W. C. SMITH.

REVERSIBLE REVOLVING CYLINDER MOTOR.

APPLICATION FILED JAN. 8, 1909.

953,979.

Patented Apr. 5, 1910.

4 SHEETS—SHEET 1.

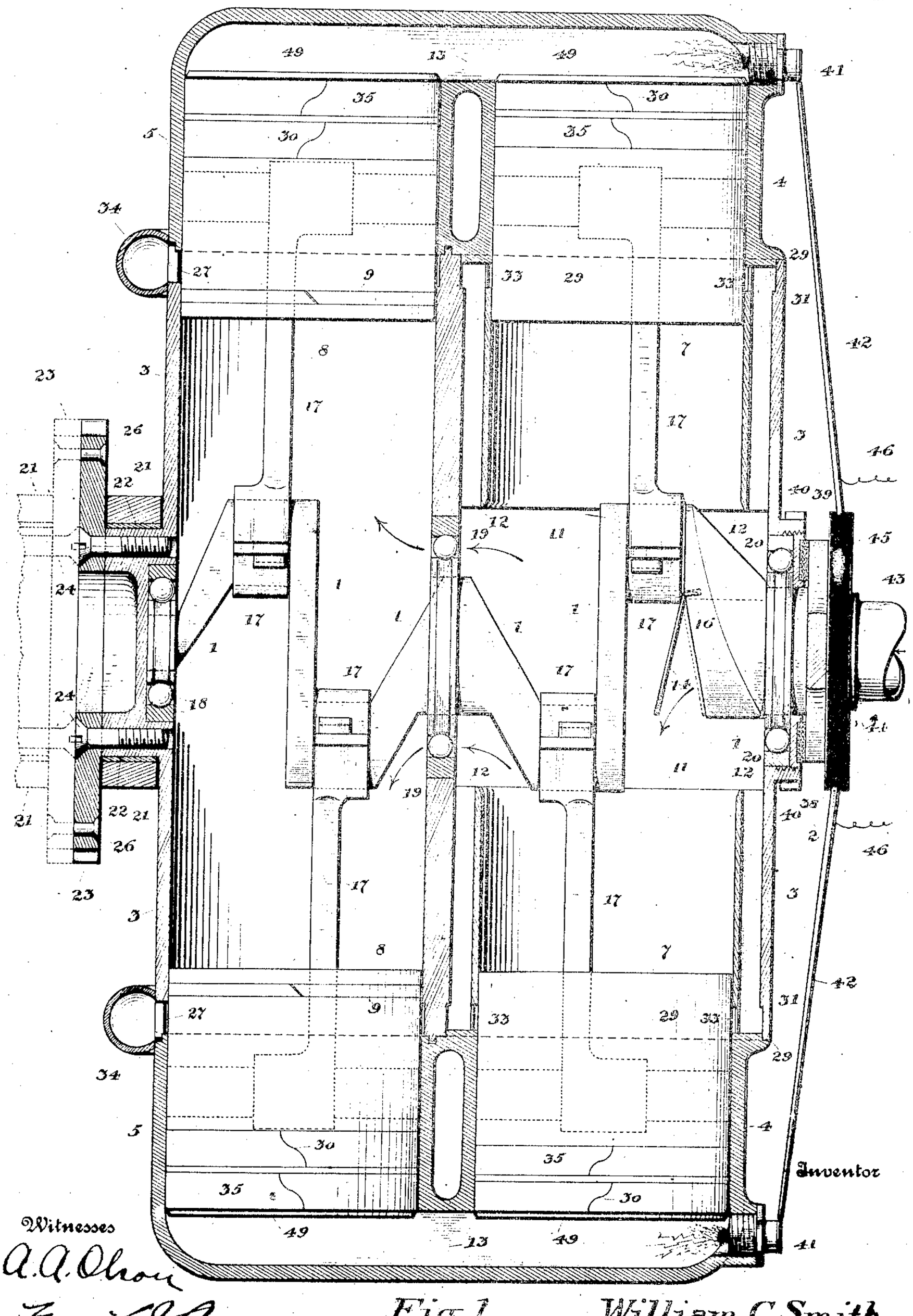

Fig. 1.

