

(No Model.)

3 Sheets—Sheet 1.

D. CLERK.  
MOTOR WORKED BY COMBUSTIBLE GAS OR VAPOR.  
No. 249,307. Patented Nov. 8, 1881.

FIG. 1.

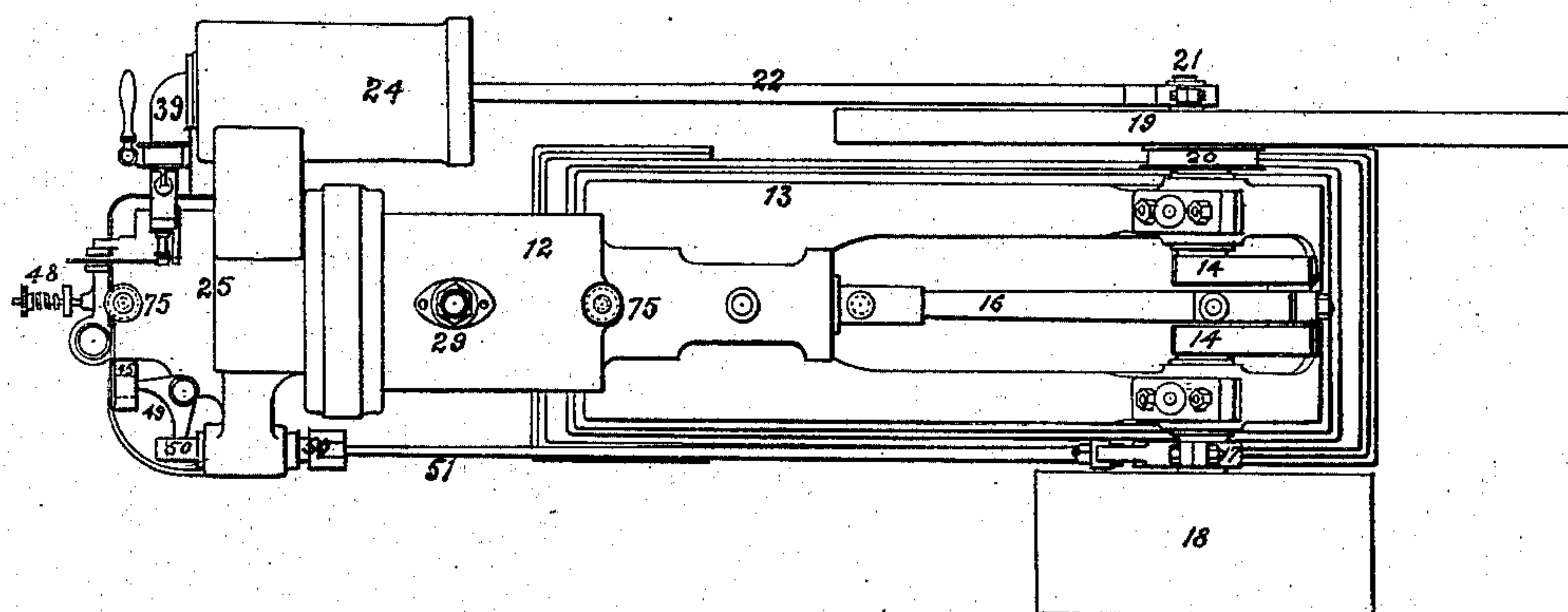
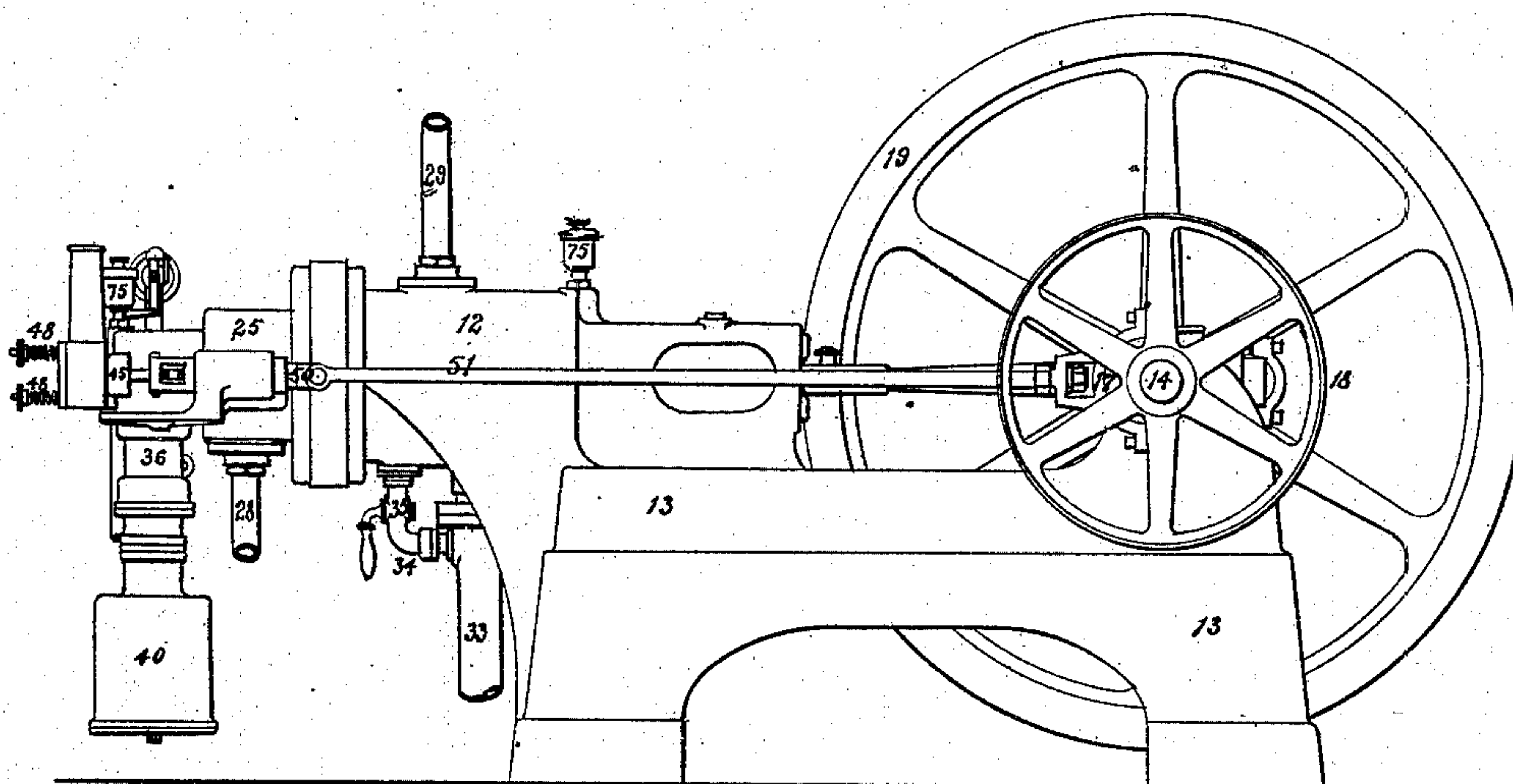


