



(72) SHOAFF, THOMAS W., US
(72) WATSON, KALVIN, US
(72) PETROVIC, DRAGAN, US
(72) SCHOENFELDER, GEORGE A., US
(72) CONFORTI, FREDERICK J., US
(72) WIEMEYER, JAMES F., US
(71) PITTSWAY CORPORATION, US

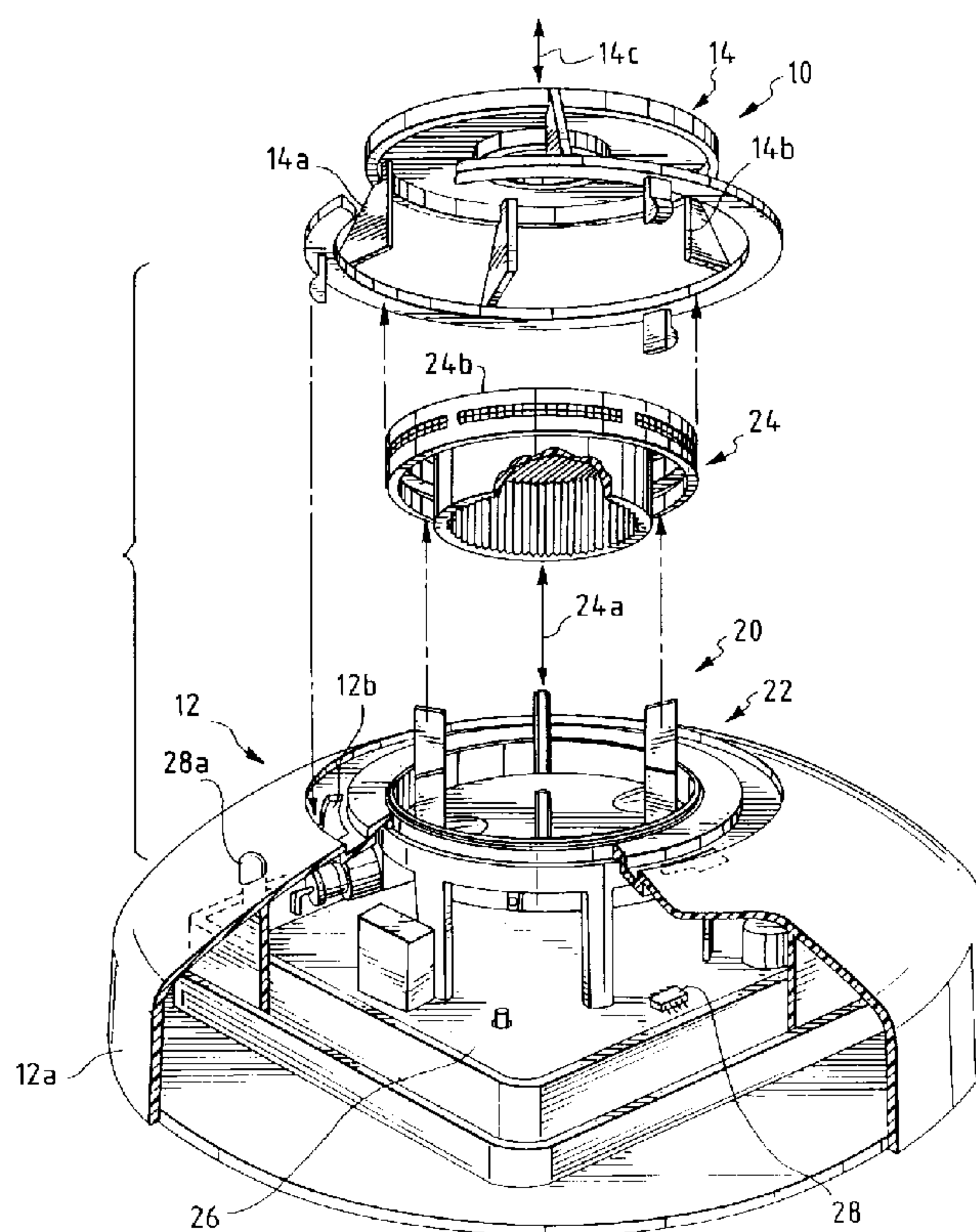
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(30) 2000/04/24 (UNKNOWN) US

(54) **DETECTEUR DE FUMEE PHOTOELECTRIQUE MINIATURISE**

(54) **MINIATURE PHOTOELECTRIC SENSING CHAMBER**



(57) A low profile, low volume smoke chamber displaces a light source, such as a light emitting diode or laser diode, and a sensor, such as photodiode or phototransistor, to the exterior of the sensing volume. A symmetrical sensing volume results which can be coupled to symmetrical input/output ports via a generally U-shaped flow path. A two part sensing chamber housing is formed with a lower cylindrical base portion and an upper cylindrical cover portion which slideably engage one another. At least the upper cylindrical portion carries a plurality of grooves for suppression of reflections and collection of dust. An exterior end of the upper portion carries a plurality of spaced apart openings which can be filled with a screen. A reduced sensing volume in combination with a selected screen size produces an acceptable signal to noise ratio and response rate while still excluding insects and other non-smoke related particulate matter.



Abstract Of The Disclosure

A low profile, low volume smoke chamber displaces a light source, such as a light emitting diode or laser diode, and a sensor, such as photodiode or phototransistor, to the exterior of the sensing volume. A symmetrical sensing volume results which can be coupled to symmetrical input/output ports via a generally U-shaped flow path. A two part sensing chamber housing is formed with a lower cylindrical base portion and an upper cylindrical cover portion which slideably engage one another. At least the upper cylindrical portion carries a plurality of grooves for suppression of reflections and collection of dust. An exterior end of the upper portion carries a plurality of spaced apart openings which can be filled with a screen. A reduced sensing volume in combination with a selected screen size produces an acceptable signal to noise ratio and response rate while still excluding insects and other non-smoke related particulate matter.

MINIATURE PHOTOELECTRIC SENSING CHAMBER

5 The benefit of the filing date of April 29, 1999 of Provisional Application
Serial No. 60/131,654 for Fast Miniature Photoelectric Sensing Chamber is hereby
claimed.

Field of the Invention:

10 The invention pertains to smoke sensors of a type used in fire detectors.
More particularly, the invention pertains to such sensors having a reduced size and a
low profile.

Background of the Invention:

Fire or smoke detectors have become widely used elements of fire alarm
systems. Such alarm systems often incorporate large numbers of such detectors
spread over substantial regions to detect and track the build-up of smoke.

15 Known detectors while effective for their purpose have at times been
regarded as less than aesthetically pleasing due to their profile and over-all size.
There thus continues to be an on-going need for smaller detectors having lower
profiles and a smaller over-all size.

20 While small chamber size has been recognized as being preferable from an
aesthetic and architectural point of view, it has also been recognized that as
chambers become smaller the signal to noise ratio can potentially drop and become
less than optimal. As chamber dimensions have become smaller, background light
levels detected in photoelectric smoke chambers by the respective light sensitive
element (such as a photodiode or a phototransistor) can increase significantly.
25 There continues to be a need for smoke sensors which while physically small
exhibit appropriate signal to noise ratios while minimizing nuisance alarms.

Summary of the Invention:

30 A photoelectric sensing chamber has a cylindrical shape with a relatively
low profile. A base element is formed with a cylindrical region and a closed end.
A cover has a hollow cylinder which extends therefrom. The cover slideably
engages the base such that the distal end of the cylinder is located adjacent to the

base. Together they form a substantially enclosed, cylindrical, symmetrical sensing chamber. The chamber encloses a symmetrical sensing region.

5 The cover carries a plurality of openings at an exterior, proximal, end displaced from the distal end of the cylinder. The openings permit ingress and egress of adjacent ambient atmosphere, which could carry smoke or particles of combustion.

An annular flow path extends between the base and the cylinder, coupled to the openings. This path, around the cylinder and extending to the base couples the openings to the sensing region.

10 The cylinder cooperates with the base to form an inflow/outflow region between the annular flow path outside of the cylinder and the internal sensing region. This produces a more or less U-shaped flow path which is symmetrical around the sensing region.

15 The symmetrical flow path and symmetrical internal sensing region are achieved by displacing a source of radiant energy, such as a light emitting diode or laser diode and a sensor of scattered radiant energy, such as a photodiode or a phototransistor, into the base of the chamber outside of the internal sensing region. With this configuration, the shape of the source does not distort and detract from the symmetry of the sensing region. Similarly, by displacing the sensor into the base,
20 its shape does not distort the symmetrical shape of the sensing region.

Each of the source and the sensor can be, in one aspect of the invention, located in conduits displaced from the sensing region. One conduit, in addition to supporting the source, provides a focusing function for the radiant energy being projected into the sensing region. Another provides a collecting function for
25 scattered incident light directed to the sensor. This increases optical gain of the chamber.

