L. WYGODSKY.

VALVE GEAR AND INJECTION TIMING MECHANISM.

APPLICATION FILED DEC. 26, 1913.

1,166,508.

Patented Jan. 4, 1916.

4 SHEETS—SHEET 1.

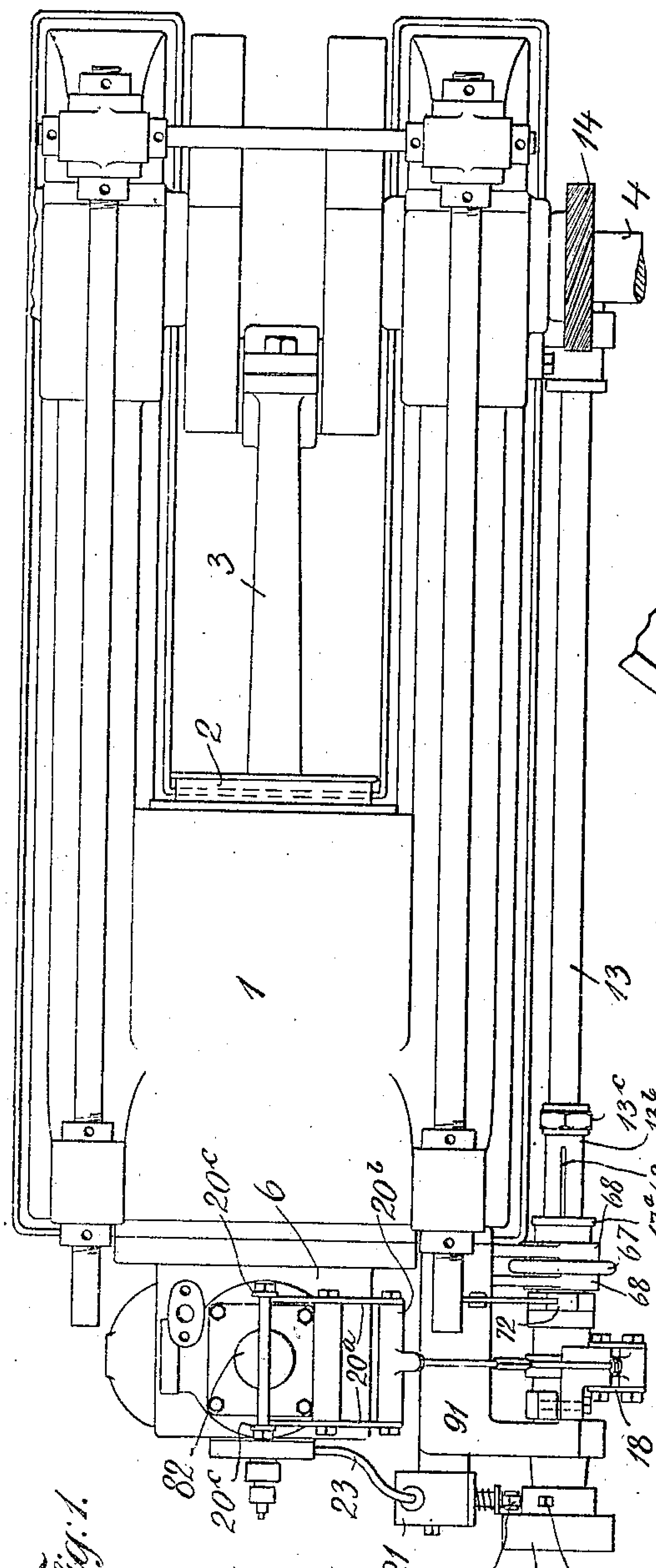

Fig. 1.

