(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 September 2012 (13.09.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/119194 A1

(51) International Patent Classification:
H01H 3/20 (2006.01) *H02J 3/20* (2006.01)

(21) International Application Number:
PCT/AU2012/000226

(22) International Filing Date:
6 March 2012 (06.03.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2011900794 7 March 2011 (07.03.2011) AU
13/246,330 27 September 2011 (27.09.2011) US

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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(54) **Title**: SOLAR CELL INSTALLATION. CUT-OUT SWITCH AND METHOD

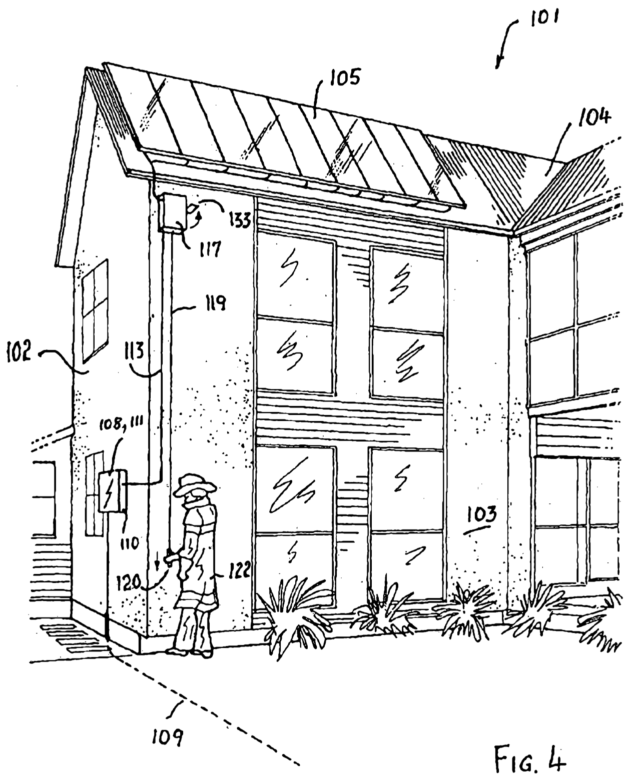

FIG. 4

(57) **Abstract**: A disconnection mechanism (16, 116, 316) is disclosed to disconnect solar cells (5, 105, 305) from high voltage DC cables (13, 113, 313) which may run through the interior of a building (1) and thus represent a hazard to emergency service personnel such as firemen attending a fire in daylight hours. Thus the DC output from the cells (5, 105, 305) can be rendered safe. The mechanism is located in an elevated position adjacent the solar cells (5, 105, 305) but is operable by an elongated actuator (19, 119) which extends to ground level. Preferably the solar cells are individually connected via corresponding cables (223, 323) to a terminal block (118) within a fire resistant housing (117, 317) for the disconnection mechanism (116, 316).

WO 2012/119194 A1

Published:

— *with international search report (Art. 21(3))*

SOLAR CELL INSTALLATION, CUT-OUT SWITCH AND METHOD

Field of the Invention

The present invention relates to the installation of solar cells and, in particular, to the installation of solar cells in a manner which is safe in the event of a fire engulfing the structure on which solar cells are mounted.

Background Art

Solar cells need to be mounted so as to receive solar radiation and for this reason are often mounted on the roof of a building. Irrespective or whether the building has one or more storeys, the roof is at an elevated position which is generally difficult to access. The solar cells generate a DC output and are connected by means of a DC cable to an inverter which converts the DC output (typically 500V DC and up to approximately 20 amps) into an AC output (typically 240V or 110V) which is either used within the building or is injected into an AC mains supply. The inverter and the AC switchboard, with which it is connected, are generally located at ground level at a position which is able to be accessed in a convenient manner. Depending upon the nature of the building and the installation, the DC cable often extends through the roof cavity of the building, through cavities between walls, and the like. The route of the DC cable is generally not marked and very often the cable will have been installed after the building has been constructed.

In the event of a fire, the fire brigade personnel arriving at the building will disconnect the wiring of the building from the AC mains supply, if this has not already been done by an occupant of the building or some other person who has raised the fire alarm. However, during the daylight hours, the output of the solar cells will continue to be produced notwithstanding that a fire may be raging within the building. As a consequence, the fire brigade personnel attending the fire are potentially exposed to an electrical hazard in the form of the energised DC cable which will remain energised until such time the solar cells are effectively destroyed by the fire.

Genesis of the Invention

The genesis of the present invention is a desire to reduce the exposure of firemen and such emergency personnel to DC electrical hazards caused by the presence of solar cells mounted on buildings and similar structures.

Summary of the Invention

In accordance with a first aspect of the present invention there is disclosed a solar cell installation comprising at least one solar cell mounted in an elevated position to receive solar radiation, said solar cell having a DC output connected via a DC cable to an inverter to convert said DC output into an AC output, wherein a cut-out switch is located in an elevated position adjacent said solar cell(s) and is operable to disconnect said DC output from said DC cable, and wherein said cut-out switch adjacent said elevated position is operable by an elongated actuator which extends from said cut-out switch to an un-elevated position at, or near, ground level.

In accordance with a second aspect of the present invention there is disclosed a method of isolating at least one solar cell mounted in an elevated position to receive solar radiation and producing a DC output, said method comprising:

interposing a cut-out switch in a DC cable interconnecting said solar cells with an inverter to produce an AC output, said cut-out switch being located in an elevated location adjacent said solar cells and being operable to disconnect said DC output from said DC cable,

connecting said cut-out switch to an elongated actuator which extends from said cut-out switch to an un-elevated position at, or near, ground level, and

operating said actuator to disconnect said DC cable from said solar cell.

In accordance with a third aspect of the present invention there is disclosed a cut-out switch operable remotely by an elongated actuator, said switch comprising a fire resistant housing, a switch located inside said housing, and an elongated actuator having two ends, one end being connected with said switch to open and close same and the other end of said actuator having an operating handle means.

In accordance with a fourth aspect of the present invention there is disclosed a solar cell installation including the abovementioned cut-out switch.

Brief Description of the Drawings

Preferred embodiments of the invention will now be described, with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of a two storey building having a roof upon which solar cells are mounted and isolated in accordance with a first embodiment;

Fig. 2 is a schematic cross-sectional view showing the mounting of the solar cells of Fig. 1 and the operation of the actuator to disconnect same;

Fig. 3 is a perspective view of the open housing in which the cut-out switch of Figs. 1 and 2 is mounted;

Fig. 4 is a perspective view of a two storey building having a roof upon which solar cells are mounted and isolated in accordance with a second embodiment;

Fig. 5 is a schematic perspective view of the open housing in which the cut-out switch of the second embodiment is mounted;

Fig. 6 is a perspective view of the lower end of the actuator;

Fig. 7 is a circuit diagram illustrating one way of interconnecting the solar cells; Fig. 8 is a view similar to Fig. 5 but showing the cut-out switch opened;

Fig. 9 is a view of a third embodiment of a housing with cut-out switches;

Fig. 10 is a circuit diagram of the arrangement of Fig. 9; or

Fig. 11 is a side elevation of the switches and linear to rotary motion mechanism of the third embodiment of Fig. 9.

Detailed Description

As seen in Fig. 1, a building 1 has an upper storey 2 and a ground floor 3. The upper storey 2 has a roof 4 upon which a number of solar cells 5 are mounted so as to receive solar radiation.

Mounted at ground level is an inverter 8 which is connected to an AC mains supply 9 which takes the form of an underground cable which leads to a housing 10 which includes both the inverter 8 and an AC switchboard 11. A DC cable 13 interconnects the inverter 8 with a junction box 14 located adjacent the solar cells 5. In the prior art the junction box 14 and the DC cable 13 are directly connected and so the DC cable 13 is always energised for so long as solar radiation falls on the solar cells 5.

