L. F. SLEADE.

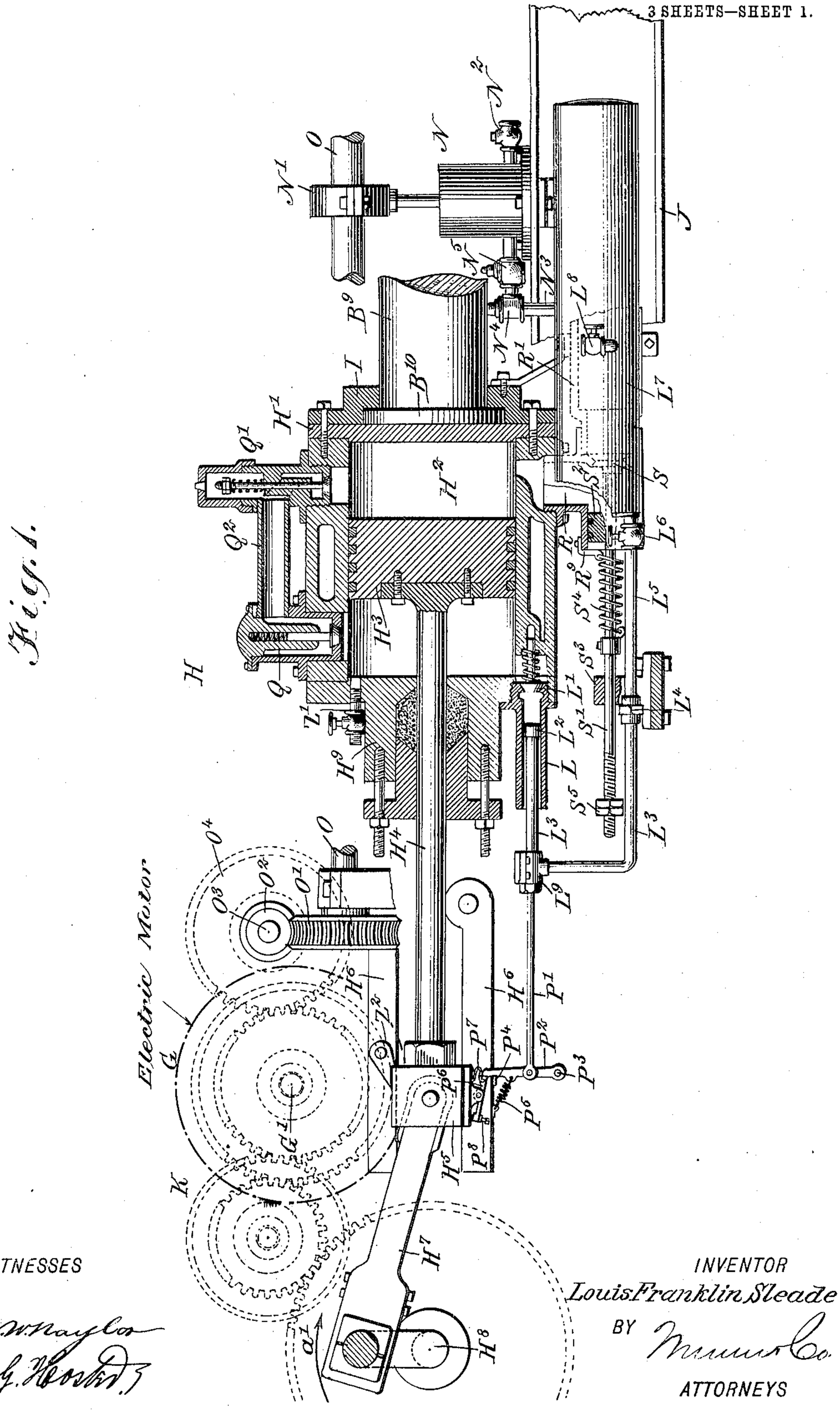
INTERNAL COMBUSTION ENGINE.

APPLICATION FILED AUG. 19, 1908.

952,438.

Patented Mar. 15, 1910.

