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(54) Jet-pump assisted scavenging and intake system for two-stroke cycle engine.

(57) A jet pump (50) amplifies air directed into a two-stroke cycle engine (10), for exhaust scavenging and air intake purposes. Air that is precompressed is directed through a jet pump (50) during the exhaust scavenging and intake cycles, and this draws in additional air through an inflow (53) to the jet pump, to combine with the compressed intake air stream and amplify the volume of air delivered to the combustion chamber (11) of the engine.

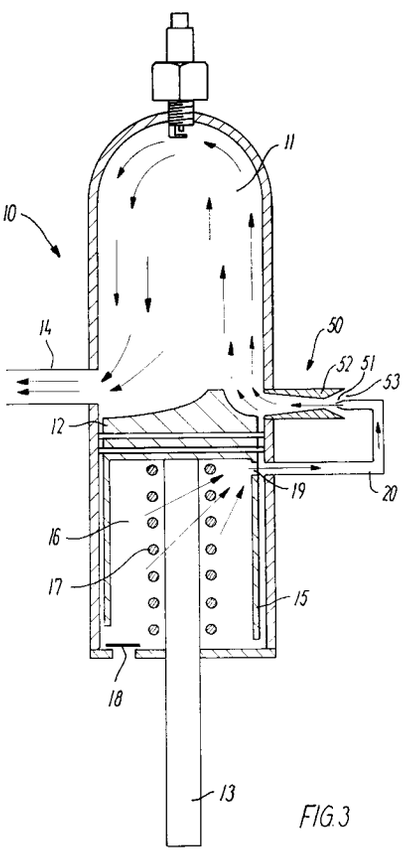

FIG.3

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TECHNICAL FIELD

This invention involves scavenging of exhaust gases and intake of combustion air during the exhaust and intake cycles of a two-stroke engine.

BACKGROUND ART

Two-stroke cycle engines exhaust combustion gases as the power stroke completes its movement, when air is admitted to the combustion chamber for scavenging exhaust gases during the exhaust cycle. Such scavenging and intake air is often precompressed by the engine. As the exhaust gases are moved out of the combustion chamber, they are replaced by intake air, providing an intake cycle for the engine. This air is compressed on the return or compression stroke of the piston, and then a fuel charge is ignited for a power cycle, to continue the process.

Several expedients have been suggested for increasing the flow of intake air for scavenging and intake purposes. These include operating a blower or supercharger powered by the engine to drive more intake air into the combustion chamber during the exhaust and intake cycles, operating an exhaust-powered turbine to drive a similar supercharger, and tuning an exhaust pipe and an exhaust port system to produce a low exhaust pressure at the instant when scavenging and intake air is admitted to the combustion chamber. The latter can be tuned to different, but usually high, cycle speeds; and its speed range of highly efficient operation is limited.

Blowers serving as superchargers are effective at directing additional air into the combustion chamber, but they require the expense of moving parts and maintenance. Exhaust-powered turbines driving superchargers also require moving parts and maintenance and have the disadvantage of requiring a forceful exhaust flow to boost the air input to the engine.

DISCLOSURE OF THE INVENTION

By my invention, the volume of air taken into a two-stroke cycle engine, for exhaust scavenging and combustion air intake purposes, is amplified by arranging a jet pump in an intake air passageway and powering the jet pump by a stream of precompressed intake air. The output side of the piston moving in the combustion chamber can be arranged for precompressing intake air to power the jet pump, which otherwise receives additional air through an inflow passageway, to deliver a larger total volume of air to the combustion chamber for scavenging and intake purposes. The delivery of compressed intake air to the jet pump preferably occurs only during the exhaust scavenging and intake cycles of the engine.

The inflow through the jet pump can be valved and controlled for operating the jet pump inflow passageway appropriately. Generally, the jet pump operates during full throttle operation of the engine, with an upper speed limit above which the jet pump is taken out of operation. This can be done by valved alternative intake passageways flowing through the jet pump for full throttle operation, and bypassing the jet pump for high-speed or restricted throttle operation. Another possibility is a jet pump inflow passage that is valved open for jet pump operation and is valved closed to provide intake through the pump orifice, without any entrainment of additional air, when conditions do not require jet pump operation.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1-4 are schematic diagrams showing the cycles of a two-stroke engine provided with the inventive exhaust scavenging and intake system, which operates during the cycle shown in Figure 3.

Figure 5 is a schematic view of a valved inflow arrangement for a jet-pump assisted exhaust scavenging and intake according to my invention.

Figure 6 is a schematic view of an alternative valved arrangement for bypassing a jet-pump assisted scavenging and intake according to my invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

My system of amplifying exhaust scavenging and intake air directed into the combustion chamber of a two-stroke cycle engine 10 involves arranging a jet pump 50 in an intake passageway to the combustion chamber 11, as schematically shown in the drawings. My jet pump amplified intake can be applied to two-stroke engines operating for different purposes, at different speeds, and under different conditions. One requirement is that the engine, or some other source, compress a supply of intake air used for powering jet pump 50. This can be done in several ways. Also, jet pump 50 can be bypassed or made inoperative during some circumstances.

