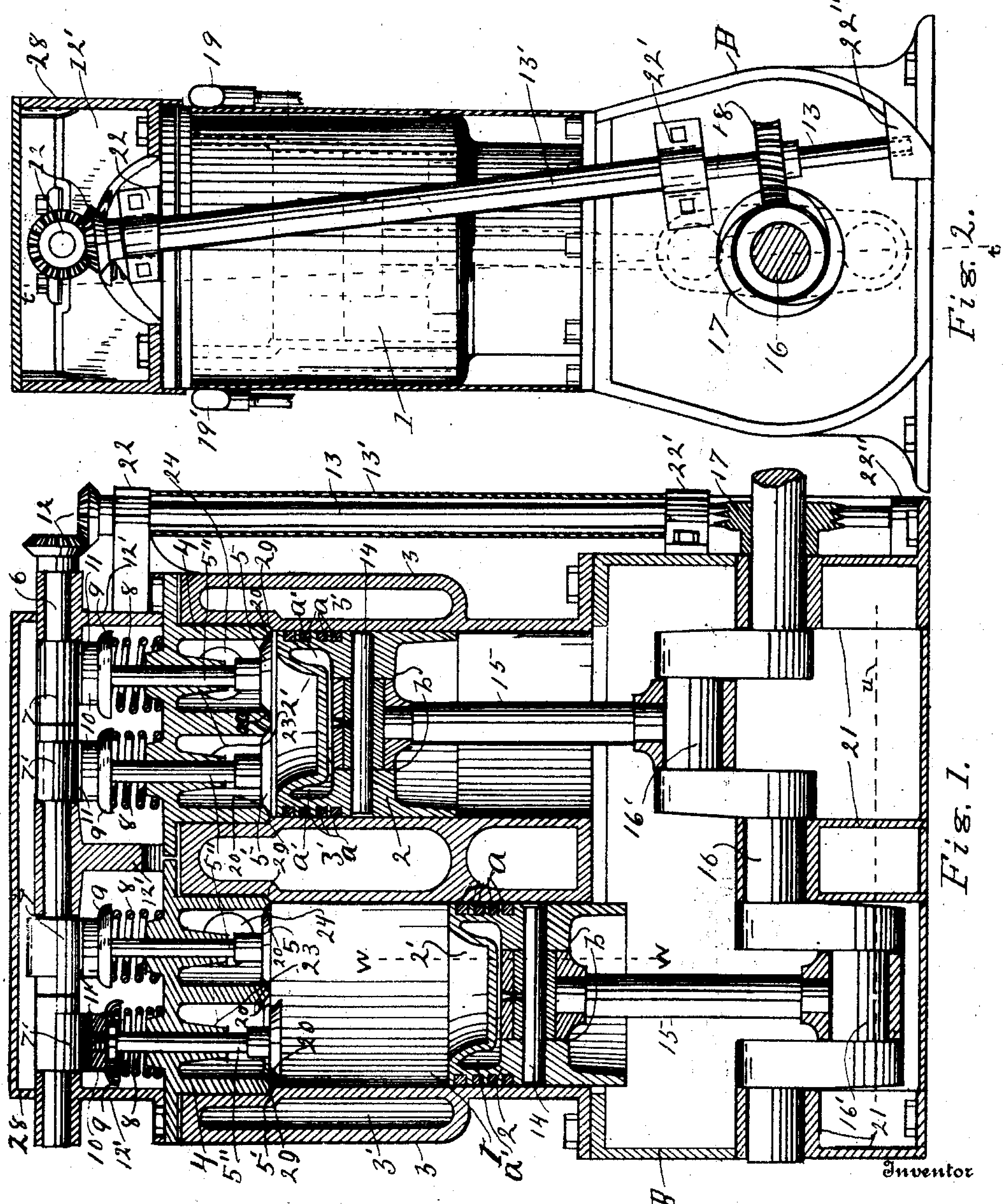
A. J. MILLER.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED APR. 27, 1908.

905,733. Patented Dec. 1, 1908.