3 SHEETS—SHEET 1.



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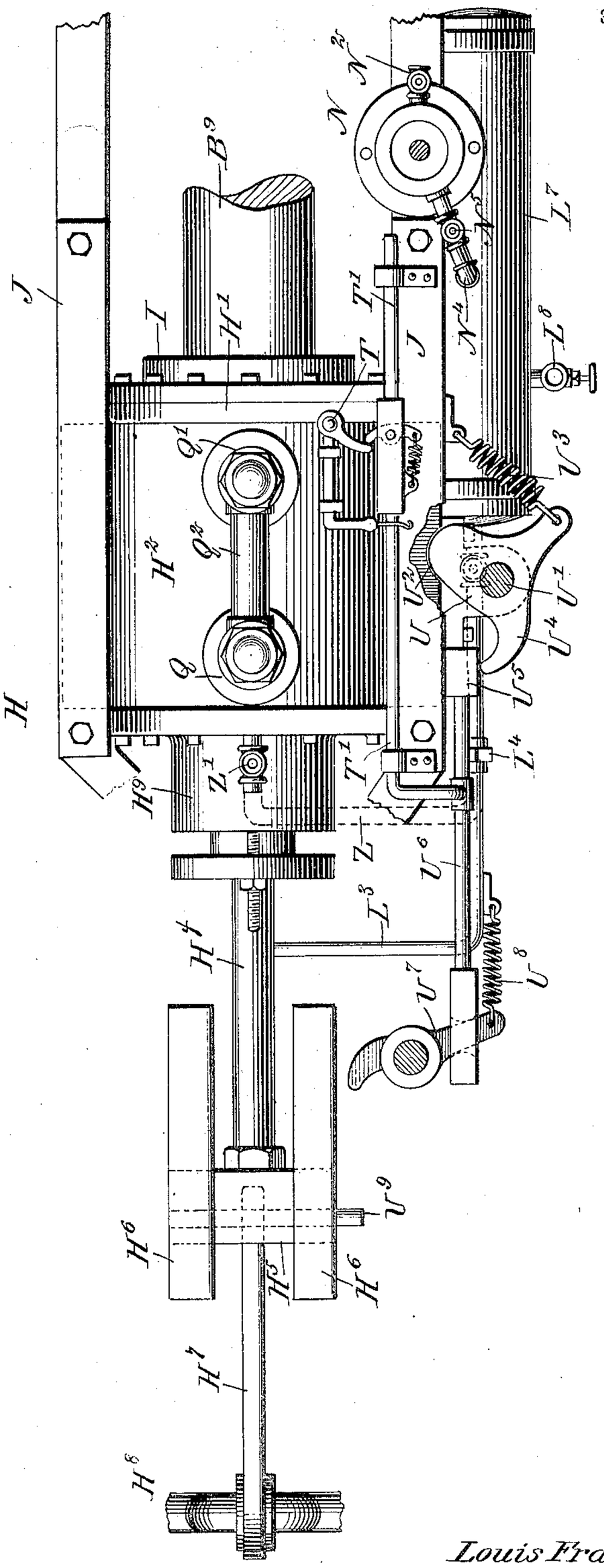

Fig. 2.

WITNESSES

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3 SHEETS—SHEET 3.

Fig. 4.