In another aspect of the invention, protrusions can be provided in the conduit for the sensor to block a first reflection of light from the source off of the internal side wall of the sensing chamber to provide an enhanced signal to noise
30 ratio. Such protrusions for example could occupy 20 to 40 percent of the area of the respective conduit to produce the noise suppressing function. A preferred

percentage is on the order of 27 percent.

A protrusion in the conduit for the source cooperates with the interior geometry of the conduit to block and reflect a portion of the light injected through the conduit by the source. This also contributes to the enhancement of the signal to noise ratio.

The conduits are located at an angle relative to one another which corresponds to the primary scattering angle for the sensing chamber. In this regard, for laser sources, an angle can be established in a range of 20 to 30 degrees. A 25 degree angle is preferable. For infrared light emitting diodes, an angle can be established in a range of 40-45°.

In another aspect of the invention, the orientation of the conduits directs the beam of light from the source and directs the field of view of the light sensitive element toward opposite sides of the grooved interior surface of the chamber. The source projects a spot of radiant energy, or light, onto the opposite wall of the sensing chamber, the internal grooved side wall of the cylinder. Preferably in this embodiment, no light will illuminate the fringe of the cover cylinder. However, if due to component variations, emitted radiant energy illuminates the cover fringe, the above-noted protrusion in the conduit for the sensor should block any resultant stray light from reaching the sensor.

The opposite side of the cover cylinder, which is intersected by the optical axis of the sensor does not receive any direct illumination from the source. As such, the sensor is directed to a region having low levels of stray background light or radiant energy.

Hence, the orientation of the conduits taken together reduces the degree of stray background light or radiant energy which can find its way onto or into the light sensor. This in turn contributes to an enhanced signal to noise ratio and a detectable level of scattered light in response to smoke permeating the sensing region.

In another aspect of the invention, the inner surfaces of the side wall and the bottom of the chamber can be formed with grooves to promote absorption of light and to provide depressed regions for accumulating dust that has drifted into the

sensing chamber.

In yet another aspect of the invention, the cylinder which extends from the cover has a continuous closed peripheral surface without perforations therethrough. Ambient atmosphere including ambient smoke, flows up and down the continuous side walls to and from the sensing region. Consequently, the cover, in yet another
5 aspect of the invention, can incorporate a screen or a mesh at an exterior end thereof. Mesh openings can have a length in a range of .013" to .02" long.

The mesh can be inserted into the mold before the cover/cylinder are molded. Alternately, the openings can be molded into the cover without a separate
10 mesh or screen.

The nested cylinders, namely the cylinder carried on the cover and the cylinder formed by the base provide a substantially continuous annular flow path into the sensing region unlike known multiple vane labyrinths which result in several, restricted flow paths into the sensing region. A substantially continuous
15 opening around the exterior perimeter of the cover of the housing can be provided for ingress and egress of smoke.

Taking into account the above-noted characteristics and features, results in a sensing chamber height on the order of .7 inches or less with a diameter of less than 1.5 inches. This produces a sensing volume of less than 1.24 cubic inches and an
20 optical spacing on the order of 1.35 inches.

The smaller sensing volume reduces time to respond to incoming ambient smoke. Additionally, a smaller mesh size can be used, thereby improving exclusion of insects and dust, while at the same time, the chamber still exhibits an acceptably short response time to ambient smoke.

Increasing the size of the mesh or screening of the chamber will also shorten
25 response time. Thus, sensing chambers in accordance with the invention produce increased signal to noise ratios as a result of a combination of reduced sensing region volume, and appropriately selected screen or mesh size in combination with the symmetry of the sensing region and the protrusions in the optical conduits
30 which reduce background chamber noise.

Numerous other advantages and features of the present invention will

become readily apparent from the following detailed description of the invention and the embodiments thereof, from the claims and from the accompanying drawings.

Brief Description of the Drawings:

5 Fig. 1 is a perspective, exploded, view of a detector in accordance with the present invention;

 Fig. 2 is a top plan view of the sensing chamber of Fig. 1 taken along plane 2-2;

10 Fig. 3 is an enlarged, side, sectional, exploded view of a sensing chamber of the detector of Fig. 1;

 Fig. 4 is an enlarged, side, sectional, assembled view of the sensing chamber of Fig. 2;

 Fig. 5 is a side elevational view of the sensing chamber of the detector of Fig. 1;

15 Fig. 6 is a bottom view of the sensing chamber of Fig. 5 taken along plane 6-6;

 Fig. 7 is a view of the interior of the cover of the sensing chamber of Fig. 1 taken along plane 7-7;

 Fig. 8 is a perspective, exploded, view of the sensing chamber of Fig. 1; and

20 Fig. 9 is a different perspective, exploded, view of the chamber of Fig. 1.

Detailed Description of the Preferred Embodiments:

 While this invention is susceptible of embodiment in many different forms, there are shown in the drawing and will be described herein in detail specific embodiments thereof with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the invention to the specific embodiments illustrated.

25 Fig. 1 illustrates a fire detector 10 in accordance with the present invention. The detector 10 includes an exterior enclosure 12 which might have a substantially cylindrical shape.

30 The enclosure 12 has a mounting base or mounting surface 12a and a central opening 12b. A removable top 14 extends into the opening 12b and can be

removably attached to the enclosure 12.

The top 14 includes a plurality of open regions, 14a, 14b which permit the ingress and egress of ambient atmosphere into the enclosure 12. It will be understood that the exact configuration of the enclosure 12 and the top 14 are not limitations of the present invention.

When the top 14 has been removed by moving it away from the enclosure 12 in a direction 14c, access is provided to a fire sensor 20. The fire sensor 20, as described further below, includes a small, low profile sensing chamber which responds to the presence of airborne particulate matter which enters and leaves the sensor 20 via cover 14.

Sensor 20 includes a generally cylindrical base section 22 and a removable cover section 24. The cover section 24 extends through opening 12b. Once top 14 has been removed, section 24 is readily removable for maintenance and service purposes. The section 24 slideably engages base section 20 as discussed in more detail subsequently.

Base section 20 is carried on a printed circuit board 26. The printed circuit board 26 also carries electronic circuitry 28 for purposes of receiving signals from the fire sensor 20 and for carrying out control and communications functions of a type associated with fire sensors as would be known to those of skill in the art. It will be understood that the exact configuration of the control circuitry 28 is not a limitation of the present invention. A light emitting diode 28a coupled to circuitry 28 can be used to provide status information.

Figs. 2-9 illustrate various features of the sensor 20. As illustrated in Figs. 3 and 4, base section 22 carries a cylindrical portion 30 with a side wall 30a which terminates at a planar end 30b. As illustrated, the fire sensor 20 is implemented as a scattering-type photoelectric smoke sensor. Conduits 32a and 32b are molded into base section 22 and extend from end surface 30b away from the cylindrical side wall 30a.

One of the conduits, such as conduit 32a, can receive a source of radiant energy, which might be a light emitting diode or a laser diode without limitation. 34a. When energized, the source 34a projects a beam of radiant energy 34b,

illustrated in phantom in Fig. 3, through conduit 32a and into a sensing region 50.

Base section 22 also carries a sensor 36a, which could be implemented as a photodiode or a phototransistor, in the conduit 32b. It will be understood that the exact choices of source 34a and sensor 36a are not limitations of the present invention.

As a result of the conduit 32b, the field of view of sensor 36a is directed toward a region formed in sensor 20 which is 180° away from the region of incidence of the radiant energy 34b from the source 34a. By so-orienting the source and the sensor, stray reflections are minimized.

It will be understood that as a result of off-setting the conduits 32a, 32b from the base 30b of the cylindrical 30, the cylinder 30 bounds, in part a symmetrical or cylindrical sensing region 50. The region 50 is free from intrusion by either the source 34a or the sensor 36a.

Extending from surface 30b are elongated support elements 40a, 40b which are substantially identical. Between the elements 40a, 40b is a support and engaging element 40c.

The cylindrical cover element 24 includes an exterior top surface 24b which terminates at circumferential edges 24c, 24d. The edges 24c, 24d bound a plurality of openings such as openings 42a, 42b which extend peripherally about the cover 24.

The openings 42a, 42b permit the ingress and egress of ambient air which in turn may be carrying fire indicating gases or particulate matter. The openings 42a, 42b could be completely open or could be closed in part by mesh having openings of various sizes.

Smaller mesh sizes are known to more effectively exclude undesirable airborne material such as dust, airborne fibers, insects or the like. For example, screen openings on the order of .017 inches or .43 mm can be used without unduly delaying the response of the chamber 20. Hence, the openings 42 which are circumferentially spaced around the entire upper edge of the cover 24 provide symmetrical access to the chamber 20 by ambient atmosphere as discussed in more detail subsequently.

The cover element 24 carries thereon a cylindrical section 46 which extends substantially perpendicularly from the exterior end surface 24b. The cylindrical section 46 is hollow defining a grooved interior region indicated generally at 46b.