3 SHEETS—SHEET 1.



Witnesses

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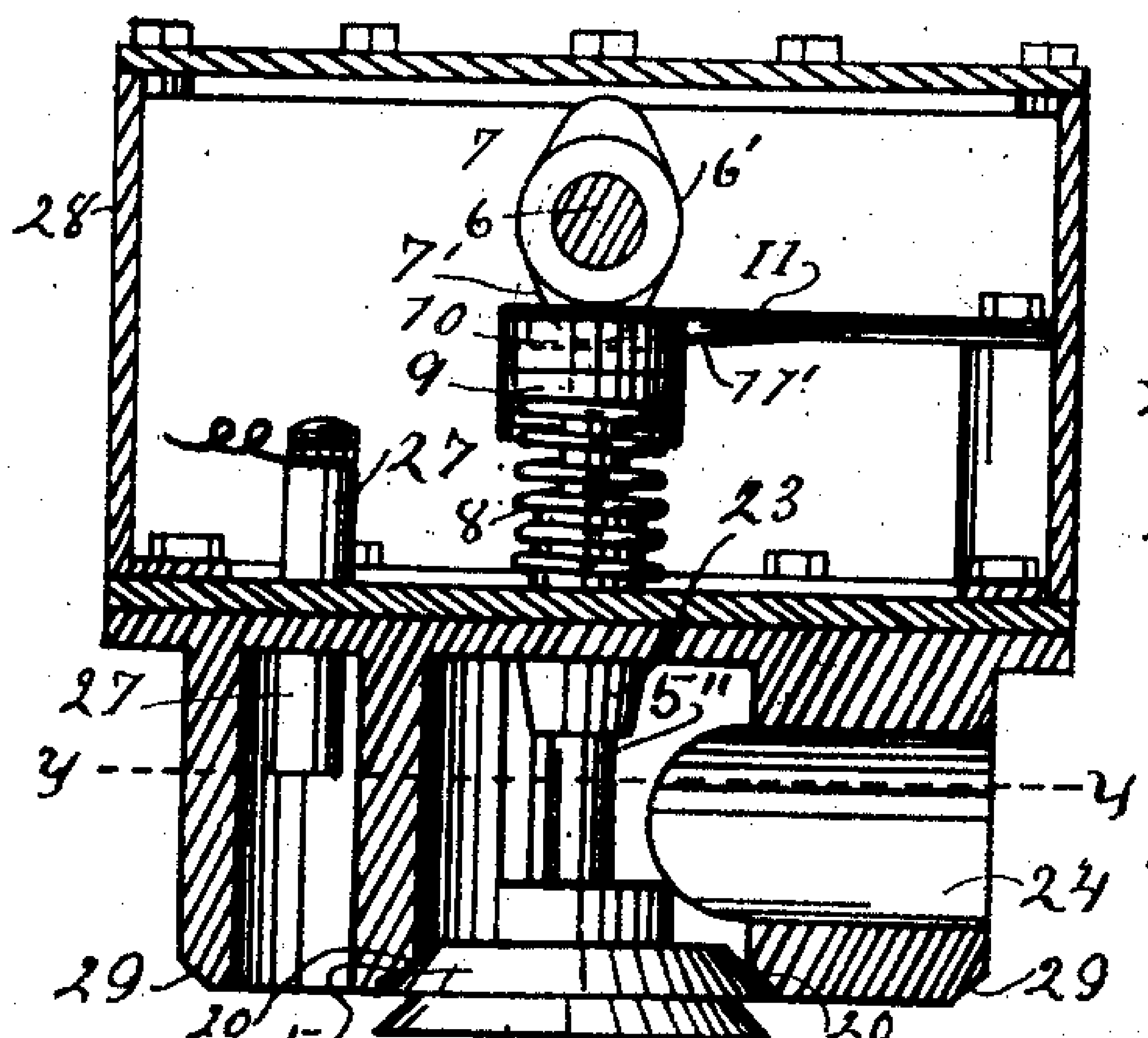


Fig. 3.