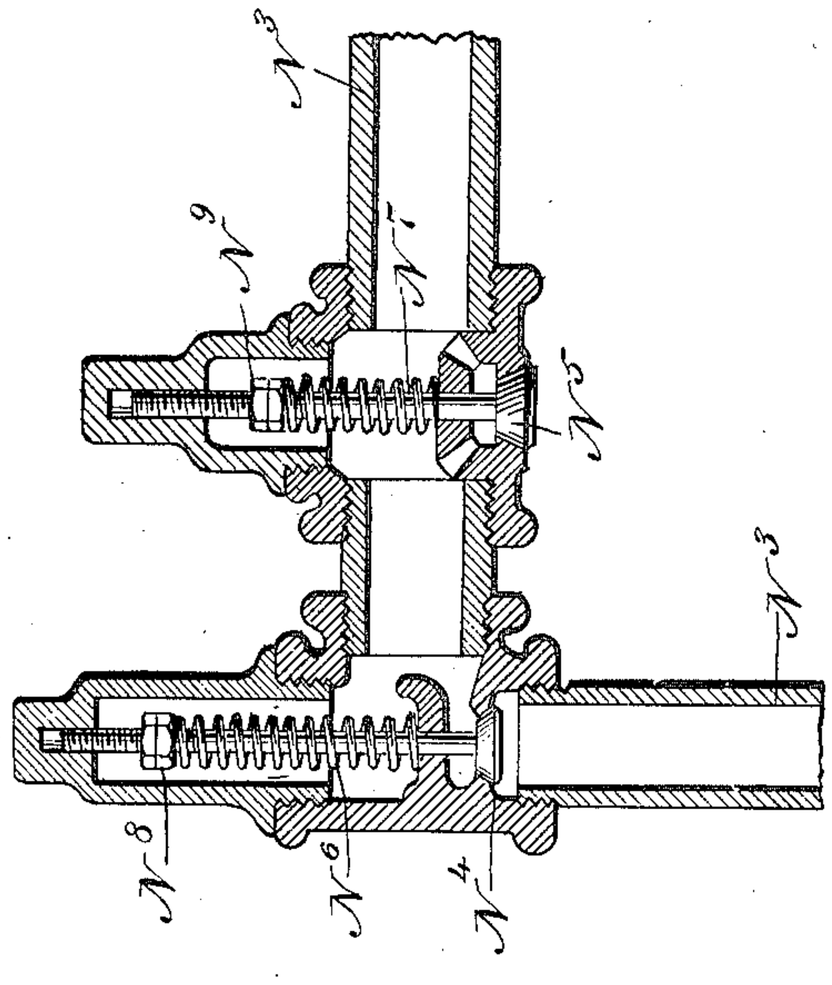


Fig. 5.

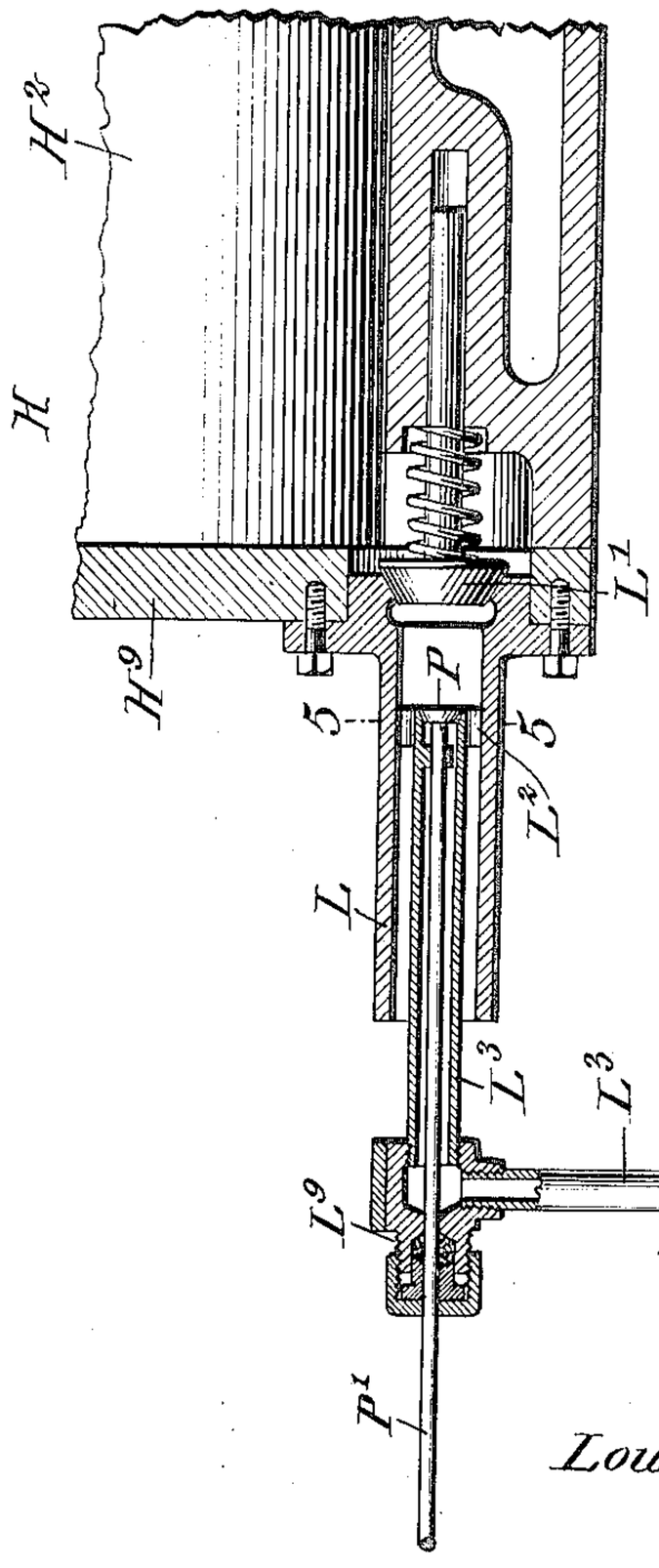
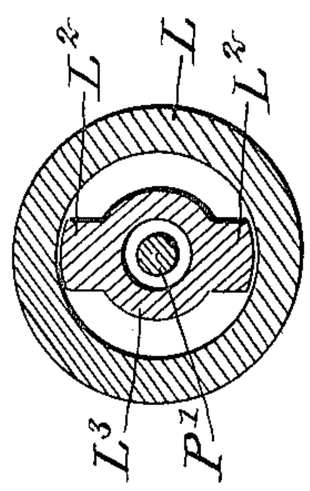


