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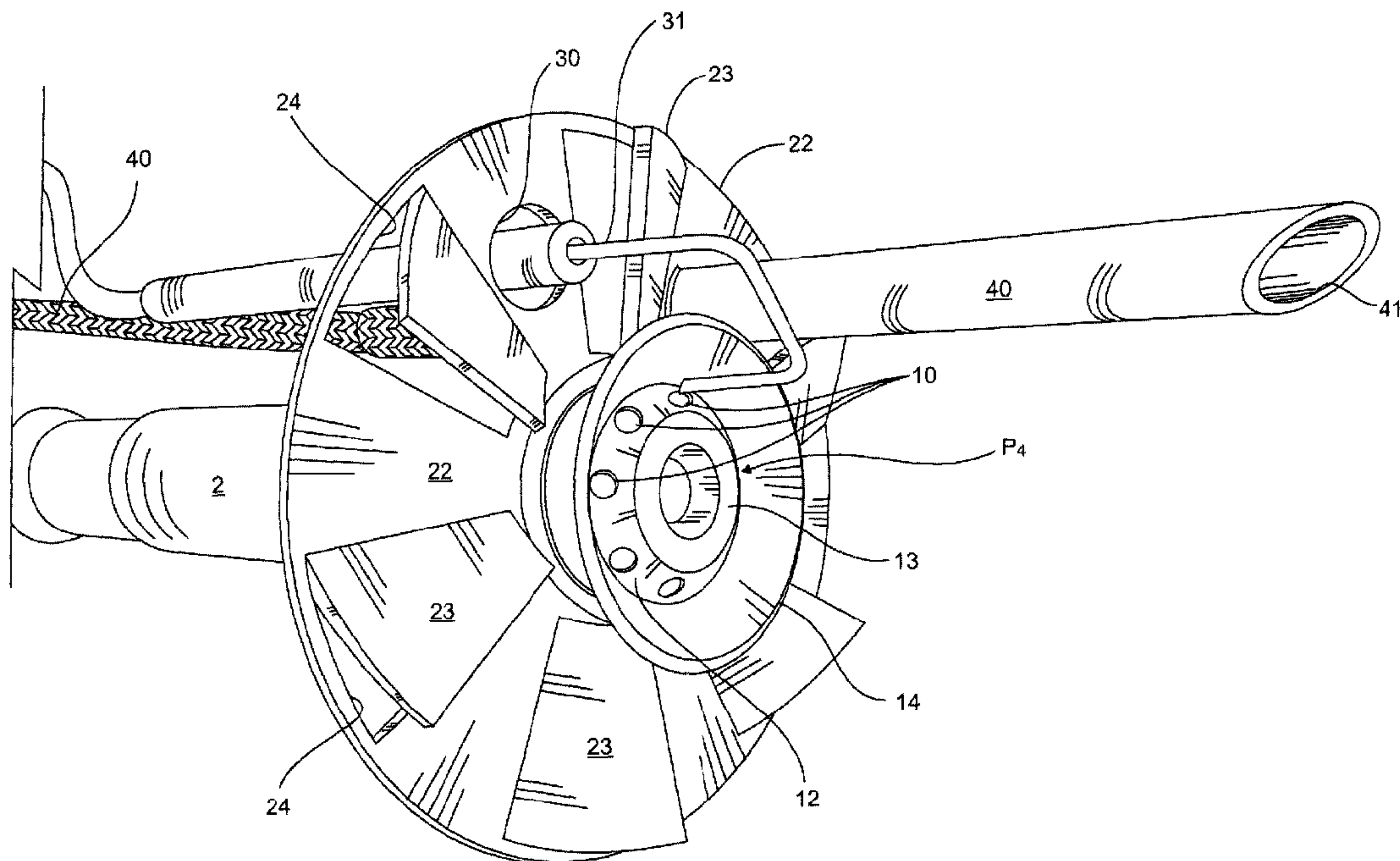
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(54) Titre : BRULEUR

(54) Title: BURNER ASSEMBLY



(57) Abrégé/Abstract:

A burner assembly has a burner head and a deflector plate extending radially therefrom and across a firetube housing for supporting the burner assembly therein. The deflector plate has a plurality of angled vanes for re-directing secondary combustion air flowing through the housing. Secondary air is deflected away from a nozzle tip at the burner head to minimize lifting of the flame by the deflector plate or by a low pressure ring formed around the nozzle tip above the deflector plate for creating an area of low pressure. Preferably, a combination of the deflector plate and low pressure ring provides a stable flame positioned at the nozzle tip under low-fire and high-fire conditions enabling use of a pilotless ignition and flame sensing system which is consistent under low and high fire conditions. More preferably, the deflector plate supports the igniter and optionally a heat return tube for heat tracing of the freeze-prone burner assembly components.

1 **“BURNER ASSEMBLY”**

2

3 FIELD OF THE INVENTION

4 The present invention relates to the field of burners and particularly

5 to gas burners used in industrial heaters.

6

7 BACKGROUND OF THE INVENTION

8 It is well known in a variety of industries to use heaters having

9 burner assemblies for a number of different applications, including kilns, drying

10 apparatus, furnaces and for preventing freezing of tanks and pipelines. In the oil

11 and gas industry, heaters are particularly used in regions where low ambient

12 temperatures may result in freezing of storage tanks or in production and process

13 pipelines. Further process heaters are used which may be used when knocking

14 water out of oil and when heating salt baths and the like. Gas burner assemblies

15 are typically arranged in a housing or firetube which extends into a storage or

16 holding tank to be heated.

17 In prior art natural draft or “non-forced draft” situations, primary

18 combustion air is drawn into a mixing chamber or mixer head of the gas burner

19 assembly as a result of the velocity of the flammable gas entering the mixing

20 chamber or venturi. The premixed gas/air fuel mixture exits the venturi at a

21 burner nozzle, typically a rosebud nozzle, where the mixture is ignited.

22 Secondary combustion air is drawn into the housing and around the burner

23 assembly as a result of draft. The secondary air, intended to aid in combustion,

24 may adversely affect the operation of the burner assembly. Large volumes of

25 secondary air creating a large turbulent draft at the burner head may result in the

1 flame being lifted from the burner nozzle or may blow out a flame at the nozzle.
2 Attempts to reduce or dampen the amount of secondary air entering the burner
3 can substantially shutoff the flow of secondary air which compromises the
4 efficiency of the burner.

5 Further, variability in operation can adversely affect the consistency
6 of ignition and flame sensing. Typically, burners may be operated in high-fire and
7 low-fire situations. In a low-fire situation, the pressure of fuel entering the burner
8 is relatively low compared to a high-fire situation. Conventional burners which
9 are set to operate under low-fire conditions can experience lifting of the flame
10 from the burner nozzle should they be used in a high-fire situation. Thus, in
11 conventional burners, ignition and flame sensing, which are optimized for one
12 flame characteristic, become problematic as the position of the flame alters. Use
13 of a pilot has provided a consistent flame source and ignition sensing. In variable
14 firing conditions, should the fuel/air ratio and secondary air flow be sufficiently
15 unstable at the burner nozzle, remote lighting of the burner becomes difficult. As
16 a result, the industry has typically relied on manual lighting of such burners which
17 has resulted in significant hazard to personnel performing the task.

18 Additionally, freezing is a common problem with natural draft burner
19 assemblies. Typically, areas of low pressure adjacent the orifice of the burner
20 may result in freezing at the orifice or in the gas lines which feed the orifice. Low
21 flow of fuel at pilot assemblies are even more prone to freezing

22 Clearly, there is interest in the industry to provide a reliable burner
23 which remains lit under ambient conditions, is safe to ignite and operate and
24 permits flame-sensing in both low fire and high fire situations, does not freeze in
25 low ambient temperature and is efficient.

1 the burner assembly comprising: a deflector for deflecting the flow of secondary
2 combustion air in the annular space away from at least the nozzle tip for
3 stabilizing at least a position of a flame thereon. Preferably, a conical low
4 pressure ring is positioned circumferentially about the nozzle tip and extends
5 radially outwardly from the burner head for substantially separating the flow of
6 primary combustion air and fuel from the flow of secondary combustion air at the
7 nozzle tip creating an area of low pressure at the nozzle tip relative to a pressure
8 of the secondary air in the annulus whereby lifting of the flame from the nozzle tip
9 is reduced.