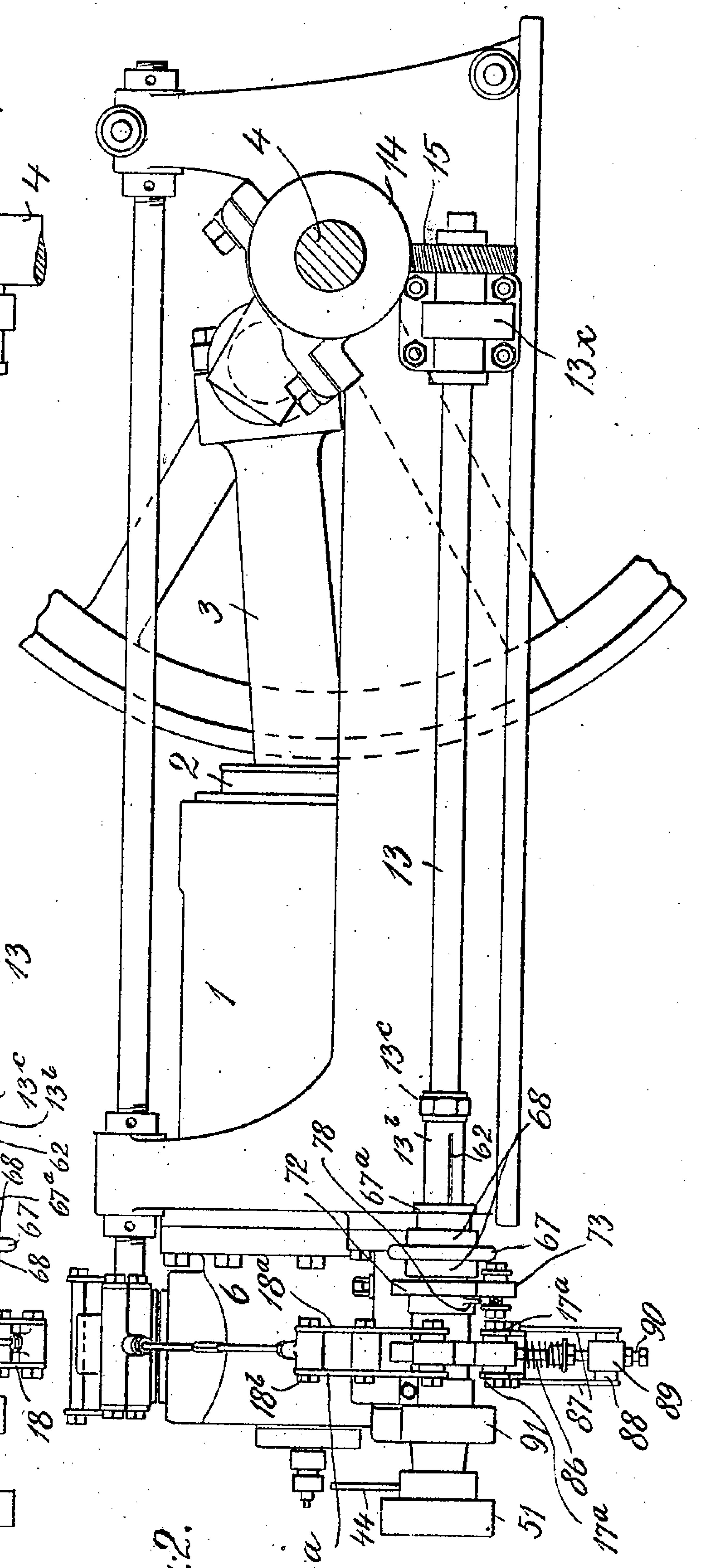

Fig. 2.

Witnesses:
Max B. A. Doring
May I. Trimble

Inventor
Leon Wygodsky
By his Attorneys
Marbe & Matthy

L. WYGODSKY.

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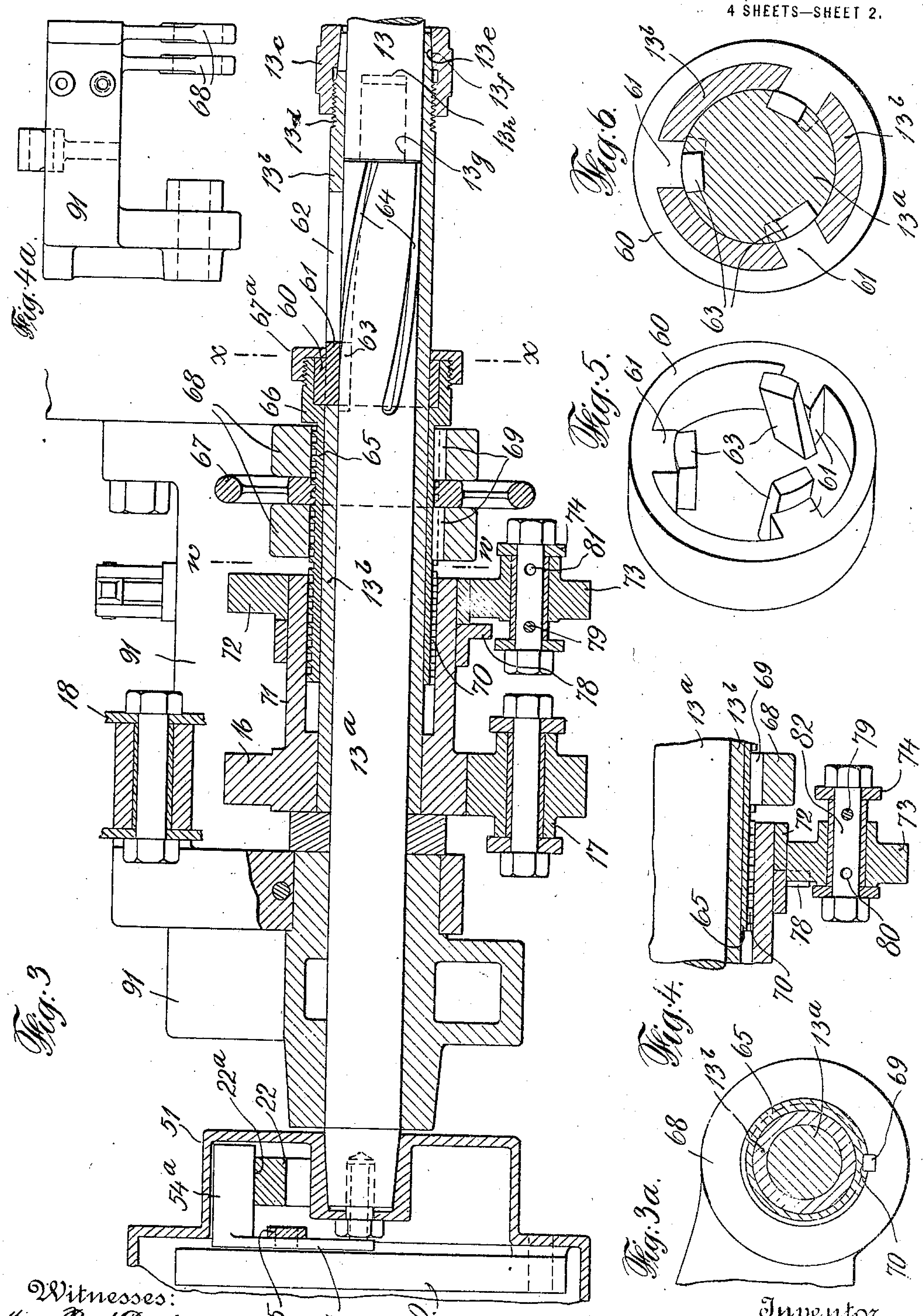

Witnesses:
Max B. A. Doring
May F. Trimble

Inventor
Leon W. [illegible]

By his Attorney
[illegible]

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4 SHEETS—SHEET 3.

Fig. 8.

