June 5, 1934. A. G. M. MICHELL 1,961,905

INTERNAL COMBUSTION ENGINE

Filed Feb. 20, 1929 5 Sheets-Sheet 1

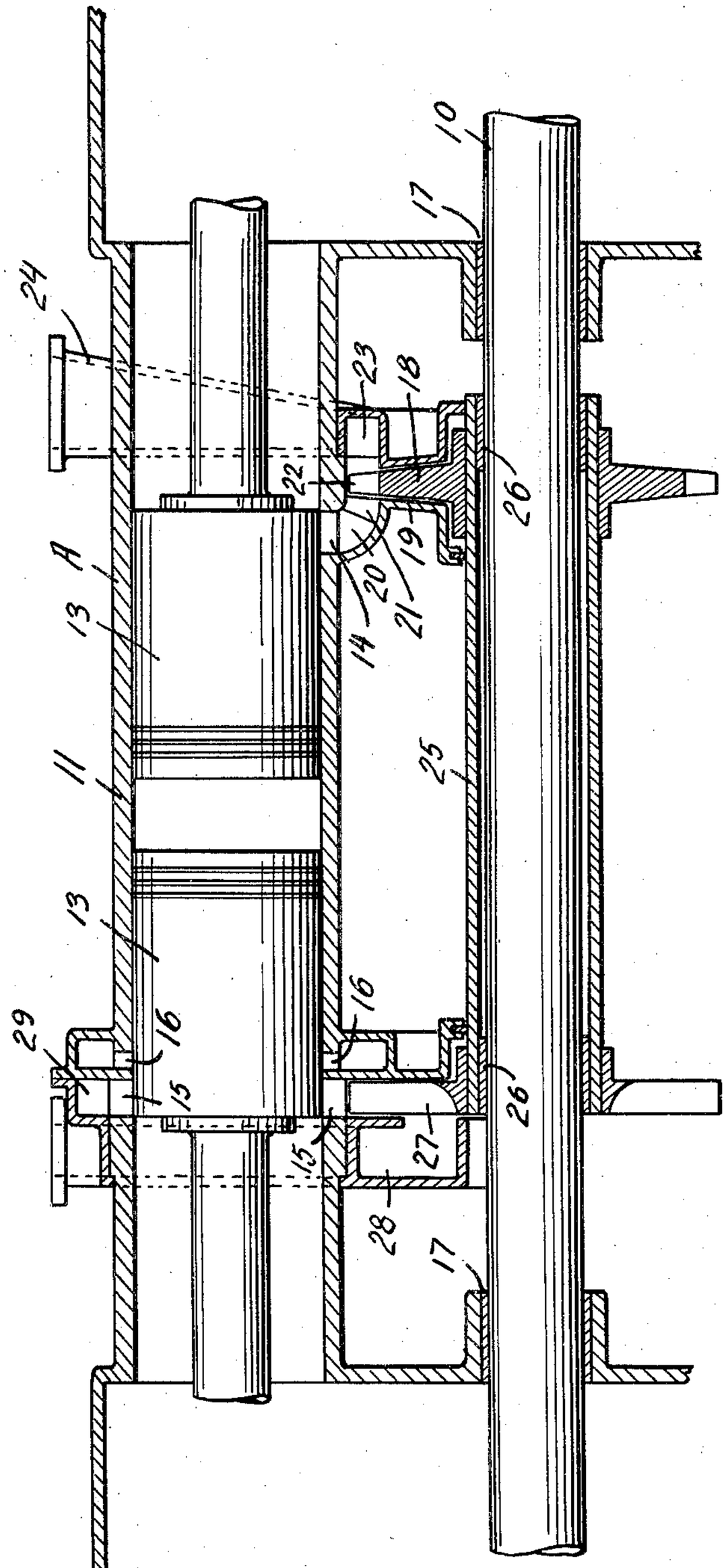

FIG. 1.

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Fig. 2.

