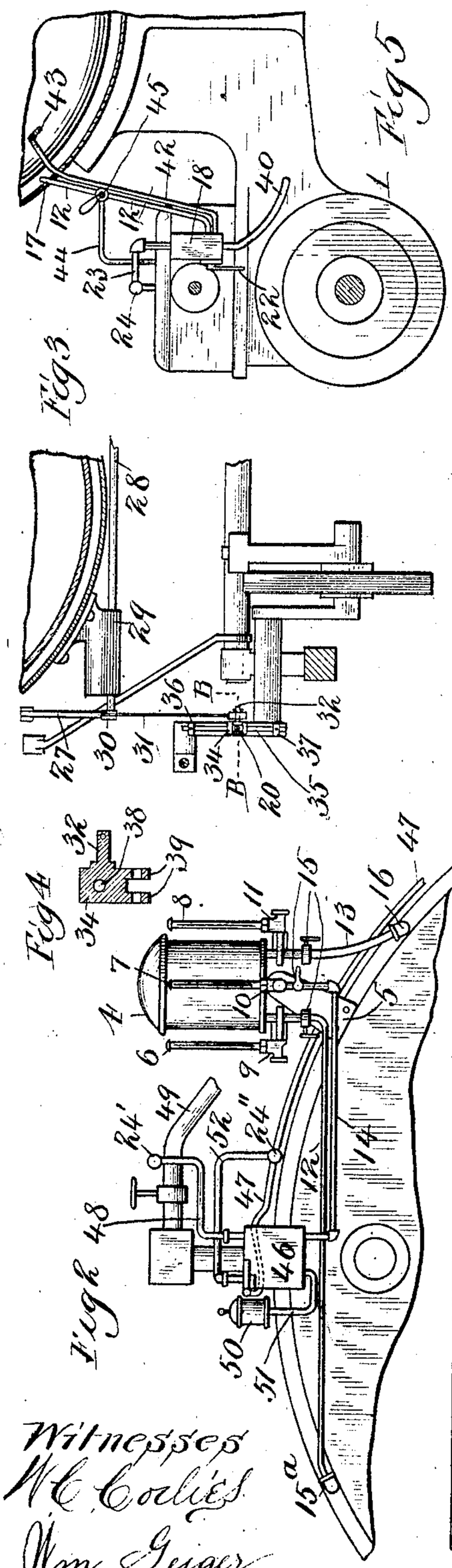
No. 822,684. PATENTED JUNE 5, 1906.

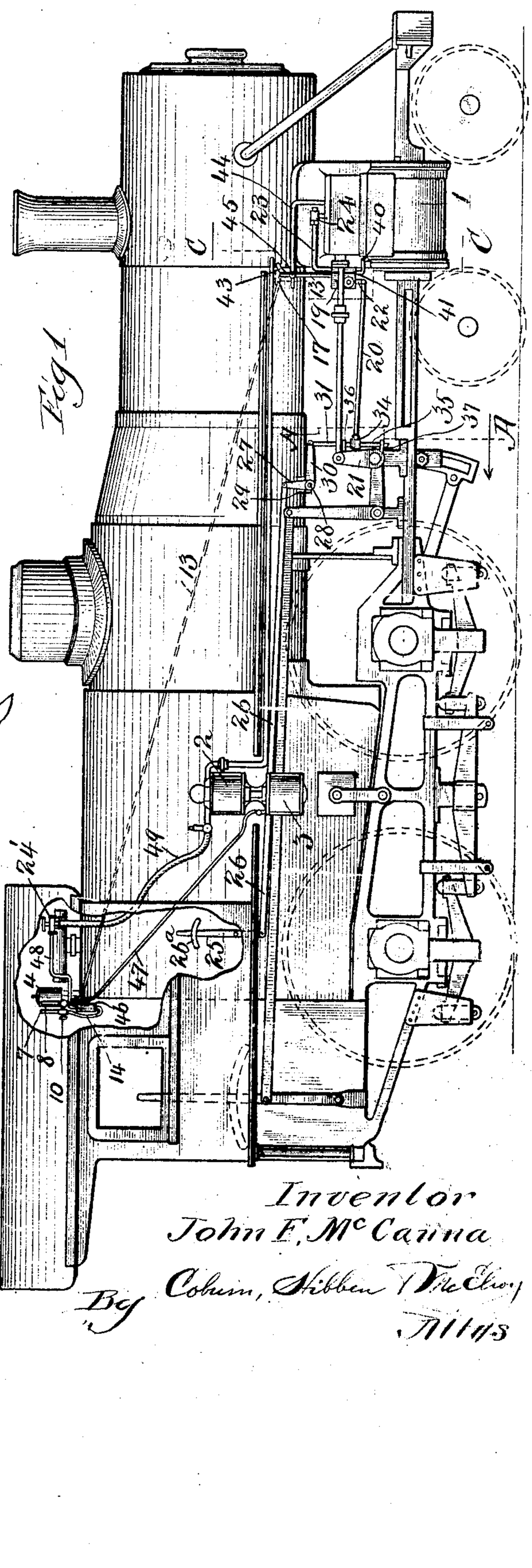
J. F. McCANNA.

LUBRICATING PUMP FOR LOCOMOTIVE ENGINES.

APPLICATION FILED JULY 28, 1900.

3 SHEETS—SHEET 1.





Witnesses
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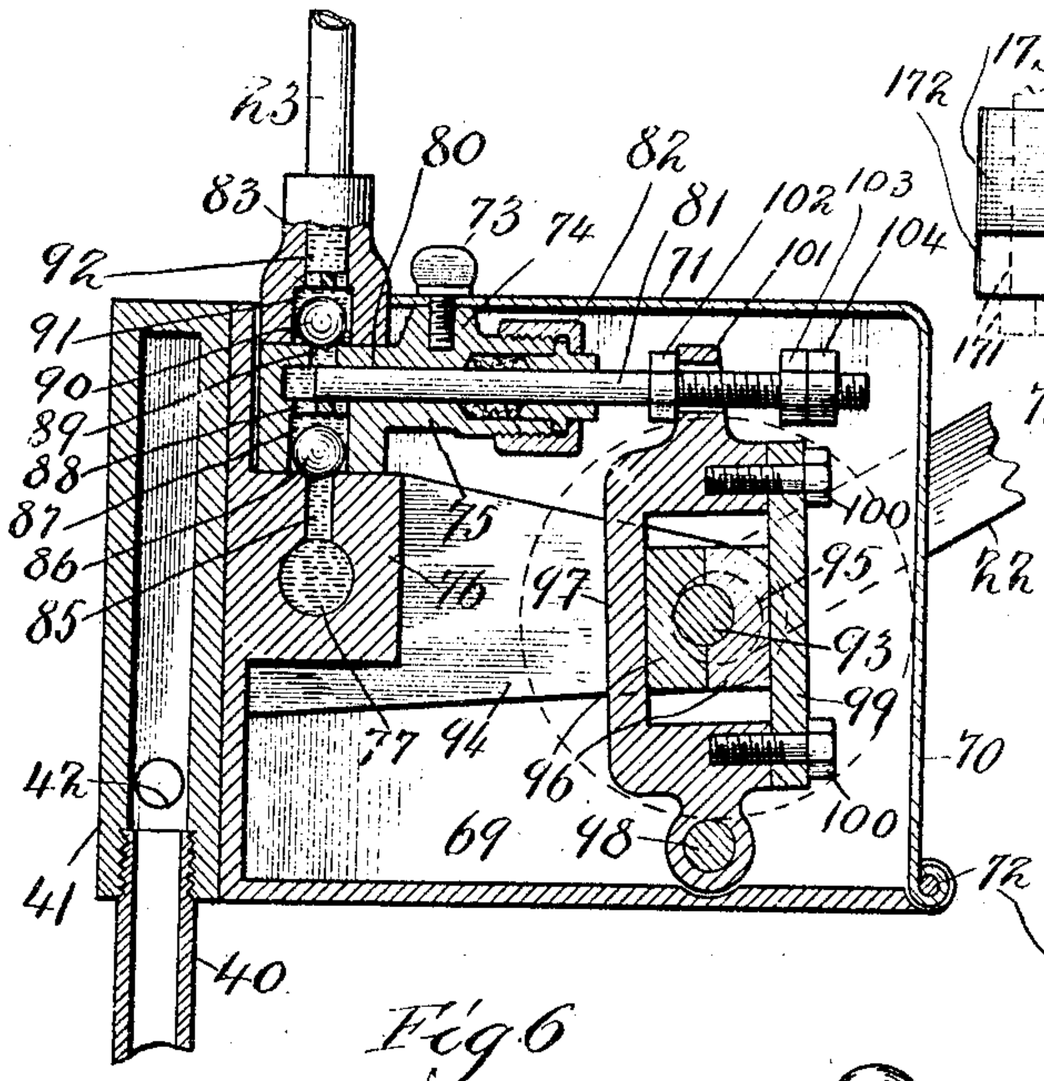