10 In another embodiment, a pilotless burner assembly comprises the
11 burner assembly as described above and further comprises an igniter supported
12 in the air deflector for remotely igniting the burner assembly which is positioned
13 adjacent the burner tip and therefore separated from the secondary air.
14 Preferably the igniter further comprises flame sensor.

15

16 BRIEF DESCRIPTION OF THE DRAWINGS

17 Figure 1 is a schematic side view of a burner according to an
18 embodiment of the invention and positioned for operation in a firetube or housing;

19 Figure 2a is a side view of the burner assembly removed from the
20 housing for clarity;

21 Figure 2b is a plan view of a deflector plate positioned at a nozzle of
22 the burner according to Fig. 1, the housing being removed for clarity;

23 Figure 3 is a bottom perspective view of a burner according to Fig.
24 1 positioned in the housing, an igniter and heat return tube removed for clarity;

1 Figure 4 is a side view of a nozzle portion of the burner according to
2 Fig. 1, the housing removed for clarity and illustrating a heat return tube for
3 preventing freezing of the burner by heat tracing;

4 Figure 5 is a schematic side view of a mixer head according to Fig.
5 1;

6 Figure 6 is a plan view of the mixer head according to Fig. 5 shown
7 along section lines A-A;

8 Figure 7 is a sectional view of the mixer head according to Fig. 5
9 shown along section lines B-B; and

10 Figure 8 is a sectional view of the mixer head according to Fig. 5
11 shown along section lines C-C.

12

1 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

2 Having reference to Figs. 1-8, a burner assembly 1 according to an
3 embodiment of the invention is shown.

4 As shown in Fig. 1, the burner assembly 1 comprises a tubular
5 barrel 2 which is mounted in the bore of a firetube or other such housing 3,
6 forming an annulus 5 therebetween. The tubular barrel 2 conducts primary fuel
7 gas G from a gas inlet 6 at a base or proximal end 8 of the tubular barrel 2 to a
8 burner head 12 at a distal end 11 of the tubular barrel 2. The barrel 2 is typically
9 of conventional configuration. The gas at the gas inlet 6 is fed at a first pressure
10 P_1 through an orifice 50 to a mixer head 7 (Figs. 5, 7 and 8) at the proximal end
11 8. Primary combustion air A_p is drawn into the mixer head 7 via natural draft and
12 the combined air A_p and gas G are mixed therein and flow through the tubular
13 barrel 2 at a second pressure P_2 to an orifice or plurality of orifices 10 in the
14 burner head 12. The air and gas discharge from the burner head 12 at a nozzle
15 tip 13 and, when ignited, form a flame 15.

16 Secondary combustion air A_s is aspirated or drawn into the annulus
17 5 and flows therein toward the nozzle tip 13 at a third pressure P_3 , to mix with the
18 primary air A_p and fuel G and enhance combustion of the primary air A_p and fuel
19 G in a combustion zone C at the nozzle tip 13 and in the housing 3 extending
20 outwardly therefrom. Depending upon the draft created by a pressure differential
21 along the burner assembly 1, the velocity of the secondary air A_s is altered. A
22 chimney effect in an exhaust stack for the heated system (not shown), aids in
23 creating a draft.

24 In low pressure fuel or low-fire conditions, the velocity of secondary
25 air A_s is relatively low compared to a high-fire condition. If unrestricted, the flow

1 of secondary air A_s up the annulus 5 and past the nozzle tip 13 can adversely
2 affect the flame 15.

3 In order to stabilize at least a position of the flame 15 relative to the
4 nozzle tip 13, means are provided to deflect the flow of secondary air A_s away
5 from at least the nozzle tip 13.

6 In a preferred embodiment, best seen in Fig. 4, the means for
7 deflecting the flow of secondary air A_s is a radially outwardly extending low
8 pressure ring 14 extending from the burner head 12. The low pressure ring 14 is
9 shaped such as an inverted, truncated frustum of a cone and is positioned
10 circumferentially about the nozzle tip 13 of the burner head 12. A diameter of the
11 low pressure ring 14 increases as it extends downstream and away from the
12 nozzle tip 13.

13 The secondary combustion air A_s flowing through the annulus 5
14 from the proximal end 8 of the burner assembly 1 to the distal end 11 of the
15 burner assembly 1 and approaching the nozzle tip 13 is deflected outwardly by
16 the low pressure ring 14, typically creating a turbulence pattern in the flow of the
17 secondary air A_s which aids in establishing a local area of low pressure P_4 at the
18 nozzle tip 13 and particularly at the plurality of orifices 10. The low pressure P_4 at
19 the tip 13 is low relative to the pressure P_3 of the secondary air A_s . Further, the
20 low pressure ring 14 separates the flow of secondary air A_s from the flow of
21 primary air A_p and fuel G exiting the orifices 10 at the nozzle tip 13 which further
22 aids in maintaining the area of low pressure P_4 . The area of low pressure P_4 acts
23 to minimize lifting of the flame 15 from the nozzle tip 13, resulting in increased
24 stability and reliability of the flame 15 regardless the pressure P_2 and velocity of
25 the primary combustion air A_p and fuel G in the burner assembly 1 and the draft

1 in the housing 3. Further, the low pressure ring 14 aids in preventing the flame
2 from being extinguished by the secondary combustion air A_s .

3 Preferably, the nozzle head 12 and the low pressure ring 14 are
4 formed as a unitary structure.

5 Alternately, as shown in Figs. 1-4, , the means for deflecting the
6 flow of secondary air A_s in the annulus 5 away from at least the nozzle tip 13 is
7 included as part of an air deflector plate 20 which extends radially outwardly from
8 the burner head 12. The deflector plate 20 extends from the burner head 12,
9 such as from an underside 21, and extends radially from the burner head 12
10 across the annulus 5. The deflector plate has an inner mounting ring 29 adjacent
11 the burner head and extending circumferentially therearound. Preferably, the
12 inner ring 29 can act to restrict and deflect the flow of secondary combustion air
13 A_s away from and around the nozzle tip 13.

14 As shown in Figs. 2a, 2b and 3, the air deflector plate 20 comprises
15 a plate base 22, preferably extending radially from the burner head 12 and across
16 a diameter of the housing 3. The burner head 12 can be conveniently supported
17 concentrically in the housing 3 by the air deflector plate 20.

18 A plurality of angled deflectors or vanes 23 are formed about the
19 plate base 22, each vane 23 being formed adjacent one of a plurality of radially
20 extending openings 24 formed in the plate base 22. The plate base 22 and the
21 openings 24 act to dampen or reduce the pressure P_3 the secondary combustion
22 air A_s reaching the burner head 12 and nozzle tip 13. Further, the angled vanes
23 23 act to direct the secondary combustion air A_s outward and circumferentially to
24 the walls of the housing 3, creating a turbulence pattern therein which
25 substantially fills the housing 3 at the combustion zone C for improved mixing of

1 the primary air A_p and fuel G therein. Preferably, angled vanes 23 also act to
2 restrict and deflect the flow of secondary combustion air A_s away from and
3 around the nozzle tip 13.

4 Thus, higher efficiency combustion is achieved as a greater amount
5 of the available fuel G is burned in the housing 3. Further, the deflection of at
6 least a portion of the gas/air mixture to the outer walls of the housing 3 caused by
7 the turbulence patterns as described establishes a flame pattern which extends
8 to about the diameter of the housing 3 aiding in a more complete combustion of
9 the gas/air mixture therein.

10 An angle of the vanes 23 of the deflector plate 20 may be
11 adjustable so as to control the amount of secondary air A_s reaching the housing
12 3 and the combustion zone C therein and thus the combustion efficiency of the
13 burner assembly 1. Controlling the rate of secondary combustion A_s air further
14 acts to control the draft of the burner assembly 1 which increases the retention
15 time in the housing 3 and permits more efficient heat transfer therein.

16 Most preferably, as shown in Figs 1, 3 and 4, the means for
17 deflecting the flow of secondary air A_s in the annulus 5 away from at least the
18 nozzle tip 13 comprises both the low pressure ring 14 and the deflector plate 20.
19 In this embodiment, the nozzle head 12, low pressure ring 14 and deflector plate
20 20 are preferably manufactured as a unitary nozzle structure.

21 As shown in Figs. 1 and 2a, a venturi sleeve 25 may be positioned
22 within the tubular barrel 2 to accelerate the flow of primary combustion air A_p and
23 fuel G therein causing turbulence which results in enhanced mixing of the primary
24 combustion air A_p and fuel G prior to reaching the orifices 10.