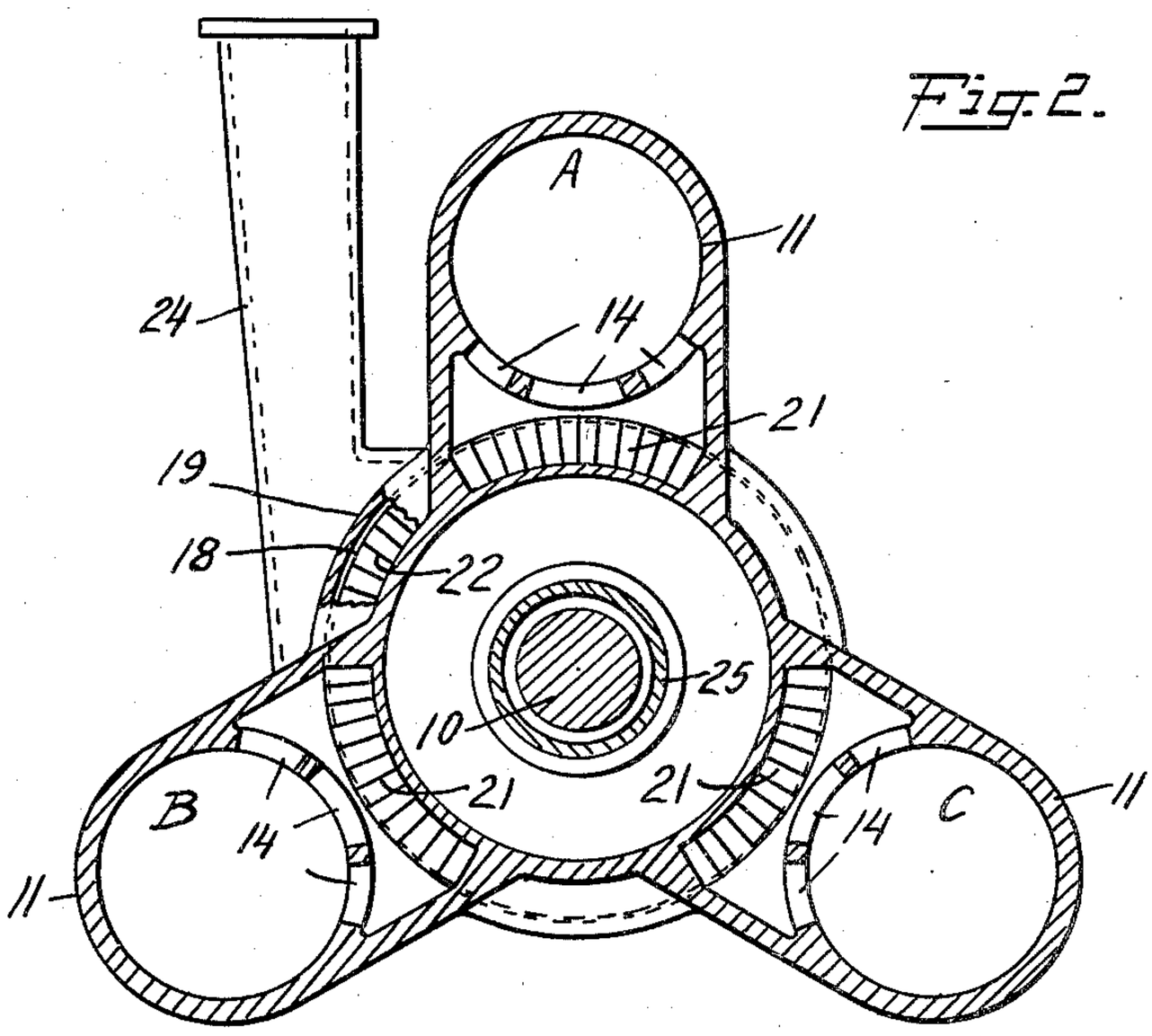


Fig. 5.

