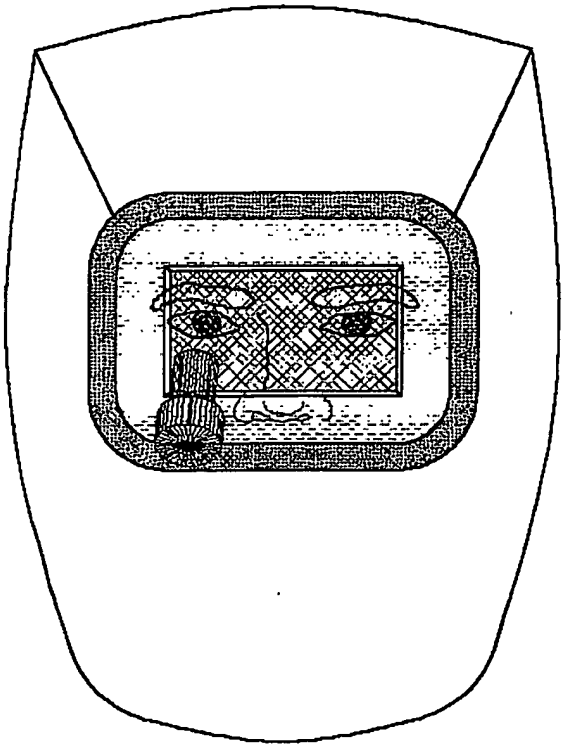


Fig. 9

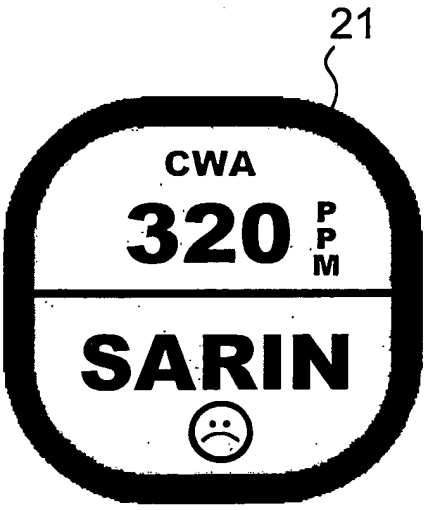


Fig. 13b

