No. 730,433. PATENTED JUNE 9, 1903.

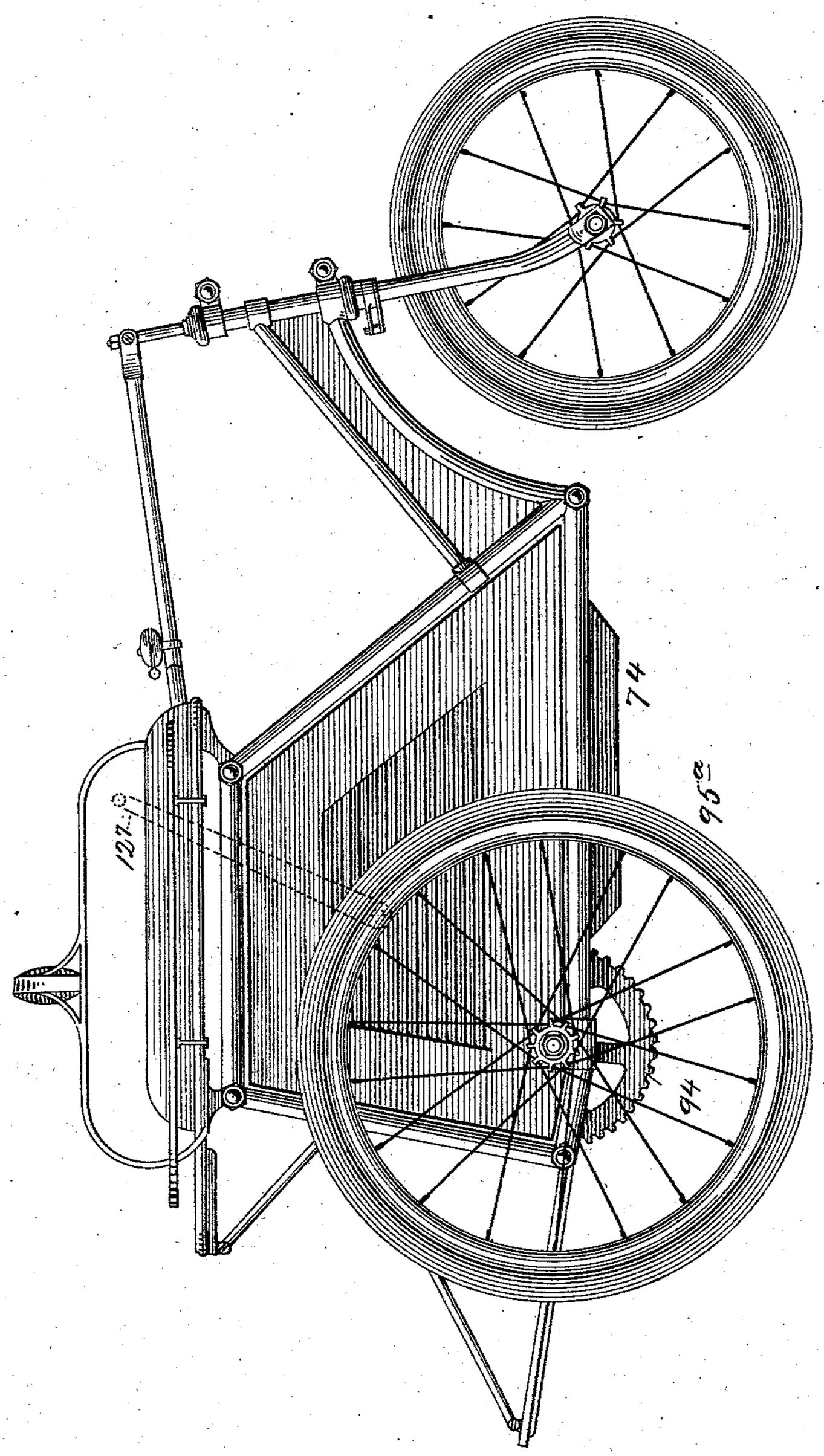
S. M. BALZER.

GAS OR OIL MOTOR.

APPLICATION FILED DEC. 17, 1897.

NO MODEL. 8 SHEETS—SHEET 1.

Fig. 1.



Witnesses
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F. E. Turner

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By his Attorney
F. F. Bourne.

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NO MODEL. 8 SHEETS—SHEET 2.

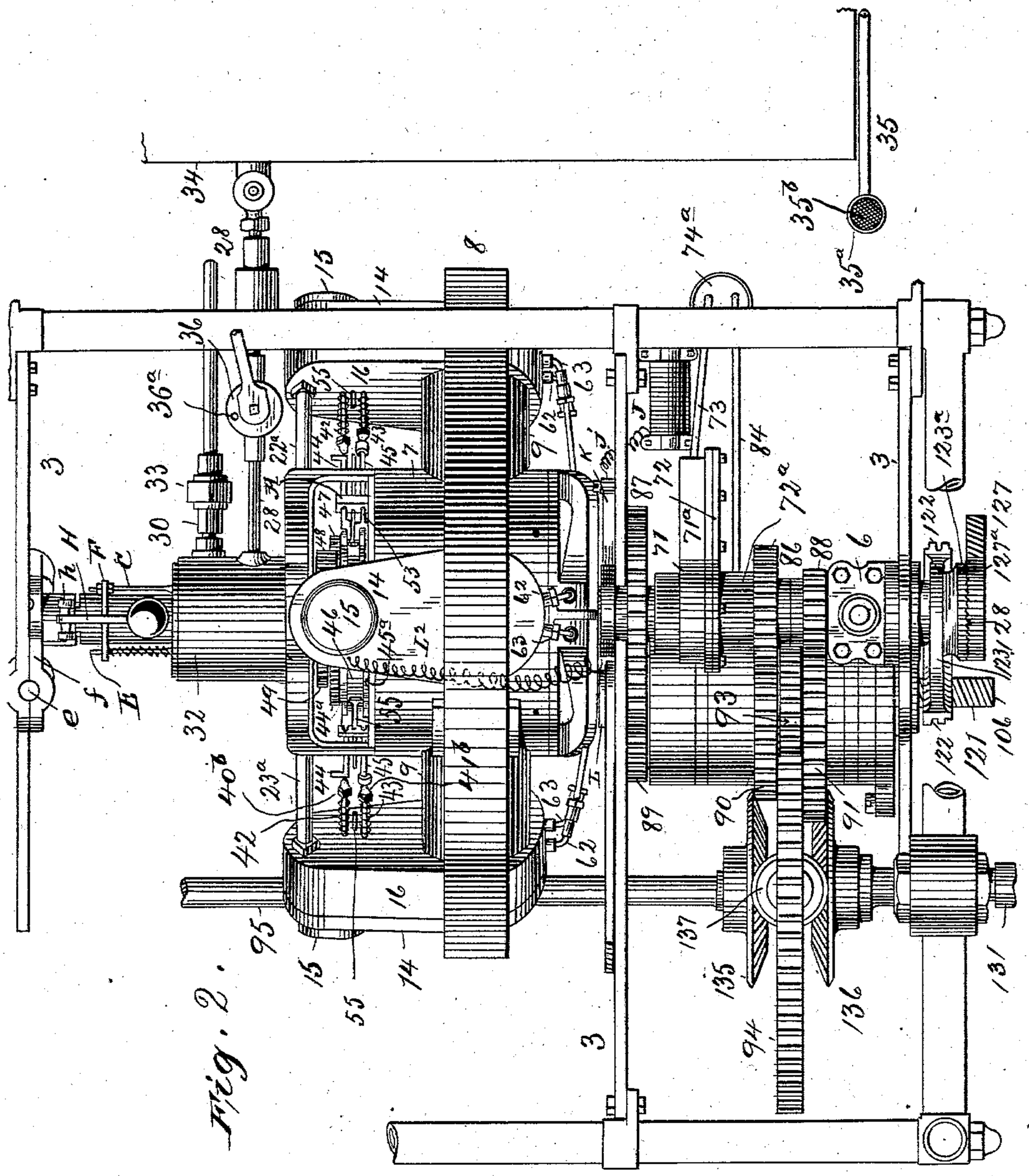

Fig. 2.

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NO MODEL. 8 SHEETS—SHEET 3.

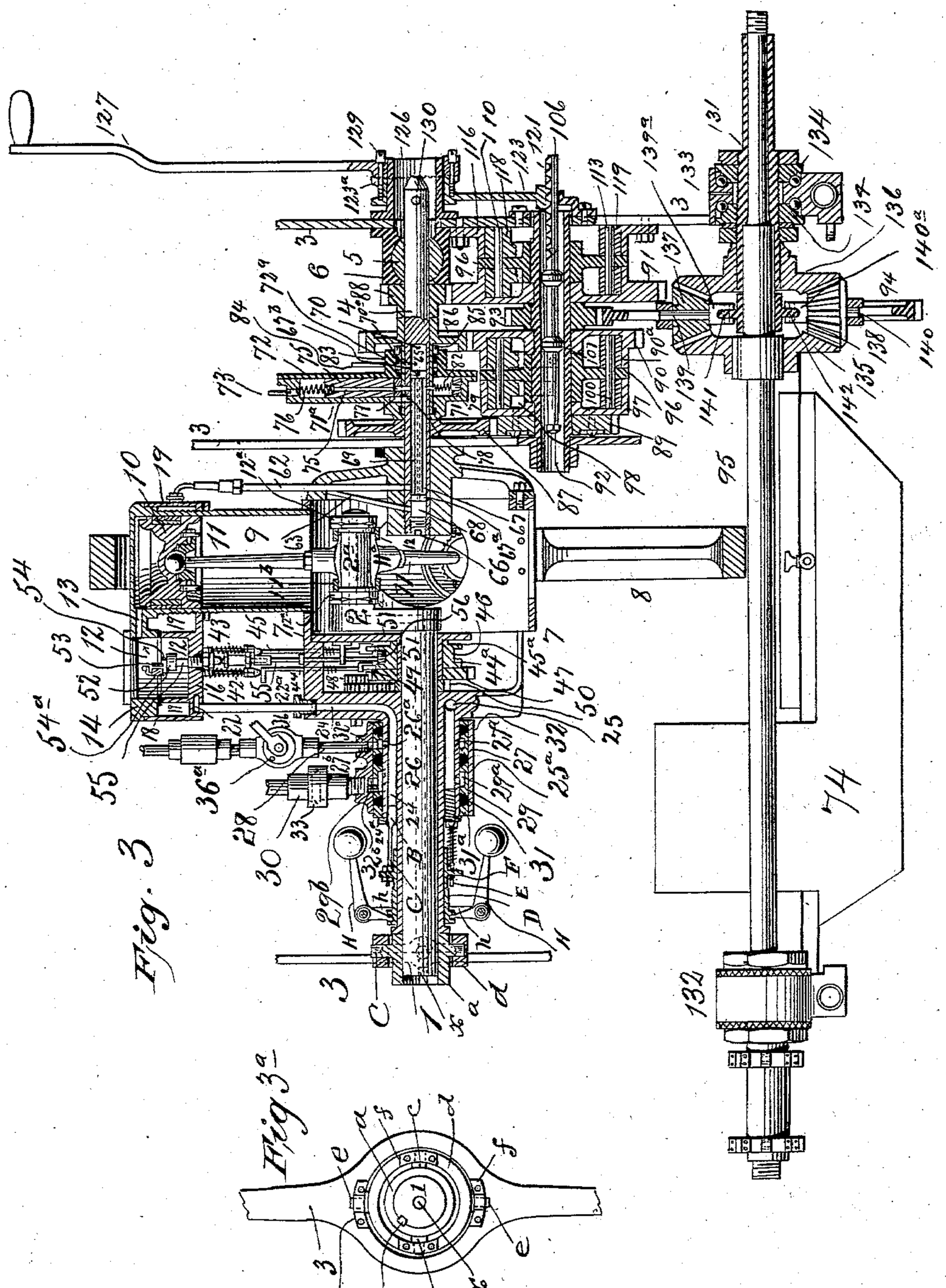

Fig. 3

Fig. 3a

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NO MODEL.