Fig. 5.



WITNESSES

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

952,438. Specification of Letters Patent. Patented Mar. 15, 1910.

Original application filed April 16, 1908, Serial No. 427,305. Divided and this application filed August 19, 1908. Serial No. 449,232.

To all whom it may concern:

Be it known that I, LOUIS FRANKLIN SLEADE, a citizen of the United States, and a resident of Denver, in the county of Denver and State of Colorado, have invented a new and Improved Internal-Combustion Engine, of which the following is a full, clear, and exact description, this being a division of the application for a tunneling machine, No. 427,305, filed by me April 16, 1908.

The object of the invention is to provide a new and improved internal combustion engine, more especially designed for use in tunneling and other machines, with a view to cause a cutting tool to deliver or strike blows on rocks or other material, without injury to the operating parts of the engine.

The invention consists of novel features and parts and combinations of the same, which will be more fully described hereinafter and then pointed out in the claims.

A practical embodiment of the invention is represented in the accompanying drawings forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views.

Figure 1 is a longitudinal central section of the improvement; Fig. 2 is a plan view of the same, parts being in section and parts being broken out; Fig. 3 is an enlarged longitudinal section of the inlet mechanism; Fig. 4 is an enlarged longitudinal section of the valves in the connection between the air compressor and the gasolene tank; and Fig. 5 is an enlarged cross sectional view of the gas inlet, the section being on the line 5—5 of Fig. 3.

The internal combustion engine H, illustrated in the drawings, is mainly designed to reciprocate a cutter or boring tool, so that the latter strikes or delivers blows against the rock or other material, with a view to cut the material into small fragments. The revoluble shaft B^9 of the cutting tool (not shown) terminates in an annular flange B^{10} held in a bearing or cap I secured to the forward head H′ of the cylinder H^2 of the internal combustion engine H. The cylinder H^2 is mounted to slide in the direction of its axis in suitable fixed guideways J arranged on the frame of the tunneling or other machine on which the internal combustion engine is used, and by the connection above described the cutter or boring tool moves bodily with the said cylinder H^2.

In the cylinder H^2 is mounted to reciprocate a piston H^3, having its piston rod H^4, extending rearwardly and connected with a cross head H^5, mounted to slide in suitable guideways H^6, held on the machine frame, and the said cross head H^5 is connected by a pitman H^7, with a crank shaft H^8, journaled in suitable bearings on the frame of the machine.

The crank shaft H^8 is driven from a motor G, preferably of the electric type, and for this purpose the crank shaft H^8 and the motor shaft G′ are connected with each other by a train of gear wheels K, so that when the electric motor G is running, the train of gear wheels K imparts a rotary motion to the crank shaft H^8, which by the pitman H^7, the cross head H^5 and the piston rod H^4, imparts a continuous reciprocating motion to the piston H^3 in the slidable cylinder H^2.