FIG. 2.



Witnesses:  
D. S. Williams  
James F. Tobin

Inventor:  
Dugald Clerk  
by his attys  
Houson and Jones



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FIG. 4.

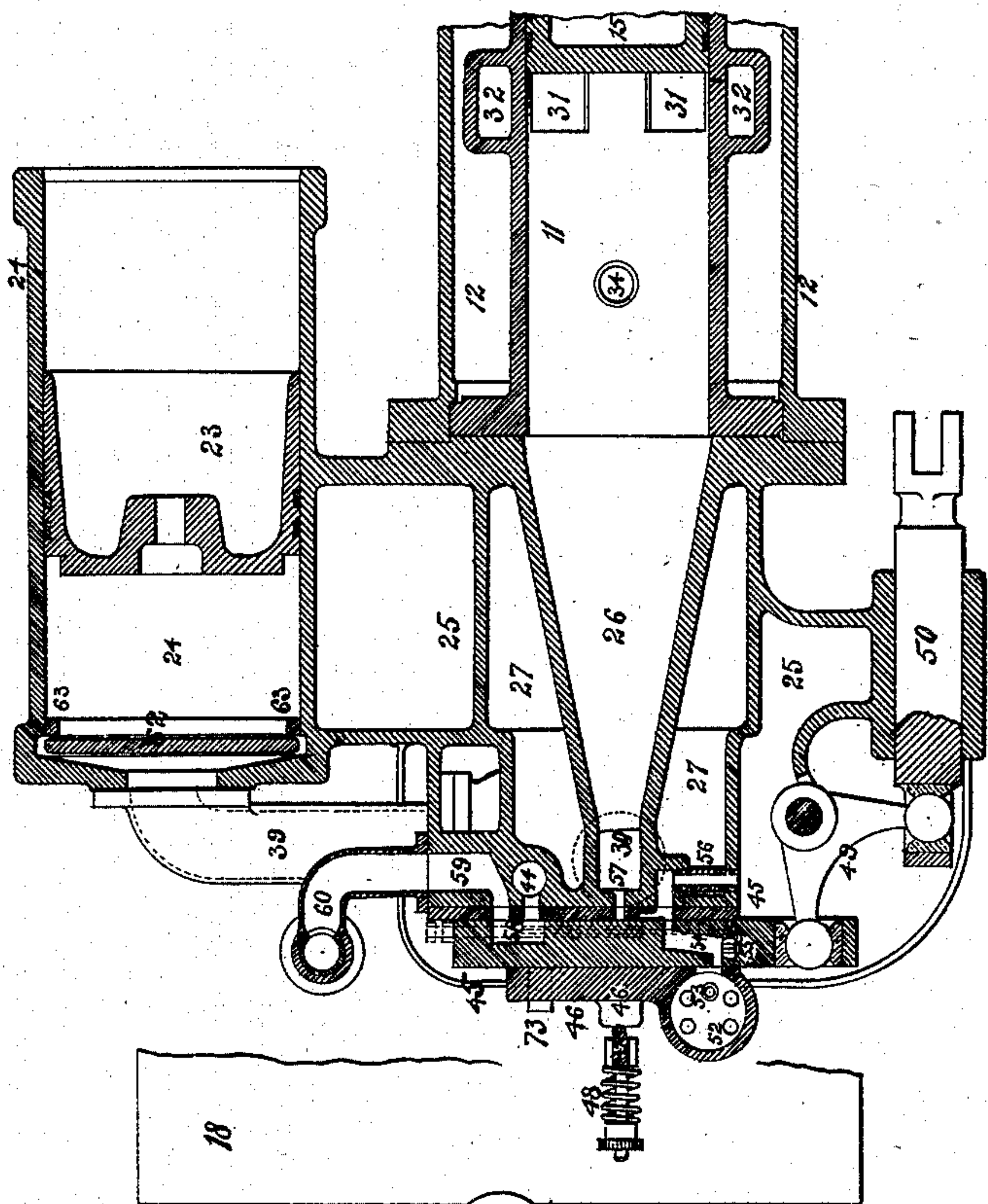
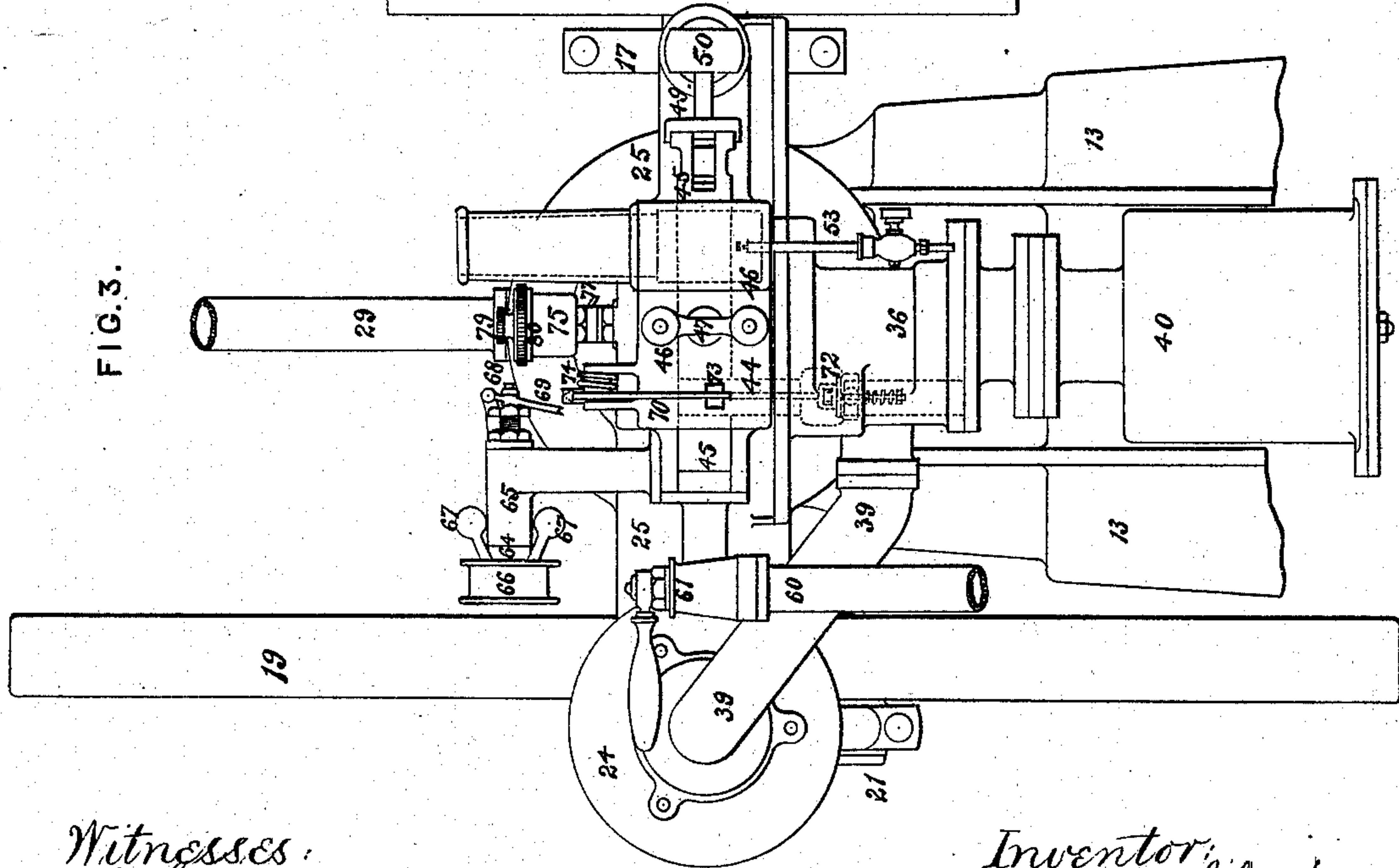