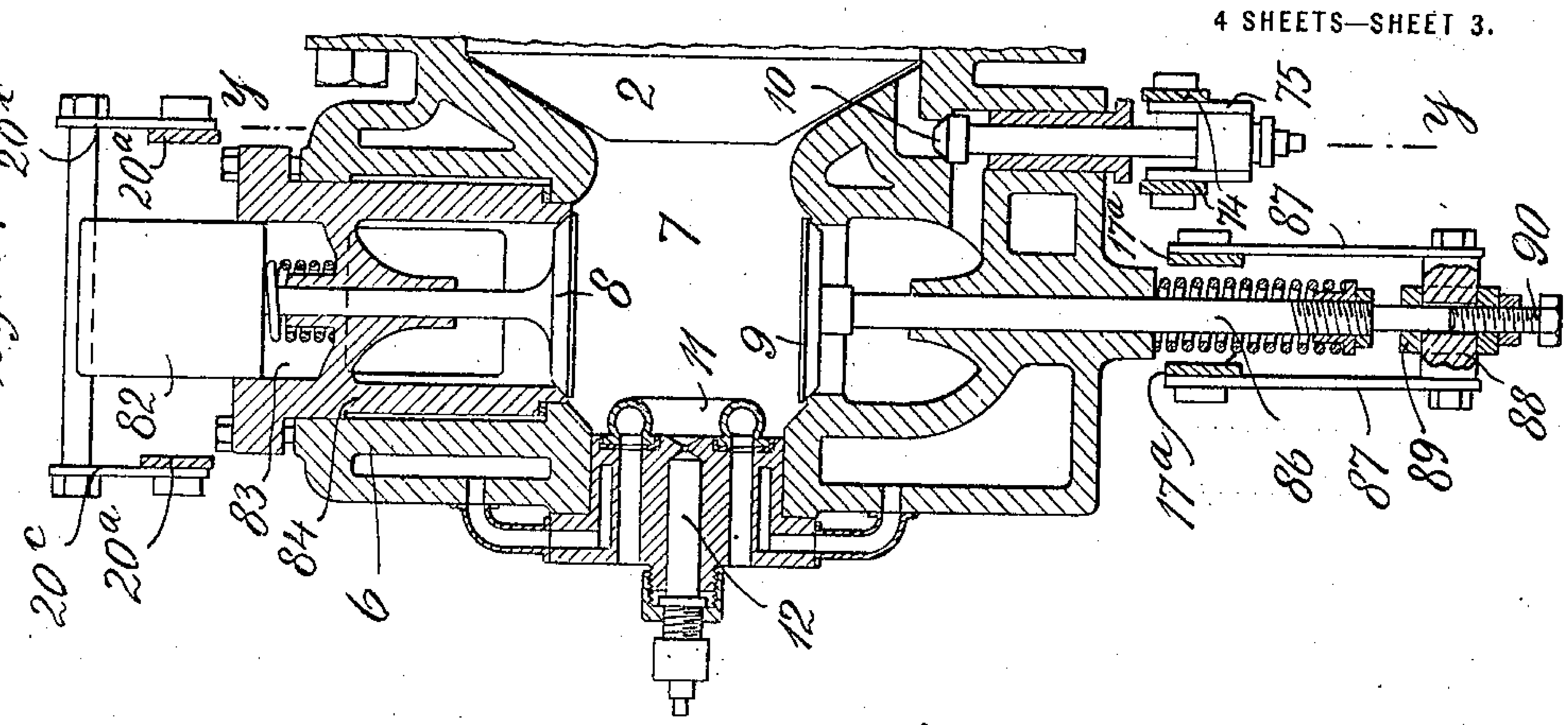
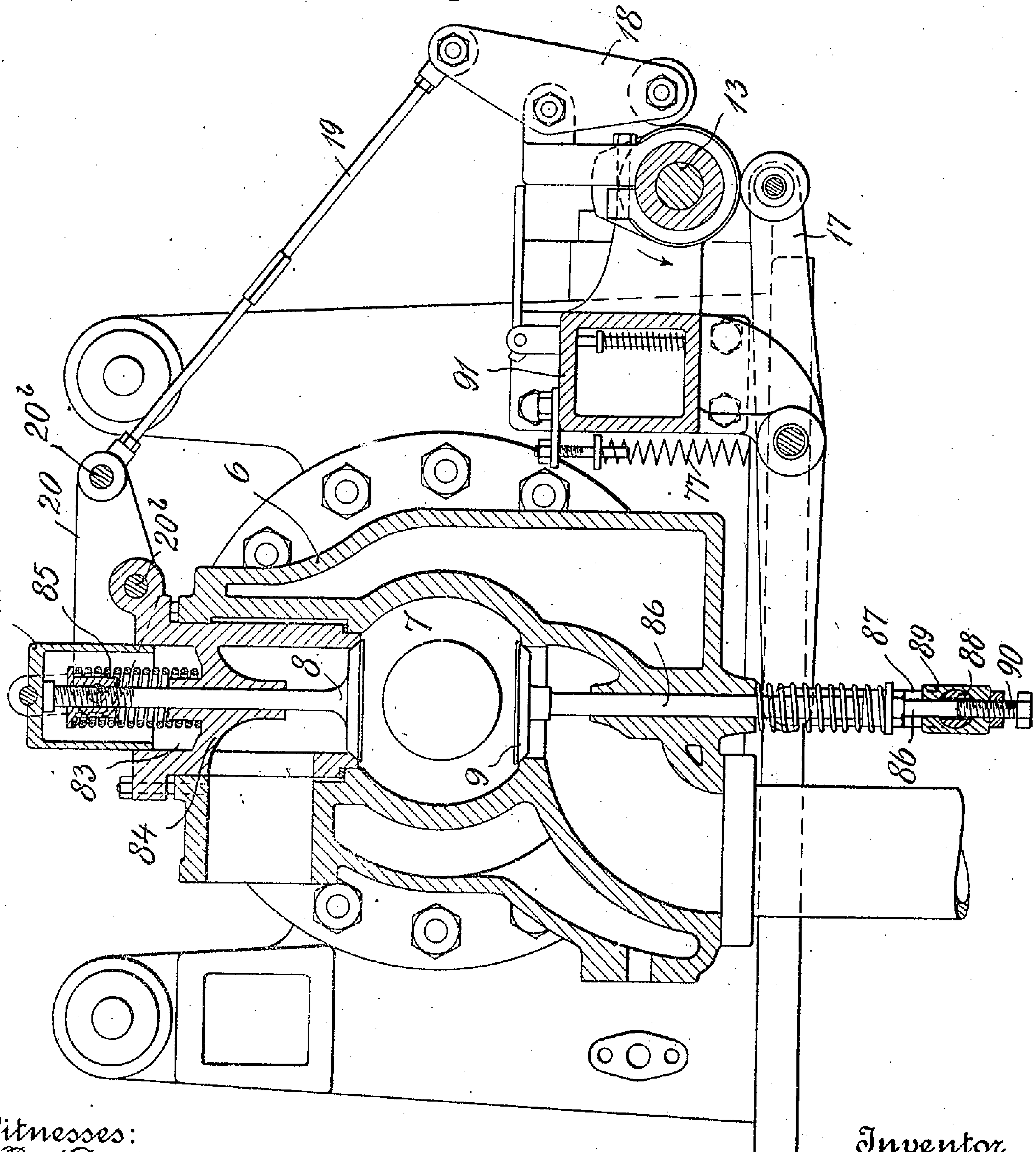