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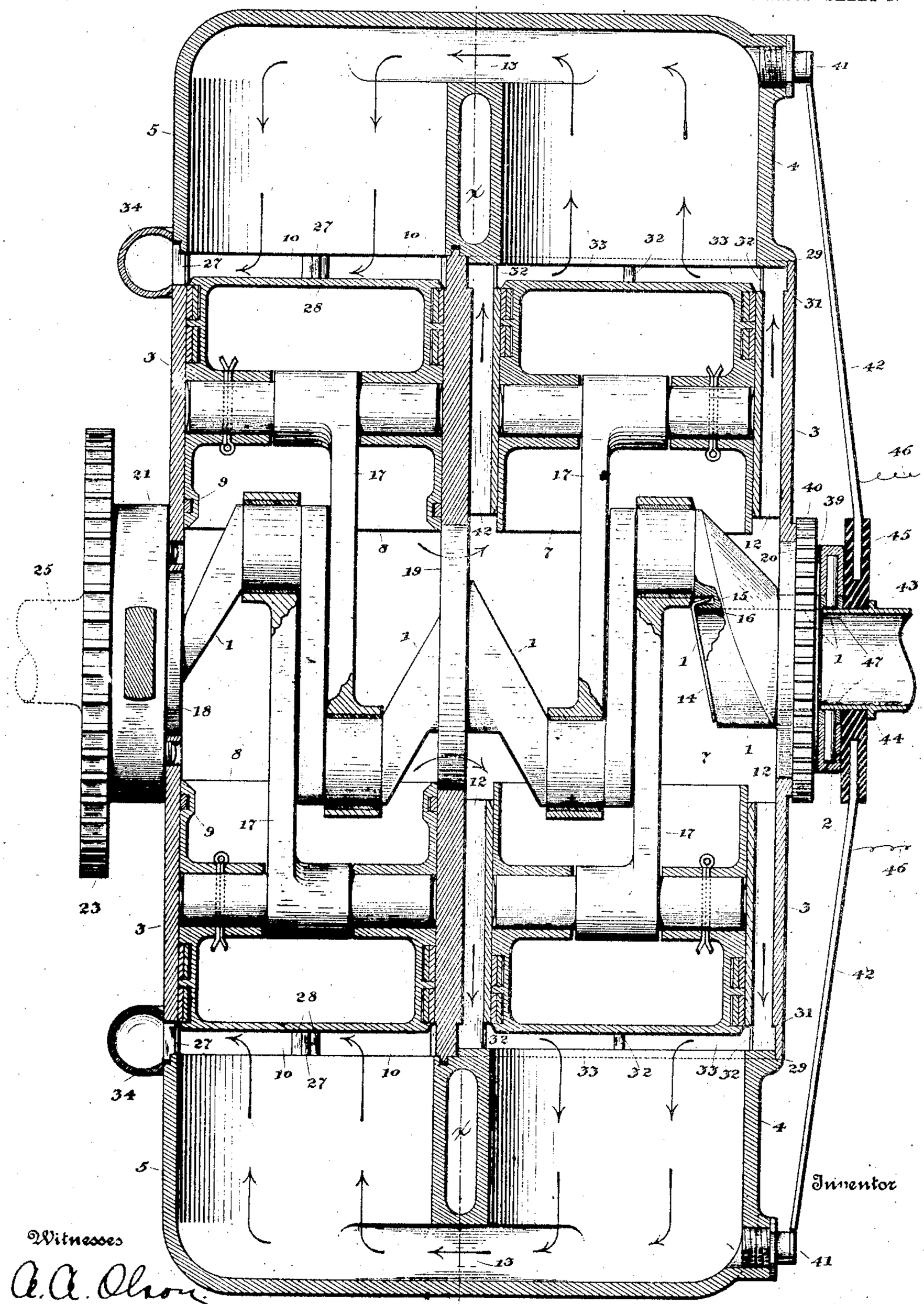

Witnesses

A. A. Olson

Fred J. Kraus

Fig. 2.

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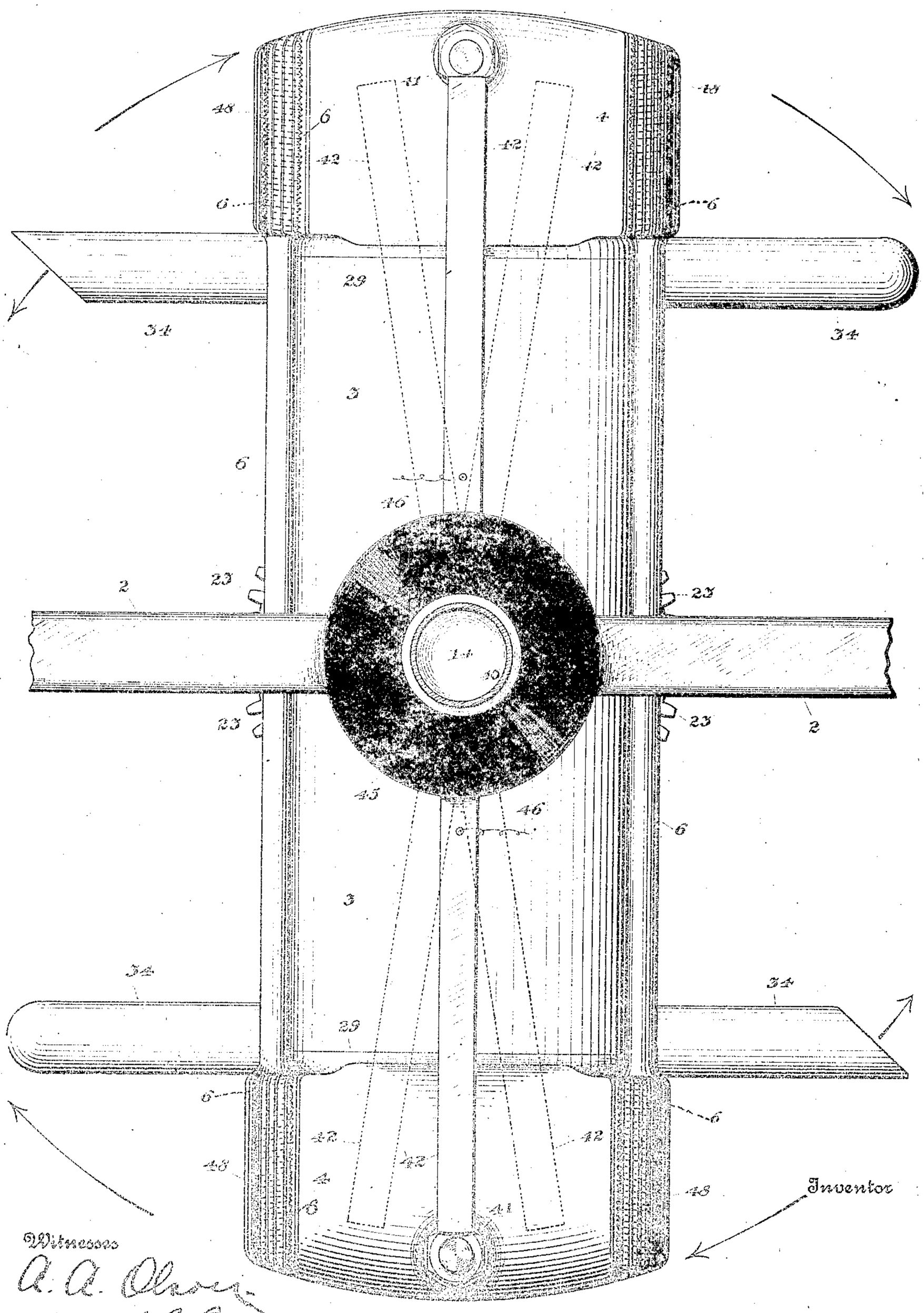