As the cover portion 24 moves toward the base portion 22, it ultimately becomes supported by and rests on upper surfaces 40a-1 and 40b-1. Additionally, cover portion 24 slideably and lockingly engages upper latching member 40c-1. Hence, the cover portion 24 is symmetrically supported and removably attached to body portion 22.

In this configuration, as illustrated in Fig. 4, an annular conduit 48 exists between the side wall 30a formed in base member 22 and exterior peripheral surface 46a of cylindrical element 46. Annular conduit 48 permits inflow and outflow of ambient airborne gases and smoke related particulate matter in a generally U-shaped flow pattern 48a in and out of the openings 42a, 42b. Flow is along the channel 48 formed by surfaces 30a and 46a and into the sensing region 50.

The flow regions for ingress and egress of ambient airborne gases and particulate matter are symmetrical about the chamber 20. The sensing region 50 is also symmetrical about a centerline thereof without any distortion thereof or intrusion therein of the source 34a and the sensor 36a. The nested cylindrical structure of the chamber 20 also contributes to the exclusion of stray exterior light.

Airborne particulate matter which enters the sensing region 50 will in turn cause scattering of the radiant energy 34b. The scattered radiant energy will in turn be sensed by sensor 36a using electronics 28 in a known fashion.

The optical axis of the emitter or source 34a relative to the optical axis of the center 36a is oriented preferably on the order of 25° for a laser diode. Where the source 34a corresponds to an infrared light emitting diode, the relative angle between the axis is preferably in a range of 40 to 45° .

Each of the conduits 32a, 32b terminates in a respective overhang 60a, 60b. The overhangs reduce noise in the chamber, as detected at sensor 36a, more than they reduce the signal sensed thereby due to airborne particulate matter. Hence, they enhance the chamber signal to noise ratio.

The emitter conduit 32a in combination with overhang 60a contributes to

focusing the beam 34b into the sensing volume or region 50. This beam 34b will ultimately be incident on grooves 60a formed within cover 24.

Preferably overhang 60b associated with sensor 36a will extend into the conduit 32b enough to prevent the sensor from directly receiving any scattered light from grooves 60b' that originated from the source 34a. The overhang 60b blocks the first reflection of any such scattered light. The optical axis of sensor 36a impinges on grooves 60a 180° away from where the beam 34b impinges thereon. This also enhances the signal-to-noise ratio.

Preferably, the overhangs in the conduits 32a, 32b will represent 20 - 40 percent of the cross sectional area of the respective conduit. A 27 percent intrusion into the respective conduit is preferred.

The chamber 20 benefits from relatively rapid response to inflowing airborne particulate matter due to its relatively small volume, on the order of 20 cc or less.

Representative chamber parameters are on the order of less than 1.5 inches in diameter with a sensing volume height of less than .7 inches to produce the noted 20 cc sensing volume. Compatible mesh sizes will be on the order of .013 - .02 inches. A preferred size is on the order of .017 inches.

Those of skill in the art will understand that the size of the openings of the mesh can be altered to effect chamber response. Somewhat larger openings will provide faster response to low energy fires at the cost of potentially permitting increased dust flow or insect problems in the chamber.

With respect to Fig. 4, a shield 26-1 is illustrated in phantom associated with sensor 36a. Such shields could be formed out of a conductive material such as metal. Alternately, base portion 22 could be molded of conductive plastic to provide a shield about the sensing element 36a. This will provide an AC ground about the chamber 22 and the sensor 36a. In one embodiment, contacts might be molded into the conductive plastic to create connections to the shield.

One of the advantages of the chamber 20 lies in the fact that the side walls of cylindrical members 30 and 46 are continuous and unperforated. They do not exhibit labyrinth-type openings therethrough. These side walls block outside

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ambient light from reflecting into the interior of sensing region 50 and contributing to noise which might be incident upon sensing element 36a. The mesh and the openings 42a, 42b can be molded into the cover portion 24. The cylindrical peripheral openings 42a, 42b provide access to the symmetrical annular flow channel 48 between the cylindrical side walls 30a and 46a into and from sensing region 50.

Additionally, internal grooves 60a' and 60b' can be provided in the side walls of the cylindrical member 46 as well as in the end portion. The grooves are very effective in absorbing light originating from the source 34a as well as any reflections from outside of the chamber. In addition, the number of required reflections for exterior light to enter the sensing region 50 is high enough so as to substantially eliminate such interference. The grooves also trap internal chamber dust and contribute to an enhanced signal-to-noise ratio.

As noted previously, the cover portion 24 extends through opening 12b of the enclosure 12. Hence, cover portion 24 can be slideably removed from base portion 22 and replaced. This process will not only provide a dust free interior side wall 46b but it can be achieved without disturbing the source 34a or the sensor 36a.

The out of phase orientation of the offset source 34a and sensor 36a, the symmetrical annular inflow/outflow channel and non-perforated side walls with internal reflection suppressing grooves each contribute to a relatively low volume, symmetrical sensing region with an acceptable signal-to-noise ratio. Readily separable and replaceable cover 24 facilitates maintenance. The small chamber size results in an aesthetically acceptable, low profile detector.

Various sizes of mesh can be molded into covers 24 to vary chamber performance characteristics. The relatively small sensing chamber volume makes feasible the use of relatively small mesh sizes yet the chamber exhibits acceptable response levels and adequate signal-to-noise ratios.

From the foregoing, it will be observed that numerous variations and modifications may be effected without departing from the spirit and scope of the invention. It is to be understood that no limitation with respect to the specific

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apparatus illustrated herein is intended or should be inferred. It is, of course, intended to cover by the appended claims all such modifications as fall within the scope of the claims.

What is Claimed:

1. A sensing chamber comprising:
a cylindrical housing having a continuous closed peripheral sidewall with first and second ends and with a length on the order of a radius of the housing;
5 a source of radiant energy positioned in one of the ends;
a cover substantially closing the other end with at least one opening, displaced axially from the one end, located adjacent to the other end permitting a flow of adjacent atmosphere into and out of the housing.
2. A sensing chamber as in claim 1 which includes a plurality of
10 openings, spaced about the housing at the other end .
3. A sensing chamber as in claim 1 wherein the housing includes a base at the one end wherein the base receives a cylindrical insert which carries the cover and wherein the insert in conjunction with the base, defines an internal region into which the source injects radiant energy.
- 15 4. A sensing chamber as in claim 3 wherein the insert is slidably received by the base.
5. A sensing chamber as in claim 3 wherein the insert carries a plurality of grooves on an internal surface.
6. A sensing chamber as in claim 3 which includes a sensor of radiant
20 energy, displaced from the source and oriented at a selected angle thereto.
7. A sensing chamber as in claim 6 wherein the angle is in a range of 20-30 degrees.
8. A sensing chamber as in claim 7 wherein the angle is on the order of 25 degrees.
- 25 9. A sensing chamber as in claim 6 wherein both the sensor and the source are located at the one end adjacent to but outside of a sensing region formed within the housing.
10. A sensing chamber as in claim 9 wherein each of the sensor and the source define an optical axis and wherein these axes intersect in the sensing region
30 at an angle between 20 and 50 degrees.
11. A sensing chamber as in claim 10 wherein the angle of intersection

corresponds to a scattering angle in a range of 40-50 degrees.

12. A sensing chamber as in claim 10 wherein the sensing region is symmetrical and not distorted by the source or sensor intruding thereinto.

13. A sensing chamber as in claim 9 wherein the sensor and source are positioned in conduits at the one end wherein one conduit focuses the radiant energy from the source and another focuses radiant energy toward the sensor.

14. A sensing chamber as in claim 13 wherein at least the conduit associated with the sensor incorporates a conduit constricting protrusion whereby the sensor is shielded from selected reflective radiant energy in the housing.

15. A sensing chamber as in claim 14 wherein the protrusion occupies a percentage of the cross section of the conduit in a range of twenty to forty percent.

16. A sensing chamber as in claim 15 wherein the protrusion occupies about twenty seven percent of the cross section.

17. A sensing chamber as in claim 14 wherein the conduit associated with the source includes a constricting protrusion.

18. A sensing chamber as in claim 17 wherein the protrusions are substantially identical.

19. A sensing chamber as in claim 13 wherein at least a portion of the housing includes an electromagnetic shield.

20. A sensing chamber as in claim 19 wherein the shield is formed, at least in part of a conductive plastic which also forms at least a part of the housing.

21. A sensing chamber as in claim 1 wherein the housing has an internal annular flow path formed in the sidewall.

22. A sensing chamber as in claim 1 wherein the inflow of adjacent atmosphere is in a direction substantially perpendicular to an axis of the housing.

23. A chamber as in claim 22 which includes a sensor of radiant energy located at the one end displaced from the source.

24. A chamber as in claim 23 wherein the source projects radiant energy into the housing at an obtuse angle relative to a central axis of the housing.

25. A chamber as in claim 24 wherein the sensor is oriented on a line which extends, relative to the one end, at an angle less than ninety degrees.

