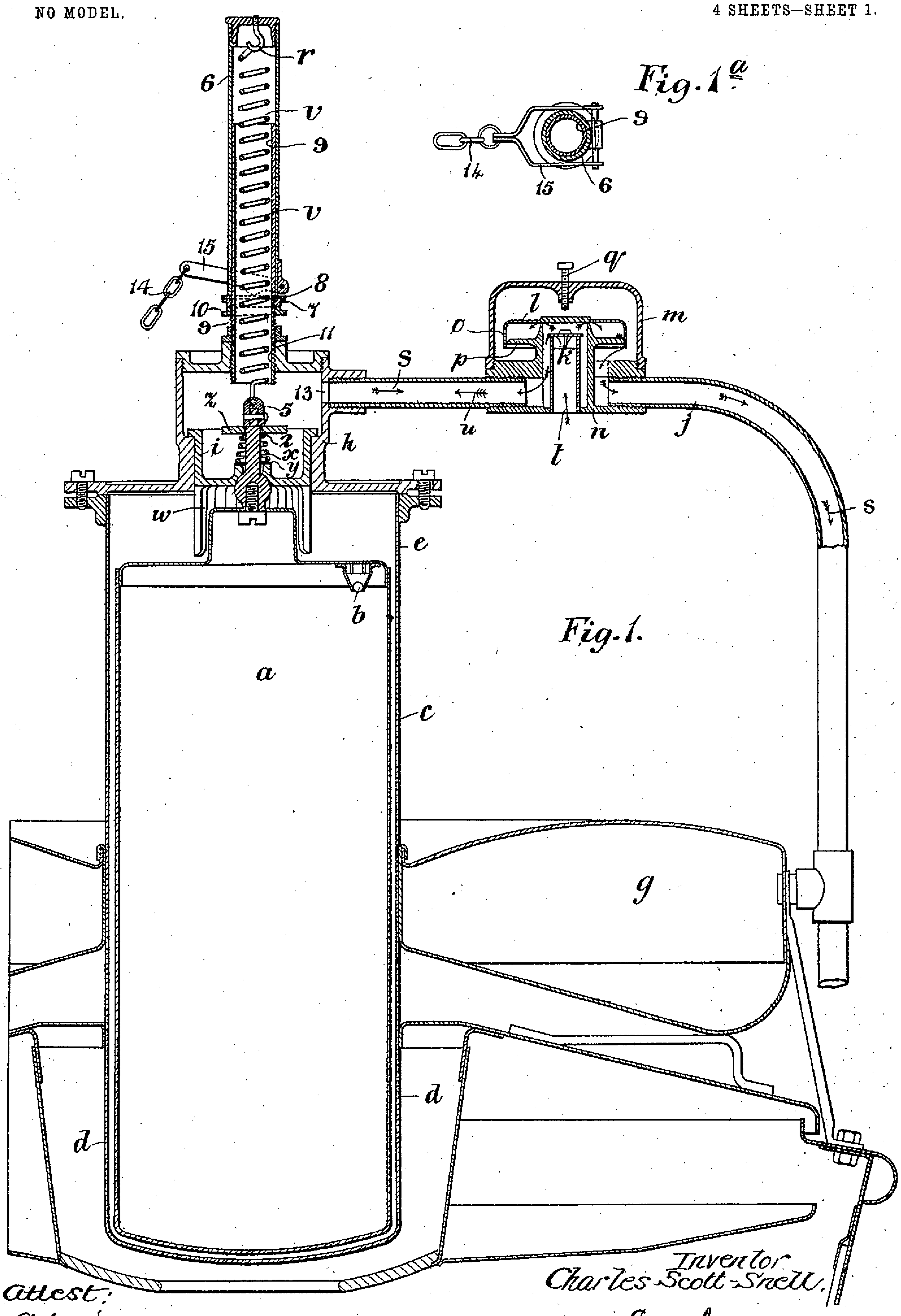
No. 725,372. PATENTED APR. 14, 1903.

