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(54) **Fire detector.**

(57) A fire detector to be disposed on a mounting surface such as a ceiling, comprising a chamber open to the ambient atmosphere the chamber having a base, a peripheral region of which lies in a single plane preferably parallel with the surface when the detector is mounted thereon, the base being formed inwardly of the peripheral region with a pair of oppositely sloped recesses meeting at a generally central ridge extending across the base laterally of the recesses, an optical source mounted at the end remote from the ridge of one of the recesses with its optimum optical path directed therealong and an optical receiver mounted at the end remote from the ridge of the other recess with its optimum optical path facing therealong, *characterised in that* said optimum optical paths are each at a different angle to said plane so that the optical axes of the source and the receiver meet at an angle between 170° and 135° at a position within the chamber spaced laterally from the ridge.

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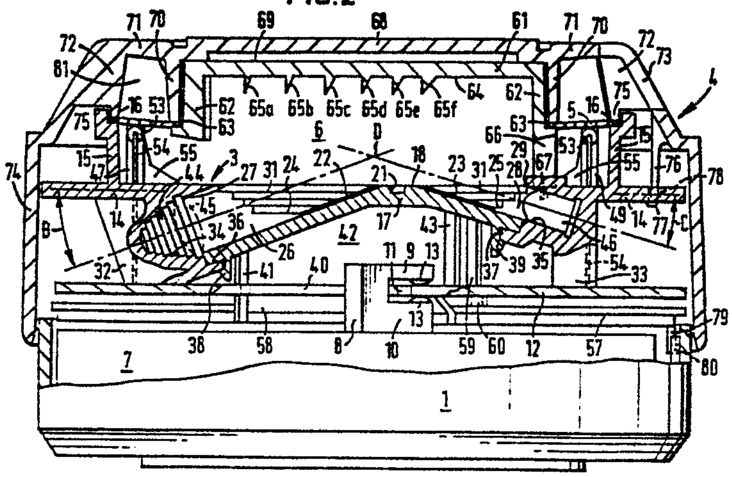
FIG. 2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Fire Detector

This invention relates to a fire detector having a chamber incorporating an optical smoke sensor.

Such optical sensors are well known and generally comprise a light emitting diode (LED) as the source and a photodiode as a receiver located in a chamber accessible to smoke from the ambient atmosphere. Within the chamber the optimum optical axes of the source and the receiver are generally disposed at an angle to one another; these axes meeting in a central region of the chamber where the presence of smoke is primarily, and most sensitively, detected. The angle referred to is in a vertical plane when the detector is conventionally mounted on a ceiling and ensures that there is no direct light transmitting path between the source and the receiver. Precautions are taken to reduce spurious reflections from the source reaching the receiver.

Fire detectors incorporating such optical sensors present a number of operational difficulties. Smoke usually enters the chamber through a mesh and it is not possible to have a mesh size sufficiently small to prevent entry of tiny insects that can cause light scatter and generate a false alarm. Furthermore the conventional disposition of the mesh does not provide consistently repeatable detection results from smoke carried in gaseous streams impinging upon the detector from differing directions in the vertical plane. Such differing directions usually result from a variation in the velocity of the streams.

An object of the present invention is to provide a fire detector with improved detection performance and having an optical sensor disposed within a chamber so as to minimise false alarms triggered by objects such as insects.

According to the present invention there is provided a fire detector to be disposed on a mounting surface such as a ceiling, comprising a chamber open to the ambient atmosphere the chamber having a base, a peripheral region of which lies in a single plane preferably parallel with the surface when the detector is mounted thereon, the base being formed inwardly of the peripheral region with a pair of oppositely sloped recesses meeting at a generally central ridge extending across the base laterally of the recesses, an optical source mounted at the end remote from the ridge of one of the recesses with its optimum optical path directed therealong and an optical receiver mounted at the end remote from the ridge of the other recess with its optimum optical path facing therealong, characterised in that said optimum optical paths are each at a different angle to said plane so that the optical axes of the source and the receiver meet at an angle between 170° and 135° at a position within the chamber spaced laterally from the ridge.

The invention will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a side elevational view split about the line X-X of a fire detector mounted on a ceiling,

Figure 2 is as view to as larger scale of the detector of Figure 1 displaced through 180° and partly in differing radial sections, and

Figure 3 is a plan view of the base of the chamber of the detector of figure 2.