Fig 6

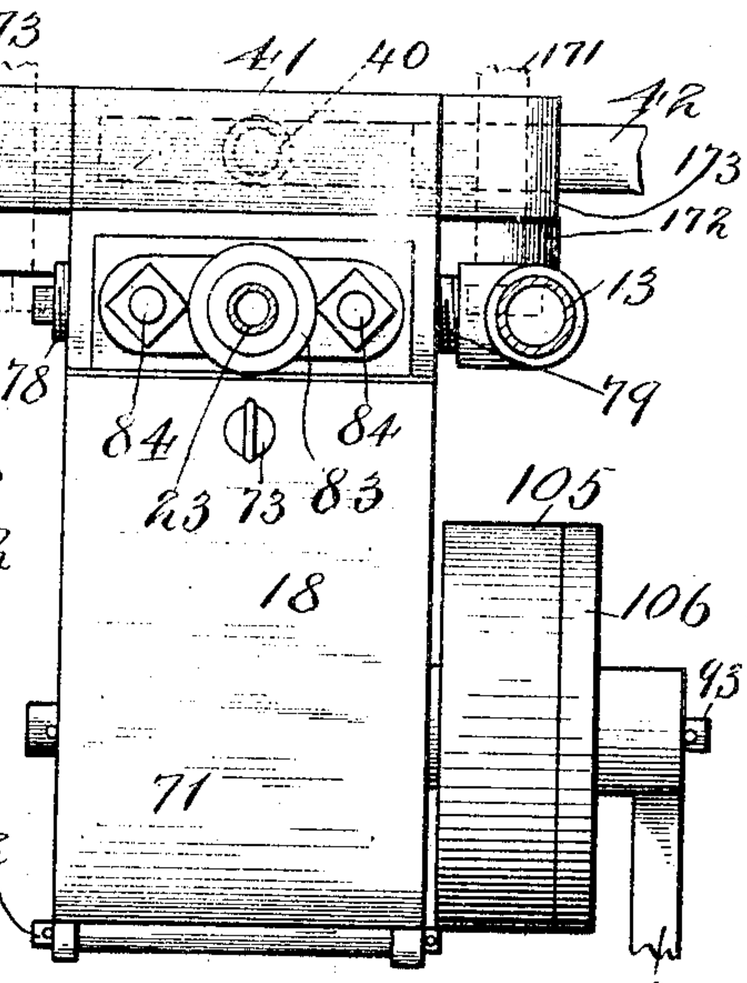

Fig 7

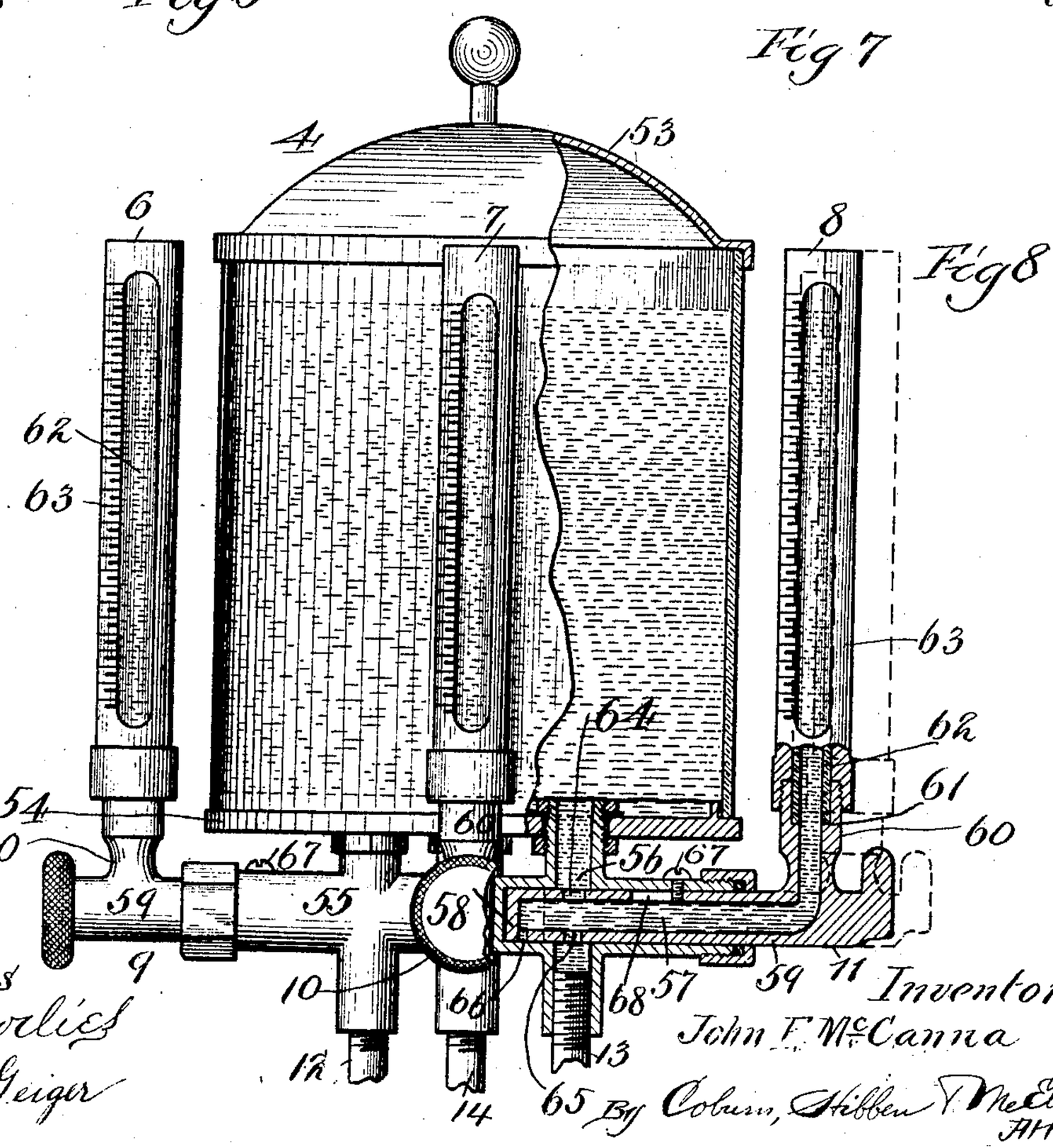

Fig 8

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3 SHEETS—SHEET 3.

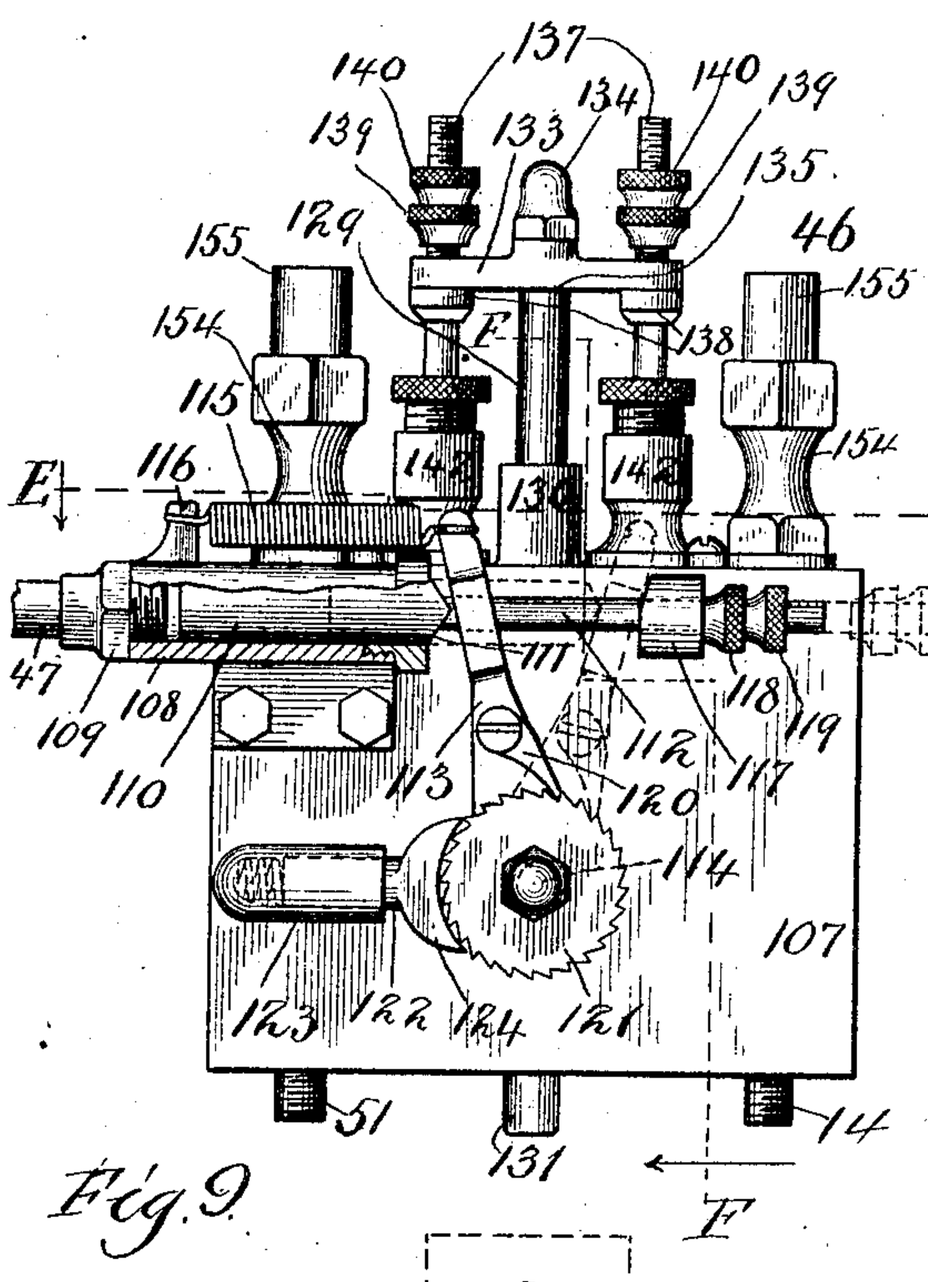

Fig. 9.