C. SCOTT-SNELL.

CALORIC ENGINE FOR SUPPLYING GAS LAMPS WITH FUEL.

APPLICATION FILED JULY 25, 1902.

NO MODEL. 4 SHEETS—SHEET 1.



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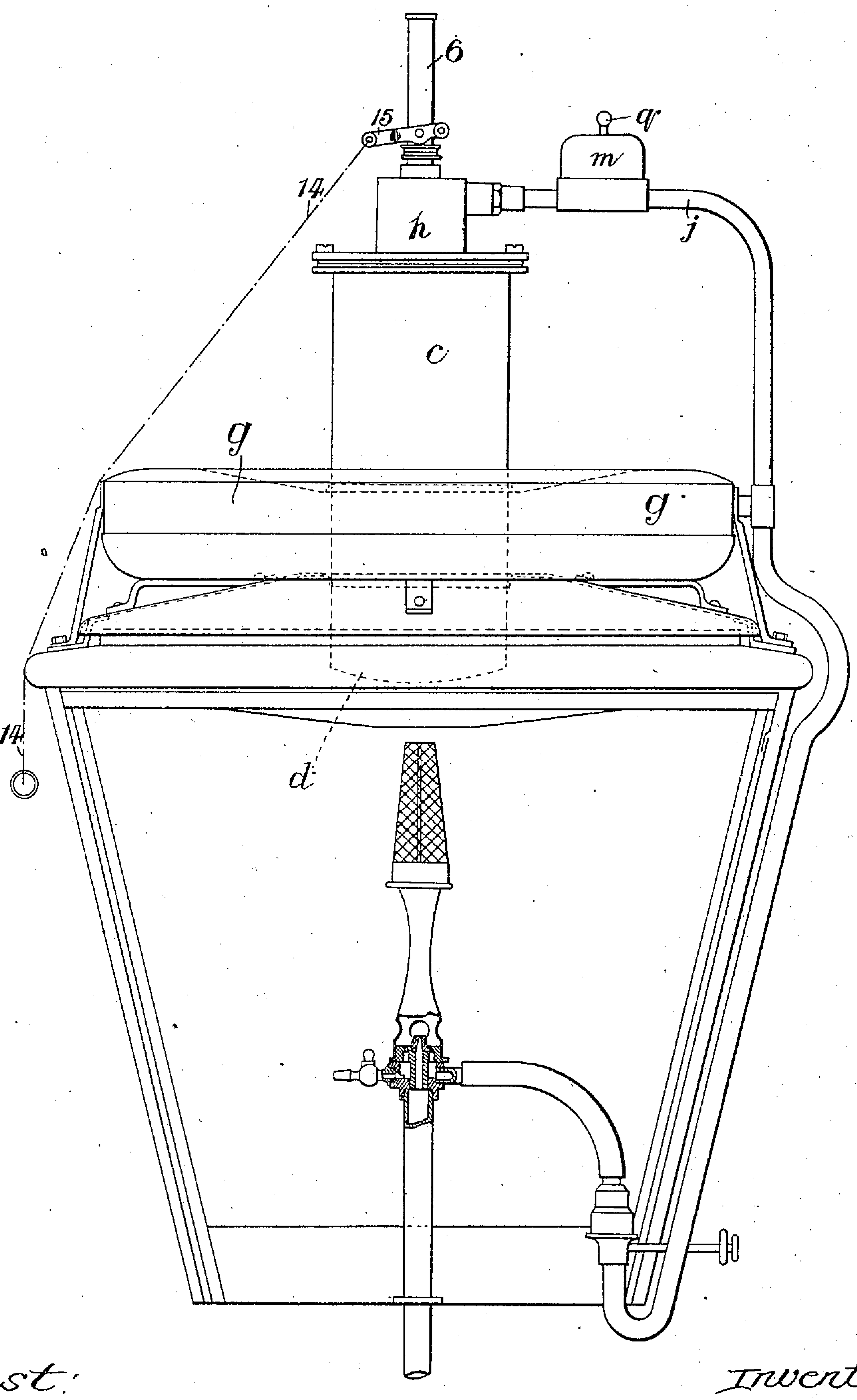

Fig. 2.