Referring to the drawings the fire detector comprises a cup-shaped body 1 to be fixed to a ceiling 2; a chamber base, indicated generally at 3 and a cover structure 4, incorporating a generally flat, annular mesh 5, the structure and the base together defining a chamber 6. The cross sectional area of the openings in the mesh are likely to be less than $1mm^2$ to exclude many of the insects causing false alarms of fire, however, the mesh size cannot be too small otherwise smoke entry becomes seriously impaired.

The body 1 contains a clip-fit box 7 having a pillar 8 having jaws 9 and 10 embracing a radial edge 11 of a printed circuit board 12, the jaws each being provided with flexible electrical wiper connectors 13 for engaging corresponding fixed contacts (not shown) on the board 12.

The chamber base 3 is circular and has a flat peripheral region 14 formed with an upstanding wall 15 the upper part of which has an inwardly directed shoulder 16. Inwardly of the region 14 the base has a chordal ridge 17 which is offset from a diameter of the base. The upper surface 18 of the ridge lies in the plane of the upper surface of the region 14 and, as shown in Fig. 3 the ridge is tapered from a narrow end 19 to a wider end 20 and is formed with a similarly tapered central groove 21. It will be understood that the centre line of the groove is not only displaced from a diameter of the base but is also at a small angle, for example, about 2° to the diameter.

On each side of the ridge 17 the base slopes away at 22 and 23 to flat parts 24 and 25. A first groove 26 is formed in the slope 22 and flat part 24 to terminate at 27. A second groove 28 is formed in the slope 23 and flat part 25 to terminate at 29. As shown in Fig. 3 the groove 26 lies on a diametrical line 30 whereas the groove 28 is displaced from this line by an angle A which may be between 3° and 12° and is preferably between 3° and 5° or about 4°.

The angle B between the median line of the groove 26 and the plane containing the region 14 is preferably about 20°. The angle C between the median line of the groove

28 and the plane containing the region 14 is preferably about 16°. The angle between the median lines of the grooves is between 170° and 135° and is preferably between 150° and 140°. Part circular stepped parts 31 extend around the slopes 22 and 23 to meet the inner perimeter of the region 14.

The printed circuit board 12 carries supports 32 and 33 having recesses 34 and 35 of generally cup-shaped formation respectively formed with lips 36 and 37 to be engaged by catches 38 and 39 on the base 3 to lock the latter and the board 12 together. The edge 11 in the board 12 forms part of a recess 40 therein and the lower surface of the base 3 has depending walls 41, 42 and 43 corresponding in size and shape with the periphery of the recess 40 and serving to seal against the board 12 and to accommodate the pillar 8.

When the base 3 and board 12 are locked together the recess 34 is in register and in contact with the end 27 of the groove 26 and the recess 35 is in register and in contact with the end 29 of the groove 28. As shown in Fig. 2 the recess 34 is formed with internal steps 44 and a photodiode (not shown) is located in the bottom of the recess, with its optimum optical path facing, through a double convex plastic lens 45 along the median line of the groove 26. The recess 35 is provided with a light emitting diode 46 having its optimum optical path directed along the median line of the groove 28. These median lines meet at D a position spaced above and laterally from the ridge 17. The diode 46 is preferably of the gallium aluminium arsenide type which emits radiation at a shorter wavelength than those conventionally used (880 mm instead of 950 mm).

The supports 32 and 33 carry pairs of pillars 47, 48 and 49, 50 respectively passing through slots 51 and 52 in the base 3. Thermistors 53 are mounted across each pair of pillars, their connections such as 54 passing downwardly to the board 12 holding them in place. It will be noted that the upper parts of the thermistors are level with the shoulder 16 of the wall 15 and they are in contact with the mesh 5.

As will be seen most clearly in fig. 3 a number of inwardly directed, sloping, buttresses 55 extend radially inwardly of the wall 15; between these buttresses circumferential ridges 56 are formed on the base 3. (These ridges are not shown in Fig. 2.)

A plate 57, formed with a recess 58 in register with the recess 40 in the board 12 is in contact with the board at several places (not shown) around its periphery and is locked with the board and the base 3 by a number of arms such as 59 having cranked ends 60 carried by the base and engaging the plate. Thus the base, the board and the plate can be assembled and handled as a single unit.