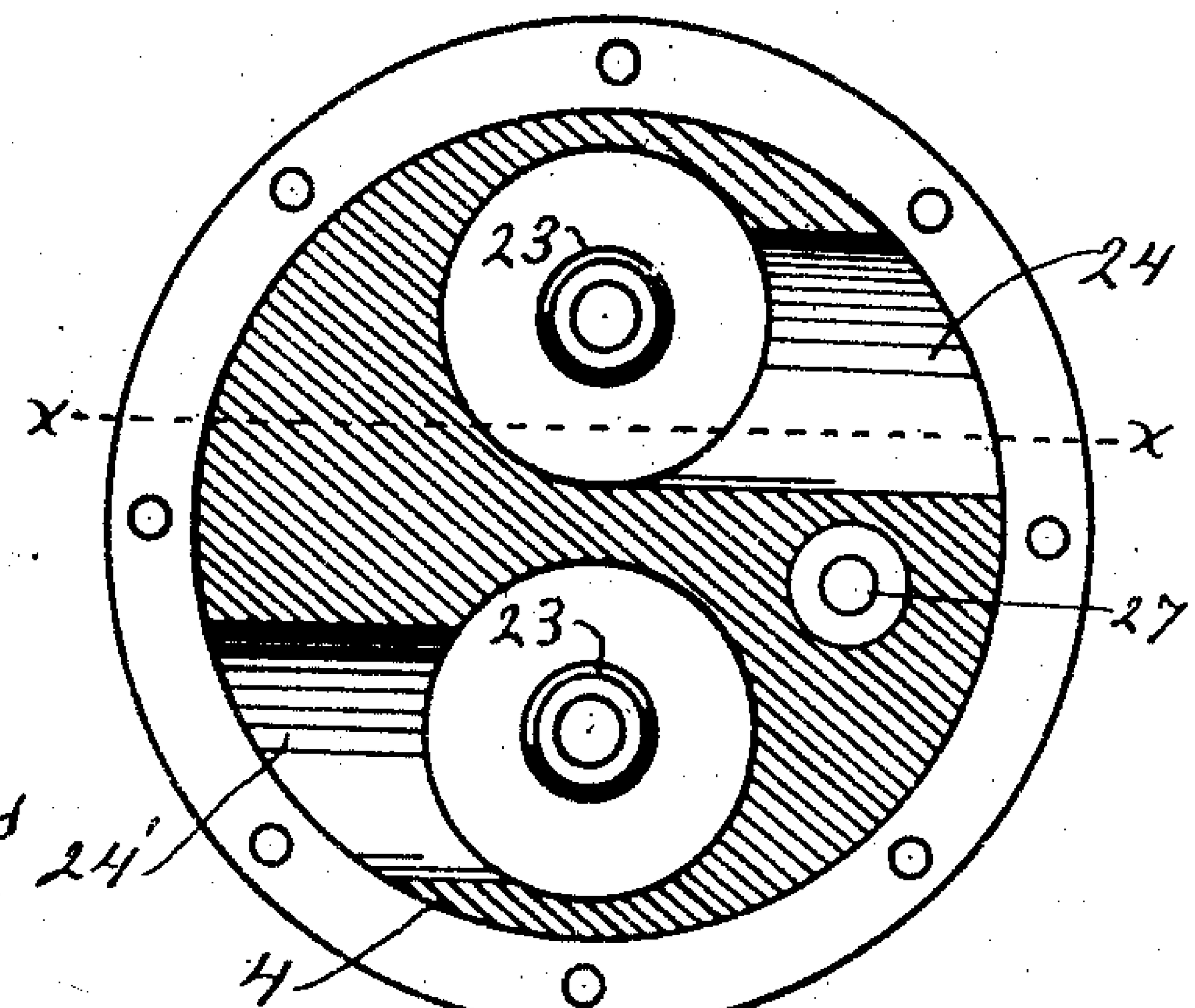
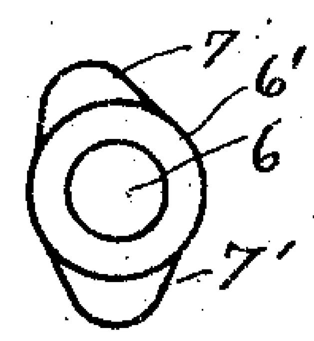


Fig. 4.

Fig. 5.


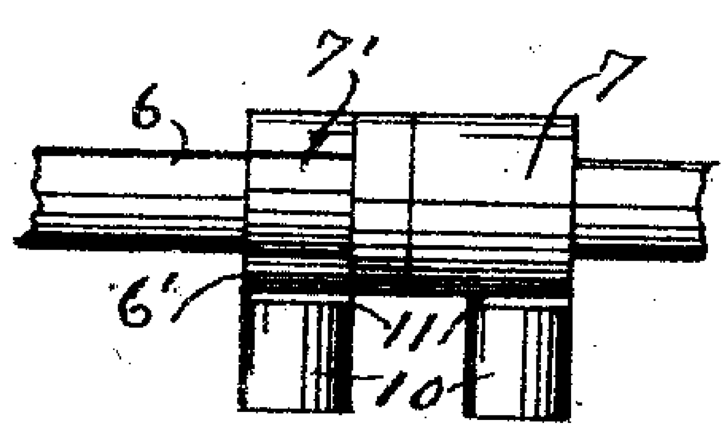


Fig. 6.