In the prior art, this has the consequence that in the event of a fire, even though the AC switchboard 11 may be disconnected from the AC mains supply 9, the DC cable 13 which runs through the roof cavity and a wall cavity is still energised with the output of the solar cells.

In order to overcome this problem in accordance with the first embodiment of the present invention, a cut-out switch 16 having a housing 17 is mounted under the eave of the roof 4. The housing 17 is therefore in an elevated position but is provided with an elongated actuator 19 having a handle 20 which is able to be operated by a fireman 22 (Fig. 2) at ground level so as to disconnect the DC cable 13 from the output of the solar cells 5.

It will be apparent from Fig. 2 that the DC cable 13 extends through the interior of the building 1 and, if not de-energised, represents an electrical hazard to emergency personnel such as the fireman 22 called to fight a fire, for example.

Turning now to Fig. 3, the housing 17 and cut-out switch 16 are illustrated. The housing 17 is preferably fire resistant and contains terminals to which are connected the DC cable 13 on one side, and the solar cell cable 23 on the other side. The DC cable 13 is preferably fire rated. The elongated actuator 19 comprises a Bowden cable, or similar, having an outer sleeve 25 and an inner cable 26, the lower end of which is connected to the handle 20. It will be apparent that pulling the handle 20 downwardly disconnects the solar cell cable 23 from the DC cable 13.

Preferably, in this embodiment, pushing the handle upwardly does not reconnect the two cables. Thus only disconnection can take place from ground level thereby rendering the interior of the building 1 undoubtedly safe once the disconnection has taken place. Furthermore, the handle 20 in the pulled down position provides a non-transient mechanical signal that the solar cells have been isolated. In addition, the mechanical actuator 19 can be relied upon to function reliably notwithstanding the heat of any fire.

Turning now to Figs. 4-8, in the description of the second embodiment, like components have been allocated a designation number increased by 100 relative to the description of the first embodiment in relation to Figs. 1-3.

As seen in Fig. 4, as before building 101 has an upper storey102 and a ground floor 103. The upper storey 102 has a roof 104 upon which a number of solar cells 105 are mounted so as to receive solar radiation.

Mounted at ground level is an inverter 108 which is connected to an AC mains supply 109 which takes the form of an underground cable which leads to a housing 110 which includes both the inverter 108 and an AC switchboard 111. A DC cable 113 interconnects the inverter 108 with a housing 117. Located within the housing 117 is a pair of cut-out switches 116. The housing 117 is in an elevated position and is provided with an elongated actuator 119 having a handle 120 (illustrated in more detail in Fig. 6) and which is able to be operated by a fireman 122 (Fig. 4) at ground level so as to disconnect the DC cable 113 from the output of the solar cells 105.

Turning now to Fig. 5, the housing 117 and two cut-out switches 116 are illustrated. The housing 117 is preferably fire resistant and contains a terminal block 118 to which are connected a DC high voltage cable 130 on one side, and the solar cell cable(s) 123 on the other side.

There are two possible ways of connecting the solar cells 105. Traditionally, as illustrated in Fig. 7 such cells have been connected together in series so that the solar cell cable 123 leading into the housing 117 carries a maximum DC voltage (and hence a minimum current). Under these circumstances, the solar cell cable 123 and the DC high voltage cable 130 have the same voltage and are simply connected together by means of the switches 116 and the terminal block 118. The switches 116 are ganged together so as to be double pole double throw.

An alternative way of connecting the solar cells 105, which is much to be preferred, is that each cell 105 has an individual cable as illustrated in Fig. 4 and that all the individual cables 223 are terminated at the terminal block 118. This arrangement is indicated by broken lines in Fig. 8. Under these circumstances, the individual solar cell cables 223 each carry the individual cell voltage and it is only the DC high-voltage cable 130 and the DC cable 113 which are at the high DC voltage. This provides an additional safety benefit. The solar cell cable(s) 123, 223 and the DC cables 113 and 130 are preferably fire rated.

The elongated actuator 119 comprises a Bowden cable, or similar, having an outer sleeve 125 and an inner cable 126 the lower end of which is connected to the handle 120. The inner cable 126 is connected to the lower part of the double pole cut-out switch 116 via a plate 131. A cam 132 is also mounted on the plate 131 so as to rotate a pivoted flag 133. With the handle 120 of Fig. 6 in the upward position illustrated in Fig. 6, the cut-out switch 116 is connected as illustrated in Fig. 5, and the flag 133 points vertically downwards. However, pulling the handle 120 downwardly as seen in Fig. 6 moves the plate 131 of Fig. 5 downwardly thereby opening the double pole cut-out switch 116 and rotating the flag 133 into a horizontal position as seen in Fig. 8 (and in Fig. 4). As a consequence, the solar cells 105 are disconnected from the DC cable 113. Further the flag 133 optionally has one side painted differently from the other so as to clearly indicate the disconnection to those at ground level.

As seen in Fig. 4, both the DC cable 113 and the solar cell cables 123 do not extend through the interior of the building 100 and thus do not constitute an electrical hazard to any emergency personnel such as the fireman 122 called to fight a fire, for example, and who enter the interior of the building. However, this desirable wiring practice will not be previously known, in general, to such emergency personnel.

Turning now to the third embodiment illustrated in Figs. 9, 10 and 11, in the description of the third embodiment, like components have been allocated a description number increased by 300 relative to the description of the first embodiment, and 200 relative to the description of the first embodiment.

Thus in Figs. 9 to 11 there are four switches 316 located within the housing 317 and which are utilised to isolate six solar cells 305. Each solar cell 305 has a nominal rating of 50V but on a bright sunny day is capable of producing approximately 85V on open circuit. Thus the DC cable 313 (Fig. 10) connected with the inverter can have approximately 500V applied to it. However, each of the solar cell cables 323 only has 50-80V applied to it. Accordingly, these cables do not represent a hazard to firemen, and the like, and can, for example, be safely cut with a pair of pliers even in bright sunshine without the risk of sparks or electrocution.

The interconnections between the individual solar cell cables 323 (which each contain two wires) are made via the terminal block 318, however, the solar cell cables 323 and the DC cables 313 of Fig. 10 are omitted in Fig. 9 so as to not overburden the drawing.

Because of the wiring arrangement of Fig. 10, the high voltage is created only within the housing 317 or within the DC high voltage cable 313 which is able to be isolated by the four switches 316. From Fig. 10 it will be seen that the switches 316 isolate pairs of series connected solar cells 305, and the series connection for each pair is made within the housing 317. Thus, each solar cell cable 323 extending between the housing 317 and a solar cell 305 only carries the 50-80V cell voltage.

Turning now to Fig. 11, it will be seen that the flag 333 is mounted on an axle 363 which has an arm 364. At the free end of the arm 364 is a ball bearing 365 which is constrained to run along a vertical track 366 formed by an inverted U-shaped housing 367. The housing 367 is mounted on, and moves with a carrier plate 331. The reciprocating linear motion of the carrier plate 331 is thus converted into reciprocating rotary motion of the flag 333 which moves between the two positions indicated by broken lines in Fig. 11. The movable contact of each of the switches 316 is mounted to, and is movable with, the carrier plate 331 so as to open or close the switches 316.

The carrier plate 331 is moved by the Bowden cable actuator 319 having a stationary outer sleeve 325 and a movable inner cable 326 which passes through a hole in the carrier plate 331. The inner cable 326 also passes through two stop members 370.

Each stop member 370 is cylindrical, has a through hole for the cable 326 and a clamping screw 371 which can be either fix the stop member 370 to the cable 326, or allow the stop member 370 to slide relative to the cable 326.