The chamber 6 is closed by a cap 61 having a circumferential wall 62 with an outwardly directed ledge 63 to receive the inner periphery of the mesh 5. The under surface 64 of the cap 61 is formed with a series of part circumferential ridges having surfaces 65a, b, c, d, e and f of decreasing radius centred on the optical centre of the diode 46. These surfaces are also inclined at different angles to the surface 64. To ensure accurate location of the cap 61 the latter is supported on a number of asymmetrically disposed pegs 66 having reduced diameter portions 67 passing into clearance holes (not shown) in the base 3.

The cover 4 has a top 68 engaging the upper surface 69 of the cap 61 and having a depending skirt 70 embracing the wall 62 and clamping the inner periphery of the mesh 5 against the ledge 63. At its outer periphery the top 68 is formed with a part 71 extending outwardly of the skirt 70 and a number of spaced apart radial fins 72 and increased

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width ribs 73 linking the top 68 with a circumferential part 74. The fins 72 are each formed with ribs 75 to clamp the outer periphery of the mesh 5 against the shoulder 16 and the buttresses 55. The cover 4 is secured to the base 3 by a series of snap fit members such as 76 having enlarged heads 77 passing through apertures 78 in the base 3. This engagement holds the mesh 5 and the cap 61 locked against the base 3.

The plate 56 is formed around its periphery with a number of locking members such as 79 rotationally engageable with members such as 80 on the body 1. The recesses 40 and 58 in the board 12 and plate 57 enable the pillar 8 to be accommodated while rotational movement between the body 1 and the remainder of the detector both locks and unlocks the plate 57 to the body 1 and at the same time engages and disengages the connectors 13.

It will be understood that the board 12 and box 7 contain electrical connectors and such circuitry as may be necessary and the box 7 also has terminals (not shown) accessible through the body 1. If desired the board 12 and box 7 could contain the necessary micro computer and other circuitry disclosed in our copending application 8431883.

As is well known, scattering by smoke particles in the chamber 6 and particularly in the region D thereof, of radiation from the diode 46 is detected by the photodiode in the recess 34. The use of a diode 46 based on gallium aluminium arsenide at a shorter than usual wavelength is important since the relationship between scatter and wavelength is an inverse fourth power law. The photodiode in the recess 34 preferably incorporates an infra-red bandpass filter to assist rejection of ambient light level that may enter the chamber 6. Light cannot directly enter the chamber 6 in the sense to fall directly on the photodiode but a low level may penetrate due to multiple reflections.

A major feature of this construction is the reduction to a defined standing level of scatter and reflections within the chamber 6 of light from the diode 46 in no smoke conditions. The defined standing level enables periodic or continuous monitoring of the working of the whole sensor.

Thus the interior surfaces of the chamber 6 are of a textured black finish to reduce spurious light reflections and these are further reduced by the presence of the parts 31, steps 44, ridges 56 and surfaces 65a-f.

The desired low scatter angle of 10° (i.e. when the optimum optical paths meet at 170°) has been determined in a series of experiments. In practice we have found considerable advantage over known constructions with scatter angles up to 45°. The different angles between these paths and the plane of the region 14 of the base 3 together with the off-centre location of the ridge 17 and the angle A enable a small scatter angle to be achieved whilst preventing direct reception by the photodiode of radiation from the diode 46. The slot 21 helps to prevent spurious scatter by small insects standing on the central part of the surface 18. Should the slot 21 not be present a small insect of a particular size at the centre of the surface 18 will create more scatter than the same insect at the edge of the surface.

The provision of the thermistors 53 increases the overall sensitivity of the detector to fires and it also increases the range of types of fire that can be detected. The mesh 5 also acts as a heat collector for the thermistors which are connected in parallel so that, because they are non-linear devices, the one at higher temperature predominates. The fins 72 do not extend across the annular gaps between the ribs 73 and the skirt 70 so that an annular space 81 exposed to the mesh 5 enables hot air to travel around the space 81 and contact the mesh 5 over a larger area thereof so as to reduce any dependence on directional approach on the horizontal plane.

When the detector is mounted on a ceiling surface 2 as shown in Fig. 1 smoke carried in a low-speed airstream travels upwardly through the mesh 5 by convection. If the airspeed is high (say above Ø.1 m/s) then a significant part of it will be travelling along the surface of the ceiling. In these circumstances this air is then deflected by the part 71 and skirt 7Ø (Fig. 2) so that a component of it passes normally through the mesh. This deflection is helped by the fins 72 and ribs 73. It has been found with the present invention that even at low air speeds the concentration of smoke within the chamber 6 can be higher then that in the airstream externally of the chamber.