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NO MODEL. 4 SHEETS—SHEET 3.

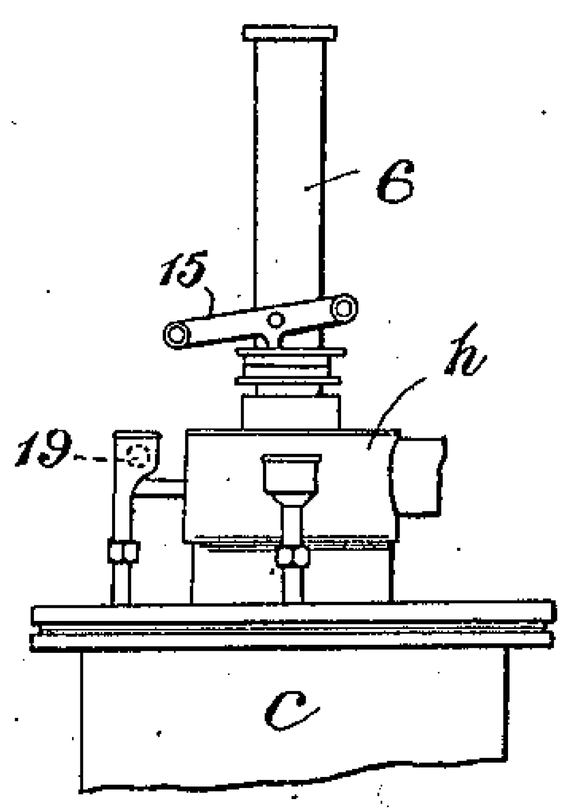

Fig. 6.

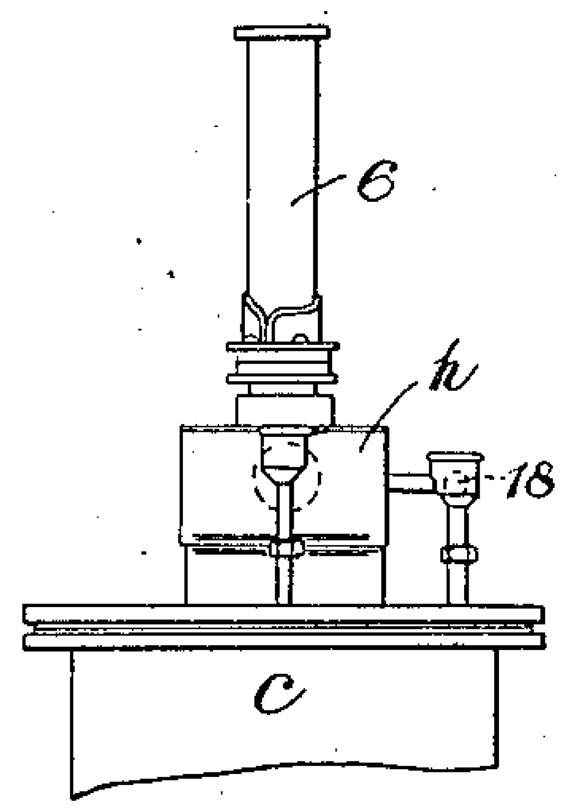

Fig. 7.