The device for controlling the admission of the explosive mixture for the internal combustion engine H is arranged as follows: An intake pipe L is bolted or otherwise secured to the rear head H^9 of the cylinder H^2, and the inner end of this intake pipe L is normally closed by a spring-pressed valve L′. In the intake pipe L is mounted to slide the head L^2 of the supply pipe L^3, connected by a coupling L^4 with a short pipe L^5, attached to a valve L^6 connected with a tank L^7, containing gasolene or a like fluid. The tank L^7 is provided with a suitable filling valve L^8, for filling the tank L^7 with the desired amount of gasolene. Compressed air is forced into the tank L^7 by the use of an air pump N, actuated by an eccentric N′ from a longitudinally-extending shaft O, journaled in suitable bearings on the frame of the machine, and the shaft O is rotated from the electric motor G, and for this purpose the rear end of the shaft O is provided with a worm wheel O′, in mesh with a worm O^2 secured on a transverse shaft O^3, carrying a gear wheel O^4, in mesh with one of the gear wheels of the train of gear wheels K above mentioned, and connecting the motor shaft G′ of the motor G with the crank shaft H^8 of the internal combustion engine H. Now when the motor G is running, a rotary motion is transmitted to the shaft O by the

gearing mentioned, and consequently the air pump N is actuated to pump air into the tank L^7. The cylinder of the air pump N is provided with an inlet valve N^2 and a discharge pipe N^3 connected with the tank L^7, and in the said discharge pipe N^3 is arranged the spring-pressed check valve N^4 and the relief valve N^5, as shown in detail in Fig. 4. The springs N^6, N^7 for the valves N^4, N^5 serve to normally hold the same to their seats, and the tension of the said springs can be adjusted by nuts N^8, N^9, as shown in Fig. 4. The spring N^7 is somewhat heavier than the spring N^6, so that the valve N^5 remains closed while the pump N is working and pumping air into the tank L^7, but when the pressure in the tank L^7 exceeds normal pressure then the valve N^5 opens to relieve the tank of any excess of pressure. Now the air tank L^7 exerts a pressure on the gasolene contained therein, to force the gasolene through the supply pipe L^3 into the intake pipe L, the said supply pipe L^3 being however held periodically closed by a valve P, which when opened allows the gasolene to pass out of the pipe L^3 and over the valve P, to be sprayed in the intake pipe L.

The valve P is located at the inner end of the pipe L^3 at the head L^2, and its stem P′ extends rearwardly and through a suitable stuffing box L^9 arranged on the pipe L^3, as shown in Fig. 3. The valve stem P′ connects with a lever P^2, fulcrumed at P^3 on the frame of the carriage, the free end of the lever P^2 normally resting against a stop P^4. A spring P^5 holds the lever P^2 normally against the stop P^4, and the said lever P^2 receives a periodical swinging motion in a forward direction by a lever P^6, fulcrumed on the cross head H^5 of the internal combustion engine H. A spring P^7 presses one end of the lever P^6, while the other end thereof is provided with a set screw P^8 abutting against the cross head H^5, and serving to adjust the lever P^6 relative to the free end of lever P^2. When the piston H^3 is at the end of its rearward stroke, then the lever P^6 is in engagement with the free end of the lever P^2, and when the piston H^3 moves forward then the lever P^6 imparts a swinging motion to the lever P^2, whereby the valve P is opened, and consequently the gasolene in the supply pipe L^3 can pass into the intake pipe L, and by way of the valve L′ into the rear end of the cylinder H^2. At the same time air is drawn into the cylinder H^2 by way of the intake pipe L, which is open at the outer end, it being understood that the head L^2 is cut out on the sides to allow the air to pass the head and to mix with the sprayed gasolene at the entrance to the cylinder H^2. As the cross head H^5 advances, the lever P^6 finally disengages the lever P^2, to allow the spring P^5 to swing the lever P^2 back to its normal position of rest, and in doing so to close the valve P. Thus the admission of gasolene into the cylinder H^2 is cut off. Now by adjusting the set screw P^8 on the lever P^6, the contact of the lever P^6 with the lever P^2 during the forward stroke of the cross head H^5 can be regulated, so as to keep the valve P open for a longer or a shorter time. On the return stroke of the cross head H^5, the lever P^6 readily passes over the free end of the lever P^2, as the said lever P^6 is yieldingly mounted.

The rear and front ends of the cylinder H^2 are connected with each other by valves Q, Q′ and a pipe Q^2 connecting the valves Q and Q′ with each other. The valve Q is arranged on the rear end of the cylinder H^2 and opens outwardly, while the valve Q′ is arranged on the forward end of the cylinder H^2 and opens inwardly, so that the gaseous mixture passing into the rear end of the cylinder H^2, as above explained, is forced by way of the valves Q, Q′ and the pipe Q^2 into the forward end of the cylinder H^2 at the time the said cylinder H^2 slides forward by the force of a previous explosion, as hereinafter more fully described.