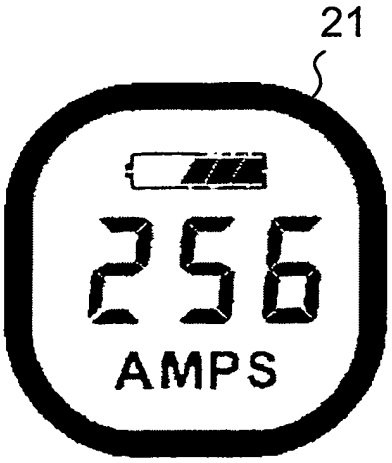


Fig. 12

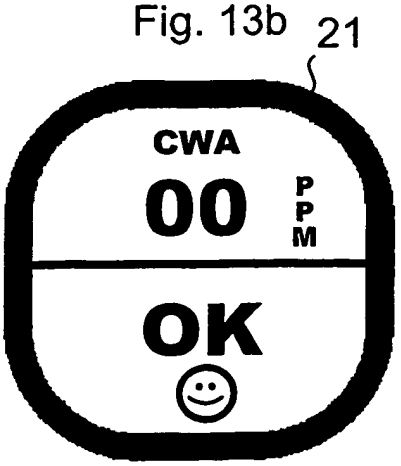
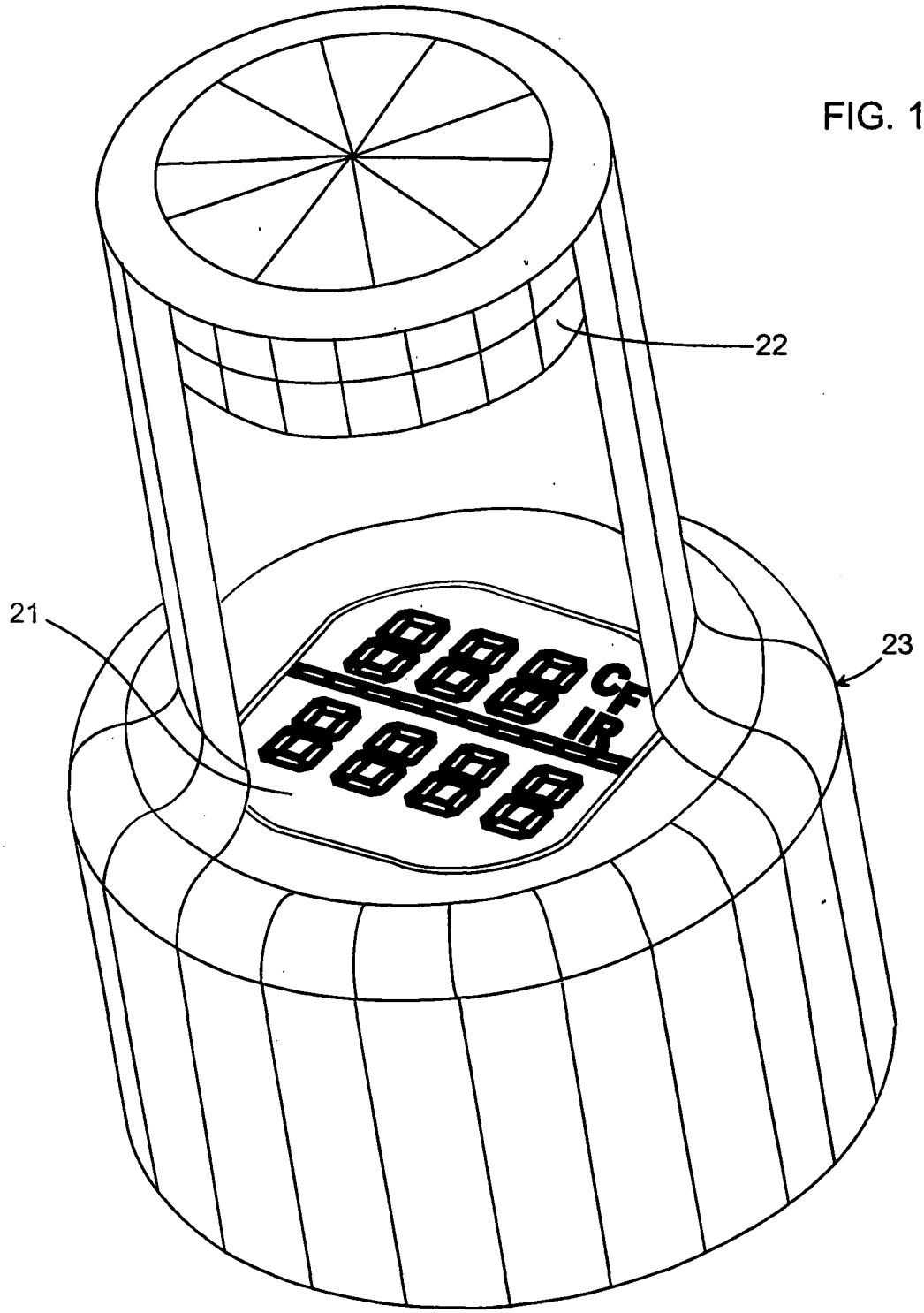


