

No. 842,985.

PATENTED FEB. 5, 1907.

W. A. WEBSTER.
COMPOUND ENGINE.

APPLICATION FILED DEC. 9, 1904.

2 SHEETS—SHEET 1.

Fig. 1.

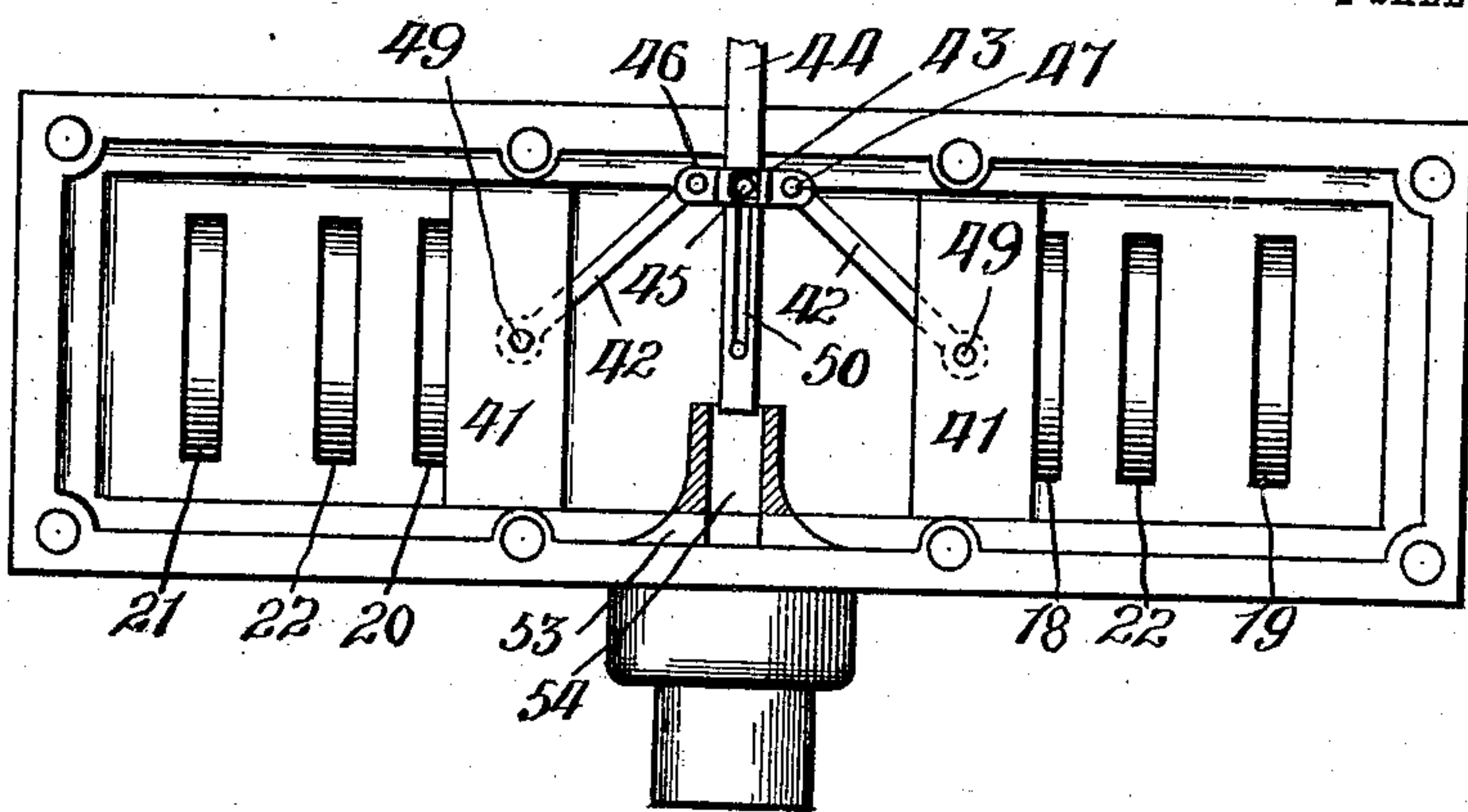


Fig. 2.