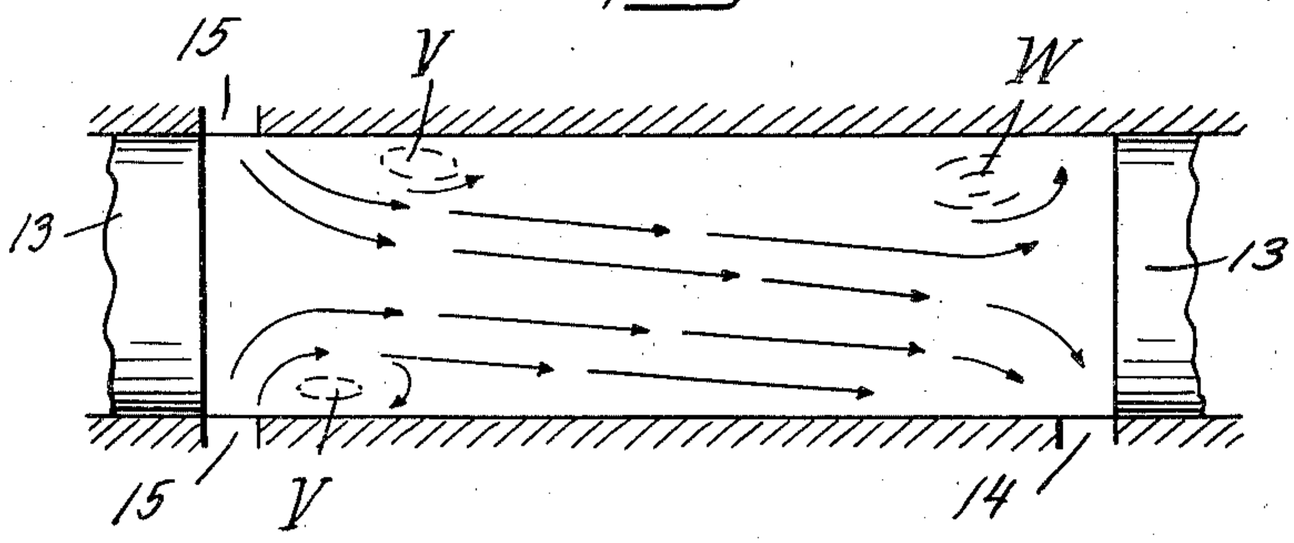
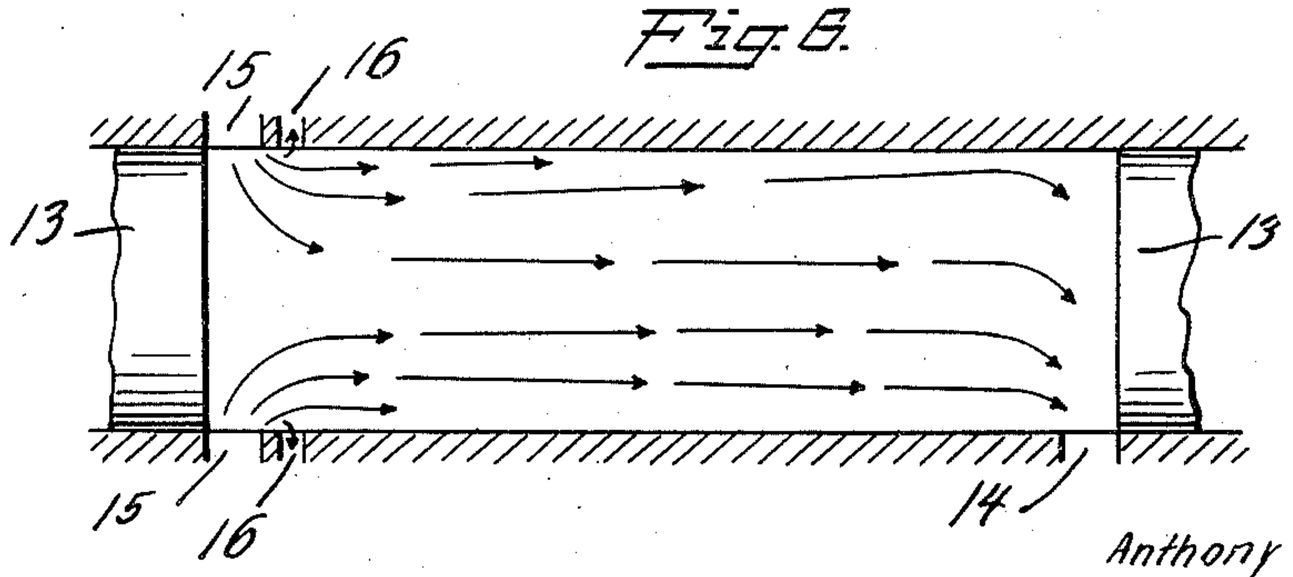


Fig. 6.