Fig. 13a

FIG. 10



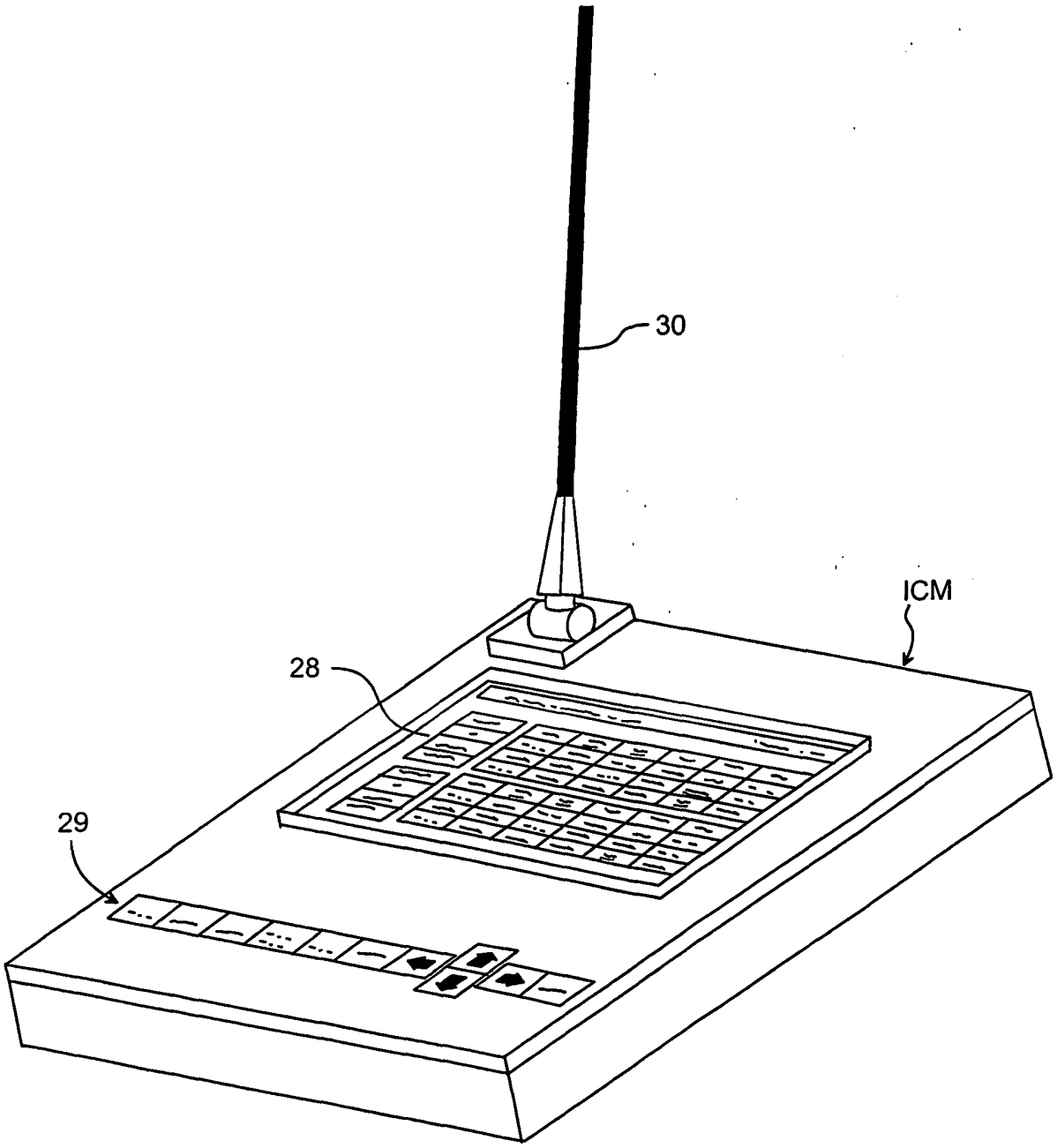


FIG. 14

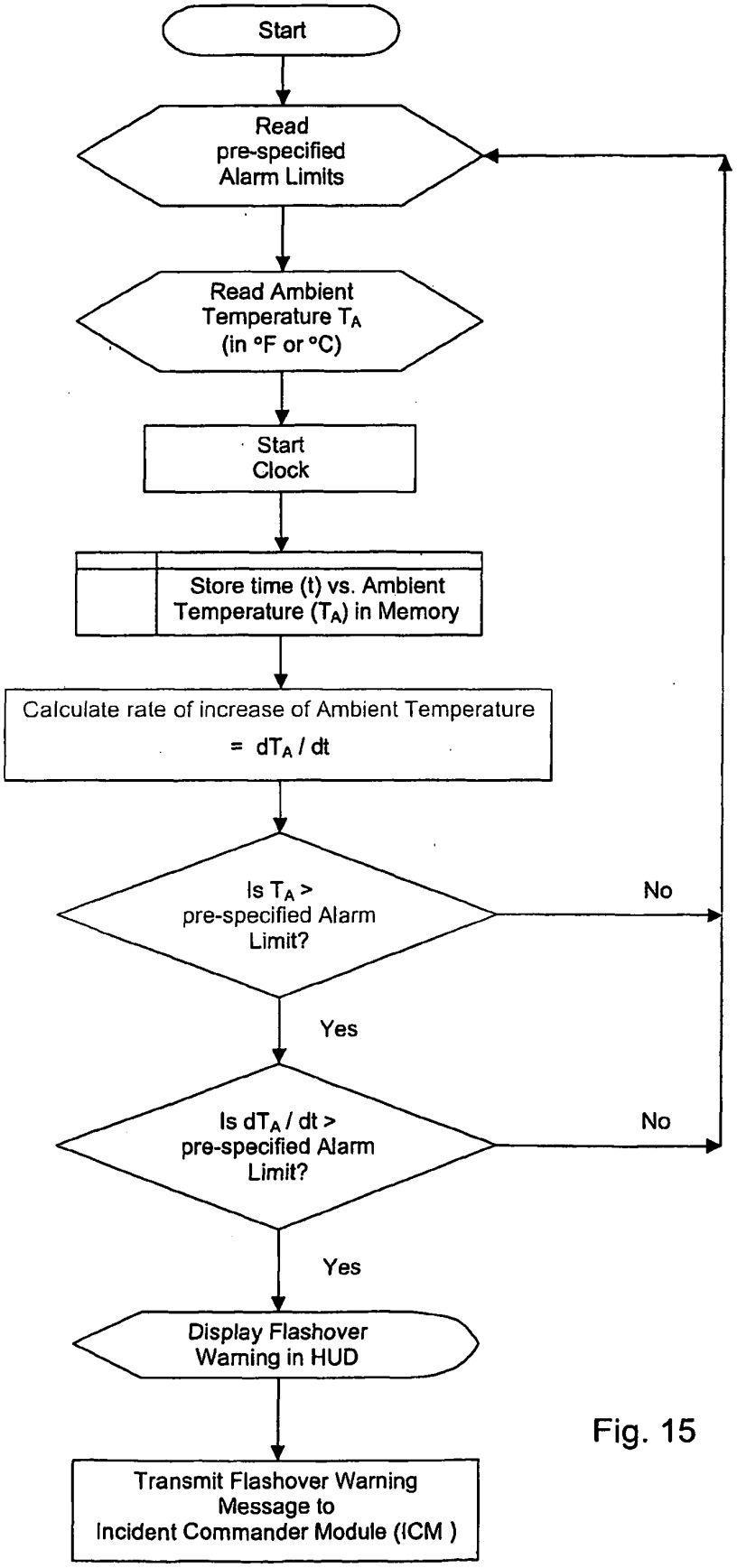

Start
Read pre-specified Alarm Limits
Read Ambient Temperature T_A (in °F or °C)
Start Clock
Store time (t) vs. Ambient Temperature (T_A) in Memory
Calculate rate of increase of Ambient Temperature = dT_A / dt
Is T_A > pre-specified Alarm Limit?
No
Yes
Is dT_A / dt > pre-specified Alarm Limit?
No
Yes
Display Flashover Warning in HUD
Transmit Flashover Warning Message to Incident Commander Module (ICM)