8 SHEETS—SHEET 4.

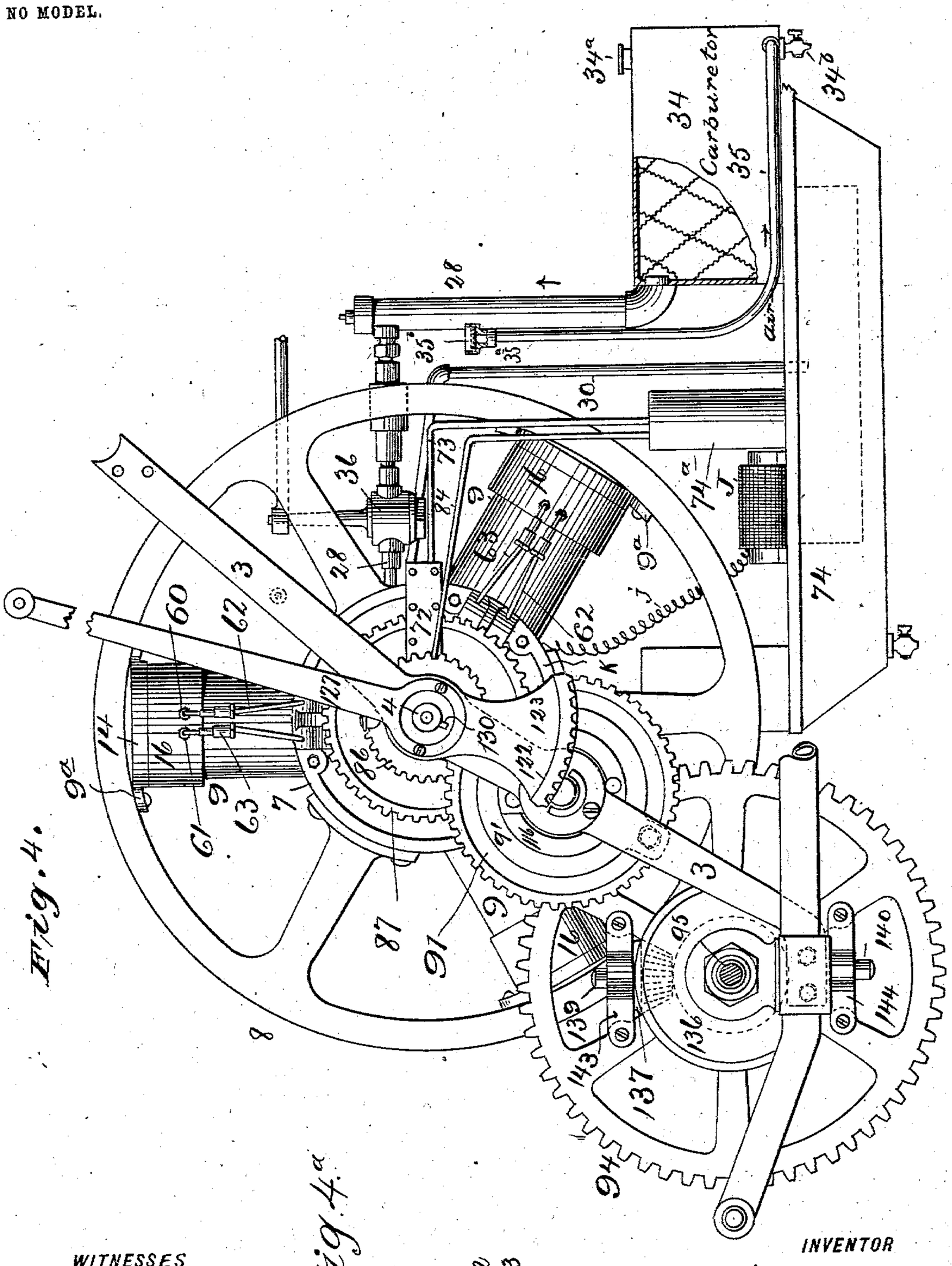

Fig. 4.

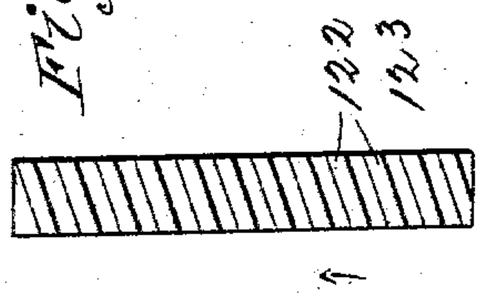

Fig. 4a.

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NO MODEL. 8 SHEETS-SHEET 5.

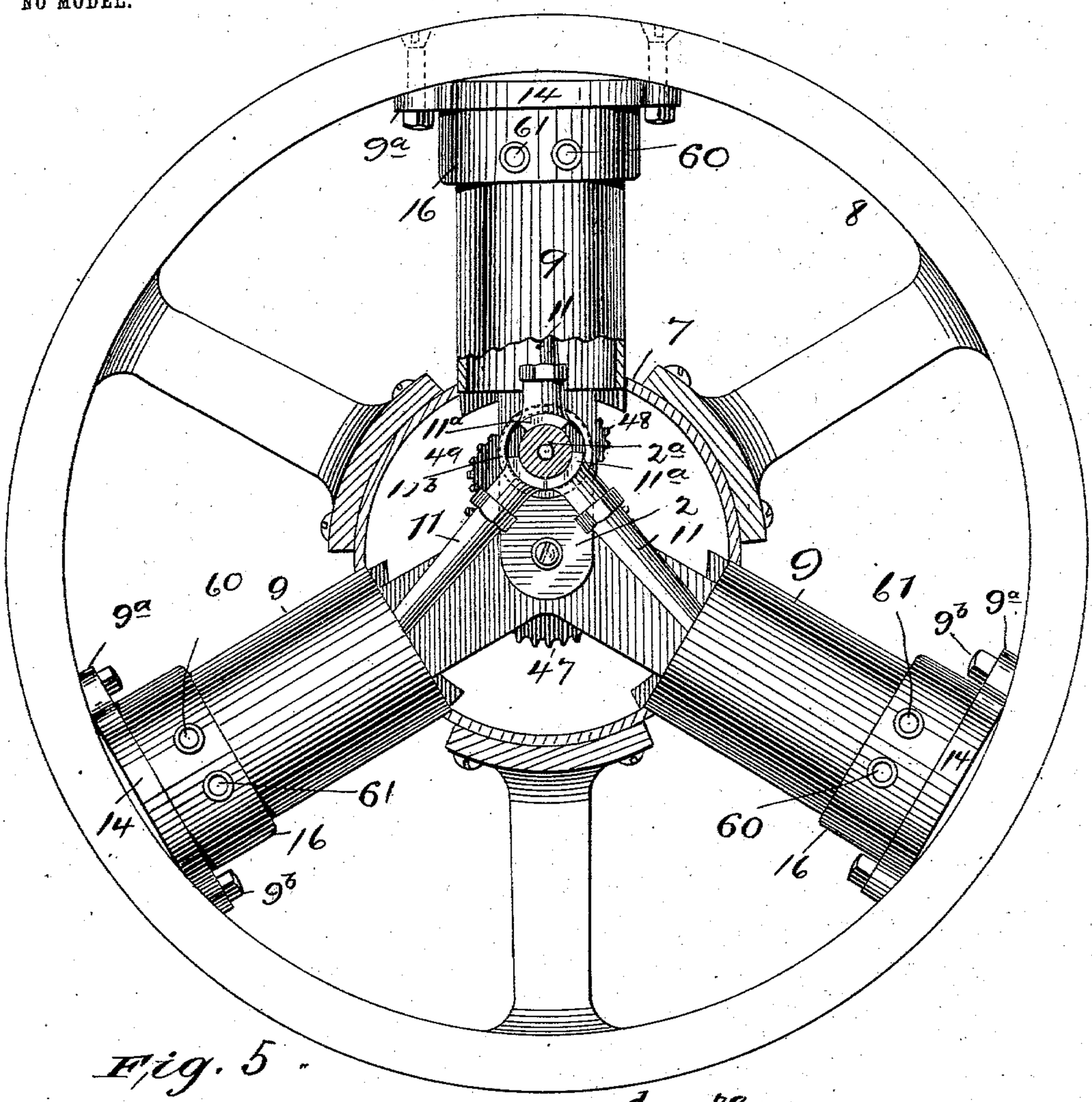

Fig. 5.

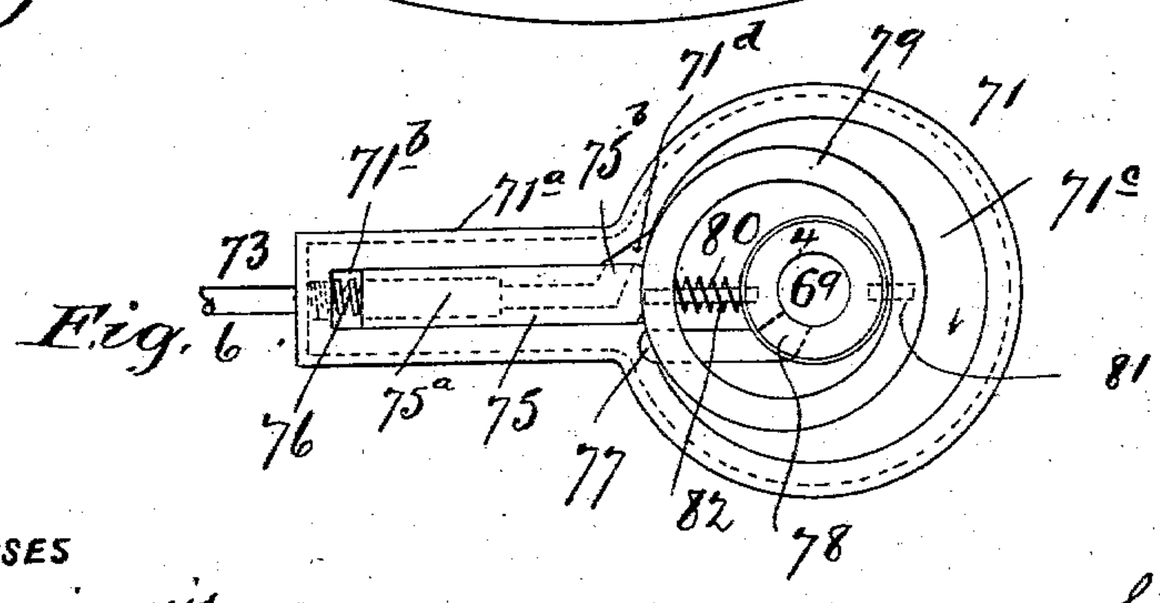

Fig. 6.

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Fig. 7.