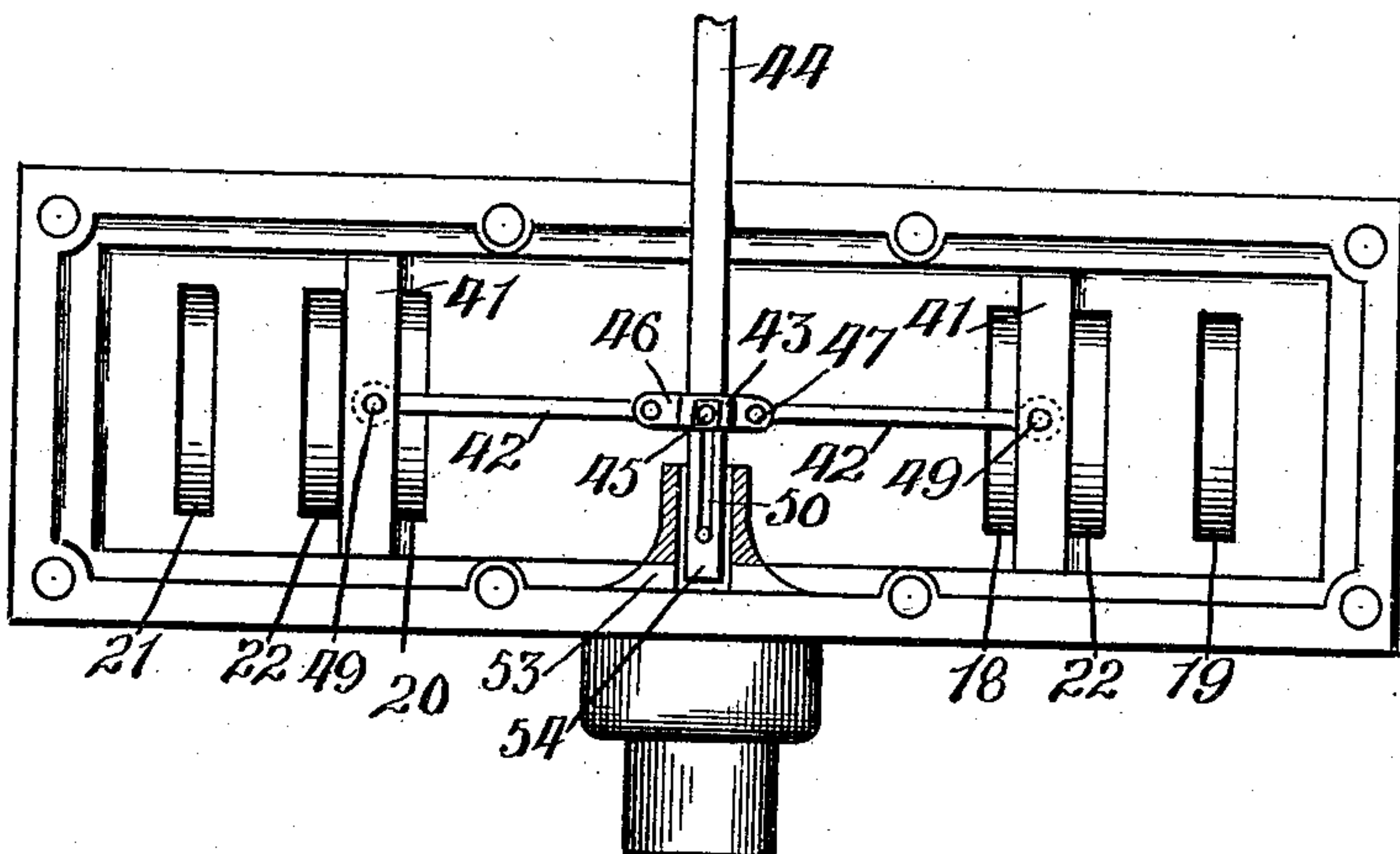
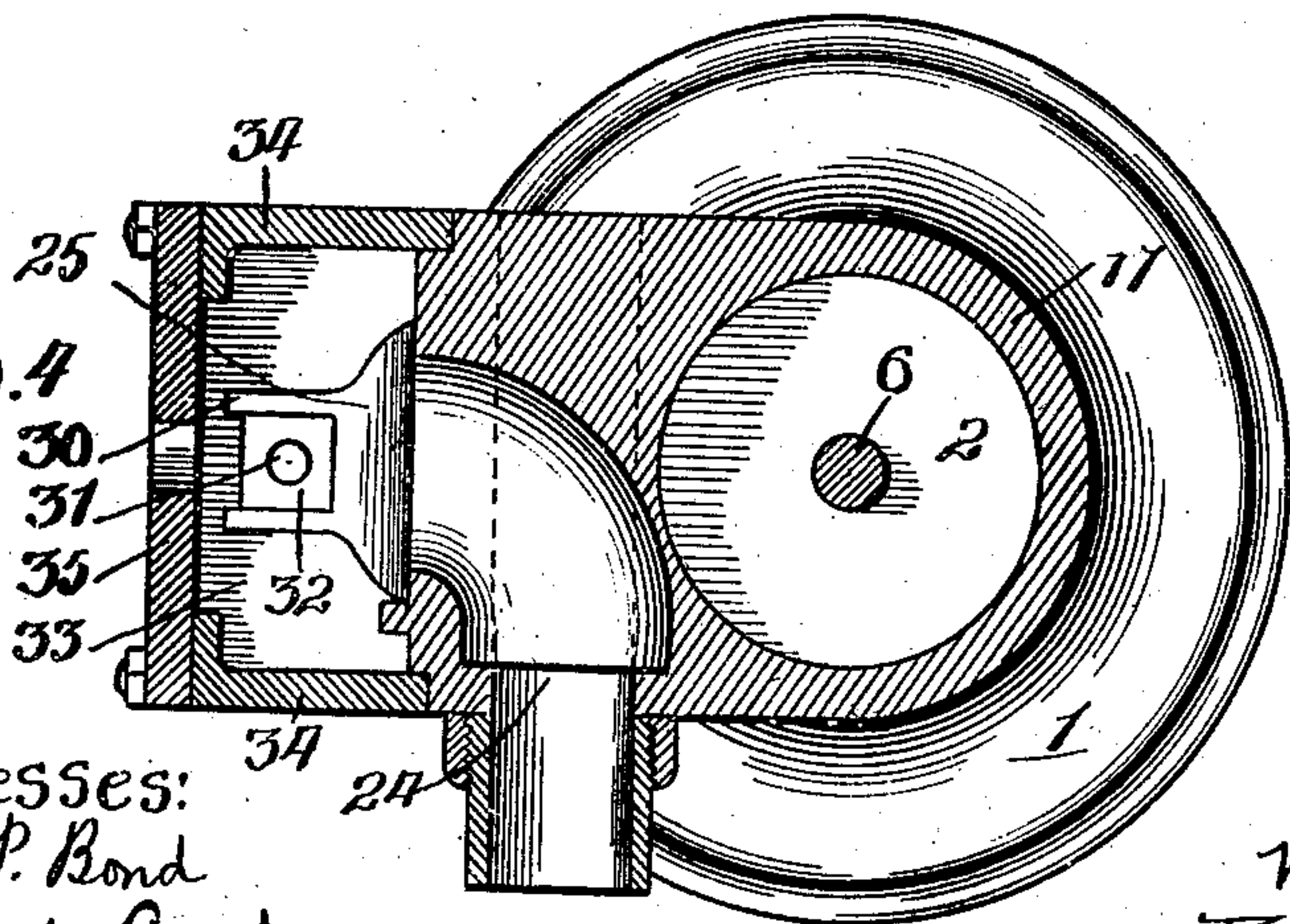