Fig. 15

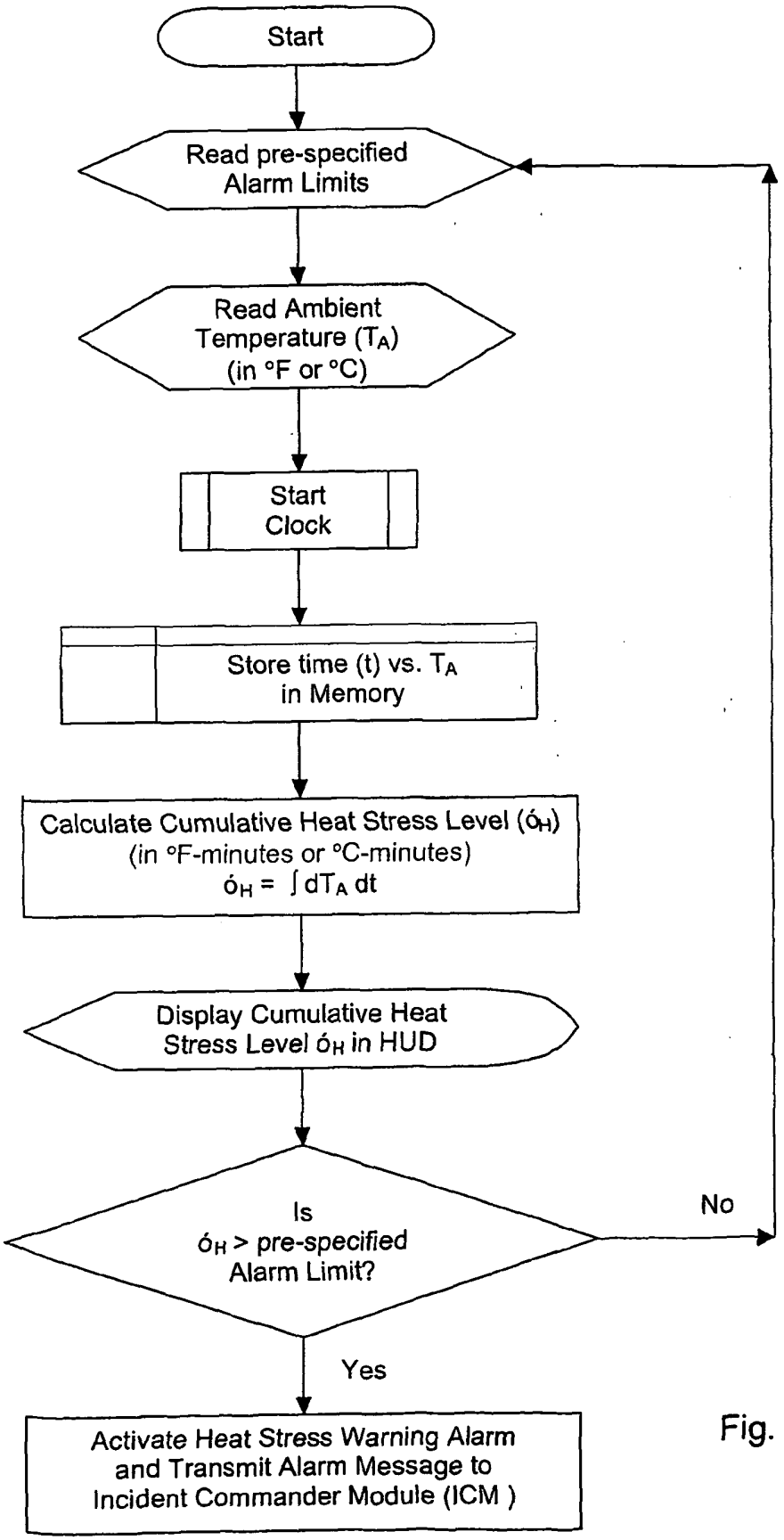

Start
Read pre-specified Alarm Limits
Read Ambient Temperature (T_A) (in °F or °C)
Start Clock
Store time (t) vs. T_A in Memory
Calculate Cumulative Heat Stress Level ($ó_H$) (in °F-minutes or °C-minutes)
$ó_H = \int dT_A\, dt$
Display Cumulative Heat Stress Level $ó_H$ in HUD
Is $ó_H$ > pre-specified Alarm Limit?
No
Yes
Activate Heat Stress Warning Alarm and Transmit Alarm Message to Incident Commander Module (ICM)