Fig. 7.



Witnesses:

Max B. A. Doring

May G. Trimble

Inventor

Leon Wygodsky

By his Attorneys

Kimberly & Matty

L. WYGODSKY.

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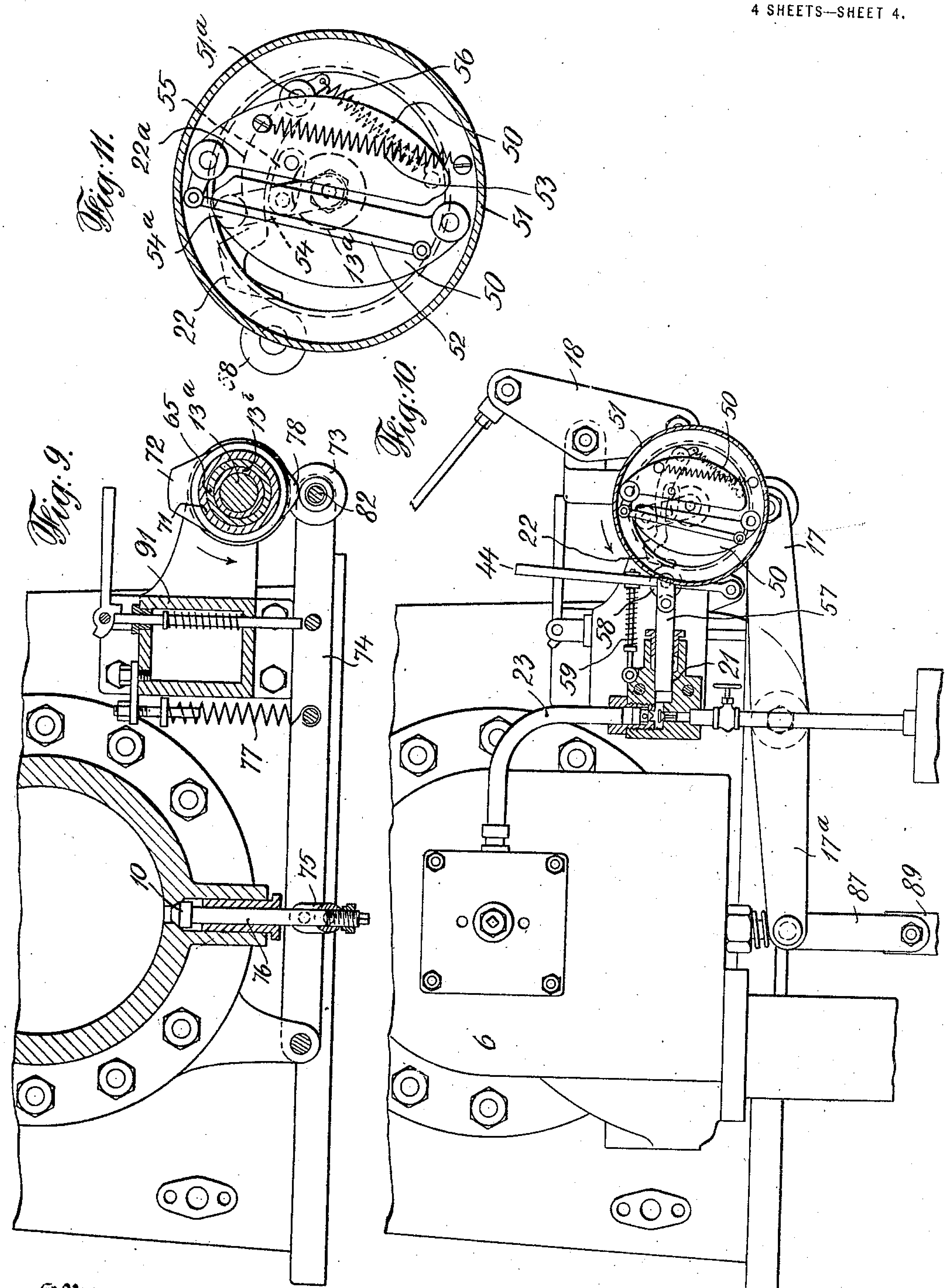

Witnesses:

Max B. A. Doring

May I. Trimble

Inventor

Leon Wygodsky

By his Attorneys

Marbury Matty

UNITED STATES PATENT OFFICE.