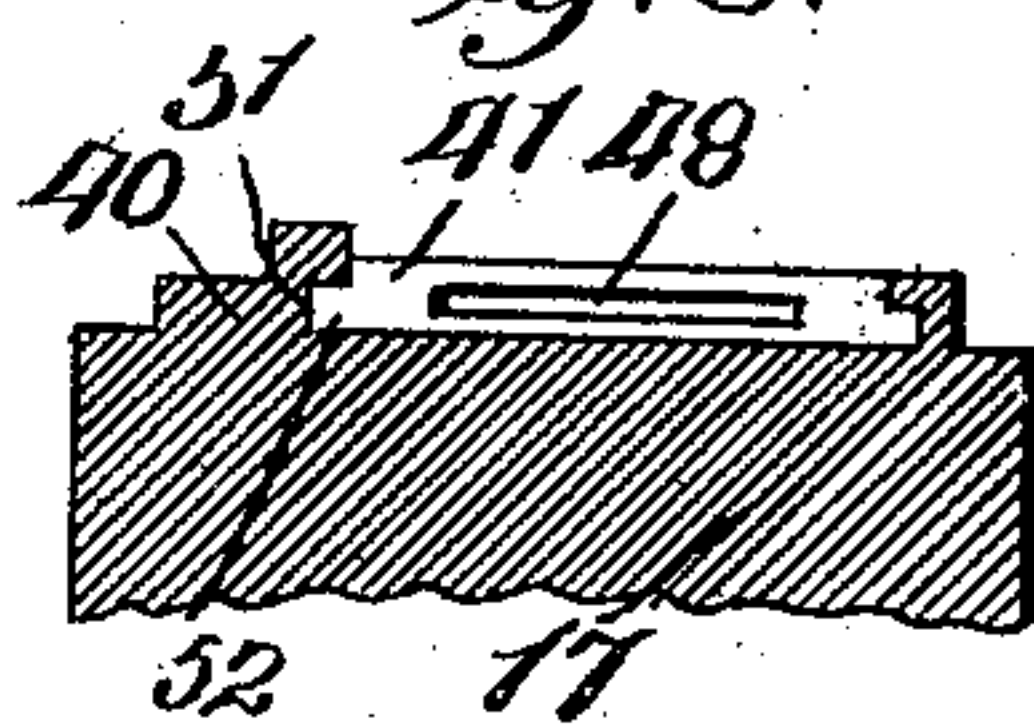