FIG. 3.



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*Jas F. Tobin*

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*Houston and Jones*



(No Model.)

3 Sheets—Sheet 3.

D. CLERK.

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FIG. 6.

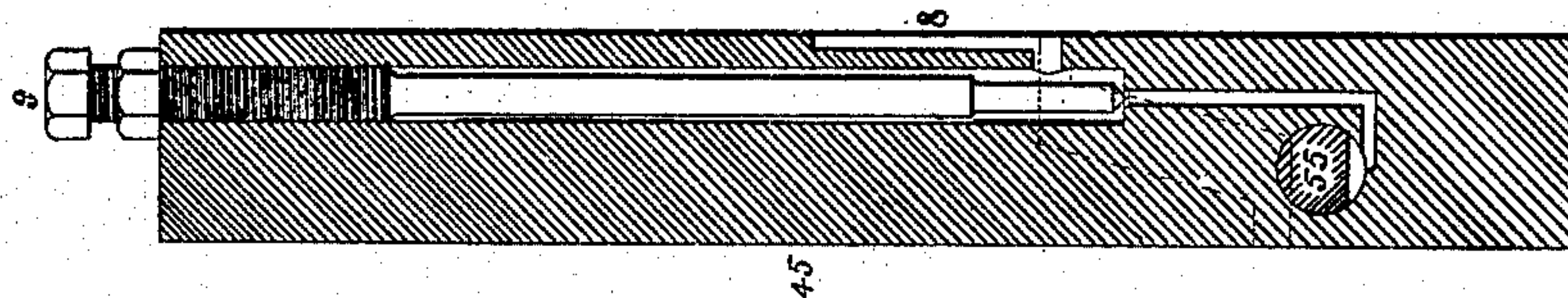
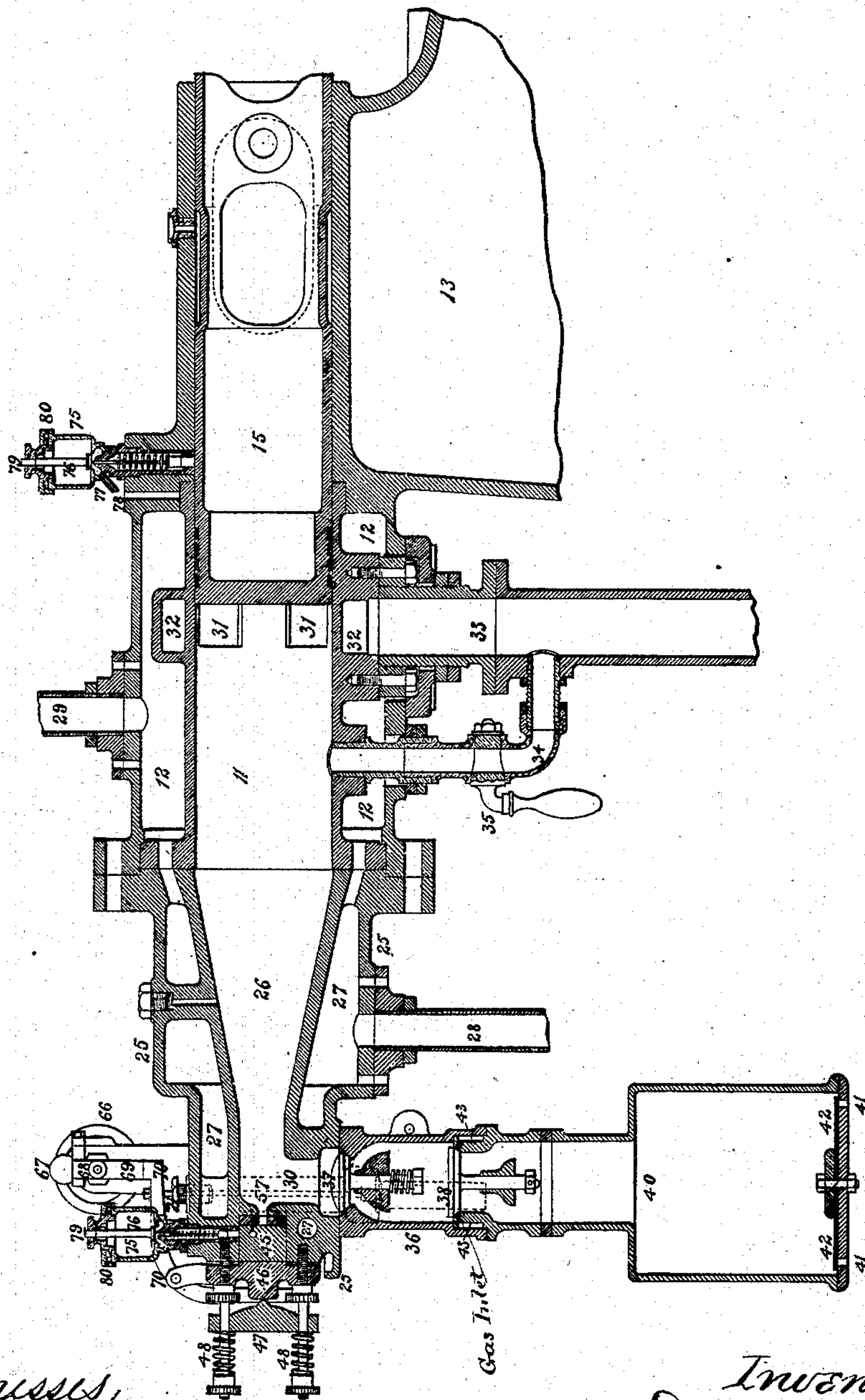


