No. 775,573. PATENTED NOV. 22, 1904.

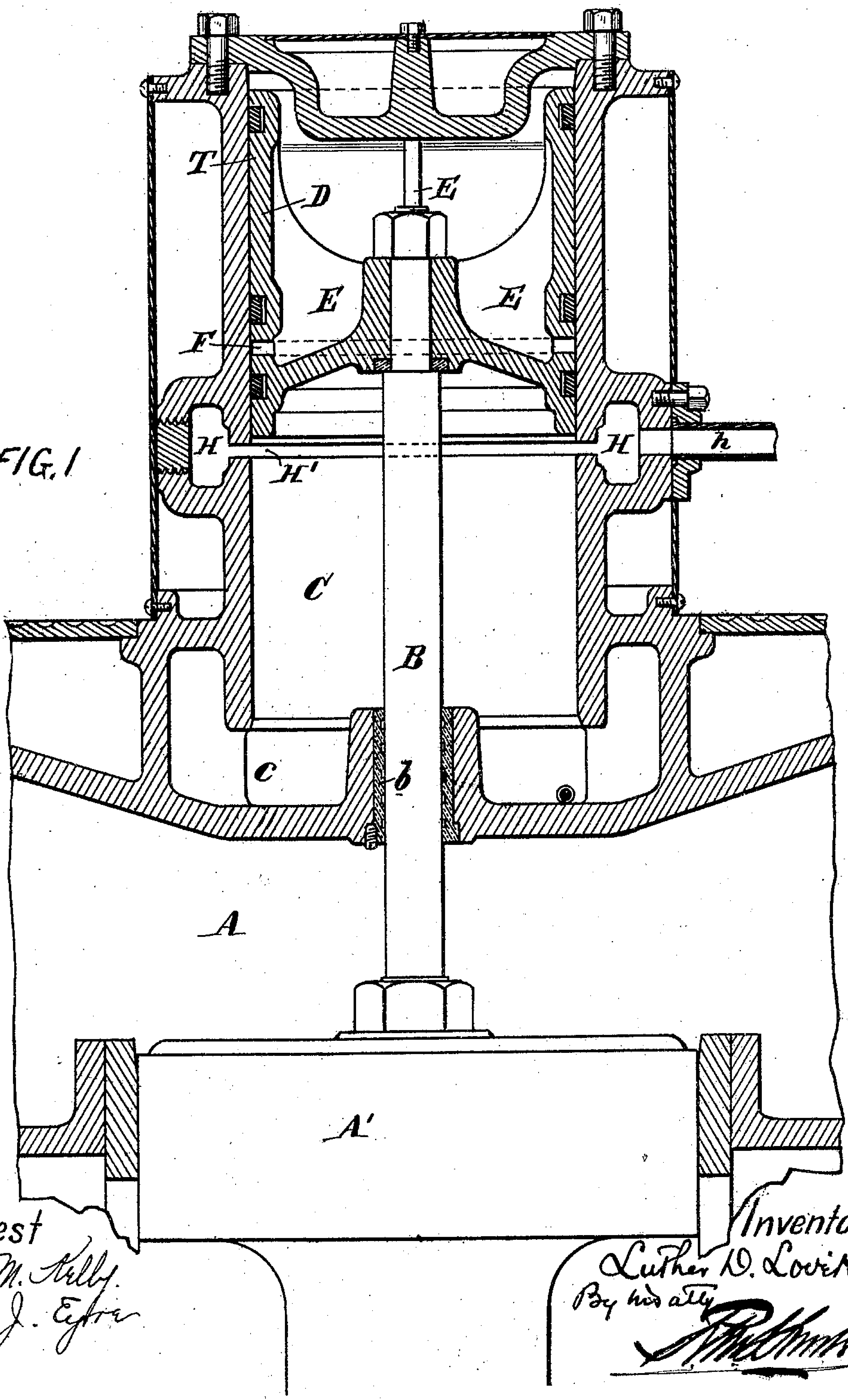
L. D. LOVEKIN.

DEVICE FOR RELIEVING FORCES DUE TO INERTIA AND WEIGHT OF VALVE GEAR.

APPLICATION FILED FEB. 25, 1904.

NO MODEL. 5 SHEETS—SHEET 1.

FIG. 1



Attest
R. M. Kelly
M. J. Ezra

Inventor
Luther D. Lovekin
By his atty
R. M. Hunter

No. 775,573. PATENTED NOV. 22, 1904.