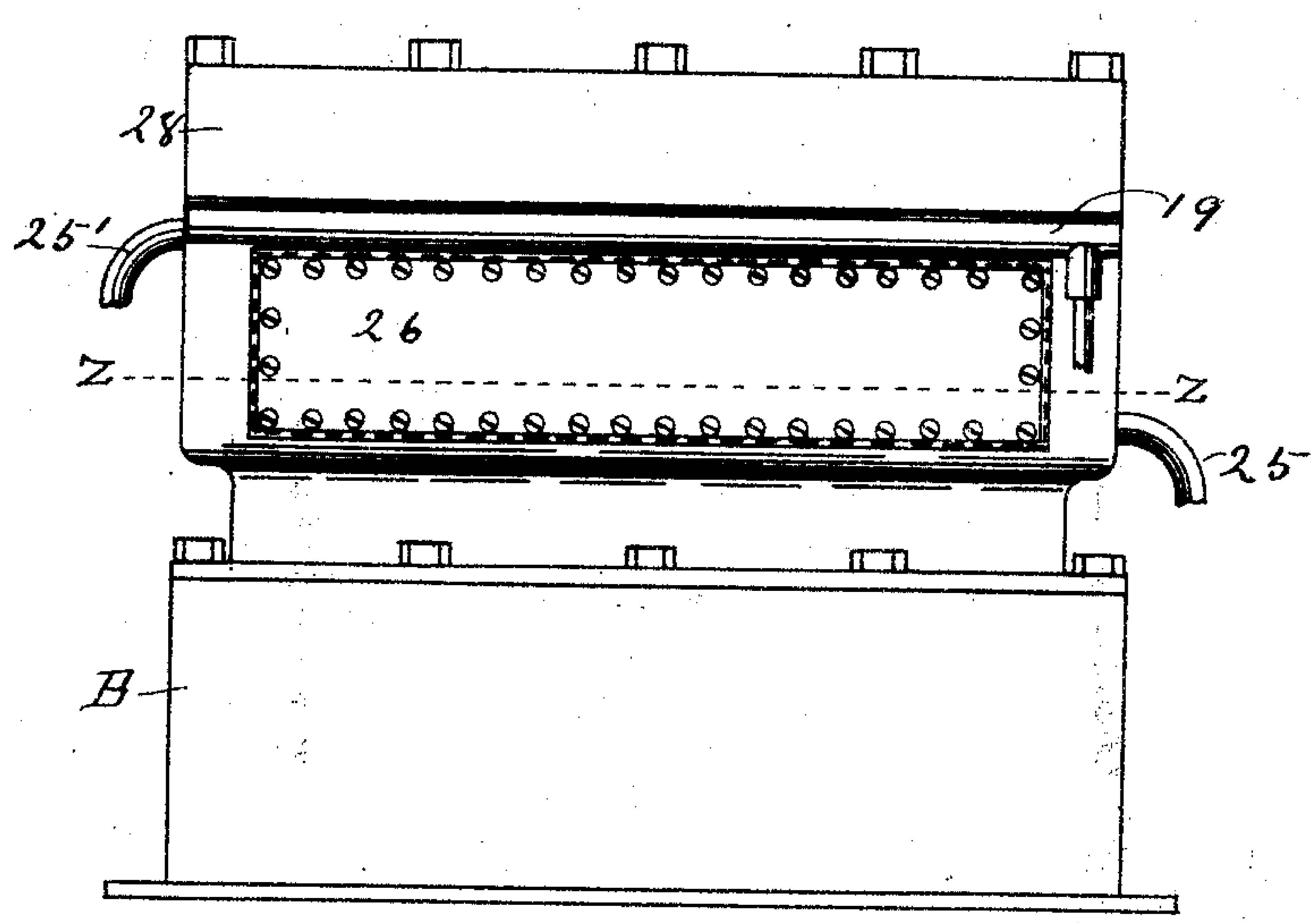


Fig. 7.

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3 SHEETS—SHEET 3.

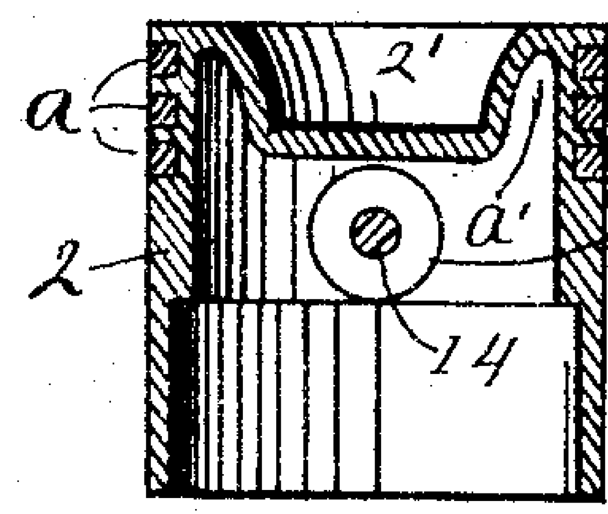

Fig. 8.