Fig. 16

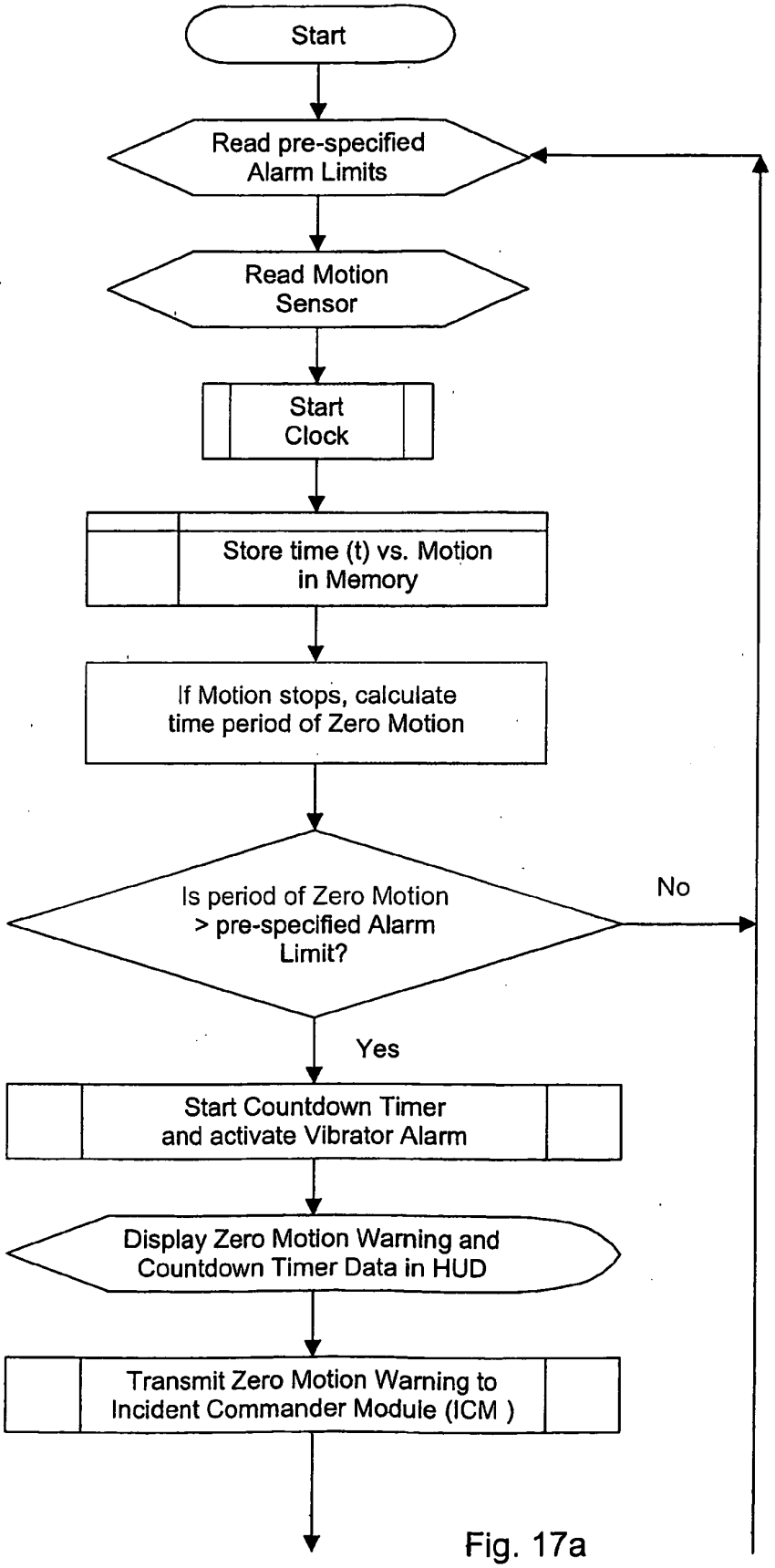

Start
Read pre-specified Alarm Limits
Read Motion Sensor
Start Clock
Store time (t) vs. Motion in Memory
If Motion stops, calculate time period of Zero Motion
Is period of Zero Motion > pre-specified Alarm Limit?
No
Yes
Start Countdown Timer and activate Vibrator Alarm
Display Zero Motion Warning and Countdown Timer Data in HUD
Transmit Zero Motion Warning to Incident Commander Module (ICM)