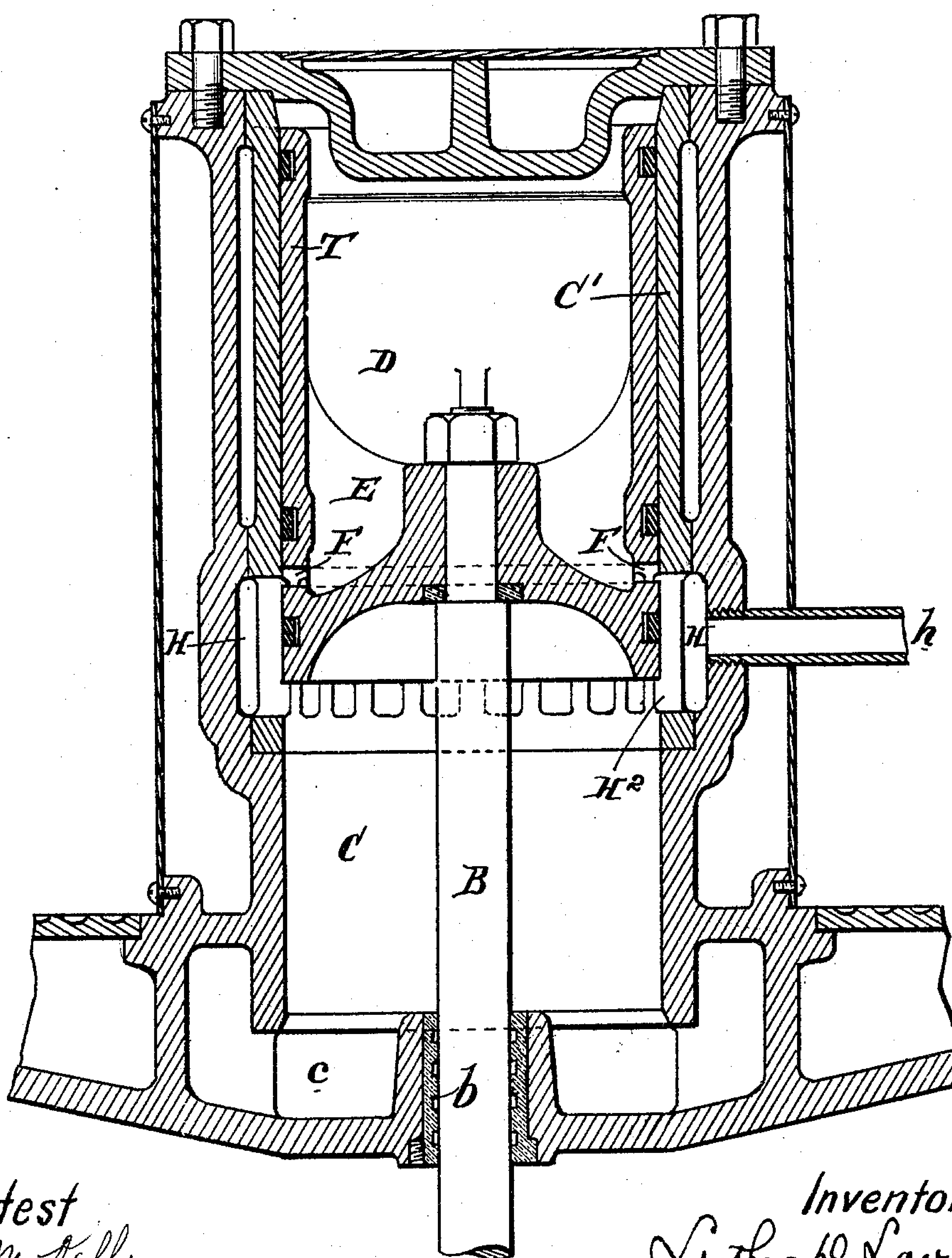
L. D. LOVEKIN.

DEVICE FOR RELIEVING FORCES DUE TO INERTIA AND WEIGHT OF VALVE GEAR.

APPLICATION FILED FEB. 25, 1904.

NO MODEL. 5 SHEETS—SHEET 2

FIG. 2



Attest
R. M. Kelly
M. J. Eyre.

Inventor
Luther D. Lovekin
By his atty

No. 775,573. PATENTED NOV. 22, 1904.