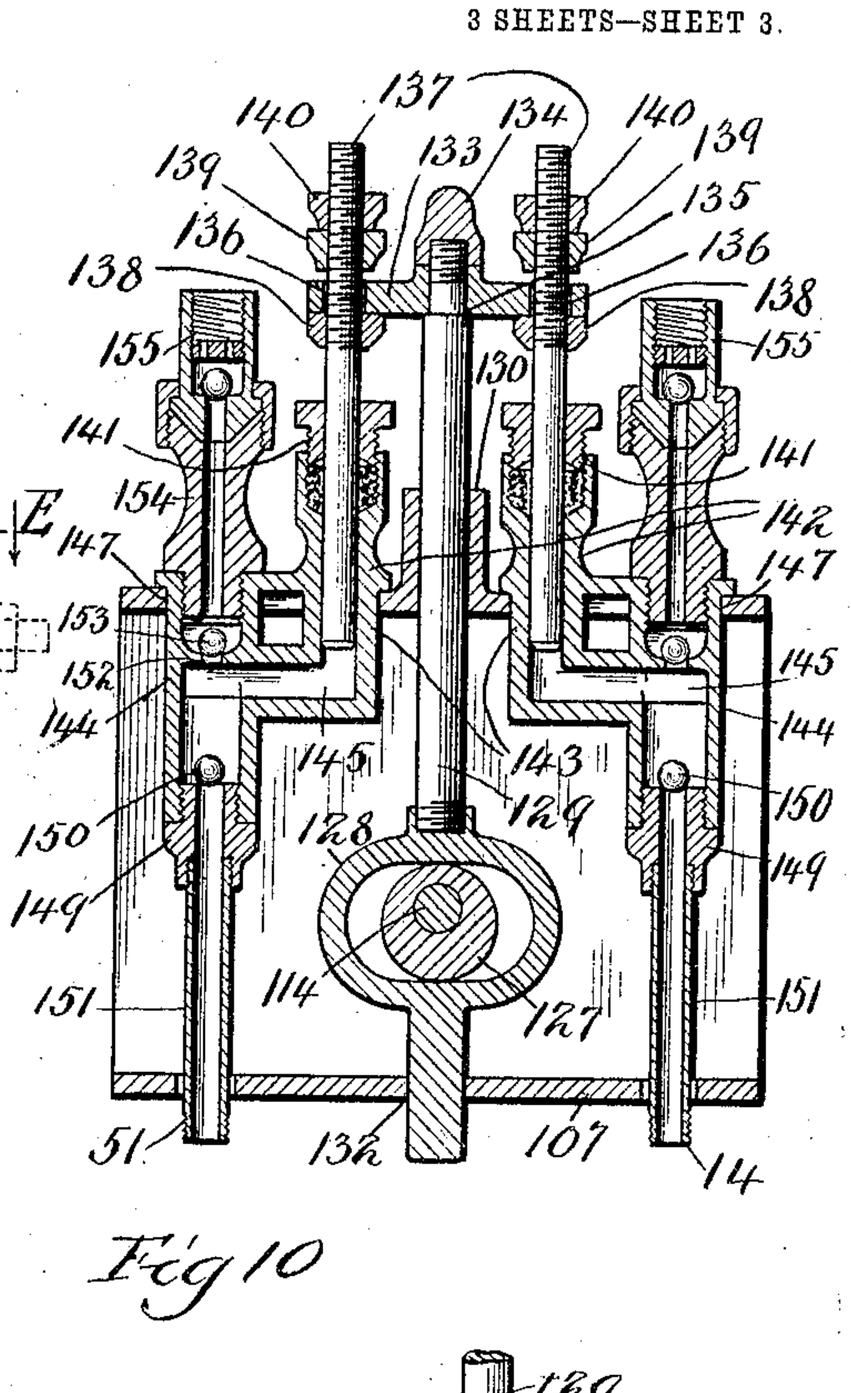

Fig 10

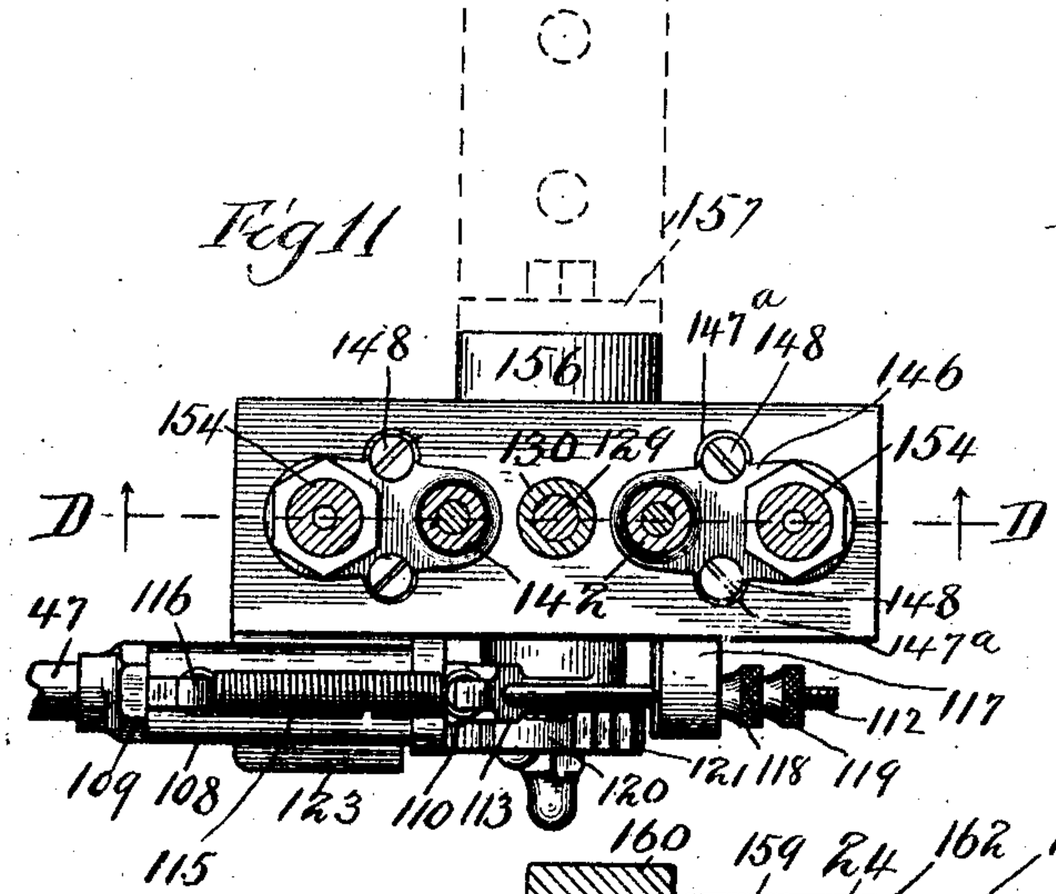

Fig 11

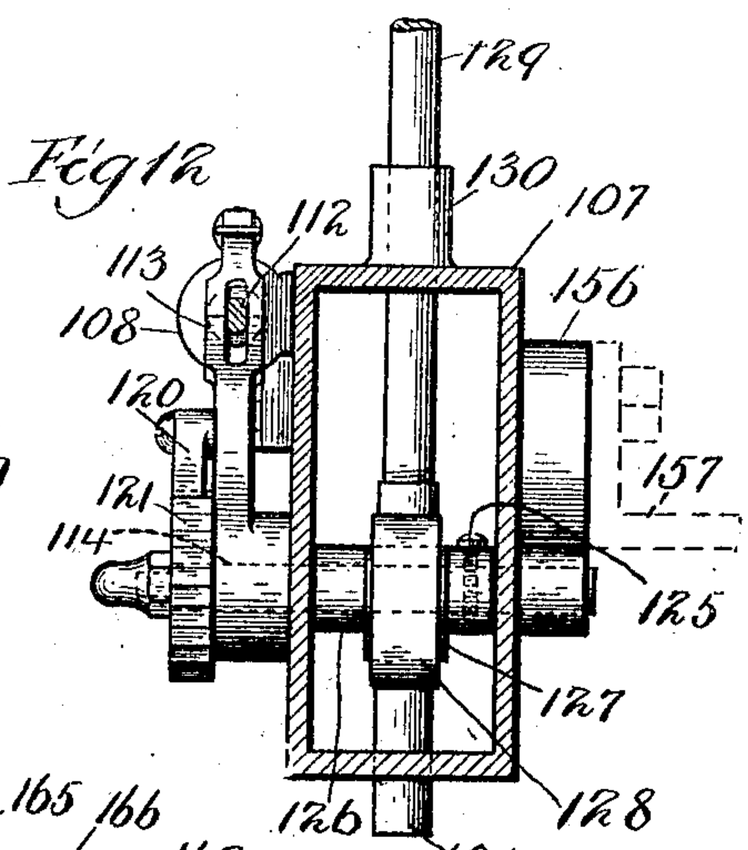

Fig 12

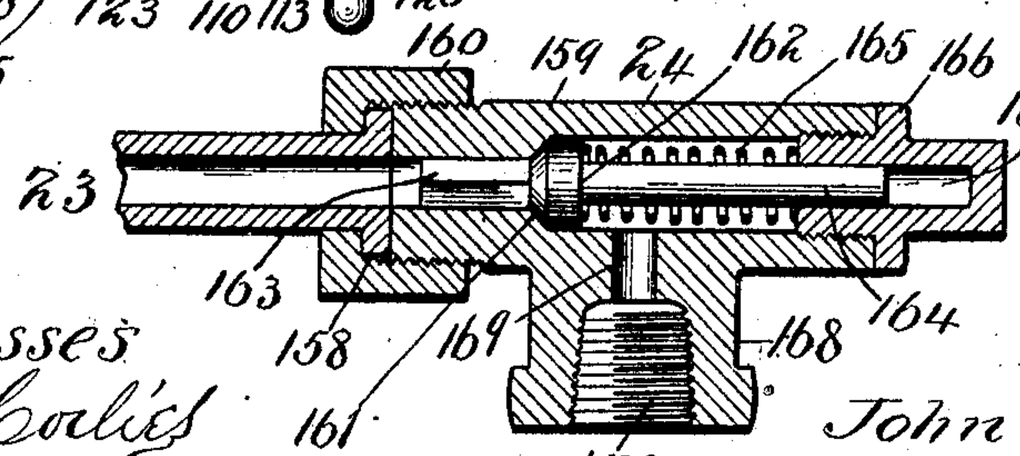

Fig 13

Witnesses
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UNITED STATES PATENT OFFICE.

JOHN F. McCANNA, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE JOHN F. McCANNA COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

LUBRICATING-PUMP FOR LOCOMOTIVE-ENGINES.

No. 822,684. Specification of Letters Patent. Patented June 5, 1906.

Original application filed January 6, 1900, Serial No. 545. Divided and this application filed July 28, 1900. Serial No. 25,107.