FIG. 5.



Witnesses,  
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# UNITED STATES PATENT OFFICE.

DUGALD CLERK, OF GLASGOW, COUNTY OF LANARK, SCOTLAND.

## MOTOR WORKED BY COMBUSTIBLE GAS OR VAPOR.

SPECIFICATION forming part of Letters Patent No. 249,307, dated November 8, 1881.

Application filed September 2, 1881. (No model.) Patented in England March 14, 1881.

*To all whom it may concern:*

Be it known that I, DUGALD CLERK, a subject of the Queen of Great Britain, and residing at Glasgow, county of Lanark, Scotland, have invented certain Improvements in Motors Worked by Combustible Gas or Vapor, (for which I have obtained a patent in Great Britain, No. 1,089, March 14, 1881,) of which the following is a specification.

My said invention has for its object to improve and simplify the construction and increase the efficiency of gas-motors or motors operating with combustible gas or vapor.

In my improved motor there are two single-acting cylinders provided with pistons connected in the ordinary way to cranks on one shaft. In one cylinder a mixture of gas or vapor and air is ignited and power developed, but the other cylinder is employed to effect displacement only, and the two cylinders are hereinafter distinguished as the "power-cylinder" and the "displacement-cylinder." The air and gas or vapor enter at one end of the power-cylinder, and the exhaust takes place by ports so situated as to be passed by the piston when approaching the end of its stroke in its movement from the entering end. The capacity of the displacement-cylinder is considerably larger than the product of the area and stroke of the power-piston; and when the displacement-piston is moving in one direction it draws in air and gas or vapor through a check-valve, but the gas or vapor is cut off as soon as the quantity of mixed air and gas or vapor is about equal to the product of the area and stroke of the power-piston, and only air is drawn in during the remainder of the stroke of the displacement-piston. On the return-stroke the displacement-piston forces the contents of its cylinder through a check-valve into the power-cylinder, the unmixed air last drawn in first entering the power-cylinder. The cranks of the two cylinders are so placed relatively to each other that while the contents of the displacement-cylinder are being forced into the power-cylinder the exhaust-ports of that cylinder are still open, and not only do the burned or used gases of the previous stroke pass out, but also the unmixed air which enters in advance of the fresh charge. This portion of unmixed air insures the clearing out of the