It will be understood that although as described above, a mesh 5 is provided this could be omitted in areas where insects are not troublesome or where other means are employed to identify spurious readings caused by insects.

CLAIMS

1. A fire detector to be disposed on a mounting surface such as a ceiling, comprising a chamber open to the ambient atmosphere the chamber having a base, a peripheral region of which lies in a single plane preferably parallel with the surface when the detector is mounted thereon, the base being formed inwardly of the peripheral region with a pair of oppositely sloped recesses meeting at a generally central ridge extending across the base laterally of the recesses, an optical source mounted at the end remote from the ridge of one of the recesses with its optimum optical path directed therealong and an optical receiver mounted at the end remote from the ridge of the other recess with its optimum optical path facing therealong, characterised in that said optimum optical paths are each at a different angle to said plane so that the optical axes of the source and the receiver meet at an angle between 170° and 135° at a position within the chamber spaced laterally from the ridge.

2. A fire detector according to claim 1 in which the optical axes meet at an angle between 150° and 140°.

3. A fire detector according to claim 1 or claim 2 in which the optimum optical paths are disposed at an angle between 3° and 12° in a plane normal to the plane containing the peripheral region.

4. A fire detector according to claim 3 in which the angle is between 3° and 5°.

5. A fire detector according to any one of claims 1 to 4 in which the ridge is spaced laterally from the centre of the chamber.

6. A fire detector according to claim 5 in which the surface is formed with a longitudinal groove.

7. A fire detector according to any one of the preceding claims in which the chamber is open to the ambient atmosphere only via a mesh having a mesh size small enough to keep out many troublesome insects the mesh being substantially flat and extending generally in a plane parallel with the mounting surface and in which a part of the casing of the detector extends externally of the mesh and is shaped so that at least a part of any gaseous stream carrying smoke, and travelling generally parallel with the plane of the mesh, is deflected through the mesh normal to the plane thereof.

8. A fire detector according to claim 7 including at least one thermal sensor in contact with the mesh.

9. A fire detector according to any one of the preceding claims in which the interior of the chamber is so shaped and is provided with such surface finishes that the reflections and scatter of light from the optical source in no smoke conditions is reduced to a defined standing level to permit periodic or continuous monitoring of the sensor.