26. A chamber as in claim 22 which has an internal volume less than 22cc.

27. A chamber as in claim 21 wherein the sidewall bounds an internal sensing region in flow communication with the annular flow path.

5 28. A chamber as in claim 27 wherein the cover carries an annular opening only at the other end.

29. A chamber as in claim 1 wherein the housing includes internal, spaced apart planar parallel end surfaces.

30. A smoke detector comprising:

10 a housing;

a smoke sensing chamber centrally located and extending in part through a central opening in the housing wherein a circumferential region of the chamber, which extends from the central opening, carries a peripherally disposed plurality of openings for ingress to and egress from the chamber within the housing wherein the circumferential region is removable from the chamber via the central opening and wherein the circumferential region carries a cylindrical bounding sidewall which extends axially therefrom wherein the bounding sidewall has a non-perforated peripheral surface.

15 31. A detector as in claim 31 wherein the bounding sidewall terminates in an open end displaced axially from the openings.

32. A detector as in claim 31 wherein the sensing chamber has a base fixed in the housing and wherein the base receives the open end thereby forming an enclosed, symmetrical, sensing volume in flow communication with ambient atmosphere, outside of the housing.

25 33. A detector as in claim 32 wherein the base carries an emitter and a sensor outside of the sensing volume.

34. A detector as in claim 33 wherein the emitter and sensor are each located in an optical conduit wherein the conduits each extend, at a selected angle, relative to the base.

30 35. A detector as in claim 34 wherein the emitter projects a beam of radiant energy through the respective conduit into the sensing region.

36. A detector as in claim 35 wherein the sensor is aligned along an axis of the respective conduit and wherein the axis of the conduit intersects the beam of radiant energy at a selected angle in the sensing region.

37. A detector as in claim 36 wherein the angle falls in a range of twenty to fifty degrees.

38. A detector as in claim 35 wherein the beam impinges on a portion of the bounding sidewall.

39. A detector as in claim 38 wherein an axis of the sensor intersects the bounding sidewall substantially 180 degrees away from where the beam impinges the sidewall.

40. A detector as in claim 32 wherein a cylindrical flow region is formed between the base and the cylindrical bounding side wall.

41. A sensing chamber comprising:
a base having a first cylinder extending therefrom wherein the cylinder is formed with a continuous, non-perforated peripheral surface;
a second cylindrical element with a closed end and at least one opening at the end with a second cylinder extending from the end wherein the first and second cylinders are positioned on a common center line thereby forming a substantially closed interior sensing region bounded by the two cylinders with an annular flow path therebetween.

42. A chamber as in claim 41 wherein the second cylinder is formed with a continuous non-perforated peripheral surface.

43. A chamber as in claim 42 wherein a flow path extends from the one opening, between the two cylinders, around one end of one cylinder and into the sensing region.

44. A smoke chamber comprising:
an elongated, housing which defines an internal sensing region and having first and second ends;
at least one opening in the housing, at one of the ends, for ingress and egress of ambient atmosphere and a bounded, axially oriented flow channel coupling, the one opening to the other end wherein ambient atmosphere in the

channel is outside of the sensing region except at the other end and wherein the sensing region abuts the other end.

45. A fire detector comprising:

5 a cylindrical sensing region bounded by a hollow sensor housing with first and second displaced ends wherein one end opens to the sensing region, a bounded conduit which has first and second ports wherein one port is in flow communication with the one end and wherein the second port is displaced therefrom at the other end and is in flow communication with adjacent ambient atmosphere; and

10 a sensing element coupled to the sensing region.

46. A detector as in claim 45 wherein the housing comprises a removable cover which forms the other end and which carries the second port adjacent thereto.

15 47. A detector as in claim 45 wherein the housing is substantially cylindrical with the conduit configured as a bounded flow region which surrounds, at least in part, the sensing region.

48. A detector as in claim 46 wherein the conduit surrounds the sensing region.

20 49. A detector as in claim 48 wherein the cover is substantially cylindrical and wherein the conduit comprises an annular flow region that extends substantially the length of the cover.

50. A detector as in claim 49 which includes an enclosure which carries at least the sensor housing, and wherein the cover is removable from the sensor housing in the presence of the enclosure.

25 51. A detector as in claim 50 wherein the enclosure defines an opening and wherein the cover protrudes therefrom.

30 52. A detector as in claim 45 which includes a source of radiant energy wherein the source directs a beam of radiant energy toward an internal region of the housing and the sensor has a field of view directed toward an internal region of the housing and wherein the regions are at opposite ends of a diameter of the sensing region.

53. A sensor comprising:

a cylindrical sensing region bounded by a hollow sensor housing with first and second displaced ends wherein one end is substantially planar and opens to the sensing region, a bounded conduit which has first and second ports wherein one port is in flow communication with the one end and wherein the
5 second port is displaced therefrom and is in flow communication with adjacent ambient atmosphere; and

a sensing element coupled to the sensing region wherein the element is located outside of the sensing region.

10 54. A sensor as in claim 53 which includes a source of radiant energy for directing radiant energy into the sensing region wherein the source is located outside of the sensing region.

55. A sensor as in claim 53 wherein the sensing region has a volume less than 20 cc.

15 56. A sensor as in claim 53 wherein the sensing region has a height less than .7 inches.

57. A sensor as in claim 53 wherein the sensing region has a diameter less than 1.5 inches.

20 58. A sensor as in claim 53 wherein a portion of the housing is formed of a conductive plastic.

59. A sensor as in claim 54 wherein the sensing element and the source are carried within respective conduits.

60. A sensor as in claim 59 wherein the conduits are oriented at a selected angle relative to one another.

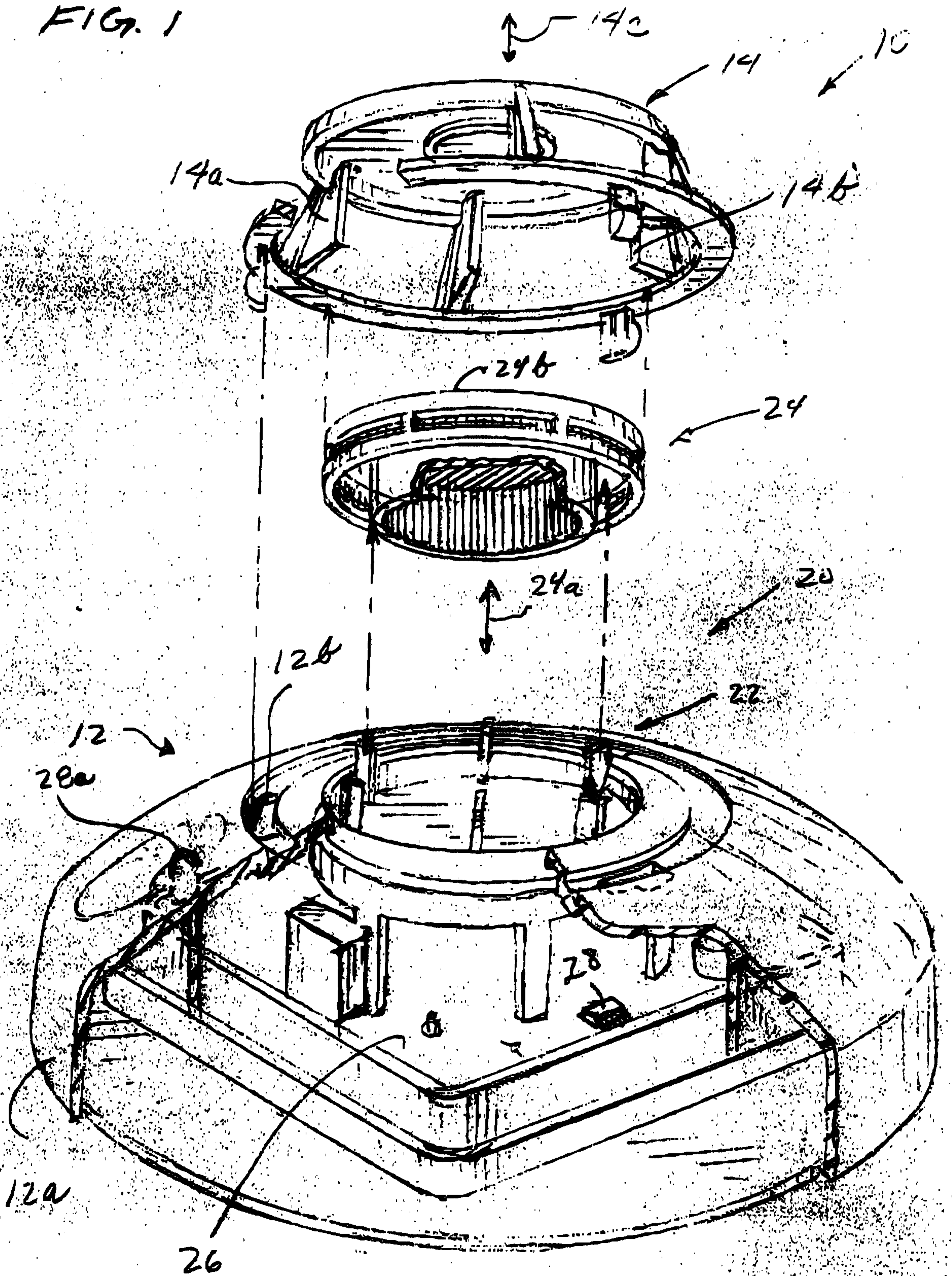
25 61. A sensor as in claim 60 wherein when the source emits monochromatic radiation, the angle is in a range of 20-30 degrees.