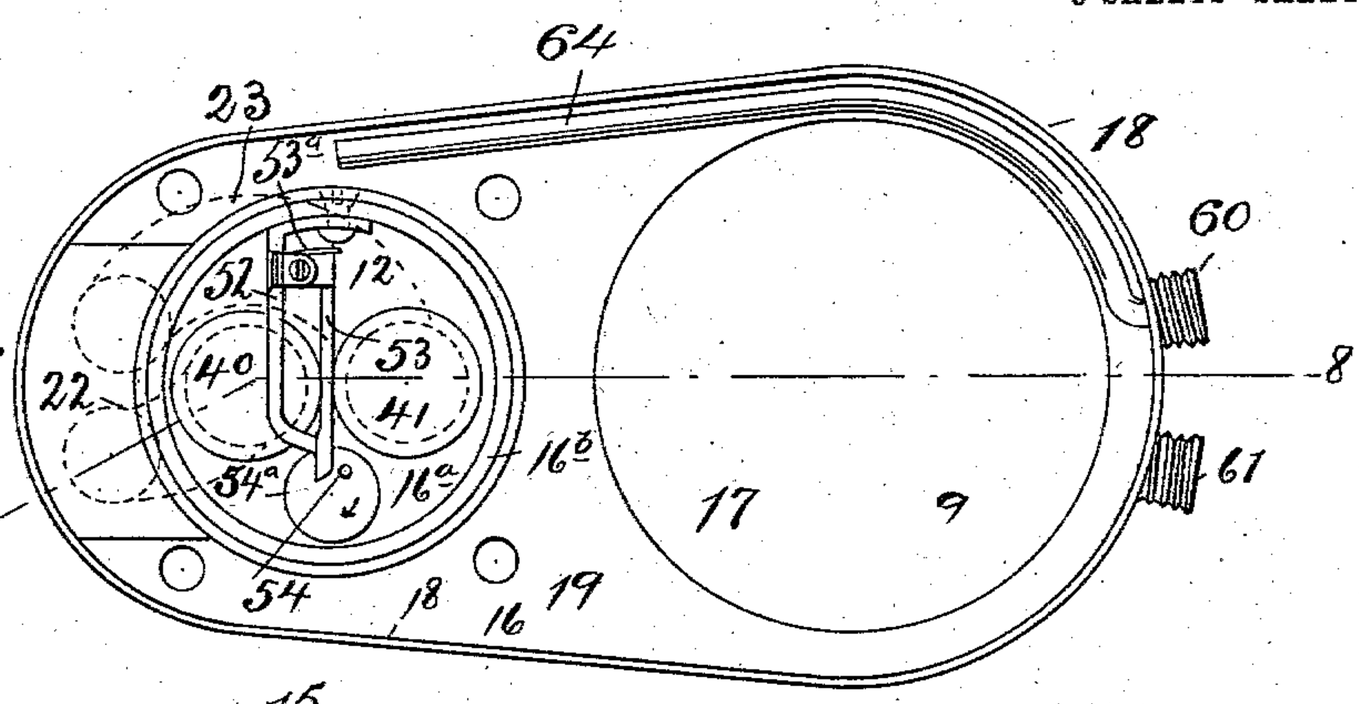


Fig. 8.

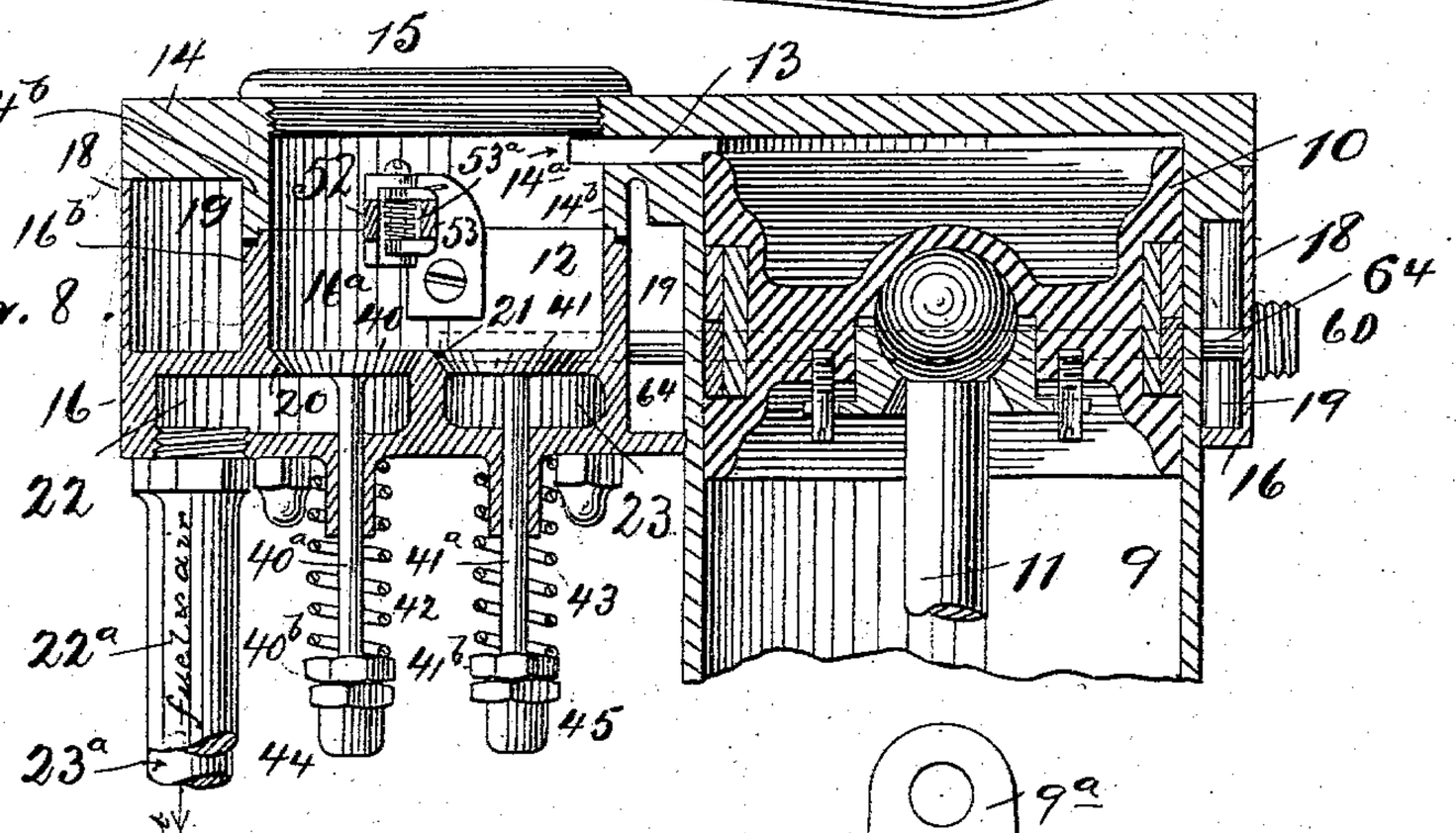
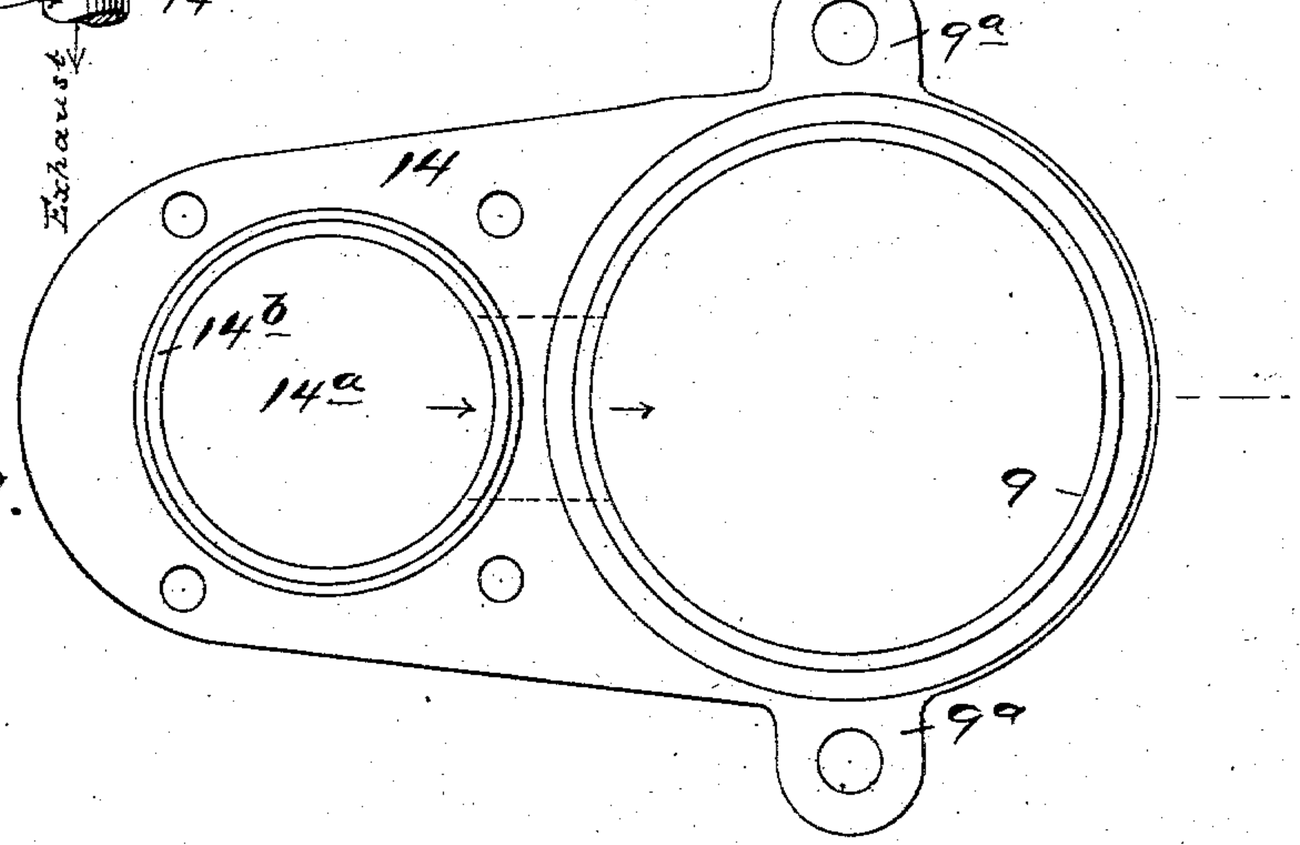


Fig. 9.



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NO MODEL. 8 SHEETS—SHEET 7.