10. A smoke detector substantially as herein described with reference to Figs. 1, 2 and 3 of the accompanying drawings.

Neu eingereicht / Newly filed
Nouvellement déposé

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FIG.1

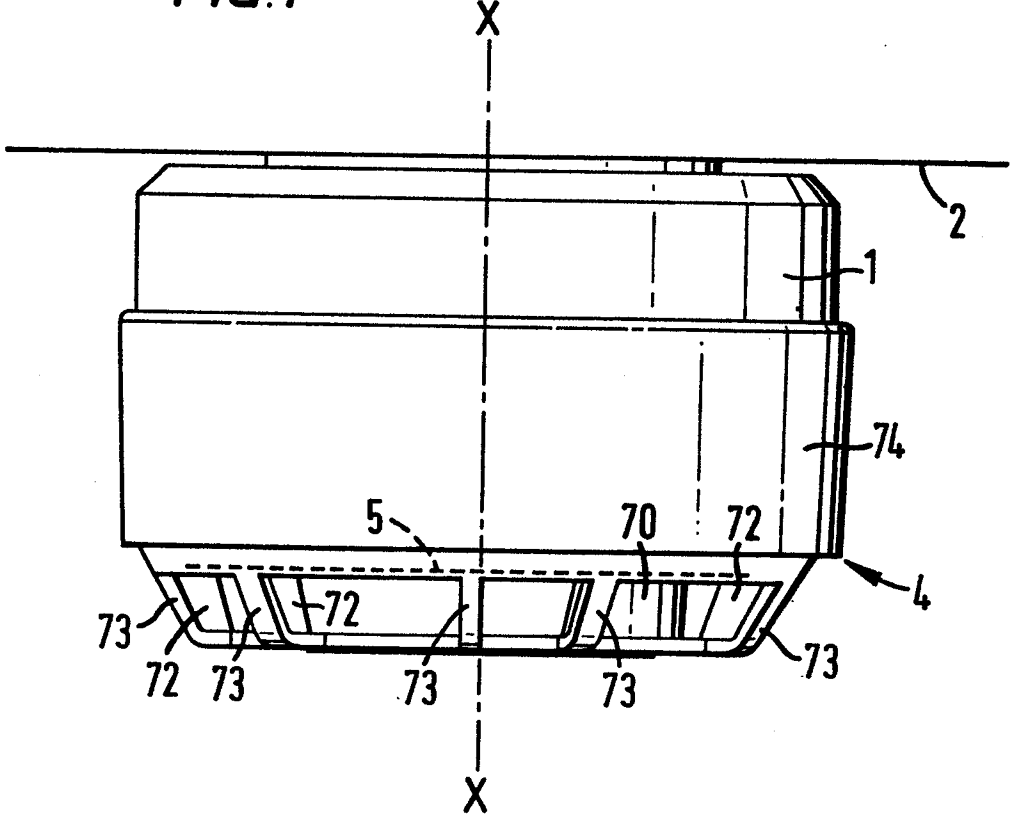


FIG.2

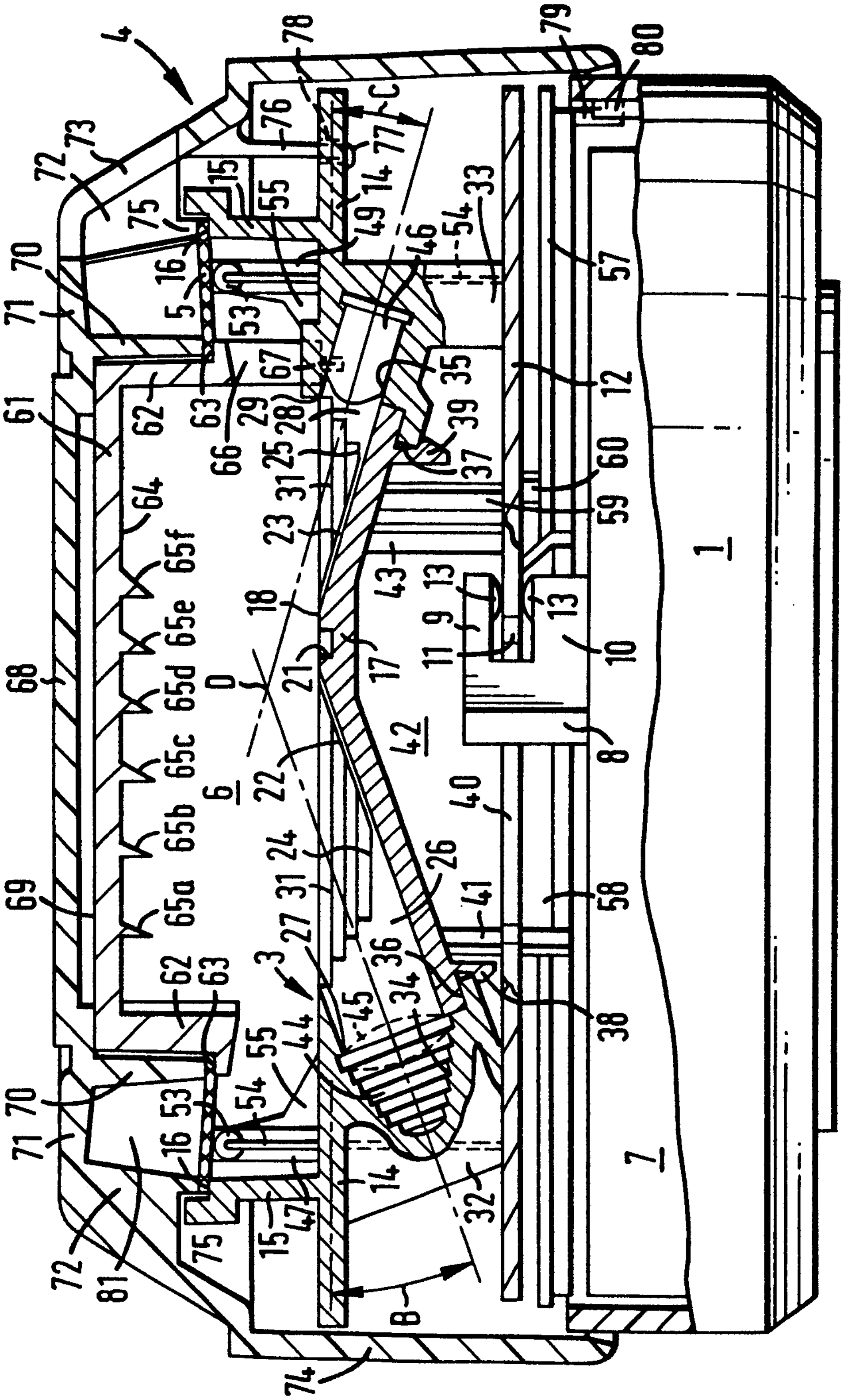
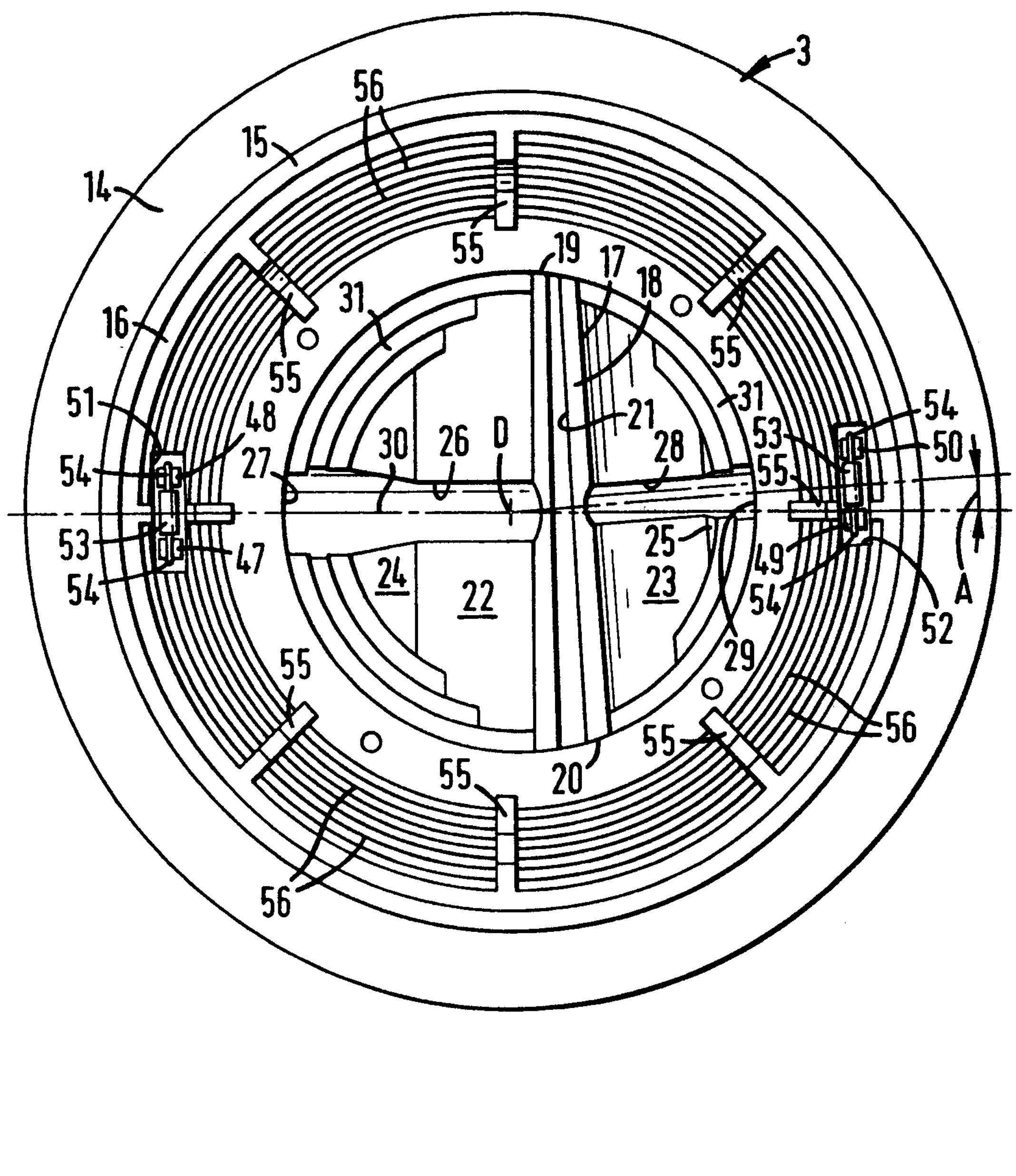


FIG. 3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