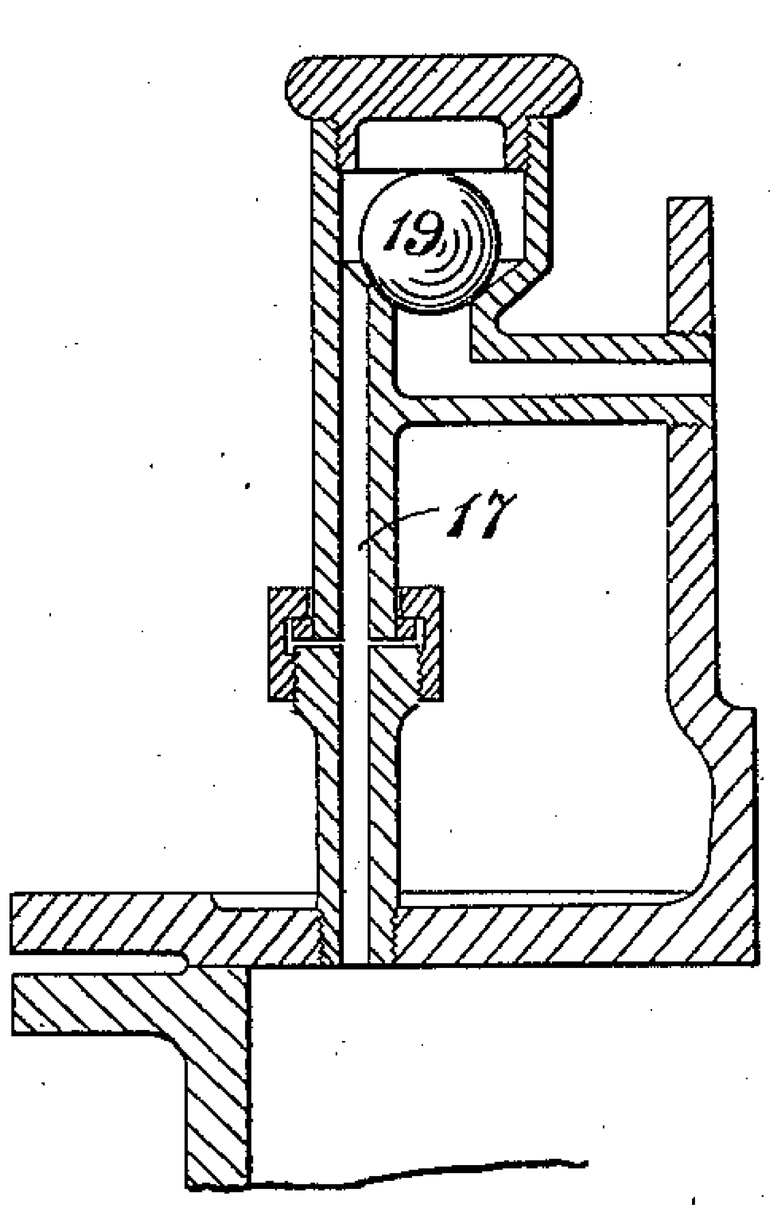

Fig. 4.