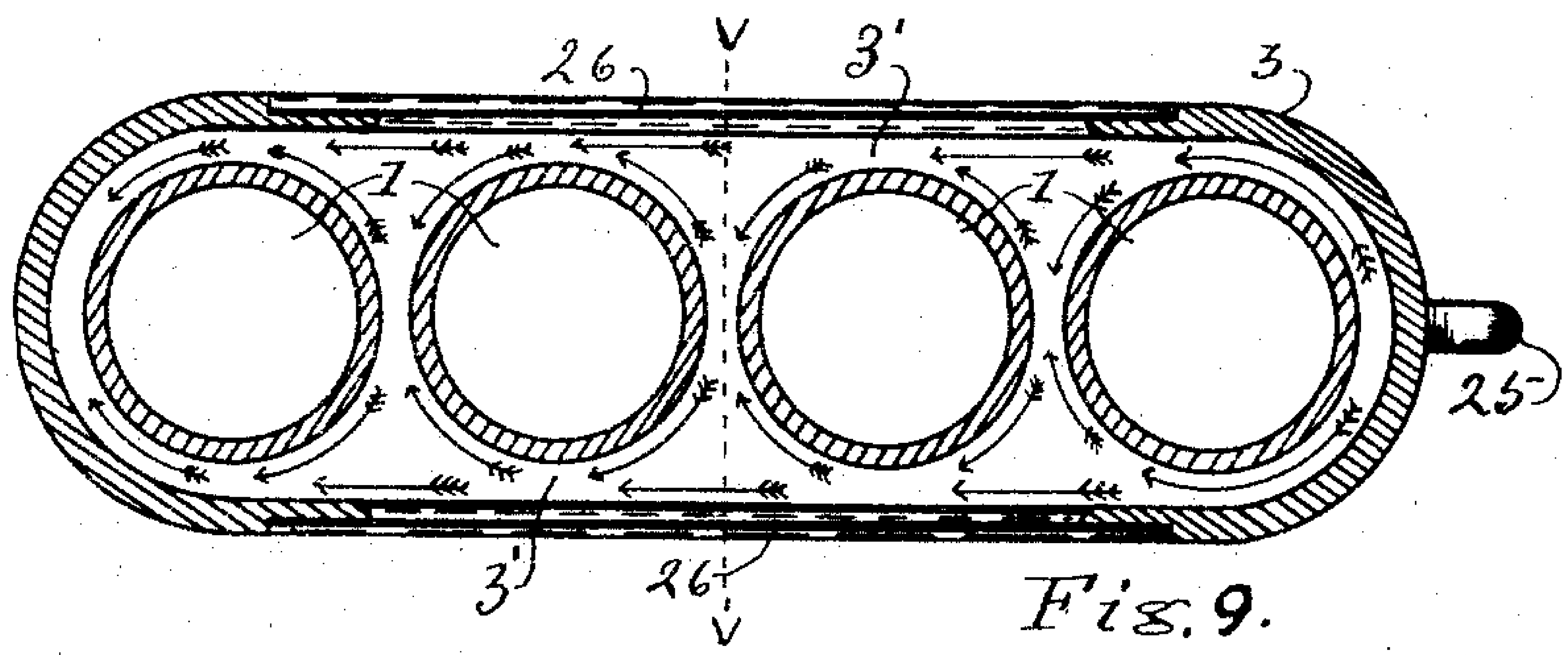

Fig. 9.