To all whom it may concern:

Be it known that I, JOHN F. McCANNA, a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Lubricating-Pumps for Locomotive-Engines, of which the following is a specification.

My invention relates to a new and useful system of mechanism for lubricating by force-feed pumps the steam-cylinders and other parts of locomotive-engines where certain and accurate lubrication is of the utmost importance in keeping up the speed and efficiency of the engine and preventing undue wear of the reciprocating parts.

The lubrication of stationary engines by force-feed pumps has been practically accomplished for many years by the employment of combined pumps and oil-cups, one for each part to be lubricated and driven directly by the moving parts; but so far as I am aware such a force-feed system has never been successfully applied to locomotive-engines prior to my present invention. As they have been hitherto lubricated in practice the oil flowed from the reservoir in the cab down into the steam-cylinders by gravity, being admitted with the steam, and when the engine stopped it was necessary to operate shut-off cocks to stop the flow of the oil, otherwise the entire supply would flow into the cylinders when the engine stopped, as it descended faster than when the engine was in motion, as it did not have to enter the cylinder against steam-pressure. The lubrication of locomotive-engines in the same manner as the stationary engines by using a combined cup and pump upon each steam-cylinder or other parts to be lubricated has been tried, but has been a failure becaues different conditions are present than those which are found in connection with stationary engines which are housed from the weather and run normally against uniform loads, whereas locomotive-engines are frequently run by the load, as on downgrades. With this arrangement in locomotive-engines, however, the cup and pump are exposed to the weather, and in the winter the oil in the cups becomes congealed, so that it will not flow, and, moreover, the engineer during the time the train is in motion sometimes for an hour or more without stopping can neither see how the lubrication is being effected nor can he change the rate of lubrication, as is necessary with the change of work occasioned by passing from upgrades to downgrades, and vice versa.

In my present invention I overcome all these difficulties by arranging a reservoir in the cab, with a delivery-pipe passing to each of the pumps of which there is one for each part to be lubricated and actuated by its own moving part, so that it is lubricated only when running and at a rate corresponding to its speed. To enable the engineer to see at all times how the pump is operating, I provide in connection with each pump a feed-test located in the cab, and in order to enable him to supply the oil in quantities as needed at each part to be lubricated I preferably not only make the rate of feed of the pumps adjustable to vary the quantity that is fed while operating at a given rate of speed, but I may also arrange the actuating connections for the pumps so that they can be adjusted by the engineer from the cab while the engine is running so as to enable him to vary the rate of feed at will independently of the speed of the engine, as may be necessary to furnish more lubrication when the load is heavy, as upon an upgrade, or to diminish the amount when the load is light, as on a downgrade. I preferably also arrange the actuation of the pumps for the driving-cylinders so that the rate of feed will be varied automatically, as a greater or less amount of steam is admitted to the cylinders to pull a greater or less load, the amount of the lubricant being increased automatically when the slide is given a long stroke and likewise diminished proportionately when the length of the stroke is decreased for lesser loads.

In connection with my system I may arrange the lubricating-pump for the air-pump steam-cylinder to be operated in the cab by air-pressure from the air-pump, so that it serves as an indicator always in sight of the engineer as to whether or not the air-pump is operating properly while at the same time lubricating the air-pump steam-cylinder and, if desired, the air-pump also at a rate corresponding to the movement of the air-pump. In connection with this system I may also employ a steam-chamber adjacent to each pump that is exposed to the weather, so that it may be kept warm by exhaust-steam in cold

weather to prevent any possible failure of the pump by reason of the oil becoming congealed therein.

My invention furthermore consists of certain combinations of instrumentalities and details of construction, all as will be hereinafter fully described, and specifically pointed out in detail in the claims.

Referring now to the accompanying sheets of drawings, in which the same reference characters designate identical parts in all the figures, Figure 1 is a side elevation of an engine equipped with my lubricating system, a portion of the cab being broken away to disclose the arrangement of the parts. Fig. 2 is a rear elevation of a portion of the top of the boiler, showing the location of the reservoir, the lubricating-pumps for the air-pump, and the arrangement of the pipe connections. Fig. 3 is a detail in section on the line A A of Fig. 1, but on a larger scale. Fig. 4 is a detail in section on the line B B of Fig. 3 on a still larger scale. Fig. 5 is a detail in section on the line C C of Fig. 1, but showing the other side of the engine. Fig. 6 is a central sectional view through one of the lubricating-pumps for the driving-cylinders. Fig. 7 is a plan view of the same. Fig. 8 is a front elevation, partly in section, of the reservoir and its sight-feed attachments in the cab. Fig. 9 is a front elevation of the lubricating-pumps for the air-pump steam-cylinder and the air-pump. Fig. 10 is a central sectional view of the same on the line D D of Fig. 11. Fig. 11 is a plan view of the same in section on the line E E of Fig. 9. Fig. 12 is a side elevation of the same in section on the line F F of Fig. 9, and Fig. 13 is a central longitudinal section of one of the vacuum-valves.

Before describing the specific construction of the various mechanisms making up the system which are illustrated in detail in Figs. 6 to 13, I will describe the general construction and arrangement of the parts and their connections, as shown in Figs. 1 to 5.

In illustrating my invention I have shown my system applied to the lubrication of the two driving steam-cylinders 1, the air-pump steam-cylinder 2, and the air-pump 3. As a single kind of oil is used for lubricating all three of the steam-cylinders, I preferably employ a reservoir 4, common to all of them, which is conveniently supported in the position shown in Figs. 1 and 2 by the bracket 5, projecting upward from the rear end of the boiler. Three feed-test mechanisms 6, 7, and 8 are connected to the reservoir through the medium of the valves 9, 10, and 11, which control the entrance of the oil to the supply-pipes 12, 13, and 14, which lead to the pumps for the left and right hand driving-cylinders 1 and the air-pump steam-cylinder 2, respectively. Shut-off cocks 15 are placed in these pipes leading to the reservoir, for a purpose to be described. The pipes 12 and 13, or continuations thereof, enter into the jacket of the engine next to the boiler, as seen at 15^a and 16, and thence pass forward and downward to the point 17, where they emerge from the jacket and pass, as directly as may be, to the pumps 18 and 19, respectively, which are secured against the rear ends of the steam-chests of their respective cylinders 1. Each of these pumps is given an impulse at each reciprocation of the slide-valve by means of a rod 20, which is connected at one end to the slide-valve rocker-arm 21 and at the other end to the actuating-arm 22 of the pump, which arm is thus reciprocated at each stroke of the driving-pistons and by the mechanism to be subsequently described slowly but regularly operates the pump to draw oil from the supply-pipe and force it through the discharge-pipes 23 and past the vacuum-valve 24 into the steam-chest of its cylinder. This vacuum-valve, which will be more fully described hereinafter, consists of a valve controlled, preferably, by a spring so adjusted as to permit the passage of the oil only toward the cylinder and that only under heavy pressure, the object of its employment being to prevent the oil from the reservoir, which being located in the cab is so much higher than the point of delivery, from flowing down by hydrostatic pressure and wasting the oil when the engine is at rest, as actually occurs with the system heretofore used unless the supply of oil is shut off when the engine is stopped. This valve also prevents the sucking of the lubricating-oil into the cylinder that takes place when the steam is shut off, as this suction is not strong enough to overcome the pressure of the controlling-spring in the vacuum-valve, and by the employment of the force-feed pump I can overcome any resistance that may be required in the vacuum-valve.

As will be more fully hereinafter described, the pumps 18 and 19 are provided with pistons which are reciprocated at a rate of speed varying directly with the speed of the engine, but the connections for which are adjustable so that the length of stroke of the piston can be varied at will to pump greater or lesser amounts of oil at a certain rate of speed of the engine. By adjusting the valves 9, 10, and 11 the oil supplied to each of the pumps can be drawn from the feed-test mechanisms 6, 7, and 8, so that the engineer can at any time observe the rate of feed of the pump without leaving his position in the cab. The rate of feed of the pumps as controlled by the length of stroke of the piston can of course be changed to suit the ideas of different engineers as to the amount of lubrication required while running under ordinary circumstances; but after it is once set the amount of lubrication relative to the speed of the engine, irrespective of the load, should not be changed. However, it is desirable that the engineer

may be able to materially increase at will the amount of lubrication with an increase of load, as a heavier grade is encountered or to diminish the amount correspondingly when a downgrade is struck and the work of the engine is reduced. To effect this change from the cab while the engine is running, I pivot in one side of the cab, preferably to the side of the boiler, the hand-lever 25, which may cooperate with a graduated segment 26ª in the customary manner to indicate the different rates of feed, depending upon the position of the lever. The lower end of this lever 25 is connected by a rod 26 with the arm 27, which is secured to a rock-shaft 28, mounted in bearings 29 and extending beneath the engine, and having the horizontal arms 30, secured at either end thereof, which arms have pivoted to their outer ends the connecting-rods 31, the lower ends of which are pivotally secured upon the wrist-pins 32, projecting inwardly from the blocks 34, which are mounted to slide freely upon the substantially vertical links 35, which are secured substantially parallel to the rocker-arms 21 by means of the lugs 36 and 37, projecting forwardly therefrom. The lugs 36 and 37 are provided with suitable apertures, (not shown,) through which the links 35 pass and which are rigidly secured therein by means of set-screws or in any other desired way. Each block 34 has the aperture 38 therein, through which its link 35 passes, and it is also provided with the apertured ears 39, in which the end of the rod 20 is pivoted. By the construction herein described it will be seen that as the lever 25 is swung in either direction the shaft 28 will be rocked and its arms 30 will thereby raise or lower the rods 31, which in turn will raise or lower the sliding blocks 34 upon the links 35, thus bringing these blocks and the pivotal point of the rod 20 farther from or nearer to the axis of the rocker-arm 21, thus increasing or diminishing the length of throw given to the rod 20 and the consequent movement of the actuating-arm 22 for the pumps 18 and 19. If the blocks 34 are dropped down to their lowermost position in line with the axis of the rocker-arm 21, it will be apparent that the lubrication will cease entirely. As will be hereinafter explained, the amount of actuation given to the pumps at each movement of the rocker-arm 21 will vary proportionately, and by means of the mechanism just described the engineer has at his hand means for instantly and simultaneously either shutting off, diminishing, or increasing very materially the amount of lubrication applied to the driving-cylinders 1, as may be necessitated by the different changes in the work required from the engine.