LEON WYGODSKY, OF NEW YORK, N. Y., ASSIGNOR TO WYGODSKY ENGINE COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

VALVE-GEAR AND INJECTION-TIMING MECHANISM.

1,166,508. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed December 26, 1913. Serial No. 808,899.

To all whom it may concern:

Be it known that I, LEON WYGODSKY, a subject of the Czar of Russia, and a resident of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Valve-Gear and Injection-Timing Mechanism, of which the following is a specification.

My invention relates to improvements in injection mechanism and valve gear for internal combustion engines, particularly engines of the type in which fuel is injected into an engine cylinder or combustion chamber, and comprises improved and simplified means for varying the time of injection of fuel, and an improved and simplified valve gear.

The objects of my invention are to improve injection mechanism and valve gear of internal combustion engines; to provide improved and simplified mechansim for varying the time of injection without varying the timing of the valve functions, and to make the mechanism simple, compact, efficient and relatively inexpensive.

I will now proceed to describe my invention with reference to the accompanying drawings, and will then point out the novel features in claims.

Figure 1 shows a top view of an internal combustion engine provided with injection mechanism and valve gear constructed in accordance with my invention. Fig. 2 shows a side elevation of such engine. Fig. 3 shows, on a larger scale than the preceding figures, a vertical axial section through the cam shaft and associated parts. Fig. 3ª shows a detail transverse section on the line *w*—*w* of Fig. 3. Fig. 4 shows a fragmentary longitudinal section of a portion of the mechanism shown in Fig. 3, and illustrates particularly the lateral adjustability of roller 73 to permit said roller to be engaged either by cam 72 alone or by both cams 72 and 78. Fig. 4ª is a detail top view of the bracket which supports the valve-shaft and associated parts. Fig. 5 shows a perspective elevation of the feather ring, and Fig. 6 shows a transverse section on the line *x*—*x* of Fig. 3, *i. e.*, a section through this feather ring and associated parts. Fig. 7 shows a transverse section through the combustion chamber of the engine, the section being taken through the air admission and main exhaust valve chambers of the engine. Fig. 8 shows a fragmentary longitudinal section of the rear portion of the engine cylinder, the section being taken through the center of the air admission and exhaust valve chambers, and through the combustion chamber. Fig. 9 shows a transverse section of the cylinder head, the section being taken through the center of the auxiliary exhaust valve, on the line *y*—*y* of Fig. 8, this figure also showing the mechanism for operating the auxiliary exhaust valve. Fig. 10 shows a fragmentary rear elevation of the engine, and a vertical section through the fuel pump and governor casing. Fig. 11 shows on a larger scale than figure 10, the construction of the governor, the view being an end view of the governor, the rotary carrier of the governor structure being sectioned transversely.

In the drawings, 1 designates the engine cylinder, 2 (Figs. 1, 2 and 8) the piston, 3 the connecting rod and 4 the crank shaft.

The engine cylinder is provided with an extended hollow rear head 6 within which is a combustion chamber 7 (Figs. 7 and 8); a suitable air admission valve 8, and a main exhaust valve 9, and supplemental exhaust valve 10 being mounted in this rear head; also an ignition ring 11 and sprayer 12, the ignition ring being of the type covered in my Patent No. 1,076,619 dated October 21, 1913, and the sprayer being of the type covered by my Patent No. 971,954, dated October 4, 1910. A valve operating shaft 13 is driven direct from the crank shaft 4 by gears 14 and 15 so constructed as to revolve shaft 13 at half the speed of the crank shaft.

13ˣ designates a front bearing for shaft 13. In line with this shaft 13 there is another shaft 13ª (Fig. 3) drivingly connected with shaft 13 in the manner hereinafter described, and carrying at its left hand end (as viewed in Fig. 3) the governor casing 51. A sleeve 13ᵇ surrounds shaft 13ª through a portion of its length and also surrounds the left hand portion of shaft 13, being split where it surrounds shaft 13, and is clamped in tight frictional engagement with shaft 13 by a clamping nut 13ᶜ having at one end a screw threaded portion engaging a screw threaded portion 13^d of the sleeve 13^b, and having a tapered portion 13^e engaging a correspondingly tapered portion 13^f of sleeve 13^b. It will be seen that by screwing up the nut 13^c upon the sleeve 13^b, the end portion of that sleeve 13^b is pressed tightly against shaft 13. Shaft 13^a has a "spigot" 13^g fitting within a central recess 13^h in the end of shaft 13.

Upon sleeve 13^b is mounted a cam 16 for operating the air admission and main exhaust valves 8 and 9 respectively. This cam 16 engages a rocker 17 to operate the main exhaust valve, and also engages another rocker 18, connected by a link 19 to a third rocker 20, to operate the air admission valve 8.

As will be seen, the engine is of the four-cycle injection type. In Fig. 10, 21 designates the fuel pump, and 22 a governor-adjusted cam (shown in dotted lines in Figs. 10 and 11) driven from shaft 13^a, and arranged to operate the fuel pump; the governor-adjusted cam and fuel pump being arranged substantially as shown in my Patent No. 1,015,115, and being arranged to inject oil or other suitable fluid, at or about the end of the compression stroke or beginning of the working stroke, into the sprayer 12, and so into the combustion chamber 7.

23 designates the fuel supply pipe leading from the pump 21 to the sprayer 12.