Fig. 3.

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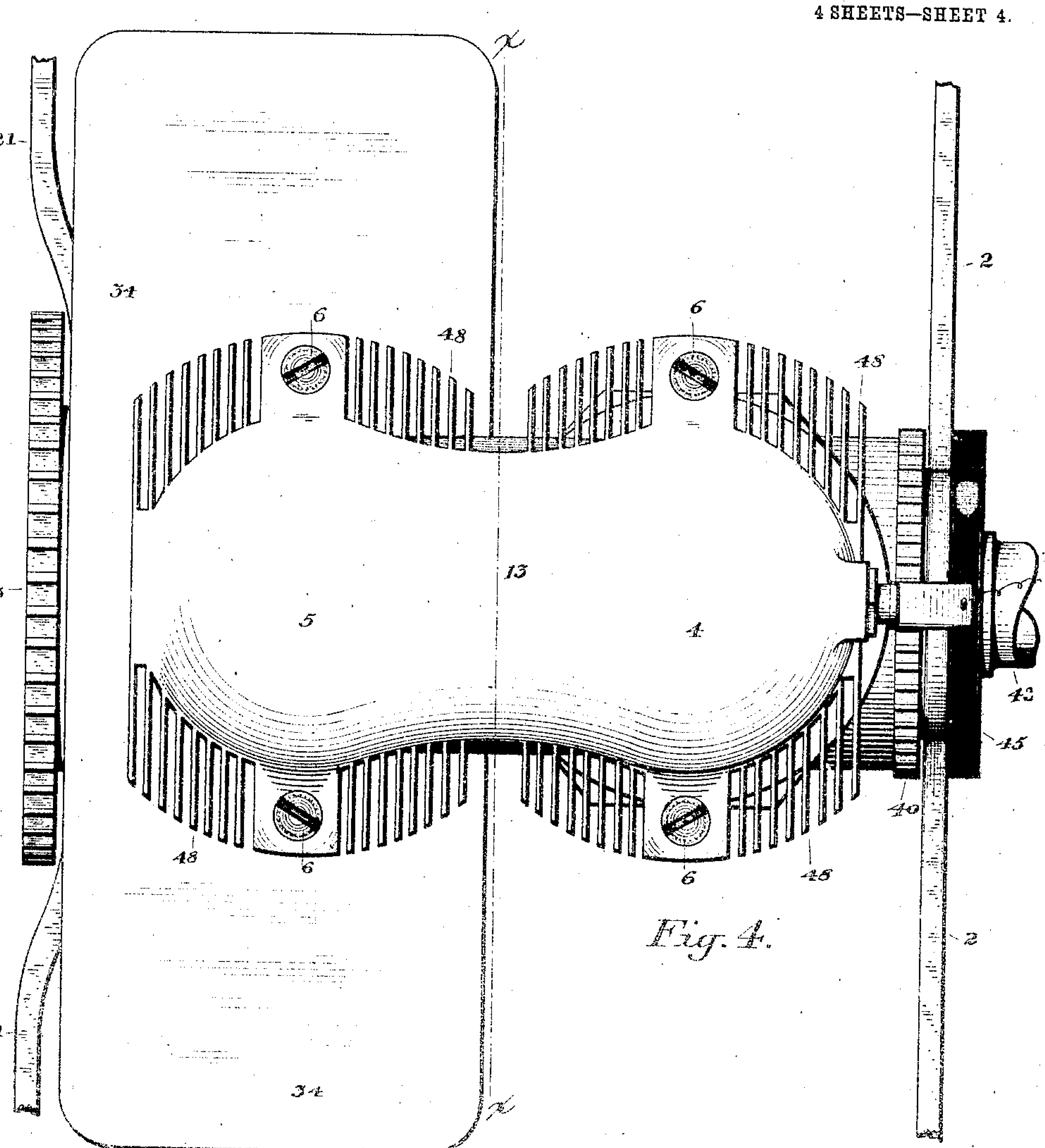

Fig. 4.