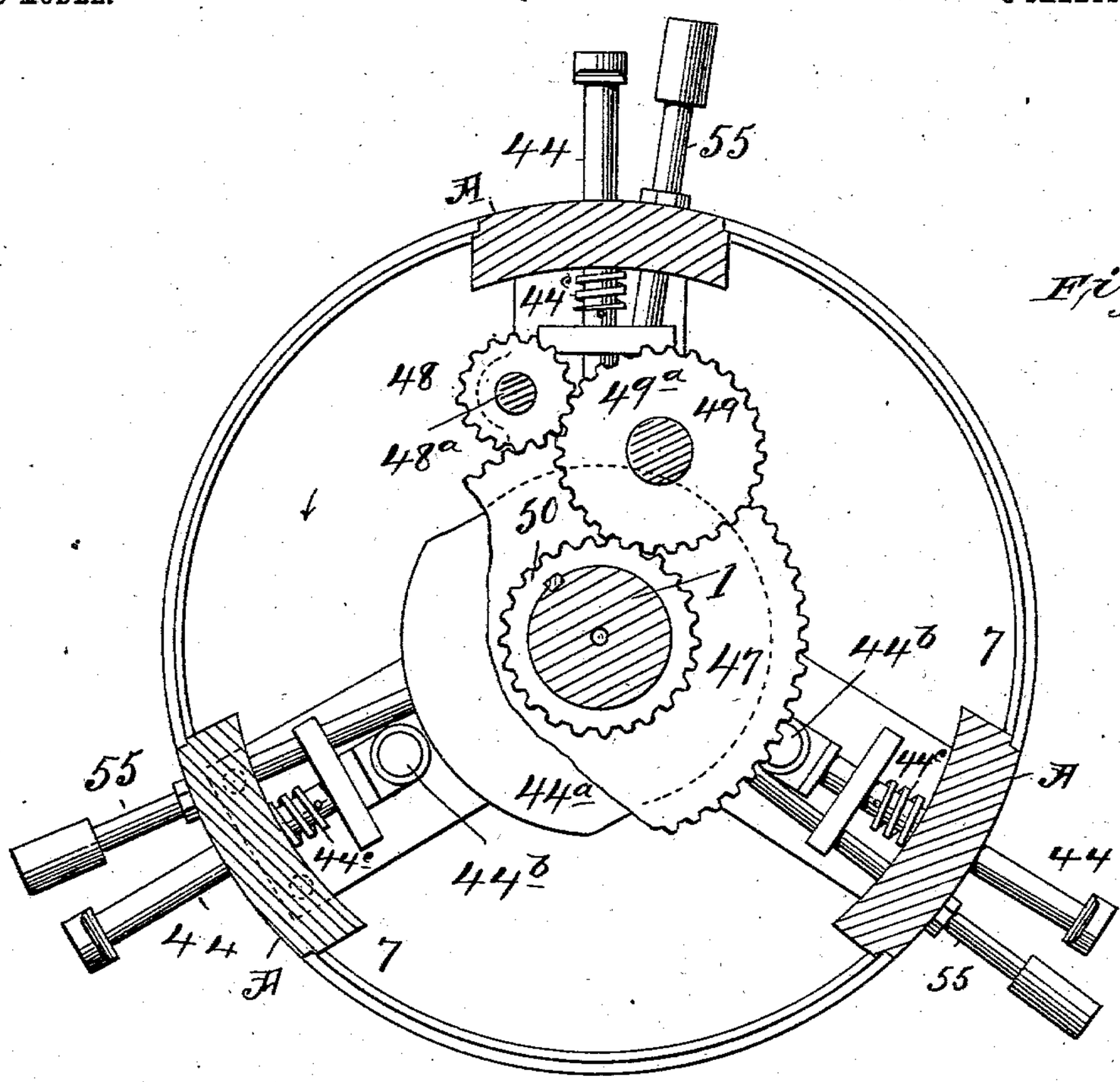

Fig. 10.

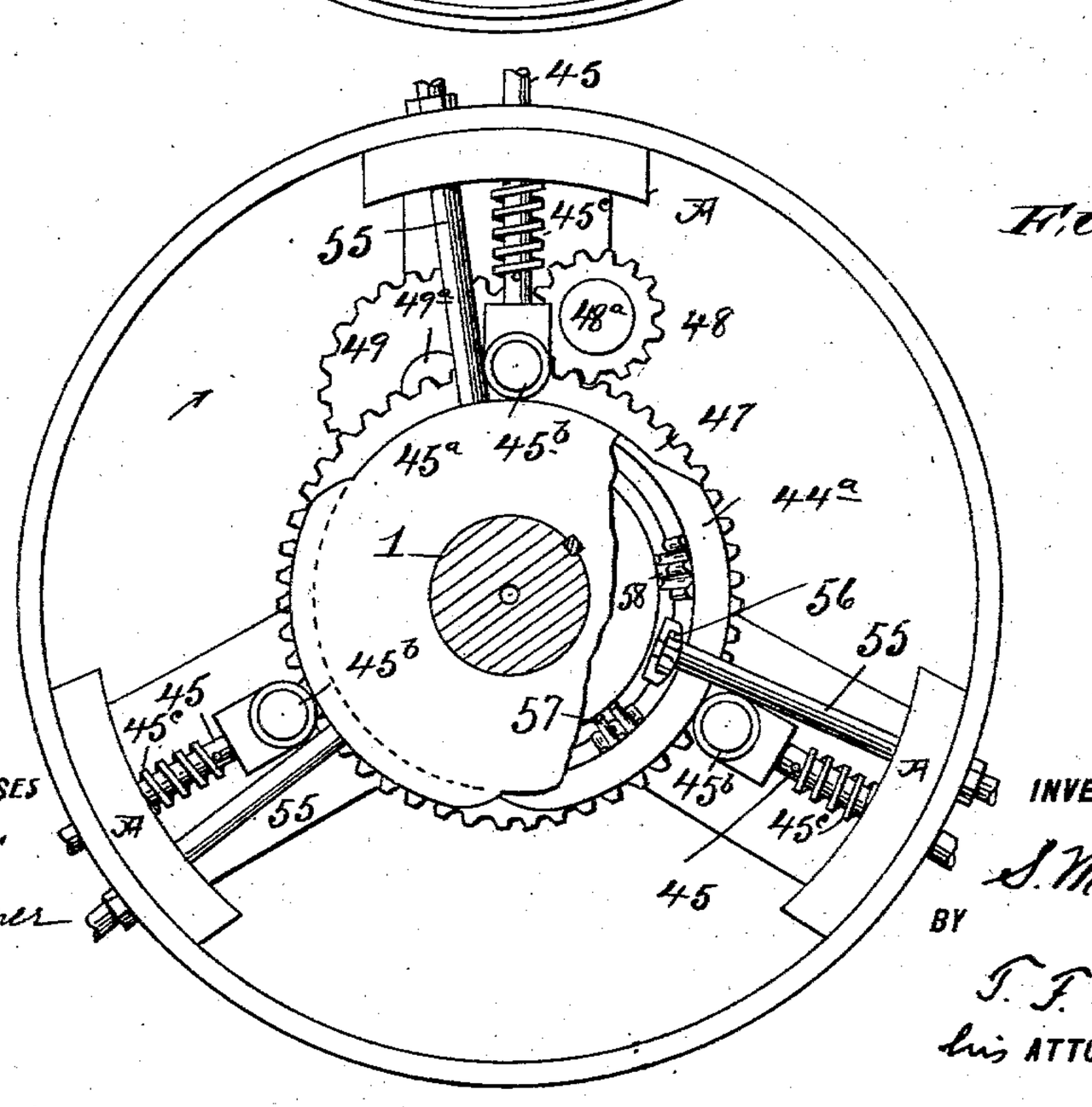

Fig. 11.

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NO MODEL. 8 SHEETS—SHEET 8.

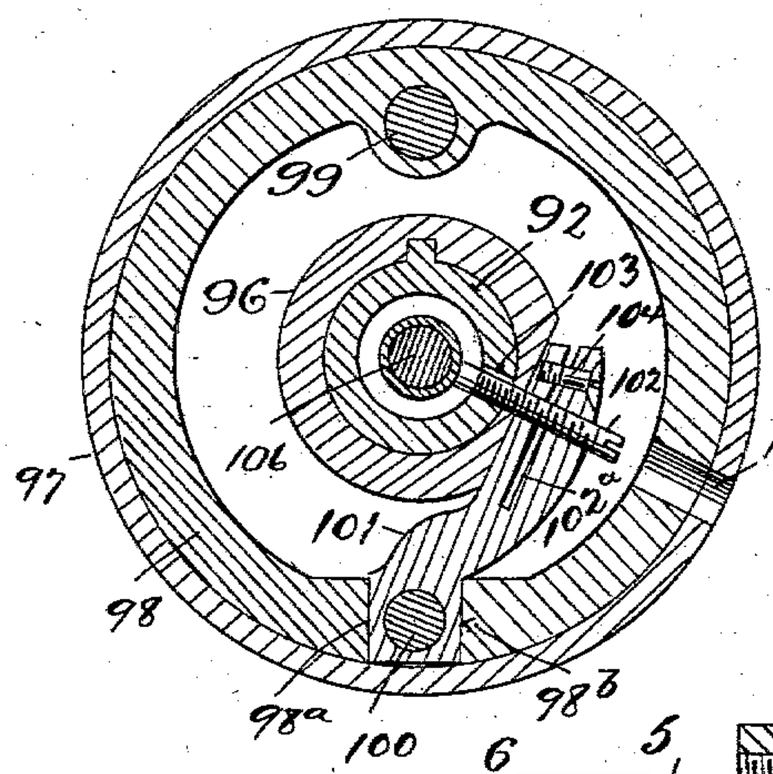
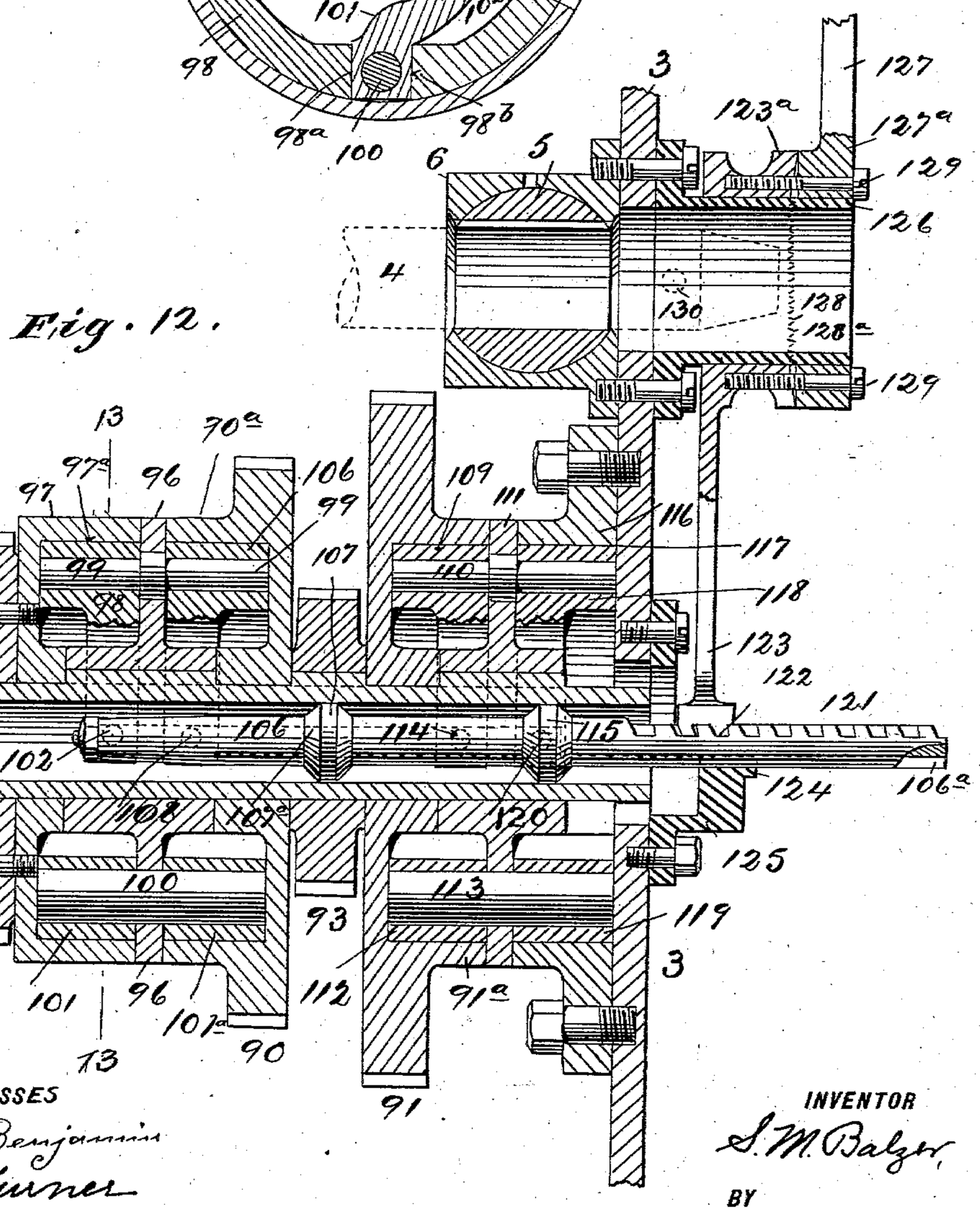


Fig. 13.