1 In an embodiment shown in Fig. 4, at least a first port 30 is formed
2 in the air deflector plate 20 to accommodate and support an ignition system,
3 preferably a pilotless ignition system such as an igniter/flame rod 31 for igniting
4 the primary fuel/air mixture exiting the plurality of orifices 10 in the burner head
5 12. The flame/igniter rod 31 preferably incorporates flame sensing using flame
6 ionization technology. Due to the isolation of the nozzle tip 13 from the direct
7 flow of secondary air A_s , a consistent flame 15 is maintained at the nozzle tip 13
8 and will be detected by the flame sensor regardless whether the burner assembly
9 1 is operated at low-fire or high-fire conditions. Thus, the burner assembly 1 can
10 be reliably and remotely lit using the igniter/flame rod 31. Incorporation of the
11 igniter/flame rod 31 eliminates the need for a conventional pilot and additional
12 troublesome components associated therewith which are conventionally subject
13 to freezing.

14 Preferably, the igniter/flame rod 31 is arranged to pass along the
15 housing 3 from the proximal end 8 of the tubular barrel 2, through the air deflector
16 plate 20 and to be positioned with a sparking tip 32 oriented at an optimal
17 sparking distance (such as about 1/8") from the nozzle tip 13.

18 Also with reference to Fig. 4, in another embodiment, at least one
19 additional port 32 is formed in the air deflector plate 20 to support a heat return
20 tube 40. The heat return tube 40, typically a flexible metal tube, extends from and
21 is in communication with the mixer head 7 at the base 8 of the burner assembly
22 1. An intermediate length of the heat return tube 40 extends along at least the
23 fuel feed line 6, along the gas inlet orifice 50 to the tubular barrel 2 and along the
24 tubular barrel 2 to extend outward through the additional port 32 into the housing
25 3 adjacent the burner tip 13, positioning a first intake end 41 adjacent or within

1 the combustion zone C. The heat return tube 40 draws heated combustion
2 gases from the housing 3 into the first intake end 41 of the heat return tube 40
3 and the heated combustion gases are communicated therealong to a second end
4 42 at the mixer head 7 to conduct heat and prevent freezing of the components of
5 the burner assembly 1 which are adjacent the heat return tube 40. A pressure
6 differential between the mixer head 7 and housing 3 at the combustion zone C
7 acts to draw the combustion gases into and along the heat return tube 40.

8 As shown in Figs. 5-8, the mixer head 7 preferably comprises a
9 tubular housing 60 having a solid base 61 through which a plurality of orifices 62
10 are formed. Primary combustion air is aspirated through the air orifices 62. The
11 air orifices 62 extend into a mixing chamber 63 formed in the tubular housing 60.
12 The mixing chamber 63 is positioned intermediate the air orifices 62 and the
13 tubular barrel 2 which is connected thereto. The gas inlet orifice 50 is formed at a
14 center of the base 61 through which fuel G is introduced to the mixing chamber
15 63 from the gas inlet 6. Fuel/primary combustion air G/A_p combined in the mixing
16 chamber 63 are discharged into the tubular barrel 2. The plurality of orifices 62
17 act to minimize or prevent gusts of primary combustion air A_p from entering the
18 mixer 7 which is particularly advantageous in low velocity fuel conditions.

19 An air shutter 26 is provided at the base 61 of the mixer head 7 for
20 controlling the amount of primary combustion air A_p entering the air orifices 62.
21 Preferably the air shutter 26 is threaded onto a gas inlet nipple 64 extending
22 outward from the mixer base 61. The air shutter 26 can be moved along the
23 nipple 64 away from and toward the base 61 of the mixer 7 to permit more or less
24 air to pass thereby into the air orifices 62.

1 Preferably, the fuel orifice 50 is provided in a fuel orifice insert 65
2 which is threadably connected into the mixer base 61. The size of the fuel orifice
3 50 can be altered by swapping the insert 65 for an insert 65 having a different
4 size fuel orifice 50.

5 Alternatively, in another embodiment of the invention as shown in
6 Figs 5, 6 and 8, the burner assembly 1 further comprises an auxiliary air inlet 51
7 in the mixer head 7 through which primary combustion air A_p may be forced into
8 the flow of fuel G in the mixer head 7 prior to entering the tubular barrel 2. In this
9 situation, the air shutter 26 at the base 8 of the burner assembly 1 can be closed
10 completely and the flow of primary combustion air A_p is controlled through the
11 forcible addition of air through the auxiliary air inlet 51. The flow of fuel gas G is
12 controlled by adjusting the size of the fuel orifice 50 in the mixer head 7. In this
13 embodiment, the burner assembly 1 can operate as a forced draft burner
14 assembly, which may be preferable in cases where a more precise control of the
15 primary combustion air /fuel ratio A_p/G is required. Secondary air A_s continues to
16 be aspirated as in the natural draft embodiment.

17 Applicant has found this unique burner assembly operates at
18 efficiencies in the order of 7-10% more efficient than other natural draft burners
19 and can operate efficiently at pressures ranging from about 0.25 psig to about 15
20 psig. Burners employing this unique design can be manufactured to range in size
21 from about 1" X 6" to about 2" X 24". Those skilled in the art would appreciate
22 these specifications are guidelines only and the burner of the present invention is
23 not limited to these dimensions or pressure ranges.

1 **THE EMBODIMENTS OF THE INVENTION IN WHICH AN**
2 **EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS**
3 **FOLLOWS:**
4

5 1. A burner assembly for mounting in a housing and forming an
6 annular space therebetween, the burner assembly having a nozzle tip mounted in
7 a burner head at a first distal end of a tubular barrel, the tubular barrel having a
8 primary combustion air inlet and a fuel inlet at a second proximal end for
9 providing a flow of primary combustion air and fuel in the tubular barrel directed
10 toward the nozzle tip and a flow of secondary combustion air in the annular space
11 directed towards the nozzle tip, the burner assembly comprising:

12 means deflecting the flow of secondary combustion air in the
13 annular space away from at least the nozzle tip for substantially separating the
14 flow of primary combustion air and fuel from the flow of secondary combustion air
15 creating an area of low pressure at the nozzle tip relative to a pressure of the
16 secondary air in the annulus whereby lifting of the flame from the nozzle tip is
17 reduced and at least a portion of the flame is stabilized thereon.

18
19 2. The burner assembly of claim 1 wherein means deflecting
20 the flow of secondary combustion air in the annular space away from at least the
21 nozzle tip comprises:

22 a conical low pressure ring positioned circumferentially about the
23 nozzle tip and extending radially outwardly from the burner head for substantially
24 separating the flow of primary combustion air and fuel from the flow of secondary
25 combustion air at the nozzle tip.

1 3. The burner assembly of claim 2 wherein the conical, radially
2 outwardly extending low pressure ring is shaped as an inverted, truncated
3 frustum of a cone.

4

5 4. The burner assembly of claim 2 wherein the nozzle head and
6 the low pressure ring are manufactured as a unitary structure.

7

8 5. The burner assembly of claim 1 wherein means deflecting
9 the flow of secondary combustion air in the annular space from at least the
10 nozzle tip comprises:

11 an air deflector plate extending from an inner ring at the burner
12 head and radially outwards therefrom, the deflector plate deflecting the flow of
13 secondary combustion air in the annular space away from at least the nozzle tip,
14 the air deflector plate having a plurality of radially extending openings formed
15 therein, each opening having an upstanding radially extending vane formed
16 therealong for deflecting secondary combustion air circumferentially therefrom,
17 the openings and the vanes acting to reduce a velocity of the secondary air
18 passing therethrough towards the nozzle tip and for creating a turbulence pattern
19 therein.

20

21 6. The burner assembly of claim 5 wherein the air deflector
22 plate extends substantially across a diameter of the housing.

23

24 7. The burner assembly of claim 5 wherein the nozzle head and
25 air deflector plate are manufactured as a unitary structure.

1 8. The burner assembly of claim 5 wherein the turbulence
2 pattern of the secondary air passing from the annulus and deflected through the
3 plurality of openings and vanes causes the secondary air to substantially mix with
4 the primary combustion air and fuel exiting the nozzle tip at a combustion zone in
5 the housing for improving efficiency of combustion of fuel therein.