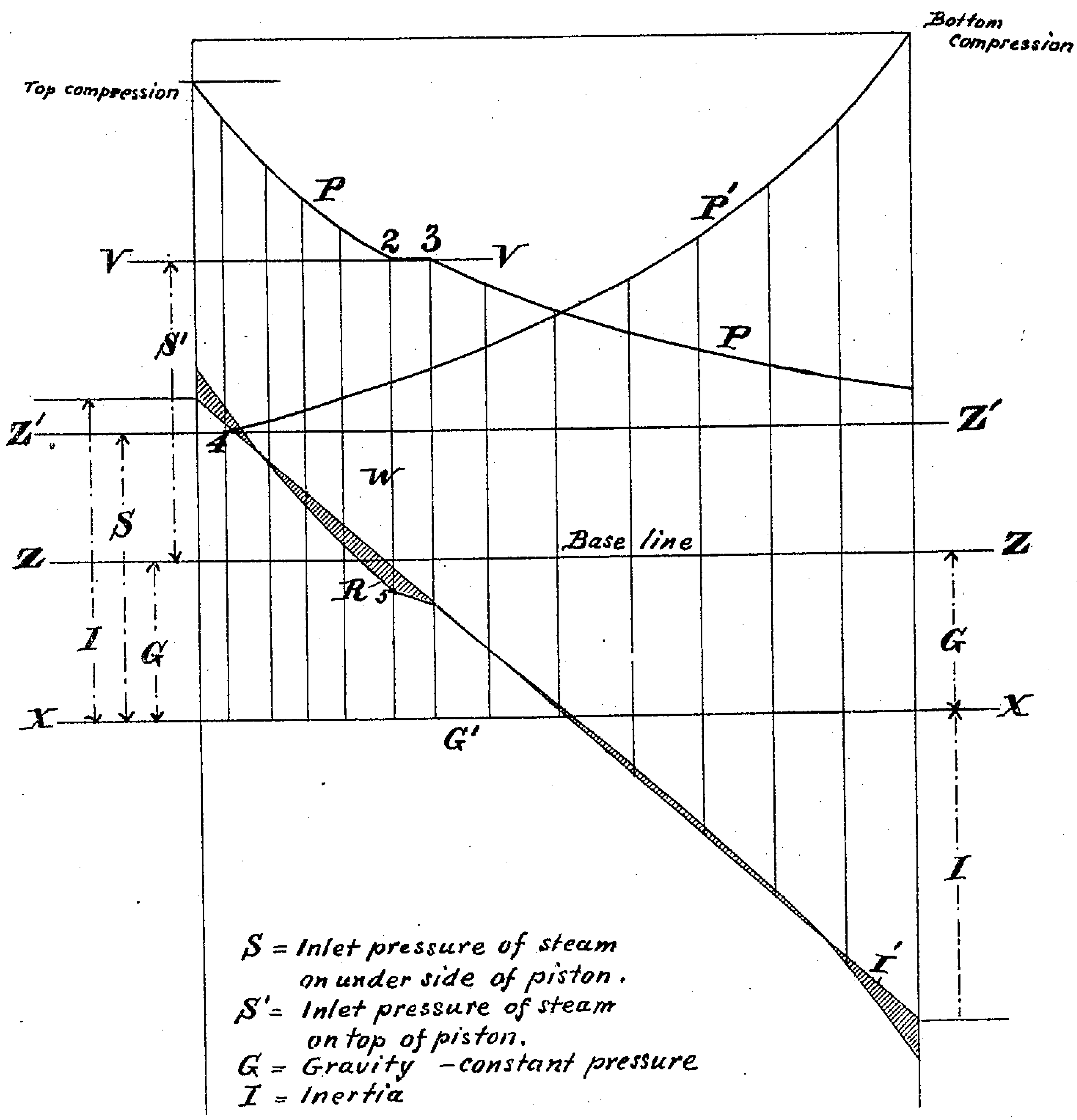
L. D. LOVEKIN.

DEVICE FOR RELIEVING FORCES DUE TO INERTIA AND WEIGHT OF VALVE GEAR.

APPLICATION FILED FEB. 25, 1904.

NO MODEL. 5 SHEETS—SHEET 3.

FIG. 3



Attest
R. M. Kelly
M. J. Eyre

Inventor
Luther D. Lovekin
By his atty

No. 775,573. PATENTED NOV. 22, 1904.

L. D. LOVEKIN.

DEVICE FOR RELIEVING FORCES DUE TO INERTIA AND WEIGHT OF VALVE GEAR.

APPLICATION FILED FEB. 25, 1904.

NO MODEL. 5 SHEETS—SHEET 4.