Thus in Figs. 9 and 11, both stop members 370 are clamped to the cable 326 on either side of the carrier plate 331. This enables the carrier plate 331 to be reciprocated by the actuator 319 to thus simultaneously open (or close) the switches 316 and rotate the flag 333 accordingly.

However, if only one stop member 170 is present as illustrated in Fig. 5, then the actuator 119 can only open the switches 116, and not close them. Closing the switches 116 can then only be carried out manually at the housing 117 at roof level by moving the flag 133.

It will therefore be apparent that in the embodiment of Figs. 9 to 11, whilst pulling the cable 326 (to the left as seen in Fig. 11) opens the four switches 316 simultaneously, pushing the cable 326 (to the right as seen in Fig. 11) closes or re-connects the cut out switches 316 and thus re-connects the cables 313 and 323 of Fig. 10. This re-connection is reliably indicted by the position of the flag 333.

However, in the embodiment of Figs. 5-8, pushing the handle 120 upwardly does not reconnect the cut-out switch 116 and thus does not reconnect the two cables 113 and 130. The flag 133 is, under these circumstances, not rotated back to the vertical position illustrated in Fig. 5 and thus the continued dis-connection is apparent.

As seen in Fig. 6, the handle 120 includes holes 135 adapted to enable the handle 120 to be locked in the cable disconnected position for those embodiments where the actuator 319 does enable the switches 316 to be closed after initially being opened. As before, the inner cable 126, 326 can be relied upon to function reliably, notwithstanding the heat of any fire.

The foregoing describes only some embodiments of the present invention and modifications, obvious to those skilled in the fire fighting arts, can be made thereto without departing from the scope of the present invention.

For example, the junction box 14 can be located between the roof 4 and the solar cells 5, or can be located within the ceiling cavity below the roof. Similarly, the cut-out switch housing 17 can be located between the roof 4 and the solar cells 5, or can be located in the ceiling cavity. If the housing 17 is located within the building, the actuator 19 can be located within the building also, or can extend through an eave or wall to the exterior of the building. Furthermore, the actuator 119 is preferably arranged to have its handle 120 located adjacent the inverter 108 and AC switchboard 111, as illustrated in Fig. 4, so that all electrical controls are close to each other.

The term "comprising" (and its grammatical variations) as used herein is used in the inclusive sense of "including" or "having" and not in the exclusive sense of "consisting only of".

CLAIMS

1. A solar cell installation comprising at least one solar cell mounted in an elevated position to receive solar radiation, said solar cell having a DC output connected via a DC cable to an inverter to convert said DC output into an AC output, wherein a cut-out switch is located in an elevated position adjacent said solar cell(s) and is operable to disconnect said DC output from said DC cable, and wherein said cut-out switch adjacent said elevated position is operable by an elongated actuator which extends from said cut-out switch to an un-elevated position at, or near, ground level.

2. The installation as claimed in claim 1 wherein said actuator comprises a cable slideably mounted within a sleeve, the lower end of said slideable cable incorporating a handle means.

3. The installation as claimed in claim 2 wherein said actuator is not reversible to reconnect said DC output and said DC cable.

4. The installation as claimed in claim 3 wherein said actuator is reversible to reconnect said DC output and said DC cable.

5. The installation as claimed in any one of claims 1-4 wherein there are a plurality of said solar cells all connected in series to provide a maximum voltage for said DC output and said cut-out switch comprises a double pole double throw switch.

6. The installation as claimed in any one of claims 1-4 wherein the are a first plurality of pairs of said solar cells and a second plurality of cut-out switches each substantially simultaneously operable by said elongated actuator, said cut-out switches are located within a housing and when closed connect said solar cells in series and when open isolate each pair of solar cells.

7. The installation as claimed in claim 6 wherein said housing includes a third plurality of contacts and each said pair of solar cells has a pair of wires

extending therefrom, one of said pair of wires of one cell of each pair of cells being connected to the other one of said pair of wires of the other cell of said pair of cells via a corresponding one of said contacts.

8. A method of isolating at least one solar cell mounted in an elevated position to receive solar radiation and producing a DC output, said method comprising:

interposing a cut-out switch in a DC cable interconnecting said solar cells with an inverter to produce an AC output, said cut-out switch being located in an elevated location adjacent said solar cells and being operable to disconnect said DC output from said DC cable,

connecting said cut-out switch to an elongated actuator which extends from said cut-out switch to an un-elevated position at, or near, ground level, and

operating said actuator to disconnect said DC cable from said solar cell.

9. The method as claimed in claim 4 including the step of:

forming said actuator such that reversing said actuator does not re-connect said DC cable and said solar cell.

10. The method as claimed in claim 4 including the step of:

forming said actuator such that reversing said actuator does re-connect said DC cable and said solar cell.

11. The method as claimed in any one of claims 8-10 including the step of interconnecting a plurality of said solar cells in series, and isolating said series connected cells via said cut-out switch.

12. The method as claimed in any one of claims 8-10 including the step of arranging a plurality of said solar cells in pairs, connecting each pair of solar cells in series, and isolating each pair of cells via a plurality of said cut-out switches.

13. A cut-out switch operable remotely by an elongated actuator, said switch comprising a fire resistant housing, a switch located inside said housing, and an elongated actuator having two ends, one end being connected with said switch to open and close same and the other end of said actuator having an operating handle means.