Fig. 4.



Witnesses:
Wm. P. Bond
Oscar W. Bond

Fig. 3.



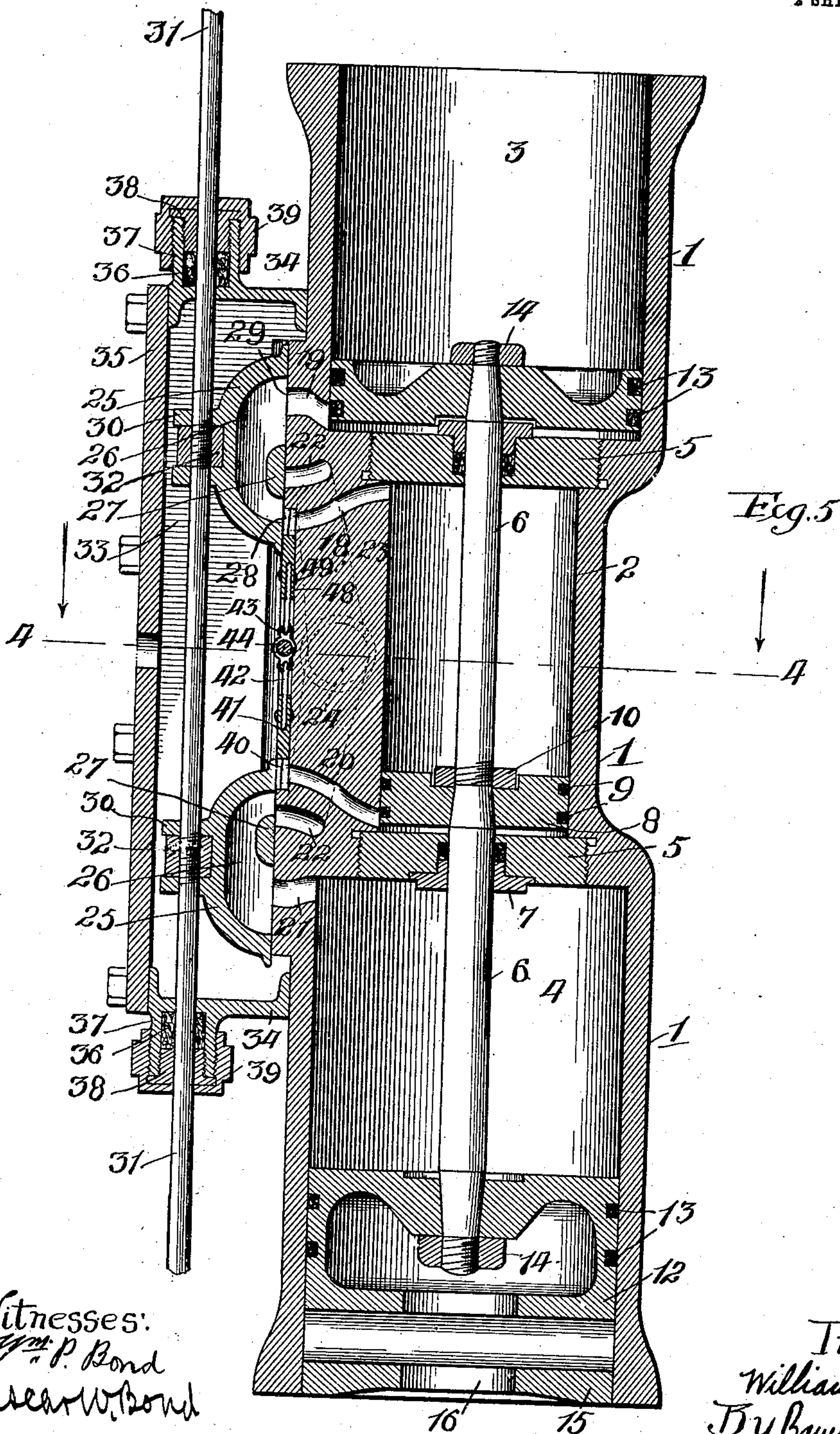
Inventor:
William A. Webster
By Banning Banning
Attys:

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2 SHEETS—SHEET 2.



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Oscar W. Bond

Inventor
William A. Webster
By Banning Banning
Attys.

UNITED STATES PATENT OFFICE.

WILLIAM A. WEBSTER, OF MONMOUTH, ILLINOIS.

COMPOUND ENGINE.

No. 842,985.

Specification of Letters Patent.

Patented Feb. 5, 1907.

Application filed December 9, 1904. Serial No. 236,232.

To all whom it may concern:

Be it known that I, WILLIAM A. WEBSTER, a citizen of the United States, residing at Monmouth, in the county of Warren and State of Illinois, have invented certain new and useful Improvements in Compound Engines, of which the following is a specification.

This invention relates to what are known or termed "compound" engines, or engines having a simple or primary cylinder and a compound or secondary cylinder so arranged as to have the pressure transmitted from the simple or primary cylinder to the compound or secondary cylinder for operating pistons or heads in said cylinder.

The objects of the present invention are to simplify and improve the construction and arrangement of the simple or primary cylinder and the secondary or compound cylinder in their relation to each other; to arrange the cylinders tandem with the simple or primary cylinder interposed between the compound or secondary cylinders, thereby enabling the fluid-pressure to operate in both directions of travel of the piston or follow-head in the simple or primary cylinder; to furnish approximately a direct lead for the pressure from the simple or primary cylinder into each compound or secondary cylinder, thereby giving increased effect to the pressure in the compound or secondary cylinder; to furnish a slide-valve controlling the passages between the simple or primary cylinder and the compound or secondary cylinder, which valve is practically a balanced-slide-valve; to connect the cylinders with a common exhaust controlled by the slide-valve; to arrange three pistons or follow-heads in tandem by which power will be derived from the travel of the piston of the simple or primary cylinder in both directions; to furnish a cut-off or throttle for the passage supplying steam or other fluid-pressure to the simple or primary cylinder, and to improve generally the construction and arrangement of the several elements entering into the engine as a whole.

In the drawings, Figure 1 is a face or side view of the steam-chest or fluid-pressure chamber, showing the passages leading to the simple or primary and the compound or secondary cylinders, and showing also the slide or cut-offs for throttling the admission of the steam or fluid pressure to the simple or primary cylinder; Fig. 2, a similar view to Fig. 1, showing a modification in the arrangement of

the slides or cut-off plates; Fig. 3, a detail in cross-section showing the manner of holding the slides or cut-off plates in position; Fig. 4, a central cross-section on line 4 of Fig. 5, and Fig. 5 a sectional plan of the engine.