With the construction and mechanism herein shown I have also provided means for automatically increasing or diminishing the amount of lubrication to correspond with the amount of work to be done as the engineer adjusts the reversing-lever for greater or less quantities of steam to be admitted to the driving-cylinders. The method of controlling the amount of steam thus admitted by the link-motion valve mechanism is well known and need not be here explained further than to say that when the load is light the slide-valve is arranged so as to have but a slight reciprocation, shutting off the steam shortly after it starts the piston in either direction, whereas when the load is heavy the valve has a longer reciprocation, not cutting off the steam until the piston is substantially at the end of its throw. As the length of the reciprocation of the slide-valve is controlled by the amount of movement given to the rocker-arm 21, it will be apparent that when the load is light and the rocker-arm is moving through a very small angle the rod 20 will be given but a slight movement, and consequently the pumps 18 and 19 will be operated more slowly than if the load is heavy and the rocker-arm is moving through a larger angle and the rod 20 is given a longer reciprocation.

For engines which are employed in latitudes where extremely cold weather prevails at any time of the year I preferably employ means for heating the pumps 18 and 19, and this is conveniently accomplished by leading a small steam-pipe 40 from the exhaust-port to a steam-pocket 41, arranged between the end of the pump and the steam-chest to which it is secured. The details of the construction of this pocket 41 are shown and will be described in connection with the detailed description of the pump. A small pipe 42 leads from this pocket and opens into the smoke-box of the engine, as at 43, so that a portion of the exhaust-steam passing through this pocket will keep it thoroughly heated, and its proximity to the pump will prevent the temperature in the pump from falling low enough to cause the oil to be congealed. As previously mentioned, the pipes 12 and 13 in passing from the cab to the pumps are carried, so far as possible, beneath the jacket of the boiler, so as to keep the temperature thereof up in spite of cold weather.

As will be seen from Figs. 1 and 5, the portions of the pipes 12 and 13 extending from the jacket to the pumps are immediately adjacent the pipes 42, so that both of them can be wrapped or incased by the same heat-retaining packing, and the exhaust-steam in the pipe 42 thus serves to keep the oil in the pipes 12 and 13 from becoming congealed while passing from the jacket of the engine to the pumps.

To provide for any accidental breakage of the pumps 18 and 19 or failure to operate from any reason, I provide an auxiliary pipe 44, opening into the pipes 12 and 13 a short distance from where they emerge from the jacket and leading to the tops of the steam-

chests and opening into them the same as the ordinary lubricators. The connection of the branch pipe 44 with the pipes 12 and 13 is furnished with a three-way cock 45, so that it can be turned when the pump is in use so that none of the oil can pass from the pipes 12 or 13 into the pipe 44, but which can also be turned in case of failure of the pump so that the oil passes from the pipe 12 into the auxiliary pipe 44 and not through the pump. If this auxiliary feed ever becomes necessary, the cocks 15, previously referred to in connection with the reservoir, can be brought into use when the engine is stopped to prevent the hydrostatic flow of the oil from the reservoir into the cylinder.

The pipe 14, which furnishes the oil for the air-pump steam-cylinder, is connected to the pump 46, which is located in the cab not far from the reservoir in the position shown, and this pump 46, which will be described in detail hereinafter, is operated by air-pressure coming from the air-pump 3 through the pipe 47 to the actuating mechanism of the pump. The discharge-pipe 48, leading from the pump 46, opens through the medium of a vacuum-valve 24′ into the steam-pipe 49, which carries the steam to the air-pump steam-cylinder 2. As the oil is forced by this pump through the vacuum-valve 24′, which is employed for the same purpose as in connection with the driving-cylinders, it enters the tube 49 and is carried down by the steam and enters the cylinder 2 to lubricate it in the customary manner. As the pump 46 is actuated by the air-pump 3, the actuating mechanism of the pump 46 not only serves to pump oil to the cylinder 2 and the air-pump 3, as will be afterward described, at a rate varying directly with their movement, but it also serves as an indicator in position where the engineer can readily observe it as to whether or not the air-pump is acting.

As the air-pump demands a different grade of oil from that used in the steam-cylinders, I provide a small auxiliary cup 50 adjacent to the pump 46, which is preferably double, as hereinafter shown, and this cup has a supply-pipe 51 leading to its portion of the duplicate pump 46 and a discharge-pipe 52 leads from said pump to the air-pipe 47, into which it opens by the vacuum-valve 24″, used for the same purposes as in case of the vacuum-valves upon the steam-cylinders. The lubricating-oil from the air-pump is thus forced into the pipe 47 at a rate of speed corresponding to that of the movement of the air-pump, and the oil being forced into the pipe 47 runs down by gravity into the air-pump 3 to lubricate the same, its flow not being in the least interrupted by the pulsations of air in the tube 47.

From the description of the general construction and operation of the system heretofore given it will be seen that I have provided certain and efficient means for lubricating the various parts of the engine and auxiliaries, all of which are entirely under the control of the engineer at all times and which can be varied within the widest ranges necessary. The general arrangement of the parts and their connections having been described, I will now describe the details of the reservoir 4 and its associated parts and the pumps 18 and 19 and 46.

Referring now to the reservoir 4, which, together with its connections, is shown in Fig. 8, I will briefly describe the construction and operation of the same, it being substantially the same as the cup shown and described in detail and claimed in my application Serial No. 545, filed January 6, 1900. The body of the cup, as shown, is preferably of a cylindrical shape and is provided with the removable cap 53, by which it is filled. The bottom 54 has secured therein by any desired means a number of cross-shaped pieces 55, having the vertical channels 56 extending therethrough and opening into the cup, as well as the horizontal channels 57, the inner ends of which are closed, as seen at 58. Of course it will be understood that these pieces 55 might be formed integrally with the bottom piece 54 and the cross-shaped design thereof abandoned, except for the intersecting channels 56 and 57. The supply-pipes 12, 13, and 14 are preferably screwed into the bottom of these cross-pieces, and the channels 57 are each provided with the sliding horizontal tubular member 59, filling said channel and having its outer end turned upward, as at 60, and with the interior shoulder 61, upon which the gage-glass 62 is seated, and the screw-threaded exterior by which the slotted graduated gage-tube casing 63 is secured in place. The horizontal portion 59 has the aperture 64 in its upper side and the aperture 65 directly beneath it, both normally registering with the channel 56. Another aperture 66 is located in the bottom side in suitable position to register with the channel 56 when the tubular member 59 is drawn out far enough to bring the openings 64 and 65 out of registration with said channel, movement to this extent being allowed, but the complete withdrawal prevented by the screw 67, arranged in the top of the cross-piece and taking into the elongated slot 68, formed in the top of the member 59. When the parts are in the adjustment of Fig. 8, it will be apparent that the oil flows into the pipe 13 freely from both the reservoir and the gage 8, but when the gage is drawn out to its dotted-line position the apertures 64 and 65 being out of register with the channel 56 and the aperture 66 being in register with said channel the oil will be pumped only from the gage-glass 8, and this tube 62 being of very small diameter and the casing 63 being graduated to indicate drops, the engi-

neer by adjustment of the desired valve 9, 10, or 11 can readily ascertain the rate of lubrication caused by either one of the pumps.

The pumps 18 and 19 are illustrated in detail in Figs. 6 and 7; but for a fuller disclosure and a more extended description of the same reference is had to my application Serial No. 18,054, filed May 26, 1900, which shows the details of construction thereof except the steam-pocket, which has been added. The framework 69 of the pump is of a generally rectangular shape, its various sides being preferably integral, except that the end 70 and the top 71 are preferably formed of sheet metal, making a cover that is hinged to the main casing at 72 and which is conveniently secured in place by a set-screw 73 passing through an aperture in the top part 71 and into a lug 74, formed on the barrel 75 of the pump. A block 76 extends from one side of the casing to the other and has the channel 77 passing therethrough, one end of which is closed by a screw-threaded plug 78, while the other end has the screw-threaded ends 79 of the pipe 12 or 13, as the case may be, this arrangement of the channel being employed so that the pump will be adapted to coöperate with either side of the engine by merely changing the position of the plug and pipe. The barrel 75 of the pump contains the horizontal cylindrical channel 80, within which the piston 81 reciprocates, and has the outer end thereof closed by the customary stuffing-box construction 82. This barrel has its inner end secured upon the top of the block 76, between it and the piece 83, the block 76, barrel 75, and piece 83 all being secured together by the bolts 84, which pass through the two upper parts and into the block 76. A small vertical channel 85 leads from the channel 77 to the top of the block 76, and upon the seat thus formed is placed the ball check-valve 86, which is held in place in the pocket 87, formed in the under side of the barrel 75, apertures 88 leading from the pocket 87 to the horizontal channel 80. A short vertical channel 89 leads from the horizontal channel 80 to the top of the barrel 75, and resting upon the seat thus formed is the ball check-valve 90, which is held in place in the pocket 91, formed on the under side of the piece 83, the pocket 91 having the vertical channel 92 opening into it, which channel 92 in turn opens into the discharge-pipe 23. It will be apparent from the structure herein disclosed that as the piston 81 is reciprocated the oil will be drawn from the channel 77 and forced out through the discharge-pipe 23 at a rate depending upon the frequency of movement of the piston and the length of its stroke. For reciprocating the piston at the desired rate of speed I provide the shaft 93, which is mounted in bearings formed in the abutments 94, extending from the sides and end of the casing 69. This shaft is preferably reduced eccentrically, as at 95, and has coöperating therewith the pieces or bearing-blocks 96, which are held together by the elongated rectangular aperture in the yoke 97, which is pivoted on the rod or shaft 98, passing through the casing at the lower side thereof. For convenience of assembling the parts the yoke 97 is preferably constructed so that one side thereof is formed by the detachable piece 99, which is secured to the body of the yoke by the screws 100. The outer screw-threaded end of the piston 81 passes through the aperture 101, formed in the upper end of the yoke, and the projection or nut 102 on the inner side of the yoke and the nut 103, secured by the lock-nut 104, serve to form the necessary movable abutments by which the length of throw of the piston can be accurately regulated, as it will be apparent that the closer the nut 103 is brought to the abutment or lug 102 the greater the portion of the swing of the yoke 97 utilized and the greater the rate of feed. By setting the nut 103 sufficiently far away the pump can be thrown completely out of action, if desired. The shaft 93 is provided with clutch mechanism 105, which may be of any desired form, but which is preferably like that shown in my Patent No. 648,628, dated May 1, 1900, and by means of this clutch mechanism 105 the reciprocation of the arm 22, which is preferably secured integrally to the disk 106, which is rotatably mounted on the reduced outer end of the shaft 93, will be transmitted to said shaft—*i. e.*, as the arm 22 is reciprocated its movement in one direction will be imparted to the shaft 93, so as to give it an intermittent rotation in that direction. As the shifting of the position of the block 34 on the rod 35 varies the length of throw of the arm 22, it will be apparent that the rate of feed of the pump will be varied by said adjustment.