power-cylinder and prevents any ignited matter from remaining in the cylinder to prematurely ignite the fresh charge. On the return-stroke of the power-piston, and after it has passed and closed the exhaust-ports it compresses the mixture of air and gas or vapor into a clearance-space at the end of the cylinder, and the compressed charge is ignited at about the commencement of the succeeding stroke. The ignition is effected by means of a slide worked by an eccentric on the crank-shaft, the details of and connected with this slide being hereinafter particularly described. Besides having passages and ports, which have to do with the power-cylinder, the slide is made with a cavity or port operating in connection with ports and passages through which the combustible gas or vapor passes on its way from the supply-pipe to the valve, through which it is drawn into the displacement-cylinder, the slide causing the gas or vapor to be cut off at such period of the indrawing stroke, so as to render the later portion of air drawn in unmixed with gas or vapor. The gas or vapor supply passage is also fitted with a valve controlled by a speed-governor.

Figures 1 and 2 on Sheet 1 of the drawings are a plan and a side elevation. Figs. 3 and 4 on Sheet 2 are an enlarged end elevation and an enlarged horizontal section, and Fig. 5, on Sheet 3, is an enlarged longitudinal vertical section, while Fig. 6 is an enlarged horizontal section of the valve-slide.

In these drawings the same reference-numerals are used to mark the same or like parts wherever they are repeated.

A single-acting power-cylinder, 11, is fixed horizontally in a jacket-casing, 12, formed at one end of a bed-frame, 13, which is at its other end provided with bearings for the crank-shaft 14. The piston 15 of the power-cylinder is in the form of a hollow plunger or ram, but is fitted with a number of metallic packing-rings, and no stuffing-box is required at the front end of the cylinder. The connecting-rod 16 of the power-piston is jointed on a double-checked crank on the shaft 14 between the bearings, and outside of the bearings there are, at one side of the machine, an eccentric, 17, for working the valve-slide, and a pulley, 18, for the belt which transmits the power from the ma-



chine, while at the other side the shaft 14 has on it a fly-wheel, 19, and a pulley, 20, a strap from which last drives the speed-governor. The fly-wheel 19 has on it a crank-pin, 21, on which is jointed the connecting-rod 22 for working the piston 23 of the displacement-cylinder 24. The displacement-cylinder 24 is placed horizontally at one side of the power-cylinder jacket 12, being formed in a casting, 25, which is bolted to the jacket 12, and which is formed with and carries various parts hereinafter described. At the inner end of the power-cylinder 11 there is a conical clearance-space, 26, formed in the casting 25, as is also a jacket-space, 27, which communicates with the space in the jacket 12, surrounding the power-cylinder 11. Water, entering by a pipe, 28, and passing off by a pipe, 29, is supplied to the jacket-spaces 12 27, to prevent the power-cylinder 11 and clearance-space 26 from becoming overheated. The air and gas enter to the power-cylinder 11 by an inlet, 30, at the outer end of the conical clearance-space 26, and the exhaust takes place through ports 31, communicating with a passage, 32, formed round the cylinder and leading to the exhaust-pipe 33, these exhaust-ports 31 being uncovered by the piston 15 as it approaches the outer end of its stroke. A pipe, 34, fitted with a stop-cock, 35, forms a communication between the exhaust-pipe 33 and a part of the cylinder 11, nearer the inner end, and is provided to facilitate the starting of the motor, the opening of the stop-cock 35 having the effect of reducing the compression and the force developed at each stroke.

Below the inlet 30 to the power-cylinder there is a valve-box, 36, having in it two check-valves, 37 38, while the space between them communicates by a pipe, 39, with the displacement-cylinder 24, and the action of the displacement-piston 23 is to draw in air and gas through the lower valve, 38, and subsequently force them through the upper valve, 37, into the power-cylinder 11.

With the view of diminishing or preventing the production of noise by the drawing in of the air a chamber or box, 40, is fixed below the lower check-valve 38, and the air enters this chamber 40 through a number of holes, 41, formed round the bottom of it and having above them a light rubber disk, 42. The opening of the lower check-valve 38 admits gas as well as air, (unless the gas happen to be shut off,) there being in the conical seat of the valve a number of small holes which communicate with an annular passage, 43, to which the gas has access by a vertical passage, 44, indicated by dotted lines in Fig. 3.