The governor is of simple construction and comprises two centrifugal governor weights 50 pivoted to a hollow carrier 51 (which also constitutes a casing for the governor) and connected by a link 52, the outward motion of these weights being resisted by a spring 53. The cam 22 is pivoted to the carrier 51 at 51^a, and an arm 54, pivoted at the center of rotation, as shown in Fig. 3, and connected by a link 55 with one of the governor weights 50, is provided with a pin 54^a engaging the curved outer surface 22^a of cam 22; the construction being such that as the governor weights move outward the pin 54^a, moving over the surface 22^a of cam 22 draws the cam 22 inward; the curvature of surface 22^a being such as to produce this effect as pin 54^a moves toward the pivotal point 51^a of cam 22. When the governor weights 50 move inward, and therefore when the pin 54^a moves away from the pivotal point 51^a of cam 22, a spring 56 moves the cam 22 outward. The pump plunger 57 is provided at its outer end with an anti-friction roller 58 adapted to be engaged and actuated by said cam. A hand lever 44 is also provided whereby the fuel pump may be operated by hand; and a spring 59 is provided which tends to hold the pump plunger and the hand lever 44 outward, in the position shown in Fig. 10.

It will be obvious that as the shaft 13^a rotates, the pump plunger 57 will be operated once for each rotation of shaft 13^a, provided the pump operating cam 22 be out far enough to engage the roller 58; and it will also be obvious that the length of stroke of the pump plunger 57, and therefore the amount of oil injected, will be proportionate to the distance the cam 22 is held outward by the governor weights 50; so that the amount of oil injected by each operation of the pump is directly under the control of the centrifugal governor. It will further be obvious that by rotating the shaft 13^a more or less with respect to the shaft 13, the time of the injection may be varied. It is to accomplish such rotation of shaft 13^a relative to shaft 13 that the mechanism shown in Figs. 3 to 6 inclusive is provided.

As shown in Figs. 3 to 6 inclusive, shafts 13 and 13^a are drivingly connected by a feather ring 60 having feather portions 61 adapted to move longitudinally in slots 62 of sleeve 13^b and having other feather portions 63 adapted to move longitudinally in helical slots 64 of shaft 13^a. It will be obvious that when feather ring 60 is held against longitudinal motion with respect to shafts 13 and 13^a, these two shafts will be held in fixed relation to one another; and it will be obvious that if feather ring 60 be moved longitudinally with reference to shafts 13 and 13^a, then shaft 13^a will be rotated somewhat with reference to shaft 13. For so holding and so moving the feather ring 60, I provide on sleeve 13^b another sleeve 65 having an enlarged end portion 66 within which feather ring 60 is seated and in which it is held by a cap 67^a screwing upon the end of sleeve 65. The key ring 60 is thus held against longitudinal motion with respect to sleeve 65. Sleeve 65 is screw threaded exteriorly, and on it is mounted a hand wheel 67, likewise screw threaded to engage the threads of sleeve 65, and forming a nut, with respect to sleeve 65. This hand wheel 67 is located between fixed abutments 68 projecting from the bracket 91 hereinafter mentioned. These abutments are provided with feathers 69 working in a longitudinal key way 70 of sleeve 65. (See Fig. 3^a). The feathers 69 obviously prevent rotation of the sleeve 65, but permit it to be moved lengthwise by rotation of the hand wheel 67. The effect of such lengthwise motion of sleeve 65 is to cause feathers 61 and 63 of feather ring 60 to travel in grooves 62 of sleeve 13^b (fast on shaft 13) and in helical grooves 64 of shaft 13^a, and therefore to force slight rotary motion of shaft 13^a with reference to shaft 13, thereby varying the time of action of the governor cam 22 on the plunger 57 of the fuel pump 21, and thereby varying the time of injection.

In a mechanism such as 13, 13^a, 13^b, 60, 65, the essential condition is that the keyways

(62 and 64) of the driving and driven members (13 and 13^a) shall be of different pitch. This condition is present in the mechanism shown, for the keyways 62 are helices of infinite pitch, while the keyways 64 are of finite pitch.

In practice, sleeve 65 is made of a metal quite different from the metal of which sleeve 13^b and cam 16 are made, to avoid any possibility of "seizing" of sleeve 65 due to accidental heating. The feather ring 60 is also made of a metal different from that of the sleeve 13^b and shaft 13^a. Hard Babbitt metal or other similar alloy is a very suitable material for feather ring 60, and if desired this feather ring may be formed by casting it *in situ*, just as Babbitt bearings are often cast.

The main cam 16 has a sleeve extension 71 upon which is mounted a second cam 72 for operating the auxiliary exhaust valve 10. There is considerable clearance between this sleeve-extension 71 and the sleeve 13^b, such clearance constituting a recess in which the sleeve 65 may travel longitudinally.

As shown particularly in Fig. 9, the cam 72 actuates the auxiliary exhaust valve by engaging an anti-friction roller 73 carried by a follower lever 74 provided with a link 75 engaging the stem 76 of said auxiliary exhaust valve. A spring 77 tends to hold the follower lever 74 up. The cam 72 is so set that it engages the anti-friction roller 73 and opens the supplemental or auxiliary exhaust valve 10, an instant before the main cam 16 engages the anti-friction roller of lever 17 and opens the main exhaust valve 9. Since the auxiliary exhaust valve 10 is so opened an instant before the main exhaust valve is opened, it follows that the opening of the auxiliary exhaust valve 10 permits escape of a considerable portion of the gas existing in the engine cylinder near the end of the expansion stroke, so that the main exhaust valve 9 is opened against relatively low pressure. The main exhaust valve 9 of necessity must have considerable area, since it must not restrict materially the exhaust of the burnt gas during the rearward stroke of the piston. A relatively small supplemental exhaust valve, such as the valve 10, will serve to release the pressure at the end of the expansion stroke; and since, with the pressure so released, the pressure opposing the opening of the main exhaust valve is small, it follows that said main exhaust valve requires relatively little power to operate it when the supplemental exhaust valve 10 is employed; while on the other hand, the diameter of the supplemental exhaust valve 10 being small, but little power is required to open that supplemental exhaust valve. The same supplemental exhaust valve is used as a starting valve to reduce the compression in the engine cylinder when the engine is being started. To this end a "half compression cam" 78 (Figs. 3, 4 and 9) is mounted upon the extension 71 of main cam 16, along side of the cam 72. As shown particularly in Figs. 3 and 4, the anti-friction roller 73 is arranged to be shifted from the position shown in Fig. 3, in which that roller will be engaged by cam 72, to the position shown in Fig. 4, in which that roller will be engaged both by cam 72 and by cam 78. A removable pin 79 is provided which pin may be thrust into either of the holes 80 and 81 of the axle 82 of anti-friction roller 73. When the pin 79 is in hole 80, the roller 73 is in position to be engaged by cam 72 only; when said pin 79 is in hole 81, the roller 73 is in position to be engaged by both cams 72 and 78. The effect of the engagement of cam 78 with roller 73 is to hold the auxiliary valve 10 open during a portion of the compression stroke in the engine cylinder, thereby reducing the compression in the cylinder and making it easier for the engine to pass through the compression period.