6

7 9. The burner assembly of claim 5 wherein an angle of the
8 vanes is adjustable for adjusting the amount of secondary combustion air at the
9 combustion zone.

10

11 10. The burner assembly of claim 5 further comprising:
12 a conical low pressure ring positioned circumferentially about the
13 nozzle tip and extending radially outwardly from the burner head for substantially
14 separating the flow of primary combustion air and fuel from the flow of secondary
15 combustion air at the nozzle tip.

16

17 11. The burner assembly of claim 10 wherein the nozzle head,
18 air deflector plate and low pressure ring are manufactured as a unitary structure.

19

20 12. A pilotless burner assembly comprising the burner assembly
21 of claim 5 further comprising an igniter supported in the air deflector plate and
22 positioned adjacent the burner tip for remotely igniting the burner assembly.

23

1 22. The burner assembly of claim 21 further comprising:
2 an auxiliary air inlet into the mixing chamber for providing a forced
3 flow of primary combustion air to the mixing chamber,
4 wherein the air shutter can be closed to prevent aspiration of
5 primary air through the plurality of air orifices.

6
7 23. A natural draft burner assembly mounted in a housing and
8 forming an annular space therebetween comprising:
9 a tubular barrel, the tubular barrel having mixer at a proximal end,
10 the mixer having a fuel inlet at and a primary combustion air inlet at the proximal
11 end for providing a flow of primary combustion air;
12 a nozzle tip mounted in a burner head at a distal end of the tubular
13 barrel, fuel in the tubular barrel and primary combustion air being directed toward
14 the nozzle tip;
15 an air deflector plate extending from an inner ring at the tubular
16 barrel and extending radially outwards into the annular space to intercept
17 secondary combustion air flowing under natural draft therethrough, the air
18 deflector plate having a plurality of radially extending openings formed therein,
19 each opening having an upstanding radially extending vane formed therealong
20 for deflecting the secondary combustion air circumferentially therefrom and into a
21 combustion zone at the nozzle tip and in the housing extending downstream
22 therefrom.

23
24 24. The natural draft burner assembly of claim 23 wherein the air
25 deflector plate extends substantially across a diameter of the housing.

1 25. The natural draft burner assembly of claim 23 or 24 wherein
2 the nozzle head and air deflector plate are manufactured as a unitary structure.

3

4 26. The natural draft burner assembly of claim 23, 24 or 25
5 wherein a turbulence pattern of the secondary combustion air passing from the
6 annulus and deflected through the plurality of openings and vanes causes the
7 secondary combustion air to substantially mix with the primary combustion air
8 and fuel exiting the nozzle tip at the combustion zone for improving efficiency of
9 combustion of fuel therein.

10

11 27. The natural draft burner assembly of any one of claims 23 to
12 26 wherein an angle of the vanes is adjustable for adjusting the amount of
13 secondary combustion air at the combustion zone.

14

15 28. The natural draft burner assembly of any one of claims 23 to
16 27 wherein the air deflector plate is located adjacent the nozzle tip and acts to
17 deflect the flow of secondary combustion air in the annular space away from at
18 least the nozzle tip for stabilizing at least a position of a flame thereon.

19

20 29. The natural draft burner assembly of any one of claims 23 to
21 28 further comprising a conical low pressure ring positioned circumferentially
22 about the nozzle tip and extending radially outwardly from the burner head for
23 substantially separating the flow of primary combustion air and fuel from the flow
24 of secondary combustion air at the nozzle tip creating an area of low pressure at

1 the nozzle tip relative to a pressure of the secondary air in the annulus whereby
2 lifting of the flame from the nozzle tip is reduced.

3

4 30. The natural draft burner assembly of claim 29 wherein the
5 conical, radially outwardly extending low pressure ring is shaped as an inverted,
6 truncated frustum of a cone.

7

8 31. The natural draft burner assembly of claim 29 or 30 wherein
9 the nozzle head and the low pressure ring are manufactured as a unitary
10 structure.

11

12 32. The natural draft burner assembly of claim 29, 30 or 31
13 wherein the nozzle head, air deflector plate and low pressure ring are
14 manufactured as a unitary structure.

15

16 33. A pilotless burner assembly comprising the natural draft
17 burner assembly of any one of claims 23 to 32 further comprising an igniter
18 supported in the air deflector plate and positioned adjacent the burner tip for
19 remotely igniting the burner assembly.

20

21 34. The pilotless burner assembly of claim 33 wherein the igniter
22 is supported in a port formed in the air deflector plate.

23

24 35. The pilotless burner assembly of claim 33 or 34 wherein the
25 igniter further comprises a flame sensor.

1 36. The natural draft burner assembly of any one of claims 23 to
2 32 further comprising means for conducting heat from the combustion zone along
3 at least a portion of the burner assembly for preventing freezing of the burner
4 assembly in low ambient temperature.

5

6 37. The natural draft burner assembly of claim 36 wherein the
7 means for conducting heat is an intake tube comprising:

8 a first intake end positioned in the combustion zone;

9 a second end connected adjacent the mixer; and

10 an intermediate length of the intake tube being positioned adjacent
11 an external surface of at least a fuel inlet tube,

12 wherein a pressure at the intake end is higher than at the second
13 end for inducing heated combustion gases to enter the intake's inlet end and to
14 be drawn to the intake's second end.

15

16 38. The natural draft burner assembly of claim 37 wherein at
17 least the first intake end of the intake tube is mounted in the air deflector plate for
18 positioning the intake end in the combustion zone.

19

20 39. The natural draft burner assembly of claim 37 wherein the
21 intermediate length of the intake tube is further positioned adjacent at least the
22 tubular barrel and the mixer.

23

1 40. The natural draft burner assembly of claim 23 wherein the
2 tubular barrel further comprises a venturi sleeve positioned therein for
3 accelerating the flow of fuel and primary combustion air therein.

4
5 41. The natural draft burner assembly of claim 23 wherein the
6 mixer further comprises:

7 a mixing chamber for combining the primary combustion air and fuel
8 therein, the mixing chamber being fluidly connected to the tubular barrel for
9 supplying the primary air and fuel mixture thereto;

10 a fuel orifice for admitting a flow of fuel therethrough to the mixing
11 chamber; and

12 a plurality of air orifices through which primary combustion air is
13 aspirated and directed into the mixing chamber.

14
15 42. The natural draft burner assembly of claim 41 further
16 comprising an air shutter for further controlling the flow of primary air through the
17 plurality of air orifices.

18
19 43. The burner assembly of claim 42 further comprising:

20 an auxiliary air inlet into the mixing chamber for providing a forced
21 flow of primary combustion air to the mixing chamber,

22 wherein the air shutter can be closed to prevent aspiration of
23 primary air through the plurality of air orifices.