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INTERNAL COMBUSTION ENGINE

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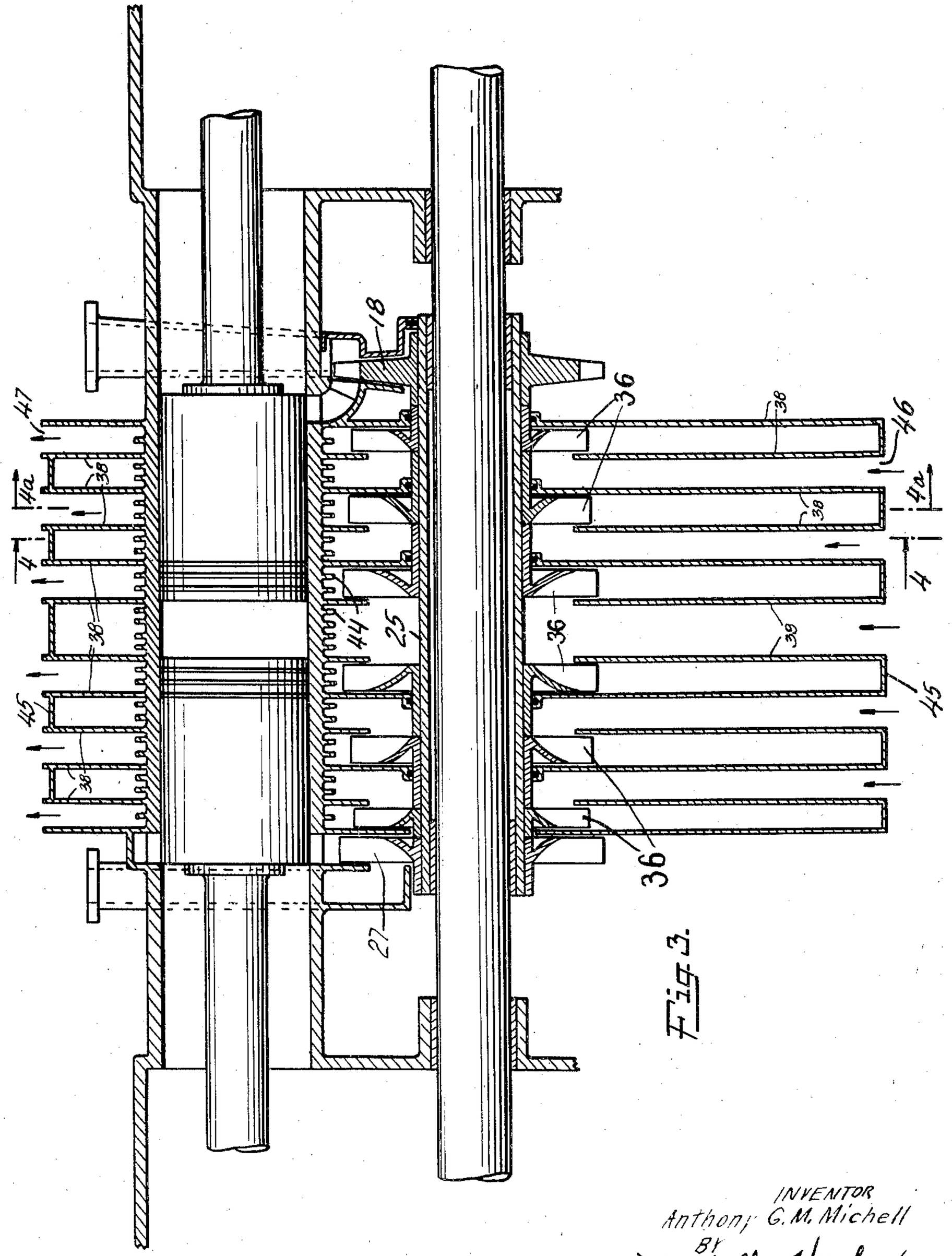

Fig. 3.