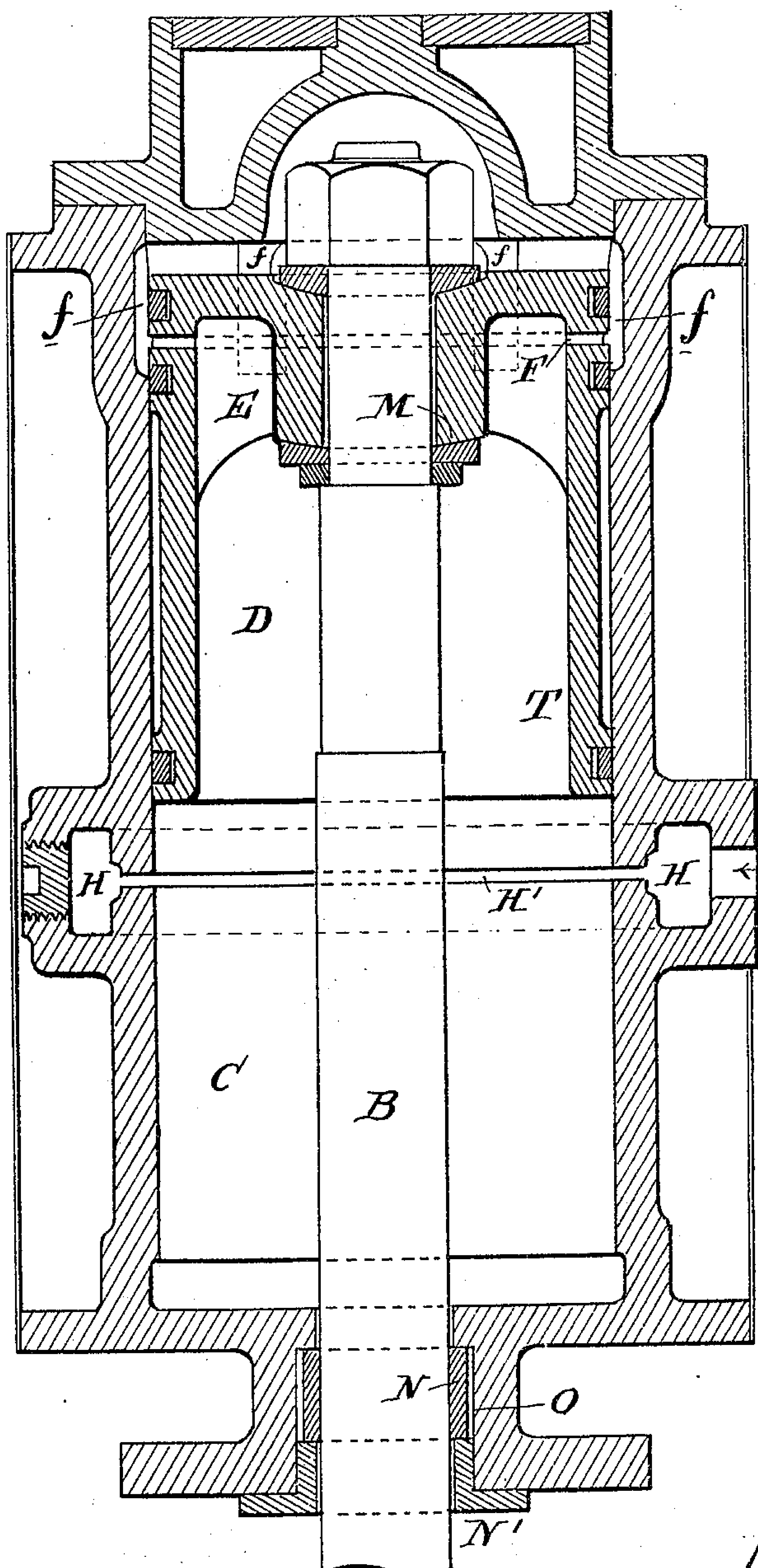


FIG. 4

Attest

R. M. Kelly.

M. J. Eyre.

Inventor

Luther D. Lovekin

By his atty

[signature]

No. 775,573. PATENTED NOV. 22, 1904.