The auxiliary exhaust valve 10 and the mechanism for operating the same, except in the specific form herein shown wherein the cam 78 is mounted upon the sleeve extension 71 of the main valve 17, is claimed in my companion application Docket No. 4213, itself a division of my prior application Serial No. 755,950, filed March 21, 1913. The stem of the main admission valve 8 (Figs. 7 and 8) carries a guide and cushion-piston 82 working within a recess 83 in the valve cage 84, such recess 83 forming a cylinder within which the cushion-piston 82 may work; the piston 82 and cylinder 83 together forming a cushioning device to prevent hammering of the valve 8 against its seat. The hollow piston 82 also forms an inclosure for the valve spring 85, serving to protect that spring and the valve stem against dirt and dust. As will be observed by comparison of Fig. 7 with Figs. 8, 1 and 2, the rocker 20 comprises two rocker arms 20^a, spaced well apart laterally, cross-connected by the rods 20^b, connected by links 20^c to the cushion-piston 82, and pivoted to the valve cage 84. The rocker 18 is also double comprising two members 18^a (Fig. 2) spaced well apart laterally, cross-connected by the rod 18^b, and pivoted to a bracket projecting from the engine frame. By employing double rockers 20 and 18, spaced well apart laterally, and with their pivotal bearings well separated, I avoid any tendency toward cramping of the joints of the valve gear, such as sometimes exists in some engines; which cramping, if it exists, interferes greatly with the free opening and closing of the valve. In like manner, the following lever 17, for operating the exhaust valve is made double, *i. e.*, is formed in two parts 17^a (see Figs. 2 and 8) well separated from each other laterally, and this follower lever is connected to the stem 86 of the main exhaust valve 9 by means of links 87 (see Fig. 8) and a block 88 mounted within a block 89 carried by said valve stem 86, said block 89 being provided with a screw 90 abutting against the end of stem 86; whereby the time of opening of the exhaust valve may be varied slightly and compensation may be made for wear of that valve.

The shaft 13^a is supported by a bearing in a bracket 91 removably secured to the rear of the engine frame and in effect forming a part of that engine frame; and the bosses 68, between which the hand wheel 67 of the valve gear is located, project from this bracket 91; all as shown in Fig. 4^a. It will be apparent that the valve gear shafts, sleeves and cams may be dismounted very readily (if for any reason dismounting of the valve gear is required) by merely backing off the clamping ring 13^c, backing off the cap 67, and then slipping out shaft 13^a; or that the valve gear shafts, sleeves and cams may be removed bodily after backing off clamping ring 13^c by detaching the bracket 91 from the engine frame. This may be done without interference with the cylinder head 6, and without touching that cylinder head 6. The support of the valve gear shaft and associated parts by a bracket secured to the engine frame and forming a part of that engine frame, and the novel engine frame herein illustrated but not specifically described, are claimed in my companion application Docket No. 4160. The centrifugal governor herein described and illustrated is covered in my Patent No. 1,015,115, dated January 18, 1912.

What I claim is:

1. Injection timing mechanism for internal combustion engines, comprising in combination driving and driven shafts arranged in line, a fuel pump, operating means for said pump operated by said driven shaft, a sleeve surrounding the driven shaft and in driving connection with the driving shaft and forming an extension thereof, said driven shaft and sleeve having keyways, the keyway of one such member being helical and the keyway of the other such member having a pitch different from the pitch of said helical keyway, a feather member movable longitudinally with respect both to said driven shaft and to said sleeve and having feather portions movable in the keyways of said driven shaft and sleeve, and means for moving longitudinally such longitudinally movable feather member.

2. Injection timing mechanism for internal combustion engines, comprising in combination driving and driven shafts arranged in line, a fuel pump, operating means for said pump operated by said driven shaft, a sleeve surrounding the driven shaft and in driving connection with the driving shaft and forming an extension thereof, said driven shaft and sleeve having keyways, the keyway of one such member being helical and the keyway of the other such member being straight, a feather member movable longitudinally with respect to both said driven shaft and to said sleeve and having feather portions movable in the keyways of said driven shaft and sleeve and means for moving longitudinally such longitudinally movable feather member.

3. Injection timing mechanism for internal combustion engines, comprising in combination driving and driven shafts arranged in line, a fuel pump, operating means for said pump operated by said driven shaft, a sleeve surrounding the driven shaft and in driving connection with the driving shaft and forming an extension thereof, said driven shaft and sleeve each having keyways, the keyways of one such member being helical and the keyways of the other such member having a pitch different from the pitch of such helical keyways, a feather ring surrounding said sleeve and having feather portions movable in the keyways of such sleeve and other feather portions, projecting from the first-mentioned feather portions, and movable in the keyways of said driven shaft, and means for moving longitudinally such longitudinally movable feather ring.