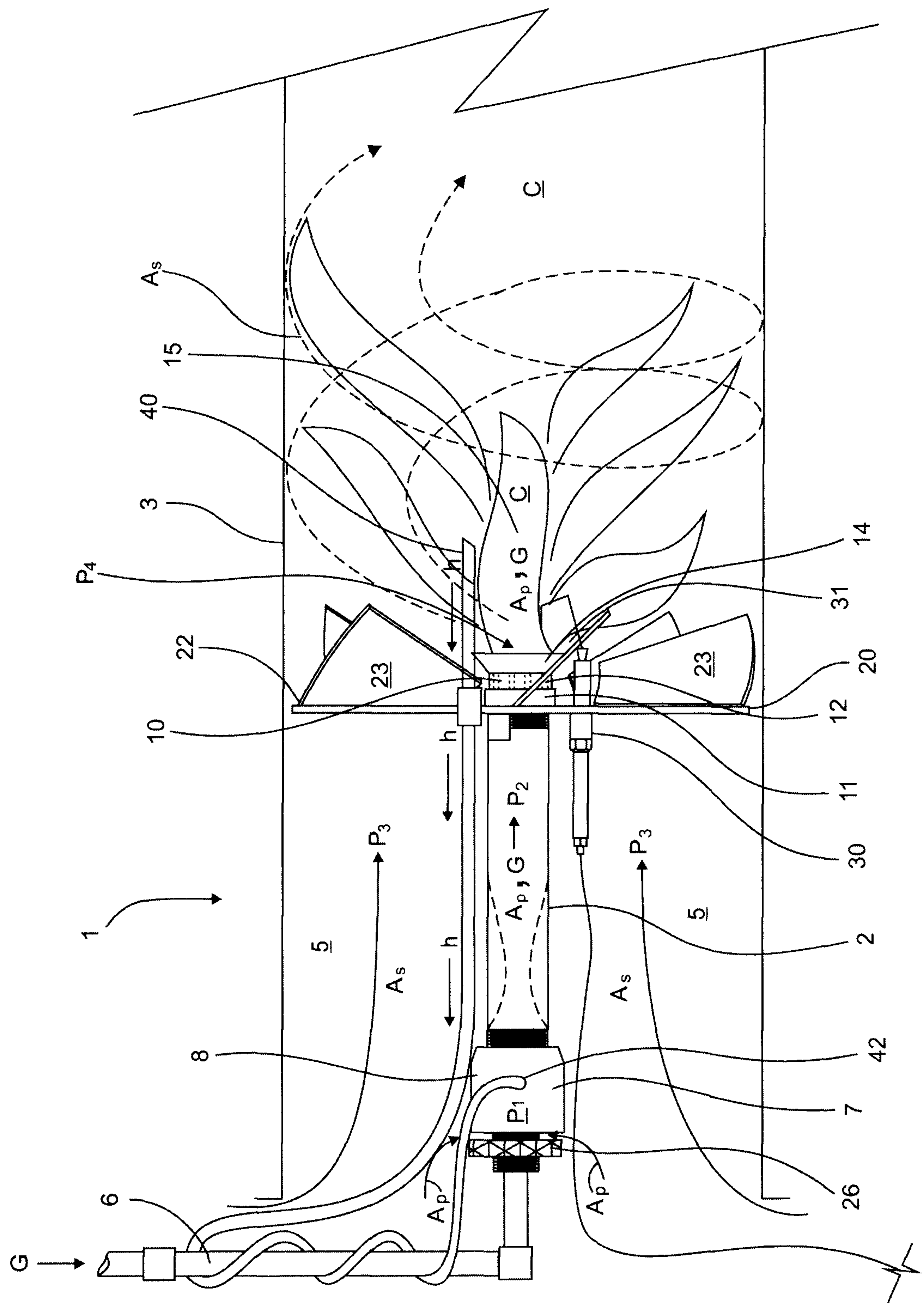


Fig. 1

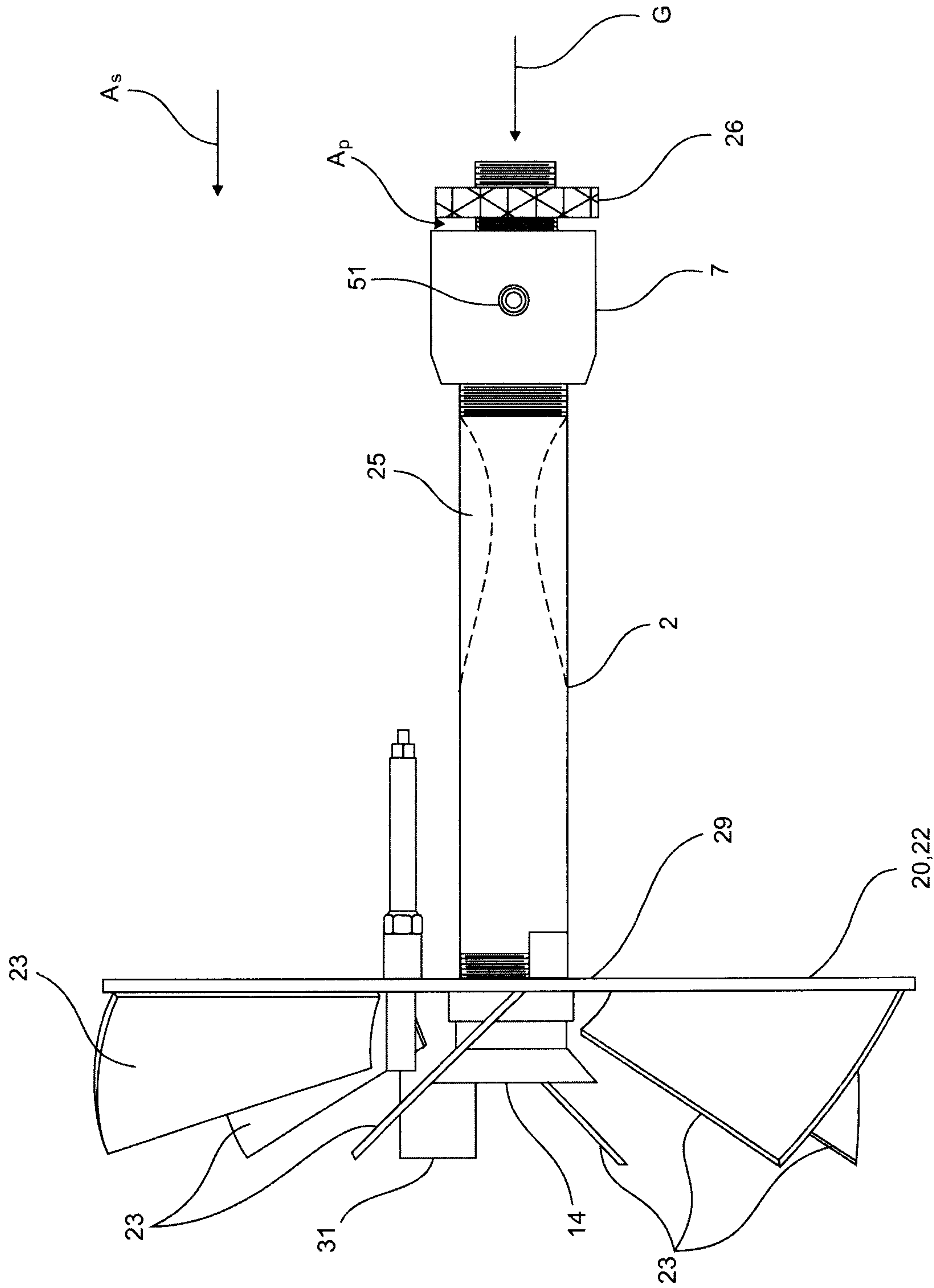


Fig. 2A

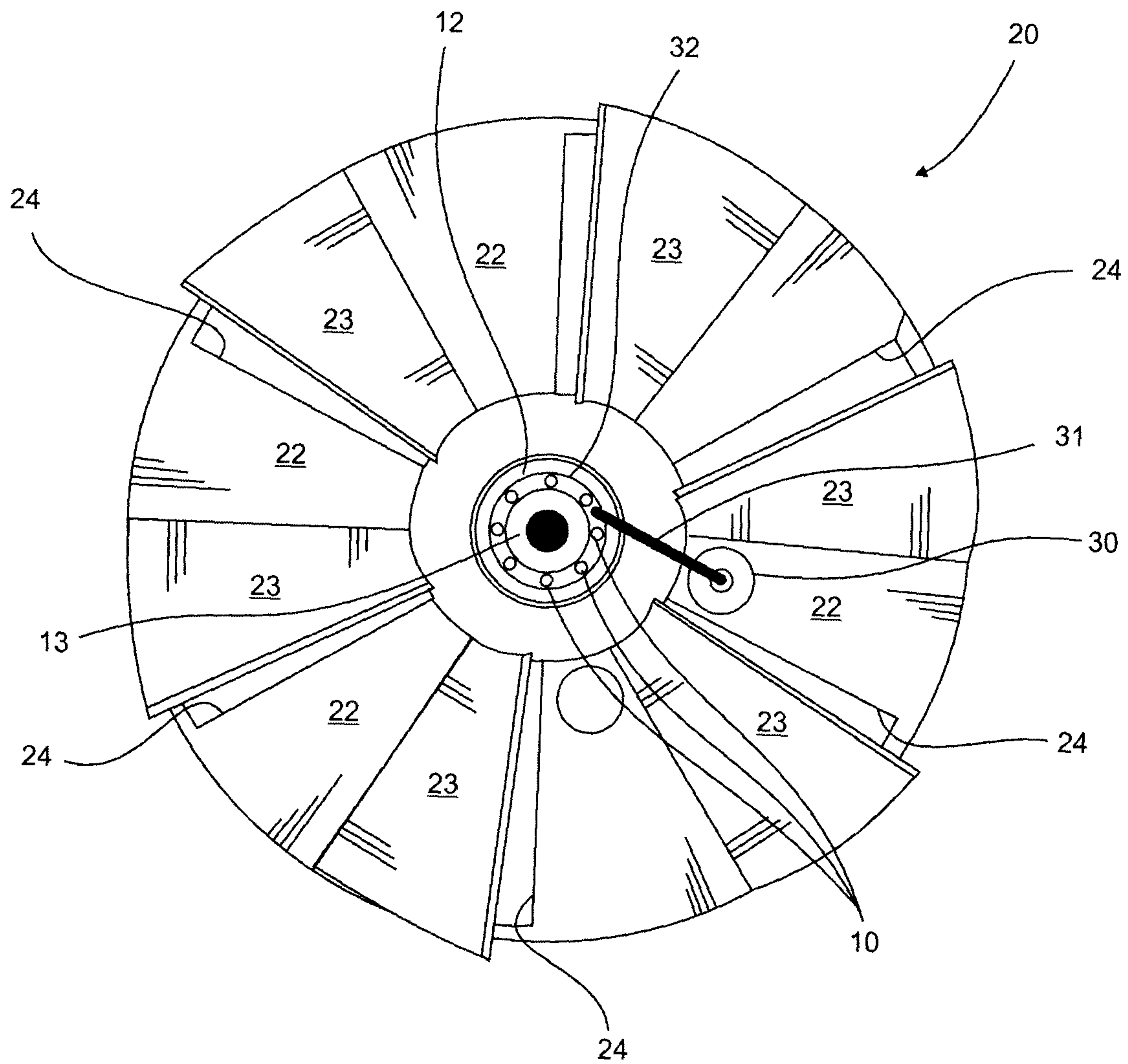