14. A solar cell installation including a cut-out switch as claimed in claim 13.

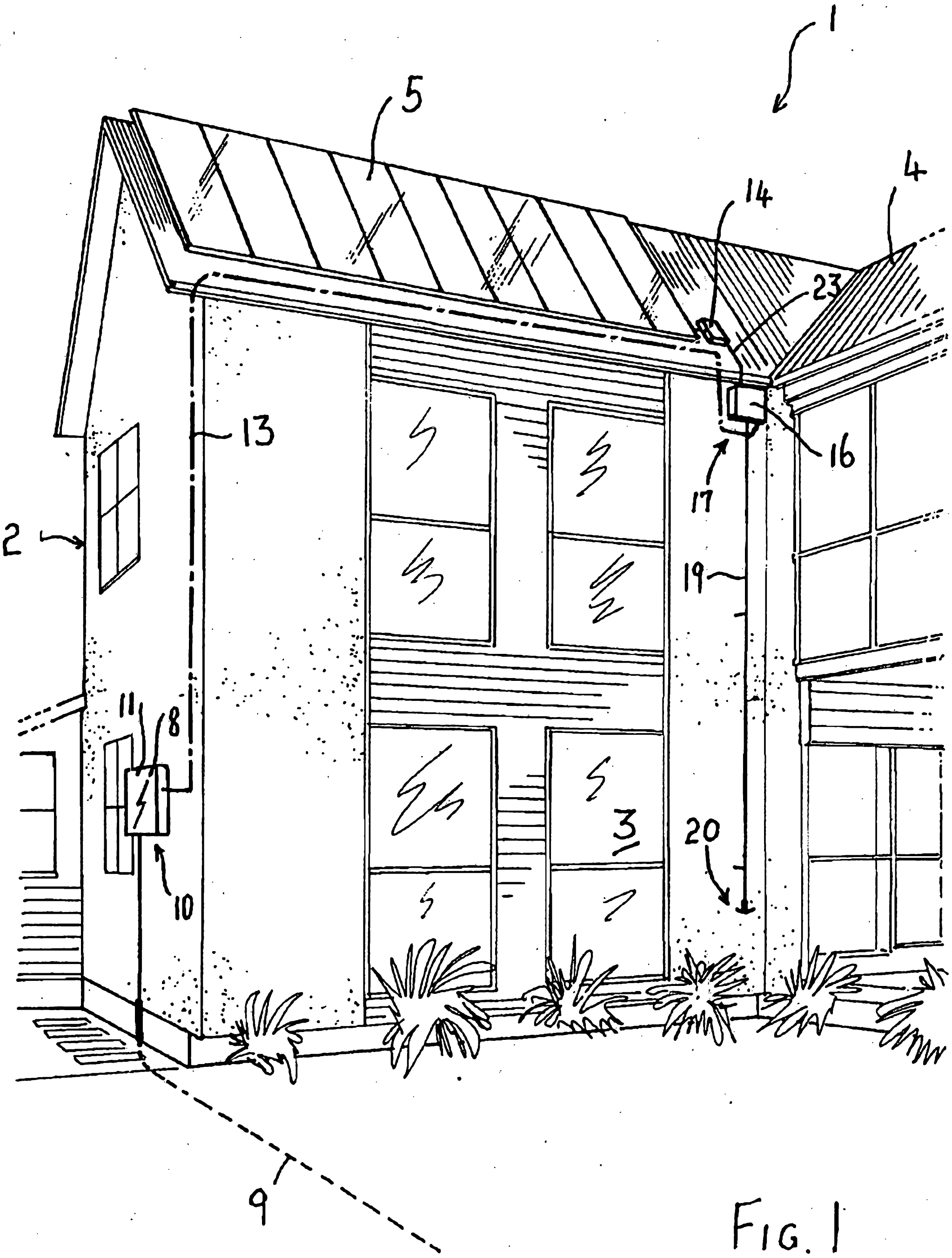