The engine has a main casing or shell 1, formed of a single casting, and having a chamber or cylinder 2 located at the center longitudinally of the shell or casing, and having at one end of the cylinder or chamber 2 a cylinder or chamber 3, and having at the other end of the cylinder or chamber 2 a cylinder or chamber 4, both of which are of greater diameter than the diameter of the cylinder or chamber 2, as shown in Fig. 5. The cylinder or chamber 2 is the simple or primary cylinder, and the cylinders or chambers 3 and 4 are the compound or secondary cylinders of the engine, and the cylinders or chambers 3 and 4 are separated from the cylinder or chamber 2 by a head 5, which, as shown, is screw-threaded into the wall of the main shell or casing. A piston-rod 6 passes through suitable stuffing-boxes 7 in the heads 5, and this piston-rod has fixed thereon, within the cylinder or chamber 2, a piston or follow-head 8, having in its periphery suitable packing-rings 9 and held in position on the piston-rod by a lock or jam nut 10, which operates to force the piston tightly onto a tapered shoulder on the piston-rod. The end of the piston-rod in the cylinder or chamber 3 has fixed thereto a piston or follow-head 11, and the end of the piston-rod in the cylinder or chamber 4 has fixed thereon a piston or follow-head 12, both pistons and or follow-heads 11 and 12 having in their peripheral faces packing-rings 13, and both pistons or follow-heads 11 and 12 held on the respective ends of the piston-rod 6 by lock or jam nuts 14, which force the pistons tightly onto a tapered shoulder of the piston-rod in the construction shown; but the several pistons 8, 11, and 12 can be secured to the piston-rod 6 in any suitable and well-known manner. The piston or follow-head 12 has an extension 15, in which is mounted the crank-pin for a crank-rod, which rod is not shown, but can be of any usual and well-known form of construction adapted for attachment to a crank-shaft.

The wall of the main shell or casing 1 on one side is thickened, forming a wall 17, extending the length of the cylinder or chamber 2, in which wall is located the lead-pas-

sages for the simple or primary cylinder or chamber 2 and the exhaust-passages and on the outer face of which wall is located and operates the slide-valve controlling the steam or pressure passages for the three cylinders or chambers. The simple or primary cylinder or chamber 2 has leading thereinto at one end adjacent to the head 5 a passage 18, and the cylinder or chamber 3 has leading thereinto adjacent to the head 5 a passage 19, which passages 18 and 19 supply steam or fluid pressure to the simple or primary cylinder or chamber 2 and from the simple or primary chamber 2 to the compound or secondary cylinder 3 when the pistons of these cylinders are at the limit of their proper stroke. The simple or primary cylinder or chamber 2 has leading thereinto at the opposite end a passage 20 adjacent to the head 5, and the cylinder or chamber 4 has leading thereinto a passage 21 adjacent to the head 5, which passages 20 and 21 supply steam or fluid pressure to the simple or primary cylinder 2 and from the simple or primary cylinder 2 to the compound or secondary cylinder 4 when the pistons of these cylinders are at their proper stroke. A passage 22 is located between each set of passages 18 and 19 and 20 and 21, and these passages 22 communicate each with a passage 23, leading to an exhaust port or passage 24, which opens to the atmosphere or other discharge for the steam or fluid pressure.

A slide-valve is provided for each set of passages 18, 19, and 22 and 20, 21, and 22. Each slide-valve consists of a wall or shell 25, inclosing a passage or chamber 26, which on the acting face of the valve is divided by a cross-plate 27 that serves as the cut-off for the eduction or discharge passage 22, closing such passage when the steam or fluid pressure is admitted from the cylinder 2 to the cylinders 3 and 4 and opening such passages for discharging the fluid-pressure from the chambers or cylinders 3 and 4. The cross-plate or cut-off 27 is so located in its relation to the chamber 26 as to leave a small opening 28 for communication with the passage from the simple or primary cylinder or chamber, and an opening 29 of increased capacity for communication with the passage leading to the compound or secondary cylinder or chamber, as shown in Fig. 5.

Each slide-valve has extending cut from its wall 25 ears 30, through which ears pass the valve-rod 31, and, as shown, each slide-valve is held in place on the valve-rod and properly adjusted by a block or nut 32, entered onto a threaded portion of the valve-rod, so that each slide-valve can be moved, as required, to properly coact with the supply-passages between the simple or primary cylinder and the compound or secondary cylinder at each end of the engine. The slide-valves are located in a chamber 33, in-

closed by a surrounding wall 34, attached to the wall of the main shell or casing and having secured to the surrounding wall 34 a cap-plate or top 35, and each end of the wall 34 has therein a chamber 36, containing a packing 37, which is compressed by a gland 38, around which is a cap 39, threaded onto the wall surrounding the chamber 36, these parts forming a stuffing-box through which the valve rod or stem 31 is free to slide in operating the slide-valves. The slide-valves are held to their seating face on the wall of the main casing or shell by the force of the steam or other fluid-pressure, which is admitted to the chamber 33 of the steam-chest in any usual and well-known manner, and this pressure on the outside of each slide-valve is counterbalanced by the pressure on the inside of the wall of the valve in the chamber 26, so that each slide-valve is a balanced valve, having approximately the same pressure on the inside as on the outside, the excess of pressure on the outside being sufficient to hold the valve to its seat. Each slide-valve is held in a direct line of travel by a flange or rim 40 on the wall of the main shell or casing within the steam or fluid pressure chamber 33 of the valve-chest, which flange 40 is of the requisite length to guide and direct the travel of the slide-valves in opening and closing the passages controlled by each slide-valve.