Fig. 2B

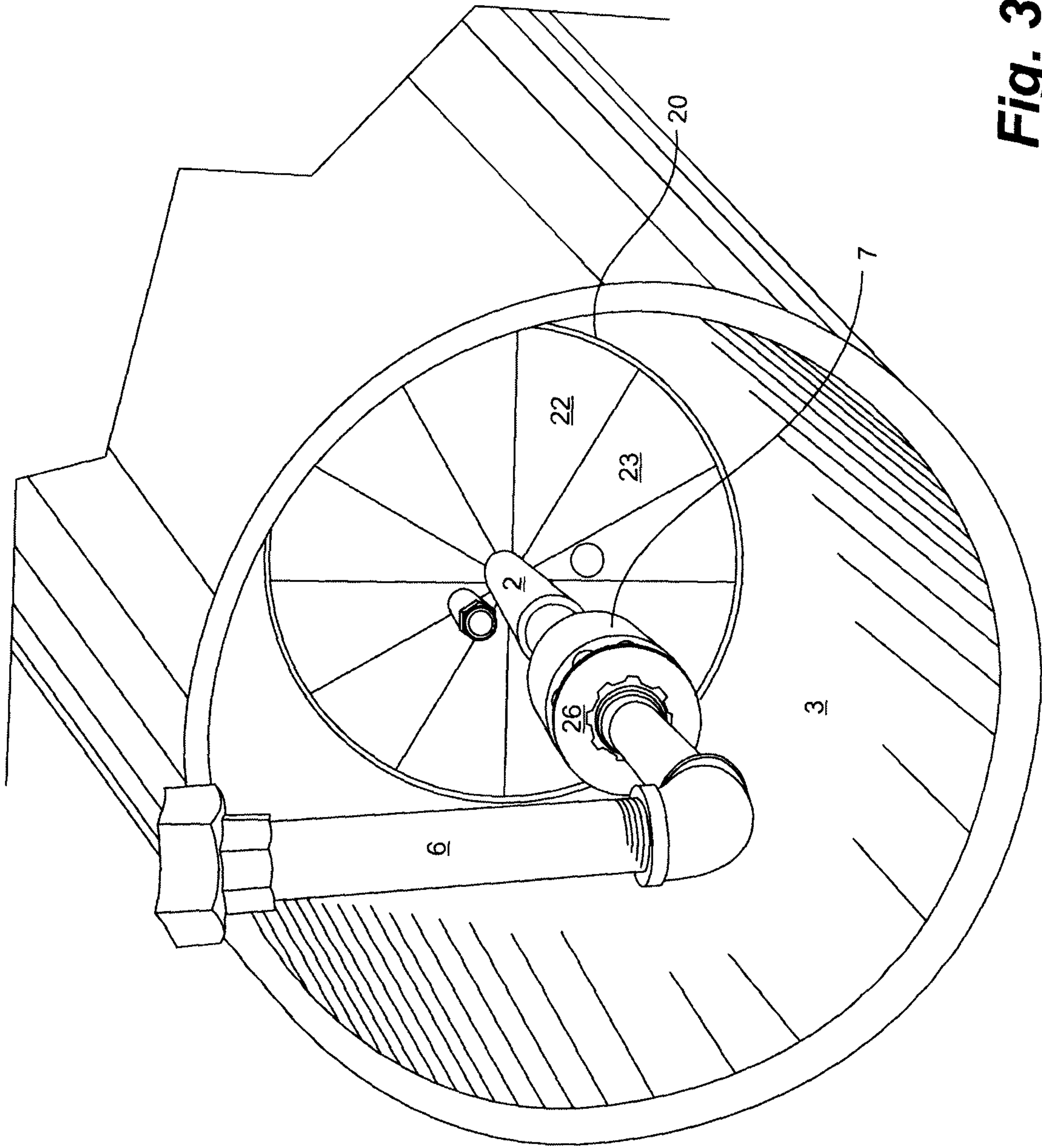


Fig. 3

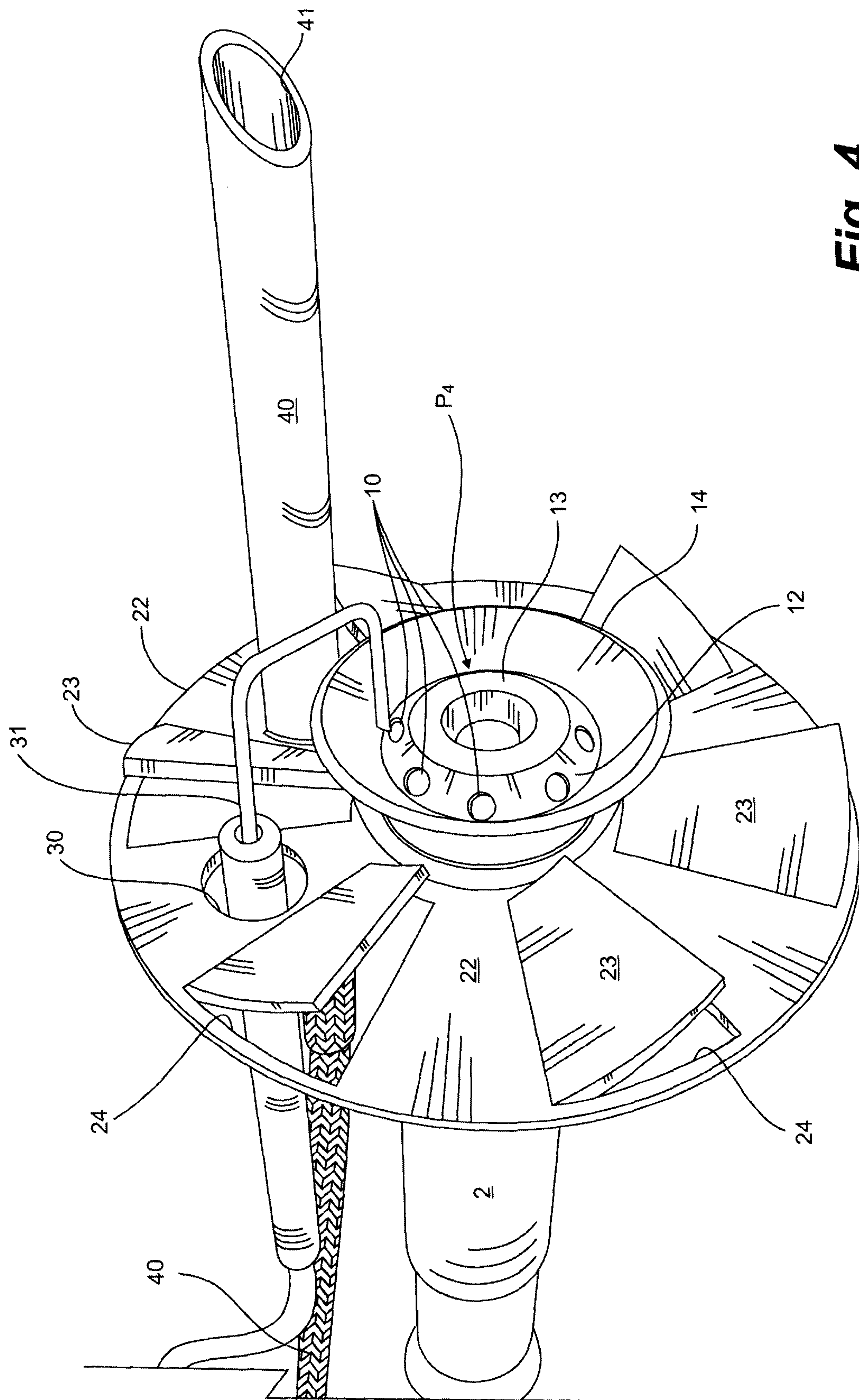


Fig. 4