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Fig. 4a

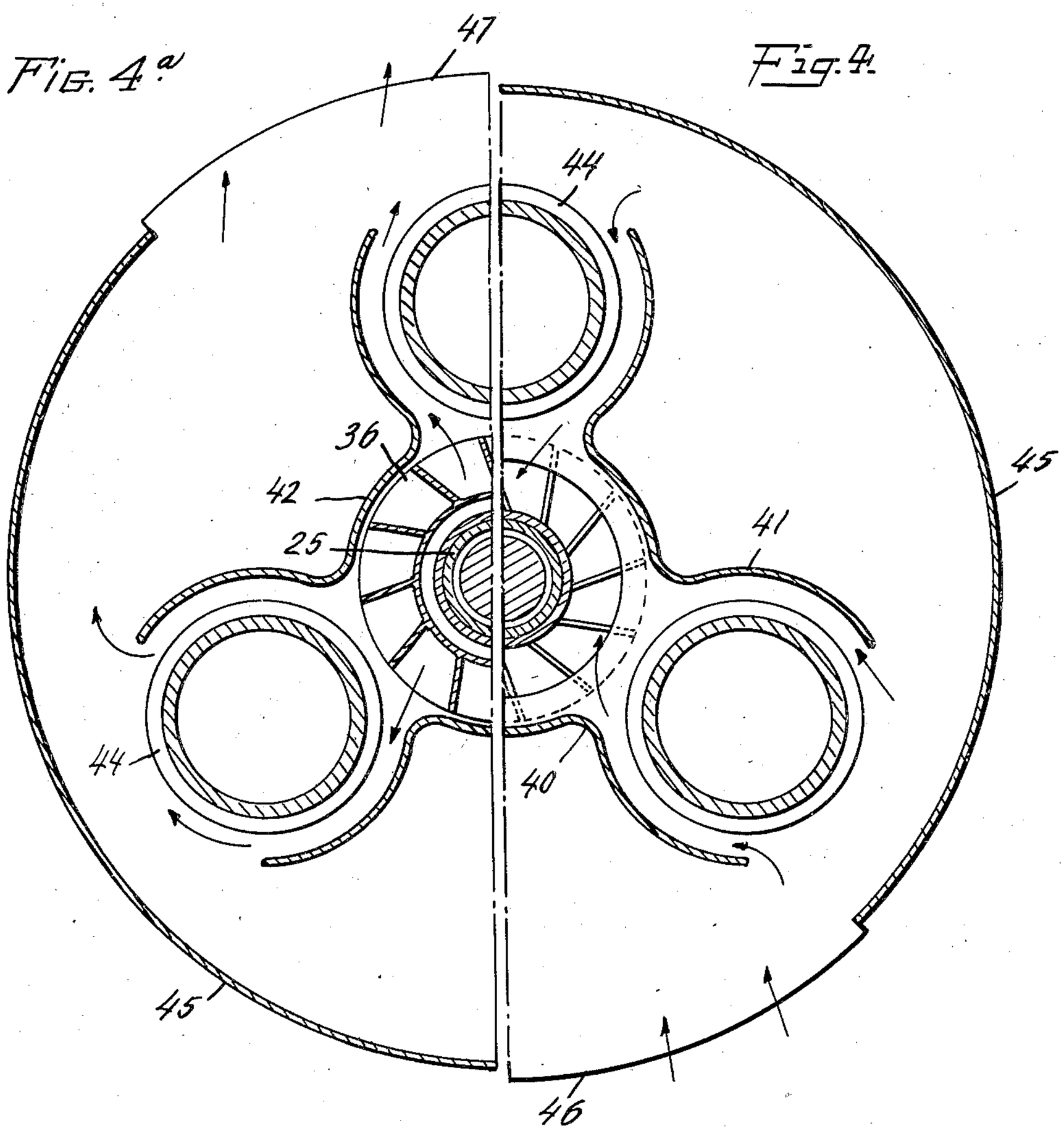

Fig. 4.

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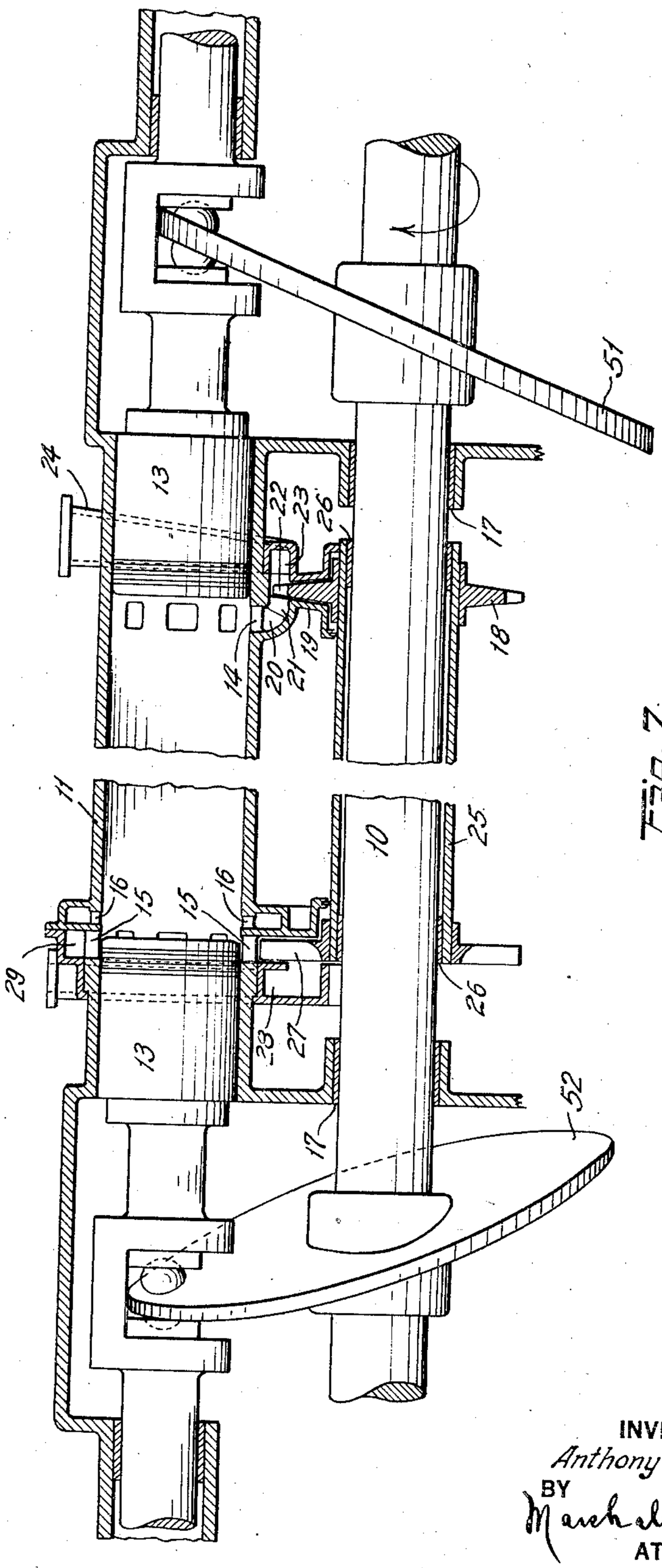

Fig. 7.