62. A sensor as in claim 60 wherein when the source comprises an infrared light emitting diode, the angle is in a range of 35-50 degrees.

30 63. A sensor as in claim 59 wherein at least one of the conduits is formed with a protrusion extending thereinto.

64. A sensor as in claim 63 wherein the protrusion occupies 20 to 40 percent of the cross sectional area of the conduit.

FIG. 1



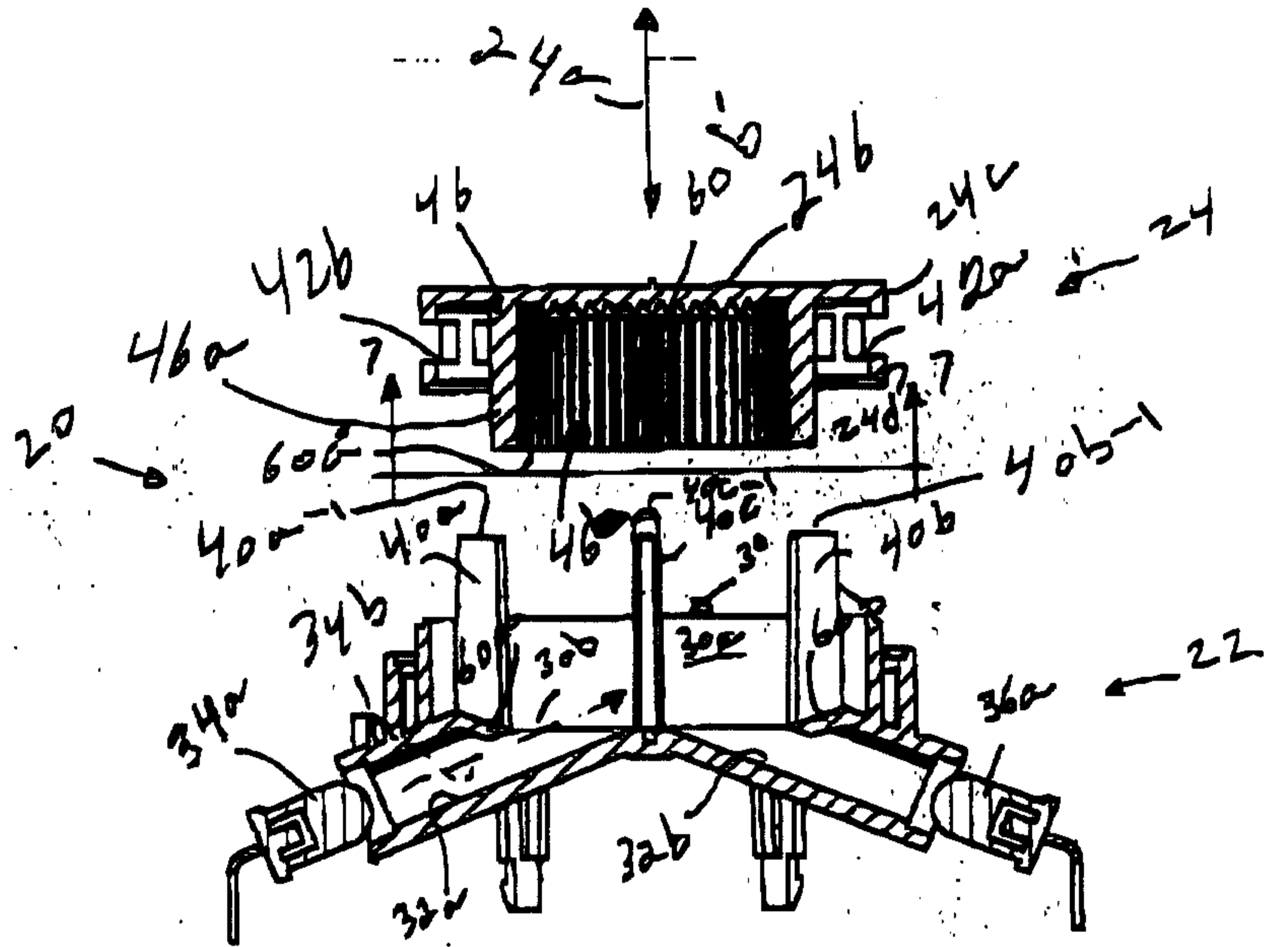