The valve-slide 45, which is of a rectangular form in cross-section, is fitted to work horizontally across the back end of the power-cylinder, or, rather, of the back casting, 25, a recess being formed for it in that casting, and having a vertical port face-piece fixed at its innermost part. The valve-slide 45 is kept in position by an adjustable covering-plate, 46, which is pressed against the slide by a bar, 47, acted

on by adjustable helical springs 48 on spindles or studs passing through the covering-plate 46 and fixed in the casting 25. The valve-slide 45 is directly acted on by a bell-crank lever, 49, itself moved by a bar, 50, working in guides and having jointed to it the connecting-rod 51 of the eccentric 17. The covering-plate 46 is formed with a small open-topped chamber, 52, in which a jet from a small gas-pipe, 53, (by preference arranged like a Bunsen burner,) is kept constantly burning. Air enters this chamber 52 by holes in its bottom, and it has at its inner side a port, past which the valve-slide 45 moves. The slide 45 has a main passage or space, 54, formed in it and extending partly along it, and this main passage 54 has a port on each side. A very small passage, shown in section in Figs. 5 and 6, and indicated by dotted lines in Fig. 4, which passage has an elongated port, 8, on the inner side of the slide 45, communicates through a grating, 55, with the main passage 54, near its port on the outside of the slide, and through this small passage there finds its way some of the combustible mixture through a small bore, (indicated by horizontal dotted lines just above the port 57 in Fig. 5.) As it is desirable to regulate the quantity passing to the grating 55, a slightly-enlarged bore is formed from the farther end of the slide 45, into which bore there is screwed a spindle, 9, made with a point, which closes the small gas-passage more or less, accordingly as the spindle 9 is adjusted, a jam-nut serving to fix the spindle when adjusted. When the slide 45 is in one position, which is that it is shown in in Fig. 4, the outer port of its main passage 54 is in communication with the port of the chamber 52 in the covering-plate 46, and then the gas which has entered the passage 54 through the grating 55 becomes ignited. At this time the inner port of the main passage 54 of the slide communicates with a passage, 56, leading to the outside, which insures the filling of the passage 54 with flame and affords visible indication of this part of the ignition being properly effected. The immediately subsequent movement of the slide 45 cuts off the communication of the outer port of its passage 54, and brings its inner port into communication with a port, 57, leading into the end of the clearance-space 26 of the power-cylinder 11, and the flame in the main passage 54 of the slide 45 is thereupon communicated to the combustible mixture in the space 26, all communication with the exterior being completely cut off. The valve-slide 45, besides effecting the ignition of the combustible gaseous mixture in the power-cylinder, also controls the admission of the combustible gas into the displacement-cylinder. The vertical passage 44, which, as hereinbefore mentioned, leads the gas to the lower check-valve, 38, through which the air is drawn in, has at its upper end a port in the port-face, upon which the valve-slide 45 works, and a cavity, 58, in the slide puts that port at the proper times in communication with the port of a passage, 59,



which leads the gas from the supply-pipe 60, the latter being provided with a stop-valve, 61, for completely shutting off the gas when the motor is not working. The valve-slide 45 allows the gas to enter, mixed with air, during the early part of the indrawing stroke of the displacement-piston 23, but cuts it off at a suitable part of the stroke, so that only air enters during the remainder of the stroke; and in order to prevent as much as possible the air last drawn in from mixing with the combustible mixture previously drawn in there is placed in the end of the displacement-cylinder 24 a plate, 62, which causes the entering air to spread from the center to the circumference, and thence enter the interior of the cylinder between the plate 62 and a ring, 63, and in directions directed more or less toward the center; or a number of inlet-ports may be formed round the cylinder itself, close to the end, for the same purpose.

Any suitable kind of speed-governor may be used, the one shown in the drawings having a horizontal spindle, 64, carried in a long bearing in a bracket, 65. On one overhanging end of the spindle 64 there is a pulley, 66, to receive the driving-belt from the pulley 20 on the crank-shaft 14; and within this pulley 66 there are jointed the arms of a pair of centrifugal balls, 67. A helical spring placed inside of the spindle 64, which is hollow, is applied to resist the centrifugal tendency of the balls 67, but this tendency, in proportion as it increases from increased speed, moves a central spindle, 68, outward at the other end of the bearing. The spindle 68 has on it a pair of collars, by which it acts on a lever, 69, centered on a small bracket, and when the proper speed is exceeded this lever 69 is moved so as to bring its bottom end over a horizontal part of a curved or bell-crank lever, 70. A rod, 71, passing through a hole in the lever 70 and resting thereon by a nut screwed on its end, passes down through a stuffing-box to a valve, 72, (indicated by dotted lines in Figs. 3 and 5,) in the gas-passage 44, and this valve 72 has a spring applied to it which tends to keep it shut. It is, however, periodically opened by the action of the lever 70, one arm of which extends down beside the covering-plate 46, and is acted on by a small block, 73, fitted to slide in a slot in the plate 46. A spiral spring, 74, makes the lever 70 tend to open the valve 72, and at the same time to press the block 73 inward, but the valve-slide 45 keeps the parts in the positions for having the valve 72 shut, except when a curved recess formed for the purpose in the slide comes opposite the block 73. At such times the block 73 can move inward, and then the spring 74 makes the lever 70 open the valve 72 and allow the gas to pass; but if the speed is at any time excessive the governor moves the lever 69 over the lever 70, which, for the time, prevents the lever 70 from opening the valve 72, and the supply of gas is in consequence shut off for one or more strokes. The combination of this valve with

the inlet-pipe will, however, form the subject of a separate application.