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No. 730,433. Patented June 9, 1903.

UNITED STATES PATENT OFFICE.

STEPHEN M. BALZER, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO BALZER MOTOR COMPANY, INCORPORATED, A CORPORATION OF DELAWARE.

GAS OR OIL MOTOR.

SPECIFICATION forming part of Letters Patent No. 730,433, dated June 9, 1903.

Application filed December 17, 1897. Serial No. 662,327. (No model.)

To all whom it may concern:

Be it known that I, STEPHEN M. BALZER, a citizen of the United States, residing in New York city, county and State of New York, have invented certain new and useful Improvements in Gas or Oil Motors, of which the following is a specification.

One object of my invention is to provide improvements in rotary gas or oil motors; and to this end the invention embraces improvements in the construction of the main parts of the motor, to improved means for feeding a propulsive medium to the motor and for exhausting it therefrom, to improved means for causing a circulation of water around the combustion and explosion chambers of the cylinder, to improved means for producing a spark in the explosion-chamber at the proper time, and to improved means for regulating the speed of the motor.

Another object of the invention is to provide improved means for communicating different speeds from the motor to a driven part without altering the speed of the motor, and in connection with this part of the invention I have shown the motor as applied to a vehicle, whereby the same may be driven at varying speeds and also brought to a rest without stopping the motor.

My invention also embraces the novel details of improvement and the combinations of parts, that will be more fully hereinafter set forth and then pointed out in the claims.

Reference is to be had to the accompanying drawings, forming part hereof, wherein—

Figure 1 is a side elevation of a motor-vehicle equipped with my improvements. Fig. 2 is a plan view of the improvements, showing part of the framing that supports the device in a vehicle. Fig. 3 is a cross-section thereof. Fig. 3ª is a partly sectional detail view of a shaft-support. Fig. 4 is a side elevation, partly broken, of the parts shown in Fig. 2. Fig. 4ª is a detail face view of a toothed sector-arm. Fig. 5 is a partly broken side elevation of the motor or casing and cylinders and connected parts. Fig. 6 is a detail view of a pump used in circulating water around the combustion and explosion chambers of the cylinders. Fig. 7 is a plan view, with the top removed, of the cylinder and explosion-chamber. Fig. 8 is a vertical section on the plane of the line 8 8 in Fig. 7. Fig. 9 is an inverted plan view of the casting 14 at the end of the cylinder. Fig. 10 is a partly sectional side detail view showing means for operating the gas and air valves. Fig. 11 is a similar view at right angles to Fig. 10, also illustrating the devices for operating the sparkers. Fig. 12 is an enlarged detail sectional view of the gears and friction devices for communicating motion from the motor to a driven part or axle, and Fig. 13 is an enlarged detail sectional view on the plane of the line 13 13 in Fig. 12.

In the accompanying drawings, in which similar numerals and letters of reference indicate corresponding parts in the several views, 1 indicates the main shaft of the motor, having a crank 2, and in the example illustrated the shaft 1 is held from rotation by being secured to a suitable frame 3.

4 is a shaft supported by the frame 3 and held in axial alinement with the shaft 1, the shaft 4 being rotative. The shafts 1 and 4 perform the function of a single crank-shaft, with this exception that one part is stationary and the other part is rotative. The shaft 1 is shown supported at its outer end by a universal joint, wherein *a* is a ring mounted on shaft 1 and secured thereto by a key *b*, the ring *a* having pivots or lugs *c*, that are pivotally carried by a ring *d*, which also has pivots *e* at right angles to pivots *c* and pivotally connected with frame 3. The pivots *c* and *e* may be held on the ring *d* and frame 3 by clamps *f*. (See Figs. 3 and 3ª.) The shaft 4 is shown provided with a ball 5, that is journaled in a cavity in a bearing 6, the bearing 6 being made in two parts and bolted together, as usual. The bearing 6 is carried by frame 3. The shaft 4 passes through and is secured to the ball 5, and the openings in the bearing 6, through which the shaft passes, are larger than said shaft, whereby the bearings 6 and shaft 4 may have oscillatory or lateral movement. The movable supports for shafts 1 and 4 allow the frame 3 to have slight independent movement, so that the shafts will not bind in their supports. (See Fig. 3.)

7 is a frame or casing of suitable construction and adapted to carry the cylinders and

certain operative parts of the motor. The frame 7 is journaled on the shaft 1 and is rigidly screwed or otherwise secured to the shaft 4, so that it may rotate on the former and carry the latter around with it.

8 is a fly or balance wheel carried by frame 7, and it may be secured thereto by bolts in suitable manner or cast in a single piece therewith.

9 represents cylinders, which are carried by frame 7 and shown set at one hundred and twenty degrees apart and in line with the crank 2, so as to rotate around the latter. (See Figs. 3 and 5.)

10 represents pistons in the cylinders 9, and 11 represents rods connecting the pistons with the crank-pin 2^a. The pistons may be of suitable construction, and the rods 11 are preferably connected to said pistons by a ball-and-socket joint, as shown in Figs. 3 and 8. The rods 11 are shown provided with feet 11^a, having curved ends that correspond to and fit against the periphery of the crank-pin 2^a, (see Fig. 5,) and these feet are shown held upon said crank-pin by means of collars or sleeves 11^b, the width of the feet 11^a being such that they can have oscillating movement on the crank-pin 2^a. (See Figs. 3 and 5.) Furthermore, the exterior surface of the feet 11^a taper or slope toward the pin 2^a, and the collars 11^b are adapted to slide upon these taper surfaces to enable proper adjustment of the feet 11^a upon pin 2^a to hold said pin and feet together in proper operative relation and to take up wear. The collars 11^b are held in position by lock-nuts 11^c, threaded on pin 2^a. (See Fig. 3.) I have shown the shaft 1, crank 2, and pin 2^a as provided with a bore x, and the pin 2^a has one or more lateral apertures leading to the feet 11 for the passage of lubricant from bore x.

The inner ends of the cylinders 9 are shown secured to the frame 7 and open into the interior thereof, and the outer ends of the cylinders are shown secured to the fly-wheel 8 by means of bolts, (see Figs. 3 and 5,) the cylinders being shown provided with flanges 9^a to receive bolts 9^b. The cylinders 9 at their outer ends are connected with an explosion-chamber 12 by a port 13. (See Figs. 3 and 8.)

The explosion-chamber 12 is formed as follows: From one side of the cylinder 9 at its outer end projects an extension 14, that is provided with a recess or opening 14^a, shown formed partially by an annular wall 14^b, the recess or opening 14^a being shown provided with a cap 15 to permit access to chamber 12. The port 13 connects the bore of the cylinder 9 and the opening 14^a and is located in extension 14.

16 is a frame or casting having recess 16^a, that is formed by an annular wall 16^b, which registers with the wall 14^b, the opening 14^a, and the recess 16^a, thereby forming the explosion-chamber 12. As shown, the meeting edges of the walls 14^b 16^b are recessed to form overlapping joints to keep the parts centered and form a tight joint. The frame or casting 16 has an opening 17, adapted to receive the cylinder 9, and this frame is thus mounted upon the cylinder and is suitably secured thereto and is alined with extension 14. The frame or casting 16 has a main outer wall 18, which passes around the cylinder 9 and incloses the walls 14^b 16^b, thereby forming a water-jacket 19 in conjunction with the cylinder and the extension 14, against which the wall 18 abuts, this water-jacket thus inclosing the upper end of the cylinder and the explosion-chamber 12, as will be understood from Figs. 3, 7, 8, and 9, tight joints being made between the parts 14 and 18.

The propulsive medium, in the form of a mixture of gas or oil and air, is to be led to the chamber 12 and there ignited while under compression, and for this purpose I have provided the following arrangement: In the bottom wall of recess 16^a of the frame or casting 16 are two apertures 20 21, which lead to ports 22 23, provided in the frame 16, (see Figs. 7 and 8,) one of these ports being to admit gas or oil and air and the other for the exhaust, as shown, the port 22 being adapted for fuel and the port 23 for the exhaust. To the port 22 is connected a tube 22^a and to the port 23 is connected a tube 23^a. The tubes 22^a 23^a lead to ports 24 25, respectively, that are provided in the frame 7, there being one of each of said ports in the frame 7 for each cylinder, and the ports 24 are adapted to receive gas or oil and air, and the ports 25 carry the exhaust. For this purpose I have shown the port 24 at one part as extending lengthwise of shaft 1 in an extension or sleeve 26, carried by frame 7. (See Fig. 3.) In said extension or sleeve are apertures 26^a, that lead to each port 24. Around the extension 26 and overlying apertures 26^a is a ring 27, provided with an interior annular groove 27^a, alined with the openings 26^a, and this ring 27 also has an aperture 27^b to receive gas and air from a feed-pipe 28. 29 is another ring surrounding extension 7 and provided with an interior annular groove 29^a, alined with apertures 25^a in extension 26, that lead to the ports 25, that extend lengthwise of extension 26, and in this ring 29 is an aperture 29^b, that leads to an exhaust-pipe 30. Between the rings 27 29 and on the outer sides thereof is placed packing 31 to produce a tight joint, the packing and rings 27 29 being held in place by a suitable bushing 31^a. These rings, the packing, and the bushing are inclosed within a bearing 32, having an annular bore to receive them, and this bearing has apertures 32^a 32^b, that communicate with the apertures 27^b 29^b and with the inlet-tube 28 and the exhaust-tube 30, respectively. A suitable valve 33 is connected with the exhaust-tube 30 and arranged to prevent back pressure, while permitting the passage of the spent products of combustion. The exhaust-tube 30 leads, by preference, to a suitable water-tank.

The inlet-tube 28 leads to a suitable tank or reservoir 34, and the latter is provided with a suitable inlet having a cap or stopper 34^a to prevent escape of gas or oil and an outlet-cock 34^b for draining, and, by preference, I provide a tube 35, connected with the tank 34 at its lower part, and at its upper end said tube has a head 35^a, provided with a gauze 35^b for the admission of air to the tank to prevent a vacuum forming, the gauze serving to break up the particles of air and preventing a noise. Thus the air is drawn up through the oil or gasolene, causing a vapor to pass off through pipe 28. The tube or pipe 28 is provided with a valve 36 to regulate the passage of gas or oil from the tank 34 to the motor, and, by preference, this valve has an auxiliary opening 36^a for the admission of air, so that a mixture of air and gas or oil may pass to the motor. The valve has three ways to regulate the passage of gas or oil and air and to regulate the relative quantities of each that may pass in a well-known manner.