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Patented June 5, 1934 1,961,905

UNITED STATES PATENT OFFICE

1,961,905

INTERNAL COMBUSTION ENGINE

Anthony G. M. Michell, Melbourne, Australia, assignor to Michell-Crankless Engines Corporation, New York, N. Y., a corporation of New York

Application February 20, 1929, Serial No. 341,353

4 Claims. (Cl. 60—13)

This invention relates to internal combustion engines and particularly to engines of the type in which the cylinders are arranged parallel to the engine shaft, such, for instance, as the engine disclosed in Michell Patent No. 1,613,116, issued January 4, 1927.

Engines of the type disclosed in the patent referred to operate on the two stroke cycle and each cylinder has operating therein a pair of opposed pistons. At the termination of each outward or working stroke of the pistons, the exhaust gases are discharged from the cylinder and the cylinder is scavenged by air admitted to the cylinder under pressure. In the patent referred to the scavenging air is compressed by an air pump directly actuated by the engine.

In internal combustion engines of various forms and types the power for effecting similar scavenging has been derived from the exhaust gases of the engine and in some cases the exhaust gas has been used to drive a gas turbine, which in turn has been used to drive the scavenging or air pump.

This invention has for its salient object to provide an engine of the character specified with simple, practical, compact and efficient scavenging and cooling means.

Another object of the invention is to provide a simple and practical arrangement of turbine driven air pump operated by the exhaust gas of the engine and so located and mounted that exhaust gases which are used to drive the turbine will be led directly thereto, thus eliminating losses due to fluid friction and cooling.

Another object of the invention is to provide simple and efficient cooling means for an engine of the type specified, the cooling means being driven by power derived from the engine.

Further objects of the invention will appear from the following specification taken in connection with the drawings, which form a part of this application, and in which

Fig. 1 is a longitudinal sectional elevation taken through one of the cylinders and the shaft of an engine of the type specified and illustrating the turbine drive and air pump driven by the turbine;

Fig. 2 is a transverse sectional elevation taken at right angles to Fig. 1;

Fig. 3 is a sectional elevation similar to Fig. 1 but showing an arrangement for cooling the engine, the cooling fans being driven by the turbine;

Figs. 4 and 4*a* are transverse sectional elevations, taken respectively on line 4—4 of Fig. 3 and on line 4*a*—4*a* of Fig. 3;

Figs. 5 and 6 are diagrammatic views illustrating the flow of gases and air in the engine cylinders during the exhaust and scavenging thereof and

Fig. 7 is a longitudinal sectional elevation similar to Fig. 1, but showing the pistons in different positions in the cycle of operation from that shown in Fig. 1 and also showing the swash plate connections between the piston rods and the engine shaft.

The invention briefly described consists of an engine of the type specified in which the cylinders are arranged parallel to the engine shaft and are spaced circumferentially around the shaft. Each cylinder has oppositely acting pistons therein and is provided with intake and exhaust ports disposed at opposite ends of the cylinders and controlled by the pistons. The exhaust ports of the cylinders are located at the same ends of all of the cylinders and a gas driven turbine is rotatably mounted on the shaft and has its periphery provided with vanes which receive gas from the exhaust ports and the exhaust gas from the ports is directed against the vanes of the turbine and the turbine is rotated thereby. The turbine shaft has mounted thereon a rotary fan and the air from the fan is directed into the cylinders and scavenges the cylinders. Furthermore, in one form of the invention the turbine shaft has mounted thereon a plurality of fans which are utilized to blow air against the cylinder walls and cool the engine. The proximity of all the exhaust ports to one another and their location at one end of the engine and also the annular disposition of the engines and exhaust ports around the shaft, provide a very efficient arrangement since the exhaust gases are conducted directly to the turbine casing and losses in efficiency, due to fluid friction and cooling of the gases in long conduits or passages, are avoided. Furthermore, the annular arrangement of the scavenge ports at the opposite end of the engine permits the fan or air pump to be arranged in a practical and efficient manner and also facilitates the arrangement of the cooling fans for cooling the engine cylinders.

Further details of the invention will appear from the following description.