The two-stroke cycle engine 10 shown in the drawings has a piston 12 powered by gases burning in combustion chamber 11 for driving a linearly moving output shaft 13. A connecting rod and a rotary output can be substituted for linear output shaft 13, and many of the possible operating details of engine 10, including: fuel injection, the way that a fuel and air charge is ignited and burned in chamber 11, cooling system, number of cylinders,

arrangement of exhaust port 14, and location and arrangement of an intake port, are all generally variable and are not prerequisites to use of my jet-pump assisted scavenging and intake.

A simple way for engine 10 to precompress intake air is by using movement of the output side of piston 12, which is underneath or opposite the side of piston 12 confronting combustion chamber 11. Partly for such air compressing purpose, a skirt 15 extends around piston 12, below the piston head, and moves in compression chamber 16. A spring 17 in chamber 16 returns piston 12 after a power stroke, but other arrangements, such as a crankshaft or pneumatic or hydraulic systems can be used for this. An intake valve 18 admits intake air to compression chamber 16, and a port 19 in piston skirt 15 serves as a valve for directing the flow of compressed air from chamber 16, via passageway 20 to jet pump 50. The way this works is shown by the engine cycles illustrated in Figures 1-4.

The power stroke for engine 10 is shown in Figure 1. This occurs when burning gases in combustion chamber 11 drive piston 12 downward, producing a power stroke on shaft 13. Check valve 18 is closed during the power stroke, which also compresses intake air in chamber 16.

Toward the end of the power stroke, an exhaust cycle begins, as shown in Figure 2. The head of piston 12 travels downward far enough to open exhaust passageway 14, and burned gases in combustion chamber 11 begin flowing out of exhaust passage 14.

As piston 12 descends to the bottom of its power stroke, as shown in figure 3, port 19 in piston skirt 15 moves into registry with passageway 20, letting compressed air in chamber 16 flow through passageway 20 to a nozzle 51 directing the compressed intake airflow through jet pump 50. In effect, port 19 in piston skirt 15 serves as a sliding valve opening passageway 20 at the right moment for delivering a rapid flow of compressed air from chamber 16 to nozzle 51. This directs a high-velocity stream of compressed air through a restricted region 52 of jet pump 50, which creates a low pressure that draws in additional air from the ambient atmosphere into an inflow 53 of jet pump 50. The additional inflow air drawn into jet pump 50 through inflow 53 combines with the compressed intake air directed into combustion chamber 11 over the head of piston 12, which at this point in its travel is below jet pump 50. As shown by the arrows in Figure 3, this amplified air inflow swirls around in combustion chamber 11, scavenging exhaust gases out of combustion chamber 11 through exhaust passageway 14 and supplying a volume of intake air larger than the volume drawn from compression chamber 16 via passageway 20.

After the exhaust scavenging and intake cycle illustrated in Figure 3, piston 12 begins a return stroke, powered, at least in part, by return spring 17. This moves port 19 out of registry with passageway 20 to close off the airflow from chamber 16, through passageway 20, to jet pump 50. It also opens intake check valve 18, as shown in Figure 4, to draw additional intake air into chamber 16. The piston return stroke serves as a compression stroke for engine 10, and at some point fuel is added to the air mixture being compressed in chamber 11 on the return stroke of piston 12. When the return or compression stroke is completed, the fuel and air mixture is ignited and burned in combustion chamber 11, producing a power stroke, such as shown in Figure 1, repeating the cycle for engine 10.

A jet pump 50 arranged in an intake line, for exhaust scavenging and intake purposes according to my invention, operates best during full throttle operation of engine 10, including nearly full or substantially wide open throttle operation. It is also desirable to have an upper cycle speed limit on the operation of a jet-pump assisted scavenging and intake system. For engines that operate variably, it is desirable to operate jet pump 50 during some engine operating conditions, and to bypass or otherwise not operate jet pump 50 during other operating conditions. Figures 5 and 6 schematically show some of the alternative possibilities for this.

In the alternative shown in Figure 5, a valve 55 is arranged in an inflow passageway 53 directing ambient air into jet pump 50, and an actuator 60 controls the operation of valve 55. The restriction 52 of jet pump 50 is preferably designed so that compressed intake air directed through nozzle 51 reaches combustion chamber 11 in adequate quantities during the exhaust scavenging and intake cycle, even when jet pump 50 is not operating. This allows actuator 60 to close inflow valve 55 during restricted throttle operation of engine 10 and during high-speed operation of engine 10. At such times when inflow valve 55 is closed, engine 10 draws adequate intake air via passageway 20 and nozzle 51, even though jet pump 50 is not drawing in additional air. When engine 10 runs at full or open throttle operation, at less than high speed, actuator 60 opens valve 55 to admit additional intake air to combustion chamber 11 via jet pump 50. This occurs as previously explained, every time valve port 19 opens passageway 20 to allow compressed air to flow from chamber 16.

A bypass around jet pump 50 can also be arranged, as schematically shown in Figure 6. Although bypasses can be arranged in a multitude of ways, the bypass passageway 56 shown in Figure 6 is arranged downstream of restricted area 52 of jet pump 50. A flapper valve 57 controlled by

actuator 61 determines whether the intake air from chamber 16 is directed through bypass 56 and directly into chamber 11 or through passageway 20, nozzle 51, and the restricted region 52 of jet pump 50, for drawing in additional air inflow en route to combustion chamber 11. A bypass around jet pump 50 can also be used in conjunction with a valved inflow passageway 53 into jet pump 50. Moreover, a valve in an inflow passageway 53 to jet pump 50 can be arranged as a check valve that opens whenever jet pump 50 is operated and otherwise remains closed to prevent intake air from leaking backwards out of jet pump 50.