It will be understood that as the motor rotates the ports 24 25 will be kept in connection with the inlet and exhaust tubes 28 30 and that the openings 20 21, connecting the ports 22 23 with the explosion-chamber 12, are to be opened and closed as required, and it will be also understood that in the device illustrated the motor draws in a supply of fuel on one stroke and then compresses it at the outer end of the cylinder and in the explosion-chamber, that thereupon the compressed fuel is ignited and pushes the piston, and that then the piston returns and forces out the spent products of combustion. To accomplish these results, I have provided the following arrangement: 40 is a valve fitting a seat formed at opening 20, and 41 is a valve correspondingly arranged for opening 21, these valves being shown adapted to open into the explosion-chamber 12. (See Figs. 7 and 8.) 40^a and 41^a are valve-stems connected with valves 40 and 41 and guided in bearings carried by the frame or casting 16, these stems having heads or enlargements 40^b 41^b, that receive springs 42 43, that bear against the frame 16 and act to hold the valves to their seats. (See Fig. 8.) The valves 40 41 are controlled through their stems by means of reciprocative rods 44 45, that are actuated by cams 44^a 45^a, that are adapted to rotate around the shaft 1, these cams being placed in such position relatively to each other that one will open the gas-valve while the exhaust-valve is closed, and vice versa. I have shown the rods 44 45 as provided with rollers 44^b 45^b, adapted to bear upon said cams, and these rods are journaled in suitable bearings A on frame 7. (See Figs. 3, 10, 11.) Springs 44^c 45^c, surrounding rods 44 45, serve to hold the corresponding rollers upon the cams 44^a 45^a, these springs being shown as located between a pin carried by the rod and part of the frame 7. (See Figs. 10, 11.) By preference the cams 44^a 45^a are secured together, as by an intermediate hub 46, (see Figs. 2 and 3,) the cams and the hub 46 in the arrangement shown being made in a single piece of metal. Means are provided for rotating the cams by and during the rotation of the motor, and for this purpose I have shown a gear-wheel 47, secured to the cam and in mesh with a pinion 48, that meshes with a gear 49, the latter being in mesh with a gear 50, secured to shaft 1. (See Figs. 3, 10, 11.) The gears 48 49 are mounted upon studs 48^a 49^a, that are suitably secured to the frame 7, and the pinion 48 is of sufficient width to mesh with gears 47 49 at the same time, these gears being placed side by side, as will be understood from the drawings. The arrangement of these gears is such that the cam will rotate somewhat faster than the motor, so as to travel ahead to operate the various valves 40 41 at the proper times. I have shown the hub 46, the cams, and the gear 47 as mounted to rotate upon a sleeve 51, that is journaled on shaft 1 and connected by a plate or arm 51^a with frame 7. (See Fig. 3.)

To govern the speed of the motor, I have shown means to admit more or less air to the ports 24, and thus to the chamber 12. For this purpose port 24 in extension 26 opens at the end of the latter and is covered with a plate 24^a, provided with an aperture that receives a head or plug B, adapted to close said aperture. The outer end of head B is tapered, so that when pushed inwardly into port 24 it will allow more or less air to enter said port. (See Fig. 3.) The head B is connected with a stem C, that is connected with a slide or sleeve D, mounted to travel on extension 26.

E is a rod guided in a lug F on slide D and surrounded by a spring G, that bears against said lug and against part of frame 7 and acts to push the slide D outwardly. The slide D is further controlled by ball-governor arms H, that are pivotally carried by arms *h*, secured to extension 26, the arms H being movably connected with slide D. The arrangement is such that as the motor rotates the balls move outwardly, and thereby the arms H push the slide D toward frame 7, the head B being likewise moved, its tapered part allowing more or less air to enter port 24, and the greater the speed the more air will be admitted. The air passes to chamber 12 and reduces the richness of the fuel mixture, thus reducing the power and slackening the speed, and so on as the motor rotates.

The means I have shown for producing a spark at the proper time in the explosion-chamber 12 are as follows: Within the chamber 12 is a stationary contact 52 and a movable contact 53, the latter being held normally in engagement with 52 by a spring 53^a. (See Figs. 7 and 8.) The contact 52 is shown secured to the wall of chamber 12. The contacts 52 53 are to be electrically connected with a battery, (not shown,) and at the proper time these contacts are to be separated to

produce a spark. For this purpose I have shown a pin 54, carried by a head 54^a on a rod or shaft 55, that projects through a suitable stuffing-box in the bottom wall of frame or casting 16 and is adapted to rotate therein. (See Fig. 3.) The inner end of rod 55 projects between the cams 44^a 45^a and carries a pinion 56, (see Figs. 3 and 11,) that is adapted to engage teeth 57 58, shown carried by one of the cams, as 44^a. (See Fig. 11.) The arrangement is such that as the cams rotate ahead of the cylinders one set of teeth will first engage pinion 56 and turn it to bring the pin 54 about into engagement with contact 53 and will then pass from said pinion to allow it to come to rest, so that a complete closing of the circuit at 52 53 will be assured, and then the other teeth will engage the pinion 56, thereupon further moving pin 54, which will break the circuit at 52 53 and produce a spark. This arrangement will be of advantage under high rotation of the motor in that it will allow a sufficient time for the circuit through the contacts to be well formed before a break is made, so as to assure a proper spark at each breaking of the circuit.

The circuit for producing a spark may be arranged in any suitable manner. I have shown an induction-coil J, from which the wire *j* leads to a brush K, carried by frame 3, which brush bears upon a commutator-ring L, carried by casing 7, (see Fig. 2,) and from the ring L a conductor L^2 leads to the contact 53, and the contact 52 is in electrical connection with the metal parts of the motor, the circuit extending thence to a battery which is connected with the coil J. Any suitable switch may be provided for making and breaking the circuit as desired.

The arrangement I have shown for causing a circulation of water in chamber 19 around the explosion-chamber 12 and the explosion end of the cylinder 9 is as follows: The wall 18 of chamber 19 is provided with an inlet and an outlet 60 61, to which tubes 62 63 are respectively connected. By preference the inlet 60 is connected with a tube 64, that is located within the chamber 19 and extends along the same around one part of cylinder 9 and well up to the wall of explosion-chamber 12. (See Fig. 7.) By this means the cooling-water is delivered directly at the explosion-chamber 9 and passes out through the outlet 61 to tube 63.

I provide a pump to keep up a circulation of water in chamber 19, and this pump is operated by and during the rotation of the motor. The shaft 4 is provided at its inner end with a bore 65, the outer end of said bore being closed by a plug 66. (See Fig. 3.) The tubes 62 63 open into said bore, as shown in Fig. 3. Within bore 65 is located a tube 67, having heads 67^a 67^b, which fit closely within said bore, and the tube 67 is of less diameter than the bore 65, said tube and its heads thereby forming two compartments, one being the compartment 69 and the other comprising the bore in the tube 62 and the spaces 68 70. The tube 62 leads to compartment 69, and the tube 63 leads to space 68, the spaces 68 70 being in communication through the bore of the tube 67, as indicated by dotted lines in Fig. 3, the compartment 69 being entirely separated from the other compartment. Mounted upon the shaft 4 is a casing 71, adapted to contain the operative parts of the pump, and 72 is a cover or plate for said casing, which is bolted thereto and provided with a hub 72^a, having ports, as will be described, the shaft 4 also passing through said plate or cover and its hub. Suitable packing is provided between the parts 71 72 72^a and the shaft 4 to prevent leakage of water. (See Fig. 3.) The casing 71 has an extension 71^a, having a bore or channel 71^b, that communicates at its outer end with a pipe or tube 73, that leads to a water-tank 74, preferably passing through a stand-pipe 74^a, connected therewith. (See Fig. 4.) Within the bore or channel 71^b is a movable plug 75, that is adapted to reciprocate therein, which plug is provided with a bore 75^a, which at its inner end projects sidewise at 75^b. (See Fig. 6.)

76 is a spring within the bore or channel 71^b and pressing against a wall thereof and against plug 75, tending to force the plug toward shaft 4. The interior of the casing 71 is annular and concentric with shaft 4 in the form of an annular recess or chamber 71^c, that communicates with channel 71^b, one part of the wall of casing 71 being cut away at 71^d. (See Fig. 6.) In the side wall of casing 71 is a groove 77, terminating on the side opposite the cut-away part 71^d and communicating with an aperture 78 in the shaft 4, that leads to the compartment 69. Within the recess or chamber 71^c of casing 71 is a ring 79, that surrounds the shaft 4 and is located eccentrically to said shaft. (See Fig. 6.) From the shaft 4 pins 80 81 project in opposite directions, and these pins pass through apertures in the ring 79, and 82 is a spring surrounding the pin 80 and pressing against shaft 4 and against the ring 79, thus serving to hold one part of the ring in contact with the inner wall of chamber or recess 71^c of casing 71. (See Fig. 6.)

From the foregoing it will be understood that as the shaft rotates in the direction of the arrow in Fig. 6 the ring 79 will be carried around with it, and as the plug 75 is in contact with said ring and the ring moves in an eccentric path the plug 75 under the influence of the ring 79 and the spring 76 will be reciprocated, thereby forming a movable wall to divide chamber 71^c; also, that when the high part of the cam is in contact with the edge of channel 71^d the flow of water into the chamber 71^c will be cut off, and that thereupon as the cam-ring rotates it will force water ahead of it and out through channels 77 78 and the plug 75 will advance to deliver water behind said ring, at the same time acting as a wall against the water that is pushed

by ring 79, the ring acting to suck or draw water through the bore in plug 75, and as the ring advances toward channel 71^d it will gradually move plug 75 back and stop the inflow of water. It will thus be seen that a rotary pump is provided which is actuated by the rotation of shaft 4 and that the water forced by the pump is delivered through channels 77, 78, and 69 to tube or pipe 62 and through pipe 64 into the chamber 19 of frame or casing 16, the water passing from there through pipe 63 to the chamber 68 and thence through the bore in tube 67 to the chamber 70. The chamber 70 communicates through an opening 70^a with an annular recess or channel 83 in the hub 72^a. This recess or channel 83 is connected by a pipe 84 with the tank 74, passing into the stand-pipe 74^a, as in Fig. 4. Thus it will be understood that as the pump operates it draws water from the tank 74, forces it through the chamber 19 to cool the explosion-chamber and the end of cylinder 9, and the water then passes through the bore in shaft 4, hub 72, and pipe 84 back to the tank 74. It will be understood that pipes 62 63 from each cylinder extend to chambers 68 69.

In Fig. 3 I have shown the pump-casing and its hub as surrounding a sleeve or boss 85, that projects from a gear-wheel 86, which sleeve or boss has openings to aline with the openings 78 and 70^a in the shaft 4, and it is also provided with suitable openings to receive the pins 81 and 82, the gear-wheel 86 being mounted upon and secured to shaft 4. The gear 86 is for the purpose of transmitting power from the motor.

The parts so far described constitute a complete rotary motor from which power can be transmitted in any suitable manner, it being understood that shaft 1 may be suitably held to enable the frame 7 and the parts connected therewith to rotate; but it will be also understood that if the frame 7 and the cylinders are held stationary the shaft 1 would be rotated and that power could be transmitted therefrom.