In the form of the invention illustrated in the drawings, the engine comprises a plurality of cylinders A, B and C arranged symmetrically around a centrally disposed shaft 10 and disposed parallel thereto. Each cylinder 11 has a pair of

oppositely acting pistons 13 and is provided at opposite ends thereof with an exhaust port 14 and a scavenge port 15 which are uncovered when the pistons reach the outer ends of their working strokes. Each cylinder may also be provided with auxiliary exhaust ports 16 disposed adjacent the scavenging ports 15. It will be obvious that the auxiliary exhaust ports will be uncovered prior to the uncovering of the scavenge ports 15 and that the auxiliary exhaust ports will be closed later than the main scavenge ports 15.

The engine shaft 10 is mounted in bearings 17 and any desired form of operative driving connections between the pistons and the shaft may be used, such, for instance, as the swash plates or slants shown in Patent No. 1,613,116, above noted.

A turbine wheel 18 is mounted coaxially with the shaft 10, the wheel being mounted in a casing 19 which is connected by conduits 20 to receive the exhaust gas from the ports 14. Guiding or directing vanes 21 in the conduits 20 direct the exhaust gases at the desired angle against the vanes or blades 22 of the turbine. The turbine casing 19 has an exhaust gas manifold 23 on the opposite side of the turbine which receives the gases discharged from the turbine wheel and conducts them away from the engine through a conduit 24.

The turbine 18 is mounted on a hollow shaft 25 which in turn is rotatably mounted on bearings 26 which surround the main shaft 10.

In the form of the invention illustrated in Fig. 1, the shaft 25 has mounted upon it at its end opposite to the turbine 18 a centrifugal fan 27 drawing air from a chamber 28 connected to the atmosphere. The air discharged from the fan 27 is directed into an annular chamber 29 which communicates with the scavenging ports 15 of the engine cylinder 11.

The relative timing of the strokes of the pistons at the scavenge and exhaust ends of each cylinder is such, according to the system explained in the Patent 1,613,116 above referred to, that the exhaust ports 14 are opened by the piston at the end of the power stroke shortly before the scavenge ports 15 are opened by the other piston in the same cylinder. This is brought about, as is shown clearly in Fig. 7, by mounting upon the shaft the slant or swash plate 51 which coacts with the exhaust piston, slightly in advance of the angular position of direct opposition to the other slant, or swash plate 52, which coacts with the scavenge piston.

Thereby, as shown in Figs. 1 and 7, the exhaust ports 14 and 16 are opened before the scavenge ports 15 and the greater part of the exhaust gases, which at the opening of the ports 14 impinge upon the blades of the turbine 18 with the velocity corresponding to the full pressure in the cylinder at the time of such opening, are discharged from the cylinder before the ports 15 are uncovered by the scavenge piston. The pressure of the gases remaining in the cylinder simultaneously falls, due to this discharge of the exhaust gases, to a pressure which is lower at the moment when the ports 15 are uncovered, and for the remainder of the exhaust period, than the pressure produced by the scavenge fan 27. For the remainder of the period during which the ports 14 remain open, the scavenge fan therefore delivers air through the ports 15 into the cylinder, this air displacing the exhaust gases still remaining in the cylinder and causing them to be discharged partly through the ports 14 and partly through the ports 16.

This scavenging action is illustrated in Fig. 6, which shows the positions of the pistons 13 at a phase later than that shown in Fig. 7,—that is to say, when the ports 14 and 15 are simultaneously open.

In order that as much as possible of the available energy of the exhaust gases may be utilized to drive the turbine wheel 18, the greater part of the exhaust gases must be discharged through the ports 14 and, therefore, the area of the ports 14 is much greater than the area of the auxiliary exhaust ports 16. The function of the auxiliary exhaust ports is particularly illustrated in the diagrammatic showings in Figs. 5 and 6. Fig. 5 shows the path of the air injected into the cylinder through the scavenging ports 15 when no auxiliary exhaust ports are provided. In this figure the streams of air which enter in approximately radial directions through the ports 15 converge toward the axis of the cylinder and thereafter tend to flow in the general direction of the exhaust ports 14. This flow of the air streams tends to leave pockets or portions of stagnant or vorticose bodies of exhaust gas adjacent the walls of the cylinder, as indicated at V, V and W. Also, a certain portion of the scavenging air tends to be discharged directly through the exhaust ports 14 instead of displacing corresponding portions of exhaust gas.

In order to overcome the difficulty outlined in the preceding paragraph, auxiliary exhaust ports 16 may be provided adjacent the intake ports 15 for the scavenging air. When such auxiliary exhaust ports are provided, the flow of the air takes place approximately as shown in Fig. 6, wherein it will be seen that the exhaust gas along the cylinder wall is displaced by the scavenging air and the air stream is not concentrated at the axis of the cylinder.

In the form of the invention illustrated in Fig. 3, the cylinders are arranged symmetrically around the engine shaft in the same manner as in the other embodiment of the invention. A turbine wheel 18 is driven by the exhaust gases from the cylinders and causes the rotation of the hollow shaft 25. The scavenging air is furnished by the centrifugal fan 27 which forces the air into the cylinders successively and effects the scavenging thereof.