It is desirable to throttle the fluid-pressure admitted from the chest into the simple or primary cylinder, and for this purpose in the construction shown in Fig. 1 a slide or cut-off plate 41 is provided for the supply-passage 18 and the supply-passage 20. The cut-off plate 41 for each supply-passage is located so that when in normal position its outer edge will be in line with the inner edge of the supply-passage with which it coöperates, as shown in Fig. 1, and each cut-off plate 41 is connected by an arm 42 with a collar 43, fixed on the rod 44 of a ball-governor. The collar 43, as shown, is attached to the rod 44 by a pin 45, passing through the collar and rod, and the collar has on opposite sides projecting ears 46, through which and the end of each arm 42 a pin 47 passes, pivotally connecting the arm 42 with the collar. The opposite end of the arm is entered into a slot 48 in the cut-off plate 41 and is attached to the cut-off plate by a pin or pivot 49; passing through the cut-off plate and the end of the arm. It will be seen that as the balls of the governor are thrown out, so as to move the rod 44 down, such downward movement of the rod will carry with it the collar 43, and the downward movement of the collar depresses the attached ends of the arms 42, forcing the arms to a more horizontal position, thereby moving the cut-off plates 41 over the passages 18 and 20, diminishing the width of such passages, and throttling the ad-

mission of steam or fluid pressure to the simple or primary cylinder 2 of the engine, thus effectually controlling the admission of steam or fluid pressure to such chamber or cylinder. The falling of the balls of the governor operates to raise the rod 44 and with it the collar 43, and such movement of the rod and collar 43 operates to raise the attached end of the arms 42, thereby withdrawing the advanced edge of the cut-off plates 41 from the passages 18 and 20, allowing more steam or pressure to enter the simple or primary chamber or cylinder of the engine. It will be seen that by these slides or cut-off plates 41 the control of the steam or fluid pressure supply is dependent on the speed of the engine, and is effectively controlled by such speed, thereby governing the engine.

The construction shown in Fig. 2 has the slides or cut-off plates 41 located between the supply-passages 18 and 20 and the passage 22 on each end of the engine; but otherwise the construction of the links 42, collar 43, and rod 44 is the same as described for these parts in Fig. 1, and the operation of the slides or cut-off plates so far as controlling or throttling the supply of steam or fluid pressure to the simple or primary cylinder or chamber of the engine is the same as described for Fig. 1, the only difference being that in the construction of Fig. 1 the slides or cut-off plates are pushed over the supply-passages 18 and 20, while in the construction of Fig. 2 the slides or cut-off plates 41 are drawn across the supply-passages. The rod 44 of the governor, as shown, is provided with a slot 50, which slot enables the rod to have attached thereto the collar 43, so as to occupy a higher position on the rod for the arrangement of slides or cut-offs in Fig. 1 and a lower position on the rod for the arrangement of slides or cut-offs 41 of Fig. 2, and when a slot 50 is used the connection of the collar 43 to the rod 44 should be by a bolt 45, so that the collar can be held in a fixed position by tightening the bolt.

The slides or cut-off plates 41 can be held in place in any suitable manner. As shown, the guide 40 and the wall opposite thereto each have a groove 51 to receive a tongue 52 on the ends of the slides or cut-off plates, holding the plates in position so that they are free to be reciprocated and also enabling the upper face of the slides or cut-off plates to be made flush with the face of the main casting or shell on which the slide-valves seat and operate. This arrangement enables the slides or cut-off plates to be actuated for throttling the engine without interfering with the movements of the slide-valves in controlling the passages from the cylinders or chambers, and at the same time has the outer faces of the slides or cut-off plates flush with the bearing-face for the slide-valves, and no interference arises in the movements

of the slide-valves, as these valves are free to reciprocate and pass over the slides or cut-off plates. The construction shown has on the main shell or casing and projecting into the chest a boss 53, having therein a hole 54 and serving as a guide to maintain a direct line of travel for the rod 44 in its descent and ascent, so that no wobble or side play of such rod will occur by which the slides or cut-off plates 41 would not be carried from their normal position to throttle and be returned to their normal position, thus making the movements of these slides or cut-off plates positive and accurate in throttling the engine.