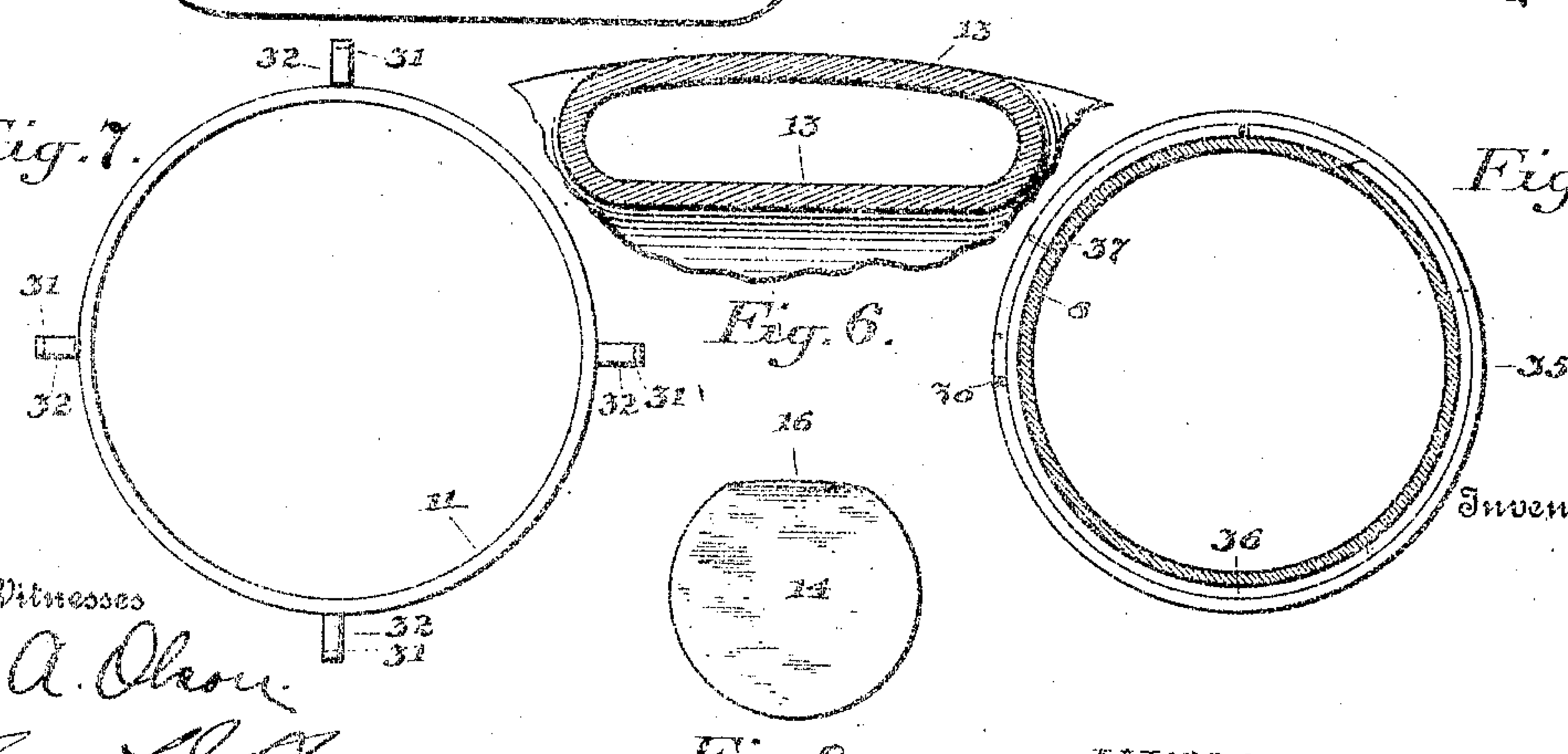

Fig. 7.

Fig. 6.

Fig. 8.

Fig. 5.

Witnesses

A. A. Olson

Fred L. [illegible]

Inventor

William C. Smith

UNITED STATES PATENT OFFICE.

WILLIAM COBB SMITH, OF CHICAGO, ILLINOIS.

REVERSIBLE REVOLVING-CYLINDER MOTOR.

953,979. Specification of Letters Patent. Patented Apr. 5, 1910.

Application filed January 3, 1909. Serial No. 471,354.

To all whom it may concern:

Be it known that I, WILLIAM COBB SMITH, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Reversible Revolving-Cylinder Motors, of which the following is a specification.

My invention relates to improvements in two-cycle internal-combustion motors, and more particularly to that type in which the cylinders are adapted to revolve about a crank-shaft fixed against rotation.

The main object of my invention is to provide such a construction and arrangement of parts in a two-cycle, or two-stroke-cycle, revolving cylinder motor that the cylinders thereof will be thoroughly charged and scavenged at each revolution of the same.

A further object of my invention is to provide a motor which shall be inexpensive of manufacture, strong and durable in its construction, and of the highest possible efficiency.

Other objects will appear hereinafter.

With these objects in view my invention consists in the novel construction, combination, and arrangement of parts which will be hereinafter fully described and more particularly pointed out in the appended claims.

My invention will be more readily understood by reference to the accompanying drawings forming a part of this specification, and in which,

Figure 1 is substantially a central longitudinal section of a four cylinder power unit in its preferred form, also indicating by dotted lines how an eight cylinder unit may be constructed, Fig. 2 is a view similar to Fig. 1, but showing the cylinder pistons at the termini of their outstrokes, and indicating by dotted lines how the motor may be direct-connected to a power shaft, Fig. 3 is a side elevation showing the exhaust pipes, Fig. 4 is an end elevation showing the longitudinally disposed air-cooling flanges, Fig. 5 is a detail elevation of the composite concentric piston rings, and a transverse section of a cylinder piston, Fig. 6 is a detail section taken on line X of Figs. 2 and 4, showing the tubular gas passage-way, Fig. 7 is a detail end elevation showing the removable portion of an intake cylinder, and Fig. 8 is an elevation of the automatic crank-case inlet disk valve.

Referring now to the drawings, 1 indicates the non-rotatable crank-shaft, and 2 the frame or support to which the same is secured. The crank-case 3 is rotatably mounted on the crank-shaft 1 preferably by means of ball-bearings, as shown. Each intake cylinder 4 is preferably cast integral with an exhaust cylinder 5, and the pair of cylinders thus formed is fitted to the crank-case 3 and may be held in position by the screws 6.