FIG. 1

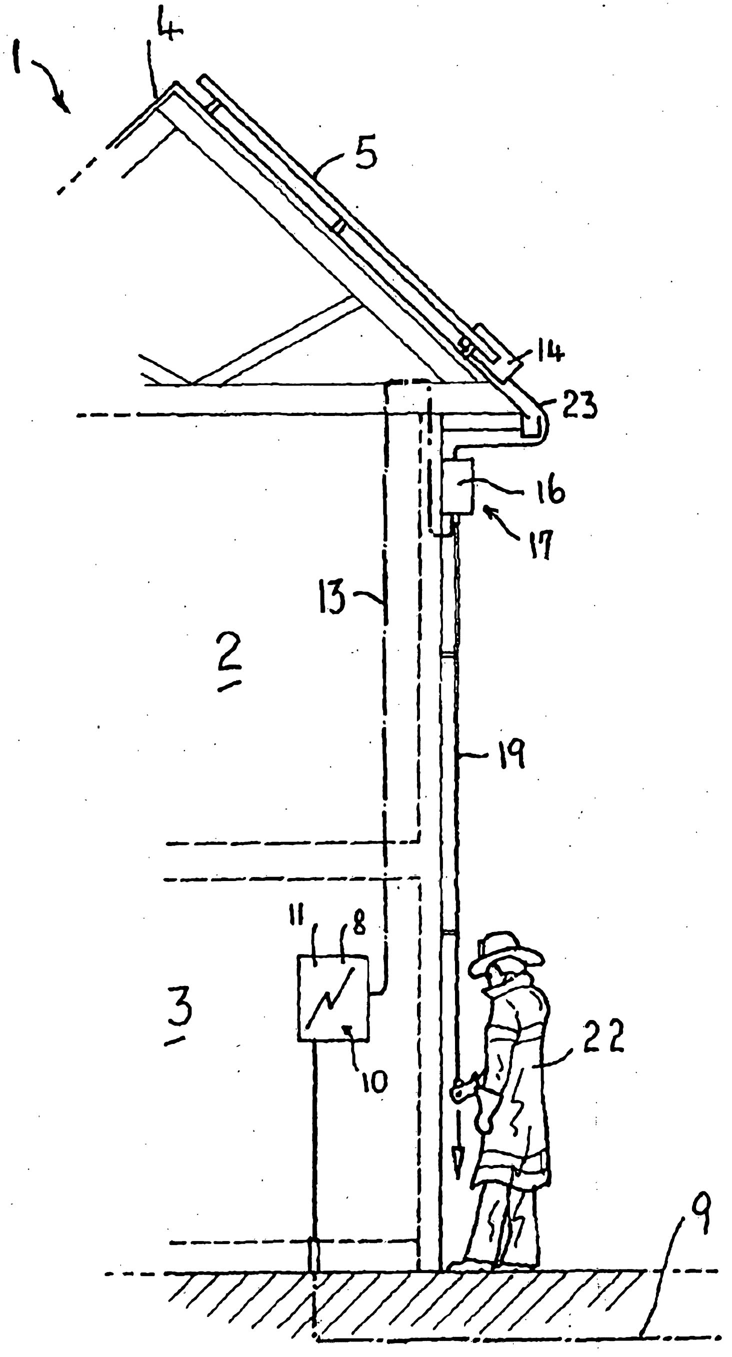

FIG. 2

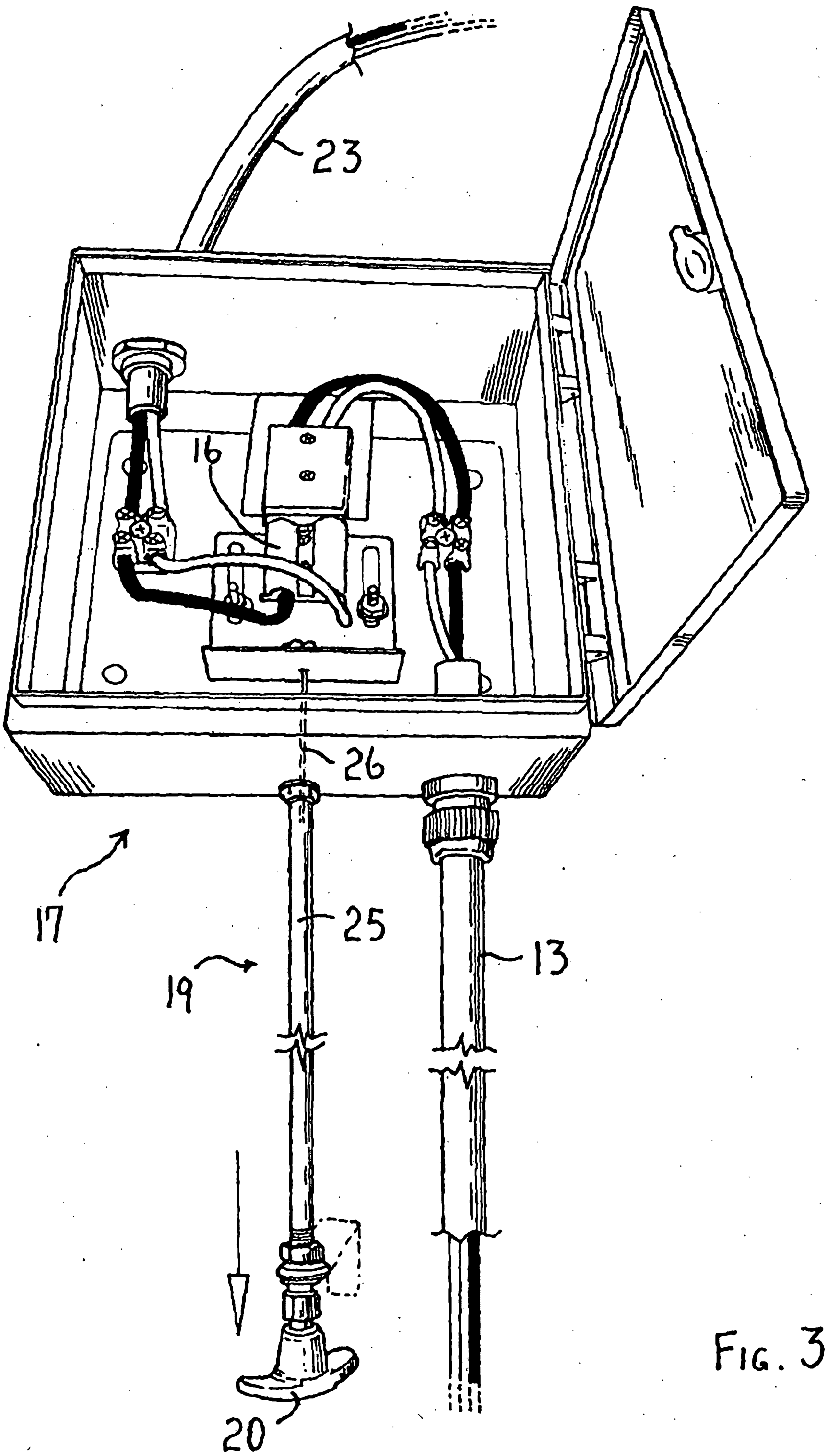

Fig. 3