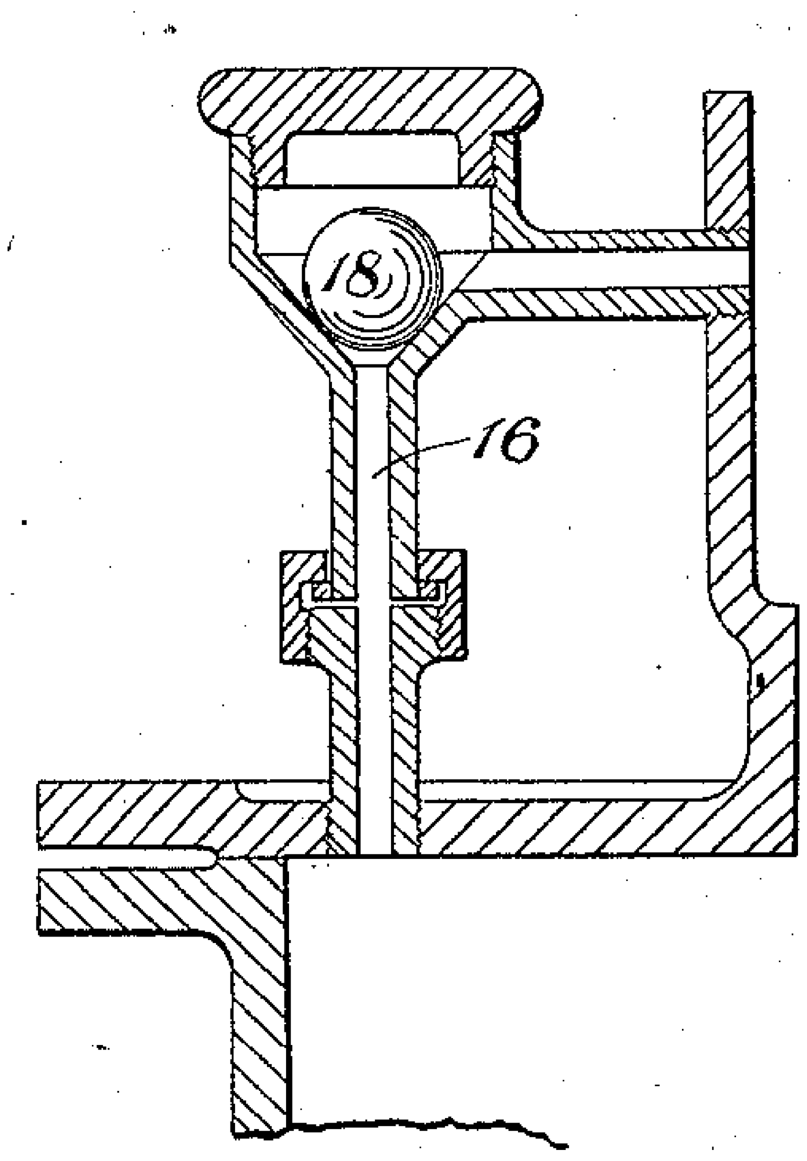

Fig. 3.

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NO MODEL. 4 SHEETS—SHEET 4.