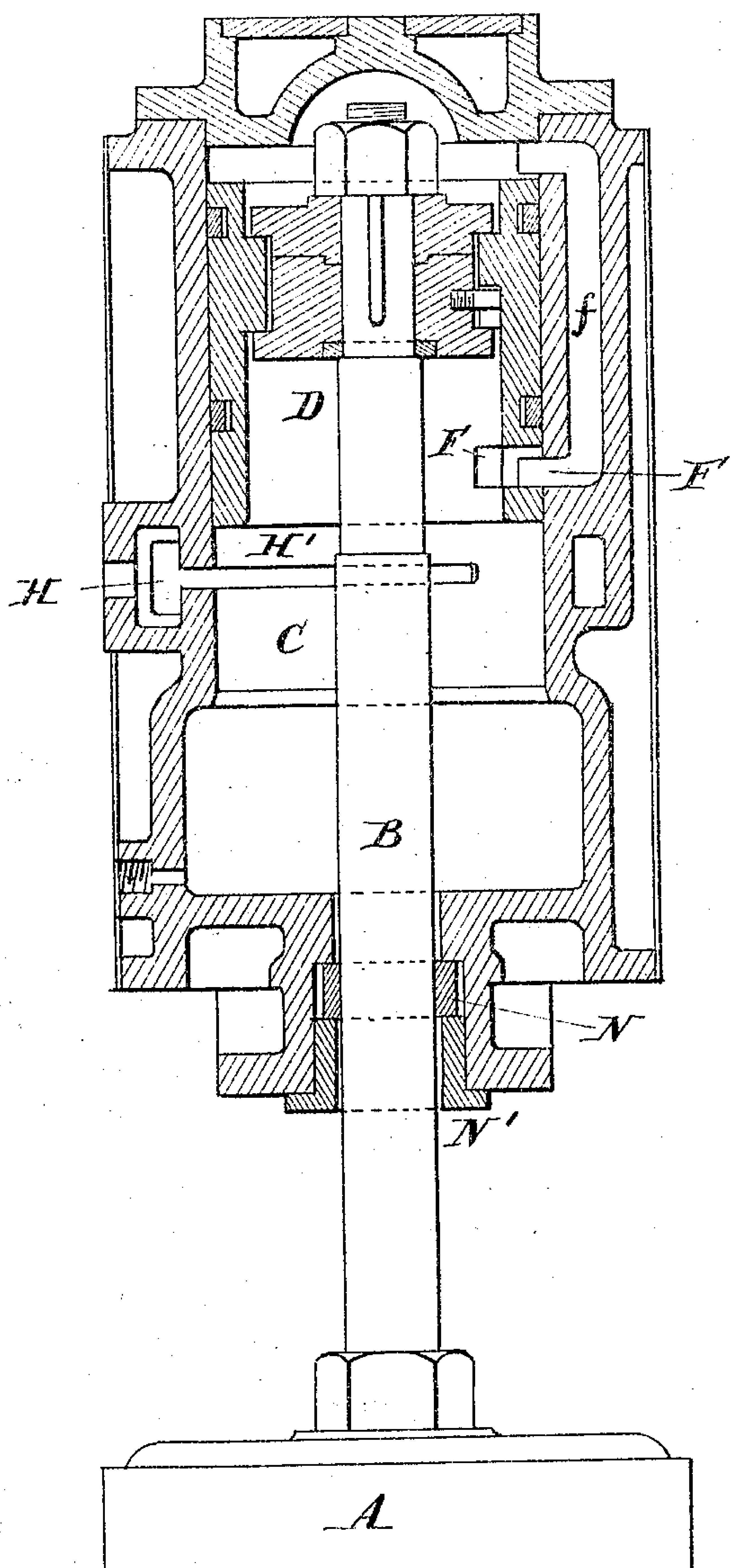
L. D. LOVEKIN.

DEVICE FOR RELIEVING FORCES DUE TO INERTIA AND WEIGHT OF VALVE GEAR.

APPLICATION FILED FEB. 25, 1904.

NO MODEL. 5 SHEETS—SHEET 5.

FIG. 5



Attest
R. M. Kelly
M. J. Eyre.

Inventor
Luther D. Lovekin
By his atty

No. 775,573. Patented November 22, 1904.

UNITED STATES PATENT OFFICE.

LUTHER D. LOVEKIN, OF PHILADELPHIA, PENNSYLVANIA.

DEVICE FOR RELIEVING FORCES DUE TO INERTIA AND WEIGHT OF VALVE-GEAR.

SPECIFICATION forming part of Letters Patent No. 775,573, dated November 22, 1904.

Application filed February 25, 1904. Serial No. 195,235. (No model.)

To all whom it may concern:

Be it known that I, LUTHER D. LOVEKIN, of the city and county of Philadelphia and State of Pennsylvania, have invented an Improvement in Devices for Relieving Forces Due to Inertia and Weight of Valve-Gear, of which the following is a specification.

My invention has reference to devices for relieving partially or wholly the forces due to both inertia and weight of valves and valve-gear of vertical marine engines or other classes of machinery; and it consists of certain improvements, all of which are fully set forth in the following specification and shown in the accompanying drawings, which form a part thereof.

The object of my invention is to relieve the forces due to both inertia and weight of the valve and valve-gear, so as to render all parts of the same free from pressure or nearly so, to increase the lasting qualities of the same, and in addition to reduce the amount of oil required for lubrication of all parts of the valve-gear.

The result of my invention is the possibility of extreme lightness in design, as well as the avoidance of the main-engine vibration due to the valve-gear forces.