It is obvious that a single pair of cylinders may be used if properly counterbalanced, but when four cylinders are used and disposed in couples on either end of the crank-case 3, as shown in the drawings, the screws 6 are preferably provided with right and left threads and the cylinders tapped to receive the same, so that by turning the screws 6 all four cylinders may be easily removed from the crank-case 3. Each intake cylinder piston 7 is similar to an exhaust cylinder piston 8, except that the latter is preferably provided with an additional ring 9 to prevent any loss of crank-case compression by leakage through the exhaust port 10. The removable portion 11 forming an extension of an intake cylinder 4 is securely pressed into position in the crank-case 3, the transfer intake gas passage 12 being substantially an annular space between the periphery of said removable portion and said crank-case. The crank-case 3 is bored to receive the exhaust cylinder pistons 8, as shown. These bored portions thus serve as a part of the exhaust cylinders.

The revolving passage-way or tubular portion 13 through which the gases in the intake cylinder 4 may flow to the exhaust cylinder 5 is the main novel feature of this revolving cylinder revolving piston motor. The tendency of the hot spent gases in flowing through this passage-way is to overheat the same, thus reducing the power of the charge by expansion, but since no other part of the motor has a higher rotative speed, said passage-way is thoroughly air-cooled, the cooling effect varying as the speed of the motor.

A crank-case disk inlet valve 14 is pivoted to the crank-shaft 1, the latter being recessed at 15 to receive a bent portion 16 in said valve. A connecting-rod 17 is adapted to retain the valve 14, as shown.

The ball bearings 18, 19, and 20 are pref-

erably of the annular type, and are so arranged on the crank-shaft that the same may resist the explosive pressures in the most effective manner.

One side of the crank-case 3 is preferably journaled in the bearing member 21 provided with the bronze bushing 22, said member being a stationary support. The driving spur gear 23 may be secured to the crank-case 3 by means of the countersunk head screws 24. Two screws 24 only are shown, but it is clear that several may be used.

It is obvious that the gear 23 may be dispensed with if the direct-connected power shaft 25 is used as indicated by dotted lines in Fig. 2.

In order to couple two four cylinder units to form an eight cylinder motor, the gear 23 of each unit may be abutted and secured together by means of a plurality of rivets 26, the same being hot riveted.

The bridges 27 extending across the exhaust ports 10 are integral with the crank-case 3, and preferably do not contact with the pistons or rings, the latter being of a width sufficient to pass said ports independent of said bridges.

The bridges 27 and the portions 28 of the screws 6 which are exposed to the exhaust gases may be coated with an insulation of asbestos or mica, if desired, this provision being possible since the piston rings do not contact with said bridges. Piston ring distortion causing leakage and low compression and burning of the cylinder oil, which are familiar results when bridges are depended on for retaining the rings in position is thus overcome.

A suitable shoulder joint 29 is provided to accurately position the cylinders on the crank-case 3, the screws 6 being depended on to hold the same in position.

The compound curved piston ring joints 30 are a special provision in this motor to prevent breaking of the piston ring ends when passing the ports. Shoulders 31 are provided on the removable portion 11, which together with the extensions 32 which abut the cylinder 4 serve to hold said portion in position.

The circumferential exhaust ports 10 and the circumferential intake ports 33 cause uniform cylinder expansion by a proper distribution of the gases, it being well known that cylinder distortion results from an unsymmetrical arrangement of the ports.

Each exhaust pipe 34 has the form of a flattened tube and is machined to fit snugly on an exhaust cylinder 5 and the crank-case 3 over an exhaust port 10. The exhaust pipes may be dispensed with if so desired, but if used, add to the efficiency of the motor by creating a partial vacuum over the exhaust ports. The orifice of each exhaust-pipe is so disposed that the exhaust gases escape in a direction opposite from that of the rotation of the motor, except when reversing, hence an effective muffling action and a reaction tending to increase the power of the motor.

The concentric piston rings 35 and 36 are fixed against rotation by means of a plain pin 37 loosely mounted in the same and in a piston, as shown in Fig. 5. Common eccentric rings may be used if desired, but the concentric rings are preferred as they heat uniformly. As the joints or slits of the concentric rings are spaced 90 degrees apart the elliptical tendency of each ring when compressed is neutralized, and unlike the eccentric type of ring gas leakage through the slits will not develop after wear of the ring peripheries.

A metallic ring 38 is screwed into the crank-case 3, the same serving as a ball bearing retainer. Felt or other soft fabric 39 is interposed between the support 2 and a circular groove formed in one side of the ring 38. The felt 39 when saturated with lubricating oil serves as a dust-proofing means and as an efficient packing to prevent loss of crank-case compression, and unlike the ordinary two-cycle motor but one bearing only needs to be packed in the present motor.

If a magneto is used to generate the electric current for sparking the motor, a gear 40 may be machined on one side of the crank-case 3 for driving said magneto which may be secured to the support 2 in any suitable manner.

The spark plugs 41 are secured in the cylinders preferably as shown in order that the same may have electrical contact with the spark advancing and retarding lever 42, the latter being rotatably mounted on the tube 43 leading from the carbureter, which tube is pressed into the crank-shaft 1. The flange 44 integral with the tube 43 retains the hub 45 of the lever 42 in position, said hub being adapted to insulate the high tension currents of the wires 46 from the motor except when the terminals of said lever contact electrically with the plugs 41. The lever 42 may be rotated by hand or in any suitable manner as indicated by dotted lines in Fig. 3 in order to properly time the spark.