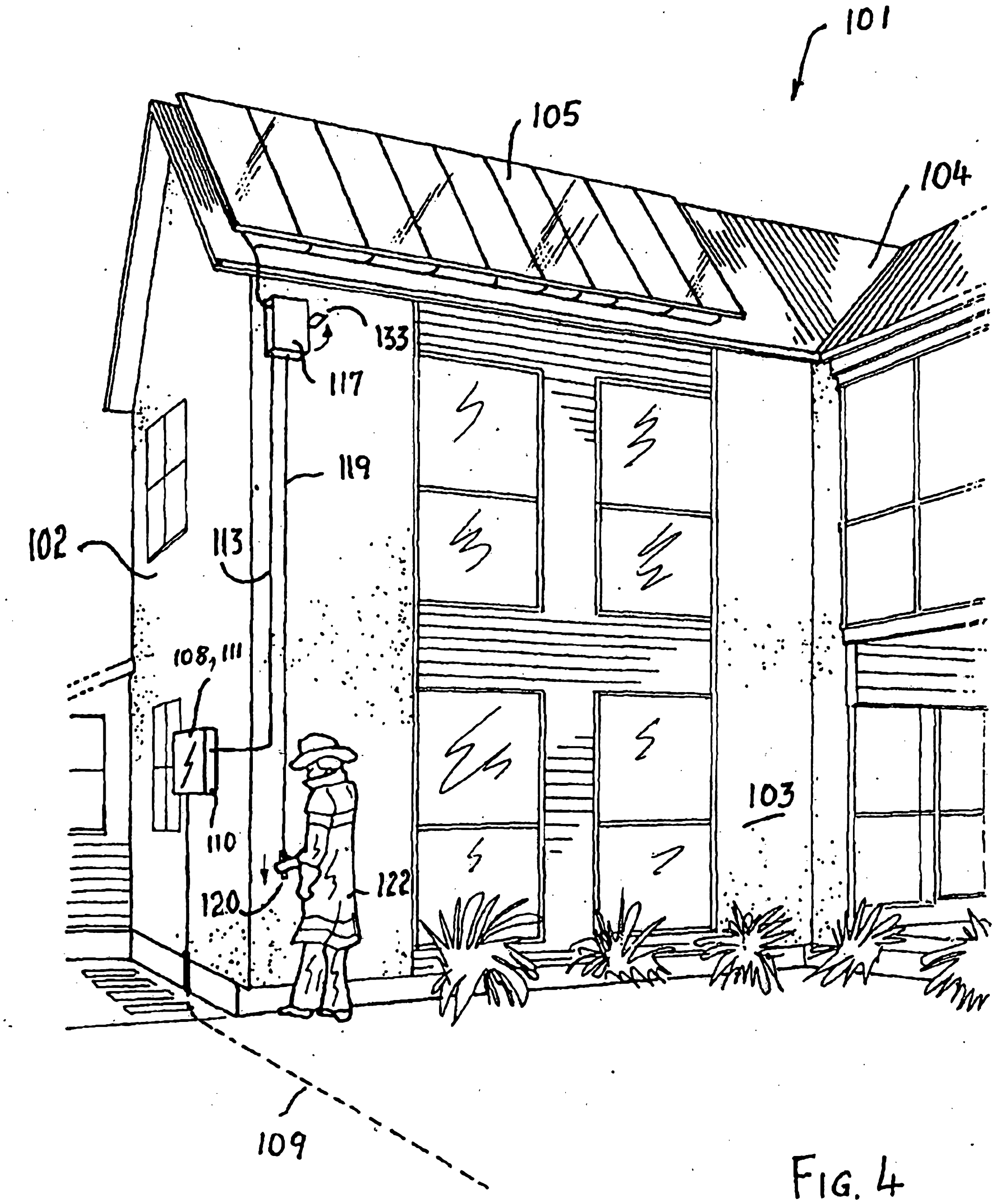

FIG. 4

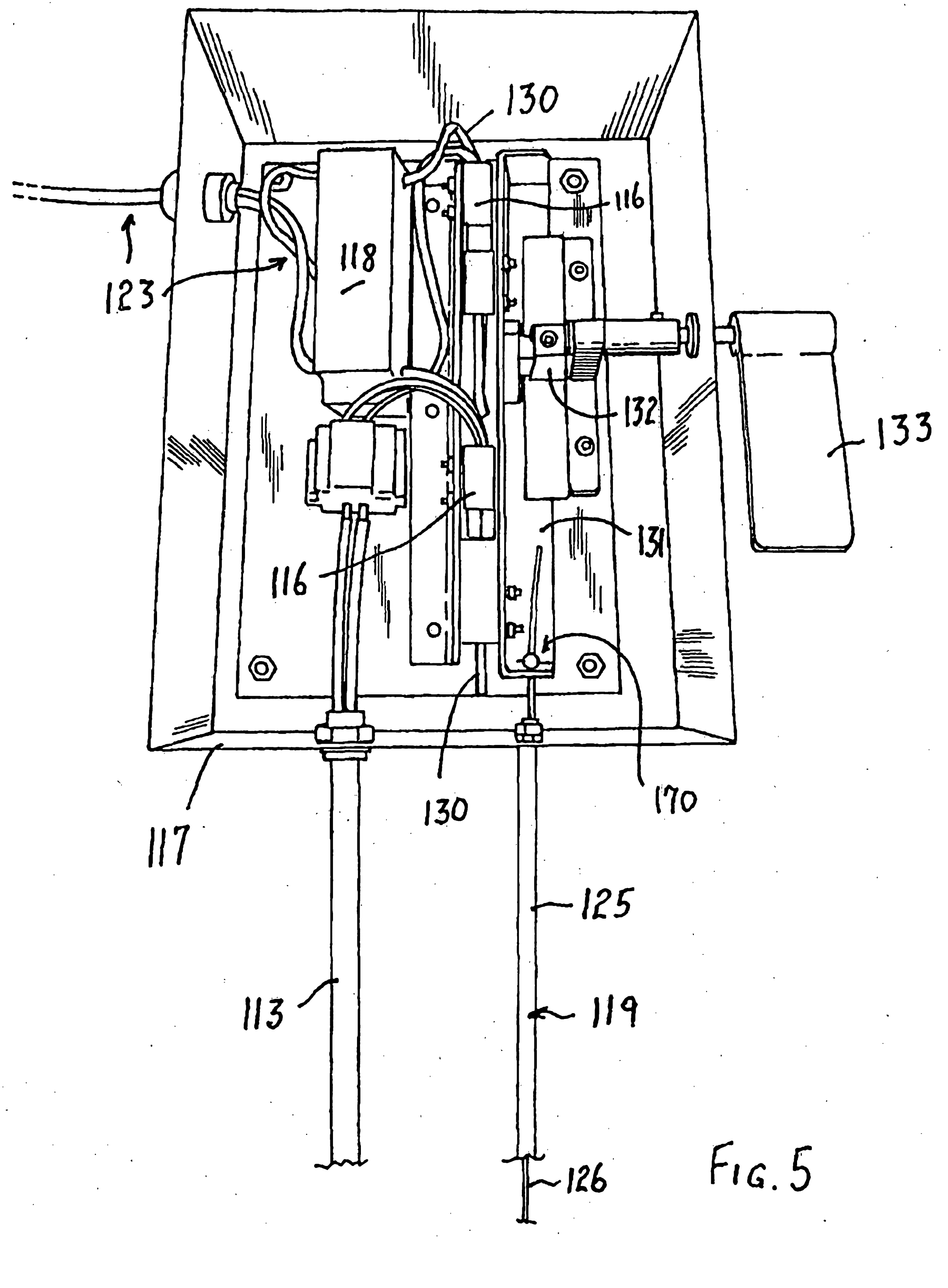

FIG. 5

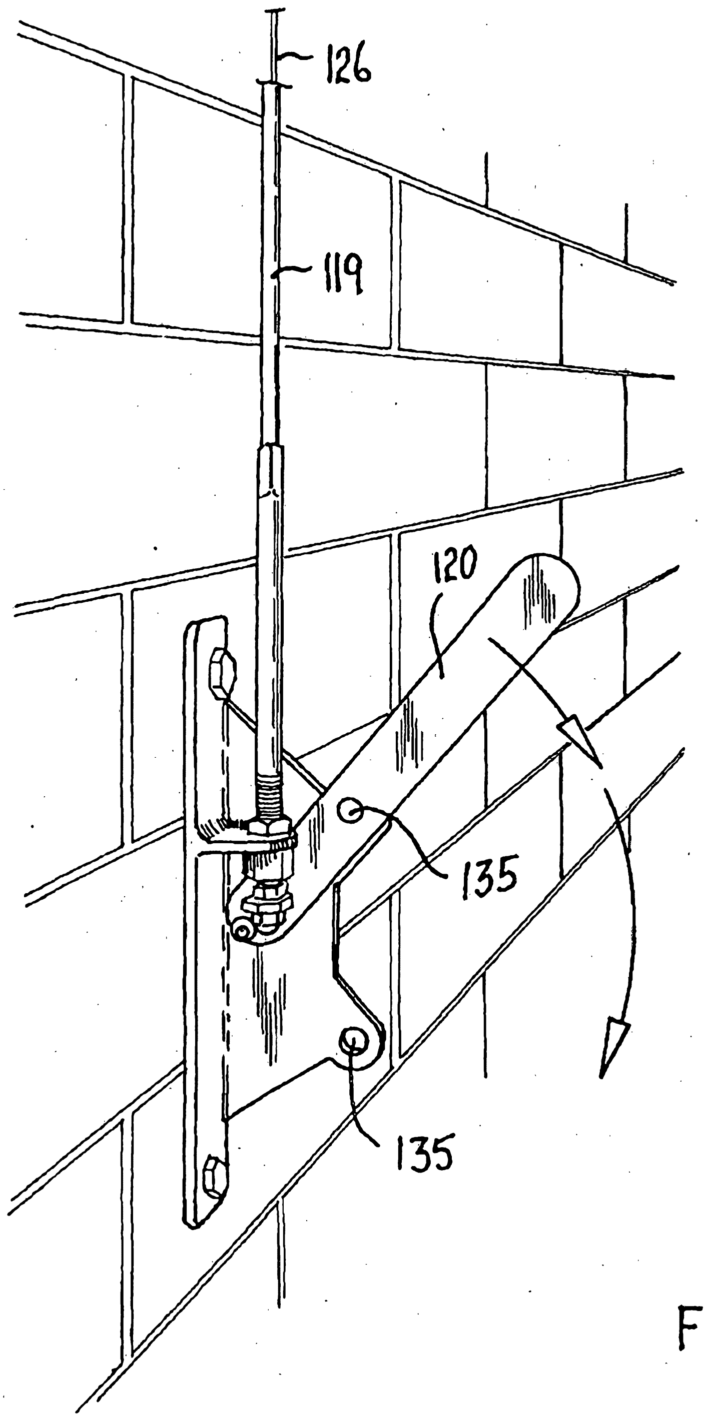

Fig.6