In carrying out my invention I provide the receiver or chest of the valve with an auxiliary cylinder having a steam-port at some distance from the bottom end, and in said cylinder I arrange a piston connected to the valve by a rod and adapted to act as means to cut off the steam entering the auxiliary cylinder in such a manner as to admit it alternately both above and below the piston. The supply of the steam for the cushioning and counterbalancing requirements is derived from the receiver when its pressure is high enough for the purpose or from the boiler or other source of steam-pressure when a higher pressure is required, such as when the invention is used with the valves of low-pressure cylinders in condensing-engines. In high pressure of triple or multiple expansion type the steam-pressure of the receiver would ordinarily be sufficient except for the valves of the low-pressure cylinders; but where the engines are running slowly, as when cruising, and the steam-pressure in the receivers is low the auxiliary cylinders may be supplied direct from the steam-boilers. There is no exhaust of steam from the assistant or auxiliary cylinder, and consequently there is no waste of steam, the loss being limited to that which is condensed within the cylinder on account of radiation alone.

My invention embodies also other features of construction, which, together with the foregoing, will be better understood by reference to the drawings, in which—

Figure 1 is a sectional elevation of an auxiliary-cylinder mechanism embodying my improvements. Fig. 2 is a similar view of a modification of same. Fig. 3 is a diagram illustrating the events which take place in the operation of the construction illustrated in Fig. 1, and Figs. 4 and 5 are sectional elevations of other modifications of my invention.

A is the receiver or valve-chest of a steam-engine. A' is the piston slide-valve, and B is the valve-stem extending upward through the valve-chest and into the auxiliary cylinder C and carrying at its upper end the piston D of special construction, to be hereinafter described.

The cylinder C opens at the bottom into a clearance-space *c*, which may receive any water of condensation and from which it may be drawn off by any usual relief-valve connection, if desired. The bottom of this cylinder is closed and is provided with a water-sealed stuffing-box *b*, through which the valve-stem B operates. The cylinder C is provided at or near its middle with an annular cored steam-channel H, surrounding the wall of the cylinder and opening into the interior of the cylinder by a narrow port H', extending entirely around the cylinder. Steam is supplied to the annular channel H at all times by pipe *h*. It is important to cut off early and quickly, and consequently while it is necessary to provide liberal admission area of port the desired results are best secured by making the port H' extend entirely around the cylinder and bore or turn it in the wall instead of relying upon cores in casting. In this manner I am enabled to secure ample steam-passage, and yet obtain a port of short length adapted to sharp cut-off. The location of the bored steam-port within the cylinder is determined by previous laying out of the diagrams, graphically illustrating the duty and work to be performed, to secure as near as possible a coincidence of the resultant of the forces created to the inertia-line.

The piston D has an extended upper shell T, which is connected to the hub and diaphragm by webs E. After the piston is turned up its outer shell is divided, as at F, to form a clean-cut annular port adapted to coöperate with the port H′. In this manner both of the ports H′ and F have sharp admission-lines and at the same time a minimum depth of opening.

It will be seen that when the port F of the piston is in line with the port H′ of the cylinder steam will be permitted to pass from channel H into the upper portion of the cylinder above the piston, and when the piston is raised to its highest position, as shown, the steam is admitted to the lower portion of the cylinder below the piston.

Assuming the parts are in the position shown in Fig. 1 and that steam is compressed above the piston and of initial pressure below the piston, the following events will take place in the descent and rise of the piston as it accompanies the operation of the valves: The steam above the piston will be under compression and will expand as the piston descends, and almost immediately the lower edge *d* of the piston cuts off the steam from port H′, and by the descent of the piston the steam under it is gradually compressed. During the descent of the piston the port F thereof soon comes into line with port H′ and release of the steam takes place. Expansion of the steam ceases for a moment, while fresh steam enters above the piston to establish an equilibrium. The steam there is sharply cut off, and the steam above the piston is under expansion simultaneously with the compression of the steam below the piston until the bottom of the stroke is reached. Now it will be noticed that expansion of steam above the initial steam-pressure took place above the piston at the beginning of the descent and continued for some time until the release took place and that during this time the compression of the steam below the piston was taking place.

In the reverse movement of the valve-gear the steam compressed below the piston will expand, while the steam above the piston will be compressed; but when the port F reaches the port H′ the steam above the piston is released and steam of initial pressure passes above the piston. Cut-off then takes place, and compression of the steam results in the completion of the upward movement of the piston. The expansion of the steam below the piston continues until the lower edge of said piston uncovers the port H′, when release takes place and steam at initial pressure enters the cylinder below the piston.