The forward end of the cylinder H^2 is provided with an exhaust chamber R having an exhaust pipe R′ for carrying off the exhaust gases. The connection of the exhaust chamber R with the pipe R′ is normally closed by a valve S, having its stem S′ extending through a piston S^2 held in a cylinder R^9 formed on the exhaust chamber R. The outer end of the stem S′ extends through a guide S^3 fixed on the frame, and a spring S^4 is coiled on the stem S′ and is attached at one end to the exhaust chamber R and at the other end to a collar on the stem S′, so as to hold the valve S normally on its seat. The terminal of the valve stem S′ is provided with adjustable nuts S^5 adapted to abut against the guide S^3 at the time the cylinder H^2 reaches the forward end of its stroke, so that the valve S is moved into an open position, and consequently the products of combustion in the forward end of the cylinder H^2 can pass by way of the exhaust chamber R into the exhaust pipe R′.

The explosive mixture passing from the rear end of the cylinder H^2 to the front end thereof, is compressed during the forward travel of the piston H^3 in the cylinder H^2, at the time the cylinder H^2 is held locked in a rearmost position, and when the piston H^3 is at the end of its forward stroke and the crank shaft H^8 stands in a dead center position, then this compressed explosive mixture in the forward end of the cylinder H^2 is ignited by a suitable igniting device T, and the force of the resultant explosion now forces the unlocked cylinder H^2 in a for-

ward direction, to cause the cutter to strike the face of the tunnel. During this forward movement of the cylinder H^2 the piston H^3 is practically stationary, and when the cylinder H^2 nears the end of its forward stroke, then the exhaust valve S is drawn open so that the products of combustion are exhausted from the forward end of the cylinder H^2. It will also be noticed that during this forward movement of the cylinder H^2, the gaseous mixture previously drawn into the rear end of the cylinder H^2 is forced through the valve Q into the pipe Q^2, and finally passes by way of the valve Q' into the forward end of the cylinder H^2, the springs of the valves Q and Q' holding the same closed until the products of combustion have been exhausted from the forward end of the cylinder H^2, so that the incoming gaseous mixture fills the forward end of the cylinder H^2.

As the motor G is running continually, it is evident that the piston H^3 in moving on its rearward stroke draws the cylinder H^2 along until the latter is in its rearmost position, and then the cylinder H^2 is locked temporarily against movement, while the piston H^3 moves at the forward or compression stroke, to compress the gaseous mixture in the forward end of the cylinder H^2. The above-described operation is then repeated, that is, another explosion takes place in the forward end of the cylinder H^2 at the time the crank shaft H^8 is in a dead center position, and consequently the cylinder H^2 is again forced forward, to cause the cutter to deliver another blow.

The device for temporarily locking and unlocking the cylinder H^2 when in its rearmost position is arranged as follows: A locking lever U is fulcrumed at U' on the guideway J in which slides the cylinder H^2, and the said locking lever U is adapted to engage a notch U^2 in one side of the cylinder H^2, and the lever U is pressed on by a spring U^3 to swing the locking lever U into engagement with the said notch U^2 on the rearward stroke of the piston H^3 and the cylinder H^2. The locking lever U is provided with an arm U^4 adapted to be engaged by the head U^5 of a rod U^6, to hold the locking lever U normally in locking position. The rod U^6 is engaged by a lever U^7 fulcrumed on the frame of the carriage, and the said lever is pressed on by a spring U^8, to move the rod U^6 forwardly into engagement with the arm U^4 of the locking lever U and to hold the locking lever U in locking position.

The lever U^7 extends into the path of a pin U^9, on the cross head H^5 of the internal combustion engine, so that when the said cross head H^5 about reaches the end of its forward stroke, the pin U^9 engages and imparts a swinging motion to the lever U^7, whereby the rod U^6 is drawn rearward and the head U^5 moves out of engagement with the arm U^4. This takes place immediately previous to actuating the igniting device T, and as the cylinder H^2 is now unlocked it is free to move forward by the force of the explosion within the cylinder H^2, as above explained. It is understood that the locking lever U after being unlocked by the head U^5, moves readily out of the notch U^2, on the forward motion of the cylinder H^2. When the cylinder H^2 and the piston H^3 return together, as previously stated, the locking lever U reëngages the notch U^2 by the action of the spring U^3, and the head U^5 slides back under the arm U^4 by the action of the spring U^8 and after the pin U^9 has left the lever U^7 on the return stroke of the cross head H^5.