Fig. 17a

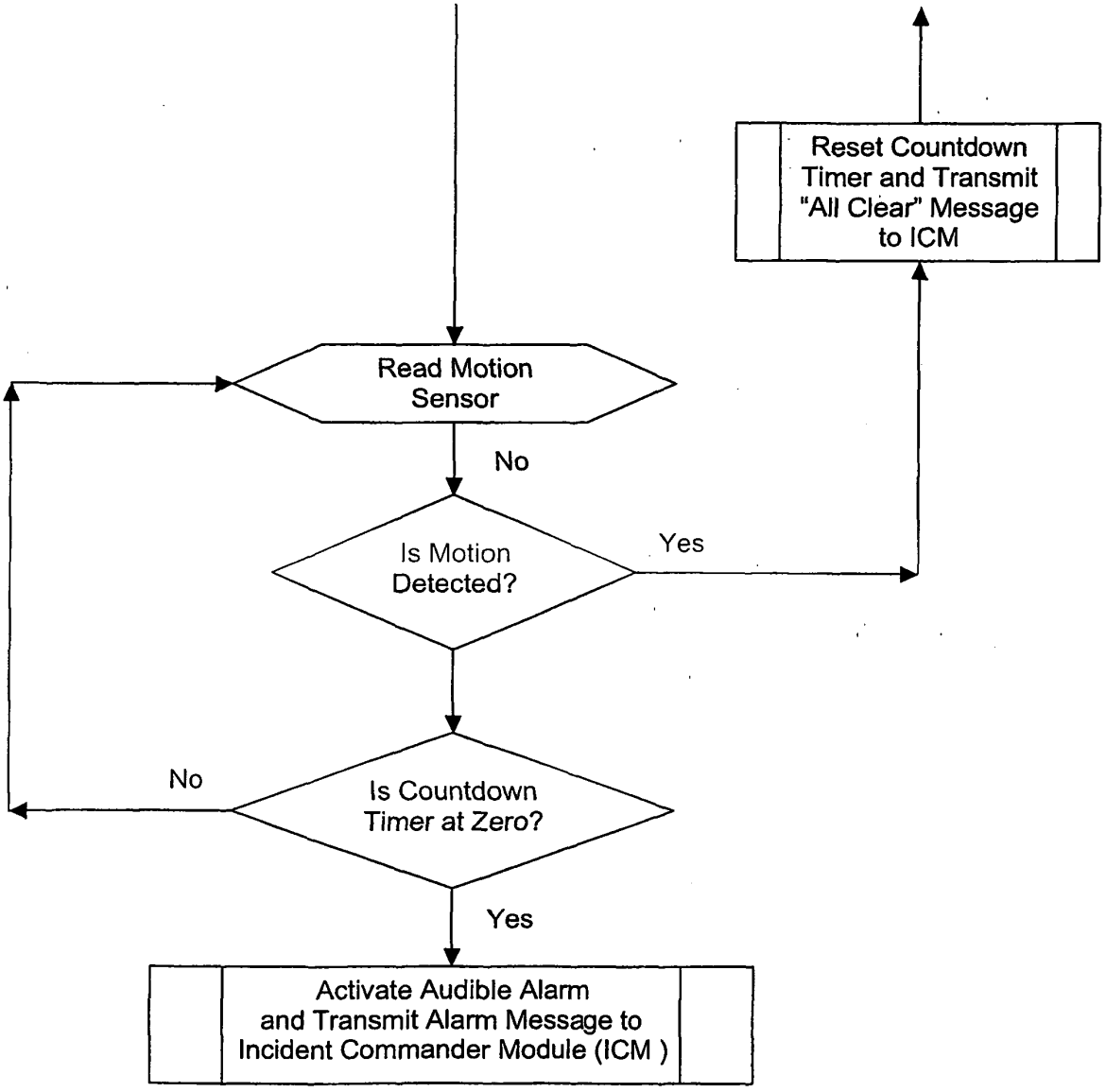

Reset Countdown Timer and Transmit "All Clear" Message to ICM
Read Motion Sensor
No
Is Motion Detected?
Yes
No
Is Countdown Timer at Zero?
Yes
Activate Audible Alarm and Transmit Alarm Message to Incident Commander Module (ICM)

Fig. 17b

REFERENCES CITED IN THE DESCRIPTION

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- US 5503145 A **[0013]**
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