The various pressures will be understood by the diagram Fig. 3, in which the line P represents the steam-pressure above the piston and P′ the pressure below the piston on each stroke. The various points will be recognized as follows: On the downward stroke 2 is the point of release of the steam above the piston, 3 is the point of cut-off and beginning of expansion of the steam above the piston, and 4 is the point of cut-off and beginning of compression of the steam below the piston. On the upward stroke the reverse order of events takes place, the line P representing compression above the piston, release at point 3, cut-off at point 2, and compression until end of stroke and the line P′ representing below the piston compression and release at point 4. Z Z represents the base-line. G represents the constant downward pressure of gravity, and G′ the gravity-line. S represents the inlet-pressure of steam from port H′ on the under side of the piston and is opposed to the gravity-pressure. S′ represents the inlet-pressure from port H′ above the piston, and I is the force due to inertia. The inertia force is zero at half-travel and a maximum at beginning and ending of stroke of the valve. The inertia-line I′ passes through the gravity-line G′, so as to get the plus and minus forces in their proper place in plotting the resultant line R, which it is desired shall approximate the inertia-line as closely as possible. The shaded portion or area inclosed between the inertia-line and resultant line of forces shows the unbalanced pressure, it being the difference between the upward and downward forces.

The line X X is the base of gravity-line and is that from which the plotting of the curve R takes place. Thus to find point 5 in the curve R, I deduct the distance from line Z Z to curve P′ on a vertical line W from the distance from said line Z Z to curve P and lay the remaining distance upward from gravity-line X X, and point 5 will be found. This is equivalent to laying off the distance between the curves P and P′ from the base of gravity-line X X.

The diaphragm here shown is taken from actual practice with a cylinder, as shown in Fig. 1, and with a total weight of moving parts of valve-gear of three thousand five hundred and forty pounds, a gravity-load of three thousand three hundred and twenty-five pounds, and a maximum inertia of six thousand and eight hundred pounds. The percentage of inertia relieved, as shown by the diagram, is ninety-one per cent. and of the gravity-load one hundred per cent., thus eliminating all but nine per cent. of the objectionable forces of inertia and gravity in this ponderous valve-gear. So perfect is this system that it is especially useful upon high-speed engines, such as used in cruisers in the navies of the world.

While my invention is especially useful in high-speed large marine engines, it may be used on stationary engines and locomotives by proper modifications in the general design to adapt it to the special uses desired.

The modified form of my invention shown in Fig. 2 is the same in result as that of Fig. 1 except that there is no compression of steam above the piston at end of upper stroke, because in this case the port H^2 is made of greater vertical width. In this case the steam curve P would not extend above the horizontal line V V, beginning with the inlet-pressure S′. As the port H^2 is too great in width to be cut completely through, as in Fig. 1, I prefer to form it in a liner C′, fitting the interior of the cylinder and having an internal diameter equal to that of the lower portion of the cylinder. The port H^2 is made of a series of openings around the wall of the liner, as shown, thus forming ribs or bridges at intervals around the cylinder to support the piston and packing-rings when passing said port structure.

In Fig. 4 I have shown the auxiliary cylinder with the steam-channel H and port H′ as in Fig. 1, but with the piston substantially reversed, so that the port F is arranged near the top. This gives a larger space for the steam below the piston than in Fig. 1. To enable the steam to pass from port F above the piston, I provide a series of channels *f* in the wall of the cylinder at the top, and the lower edges of these channels regulate the time of release of compression on the upstroke and point of cut-off on the downstroke for the steam above the piston.

In Fig. 4 I have shown the piston-rod B connected with the piston by a ball-and-socket joint M, so formed as to permit a small adjustment of the rod in the hub. I also have the piston-rod working through the bottom of the cylinder C with a clearance all around it, and to make a steam-tight joint I place upon the piston-rod a brass ring N, fitting it tightly until expanded by the heat of the steam, which ring is held between the end of a chamber O and the end of a gland N′, fitting into said chamber and also having a clearance between it and the piston-rod. In this way the rod may have freedom of small lateral adjustment to compensate for any defect in the alinement, such as is sometimes found in large slide-valves. The ring N is substantially a floating ring and may play laterally in the chamber O under the movement of the piston-rod should such result from the defective alinement mentioned above.

In Fig. 5 I have shown the same construction of steam-joint between the bottom of the cylinder and piston-rod as illustrated in Fig. 4; but the piston is somewhat modified. The port F is formed near the bottom and is made only part way around the piston. This port F coöperates with the port F′ in the cylinder C, which communicates by channel *f* with the upper end of the said cylinder and above the piston when fully raised. It will be observed that the capacity of the cylinder below the piston is somewhat less in this case than in Fig. 4.

In both Figs. 4 and 5 the steam above the piston exerts a downward force for a short distance at initial pressure, and as soon as the port F cuts off the steam the balance of the stroke is performed under the influence of the expansion of the steam locked above the piston. The steam below the piston is at initial pressure for a given portion of the stroke of the piston, and when the lower edge of the piston meets the lower edge of the port H′ the steam is cut off and compression takes place for the balance of the downward stroke. In both of these cases of Figs. 4 and 5 the diagram of forces would be substantially of the character of that of Fig. 3 except for the portion of P above the line V V. The difference in the time of cut-off and pressures above and below the piston are determined by the requirements of the valve-gear construction of the engine. Hence while the compression of the steam at the upper terminal of movement of the piston is important in some types of engines it is not required in other types, in which cases I may employ the auxiliary cylinders of Figs. 2, 4, and 5.