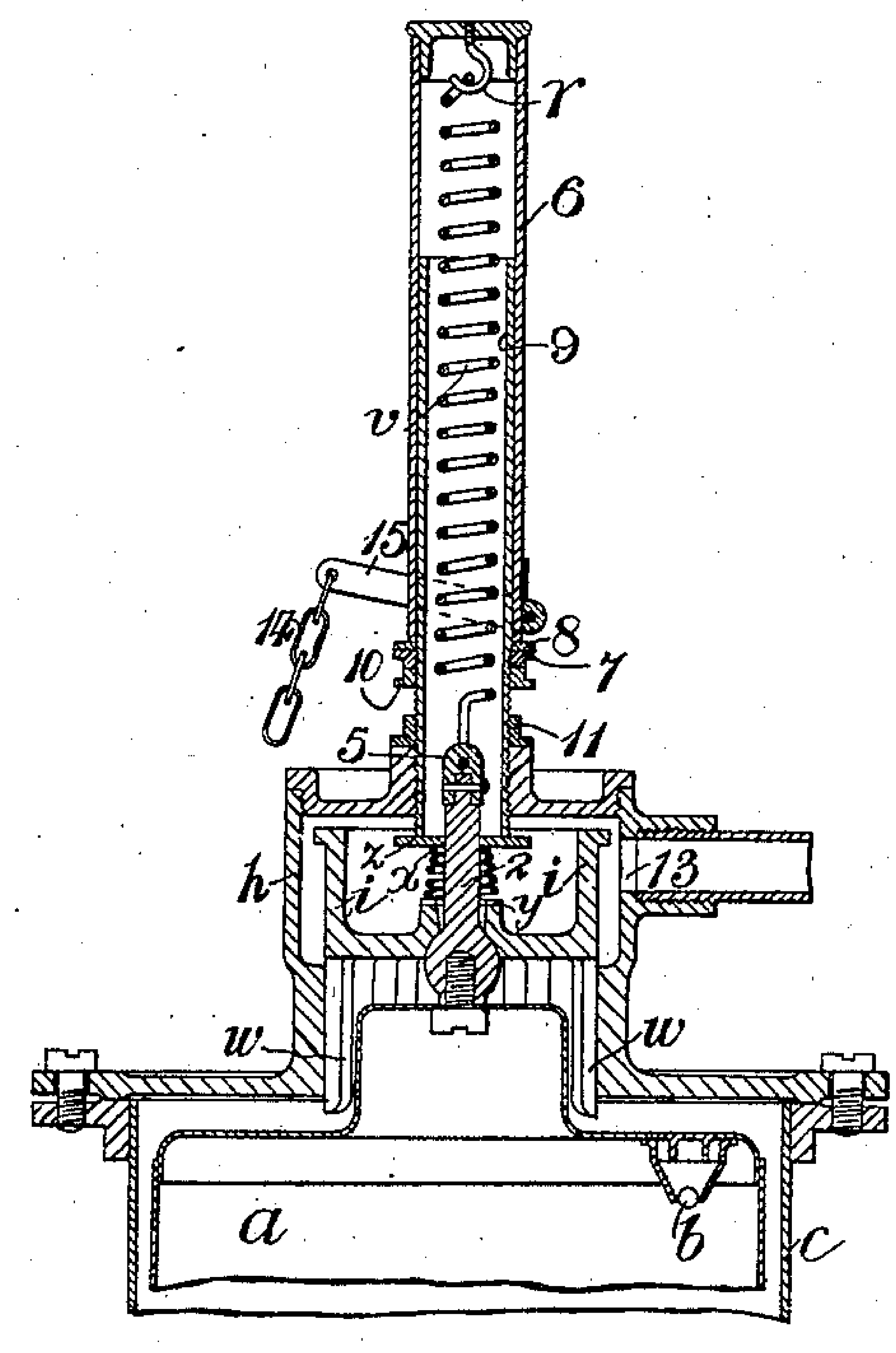

Fig.5.

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UNITED STATES PATENT OFFICE.

CHARLES SCOTT-SNELL, OF WESTMINSTER, ENGLAND.

CALORIC-ENGINE FOR SUPPLYING GAS-LAMPS WITH FUEL.

SPECIFICATION forming part of Letters Patent No. 725,372, dated April 14, 1903.

Application filed July 25, 1902. Serial No. 117,008. (No model.)

To all whom it may concern:

Be it known that I, CHARLES SCOTT-SNELL, a subject of the King of Great Britain and Ireland, residing at 51 Victoria street, Westminster, London, S. W., England, have invented certain new and useful Improvements in Caloric-Engines for Supplying Gas-Lamps with Fuel, (for which I have made application for Letters Patent in Great Britain, No. 15,520, dated July 11, 1902,) of which the following is a specification.

My invention relates to improvements in apparatus for intensifying the pressure in incandescent gas-lamps.

My improvements in the compressing apparatus are of course applicable to elastic-fluid compressors operating by heat applied for other purposes than incandescent lighting.

My invention consists, first, in a new means for operating the displacer of the compressor whereby the losses of volume of compression fluid due to changes in curvature of the diaphragm or to the movements of the piston are obviated, the upper side of the piston being closed and not open to the atmosphere except through the inlet-valve; second, in means for suspending the displacer and its piston from a single spring, preferably a long helical spring; third, in devices comprising valve arrangements for enabling the compressor to start automatically when the lamp is first lighted and emergency-levers for starting by hand, if desired; fourth, and in a buffer and piston arrangement to eliminate injurious knocking of the displacer at the ends of the stroke. I find that these improvements greatly increase the efficiency and durability of the compressor and render an incandescent lamp using a compressor of this type more reliable than has hitherto been the case.