The electric igniting device T is preferably of the make and break type, and is actuated by a rod T' held on the rod U^6, so that the igniting of the explosive mixture in the forward end of the cylinder H^2 takes place immediately after the cylinder H^2 is unlocked. As the igniting device T may be of any approved construction, it is not deemed necessary to show or describe the same in detail.

The operation is as follows: When the several parts are in the position as shown in Figs. 1 and 2, and the electric motor G is running, then the crank shaft H^8 turns in the direction of the arrow a' so that the piston H^3 of the internal combustion engine H travels forward in the cylinder H^2, now locked by the locking lever U in a rearmost position. An explosive charge is drawn into the rear end of the cylinder H^2, while the advancing piston H^3 compresses the charge in the front end of the cylinder H^2, and when the crank of the crank shaft H^8 reaches a forward dead center position, then the cylinder H^2 is unlocked and the igniting device T is actuated, so that the explosive charge in the cylinder H^2 is ignited and the force of the resultant explosion now drives the cylinder H^2 forward and with it the shaft B^9 of the cutter, whereby the latter strikes or delivers a blow on the face of the material to be cut into fragments. As the crank shaft H^8 keeps on turning, in the direction of the arrow a', it moves out of the forward dead center position and in doing so causes the piston H^3 to travel rearwardly, and as the piston H^3 is near the rear cylinder head H^9 with a gas cushion between them, it is evident that the cylinder H^2 is carried along, that is, is drawn back and with it the cutter. When the cylinder H^2 and the piston H^3 reach the end of their rearmost stroke, the cylinder H^2 is again locked in place by the locking lever U, and the piston H^3 now begins its next forward stroke and the above-described operation is repeated. When starting the bore of a tunnel along a slope or the like, it is desirable

to strike but light blows with the cutter, and for this purpose the internal combustion engine H is not run as a combustion engine and hence no gasolene is used, and the tank L^7 is not filled with gasolene, but is charged with compressed air supplied by the air pump N. The tank L^7 is now directly connected with the rear end of the cylinder H^2, and for this purpose the pipe L^5 is removed and the valve L^8 is connected by a high pressure hose Z with a valve Z′ on the rear cylinder head H^9. The nuts S^5 on the exhaust valve stem S′ are removed, so that the exhaust valve S remains in a closed position. One of the gear wheels in the train of gear wheels K is removed, and the piston H^3 is temporarily locked in a rearmost position by the use of a dog Z^2 (see Fig. 1) temporarily bolted to the cross head guidway H^6 and engaging the cross head H^5. The electric motor G is now started, and as this motor is disconnected from the crank shaft H^8 it is evident that the shaft H^8 is not driven from the electric motor G, but the latter drives the shaft O so that the air pump N is actuated and fills the tank L^7 with compressed air. The valves L^6, Z′ are now opened to allow compressed air to pass from the tank L^7 by way of the valves L^6, Z′ and the hose Z into the rear end of the cylinder H and by way of the by-pass (the valves Q, Q′ and the pipe Q^2) into the front end of the cylinder H^2 to equalize the pressure on both sides of the piston H^3, held against forward movement by the locking of the cross head H^5 by the dog Z^2. The air pressure in the cylinder H^2 cannot escape by way of the intake pipe L as the valve L′ is held in a closed position by the air pressure, and the latter cannot escape by way of exhaust chamber R, as the exhaust valve S is held in a closed position by the air pressure. In order to allow the use of a high pressure in the tank L^7, the springs N^6, N^7 and the valves N^4, N^5 are adjusted correspondingly. After the cylinder H^2 is charged with the desired pressure, the electric motor G is stopped, the valves L^6, Z′ are closed and the hose Z is removed. The dog Z^2 is next removed and the removed gear wheel in the train of gear wheels K is replaced, after which the electric motor G is started up to cause the cylinder H^2 and the piston H^3 to travel in unison with each other and with an air cushion on either side of the piston H^3, so that the blows struck by the cutter are light, as the cutter can readily rebound owing to the high pressure air cushion in the cylinder H^2.