Compressed intake air supplied to jet pump 50 need not be derived from a compression chamber arranged directly under an engine piston, as illustrated in the drawings. A blower powered by engine 10, or a turbine powered by exhaust from engine 10, can also supply compressed intake air to jet pump 50. However this is done, I prefer that a valve be arranged to establish a high-velocity intake air flow through jet pump 50 at the proper moment during the engine cycle to direct an amplified volume of intake air into combustion chamber 11 for exhaust scavenging and intake purposes. A preferred way to accomplish this is a valve moving with piston 12, such as the illustrated valve port 19 registering with passageway 20, but other valving arrangements can also be synchronized with the movement of piston 12.

Not all two-stroke cycle engines benefit from amplified intake air for exhaust scavenging and intake purposes. The desirability of amplifying the intake air via a jet pump according to my invention, depends on the operating circumstances of each engine, including its tendency to produce oxides of nitrogen (NO_x). These occur based on a factor of combustion time and temperature, and can be suppressed somewhat by leaving some exhaust gases in combustion chamber 11. Engines that burn a combustible mixture more rapidly can benefit from jet-pump amplified air intake without producing unacceptable levels of NO_x compounds in the engine exhaust.

Claims

1. A scavenging and intake system for a two-stroke cycle engine, said system using a source of compressed intake air, and said system comprising: a jet pump arranged to be powered by flow of said compressed intake air for drawing additional inflow air into a combustion chamber for said engine along with said compressed intake air.

2. The system of claim 1 wherein said jet pump has a valved inflow passageway.

3. The system of claim 2 wherein an actuator is arranged for opening said inflow passageway during full throttle operation of said engine.

4. The system of claim 3 wherein said actuator is arranged for closing said inflow passageway at high-speed operation of said engine.

5. The system of claim 1 wherein a valved passageway is arranged for alternatively flowing said compressed intake air to pass through said jet pump or to bypass said jet pump.

6. The system of claim 5 wherein a controller directs said compressed intake air flow to pass through said jet pump during full throttle operation of said engine.

7. The system of claim 6 wherein said controller directs said compressed intake air to bypass said jet pump at high-speed operation of said engine.

8. The system of claim 1 including a valve arranged for delivering said compressed intake air to said jet pump only during exhaust scavenging and intake cycles for said engine.

9. The system of claim 8 wherein said valve comprises a port in a skirt for said piston moving into registry with a passageway leading said compressed intake air to said jet pump.

10. The system of claim 8 wherein said jet pump has a valved inflow passageway.

11. In a two-stroke cycle engine arranged for compressing intake air for a combustion chamber, the improvement comprising: a jet pump arranged to be powered by flow of said compressed intake air for drawing additional air into said combustion chamber along with said compressed intake air.

12. The improvement of claim 11 including a valve arranged for delivering said compressed intake air to said jet pump only during exhaust scavenging and intake cycles for said engine.

13. The improvement of claim 12 wherein said valve includes a port moving with a piston for said engine into registry with a passageway leading said compressed intake air to said jet pump.

14. The improvement of claim 11 including a valve arranged for opening and closing an inflow

passageway to said jet pump.

15. The improvement of claim 11 including a valve arranged for directing said compressed intake air alternatively through said jet pump or through a bypass of said jet pump.

16. The improvement of claim 11 including a valve arranged for directing said additional intake air into said combustion chamber during full throttle operation of said engine.

17. The improvement of claim 16 wherein said valve is arranged for not directing said additional intake air into said combustion chamber during high-speed operation of said engine.

18. A method of amplifying air flow directed into a combustion chamber of a two-stroke cycle engine for exhaust scavenging and intake purposes, said method comprising

a. arranging a jet pump in an intake passageway to said combustion chamber; and

b. powering said jet pump with a flow of compressed intake air for drawing additional air through said jet pump to combine with said compressed intake air flow and amplify the total volume of air that is flowed into said combustion chamber during exhaust scavenging and intake cycles of said engine.

19. The method of claim 18 including valving the flows of said intake and said additional air for not drawing said additional air through said jet pump during restricted throttle operation of said engine and during high-speed operation of said engine.

20. The method of claim 18 including valving the flows of said intake and said additional air to draw said additional air through said jet pump during full throttle operation of said engine.

21. The method of claim 18 including delivering said compressed intake air to said jet pump only during said exhaust scavenging and intake cycles.

22. The method of claim 18 including bypassing said jet pump during restricted throttle and high-speed operation of said engine.

Amended claims in accordance with Rule 86-(2) EPC.

1. A scavenging and intake system for a two-stroke cycle engine, said system using a source of compressed intake air, and said system comprising: a jet pump arranged to be powered by flow of said compressed intake air for drawing additional inflow air into a combustion chamber for said engine along with said compressed intake air, the source of compressed air being a compression chamber formed under a skirt for the piston by a transverse wall that encloses a cylinder for the piston on an output side of the piston.

2. The system of claim 1 wherein said jet pump has a valved inflow passageway.

3. The system of claim 2 wherein an actuator is arranged for opening said inflow passageway during full throttle operation of said engine.