An efficient means of rigidly securing the crank-shaft 1 to the support 2 is formed by driving a series of radially disposed pins 47 through said crank-shaft into said support, the tube 43 serving as a retainer for said pins. The cooling flanges 48 may be dispensed with as they add but a trifle to the efficiency of the motor.

Beveled edges 49 are provided on the pistons.

The present motor may be a two, four, or an eight cylinder power unit, and, as a four cylinder unit, two explosions occur in a sin-

gle revolution. An eight cylinder unit may be made by simply coupling two four cylinder units in such a manner that the pistons of one unit are at the termini of their instrokes at the same time as the pistons of the other unit are at the termini of their outstrokes. And in the eight cylinder unit two explosions occur at every 180 degrees of rotation. As many eight cylinder units may be geared to a main shaft by means of spur gearing as may be desired.

The revolving tubular portion or gas passage-way 13 may be integral with the intake and exhaust cylinders, as shown, or the same may be a separate conduit or pipe connecting the heads of said cylinders, either construction being a substantial equivalent of the other.

The scale of the original drawings is one-half the preferred size of motor, the cylinder dimensions being $4\frac{1}{2}$ inches bore by $3\frac{1}{2}$ inches stroke. The length of the connecting-rods, between centers, the length of the crank shaft, and the distance from the center of rotation to the periphery of the motor are 6, 12, and 11, inches respectively.

The operation of the motor is as follows: Fig. 1 shows the incoming charge from the carbureter caused by the suction of the pistons. The charge passes through the sensitive automatic inlet valve 14, which instantly closes on the outstroke of the pistons, thus imprisoning said charge. The charge in the crank-case 3 is compressed and, when the circumferential intake ports 33 open, flows into the cylinders as shown in Fig. 2, this action being accelerated by centrifugal force. The exhaust ports 10 open slightly before the intake ports 33 allowing a portion of the products of combustion to escape, the remaining products of combustion escaping simultaneously with the charging of the cylinders. The cylinder charge is ignited when compressed as shown in Fig. 1. To reverse the motor, the same is throttled and the spark advanced by means of the lever 42. It is apparent that the centrifugal force acquired by the gases in their passage from the center of rotation of the motor to a cylinder intake port accelerates their movement through the two adjacent revolving cylinders, thus facilitating the charging and scavenging thereof, and that the movement of the gases in the revolving cylinders from the center of cylinder revolution through the piston-controlled intake port into the first cylinder, thence through a passage-way between the cylinder heads into the second cylinder, and thence out through the piston-controlled exhaust port, is a feature peculiar to this motor. When the exhaust port is uncovered by the piston in the exhaust or second cylinder, the terminal pressure of the gases and the consequent inertia thereof will rid the cylinders of a portion of the products of combustion before the intake port is uncovered in the first or intake cylinder. Then the intake gases will follow the spent gases and be slightly intermingled therewith in the first cylinder. But during the passage of the two gases in the second cylinder the heavy fuel vapor of the charge or intake gases which may have mixed with the spent gases in the first cylinder will tend to be separated therefrom by centrifugal force, said second cylinder thus serving as a centrifugal separating chamber. It is obvious that the hot light spent gases will approach the center of revolution and flow out through the exhaust port, and that the cool heavy air and vapor of the charge will remain in the cylinders. It is of course possible, however, that minute quantities of the cold heavy air of the charge which may have mixed with the spent gases in the intake cylinder will fail to be separated therefrom in the exhaust cylinder and consequently be lost, but the possibility of any such loss of the costly gasolene or other fuel vapor of the charge which is heavier by far than the air thereof is remote. The combined effect of the suction over the exhaust ports, the centrifugal force and separation of the gases, and the crank-case compression, together with the terminal pressure and consequent inertia of the gases is to thoroughly charge and scavenge the cylinders at each revolution of the motor, the advantage of pure charges undiluted by the products of combustion being of course apparent.

Features of the present motor are the symmetrical arrangement and consequent perfect balancing of the opposed moving parts, and the elimination of reciprocating motion. High speeds are attainable as in a turbine or electric motor because of the simple revolving parts. And because of its high efficiency and extremely light weight, having no fly-wheel or water system, this motor is especially adapted for heavier-than-air flying-machines and automobiles.

While I have shown what I deem to be the preferable form of my invention, I do not wish to be limited thereto as there might be many changes made in the details of construction and arrangement of parts without departing from the spirit and scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In a motor, a crank shaft, a pair of cylinders in open communication with each other and mounted to revolve about said crank shaft with their axes in planes substantially perpendicular to the axis thereof, pistons operating in said cylinders and connected with said crank shaft, means of admission of an explosive mixture into one cylinder, a piston-controlled exhaust port in the other cylinder, and means for ignition.

2. In a motor, a crank shaft, a pair of cylinders mounted to revolve about said crank shaft and in open communication with each other in the region most remote from the axis of revolution, pistons operating in said cylinders and connected with said crank shaft, means of admission of an explosive mixture into one cylinder, a piston-controlled exhaust port in the other cylinder, and means for ignition, the axes of said cylinders being in planes substantially perpendicular to the axis of said crank shaft.

3. In a motor, a crank shaft fixed against rotation, a pair of cylinders mounted to revolve about said crank shaft with their axes in planes substantially perpendicular to the axis thereof, pistons operating in said cylinders and connected with said crank shaft, said cylinders being in open communication with each other at their outer ends beyond the range of operation of said pistons, admission means in one cylinder, a piston-controlled exhaust port in the other cylinder and means for ignition.