Referring now to the pump 46, which is illustrated in detail in Figs. 9 to 12, the casing 107 thereof is in the form of a hollow body, open at its ends, and this casing has secured at the upper left-hand corner thereof the small air-cylinder 108, which is joined by the connection 109 to the end of the pipe 47, previously referred to as leading to and opening into the air-pump 3. As the piston of the air-pump reciprocates it will be apparent that the air in the tube 47 will be alternately compressed and released, and the increased pressure transmitted to the piston 110 in the air-cylinder 108 will cause it to be moved to its dotted-line position, and the shoulder 111 between it and its reduced portion 112, coöperating with the slotted lever 113, through which said reduced portion 112 passes, will cause said lever 113 to be swung about its bearing on the outer end of the shaft 114 against the stress of the helically-coiled spring 115, secured at one end to the upper

end of the lever 113 and at the other end to the lug 116, projecting upwardly from the top of the cylinder 108. The outer end of the reduced portion 112 passes through the bearing-lug 117, secured upon the front of the casing in the position shown, and which serves to limit the throw of the lever 113. The nut 118 and the jam-nut 119 on the screw-threaded outer end of the reduced portion 112 serve to control the position of the piston 110 and the consequent possible length of its throw under the impulse of the compressed air. The lever 113 has loosely pivoted thereon the dog 120, whose nose engages the teeth of the ratchet-wheel 121, which is rigidly secured by any desired means upon the outer end of the shaft 114, so that as the piston 110 is moved the ratchet-wheel 120 is advanced a distance corresponding to the length of movement of the piston. To prevent any possible overthrow of the ratchet-wheel, owing to the sudden impulse given it by the piston, I preferably provide the spring-pressed plunger 122, mounted in the socket 123, secured upon the face of the casing 107 and having the crescent-shaped head 124, whose inner face takes against the periphery of the ratchet-wheel to hold it by friction from any accidental movement. The shaft 114 has rigidly secured upon it, inside of the casing 107, as by the screw 125, a sleeve 126, which has centrally located thereon an eccentric disk 127, which is inside of the yoke 128, which is secured to a rod 129, mounted to slide in the elongated bearing 130, provided in the top of the casing. The yoke 128 is also preferably provided with the extension 131, passing through an aperture 132 in the bottom of the casing, and thus furnishing an additional guide for the reciprocating rod 129. This rod 129 is provided with a cross-head 133, secured in position by any suitable means, such as the screw-threaded cap 134, which when in position confines the cross-head between the shoulder 135 on the rod 129 and the lower end of said cap. The ends of the cross-head 133 are provided with the apertures 136, through which pass the piston-rods 137, which are provided with the abutments 138, secured beneath the cross-head, and preferably taking the form of nuts and with the adjustable abutments, such as the set-nuts 139, above the cross-head, which are held in their adjusted position by the jam-nuts 140. By adjusting the nuts 139 nearer to or farther from the abutments 138 it will be apparent that a greater or less portion of the longitudinal movement of the rod 129, caused by the rotation of the shaft 114, will be imparted to the pistons 137, and that each of them can be adjusted independently of the other to regulate the rate of pumping, as may be required for the different parts to be lubricated. The pistons 137 pass through the stuffing-boxes 141, formed in the top of the barrels 142, of the pumps 143. These pumps are provided with the cylindrical body portions 144, which are connected with the barrels by the channeled cross-pieces 145 and are preferably provided with the exterior flanges 146, which connect the barrel and the body portion and which extend outside of these portions sufficiently to form a flange which rests upon the edges of the apertures 147, formed in the top of the casing and of the shape and size to permit the passage of the pumps, which are preferably secured in place by the screws 148, passing through the webs 147[a] and into the top of the casing 107. The bodies 144 of the pumps have the connections 149 screwed into the lower end thereof, and the shoulders formed by the upper ends of these connections, together with the reduced bore thereof, as compared with the bore of the body portion of the pumps, serves as a seat for the ball check-valves 150. The connections 149 have the pipes 151 screwed into their lower ends, and these right and left hand pipes are respectively connected to the supply-tubes 14 and 51, previously referred to. The body portions 144 of the pumps have the contracted portions in their channels above the horizontal channels 145, which furnish the seats 152 for the ball check-valves 153. These check-valves are held in place by the ends of the connections 154, screwed into the top of the body portions of the pumps, and these connections 154 support the check-valve lugs 155, the construction and operation of which are clearly apparent from the drawings. With the constructions herein shown it will be evident that as the piston 110 is reciprocated by the impulses from the air-pump the sliding shaft 129 will be slowly reciprocated, and the desired portion of its movement will be transferred to the pumps 143, which will pump the oil from the reservoir 4 to the air-pump steam-cylinder 2 and from the reservoir 50 to the air-pump 3, thus providing for their thorough and uniform lubrication. The casing 107 is provided on its rear side with the projection 156, to which is secured the angular bracket 157, which in turn is secured to the top of the boiler, upon which the pump is supported.

The construction of the vacuum-valves 24, previously referred to, is shown in the central sectional view thereof in Fig. 13, where it will be seen that the pipes leading thereto may be provided at their ends with the flange 158, which takes against the left-hand end of the horizontal portion 159 of the T-shaped body of the valve. A nut 160, coöperating with the screw-threaded outer end of the part 159, clamps the pipe to the valve. The horizontal body portion 159 has the channel extending therethrough, which is reduced at its left-hand end, and has the inclined shoulder 161 connecting the reduced with the enlarged portions arranged to form

the valve-seat for the valve 162, which coöperates therewith, it preferably being provided with the angular stem 163, projecting toward the tube to which it is connected, as well as with the circular stem 164, projecting in the other direction. This circular stem 164 is surrounded by the helically-coiled expanding spring 165, which is confined between the shoulder between the valve and the stem and the screw-plug 166, which is of the shape shown in cross-section and which has the channel 167 therein to accommodate the movement of the stem 164 as the valve is unseated by the pressure of the oil passing it. The amount of tension upon the valve 162 is regulated by the strength of the spring, which is at least enough to give a pressure of fifteen pounds to the square inch necessary to overcome the possible suction of the steam-cylinder pistons when the steam is cut off. The vertical portion 168 of the body of the valve is provided wth the vertical channel 169, connecting the horizontal channel with the screw-threaded opening 170, by which the vacuum-valve is secured to the pipe into which the oil is discharged.

The details of the steam-pocket construction are shown in Figs. 6 and 7, where it will be seen that the pockets 41 consist of hollow rectangular boxes adapted to be bolted between the end of the pump and the steam-chest by the bolts 171, which pass through the lugs 172, projecting from the side of the casing of the pump, through the lugs 173, projecting from the sides of the pocket 41, and into the flange of the steam-chest. The pipe 40 leads from the exhaust-port and opens into the bottom of the pocket, as seen in Fig. 6, while the pipe 42, leading therefrom, opens into the pocket at the lower portion of the side of the pocket adjacent to the smoke-box.

From a consideration of the details of the foregoing system it will be apparent that the rate of lubrication of the parts is completely under the control of the engineer and that it can be observed and controlled by him from his seat in the cab, so that he is in complete control of the lubrication even when the engine is moving at its greatest speed. The first factor in controlling the rate of lubrication is of course the speed of the engine or the part to be lubricated, and this is ordinarily varied automatically as it is needed, the greater the speed the greater the lubrication required. The second factor is the length of reciprocation given to the piston of each of the pumps as they are operated. This is not automatic; but each pump must be set while the engine is at rest and can be varied from a short stroke discharging one fiftieth of a drop of oil to a long one discharging five or more drops. The third factor is the adjustment of the reversing-lever to control the amount of steam admitted to the cylinders. and while the amount of steam thus admitted is under the control of the engineer the pumps are adjusted automatically in a direct ratio with the adjustment of the reversing-lever. The fourth and last factor is the position of the block 34 upon the rod 35, and this, as before stated, is entirely and at all times under the control of the engineer.

The general construction and mode of operation of my improved lubricating system is apparent from the foregoing description, and I have found by actual experiment that the lubrication provided thereby for locomotive-engines is in every way more certain, regular, and satisfactory than in the systems previously in use and that it saves at least sixty per cent. of the oil heretofore used in lubricating engines and that a very material saving in the amount of coal consumed, amounting to approximately fifteen per cent., occurs in the running of engines in which my lubricating system is employed. I have also found by actual tests with a dynamometer that there is an increase in efficiency as measured by the load that can be pulled of eighteen per cent. resulting from the employment of my system. The reason for so great an increase in efficiency is doubtless found in the fact that when an engine moves slowly, as in starting or upon an upgrade, a very considerable percentage of the power available at such slow speeds is used in overcoming the friction of the pistons in the cylinders, and any reduction of this friction by superior lubrication becomes very material at such speeds, while of the power available at high speeds only a small percentage is necessary to overcome this friction.