4. The system of claim 3 wherein said actuator is arranged for closing said inflow passageway at high-speed operation of said engine.

5. The system of claim 1 wherein a valved passageway is arranged for alternatively flowing said compressed intake air to pass through said jet pump or to bypass said jet pump.

6. The system of claim 5 wherein a controller directs said compressed intake air flow to pass through said jet pump during full throttle operation of said engine.

7. The system of claim 6 wherein said controller directs said compressed intake air to bypass said jet pump at high-speed operation of said engine.

8. The system of claim 1 including a valve arranged for delivering said compressed intake air to said jet pump only during exhaust scavenging and intake cycles for said engine.

9. The system of claim 8 wherein said valve comprises a port in a skirt for said piston moving into registry with a passageway leading said compressed intake air to said jet pump.

10. The system of claim 8 wherein said jet pump has a valved inflow passageway.

11. In a two-stroke cycle engine arranged for compressing intake air for a combustion chamber, the improvement comprising: a jet pump arranged to be powered by flow of said compressed intake air for drawing additional air into said combustion chamber along with said compressed intake air.

12. The improvement of claim 11 including a valve arranged for delivering said compressed intake air to said jet pump only during exhaust scavenging and intake cycles for said engine.

13. The improvement of claim 12 wherein said valve includes a port moving with a piston for said engine into registry with a passageway leading said compressed intake air to said jet pump.

14. The improvement of claim 11 including a valve arranged for opening and closing an inflow passageway to said jet pump.

15. The improvement of claim 11 including a valve arranged for directing said compressed intake air alternatively through said jet pump or through a bypass of said jet pump.

16. The improvement of claim 11 including a valve arranged for directing said additional intake air into said combustion chamber during full throttle operation of said engine.

17. The improvement of claim 16 wherein said valve is arranged for not directing said additional intake air into said combustion chamber during high-speed operation of said engine.

18. A method of amplifying air flow directed into a combustion chamber of a two-stroke cycle engine for exhaust scavenging and intake purposes, said method comprising

a. arranging a jet pump in an intake passageway to said combustion chamber; and

b. powering said jet pump with a flow of compressed intake air for drawing additional air through said jet pump to combine with said compressed intake air flow and amplify the total volume of air that is flowed into said combustion chamber during exhaust scavenging and intake cycles of said engine.

19. The method of claim 18 including valving the flows of said intake and said additional air for not drawing said additional air through said jet pump during restricted throttle operation of said engine and during high-speed operation of said engine.

20. The method of claim 18 including valving the flows of said intake and said additional air to draw said additional air through said jet pump during full throttle operation of said engine.

21. The method of claim 18 including delivering said compressed intake air to said jet pump only during said exhaust scavenging and intake cycles.

22. The method of claim 18 including bypassing said jet pump during restricted throttle and high-speed operation of said engine.