4. In a motor, a crank shaft fixed against rotation on a support provided therefor, a pair of adjacent cylinders mounted to revolve about said crank shaft, pistons in said cylinders connected with said crank shaft, a gas passage-way adjacent the heads of said cylinders leading from one cylinder to the other, a piston-controlled intake port in one cylinder and a piston-controlled exhaust port in the other, ignition means, and means for conducting an explosive mixture to said intake port, the axes of said cylinders being in planes substantially perpendicular to the axis of said crank shaft.

5. In a motor, a stationary crank shaft, a pair of adjacent and parallel cylinders mounted to revolve about said crank shaft, pistons operating in said cylinders and connected with said crank shaft, a passage-way between said cylinders adjacent the heads thereof and beyond the range of operation of said pistons, circumferential piston-controlled ports in said cylinders, means for conducting an explosive mixture to one of said ports, ignition means, and means for holding said crank shaft in position, said cylinders being radially disposed.

6. In a two-cycle motor, a stationary crank shaft and means of support therefor, a pair of connected cylinders connected with and adapted to revolve about said crank shaft, pistons in said cylinders connected with said crank shaft by means of connecting-rods pivoted thereto and to said crank shaft, a passage-way between said cylinders whereby gas may flow freely from one cylinder to the other, a piston-controlled intake port in one cylinder and a piston-controlled exhaust port in the other, means for conducting an explosive mixture to said intake port, a spark plug secured in one of said cylinders and means for conducting an electric current thereto, and an exhaust-pipe connected with said exhaust port, said cylinders being approximately radially disposed to the axis of said crank shaft.

7. In a two-cycle motor, a non-rotatable crank shaft and a support rigidly secured to one end thereof, a pair of cylinders connected with and adapted to revolve about said crank shaft, pistons operating in said cylinders and connected with said crank shaft by means of connecting-rods, a crank case mounted on said crank shaft to which said cylinders are connected, power transmission means connected to said crank case, a piston-controlled intake port in one cylinder and a piston-controlled exhaust port in the other, ignition means, means of charge admission to said intake port, and a passage-way between said cylinders more removed from the center of cylinder revolution than said ports, said cylinders being substantially radially arranged.

8. In a two-cycle motor, a crank shaft and a pair of cylinders mounted to revolve thereabout, said cylinders being radially disposed and adjacent to each other, a passage-way connecting said cylinders having continuously solid walls and adapted to revolve therewith, said cylinders and passage-way being air-cooled by their rapid movement through the air, pistons operating in said cylinders connected with and adapted to revolve about crank pins of said crank shaft, a piston-controlled intake port in one cylinder and a piston-controlled exhaust port in the other, said ports being arranged nearer the center of cylinder revolution than said passage-way, ignition means, and means for conducting a charge to said intake port.

9. In a two-cycle motor, a stationary crank shaft rigidly secured to a support provided therefor, a crank-case rotatably mounted on said crank shaft, a pair of cylinders secured to said crank-case and adapted to revolve about said crank shaft, revolving pistons operating in said cylinders and connected with said crank shaft, cylinder heads at the outer ends of said cylinders, a passage-way leading from one cylinder to the other adjacent the heads thereof, a piston-controlled intake port in one cylinder and a piston-controlled exhaust port in the other, means for conducting a combustible charge into said crank-case and thence to said intake port, and a spark plug secured in the cylinder provided with said intake port and means for conducting an electric current thereto, the axes of said cylinders being in planes perpendicular to the axis of said crank shaft.

10. In a two-cycle motor, a stationary support and a crank shaft rigidly secured thereto, a crank-case rotatably mounted on

said crank shaft, a pair of revolving cylinders secured to said crank-case whose axes are in planes perpendicular to the axis of said crank shaft, revolving pistons operating in said cylinders and connected with said crank shaft, a tubular passage-way connecting said cylinders surrounded by atmosphere and having unbroken inner and outer surfaces so that the same may be efficiently and uniformly air-cooled, a piston-controlled intake port in one cylinder and a piston-controlled exhaust port in the other, ignition means, an inlet passage in said crank shaft leading to said crank-case, and a passage-way in said crank-case leading to said intake port, said tubular passage-way being farther removed from the center of cylinder revolution than said intake and exhaust ports.

11. In a two-cycle motor, a crank shaft and means to prevent the same from rotating, a crank-ca... rotatably mounted on said crank shaft, a pair of adjacent revolving cylinders secured to said crank-case whose axes are in planes perpendicular to the axis of said crank shaft, revolving pistons operating in said cylinders and connected with said crank shaft, a passage-way leading from one cylinder to the other, an intake port in one cylinder and an exhaust port in the other, means for opening and closing said ports, means for conducting a combustible charge into said crank-case and thence to said intake port, ignition means, and means for imprisoning said combustible charge in said crank-case prior to the opening of said intake port, said passage-way being more removed from the center of cylinder revolution than said ports which are removed at substantially equal distances therefrom.

12. In a two-cycle motor, a support and a crank shaft having a tubular portion secured thereto, a pair of cylinders mounted to revolve about said crank shaft whose axes of revolution are substantially coincident with the axis of said tubular portion, pistons operating in said cylinders and connected with said crank shaft, a piston-controlled intake port in one cylinder and a piston-controlled exhaust port in the other, a gas passage-way leading from one cylinder to the other located more remote from the center of cylinder revolution than said ports, a sensitive automatic inlet valve pivoted to the inner end of said tubular portion permitting an intermittent flow of a combustible charge therethrough, means for conducting said charge from said tubular portion to said intake port, and ignition means, the axes of said cylinders being in planes perpendicular to the axis of said crank shaft and said tubular portion thereof, and said ports being removed at substantially equal distances from the center of cylinder revolution.