While I have shown my invention as embodied in the form which I at present consider best adapted to carry out its purposes, it will be understood that it is capable of wide modifications and that I do not desire to be limited in the interpretation of the following claims except as may be necessitated by the state of the art.

This application is a division of application, Serial No. 545, filed by me January 6, 1900.

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

1. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir located in the cab of the engine, of a pump adjacent to the mechanism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to actuate the pump positively in both directions at intervals varying directly with the speed of the mechanism to be lubricated, and piping connecting said reservoir and pump and said pump and mechanism to be lubricated.

2. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir located in the cab of the engine,

feed-test apparatus in connection therewith by which the rate of feed can be observed, of a pump adjacent to the mechanism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to reciprocate the pump-plunger positively in both directions and at intervals varying directly with the speed of the mechanism to be lubricated, and piping connecting said reservoir and pump and said pump and the mechanism to be lubricated.

3. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir located in the cab of the engine, of a pump adjacent to the mechanism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to reciprocate the pump-plunger positively in both directions and at intervals varying directly with the speed of the mechanism to be lubricated, piping connecting said reservoir and pump and said pump and mechanism to be lubricated, and a vacuum-valve interposed in said piping between the pump and the mechanism to be lubricated.

4. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir located in the cab of the engine, feed-test apparatus in connection therewith by which the rate of feed can be observed, of a pump adjacent to the mechanism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to actuate the pump at intervals varying directly with the speed of the mechanism to be lubricated, piping connecting said reservoir and pump and said pump and the mechanism to be lubricated, means for connecting the test apparatus with and disconnecting the reservoir from the piping leading to the pump without stopping the lubricating action, and a vacuum-valve interposed in the piping between the pump and the mechanism to be lubricated.

5. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir located in the cab of the engine, a sight-tube connected at its lower end to said reservoir, and a valve whereby communication with the reservoir may be cut off and the supply of oil drawn from the sight-tube only, of a pump adjacent to the mechanism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to actuate the pump at intervals varying directly with the speed of the mechanism to be lubricated, means for adjusting such connections to vary the rate of delivery of the pump independently of the speed of said mechanism, piping connecting said reservoir and pump and said pump and the mechanism to be lubricated, and a vacuum-valve interposed in said piping between the pump and the mechanism to be lubricated.

6. In a force-feed lubricating system, the combination with a reservoir, a feed-test apparatus in connection therewith by which the rate of feed can be observed, of a pump adjacent to the mechanism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to actuate the pump at intervals varying directly with the speed of the mechanism to be lubricated, said connections being adjustable to regulate the amount of movement that shall be given to the pump at each interval, piping connecting said reservoir and pump and said pump and the mechanism to be lubricated, and a valve for simultaneously connecting the test apparatus with and disconnecting the reservoir from the pipe leading to the pump without interfering with the lubricating action.

7. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir located in the cab of the engine, a sight-tube connected at its lower end to said reservoir, a valve whereby communication with the reservoir may be cut off and the supply of oil drawn from the sight-tube only, of a pump adjacent to the mechanism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to actuate the pump at intervals varying directly with the speed of the mechanism to be lubricated, said connections being adjustable to regulate the amount of movement that shall be given to the pump at each interval, means located in the cab for controlling said adjustment, piping connecting said reservoir and pump and said pump and the mechanism to be lubricated, and a vacuum-valve interposed in said piping between the pump and the mechanism to be lubricated.

8. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir, of a pump adjacent to the mechanism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to actuate the pump at intervals varying directly with the speed of the mechanism to be lubricated, said connections being adjustable to regulate the amount of movement that shall be given to the pump at each interval, means to control said adjustment extending to the cab, and piping connecting said reservoir and pump and said pump and the mechanism to be lubricated.

9. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir located in the cab of the engine and having feed-test apparatus in connection therewith by which the rate of feed can be observed, of a pump adjacent to the mechan-

ism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to actuate the pump at intervals varying directly with the speed of the mechanism to be lubricated, said connections being adjustable to regulate the amount of movement that shall be given to the pump at each interval, means to control said adjustment extending to the cab, and piping connecting said reservoir and pump and said pump and the mechanism to be lubricated.

10. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir, of a pump adjacent the mechanism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to actuate the pump at intervals varying directly with the speed of the mechanism to be lubricated, said connections being adjustable to regulate the amount of movement that shall be given to the pump at each interval, means to control said adjustment extending to the cab, piping connecting said reservoir and pump and said pump and the mechanism to be lubricated, and a vacuum-valve interposed between the pump and the mechanism to be lubricated.

11. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir located in the cab of the engine and having a feed-test apparatus in connection therewith by which the rate of feed can be observed, of a pump adjacent to the mechanism to be lubricated, connections between said pump and a moving member related to the mechanism to be lubricated to actuate the pump at intervals varying directly with the speed of the mechanism to be lubricated, said connections being adjustable to regulate the amount of movement that shall be given to the pump at each interval, means to control said adjustment extending to the cab, piping connecting said reservoir and pump and said pump and the mechanism to be lubricated, and a vacuum-valve interposed in said piping between the pump and the mechanism to be lubricated.

12. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir, of a plurality of pumps, each located adjacent to the mechanism it is to lubricate, connections between each of said pumps and a moving member related to the mechanism to be lubricated thereby to actuate the pump at intervals varying directly with the speed of its mechanism to be lubricated, said connections being simultaneously adjustable to regulate the amount of movement that shall be given to the pump at each interval, means to control said adjustment extending to the cab, and piping connecting said reservoir and each of said pumps and each of said pumps and its mechanism to be lubricated.

13. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir located in the cab of the engine, of a plurality of pumps, each located adjacent to the mechanism it is to lubricate, a plurality of feed-test apparatus corresponding in numbers to the pumps and each associated with a certain pump by which the rate of feed of each pump can be observed, connections between each of said pumps and a moving member related to the mechanism to be lubricated by said pump to actuate it at intervals varying directly with the speed of the mechanism it is to lubricate, said connections being simultaneously adjustable to regulate the amount of movement that shall be given to the pump at each interval, means to control said adjustment extending to the cab, and piping connecting said reservoir and each of the pumps and each of said pumps and its mechanism to be lubricated.

14. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir, of a plurality of pumps, each adjacent to the mechanism it is to lubricate, connections between each of said pumps and a moving member related to the mechanism it is to lubricate to actuate the pump at intervals varying directly with the speed of the mechanism it is to lubricate, said connections being simultaneously adjustable to regulate the amount of movement that shall be given to a pump at each interval, means extending to the cab of the locomotive to control said adjustment piping connecting said reservoir and each of said pumps and each of said pumps and its mechanism to be lubricated, and a plurality of vacuum-valves interposed in said piping, one between each pump and its mechanism to be lubricated.

15. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir located in the cab of an engine, of a plurality of pumps, each adjacent to the mechanism it is to lubricate, a plurality of feed-test apparatus corresponding in number to the pumps and each associated with a certain pump by which the rate of feed of each pump can be observed, connections between each of said pumps and a moving member related to the mechanism it is to lubricate to actuate the pump at intervals varying directly with the speed of the mechanism it is to lubricate, said connections being simultaneously adjustable to regulate the amount of movement that shall be given to the pump at each interval, means to control said adjustment extending to the cab, piping connecting said reservoir and each of said pumps and each of said pumps and its mechanism to be lubricated, and a plurality of vacuum-valves interposed in said piping, one between each pump and its mechanism to be lubricated.

16. In a force-feed lubricator, the combi-

nation with a reservoir, a feed-test apparatus therefor, a pump adjustable to vary the amount of oil delivered thereby adjacent the mechanism to be lubricated, a pipe leading to the pump, a valve for placing the reservoir and feed-test apparatus simultaneouly in communication with the said pipe and also for establishing communication between the feed-test apparatus and the pipe independently of the reservoir, connection between the pump and a moving member related to the mechanism to be lubricated to actuate the pump at intervals varying directly with the speed of the mechanism to be lubricated, said connection being adjustable to regulate the amount of movement that shall be given to the pump at each interval, and piping connecting the pump and the mechanism to be lubricated.

17. In a force-feed lubricating system, the combination with a pump, of a reservoir connected therewith and located above the mechanism to be lubricated, a supply-pipe leading from said reservoir to the pump, a discharge-pipe leading from said pump to the mechanism to be lubricated, an auxiliary discharge-pipe leading from the supply-pipe to the mechanism to be lubricated, and connections between the auxiliary discharge-pipe and the supply-pipe to pass the oil through or around the pump, as may be desired.

18. In a force-feed lubricating system, the combination with a pump, of a reservoir connected therewith and located above the mechanism to be lubricated, a supply-pipe leading from said reservoir to the pump, a discharge-pipe leading from the pump to the mechanism to be lubricated, a vacuum-valve in said discharge-pipe, an auxiliary discharge-pipe leading from the supply-pipe to the mechanism to be lubricated, a stop-cock in said supply-pipe between the reservoir and the auxiliary discharge-pipe, and connections between the auxiliary discharge-pipe and the supply-pipe to pass the oil through or around the pump, as may be desired.

19. In a force-feed lubricating system for locomotive-engines, the combination with the pump adjacent to the steam-chest, of the steam-pocket in immediate proximity to said pump, and a pipe leading from the steam-cylinder exhaust-port to said pocket.

20. In a force-feed lubricating system for locomotive-engines, the combination with the pump adjacent to the steam-chest, of the steam-pocket in immediate proximity to said pump, a pipe leading from the steam-cylinder exhaust-port to said pocket, and another pipe leading from the pocket into the smoke-box, substantially as and for the purpose described.

21. In a force-feed lubricating system for locomotive-engines, the combination with the pump and adjacent to the steam-chest, of the rectangular steam-pocket immediately between the steam-chest and the pump, a pipe leading from the steam-cylinder exhaust-port to said pocket, and another pipe leading from the pocket into the smoke-box, substantially as and for the purpose described.