In this form of the invention, however, there are provided a plurality of cooling fans 36 which are mounted on the hollow shaft 25 and are adapted in the manner hereinafter described to direct air against the cylinder walls. It will be seen from the showing in Fig. 3 that the fan blades for the fans 36 adjacent the longitudinal centers of the cylinders are larger than the blades at the ends of the cylinders. This is preferable since the cylinders will be hotter adjacent their longitudinal centers and, therefore, will require a greater amount of air to effect the same amount of cooling as the outer ends of the cylinders. Partitions 38 are preferably provided between the fans 36 and the cylinders are preferably partially surrounded by casing walls or baffle plates 40, 41 and 42 which direct the ingress of the air to the fans and the egress of the air therefrom. The cylinders may have cooling fins 44 to enhance the cooling effect.

It will also be seen from the showing in Fig. 3 that the cooling fans 36 at one side of the longitudinal center of the cylinders are left hand fans and that the cooling fans on the opposite ends of the cylinders are right hand fans. This construction is preferable since the thrusts imposed

on the shaft 25 are equalized. Furthermore, the two fans nearest the center have a common inlet passage.

The path of the air directed by the cooling fans is illustrated particularly in Fig. 4. At the right hand side of this figure there is illustrated the ingress of the air from the atmosphere to the intake of one of the cooling fans and at the left hand side of this figure the egress of the air from the same fan is shown. The baffle plates 40, 41 and 42 and the partitions 38 direct the flow of the air through the fans and from the fans around the cylinders.

In order to prevent the air which has been circulated around the cylinders and has been heated thereby from entering the fan intakes and being recirculated, the spaces between the successive partitions 38 are alternately closed on opposite sides of the engine by circumferential walls 45 in which openings 46 and 47 are provided for the ingress and egress of the air.

From the foregoing description it will be clear that the arrangement of the turbine drive for the cooling and scavenging fans has been so worked out as to cut down to a minimum the length of the passages from the exhaust ports of the cylinders to the turbine, thus effectively eilminating losses due to fluid friction and cooling of the exhaust gas. Furthermore, the arrangement provides a particularly compact construction and the construction illustrated and described will obviously take up a minimum amount of space.

Although certain specific embodiments of the invention have been particularly shown and described, it will be understood that the invention is capable of modification and that changes in the construction and in the arrangement of the various cooperating parts may be made without departing from the spirit or scope of the invention, as expressed in the following claims.

What I claim is:

1. In an internal combustion engine, a shaft, a plurality of cylinders arranged around the shaft, and disposed parallel thereto, pistons in said cylinders operatively connected to said shaft, each cylinder having an exhaust port at one end thereof, a turbine wheel mounted on but rotatable independently of the shaft, said ports being located radially of the wheel axis, an air inlet port for each cylinder, conduits for conducting exhaust gases from the exhaust ports to the peripheral portion of the turbine wheel, a fan driven by said turbine, and conduits for conducting air from the fan to the air inlet ports.

2. In an internal combustion engine, a shaft, a plurality of cylinders arranged around and having their axes parallel to the shaft, a pair of opposed pistons in each cylinder operative connections between said pistons and said shaft, an inlet and an exhaust port in each cylinder, said ports being disposed at the opposite ends of the cylinders, a turbine wheel mounted adjacent the ends of the cylinders having the exhaust ports therein, means for conducting exhaust gases from said ports to the turbine wheel to drive said wheel, a fan operatively connected to said turbine, and conduits for conducting air from the fan to the cylinder inlet ports, said turbine and fan being surrounded by said cylinders and rotatable independently of said shaft.

3. In an internal combustion engine, a shaft, a plurality of cylinders arranged around and having their axes parallel to the shaft, each cylinder having an exhaust port, a turbine wheel mounted on an axis coaxial with the shaft axis, and a plurality of cooling fans arranged coaxially with the turbine wheel and driven thereby, said fans being arranged to blow air transversely against the cylinder walls, the fans adjacent the longitudinal centers of the cylinders being larger than the fans opposite the end portions of the cylinders.

4. In an internal combustion engine, a shaft, a plurality of cylinders arranged around said shaft with their axes parallel thereto, each cylinder having an inlet and an exhaust port therein, a turbine wheel having its axis coaxial with the shaft axis but rotatable independently of the engine shaft and disposed between the shaft and said cylinders, conduits for conducting the exhaust gases from the cylinder exhaust ports to said turbine wheel, a fan driven by said turbine and surrounded by said cylinders, and means including an annular chamber for conducting air from said fan to the inlet ports of said cylinders.

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