13. In a two-cycle motor, a crank shaft and a pair of cylinders mounted to revolve thereabout, said cylinders being radially disposed and one serving as an intake cylinder and the other as an exhaust cylinder, pistons operating in said cylinders and connected with said crank shaft, a piston-controlled intake port in said intake cylinder and a piston-controlled exhaust port in said exhaust cylinder, a passage-way between said cylinders more removed from the center of cylinder revolution than said ports, means for conducting a combustible charge to said intake port, and an exhaust pipe connected to said exhaust cylinder over said exhaust port, the outer extremity of which is approximately the same distance from the center of cylinder revolution as the heads of said cylinders.

14. In a two-cycle motor, a stationary crank shaft and supporting means therefor, a pair of cylinders mounted to revolve about said crank shaft whose axes lie in planes perpendicular to the axis of said crank shaft, revolving pistons operating in said cylinders and connected with said crank shaft, a piston-controlled intake port in one cylinder and a piston-controlled exhaust port in the other, means for conducting a charge to said intake port, a passage-way leading from one cylinder to the other farther removed from the center of cylinder revolution than said ports, and an exhaust pipe leading from said exhaust port and disposed substantially at right angles to the cylinder provided therewith, so that the exhaust gases will escape in a direction nearly opposite from the direction of revolution of said cylinders when the motor is running in one direction, the axis of said exhaust pipe being in a plane substantially perpendicular to the axis of said crank shaft.

15. In a two-cycle motor, a crank shaft and a crank-case rotatably mounted thereon, a stationary support arranged adjacent one side of said crank-case to which one end of said crank shaft is rigidly secured, a bearing support arranged adjacent the other side of said crank-case and a journal formed on said crank-case mounted therein, power transmission means secured to the outer end of said journal, packing means arranged adjacent the inner side of said stationary support and surrounding said crank shaft, a pair of revolving cylinders secured to said crank-case whose axes lie in planes perpendicular to the axis of said crank shaft, revolving pistons operating in said cylinders and connected with said crank shaft, a piston-controlled intake port in one cylinder and a piston-controlled exhaust port in the other, a passage-way leading from one cylinder to the other more removed from the center of cylinder revolution than said ports, means for conducting a charge to said intake port, and

means for conducting away the exhaust from said exhaust port.

16. In a two-cycle motor, a crank shaft and a crank-case rotatably mounted thereon, a stationary support arranged adjacent one side of said crank-case to which one end of said crank shaft is rigidly secured, a bearing support arranged adjacent the other side of said crank-case and a journal formed on said crank-case mounted therein, the other end of said crank shaft terminating within said crank-case, a tubular portion in said crank shaft connected with a carbureter and leading into said crank-case, an automatic inlet valve pivoted to said crank shaft and adapted to control the admission of an explosive mixture through said tubular portion, a pair of cylinders secured to said crank-case whose axes lie in planes perpendicular to the axis of said crank shaft, pistons operating in said cylinders and connected with said crank shaft, a piston-controlled intake port in one cylinder and a piston-controlled exhaust port in the other, a passage-way leading from one cylinder to the other farther removed from the center of cylinder revolution than said ports, a cylinder extension secured in said crank-case, and a substantially annular transfer gas passage-way surrounding said cylinder extension and leading to said intake port.

17. In a two-cycle motor, a crank shaft, a pair of cylinders mounted to revolve about said crank shaft with their axes in planes perpendicular to the axis of said crank shaft, pistons in said cylinders traveling synchronously, said cylinders being in open communication with each other at their outer ends beyond the range of travel of said pistons, charge admission means in one cylinder, a piston-controlled exhaust port in the other, and ignition means.

18. In a two-cycle motor, a stationary crank shaft, a pair of adjacent and parallel cylinders mounted to revolve about said crank shaft, pistons having piston rings operating in said cylinders and connected with said crank shaft, a passage-way between said cylinders adjacent the heads thereof and beyond the range of operation of said pistons, a circumferential port in each cylinder, means for conducting an explosive mixture to one of said ports, said cylinders being radially disposed, and beveled edges on the heads of said pistons extending to the first rings thereof, said ports being positively controlled by the latter, and said rings being wider than their respective ports.

19. In a two-cycle motor, a crank shaft 1 secured to the support 2, a crank-case 3 rotatably mounted on said crank shaft, cylinders 4 and 5 connected by a passage-way at the outer ends thereof secured to each end of said crank-case by means of the screw 6, the axes of said cylinders lying in planes perpendicular to the axis of said crank shaft, pistons 7 and 8 operating in the cylinders 4 and 5 respectively and connected with said crank shaft by means of the symmetrically arranged and balanced connecting-rods 17, the cylinders 4 being in axial alinement and the cylinders 5 being in axial alinement, a bearing support 21 in which said crank-case is mounted, spark plugs 41 secured in one side of the cylinders 4, a spark advancing and retarding lever 42 adapted to contact electrically with said plugs and secured in the insulating hub 45 which is rotatably mounted on the tube 47, the latter being pressed into a tubular portion provided in said crank shaft, an inlet valve 14 pivoted to the inner end of said tubular portion, cylinder extensions 11 secured in said crank-case and surrounded by the substantially annular transfer gas passages 12, circumferential intake ports 33 leading from the passages 12 into the cylinders 4, and circumferential piston-controlled exhaust ports 10 in the cylinders 5, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM COBB SMITH.

Witnesses:

R. C. BRETCHER.

FREDK. J. LARSON.