Referring now to the accompanying drawings, Figure 1 is a vertical section of the upper part of a lamp with my invention applied. The extreme left-hand side of this figure is not shown; but it is to be understood that it is the same as the right-hand half without the delivery-pipe. In this view the piston is shown at the bottom of its stroke. Fig. 1ª is a detail of the emergency-levers. Fig. 2 is a diagrammatic view of the whole lamp. Figs. 3 and 4 are enlarged sectional views of the upward and downward flow check-valves, respectively. Fig. 5 is a part vertical section of the piston and cylindrical extension, showing the piston in at the top of the stroke. Figs. 6 and 7 are side and end elevations of the upper part of the lamp-body drawn to reduced scale, showing the positions of the valves 18 and 19.

In carrying my invention into effect according to one modification as applied in self-intensifying gas-lamps in which the air for combustion is compressed instead of the gas I employ a long cylindrical displacer *a*, closed at both ends, but provided, preferably, at the top with a relief-valve *b* to prevent undesirable rise of pressure within the displacer. The displacer is adapted to reciprocate vertically within a displacer-casing *c*, the lower portion *d* of which is heated by the hot gases arising from the gas jet or mantle of the burner and the upper part *e* cooled by means of radiation, or a water-jacket may be added to meet exceptional atmospheric conditions. The middle portion of the casing *c* is surrounded by an air-reservoir *g*, which consists simply of an annular chamber surrounding the upper part of the lamp-body.

Before the date of this application for Letters Patent I have employed a displacer operated by the agency of a diaphragm or piston attached to the displacer and which was at one side continuously subject to atmospheric pressure and on the reverse side subject to variations of pressure within the body of the lamp. The movement of such a diaphragm or piston, however, caused an increase or decrease in the internal capacity of the containing vessel or body of the lamp of a character adverse to its efficiency—*i. e.*, when it lifted, and thereby increased the internal capacity, elastic fluid was at the same time being delivered into the reservoir, and therefore the full amount of elastic fluid on the upper part of the displacer was not discharged into the reservoir. In order to prevent this loss, I attach to the displacer-casing a cylindrical extension *h* with enlarged end, within which operates a freely-moving piston *i*, attached to the displacer *a*. The top of the enlargement of the extension *h* is closed; but it is connected with non-return inlet and outlet valves k and l. These valves may be contained within a casing m, situated in the pipe j, the left-hand portion of which serves the double purpose of delivery and inlet pipe. The delivery-valve consists of a cylindrical passage or pipe n, carrying the valve-disk l on its upper edge. The valve-disk l is provided with a flange o, which overlaps the flange p, carried by the pipe n, by means of which it is guided. The lift of the valve may be adjusted by means of the screw q, passing through the casing or cover m. Delivery of air to the reservoir g takes place as indicated by the unfeathered arrows s. The inlet-valve consists of a small tube t, inserted within the pipe or passage n. This tube is open to the atmosphere at the bottom, but carries a valve-disk k. When the pressure of air in the cylinder h above the piston i is below that of the atmosphere, the valve-disk k lifts and a flow of air takes place into the cylinder h, as indicated by the feathered arrows u in Fig. 1.

In order to prevent the displacer from knocking against the end of its casing and to utilize its momentum for reversing its motion, I provide a cushioning or buffer spring x, whereby the energy is absorbed and a rapid reaction or rebound is produced as soon as the direction of motion is reversed.

The piston i is allowed to overrun the cylinder h and to travel into the enlarged extension at its head, alinement being preserved by the tail-blades w. When the piston has overrun the cylinder proper, its power as a piston then ceases, as equilibrium exists all around it, although such a pressure may obtain in the elastic fluid as to be causing a delivery through the outlet-valve into the reservoir. Obviously if the piston traveled entirely within the limits of its cylinder and had its top exposed to the atmosphere the upward impulse would still obtain as long as the pressure continued above atmospheric, and reversal of motion would have to be effected against or in spite of such pressure.