When the engine is used as before described, the locking device is thrown out of action in any suitable manner as for instance by releasing the springs U^3, U^8 from the lever U and the lever U^7 respectively, and moving the rod U^6 in such position that the block U^5 will be out of engagement with the lever U when the lever may be turned out of locking position.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. An internal combustion engine, comprising a cylinder mounted to slide in the direction of its axis and provided with means for carrying a tool, a piston in the said cylinder, a motor connected with the said piston to reciprocate the same, and means for producing explosions in the forward end of the said cylinder at the time the cylinder is at the end of its rearward stroke and the piston is at the front end of the cylinder, to move the cylinder forward.

2. An internal combustion engine, comprising a cylinder mounted for sliding movement in the direction of its axis, a piston in the cylinder, means disconnected from the cylinder for continuously reciprocating the piston, and means for producing an explosion in one end of the cylinder and at the time the piston is at this end.

3. An internal combustion engine, comprising a cylinder mounted for sliding movement in the direction of its axis, a piston in the cylinder, means disconnected from the cylinder for continuously reciprocating the piston, and means for producing an explosion in one end of the cylinder and at the time the piston is at this end, and means operated by the piston for alternately locking and unlocking the cylinder.

4. An internal combustion engine, comprising a cylinder mounted for sliding movement in the direction of its axis, a piston in the cylinder, means disconnected from the cylinder for continuously reciprocating the piston, means for producing an explosion in one end of the cylinder and at the time the piston is at this end, and means for temporarily locking and unlocking the cylinder.

5. An internal combustion engine, comprising a cylinder mounted to slide in the direction of its axis, a piston in the said cylinder, a cross head connected with the said piston, a shaft connected with the said cross head, means for continuously rotating the shaft, means for producing an explosion in one end of the cylinder at the time the piston is at this end, and locking means controlled by the said cross head for temporarily locking and unlocking the said cylinder.

6. An internal combustion engine, comprising a piston, a motor for continuously reciprocating the piston, a cylinder within which the piston is movable, said cylinder being mounted to slide in the direction of its axis, and to move independently of the movement of the piston, a valved connection between the ends of the cylinder for the passage of the gaseous charge, means for delivering the charge to one end of the cylin-

der, means at the other end for carrying off burned gases, and means for igniting the charge in this end of the cylinder, said cylinder being movable in one direction by the explosion and in the opposite direction by the piston.

7. An internal combustion engine, comprising a cylinder, a piston therein, an intake tube open at one end to the atmosphere and connected at the other end with the said cylinder, a supply pipe connected with a source of fuel supply and having a head extending into the said intake tube, portions of the head being cut out to form passages to the atmosphere, a valve for closing the said supply pipe, a mechanism for actuating the said valve from a reciprocating part of the engine, the said mechanism including an actuating lever connected with the stem of the said valve, and a spring-pressed trip lever fulcrumed on the said reciprocating part and adapted to engage the said actuating lever.

8. An internal combustion engine, comprising a cylinder, a piston therein, an intake tube open at one end to the atmosphere and connected at the other end with the said cylinder, a supply pipe connected with a source of fuel supply and having a head extending into the said intake tube, portions of the head being cut out to form passages to the atmosphere, a valve for closing the said supply pipe, a mechanism for actuating the said valve from a reciprocating part of the engine, the said mechanism including an actuating lever connected with the stem of the said valve, a spring-pressed trip lever fulcrumed on the said reciprocating part and adapted to engage the said actuating lever, and means for adjusting the said trip lever relative to the said actuating lever.

9. An internal combusion engine comprising a piston, a motor for continuously reciprocating the piston, a cylinder within which the piston is movable, said cylinder being mounted to slide independently of the movement of the piston, means for introducing a charge into one end of the cylinder, means for igniting the same whereby the explosion will move the cylinder in one direction, the piston moving it in the opposite direction.

10. An internal combustion engine, comprising a piston, means for continuously reciprocating the piston, a cylinder in which the piston reciprocates, said cylinder being normally freely and independently movable with respect to the piston, for the purpose set forth.

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

LOUIS FRANKLIN SLEADE.

Witnesses:
J. M. BONGERS,
J. H. PRIEST.