In order to enable varying speeds to be transmitted from the motor without checking the speed of the same, and, furthermore, in order to apply a motor to a vehicle or road-wagon, I have provided means for transmitting power at varying speeds from the motor to the axle or wheels of such vehicle, and in connection therewith I utilize friction devices to prevent undue strain upon the gearing, particularly in changing from one gear to another. In the arrangement I have shown I have provided for three speeds—a high, a low, and an intermediate speed. In addition to the gear-wheel 86 there are secured upon the shaft 4 gears 87 88, the arrangement shown being such that gear 87 will produce a high speed, gear 86 an intermediate speed, and gear 88 a low speed or power. The gear 87 meshes with a gear 89, the gear 86 with a gear 90, and the gear 88 with a gear 91, the gears 89, 90, and 91 being loosely mounted upon a shaft 92, which is suitably supported in bearings on the frame 3. Upon the shaft 92 is mounted a pinion 93, which meshes with a gear 94, that is adapted to rotate a driven part, such as an axle or shaft 95, with which said gear is properly connected. As the gears 89 90 91 are loosely mounted upon shaft 92, I have provided friction clutches or devices for connecting either one of such gears with the shaft and for disconnecting them therefrom to allow the motor and the driven shaft or axle 95 to move independently, and in connection therewith I have provided a friction-brake for checking the momentum of the vehicle or the driven part 95, the arrangement I have shown being as follows: Rigidly mounted upon shaft 92 is an arm or extension 96, projecting outwardly from said shaft in two directions and which may be secured thereto by a spline and feather. 97 is a friction drum or disk having an internal bore or socket 97^a, this disk or drum having a central bore to receive the shaft 92, upon which it is loosely mounted. To the drum or disk 97 is secured gear-wheel 89, being shown secured thereto by screws 89^a, the principal reason that the gear 89 is separate from the friction disk or drum 97 being that said gear is smaller in diameter than said drum and is therefore easier to construct in this manner; but it is evident that the parts 89 and 97 can be constructed in a single piece of metal. Within the bore 97^a of the friction drum or disk 97 is located a split friction-ring 98, that is shown carried by a pin 99, projecting from support 96. A pin 100, also carried by the support 96, projects laterally therefrom and carries an arm or finger 101, one portion of which is located between the ends 98^a 98^b of the friction-ring 98, as shown in Fig. 13, so that when arm 101 is turned on its pivot it will expand the ring 98 into frictional engagement with the friction disk or drum 97, whereby as the gear 89 is rotated the parts 97, 98, 96, and 92 will be driven thereby.

The means I have shown for expanding ring 98 through the medium of arm or lever 101 consists of a pin 102, carried by said arm and projecting into the bore of shaft 92 through an aperture 103 in said shaft. (See Fig. 13.) For the purpose of enabling adjustment of pin 102 I have shown it in the shape of a screw threaded into a suitable aperture in arm 101, and to lock it firmly to said arm I have shown said arm split longitudinally at 102^a and provided with a screw 104, threaded in the two members thus formed, so as to expand or contract the members of said arm to lock the pin 102.

105 is an aperture passing through the friction drum or ring 97 and the split ring 98 to permit the passage of a tool to adjust the threaded pin 102. Within the bore of shaft 92 is a longitudinally-movable rod or presser 106, that is adapted to act upon pin 102 to force the same outwardly in order to turn the arm 101 on its pivot to expand ring 98,

and for this purpose the rod 106 is shown provided with an annular enlargement 107, having a beveled or cone-like surface 107ª, adapted to ride against said pin to actuate the same. (See Fig. 12.) The enlargement 107 is shown of a sufficient size to fit snugly within the bore of shaft 92, and the rod 106 is sufficiently small so that it will not operate pin 102.

In order to drive gear 90 frictionally, an arrangement similar to that just described with reference to Figs. 12 and 13 is provided, in which a friction drum or ring 90ª is connected with gear 90, in the arrangement shown the parts 90 and 90ª being made in a single piece of metal bored out to receive a split ring 90ᵇ, that is supported on pin 99, and 101ª is an arm carried by pin 100 and located between the ends of ring 90ᵇ and provided with a pin 108, these parts being substantially similar to parts 98 99 100 101 102 and acting in the same manner, the pin 108 passing through an aperture in shaft 92 to be engaged by the enlargement 107 on rod 106. Thus if pin 102 is operated by parts 106 107 gear 89 will drive shaft 92; but if pin 108 is operated by parts 106 107 gear 90 will drive said shaft and at a different speed from that produced by gear 89. It will also be seen that enlargement 107 is not adapted to engage pins 102 and 108 at the same time, but may pass between said pins and is cone-like on opposite faces. Gear 91 is provided with a drum or ring 91ª, the parts being counterbored to receive a split ring 109, that is supported on a pin 110, carried by an extension or disk 111, secured to shaft 92, as by a spline and feather, and an arm 112 is carried by a pin 103, supported by extension 111, the arm 112 having a pin 114, the parts being substantially similar to the arrangement shown in Fig. 13. Upon rod 106 is an enlargement 115, having its opposite sides beveled or cone-like and adapted to act upon pin 114 to cause gear 91 to be frictionally connected with shaft 92 in manner described with relation to parts 89 97, &c. Thus the shaft 92 may be frictionally driven at three different speeds.

In order to resist the rotation of shaft 92, I have shown a friction disk or drum 116 secured to frame 3 and provided with a bore 117, in which is located a split ring 118, supported on pin 110, and between its ends is an arm 119, supported on pin 113 and provided with a pin 120, adapted to be acted upon by enlargement 115 of rod 106, (see Fig. 12,) all in manner similar to that shown in Fig. 13 and described with relation to parts 89 97, &c., the arrangement being such that when enlargement 115 of rod 106 operates pin 120 the split ring 118 will produce frictional engagement with friction-drum 116, and thereby retard or prevent the rotation of shaft 92. The distance between pins 114 and 120 is such that enlargement 115 may rest between them without operating either, and the arrangement is such that after enlargement 115 has passed pin 120 and the rod 106 is moved farther said enlargement will engage pin 114 to frictionally connect shaft 92 with gear 91. If a higher speed is desired, rod 106 will be moved (to the left in Fig. 12) until enlargement 115 releases pin 114 and enlargement 107 engages pin 108, whereupon gear 90 will be frictionally connected with shaft 92, and if a still higher speed is desired rod 106 will be moved (to the left in Fig. 12) until enlargement 107 releases pin 108 and engages pin 102, whereupon gear 89 will be frictionally connected with shaft 92. It will be understood that if shaft 92 is rotating at either speed and it is desired to throw off the gear it will only be necessary to move rod 106 far enough to release the pin with which its enlargement is in engagement. At any time that it is desired to apply the brake it is only necessary to move rod 106 (to the right in Fig. 12) until enlargement 115 comes into engagement with pin 120, and although either or both enlargements on rod 106 may pass over one or more of said pins in the meantime no ill effects will arise.

Any suitable means may be provided for moving rod 106 longitudinally back and forth. The arrangement I have shown for the purpose is as follows: Upon one side rod 106 is provided with a series of teeth 121, which are cut in the form of a worm and are adapted to receive corresponding teeth 122 on a sector-like arm or lever 123. (See Figs. 4 and 12.) These teeth 122 on arm 123 are shown in face view in Fig. 4ª, in which they are placed at an acute angle to a line passing through the longitudinal center of the face of arm 123, and the arrangement is such that as arm 123 is rocked forward or backward the teeth 122 will act upon the teeth 121 to slide the rod 106 longitudinally. To keep rod 106 from rotating under the action of arm 123, I have shown said rod as provided with a spline 106ª, adapted to receive a feather or projection 124 at the end of an arm 125, secured to frame 3. (See Fig. 12.) The arm 123 is pivotally hung upon a stud or shaft 126, carried by frame 3, and 127 is a lever or arm secured to arm 123, whereby the latter may be rocked upon its pivot. For the purpose of enabling lever 127 to be brought into convenient position to be operated by the occupant of a vehicle when the devices before described are applied to a vehicle without altering the position of arm 123 relatively to rod 106 I have shown the outer face of hub 123ª of arm 123 provided with teeth 128, that are adapted to mesh with teeth 128ª, carried by the hub 127ª of lever 127, screws 129 being provided to hold the parts 123 and 127 together. (See Fig. 12.)

In order to start the motor-shaft 4, it has to be rotated by hand, and for this purpose I have shown the shaft or stud 126 as tubular and its bore located in line with shaft 4 to enable a suitable crank or handle to be attached to said shaft within or through the

bore of shaft or stud 126. (See Figs. 3, 4, and 12.) Said shaft is shown provided with a pin 130, upon which a crank or handle (not shown) may operate to turn said shaft in well-known manner.

In applying my improvements to a vehicle any suitable frame therefor may be provided. In the drawings I have shown a vehicle composed of tubing to which the frame parts 3 are attached for supporting the motor, and the tanks or receptacles for oil and water are suitably carried by said vehicle. While the gear 94 may be suitably connected with axle 95 or drive-wheel 95ª, I have shown an arrangement for equalizing the axle 95 to enable the vehicle to conveniently turn corners, as follows: The shaft 95 at one end carries a sleeve 131, which is adapted to rotate independently of said shaft (see Fig. 3) and is to be attached to the hub of wheel 95ª. Suitable bearings 132 133 are provided and carried by the frame of the vehicle, the sleeve 131 being adapted to rotate in the bearings 133, and for this purpose said sleeve is shown provided with cones 134 to act with the friction-balls of the bearing. (See Fig. 3.) The gear 94 is movably attached to shaft 95, and to said shaft is also attached a bevel-gear 135, and to the sleeve 131 is attached a corresponding bevel-gear 136, the gears 135 and 136 being located on opposite sides of gear 94 and adjacent thereto. (See Figs. 2 and 3.) The gear-wheel 94 carries one or more bevel-pinions 137 138, that mesh with the gears 135 136 at the same time. (See Figs. 2, 3, 4.) For this purpose I have shown the gear 94 provided with shafts 139 140, upon which the pinions 137 138 are respectively mounted. In order to permit the ready attachment and removal of the shafts 139 140 to and from the gear 94, I have shown the hub of said gear provided with apertured lugs 141 142, adapted to receive the forked ends 139ª 140ª of shafts 139 140, said forked ends of the shafts being provided with apertures to receive pins that pass through them and through the apertured lugs, and the outer ends of said shafts are held between clamps 143 144, secured to the spokes of the gear-wheel 94. (See Figs. 3 and 4.) The arrangement is such that as gear 94 is rotated and shaft 95 is traveling in a straight line the pinions 137 will act upon gears 135 136 uniformly, so as to carry said gears around in the same direction and at the same speed; but if the vehicle is turning from a straight line one of its wheels will travel faster than the other, and thereupon said pinions 137 138 will act upon the gears 135 136 in such manner that said gears may rotate at different speeds, in which event the pinions will cause one of said gear-wheels to rotate faster than the other, at which time said pinions will have independent movement on their axes, at the same time causing axle or shaft 95 to continue to rotate.

The operation of the motor is as follows: The inlet for the fuel is opened, the circuit for the sparkers is closed, and the motor is started by first rotating the shaft 4. The piston in one cylinder moves toward the crank and draws in a supply of fuel in the form of a mixture of gas and air, filling the cylinder and its explosion-chamber 12 during one half-rotation, during which time the corresponding inlet-valve 40 is opened by the action of its cam 44ª. During the next half-rotation the piston moves outwardly and compresses the charge in the chamber 12 and the outer end of the cylinder, during which time the rod 55 is turned to bring its pin 54 near contact 53, and thereupon when the piston is ready to move outwardly again the rod 55 is turned again to cause the contacts 52 53 to produce a spark, whereupon an explosion occurs to drive the piston toward the open end of the cylinder, (during the third rotation,) and thereafter when the piston starts on its return stroke during the next half-rotation the exhaust-valve 41 is opened by the action of its cam 45ª. As there are three cylinders and three pistons, a similar action will take place in each, and as the cams rotate faster than the cylinders they will travel ahead, so as to cause the corresponding valves 40 and 41 and the sparkers of each cylinder to operate successively and at the proper time. The arrangement is such that there will be three explosions to two revolutions of the casing 7, the difference in speed between the casing 7 and the cams enabling the latter to advance so as to operate from cylinder to cylinder to produce the necessary operations of taking in, compressing, exploding, and exhausting the charges for the different cylinders.