Lubricators 75 are fitted for lubricating the piston or ram 15 and the valve-slide 45. In each case the lubricator 75 is fitted with a central valve-spindle, 76, the valve on which closes a communication from the bottom of the reservoir into an annular passage from which there is an open spout, 77, and the lubricant drops from this spout down a passage, 78, leading to the rubbing-surfaces. The valve-spindle 76 extends down into a chamber below the lubricator, in which chamber there is applied to it a spring tending to close the valve. The chamber has an opening through into the interior, in which the piston or ram 15 works, and in this opening there is fitted a small movable block, which, when the valve is shut, projects down into a recess formed in the surface of the piston or ram 15, but which recess is too small to be shown in the drawings. As the piston or ram moves the unrecessed part comes under and raises the movable block, and through it the valve-spindle 76, and allows a little lubricant to pass out by the spout 77. The upper end of the spindle 76 is squared, and enters a square hole in the cover 79, by turning which the spindle can be screwed more or less into the nut which is at its bottom end, and which compresses the spring. By these means the extent of opening of the valve can be adjusted and the rate of flow of the lubricant thereby regulated; and it can be seen at any time how the lubricator is working by watching the lubricant dropping from the spout 77 into the passage 78. A clamping-ring, 80, screwed on the rim of the lubricator-cup, serves for fixing the cover 79 when adjusted. These lubricators, however, will form the subject of a separate application.

The displacement-cylinder 24 is represented as having a capacity about equal to double the product of the area and stroke of the power-piston, and the crank 21, for working the displacement-piston 23, is placed a little more than a quarter of a circle in advance of the crank of the power-piston 15. These relative proportions and arrangement, may, however, be varied in different cases.

What I claim as my invention is—

1. In a gas-motor, a power-cylinder with inlet at one end and with outlets round a part of the cylinder uncovered by the piston when approaching the end of its outstroke, the said power-cylinder being combined with a displacement-cylinder which forces into the power-cylinder preparatory to each explosive stroke, first, unmixed air to drive out the used gases of the preceding stroke and itself also passing out after the used gases; and, secondly, a mixture of air and combustible gas for the succeeding stroke, the parts being arranged and operating substantially as set forth.

2. In a gas-motor, a displacement-cylinder for supplying unmixed air and a mixture of combustible gas and air to a power-cylinder, combined with inlet and discharge check-valves



for the air and gas, and with a separate valve to cut off the supply of gas, so that the latter portion of air drawn in may be unmixed, the parts being arranged and operating substantially as set forth.

3. An igniting device for a gas-motor, such device having combined in it, first, a covering-plate, 46, formed with a chamber, 52, in which a gas-jet constantly burns, and which has a port at its inner side; secondly, a valve-slide, 45, reciprocating between the covering-plate and a port-face, which last has an ignition-port, 57, leading into the power-cylinder, and a port and passage, 56, communicating with the exterior; and, thirdly, a main passage or space, 54, formed in and partly along the valve-slide, with a port at one end on the inner face, and with a port at the other end on the outer face, there being close to the latter port a grating, 55, through which inflammable gas issues into the main passage, such gas passing through small additional passages from the power-cylinder to the grating, and becoming ignited by the constant flame when the valve-slide brings the port on its outer side into communication with the port in the chamber 52 in the cover-

ing-plate, all the parts being arranged and operating substantially as set forth.

4. In an igniting device for a gas-motor, the combination of a main passage, 54, in the valve-slide with a grating, 55, for the entrance of combustible mixture into the end of the main passage at its outer port, and with a small passage leading the gas to such grating, and provided with an adjustable regulating-valve, 9, substantially as and for the purposes set forth.

5. In a gas-motor, a device for drawing in together and mixing combustible gas or vapor and air, consisting of a valve, 38, with a conical seating, which seating is formed with perforations communicating with an annular gas-supply passage, in addition to the usual central opening, through which last the air enters, substantially as set forth.

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

DUGALD CLERK.

Witnesses:

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DAVID FERGUSON.