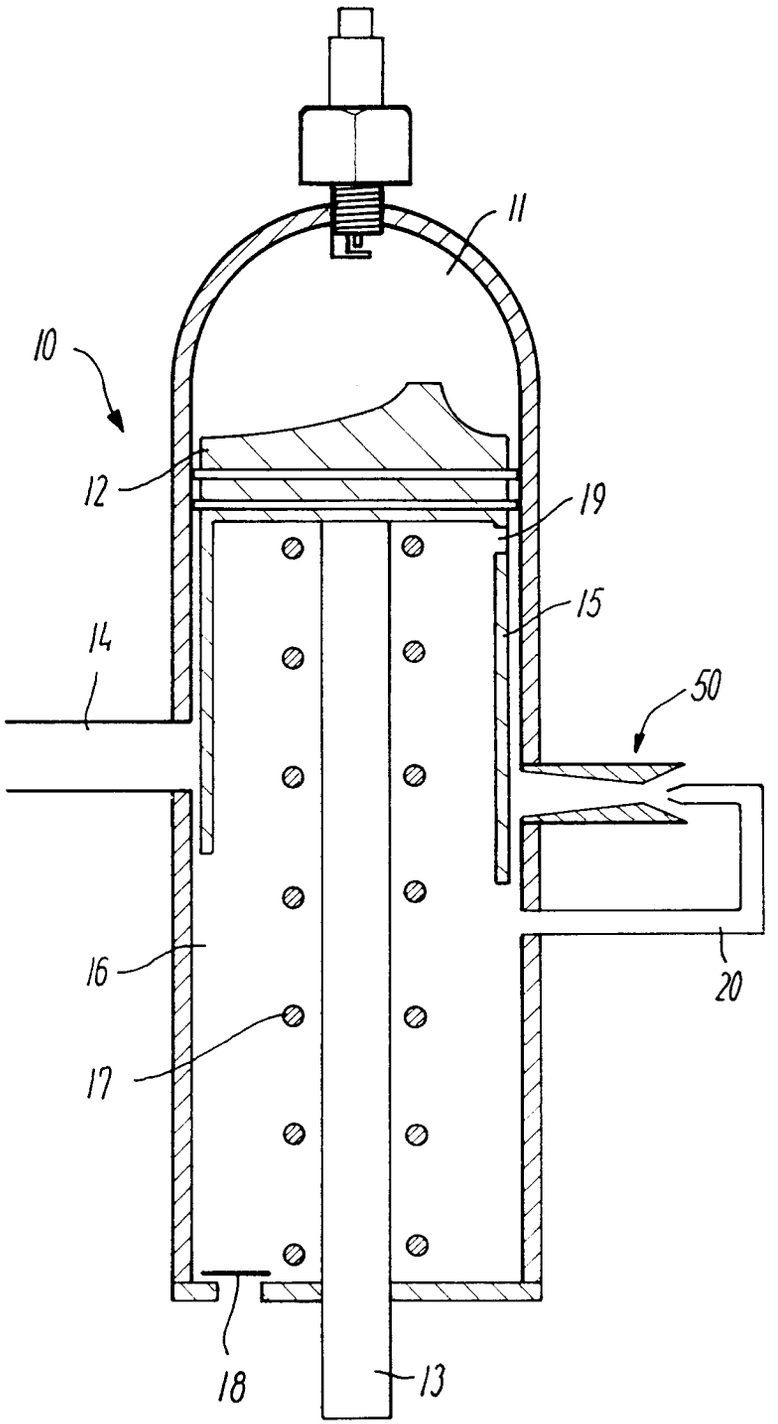

FIG. 1

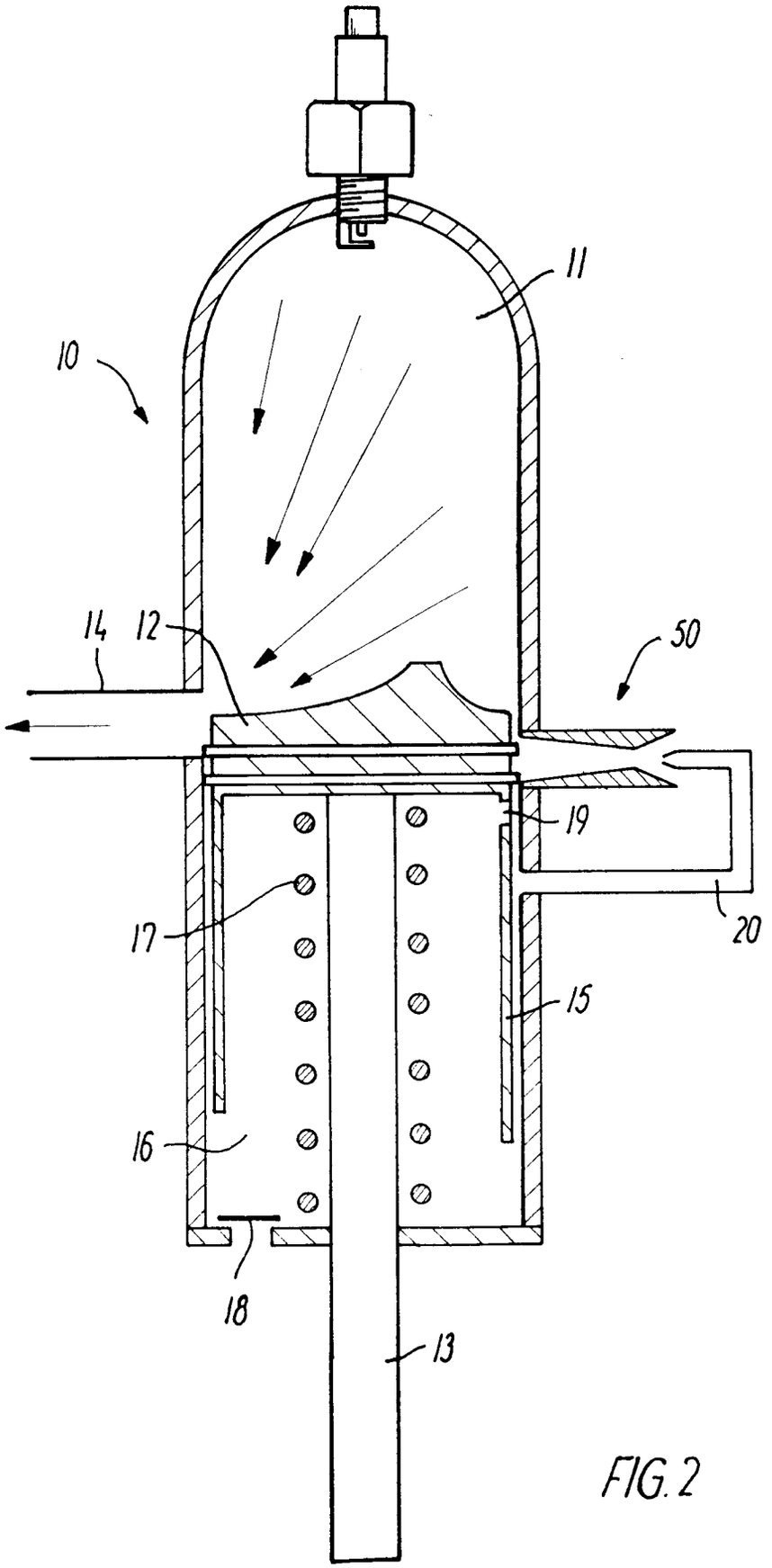

FIG. 2

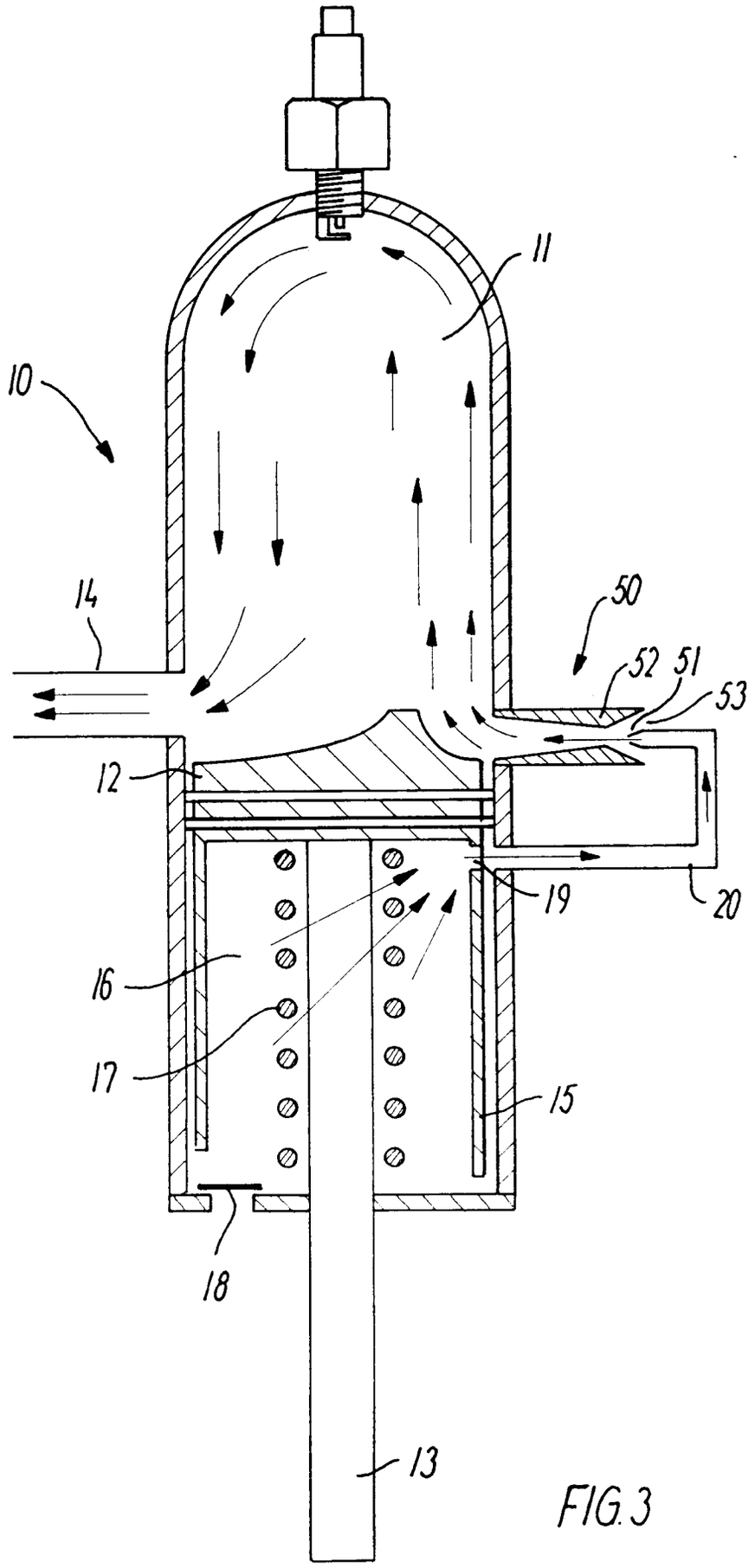

FIG. 3

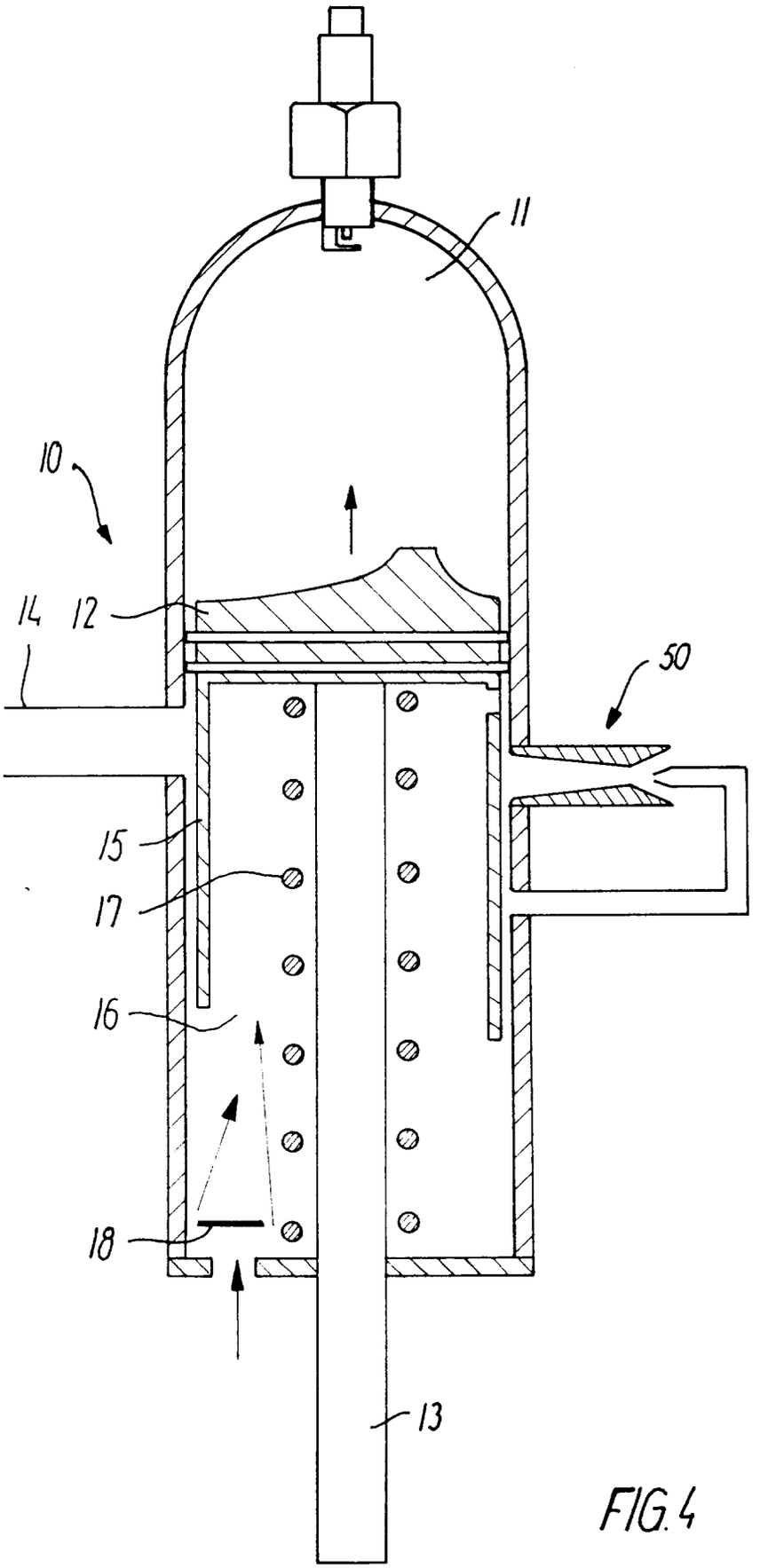

FIG. 4

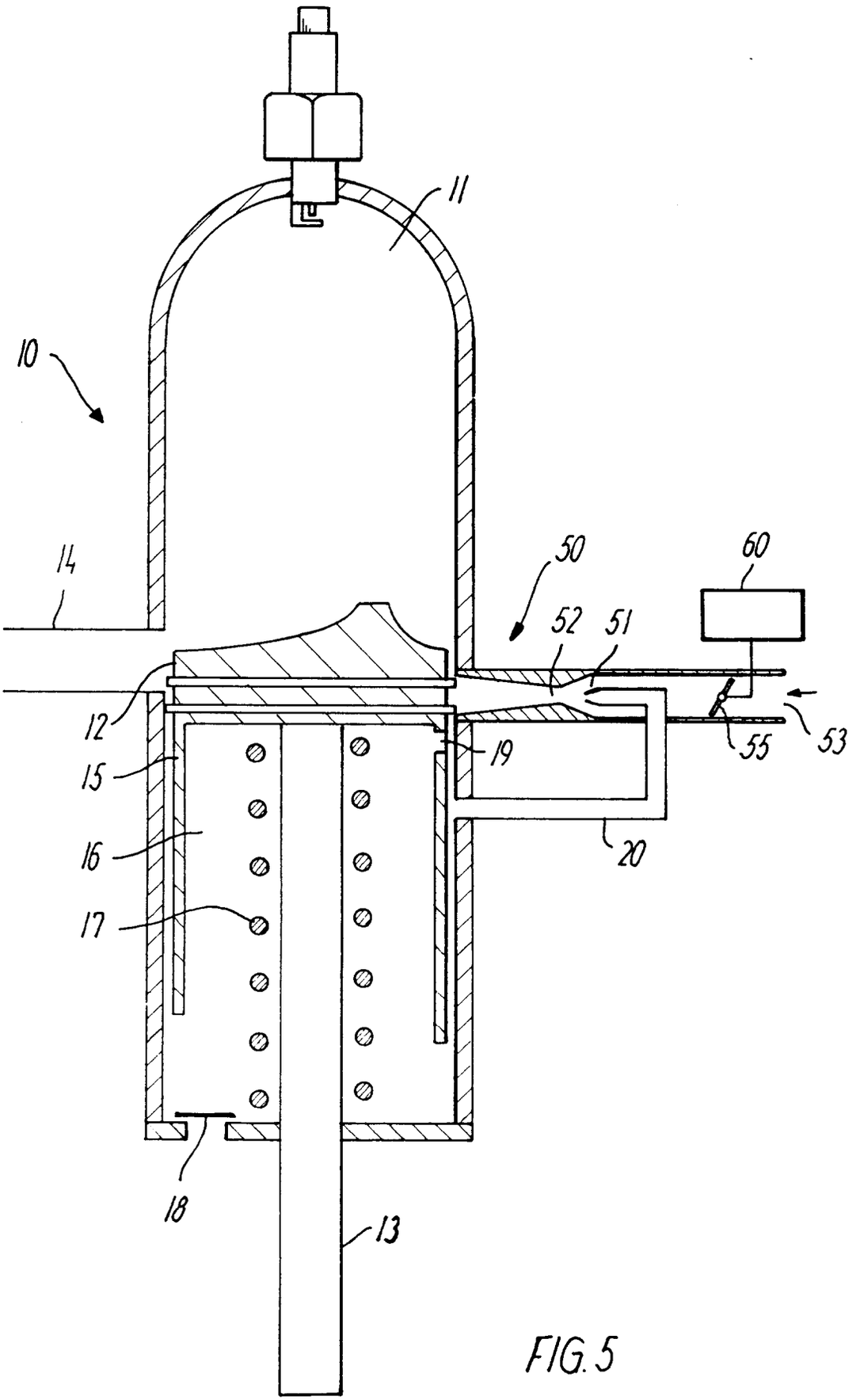