The operation is as follows: The pistons or follow-heads, as shown in Fig. 5, are at one end of their stroke, the stroke having just been finished. The slide-valves have been carried to a position where live steam or other fluid-pressure can pass from the chamber 40 of the chest, through the passage 20, back of the piston or follow-head 8 in the simple or primary cylinder, and the steam which has been utilized in driving the piston or follow-head 8 to the position shown in Fig. 5 is free to escape from the simple or primary cylinder or chamber 2 through the passage 18 and chamber 26 of the slide-valve and the passage 19 back of the piston 11 in the compound or secondary chamber or cylinder 3 of the engine, and the slide-valve for the other end of the engine has been carried to a position to open the passage 21 for steam or other fluid-pressure to pass through such passage and the chamber 26 of the slide-valve into the passage 22 and exhaust through the passage 23 and 24 to the atmosphere or otherwise. The pressure back of the piston 8 serves to drive the piston to the opposite end of the chamber or cylinder 2, and at the same time the pressure back of the piston 11 serves to drive such piston toward the open end of the chamber or cylinder 3 of the engine, so that pressure is exerted on both the piston 8 and the piston 11 to drive the engine, the pressure on the piston 11 being expanded, owing to the difference between the diameters of the chambers or cylinders 2 and 3, the same as in engines having primary and secondary cylinders. When the piston 8 reaches the limit of its stroke in the direction of the opposite end of the chamber or cylinder in which it travels, the slide-valve will have been moved, so as to open communication with the chest for the pressure from the chamber of the chest to flow through the passage 18 back of the piston 8 and pressure from the chamber or cylinder 2 to flow through the passage 20, chamber 26, and passage 21 back of the piston 12, and the pressure forward of the piston 11 will escape from the chamber or cylinder 3 through the passage 19 and passage 22 into the passage 23 to discharge at the port 24 to the atmosphere or otherwise. The pressure admitted

through the passage 18 back of the piston 8 serves to drive such piston toward the end of the cylinder or chamber 2, in which it is shown in Fig. 5, and at the same time pressure from the cylinder or chamber 2 admitted to the chamber 4 through the passages 20 and 21, back of the piston 12, serves to drive the piston 12 to the position shown in Fig. 5. It is to be noted that the pressure acts on the piston 8 to drive such piston from one end to the opposite end and return and at the same time with the pressure back of the piston 8 when in the position shown in Fig. 5. The pressure back of the piston 11 also acts to move the piston-rod in the direction of the cylinder 3, exhausting the pressure from the chamber or cylinder 4 back of the piston 12, and with the travel of the piston to the position shown in Fig. 5 the pressure acts back of the piston 12 to force such piston to the position shown in Fig. 5, at the same time allowing the pressure to exhaust from the cylinder 3 of the engine. The driving force of the engine is thus increased in both directions of travel of the piston 8 by reason of the pressure on the pistons 11 and 12, giving the engine the benefit in a direct line of the pressure on two pistons at one and the same time, thus increasing the driving force of the engine and enabling the working steam to be utilized to its full capacity in the compound or secondary cylinders or chambers of the engine.

The engine when running under its ordinary speed has a free passage of the steam or fluid pressure from the chest into the simple or primary cylinder or chamber; but in case of an increase of speed the governor will at once act and throttle the supply of steam or fluid pressure by advancing the slides or cut-off plates wholly or partially over the supply-passages for the steam or fluid pressure, and with the reduction of speed to a normal condition the governor operates to withdraw the slide or cut-off plates from the supply-passages for the steam or fluid pressure so that a full head of steam or fluid pressure can enter the simple or primary cylinder or chamber, thus putting the throttling of the engine under the control of its speed. It will be understood that, if so desired, the engine could be throttled manually by moving the governor-rod in the proper direction to operate the slides or cut-off plates and close or partially close the supply-passages between the main chest and the simple or primary cylinder or chamber. The slides or cut-off plates are inset into the face of the wall of the main shell or casing, so as to be flush with the face on which the slide-valves seat and not interfere with the operation of the slide-valves in controlling the supply and exhaust passages from the cylinders or chambers.

The engine is of simple construction, but

has an increase of power or driving force arising from the arrangement of the pistons or follow-heads tandem, one in line with the other, and having two of the pistons or follow-heads operative at the same time to furnish power. The lead from the simple or primary cylinder or chamber to each of the compound or secondary cylinders or chambers is almost direct, so that no great loss of force is had in the flow of the steam or other fluid pressure from the simple or primary cylinder into the compound or secondary cylinder. The exhaust is common to both end cylinders or chambers, so that when one cylinder or chamber is exhausting there is a release of force back of the piston or follow-head of such cylinder or chamber, leaving the full force exerted on the pistons or follow-heads of the acting cylinders or chambers to be exerted in driving the engine. The slide-valves controlling the passages into and out from the cylinders or chambers is practically a balanced valve with only a sufficient excess of pressure on the exterior face to hold the valve to its seat, which pressure does not interfere to any great extent with the easy movement of the valves in shifting to open and close the passages. The slides or cut-off plates enable the engine to be throttled automatically from the speed, thus assuring only the necessary supply of steam or fluid pressure to the simple or primary cylinder in a sufficient amount to drive the engine. These advantages make the engine positive and reliable as regards its driving power and the control of the steam or other fluid pressure.