22. In a force-feed lubricating system for locomotive-engines, the combination with the reservoir, of a lubricating-pump located in the cab, a supply-pipe leading from said reservoir to the pump, an air-cylinder having a piston therein, an oscillating member actuated by the piston and for operating said pump, and an air-pipe connecting the air-brake pump with said air-cylinder.

23. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir, of a lubricating-pump located in the cab, a supply-pipe leading from said reservoir to the pump, an air-cylinder having a piston therein for operating said pump, an air-pipe connecting the air-brake pump with said air-cylinder, and a discharge-pipe leading from the lubricating-pump into the air-pipe.

24. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir, of a lubricating-pump located in the cab, a supply-pipe leading from said reservoir to the pump, an air-cylinder having a piston therein for operating said pump, an air-pipe connecting the air-brake pump with said air-cylinder, a discharge-pipe leading from the lubricating-pump into the air-pipe, and a vacuum-valve in said discharge-pipe between the lubricating-pump and the air-pipe.

25. In a force-feed lubricating system for locomotive-engines, the combination with the reservoir, of a fluid-pressure-operated lubricating-pump located in the cab, connections between said reservoir and pump, connections from the air-cylinder of the air-pump for operating the lubricating-pump at intervals corresponding with the movements of the air-pump, a steam-pipe leading to the air-pump, and a discharge-pipe leading from the lubricating-pump to the steam-pipe.

26. In a force-feed lubricating system for locomotive-engines, the combination with the reservoir, of a lubricating-pump located in the cab, connections between said reservoir and pump, connections from the air-cylinder of the air-pump for operating the lubricating-pump at intervals corresponding with the movements of the air-pump, a steam-pipe leading to the air-pump, a discharge-pipe leading from the lubricating-pump to the steam-pipe, and a vacuum-valve in said discharge-pipe between the lubricating-pump and the steam-pipe.

27. In a force-feed lubricating system for locomotive-engines, the combination with the reservoirs, of a pair of lubricating-pumps located in the cab, connections between said

reservoirs and their respective pumps, connections from the air-pump for operating said lubricating-pumps at intervals corresponding with the movements of the air-pump, a discharge-pipe leading ultimately from one of said lubricating-pumps to the air-pump steam-cylinder, and another discharge-pipe leading from the other lubricating-pump ultimately to the air-pump.

28. In a force-feed lubricating system for locomotive-engines, the combination with the two reservoirs, of a pair of lubricating-pumps located in the cab, a supply-pipe leading from each of said reservoirs to its connected lubricating-pump, an air-cylinder having a piston therein for operating said lubricating-pumps, an air-pipe connecting the air-brake pump with said air-cylinder, a discharge-pipe leading from one of said lubricating-pumps into the air-pipe, and a discharge-pipe leading from the other of said pumps to a steam-pipe leading to the air-pump steam-cylinder.

29. In a force-feed lubricating system for locomotive-engines, the combination with the two reservoirs, of a pair of lubricating-pumps located in the cab, a supply-pipe leading from each of said reservoirs to its connected lubricating-pump, an air-cylinder having a piston therein for operating said lubricating-pumps, an air-pipe connecting the air-brake pump with said air-cylinder, a discharge-pipe leading from one of said lubricating-pumps into the air-pipe, a steam-pipe leading to the air-pump steam-cylinder, a discharge-pipe leading from the other of said pumps to the steam-pipe, and a vacuum-valve interposed in each discharge-pipe beyond the connected lubricating-pump.

30. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir, of a pump adjacent the driving-cylinder and connected to said reservoir, connections between said pump and a moving member associated with the driving-cylinder for operating said pump at intervals corresponding to the movements of the driving-piston, said connections being adjustable to regulate the amount of movement that shall be given to the pump at each interval, and means to control said adjustment extending to the cab.

31. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir, of a pump adjacent the driving-cylinder and connected to said reservoir, and connections for operating said pump at intervals corresponding to the movement of the driving-piston, said connections being adjustable to regulate the amount of movement that shall be given to the pump at each interval and comprising a link connected to the pump-actuating arm, a rod substantially parallel to and supported by the slide-valve rocker-arm, a block slidably mounted on the rod and connected to the link, and means for shifting the position of the block on the rod.

32. In a force-feed lubricating system for locomotive-engines, the combination with a reservoir, of a pump adjacent the driving-cylinder and connected to said reservoir, a pump-actuating arm, and connections between said pump and the slide-valve rocker-arm for operating said pump at intervals corresponding to the movement of the driving-piston, said connections being adjustable from the cab to regulate the amount of movement that shall be given to the pump at each interval and comprising a link connected to the pump-actuating arm, a rod substantially parallel to and supported by the slide-valve rocker-arm, a block slidably mounted on the rod and connected to the link, and means for shifting the position of the block on the rod.

33. In a force-feed lubricating system for locomotive-engines, the combination with two pumps, one adjacent each of the driving-cylinders, of means for supplying said pumps with oil, connections between each of said pumps and a moving member associated with the corresponding steam-cylinder for operating its connected pump at intervals corresponding to the movement of the driving-piston, and means for adjusting said connections extending to the cab to simultaneously regulate the amount of movement that shall be given to each pump at each interval.

34. In a force-feed lubricating system for locomotive-engines, the combination with two pumps, one adjacent each of the driving-cylinders, an actuating-arm for each pump, of means for supplying said pumps with oil, and connections between each of said pumps and the slide-valve rocker-arm associated with the corresponding steam-cylinder for operating its connected pump at intervals corresponding to the movement of the driving-piston, said connections being adjustable from the cab to simultaneously regulate the amount of movement that shall be given to each pump at each interval, said connections comprising links connected to the pump-actuating arms, rods substantially parallel to and supported by the slide-valve rocker-arms, blocks slidably mounted on the rods and connected to the links, and means extending to the cab of the locomotive for shifting the positions of the blocks on the rods.

35. In a force-feed lubricating system for locomotive-engines, the combination with two pumps, one adjacent each of the driving-cylinders, of means for supplying said pumps with oil, and connections between each of said pumps and the slide-valve rocker-arm associated with the corresponding steam-cylinder for operating its connected pump at intervals corresponding to the movement of the driving-piston, said connections being

adjustable from the cab to simultaneously regulate the amount of movement that shall be given to each pump at each interval and comprising the adjustable hand-lever, an arm 27, a rock-shaft to which said arm is secured, a connection between the hand-lever and the arm 27, arms 30 fixed to the rock-shaft, links 31 connected to the arms 30, sliding blocks pivotally secured to the links 31, rods secured to the slide-valve rocker-arms and on which the blocks are slidably mounted, pump-actuating arms, and connections between the blocks and the pump-actuating arms.

36. In a force-feed lubricating system, the combination with a force-feed pump, of a moving member the amount of whose movement controls the amount of power applied to the mechanism to be lubricated, and operating connections between said member and said pump.

37. In a force-feed lubricating system, the combination with a force-feed pump, of the slide-valve rocker-arm of a steam-cylinder to be lubricated, and connections between said rocker-arm and said pump.

38. In a force-feed lubricating system, the combination with a force-feed pump, of a moving member the amount of whose movement controls the amount of power applied to the mechanism to be lubricated, operating connections between said member and said pump whereby the pump is operated at a rate varying automatically with the power applied to said mechanism to be lubricated, and means under the control of the operator for shifting said connections at will to still further increase or diminish the rate of operation of the pump.

39. In a force-feed lubricating system, the combination with a force-feed pump, of the slide-valve rocker-arm of a steam-engine cylinder to be lubricated, operating connections between said rocker-arm and the pump, and means for shifting the position of the connections on the rocker-arm to still further increase or diminish the rate of operation of the pump.

40. In a force-feed lubricating system, the combination with a force-feed pump, of connections between the slide-valve rocker-arm of a steam-engine cylinder, and the pump whereby the pump is operated at a rate varying automatically with the power applied to said mechanism, said connections consisting of a rod between said pump and rocker-arm so connected to said rocker-arm as to be moved a distance varying directly with the swing of said arm, and means for shifting the position of the connection on the rocker-arm, substantially as and for the purpose described.

41. In a force-feed lubricating system for locomotive-engines, the combination with the pump adjacent to the steam-chest, of the steam-pocket in immediate proximity to said pump, and a pipe connected with a source of steam-supply leading to said pocket.

42. In a lubricating system for locomotive-engines, the combination with a pump adjacent to the steam-chest, of a steam-pocket in immediate proximity to said pump, an oil-supply pipe leading to the pump, and a steam-pipe immediately adjacent said oil-supply pipe and opening into said steam-pocket.

43. In a lubricating system for locomotive-engines, the combination with a pump adjacent to the steam-chest, of a steam-pocket in immediate proximity to said pump, an oil-supply pipe connected to the oil-reservoir and leading through the boiler-jacket to the pump, and a steam-pipe adjacent said oil-supply pipe leading from said pocket to the smoke-box.

44. In a lubricating system for locomotive-engines, the combination with a pump adjacent to the steam-chest, of a steam-pocket in immediate proximity to said pump, an oil-supply pipe leading through the boiler-jacket to the pump, a steam-supply pipe leading from the exhaust-port to said pocket, and a steam-discharge pipe immediately adjacent said oil-supply pipe and leading from said steam-pocket into the smoke-box.

45. In a force-feed lubricating system, the combination with the reservoir for the oil-supply, of a force-feed pump for drawing oil from the reservoir, and a vacuum-valve located beyond the pump and through which the oil must be forced to reach the object to be lubricated.

46. In a force-feed lubricating system for locomotive-engines, the combination of the air-cylinder, a piston in said air-cylinder, a pipe connecting said air-cylinder to the air-brake air-pump, so that the piston in said air-cylinder is operated as the air-pump is operated, the two oil-pumps connected with the air-pump and the air-pump steam-cylinder, respectively, and operated by the reciprocation of said piston, and the two oil-reservoirs connected with said oil-pumps.

JOHN F. McCANNA.

Witnesses:
LOUISE E. SERAGE,
HATTIE O. HALVORSON.