Having now described my invention, what I claim is—

1. A motor comprising a plurality of cylinders, pistons, a crank connected with said pistons, an explosion-chamber communicating with each cylinder, ports for said chambers, valves to control said ports, a cam to operate the inlet-valve, a cam to operate the exhaust-valve, said cams being connected together, and gearing for operating said cams by and during the rotation of the motor, said gearing being arranged to drive said cams at a speed greater than the speed of the motor, substantially as described.

2. The combination of a crank-shaft, a frame, cylinders, pistons connected with the crank, an explosion-chamber connected with each cylinder, inlet and exhaust ports for said chamber, said ports having a portion located in an extension from said frame, said extension having apertures leading to said ports respectively, rings around said extension provided with annular channels communicating with said apertures, inlet and exhaust pipes connected with said channels, valves for opening and closing the ports, means for operating said valves, and means for producing an explosion, substantially as described.

3. The combination of a crank-shaft, a frame, cylinders, pistons connected with the crank, an explosion-chamber connected with each cylinder, inlet and exhaust ports for said chamber, valves to control said ports, a cam to operate the inlet-valves, a cam to operate the exhaust-valves, said cams being connected together, gearing connecting said cams with the shaft, part of the gearing being connected with said frame, and means to be operated by the rotation of the motor for causing an explosion, substantially as described.

4. The combination of a crank, cylinders and pistons, means for supplying the cylinders with a propulsive medium, valves to control the supply and exhaust, cams to operate said valves, and gearing for operating said cams by and during the rotation of the motor, said gearing being arranged to drive said cams at a speed greater than the speed of the motor, substantially as described.

5. The combination of a crank, a frame, cylinders and pistons, said frame having an extension provided with ports in communication with said cylinders, means to control the supply and exhaust to and from said cylinders said extension having apertures leading to its ports respectively, a ring surrounding said extension and having a channel communicating with said apertures, and a pipe communicating with the ring, substantially as described.

6. The combination of a crank, a frame, cylinders and pistons, said frame having an extension provided with ports in communication with said cylinders, means to control the supply and exhaust to and from said cylinders, said extension having apertures leading to its ports respectively, a ring surrounding said extension and having a channel communicating with said apertures, a bearing inclosing said ring and having an aperture leading to the channel in said ring, and a pipe connected with the aperture in the bearing, substantially as described.

7. The combination of a crank, a frame, cylinders and pistons, said frame having an extension provided with ports in communication with said cylinders, means to control the supply and exhaust to and from said cylinders, said extension having apertures leading to its ports respectively, rings surrounding said extension and having channels respectively communicating with the apertures in said extension that lead to the inlet and exhaust ports, packing between said rings surrounding said extension, a bearing surrounding said rings and packing, said bearing having apertures communicating with apertures in the rings that lead to the respective channels, and pipes or tubes connected with the apertures in the bearing, substantially as described.

8. The combination of a crank-shaft, cylinders, means to support said cylinders, pistons connected with the crank, means for supplying the cylinders with a propulsive medium, valves to control the supply and exhaust, cams to operate said valves, gearing connecting said cams with the shaft, part of the gearing being connected with the support for the cylinders, and means for causing an explosion, substantially as described.

9. The combination of a crank-shaft, a frame, cylinders and pistons, means for supplying the cylinders with a propulsive medium, valves to control the supply and exhaust, contacts to produce an explosion, fingers to operate said contacts, and means for giving said fingers a step-by-step movement, substantially as described.

10. The combination of a crank-shaft, a frame, cylinders and pistons, an explosion-chamber connected with each cylinder, means for supplying the cylinder with a propulsive medium, contacts in each cylinder, rotative rods each carrying a finger to operate said contacts, respectively, said rods each having a pinion, and teeth to be operated by the motor for actuating said pinion intermittently, substantially as described.

11. The combination of a crank-shaft, a frame, cylinders and pistons, an explosion-chamber connected with each cylinder, means for supplying the cylinder with a propulsive medium and for exhausting the spent charge, contacts in each cylinder, rotative rods each carrying a finger to operate each contact, said rod having a pinion, a rotative part carrying teeth to operate said pinions, and means for operating said part by the rotation of the motor, substantially as described.

12. The combination of a crank-shaft, a frame, cylinders and pistons, an explosion-chamber for each cylinder, means for supplying the cylinders with a propulsive medium, ports for said explosion-chambers, valves for controlling said ports, cams and connections therefor to operate said valves, means for operating said cams by the rotation of the motor, contacts in each explosion-chamber, rods each carrying a finger to operate said contacts, a pinion carried by each rod, and teeth connected with a cam for operating said pinions, substantially as described.

13. The combination of a crank-shaft, a frame, cylinders, pistons connected with the crank, an explosion-chamber for each cylinder, an inlet-port for each explosion-chamber, valves for controlling the same, a cam to control said valves, means for supplying said ports with a propulsive medium, contacts in each explosion-chamber, rods each carrying a finger to operate said contacts, a pinion carried by each rod, two sets of teeth connected with the cam for operating said pinions, said teeth having a space between them for giving the pinions an intermittent motion, and means for operating said cam, substantially as described.

14. In a gas or oil motor the combination of cylinders, pistons, means for supplying a propulsive medium thereto, and means for producing an explosion controlled by the rota-

tion of the frame, with a frame and a crank-shaft divided into two portions, one portion being rigidly connected with the frame and the other portion having the crank being movably connected with the frame, substantially as described.

15. In a motor the combination of cylinders, pistons, and means for supplying a propulsive medium thereto, with a frame and a crank-shaft divided into two portions, one portion being rigidly connected with the frame and the other portion having the crank being movably connected with the frame, means for producing an explosion controlled by the rotation of the frame and movable supports for the separate parts of the shaft, substantially as described.

16. In a gas or oil motor the combination of a frame, cylinders, pistons, means for supplying the propulsive medium to the cylinders, and means for producing an explosion controlled by the rotation of the frame, with a crank-shaft having a movable and a stationary portion, the crank being connected with one of said portions, and the frame being rigidly connected to the other portion, the two portions of the crank-shaft being supported in alinement, means for holding one portion of the shaft from rotation and a bearing for the other portion of the shaft, substantially as described.

17. In a motor the combination of a frame, cylinders, pistons, and means for supplying a propulsive medium to the cylinders, with a crank-shaft having a movable and a stationary portion, the crank being connected with one of said portions, and the frame being rigidly connected to the other portion, the two portions of the crank being supported in alinement, means for holding one portion of the shaft from rotation, a ball carried by the other portion of the shaft, and a bearing to receive said ball, substantially as described.

18. In a motor the combination of a frame, cylinders, pistons, and means for supplying a propulsive medium to the cylinders, with a divided crank-shaft, a crank carried by one portion of the shaft, a universal joint for supporting one portion of the shaft, and a bearing for the other portion of the shaft adapted to permit oscillatory movement of the shaft relatively thereto, substantially as described.

19. In a motor the combination of a frame, cylinders, a plurality of pistons and a crank-shaft to which all of said pistons are connected, with an explosion-chamber connected with each cylinder, a water-jacket around the explosion-chamber, and a pump operated by the rotation of the motor for producing a circulation of water in said water-jacket, substantially as described.

20. In a motor the combination of a frame, cylinders, a plurality of pistons, and a crank-shaft to which all of said pistons are connected, with an explosion-chamber connected with each cylinder, a water-jacket surrounding said chamber and a pump having a movable part to be operated by the motor, a water-supply and connections between the supply and the jacket through the pump for causing a circulation of water through said jacket, substantially as described.

21. In a motor the combination of a frame, cylinders and pistons, with an explosion-chamber connected with each cylinder, a water-jacket surrounding each explosion-chamber, a crank-shaft having a movable and a stationary part, a pump connected with the movable part, and connections between the water-jackets and the pump for producing a circulation of water in said jackets, substantially as described.

22. In a motor the combination of a frame, cylinders, pistons, an explosion-chamber connected with each cylinder, a water-jacket surrounding the corresponding cylinders and explosion-chambers, a tube in said jacket leading to the explosion-chamber, a pump, means for operating the pump by the rotation of the motor, and connections between the pump and the tube in the water-jacket, and means for carrying water away from the water-jacket, substantially as described.

23. The combination with a cylinder having an extension provided with a recess, of a frame or casting for connection with said cylinder and having a corresponding recess to register with the recess in said extension, whereby an explosion-chamber is formed, and a port connecting the explosion-chamber with the cylinder, substantially as described.

24. The combination with a cylinder having an extension provided with a recess, of a frame or casting having an aperture to receive said cylinder and a recess adapted to aline with the recess in said extension, whereby an explosion-chamber is formed, and a port leading from said chamber to the cylinder, substantially as described.

25. The combination with a cylinder having an extension provided with a recess, of a frame or casting having an inner wall forming a recess to register with the recess in the extension, whereby an explosion-chamber is formed, and an outer wall forming a water-jacket surrounding said explosion-chamber, and a port connecting said chamber with the cylinder, substantially as described.

26. The combination with a cylinder having an extension provided with a recess, of a frame or casting having an inner wall forming a recess to register with the recess in the extension whereby an explosion-chamber is formed, and an outer wall forming a water-jacket surrounding said chamber and the outer portion of the cylinder, and a port connecting said combustion-chamber with the cylinder, substantially as described.

27. The combination of a cylinder having an extension provided with a recess or opening, a plug or cap to close said opening, and a wall 14^b, with a frame or casting having an opening to receive the cylinder and an inner wall forming a recess to register with the wall

14[b] to form an explosion-chamber, an outer wall surrounding the end of the cylinder and the explosion-chamber, and a port connecting said chamber with the cylinder, substantially as described.

28. In a motor, the combination with a shaft, a crank, pistons, cylinders, and means for supplying them with a propulsive medium, of a water-jacket, the shaft having compartments, connections between said compartments and the water-jacket, and a pump adapted to circulate water through said compartments and the water-jacket, substantially as described.

29. In a motor, the combination of a shaft, a crank, cylinders, a combustion-chamber connected with each cylinder and a water-jacket, said shaft having compartments connected with the water-jackets, a pump to be operated by said motor and having an inlet-chamber connected with one of said compartments and an outlet-chamber connected with the other of said compartments, and means for operating said pump, substantially as described.

30. In a motor, the combination of a shaft, a crank, cylinders, an explosion-chamber connected with each cylinder, water-jacket, said shaft having a bore, a tube in said bore having heads forming compartments, tubes connecting said compartments with the water-jackets, a pump having a supply-channel connected with one compartment and an exhaust-channel connected with the other compartment, and means for operating said pump, substantially as described.

31. In a motor, the combination of a shaft, a crank, cylinders, a combustion-chamber connected with each cylinder, a water-jacket, said shaft having a bore, a plug or stopper for said bore, a tube in said bore having heads forming a compartment within the bore around said tube and a compartment at the end of said tube, a pump having a supply-channel connected with the first-mentioned compartment, an exhaust-channel connected with the other compartment, and means for operating said pump, substantially as described.

32. The combination of a crank-shaft, a frame, cylinders, pistons, an explosion-chamber for each cylinder having a port leading to the cylinder, means for supplying a propulsive medium to said chambers, a water-jacket around said chambers, a pump adapted to be operated by the motor, connections between the pump and the water-jackets including a bore in the shaft, a tank, and inlet and exhaust pipes leading from said pump to said tank, substantially as described.

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