FIG 3

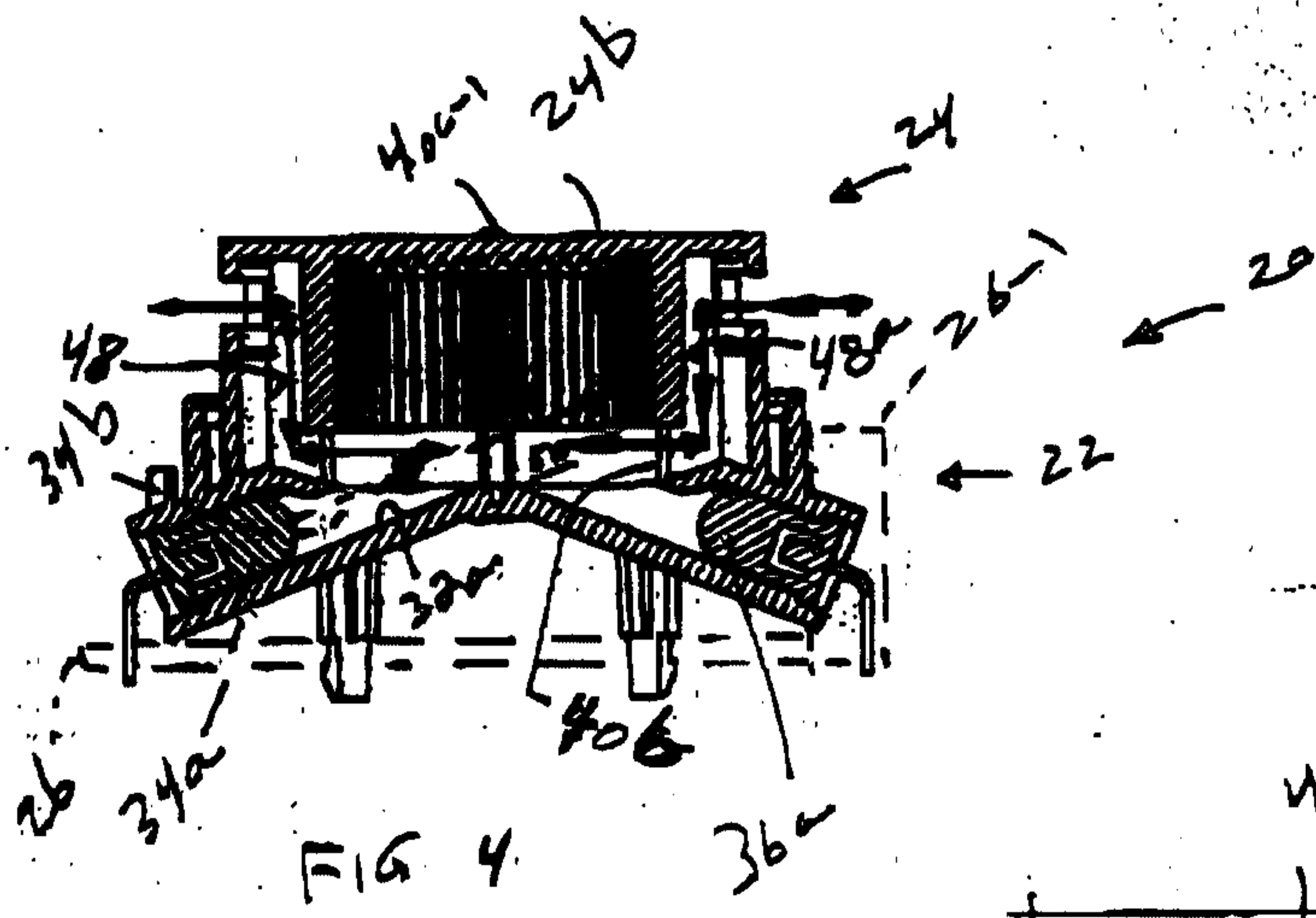


FIG 4

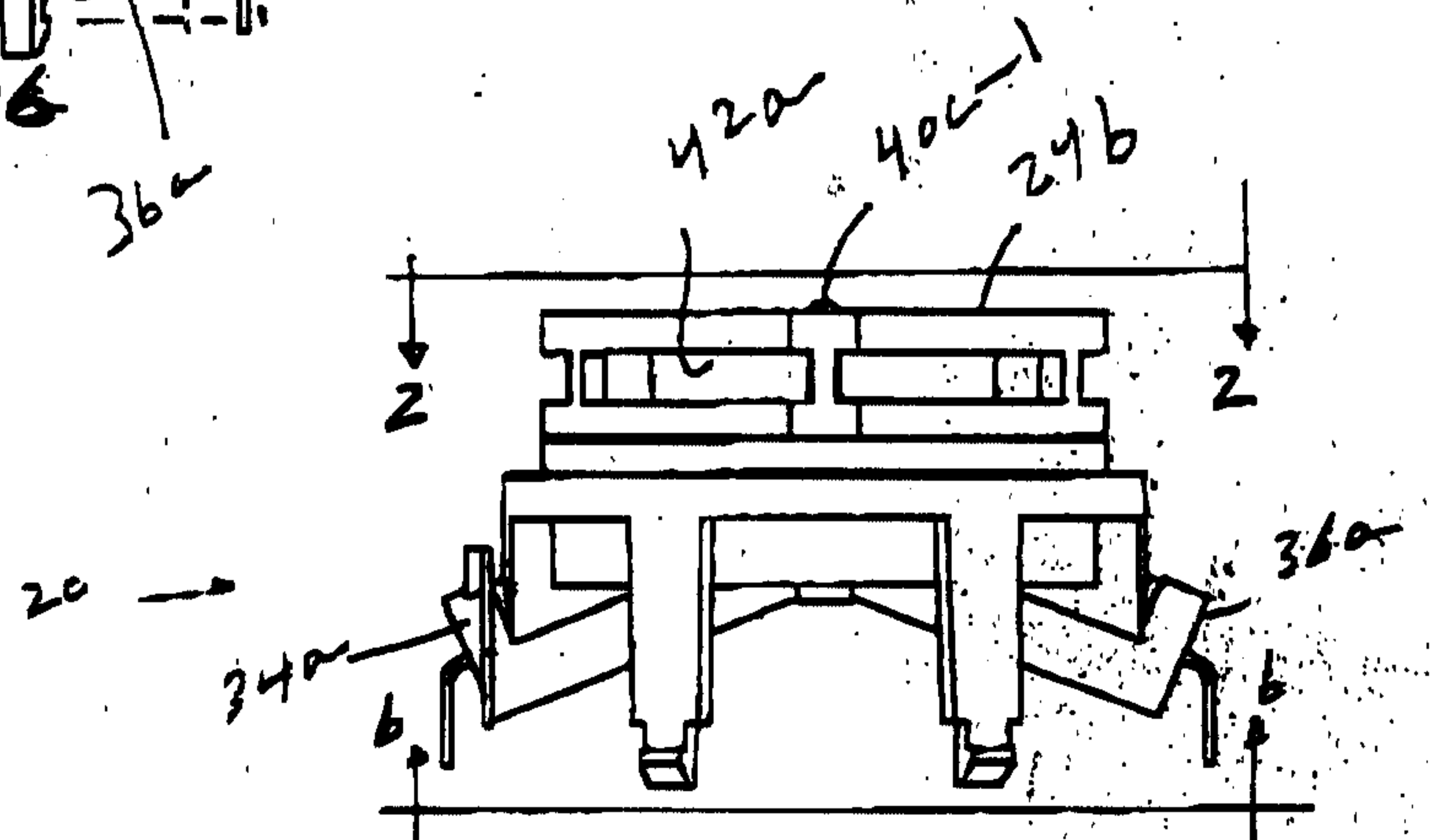


FIG 5

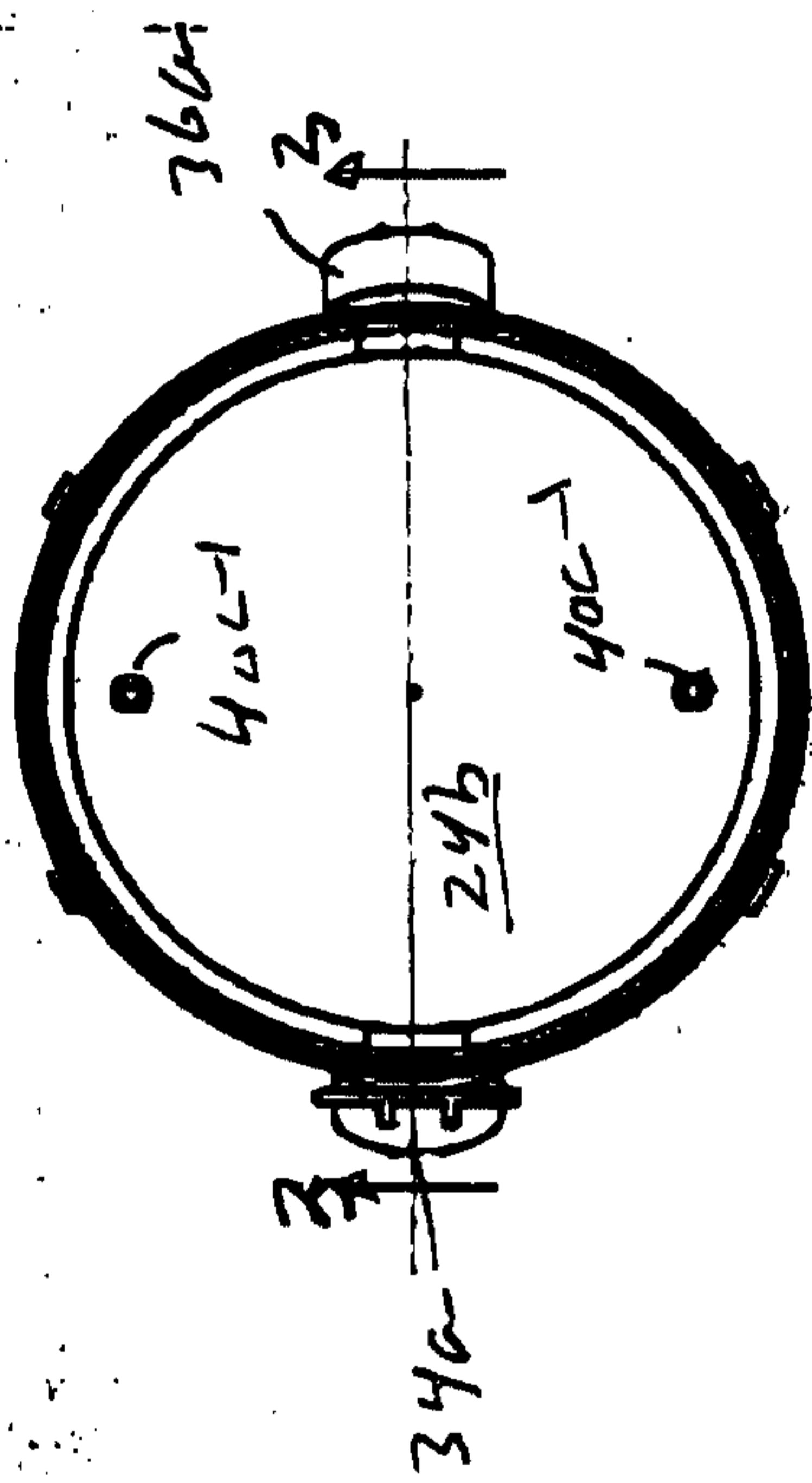


FIG 2

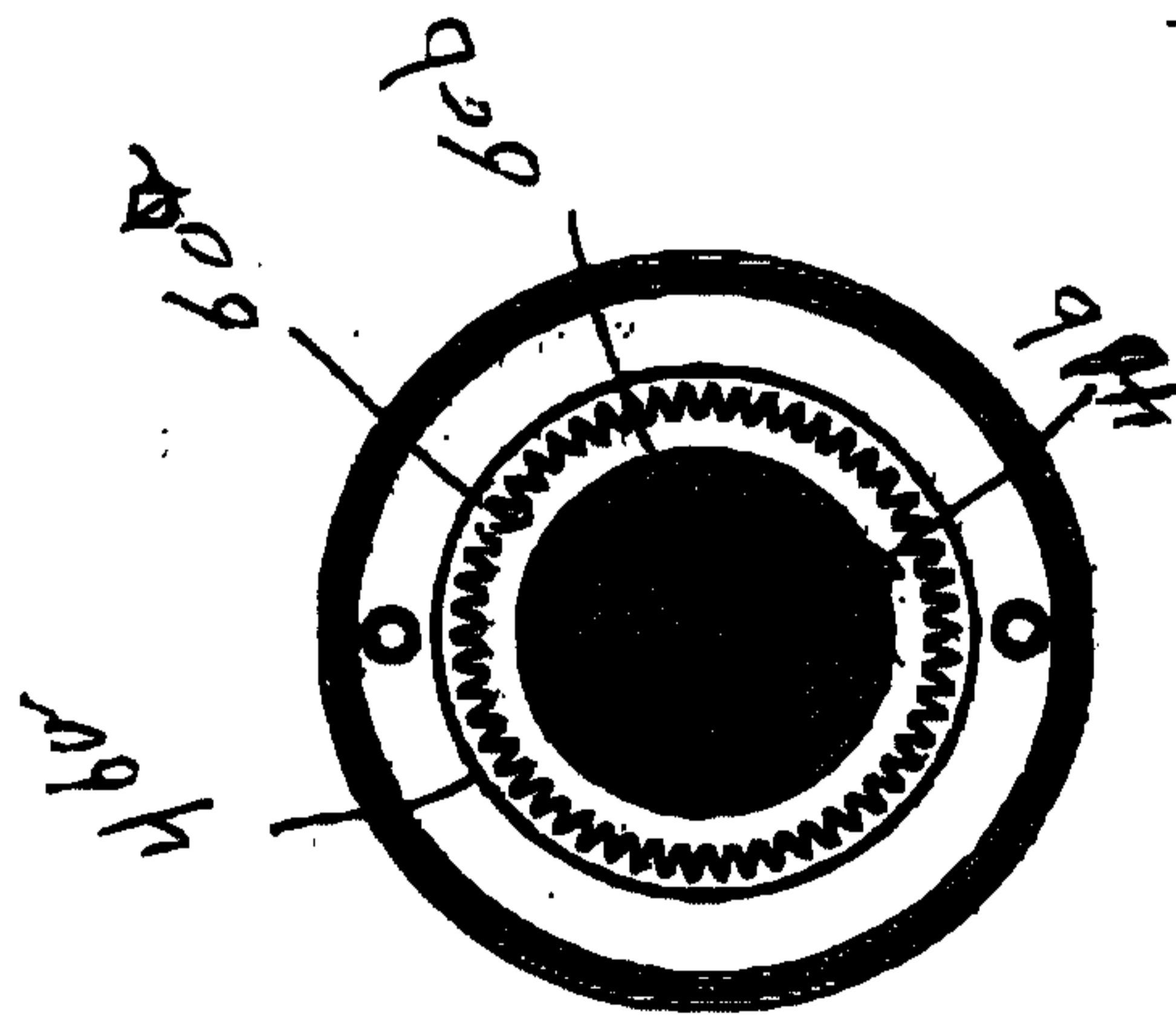