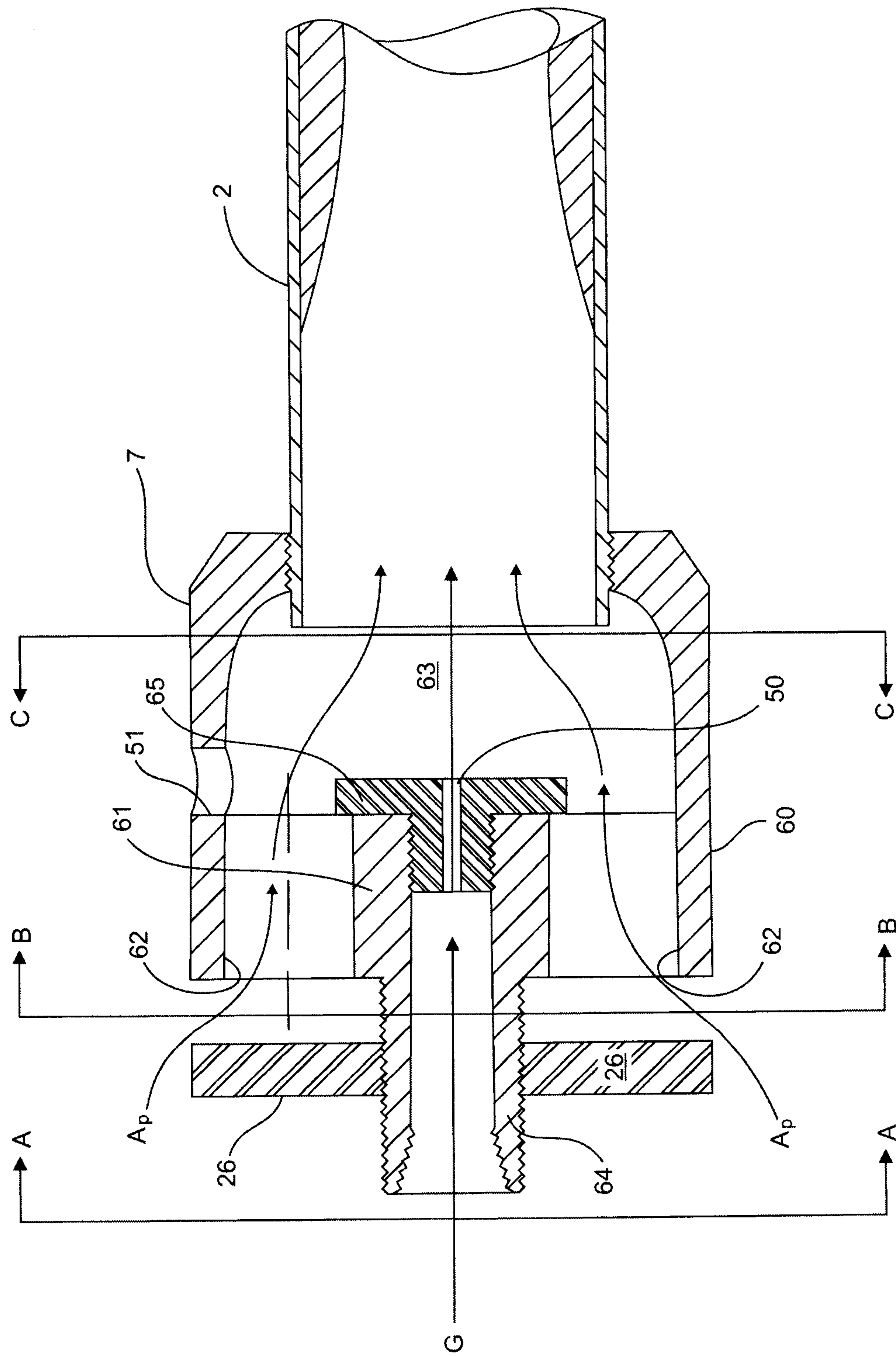
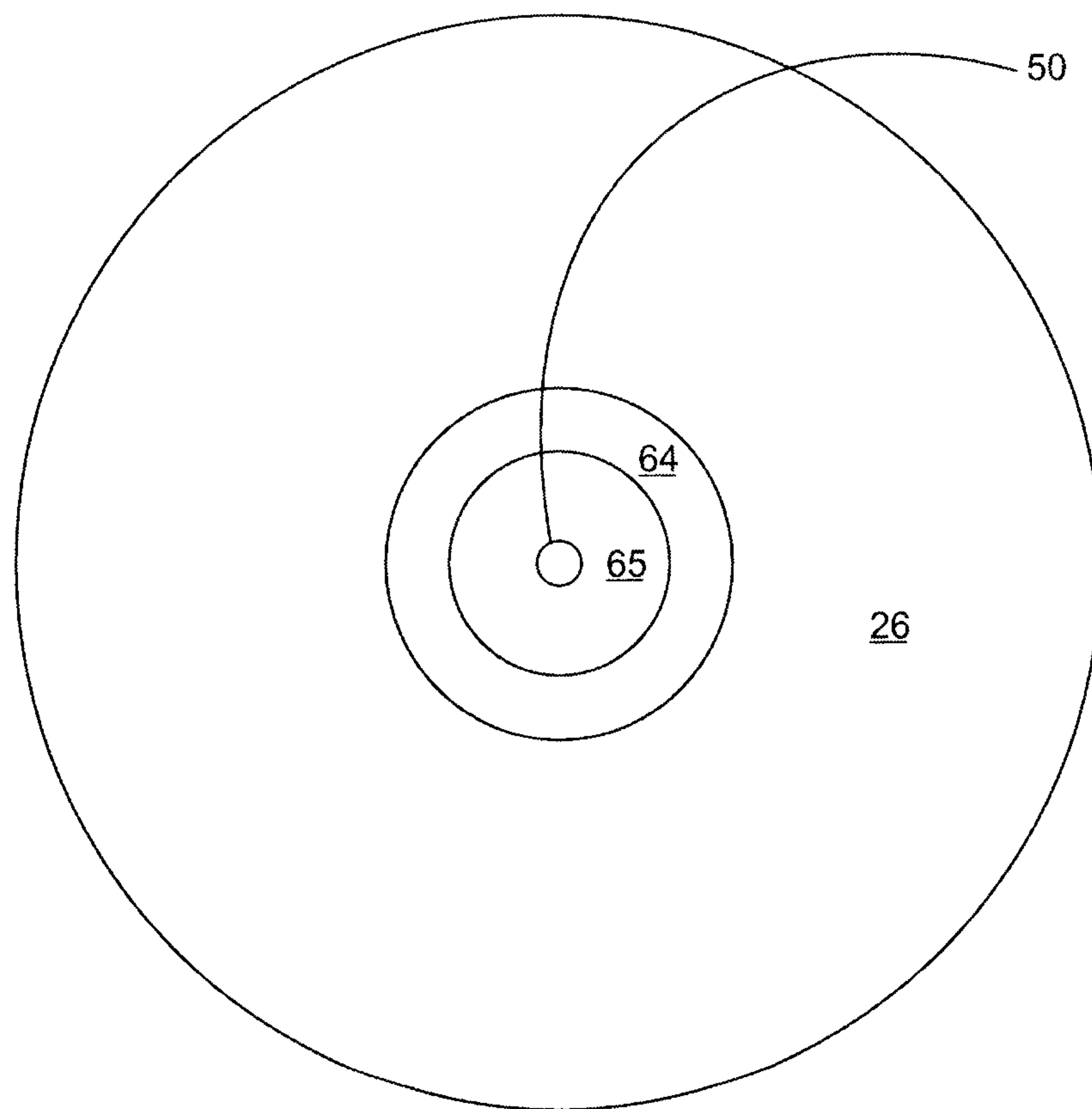
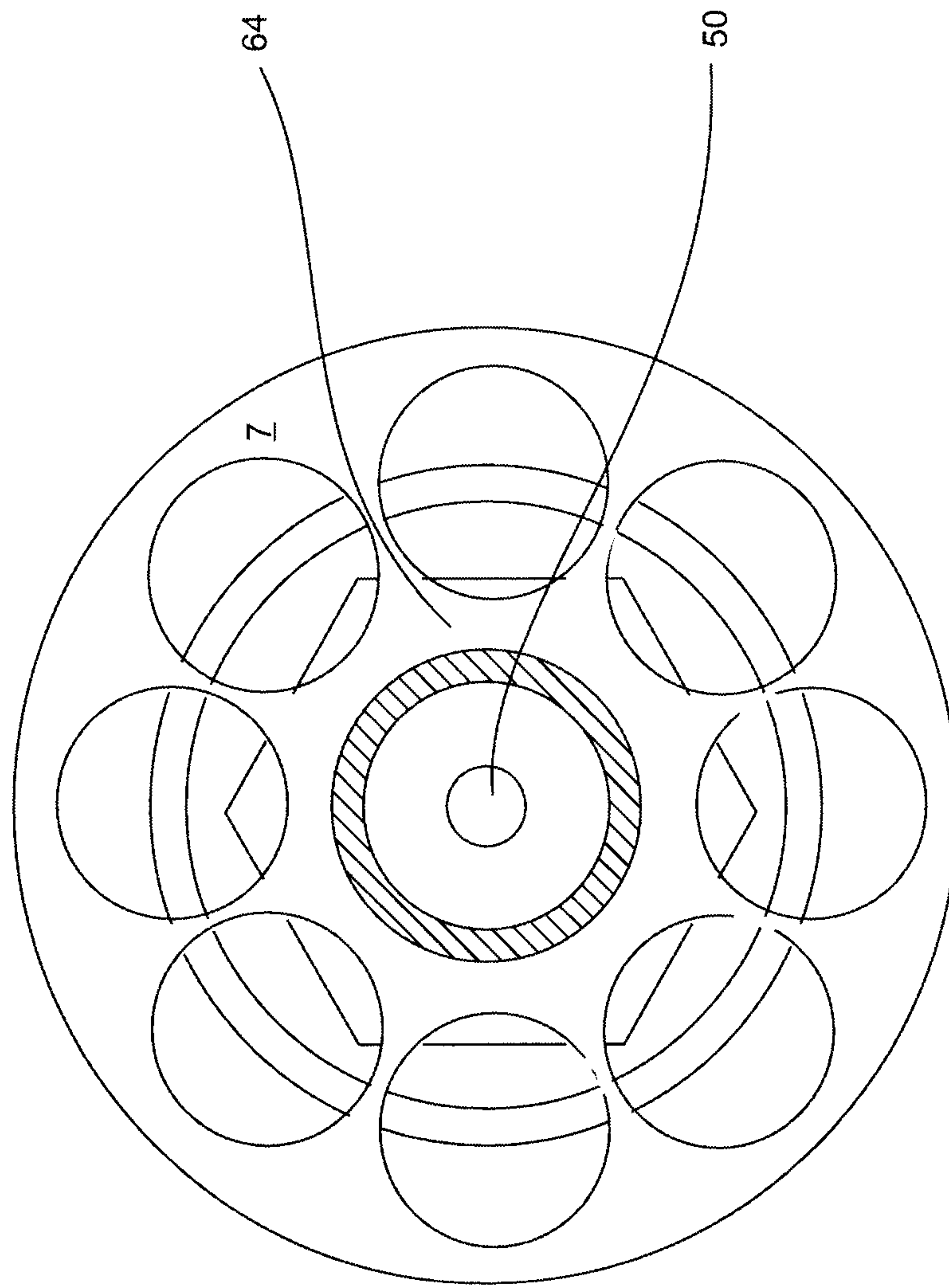