While I prefer the constructions herein set out as excellently adapted for the purposes of my invention, I do not confine myself to the details thereof, as they may be modified without departing from the spirit of the invention.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a steam-engine the reciprocating valve combined with a closed auxiliary cylinder devoid of exhaust-ports having an annular steam-inlet port cut completely around its inner wall intermediate of its ends and communicating with a source of steam-supply, a piston for said cylinder acting as a valve to said inlet-port to admit steam alternately below and above the piston during a short portion of the travel of the piston, and a piston-rod for connecting the piston with the valve mechanism of the engine.

2. In a steam-engine the reciprocating valve combined with a closed auxiliary cylinder having an annular steam-inlet port cut completely around its inner wall intermediate of its ends and communicating with a source of steam-supply, a piston for said cylinder having an annular port F near its lower part and opening to the space above the piston whereby said port F and the lower edge of the said piston enable it to act as a valve to said inlet-port to admit steam alternately below and above the piston during a short portion of the

travel of the piston, and a piston-rod for connecting the piston with the valve mechanism of the engine.

3. In a steam-engine the reciprocating valve combined with a closed auxiliary cylinder devoid of exhaust-ports having an annular steam-inlet port cut completely around its inner wall intermediate of its ends and communicating with a source of steam-supply, and a piston reciprocating in said cylinder under the action of the valve to admit steam from the inlet-port above the piston during a short period of time intermediate of the limits of its travel and to admit steam from the said inlet below the piston only at one terminal of its stroke.

4. In a steam-engine the reciprocating valve combined with a closed auxiliary cylinder devoid of exhaust-ports having an annular steam-inlet port cut completely around its inner wall intermediate of its ends and communicating with a source of steam-supply, and a piston reciprocating in said cylinder under the action of the valve mechanism of the engine and having its lower edge acting as a valve to the inlet-port and also having a port through its lower portion coacting with the inlet-port and communicating with the interior of the cylinder above the piston whereby the steam admitted above the piston may be continuously confined and compressed with the movement of the piston in one direction and expanded with the movement of the piston in the other direction.

5. In a steam-engine the reciprocating valve combined with a closed auxiliary cylinder devoid of exhaust-ports having an annular steam-inlet port cut completely around its inner wall intermediate of its ends and communicating with a source of steam-supply, a piston reciprocating in said cylinder under the action of the valve mechanism of the engine, and means for supplying steam to the cylinder above the piston during a short period of its travel intermediate of the limits of its travel and below the piston only when it has completed its upward movement.

6. In a steam-engine, the reciprocating valve, combined with a closed auxiliary cylinder devoid of exhaust-ports having a steam-inlet port near its middle communicating with a source of steam, a piston reciprocating in said cylinder under the action of the valve mechanism of the engine, and means for supplying steam to the cylinder above the piston during a short period of its travel intermediate of the limits of its travel and below the piston only when it has completed its upward movement.

7. An auxiliary cylinder for a valve of a steam-engine having an inlet-port intermediate of its ends and extending around its interior wall, combined with a piston D having an extended cylindrical part T connected to the hub by webs E and having an annular port F cut entirely through the cylindrical part so as to divide it into two portions.

8. In a steam-engine the reciprocating valve, combined with a closed auxiliary cylinder devoid of exhaust-ports having a clearance-chamber *c* at the bottom of greater diameter than the cylinder and also having an inlet steam-port near its middle, and a piston connecting with the valve and having a port formed through its wall and communicating with the space within the cylinder above the piston.

9. In a steam-engine, a reciprocating valve combined with an auxiliary cylinder, having a steam-inlet port near its middle, a piston working in the cylinder for controlling the supply of steam above and below it, a piston-rod rigidly connecting the piston with the reciprocating valve and extending through a guide into the auxiliary cylinder and a self-adjusting connection between the piston and piston-rod.

10. In a steam-engine, a reciprocating valve combined with an auxiliary cylinder, having a steam-inlet port near its middle, a piston working in the cylinder for controlling the supply of steam above and below it, a piston-rod connecting the piston with the reciprocating valve and working loosely through the bottom of the cylinder, and a steam-joint between the lower end of the cylinder and piston-rod consisting of a floating solid ring tightly fitting the piston-rod and means consisting of two annular faces surrounding the piston-rod and against which the ring rests for holding the ring against longitudinal movement but permitting it to have small lateral adjustment.

In testimony of which invention I hereunto set my hand.

LUTHER D. LOVEKIN.

Witnesses:
R. M. HUNTER,
R. M. KELLY.