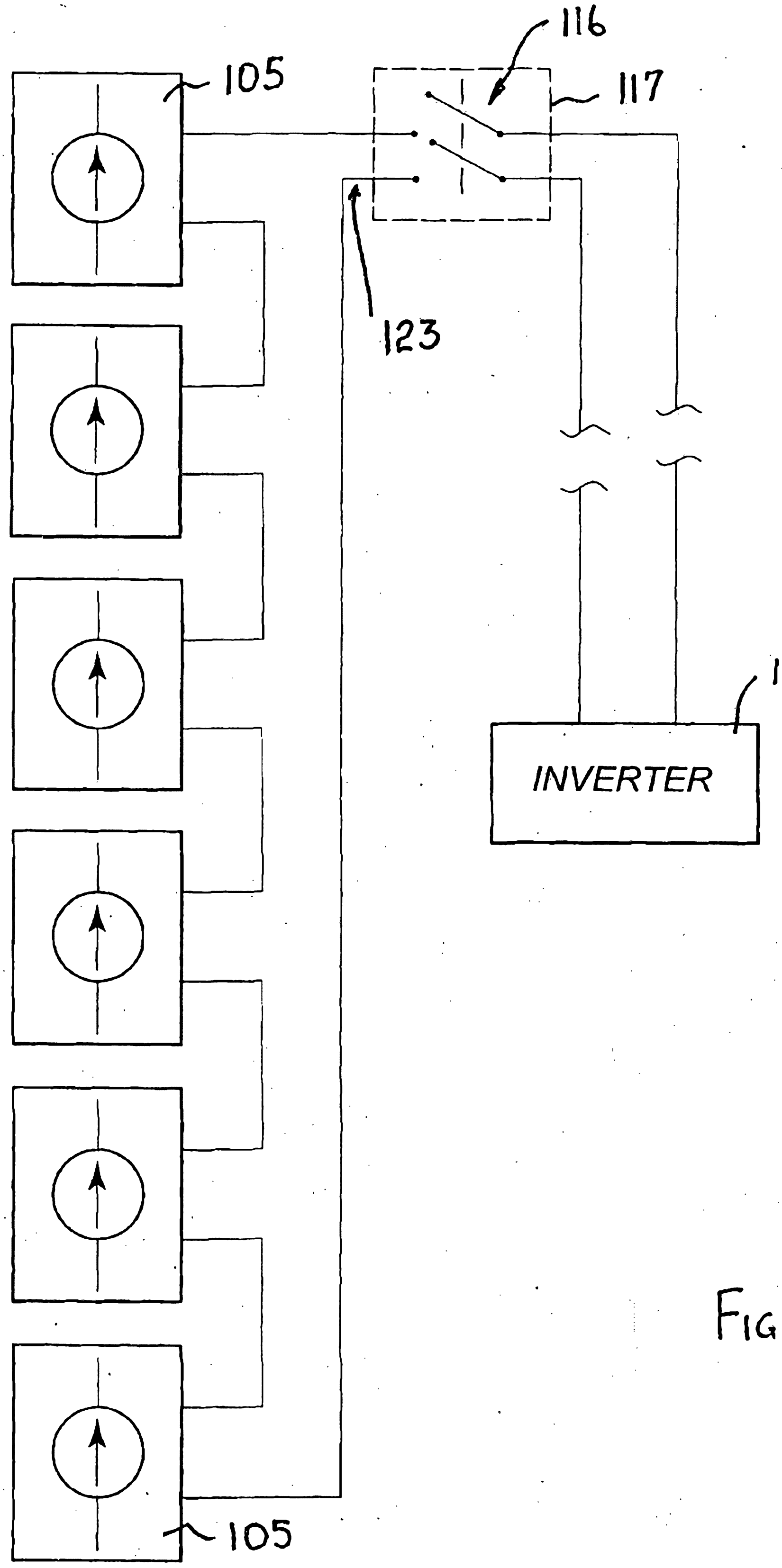

Fig. 7

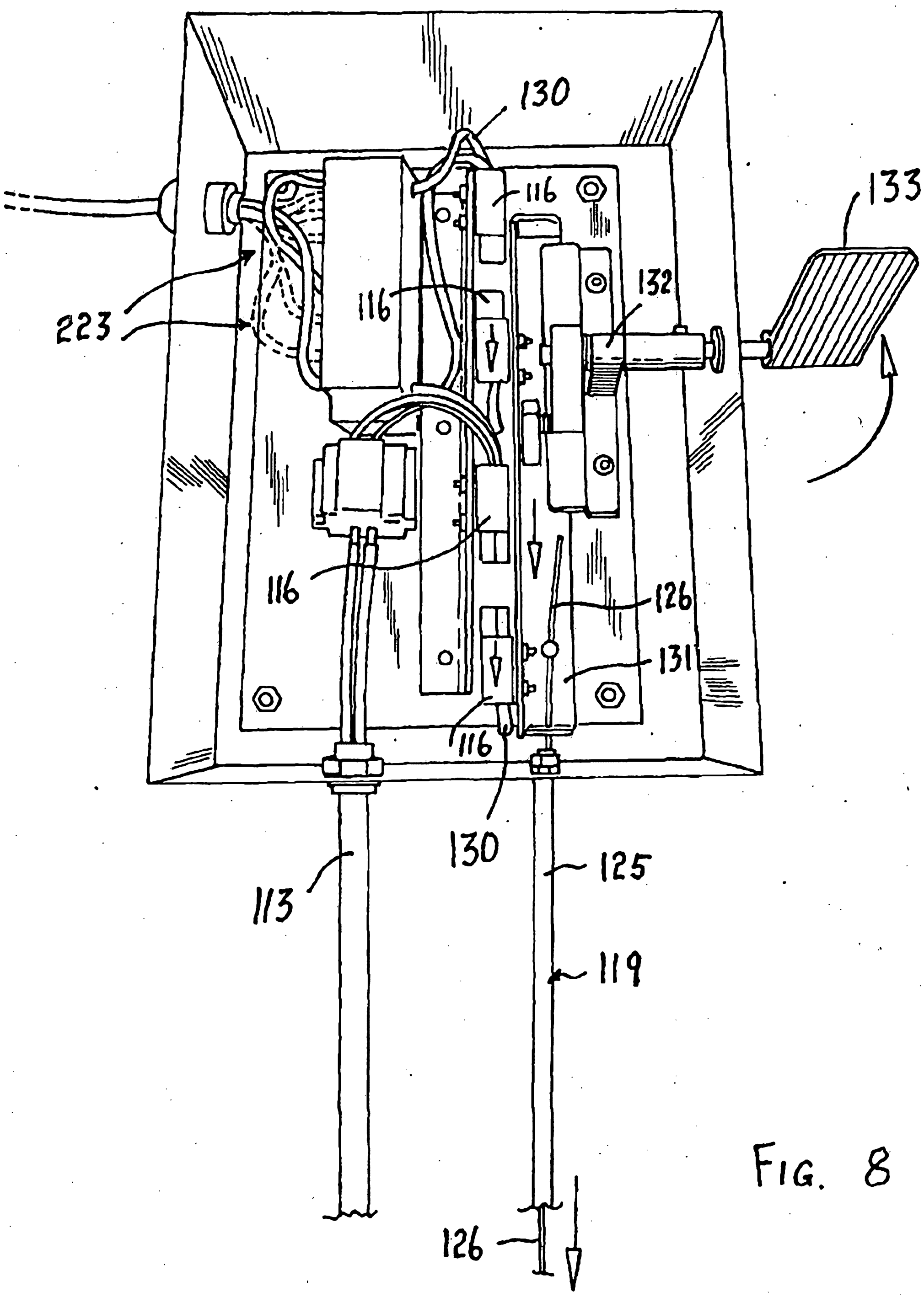

FIG. 8

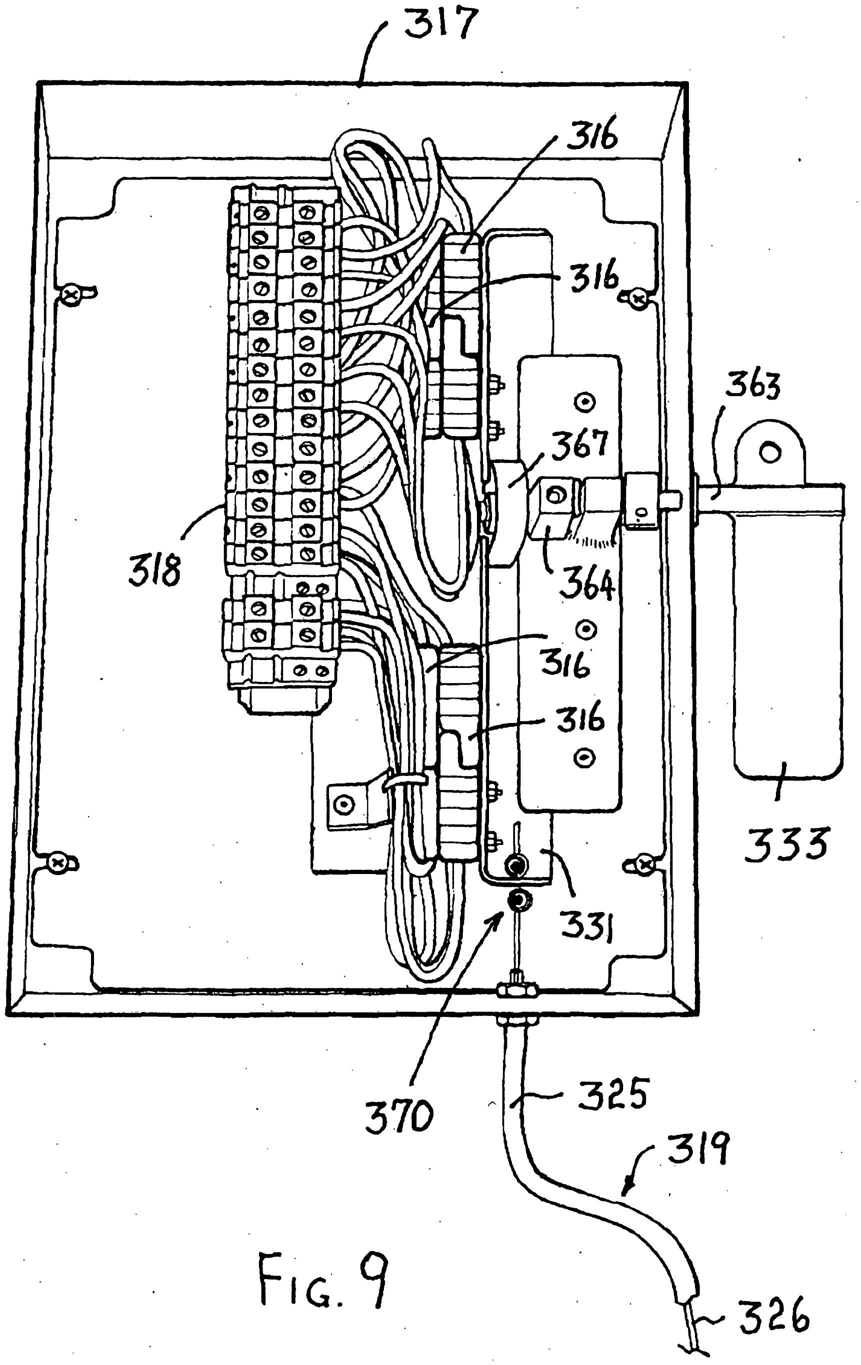