4. Injection timing mechanism for internal combustion engines, comprising in combination driving and driven shafts arranged in line, a fuel pump, operating means for said pump operated by said driven shaft, a sleeve surrounding the driven shaft and in driving connection with the driving shaft and forming an extension thereof, said driven shaft and sleeve having keyways, the keyway of one such member being helical and the keyway of the other such member having a pitch different from the pitch of said helical keyway, a feather member movable longitudinally with respect both to said driven shaft and to said sleeve and having feather portions movable in the keyways of said driven shaft and sleeve, and means for moving longitudinally such longitudinally movable feather member comprising an externally threaded sleeve mounted to slide longitudinally upon said first mentioned sleeve, and connected to said feather member to move same longitudinally in both directions, a screw-threaded nut mounted on said threaded sleeve and arranged to be rotated, and means for holding such nut against longitudinal motion.

5. Injection regulating and timing mechanism for internal combustion engines, comprising in combination driving and driven

shafts, a fuel pump, a speed governor driven by said driven shaft and comprising means arranged to operate such pump at a predetermined point in the rotation of such driven shaft and to vary the extent of operation of the pump in accordance with the operation of said governor, and means drivingly connecting said driving and driven shafts comprising means which holds the driving and driven shafts in fixed relation during their rotation or, at will, rotates the driven shaft with respect to the driving shaft, thereby varying the time of operation of the pump.

6. Injection regulating and timing mechanism for internal combustion engines, comprising in combination driving and driven shafts arranged in line, a fuel pump, a speed governor driven by said driven shaft and comprising a cam, arranged to operate said fuel pump, and means for varying the position of such cam in accordance with varying speed of the driven shaft, and means for drivingly and adjustably connecting said driving and driven shafts comprising a member, shiftable longitudinally with respect to said shafts, and having a screw connection with one of the shafts and a longitudinal sliding connection with the other, whereby by shifting said longitudinally shiftable member the driven shaft may be rotated with reference to the driving shaft.

7. Valve gear and injection timing mechanism for internal combustion engines, comprising in combination driving and driven shafts and means drivingly connecting said shafts arranged to hold said shafts in fixed relation to each other or at will to rotate the driven shaft with reference to the driving shaft, an injection pump, means driven by the driven shaft for operating said pump, said driving shaft having a sleeve extension inclosing a portion of the driven shaft, a valve operating cam on said sleeve extension, and valve operating means operated by said cam, whereby rotation of the driven shaft with reference to the driving shaft to change the time of operation of the pump does not change the time of operation of the valve operating means.

8. Valve gear and injection timing mechanism for internal combustion engines, comprising in combination driving and driven shafts arranged in line, said driving shaft having a sleeve extension inclosing a portion of the driven shaft, a fuel pump, operating means for said pump operated by said driven shaft, means drivingly connecting the driving and driven shafts comprising a feather member having a screw connection with one of said driving and driven shafts, and a longitudinal sliding connection with the other of said shafts, and means for moving said feather member longitudinally comprising a sleeve connected to said feather member and mounted on the sleeve extension of the driving shaft, means for moving such feather member adjusting sleeve longitudinally, a valve operating cam on said sleeve extension of the driving shaft, such valve operating cam having a sleeve extension inclosing said feather-adjusting sleeve and another valve-operating cam on the sleeve extension of said first mentioned cam.

9. An internal combustion engine comprising in combination an engine frame, cylinder, piston, connecting rod, and crank shaft, a shaft extending longitudinally of the engine from near the crank shaft rearwardly, means drivingly connecting the crank shaft to such longitudinal shaft, a bearing for such longitudinal shaft, a valve-shaft bracket removably connected to the engine frame, a second shaft drivingly and detachably connected to said longitudinal shaft and having a bearing in said bracket and valve gear comprising an operating cam carried by said second shaft whereby by detaching said shafts and detaching the bracket from the engine frame, said cam and the shaft carrying it may be removed.

10. An internal combustion engine comprising in combination an engine frame, cylinder, piston, connecting rod, and crank shaft, a shaft extending longitudinally of the engine from near the crank shaft rearwardly, means drivingly connecting the crank shaft to such longitudinal shaft, a bearing for such longitudinal shaft, a cam-shaft bracket removably connected to the engine frame, a second shaft having a bearing in said bracket, a sleeve surrounding said second shaft and drivingly and detachably connected to and forming an extension of said longitudinal shaft, means engaging said sleeve and second shaft for drivingly connecting the same, and valve gear comprising an operating cam mounted upon said sleeve whereby by disconnecting said sleeve and longitudinal shaft and disconnecting said bracket from the engine frame, the said cam and the shaft and sleeve carrying it may be removed from the engine.

11. An internal combustion engine comprising in combination an engine frame, cylinder, piston, connecting rod, and crank shaft, a shaft extending longitudinally of the engine from near the crank shaft rearwardly, means drivingly connecting the crank shaft to such longitudinal shaft, a bearing for such longitudinal shaft, a valve-shaft bracket removably connected to the engine frame, a second shaft having a bearing in said bracket, a sleeve surrounding said second shaft and drivingly and detachably connected to and forming an extension of said longitudinal shaft, means engaging said sleeve and second shaft for drivingly connecting the same, and valve gear comprising an operating cam mounted upon said sleeve, whereby by disconnecting said sleeve and

longitudinal shaft and disconnecting said bracket from the engine frame, the said cam and the shaft and sleeve carrying it may be removed from the engine, a fuel injection pump, and a speed governor mounted on said second shaft and comprising means for operating said fuel pump.

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

LEON WYGODSKY.

Witnesses:
H. M. MARBLE,
PAUL H. FRANKE.