Fig. 5



A-A

Fig. 6



B-B

Fig. 7

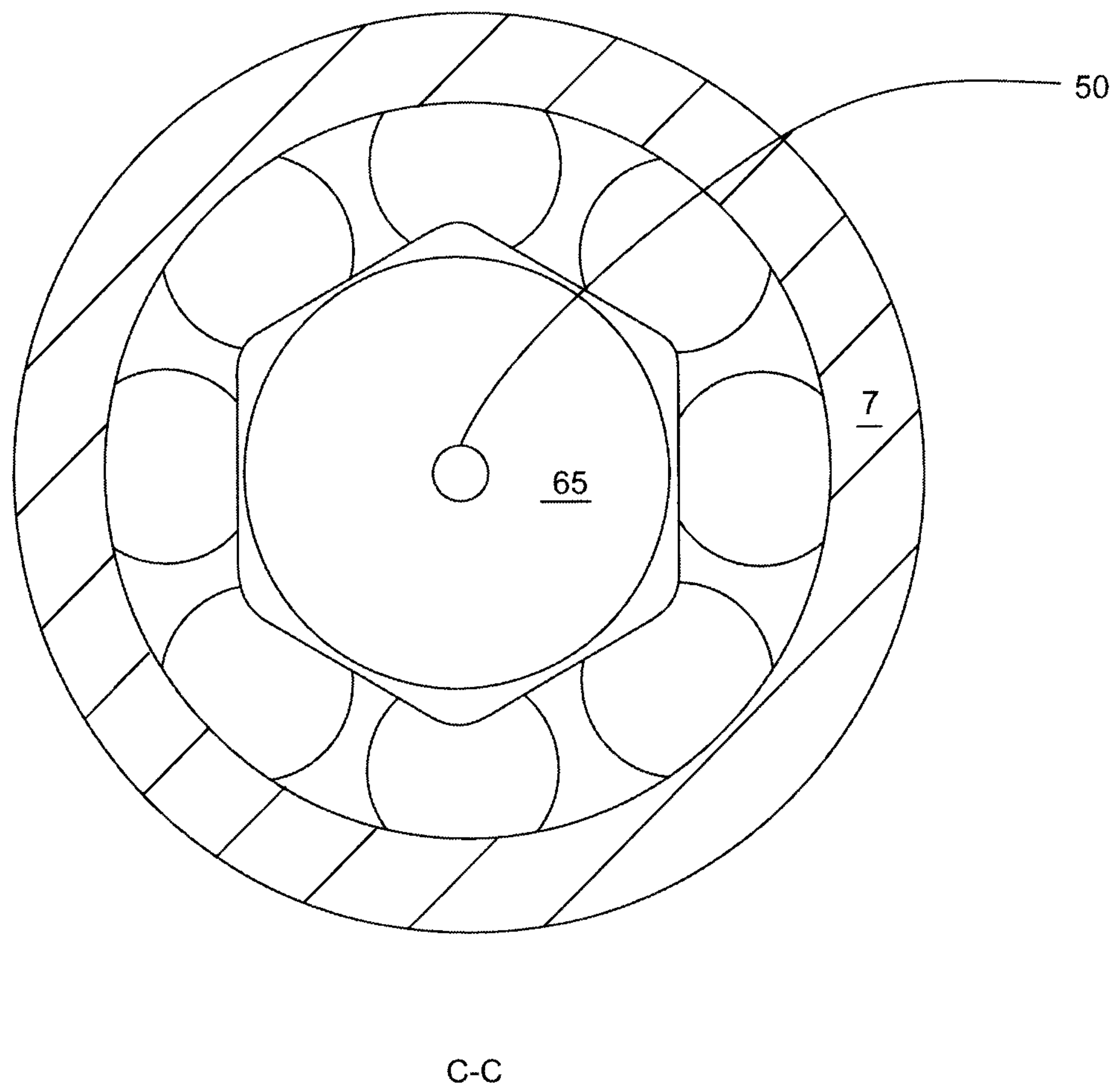


Fig. 8