FIG 7

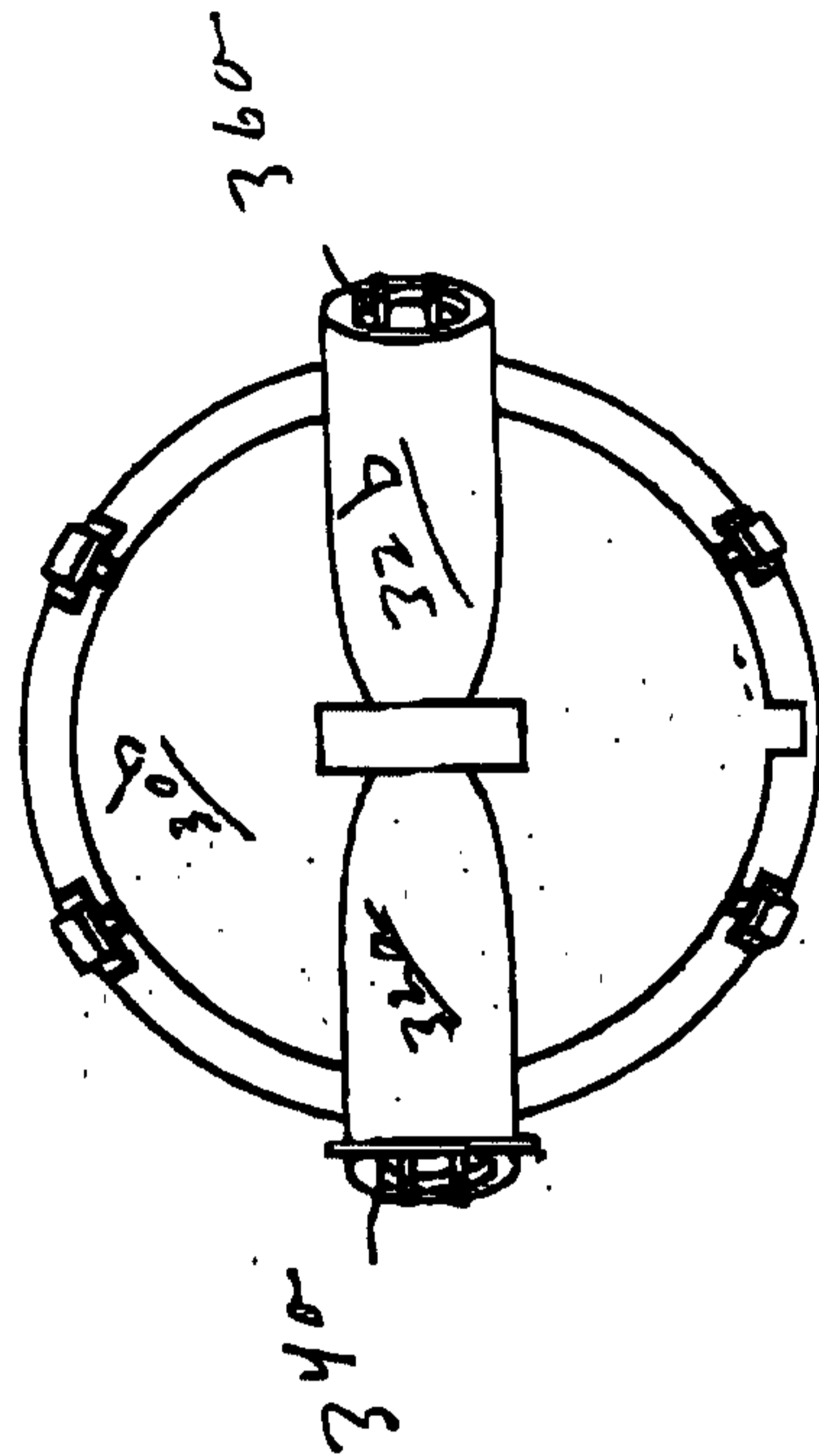


FIG 6

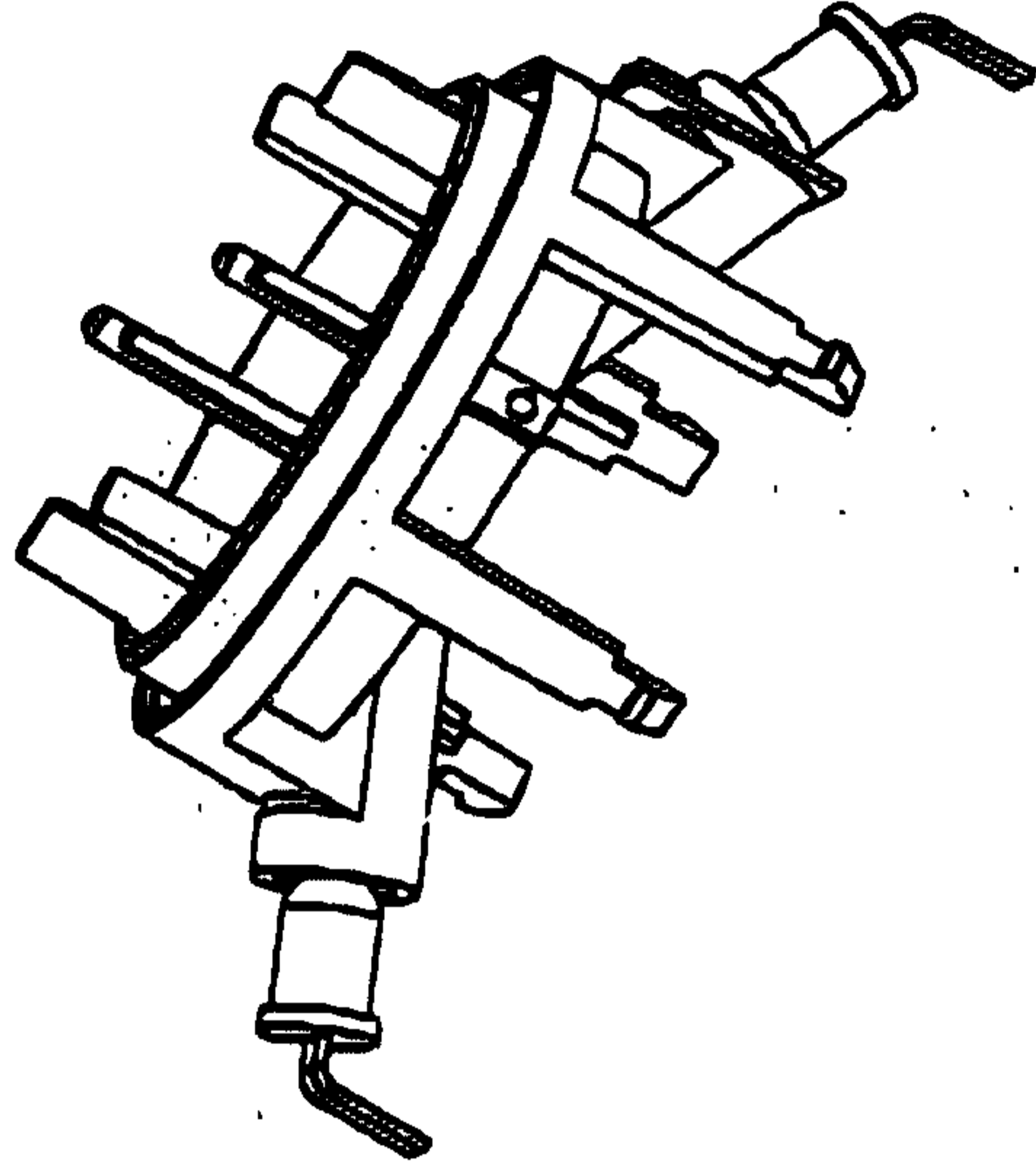
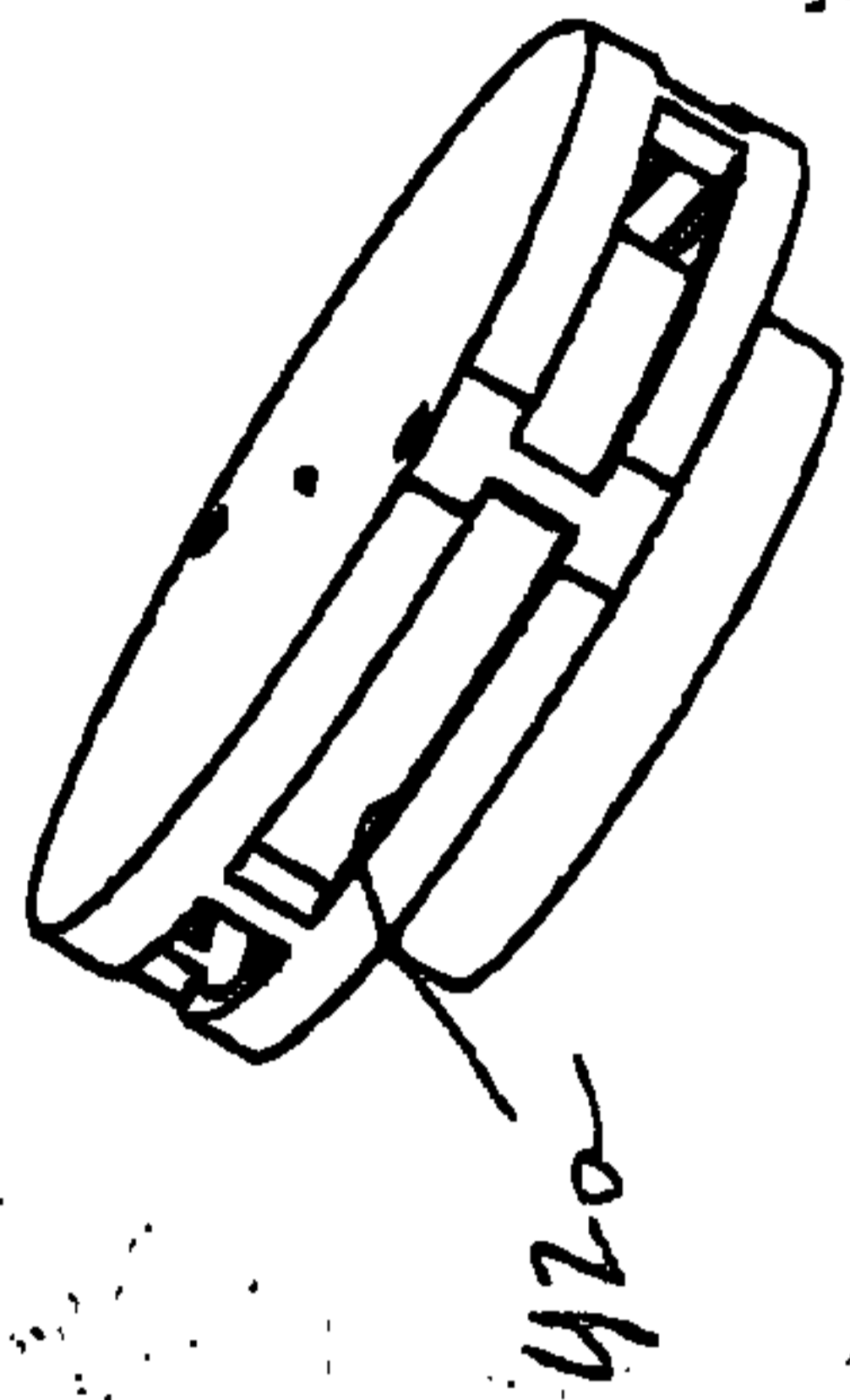


FIG 9

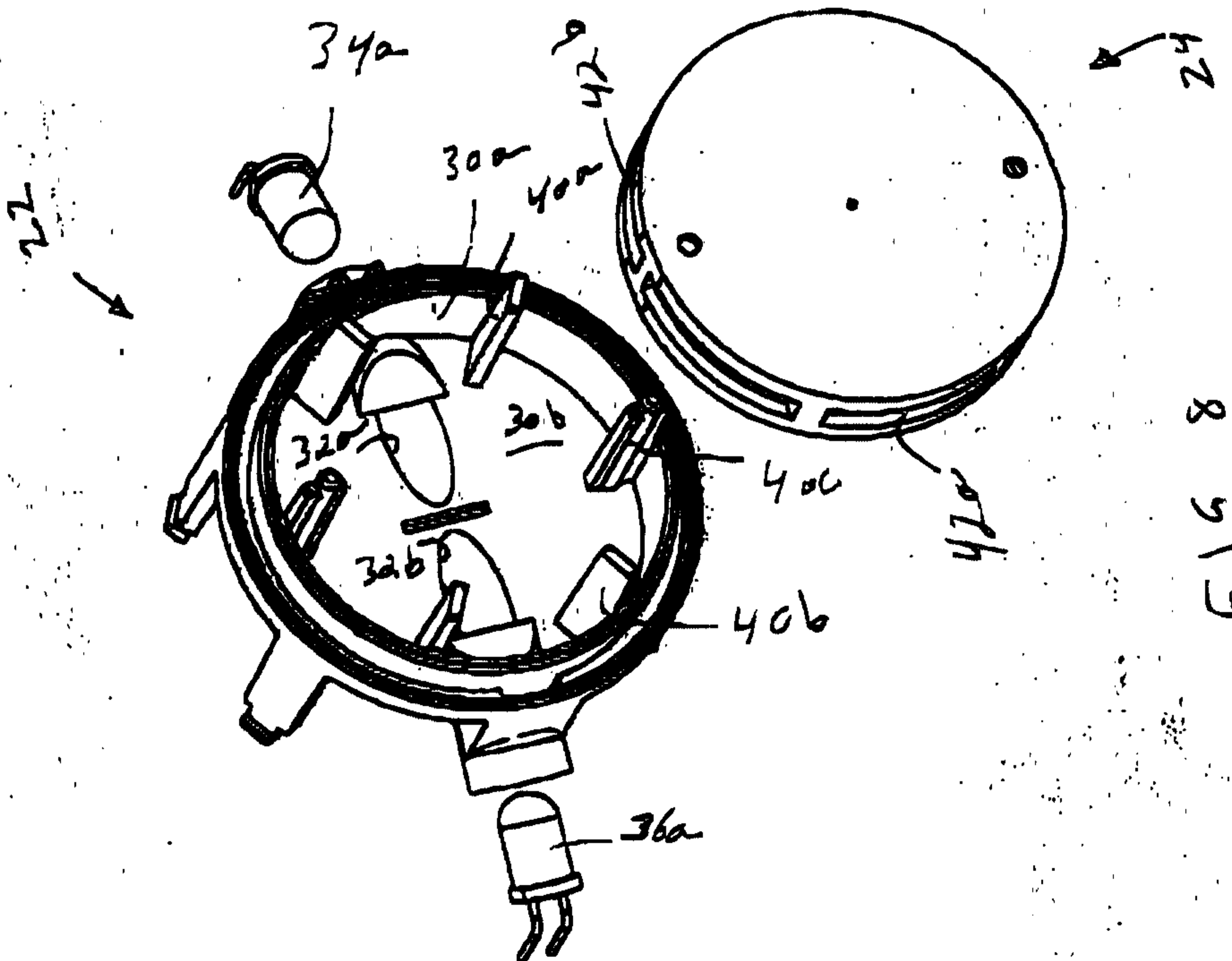


FIG 8