FIG. 9

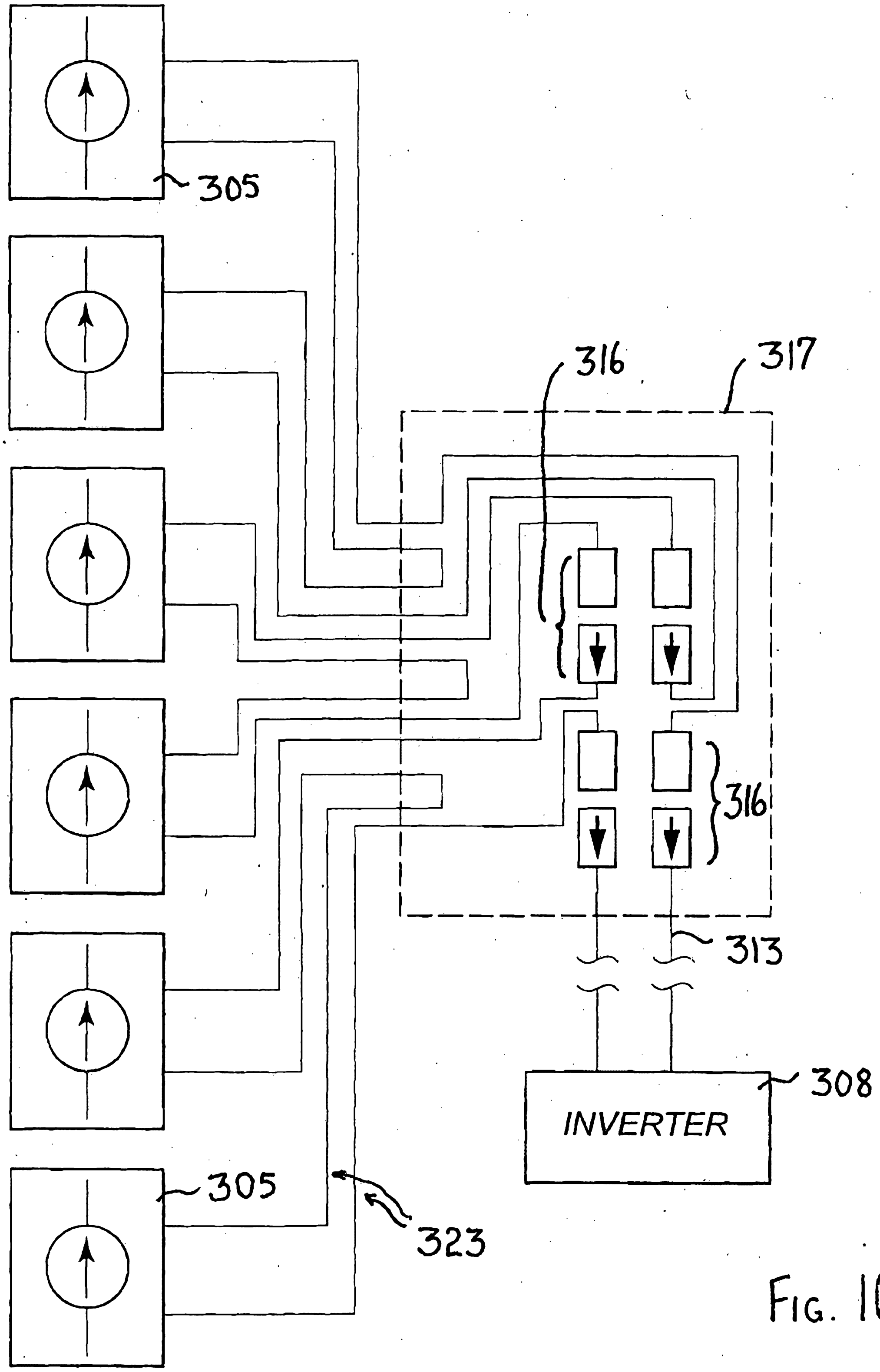

Fig. 10

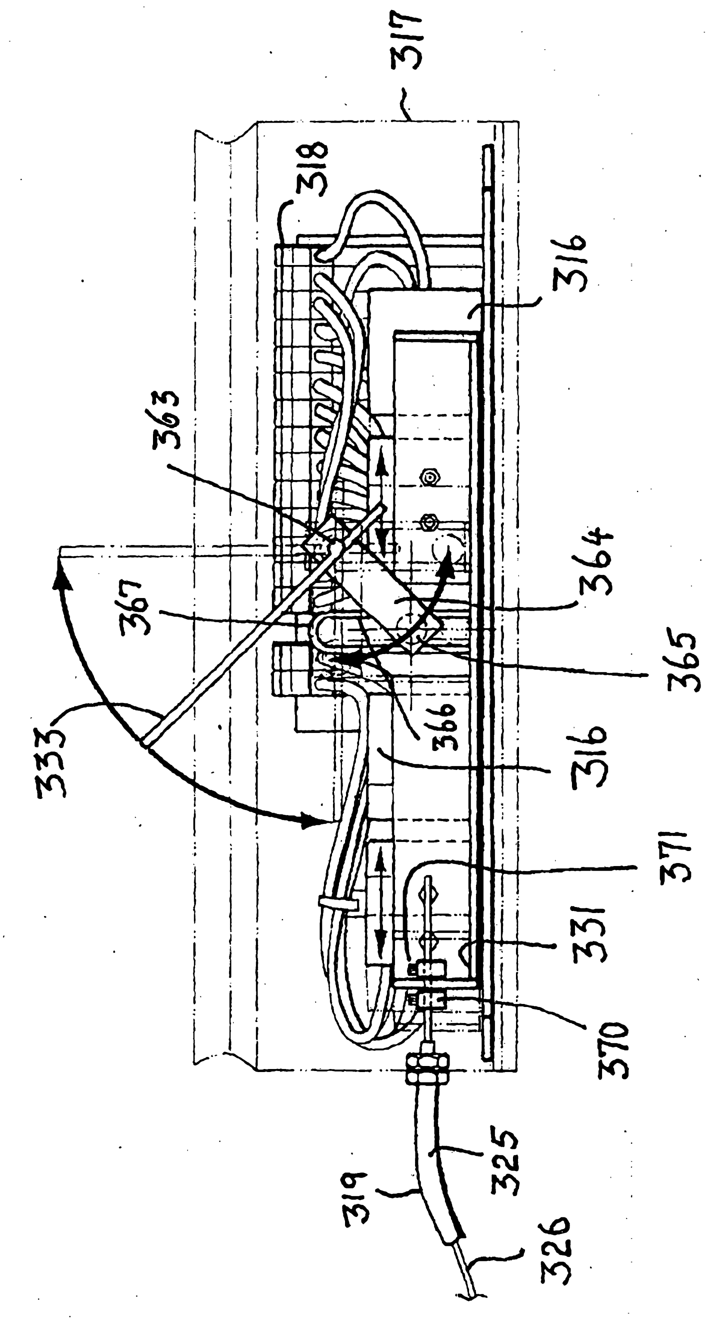

FIG. 11