FIG. 5

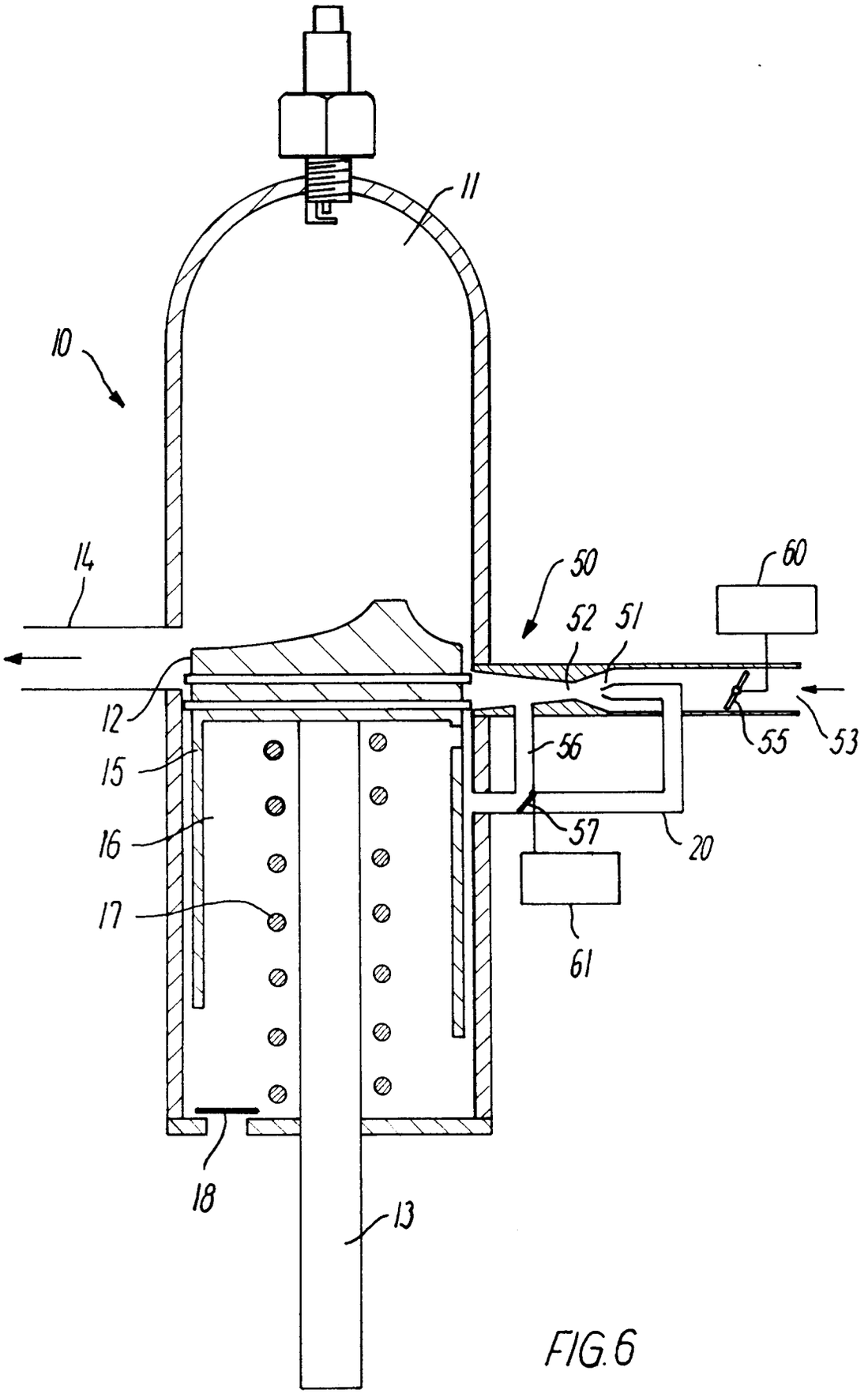

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number

EP 92 11 9149

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-3 257 996 (HENRIKSON) * the whole document * ---	1,2,3, 8-14,18	F02B33/44
X	DE-B-1 012 117 (SULZER) * the whole document * ---	1-3,8-22	
A	US-A-4 461 251 (SHEAFFER) * abstract; figure 1 * ---	1	
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 95 (M-209)(1240) 21 April 1983 & JP-A-58 18 519 (JIDOSHA KIKI K.K) 3 February 1983 * abstract * -----	1-22	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 JUNE 1993	WASSENAAR G.C.C.

CATEGORY OF CITED DOCUMENTS

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