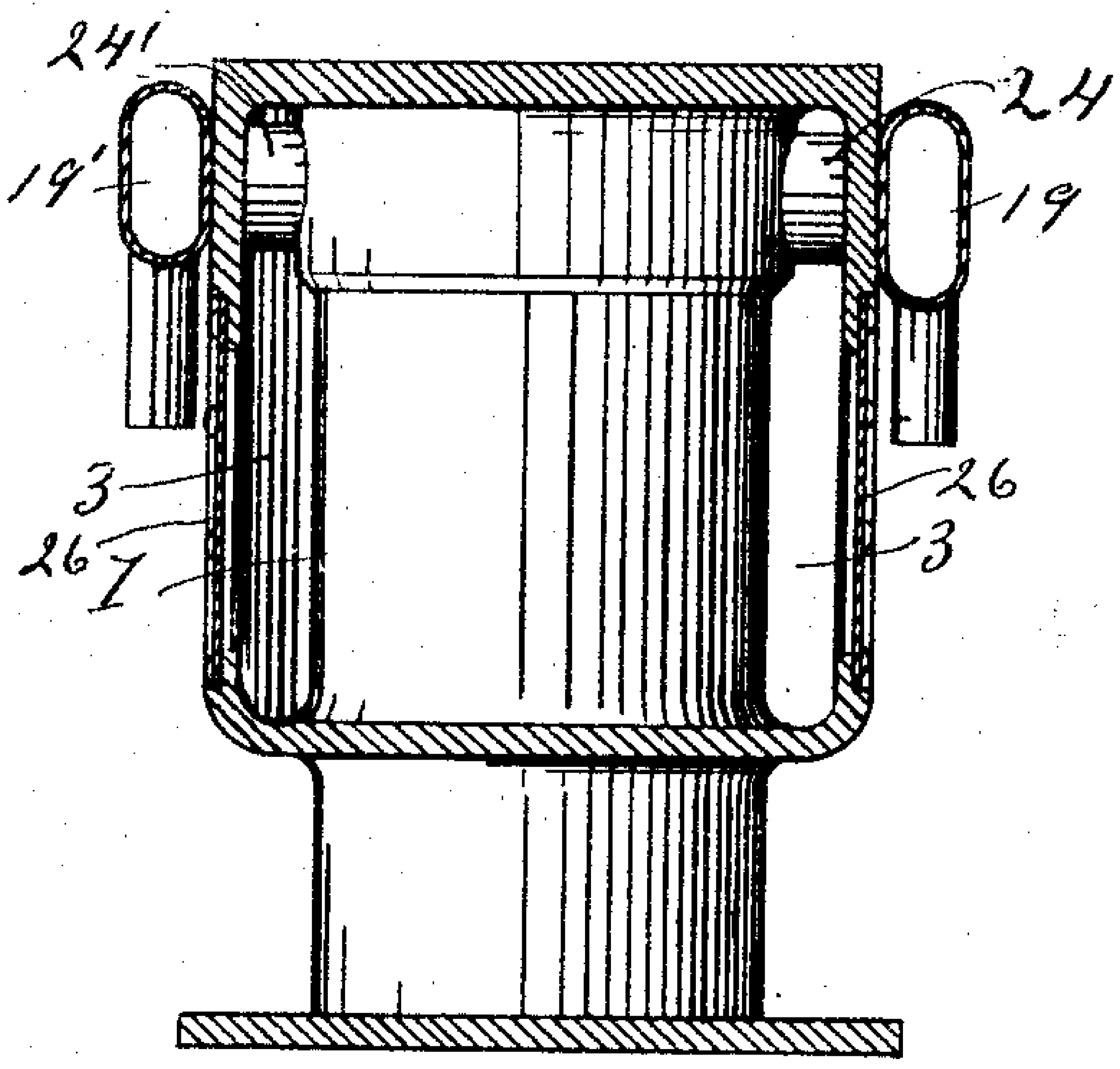

Fig. 10.

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UNITED STATES PATENT OFFICE.

ARTHUR J. MILLER, OF GRAND RAPIDS, MICHIGAN.

INTERNAL-COMBUSTION ENGINE.

No. 905,733. **Specification of Letters Patent.** **Patented Dec. 1, 1908.**

Application filed April 27, 1908. Serial No. 429,566.

To all whom it may concern:

Be it known that I, ARTHUR J. MILLER, a citizen of the United States, residing at Grand Rapids, in the county of Kent and State of Michigan, have invented certain new and useful Improvements in Engines, of which the following is a specification.

My invention relates to improvement in internal combustion engines, and its objects are: First, to provide a valve mechanism to this class of engines with which the valves are actuated by means of cams acting directly at the ends of the valve stems, and without danger of pressing the stem sidewise to cause it to become cramped in its bearing. Second, to so construct the valve mechanism in the cylinder head that the removal of the cylinder head will remove all of the valve connections and will leave the end of the cylinder open so that the piston may be removed directly through the end of the cylinder without the necessity of removing the cylinder from its base. Third, to so construct the piston and valve mechanism that the piston may travel to close proximity with the valves and thus avert the necessity of heating a long distance of the upper end of the cylinder above the travel of the piston and causing it to expand much more at the upper end than it does at the center and lower end. Fourth, to so construct the piston that the oil that is stored in the bottom of the base will be thrown into the interior of the piston and act as an oil cooler therefor. Fifth, to provide a means whereby the several cylinders of a multi-cylinder engine, together with a water jacket arranged to allow of a free flow of water entirely around each and every cylinder, may be cast in a single piece, and at the same time enable me to so construct the water jacket that it cannot be broken by the transformation of water into ice inside the water jacket. I attain these objects by the mechanism illustrated in the accompanying drawing, in which:

Figure 1 is a sectional elevation of the engine on the line *t t* of Fig. 2. Fig. 2 is an end elevation of the same shown partly in section. Fig. 3 is a section of the cylinder head and valve cup practically on the line *x x* of Fig. 4. Fig. 4 is a transverse section of the cylinder head on the line *y y* of Fig. 3. Fig. 5 is an end view of the valve actuating cams. Fig. 6 is a side view of the same in position so that both valves will be held in the same position, closed. Fig. 7 is a side elevation of a multiple cylinder engine showing the frost protecting plate in place. Fig. 8 is a vertical section of the piston on the line *w w* of Fig. 1. Fig. 9 is a sectional view of the multi-cylinder engine on the line *z z* of Fig. 7 showing the circulation of water between the water jacket and the cylinders and, also, the position of the frost protection plates, and Fig. 10 is a sectional view of the same on the line *v v* of Fig. 9.