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

1. In a compound engine, the combination of a primary cylinder, a secondary cylinder at each end of the primary cylinder with the cylinders arranged tandem and the primary cylinder of smaller capacity than the secondary cylinder, a passage for both inducing and educting pressure at each end of the primary cylinder, a passage for both inducing and educting pressure at the inner end of each secondary cylinder and adapted to be brought into communication with its companion inducing and educting passage of the primary cylinder, an exhaust-passage for each secondary cylinder located between the induction and eduction passages of the primary and secondary cylinders for alternately supplying pressure to and exhausting pressure from the secondary cylinder, a slide-valve for each set of passages controlling the induction and eduction of pressure into and from the primary and secondary cylinders and having an induction-opening of less dimension than the eduction-opening, and a pressure-receiving chest inclosing the slide-valve and mounted on the main casing of the engine, substantially as described.

2. In a compound engine, the combination

of a primary cylinder, a secondary cylinder at each end of the primary cylinder, with the cylinders arranged tandem and the primary cylinder of smaller capacity than the secondary cylinder, a passage for both inducting and educting pressure at each end of the primary cylinder, a passage for both inducting and educting pressure at the inner end of each secondary cylinder and adapted to be brought into communication with its companion inducting and educting passage of the primary cylinder, an exhaust-passage for each secondary cylinder located between the induction and eduction passages of the primary and secondary cylinders for alternately supplying pressure to and exhausting pressure from the secondary cylinder, a slide-valve for each set of passages controlling the induction and eduction of pressure into and from the primary and secondary cylinders and having an induction-opening of less dimension than the eduction-opening, a pressure-receiving chest inclosing the slide-valve and mounted on the main casing of the engine, and a rod slidable in the end walls of the pressure-receiving chest and having both slide-valves mounted thereon, substantially as described.

3. In a compound engine, the combination of a primary cylinder, a secondary cylinder at each end of the primary cylinder with the cylinders arranged tandem and the primary cylinder of smaller capacity than the secondary cylinder, a passage for both inducting and educting pressure at each end of the primary cylinder, a passage for both inducting and educting pressure at the inner end of each secondary cylinder and adapted to be brought into communication with its companion inducting and educting passage of the primary cylinder, an exhaust-passage for each secondary cylinder located between the induction and eduction passages of the primary and secondary cylinders for alternately supplying pressure to and exhausting pressure from the secondary cylinder, a slide-valve for each set of passages controlling the induction and eduction of pressure into and from the primary and secondary cylinders and having an induction-opening of less dimension than the eduction-opening, a pressure-receiving chest inclosing the slide-valve and mounted on the main casing of the engine, and cut-off plates automatically actuated from the speed of the engine and operating to throttle the passage leading into the primary cylinder, substantially as described.

4. In a compound engine, the combination of a primary cylinder, a secondary cylinder at each end of the primary cylinder, with the cylinders arranged tandem and the primary cylinder of smaller capacity than the secondary cylinder, a passage for both inducting and educting pressure at each end

of the primary cylinder, a passage for both inducting and educting pressure at the inner end of each secondary cylinder and adapted to be brought into communication with its companion inducting and educting passage of the primary cylinder, an exhaust-passage for each secondary cylinder located between the induction and eduction passages of the primary and secondary cylinders for alternately supplying pressure to and exhausting pressure from the secondary cylinder, a slide-valve for each set of passages controlling the induction and eduction of pressure into and from the primary and secondary cylinders and having an induction-opening of less dimension than the eduction-opening, a pressure-receiving chest inclosing the slide-valve and mounted on the main casing of the engine, cut-off plates automatically actuated from the speed of the engine and operating to throttle the passage leading into the primary cylinder, a slidable rod, and arms connecting the slidable rod and the cut-off plates for advancing and receding the cut-off plates, substantially as described.

5. In a compound engine, the combination of a primary cylinder having at its end an induction and eduction passage for pressure, a secondary cylinder in line with the primary cylinder and having at its inner end an inducting and educting passage for pressure, a valve controlling communication between the inducting and educting passages of the two cylinders, a chest for receiving pressure and in communication with the primary cylinder through the inducting and educting passage of said cylinder, and a cut-off plate located below the controlling-valve and operating to throttle the passage leading into the primary cylinder, substantially as described.

6. In a compound engine, the combination of a primary cylinder having at its end an inducting and educting passage for pressure, a secondary cylinder in line with the primary cylinder and having at its inner end an inducting and educting passage for pressure, a slide-valve controlling communication between the inducting and educting passages of the two cylinders, a chest for receiving pressure and in communication with the primary cylinder through the inducting and educting passage of said cylinder, and a cut-off plate located below the controlling-valve and operating to throttle the passage leading into the primary cylinder, substantially as described.

7. In a compound engine, the combination of a primary cylinder having at its end an inducting and educting passage for pressure, a secondary cylinder in line with the primary cylinder and having at its inner end an inducting and educting passage for pressure, a slide-valve controlling communica-

tion between the inducting and educting passages of the two cylinders, a chest for receiving pressure and in communication with the primary cylinder through the inducting and educting passage of said cylinder, a cut-off plate located below the controlling-valve and operating to throttle the passage leading into the primary cylinder, a slidable rod, and an arm connecting the slidable rod with the cut-off plate, substantially as described. 10

WILLIAM A. WEBSTER.

Witnesses:

I. H. BARTLETT,
J. W. CLENDENIN.