Similar letters and numerals refer to similar parts throughout the several views.

These engines are constructed, preferably, upon the four cycle principle and I will proceed to describe the engine wholly upon this theory.

1 represents the cylinders and 2 represents the pistons that reciprocate in the cylinders. These pistons are made cup shaped in the upper surface, as indicated at 2′, for the purpose of allowing sufficient space between the lower surfaces of the valves 5 and 5′ for the reception of sufficient gas from back of the valves 5 to expand, when ignited, sufficiently to give full, strong impetus to the piston, and the piston is made hollow from below, as shown at *a*′, to make plenty of room around the lugs *b* and the upper end of the connecting rod 15 so that oil taken up by the cranks 16′ will be thrown into the piston far enough, not only to insure perfect lubrication of the bearing of the upper end of the connecting rod 15 on the pin 14, but to thoroughly spray the entire inner surface of the piston and thus act as a cooling element for the piston. With these engines it is designed to keep the base B filled with oil as high up as the dotted line *u*, so that the cranks 16′ and the lower ends of the connecting rods 15 will strike into, and spatter the oil sufficiently to spatter the oil in a fine spray filling the entire base and the lower ends of the cylinders completely and constantly when the engines are running.

With a four cycle engine the shaft 16 must make two complete revolutions, giving each piston four complete strokes for each explosion of gas. To time the reception or inflow of gas, and the exhaust, properly, the valve 5 should be forced open, or away from its seat 20, during the last half of the first down stroke of the piston so that the balance of the stroke will form sufficient of vacuum in the cylinder to draw the gas forcibly through the supply pipe 19 and the port 24 into the cylinder, and the valve should close as the piston approaches the end of this stroke so that the upward stroke of the piston will compress the gas fully before ignition takes place, and the spark plug 27 should be so timed that a spark will be induced in the cylinder as the piston starts on its second downward stroke so that the explosion of gas will take place at the exact proper time to exercise the greatest possible exertion upon the piston, and as the piston approaches the end of its second downward stroke the exhaust valve 5′ should be forced open for the free escape of the burned gas, and held open until the piston reaches very near the end of its second upward stroke, when it should close and the valve 5 should again open upon the succeeding down stroke, as before, which action is repeated alternately so long as gas is supplied to the cylinder and properly ignited.

To properly actuate the valves 5 and 5′, as hereinbefore set forth, I place an actuating shaft 6 in the bearings 12′ within the case 28, and place cams 7 and 7′ thereon in such positions that as the shaft 6 revolves the cam 7 will actuate the valve 5 and the cam 7′ will actuate the valve 5′ to force them downward at the proper times, as hereinbefore described, the connections being as follows: The valves are provided with valve stems 5″ that pass up through the long bearings 23, in the valve cups, to a position just below the hub 6′ of the cams and are held to position by the springs 8, or other suitable resilient support. When the spiral spring 8 is used I secure a cap 9 upon the upper end of the stem 5″ for the spring to press against, so that the valves will be held firmly upon their seats by the springs. To avert the danger of springing the valve stems I secure one end of flat springs 11 to the case 28, as indicated in Fig. 3, with the free ends of said springs between the tops of the valve stems 5″ and the cams 7 7′ so that as the cams come in contact with the upper surfaces of the springs 11 or 11′ they will slide along on the surfaces of the springs and force them down upon the valve stems against the tension of the springs 8 to force the valves directly down without danger of pressing them sidewise, as would be the case if the cams came in direct contact with the ends of the valve stems. I have provided to insure a smooth, noiseless action at these points, first, by so placing the springs 11 11′ that they will press firmly against the cams 7 7′ or their hubs 6′, and, second, by placing a wood fiber cap 10, or other insulating cap, upon the upper ends of the valve stems, as indicated in Figs. 1, 3 and 6, so arranged that they will be in constant contact with the springs 11 11′ so that no jar or sudden motion can take place between the cams and the valve stems.

The valve casings are formed in the downward extending body 4 of the cylinder heads and are provided with an intake port 24 that leads from the supply pipe 19, and an exhaust port 24′ that leads to the exhaust pipe 19′, and the cylinder heads are firmly bolted to the ends of the cylinders in such a way that the lower ends will form a gas tight joint with a shoulder in the cylinders, as indicated at 29 in Fig. 1, before the flange at the upper end of the cylinder head comes in contact with the cylinder.

I provide for transmitting motion to, and properly timing the revolutions of the shaft 6 through the medium of the bevel gearing 12, the shaft 13 and the worm gears 17, 18, the latter being made of a proper relative size and pitch of teeth so that the shaft 16 will make exactly two revolutions while the shafts 13 and 6 are making one revolution, which, with the cams 7—7′ properly set upon the shaft 6, will insure the exact proper timing of the movement of the valves 5 and 5′.

It will be readily understood that with the depression 2′ in the upper surface of the piston 2 I am enabled to use a much longer piston, a shorter cylinder, and to bring the upward movement of the piston much nearer the lower surfaces of the valves 5 5′ than I could with a piston formed with a plain upper surface, thus economizing in several ways in the construction and operation of the engines.

In Figs. 1 and 8 I have shown expansion, or packing rings *a* placed in the peripheral surface of the pistons, and in Fig. 1 I have, also, shown pillar blocks 21 for carrying the main shaft 16.

The cold water circulation in this engine is arranged as follows: Water is presumed to flow into the water jacket through the pipe 25, and to flow out through the pipe 25′ and to pass through the water chamber practically as indicated by the arrows in Fig. 9, the water channel 3′ being an open space entirely surrounding each and every cylinder 1 in the engine, as shown in Fig. 9, and is within the jacket or casing 3 which, as indicated in Figs. 1 and 10, is cast integral with the cylinders at the top and bottom. To cast this water jacket and several cylinders in one piece requires the use of a very peculiarly formed core, and to provide for the placing and proper anchorage of this core I have left a broad and long opening through each side of the jacket, as shown in Figs. 7, 9 and 10, and I utilize these openings to form an easily displaced wall in the jacket by securing a thin piece of copper plate 26 in each of the openings in such a manner that if water is left in the channel 3′ in freezing weather the expansion of the water when just at the point of freezing will press the copper plates outward between the screws or other securing elements, so that the water will leak out before it instead of breaking the cast iron case 3, thus utilizing these openings for two vitally important purposes in the construction and operation of these engines, and providing the only means whereby it would be possible to cast the cylinders and the jacket integral.

The tube 13′, shown in Figs. 1 and 2, as surrounding the shaft 13, though not a necessary element in the construction or operation of this engine is a very convenient adjunct thereto, first, to protect the shaft 13 if the engines are so constructed that said shaft would, otherwise, be exposed, and, second, it may be made to act as a conducting pipe to carry dripping oil from the bearing 22 to the bearing 22′, said shaft being supported in these and the step bearing 22″ as shown in Figs. 1 and 2.

With an engine constructed as hereinbefore described, and as shown in the drawings, when the cylinder head 4 is removed it not only carries with it the entire valve and sparker mechanism of the engine, but it opens up the top of the engine cylinder so that perfect access may be had to the piston, and, if desired, the piston may be readily removed through said opening without the necessity of removing the cylinders from the base, and with the copper panels in the walls of the water jacket it is a simple matter to open the sides of the jacket and remove scale or dirt from the interior of the water jacket.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an internal combustion engine, cylinders having the internal diameter larger at the upper end than at working part of the cylinders with an inclined shoulder in each between the large and the small portions, a cylinder head having a rim and a body extending downward from the rim with a bearing formed thereon to engage the shoulder in the cylinders, and having cupped openings for the ingress and egress of gas and the seating of inlet and exhaust valves, valves, springs for holding the valves to position, cams for pressing the valves directly downward, valve stems on the valves and springs between the cams and the upper ends of the valve stems.

2. In an internal combustion engine, a cylinder having the upper internal diameter larger than the working portion and an inclined shoulder between the two portions, a head having a long depending body fitted to form a gas tight joint upon the shoulder, and having cups drilled in and ports formed thereto, valves seated in said cups, valve stems projecting through the heads, springs for holding the valves to position, a cap upon the valve stem, an insulating cap above the first named cap, cams directly above the valve stems, a spring between each cam and its corresponding valve stem, and shafting and gears for actuating the cams and valves, as shown and described.

3. In an internal combustion engine, cylinders having the upper end large and a shoulder well down in the cylinder, a head having a body extending down to form a gas tight joint on the shoulder and having cups drilled in for valve seats and ports for the ingress and egress of gas, valves and valve stems mounted in said heads and actuated by cams and springs, spring plates secured at one end to the cylinder head with the free ends between the cams and the ends of the valve stems to avert sidewise strain upon the valve stems, pistons working in the lower portions of the cylinders and having their upper surfaces depressed, and a sparker post in the cylinder head.

Signed at Grand Rapids Michigan April 24, 1908.

ARTHUR J. MILLER.

In presence of—
I. J. CILLEY,
A. ALLGIER.