The cushioning-spring x is arranged to operate between two collars y and z on the piston-rod 2. The collar z bears against a small cap 5, fastened to the end of the piston-rod 2. The piston-rod is provided with a ball or spherical end fitting into a socket in the piston, the extreme end of which is elongated and recessed to receive the end of a stud carried by the displacer. A pin passes through the elongation and the stud in order to connect the displacer to the piston-rod. On the downward stroke the piston rests, finally, by the collar at its upper end upon the edge of the cylinder proper, and the momentum of the displacer pulling upon the piston-rod draws it downward, compressing the buffer-spring x until the momentum is absorbed and allowing the vacuum to be entirely filled by the inrush of air between the ball and socket.

The displacer a is suspended by the long spring v hereinbefore referred to. One end of the spring is attached to the small cap 5, fixed to the end of the piston-rod 2, and the other end is attached to a hook r on the end of the tubular cap. The bottom edge of the tubular cap rests upon a washer 8, bearing upon a nut 7, screwed upon the support 9. The cap 6 is of greater diameter than the support 9, over which it fits. The bottom of the tubular support screws into the piston-cover, a nut 11 being provided to prevent it from working loose on account of vibration. The end of the tubular support projects a short distance into the cylinder, so that the washer z of the buffer arrangement may strike against it when the piston reaches the top of its stroke. The tension of the spring may be so adjusted by raising or lowering the nut 7 that the displacer shall stand at or near its mid-position when it is at rest. A lock-nut 10 may be provided to hold the nut 7 in its proper position. The lifting and lowering of the cap 6, which freely slides on the tube 9, by agitating the spring v will give an initial start to the displacer, and this may be effected by pulling a chain 14, which is attached to rocking levers 15, pivoted at the other extremity to the cap 6 and resting upon the washer beneath it. A pull upon the chain will cause the levers to raise the cap, and therefore the spring attached to same, and give motion to the displacer. This action may become necessary if by reason of neglect to keep the valves clean one may not be quite tight. On the upward stroke of the piston the intermediate piece 11 receives the impact of the washer z, which it holds stationary, while the further movement of the piston and displacer compresses the spring x and absorbs the momentum.

The delivery and inlet pipe j opens into the cylinder extension through the passage 13 near its top. When expansion is slowly effected—as, for instance, when the lamp is newly lighted and the metal work of the lamp has to be heated up from a cold condition—equilibrium will be established on both sides of the piston if the piston does not fit fairly well in the cylinder h, and there will be no tendency to start motion. The valve l, which controls the outlet-passage, is therefore made specially heavy, so that it will not lift until a considerable pressure has been raised. The whole area of the delivery-valve disk l in relation to the area of the passage which it closes is such that the released fluid when it begins to lift, acting on the relatively large area of the valve, rapidly and completely raises it, so that a very free exit is made, and pressure on the top of the displacer-piston i is suddenly removed, thus upsetting the equilibrium and causing motion to ensue by reason of the excess of pressure below the piston. The travel then brings the buffer-spring into operation, and the motion is reversed, thus starting condensation and causing atmospheric pressure to drive down the piston to the full limit, as already explained, which causes the buffer-spring to again operate and reverse the motion.

The apparatus operates in the following manner: Assume the piston to be a half-stroke—that is, midway between the positions shown in Figs. 1 and 5. In this position the spring *v* is under a tension equal to the weight of the displacer and its piston. The heat from the burner playing around the bottom of the displacer-casing expands the air within the casing and raises its pressure. This air-pressure, acting upon the bottom of the piston *i*, causes the piston and displacer to rise until the piston overruns the edge of the cylinder and the collar *z* comes in contact with the projecting tubular support 9. The compressed air in the casing is thus suddenly released, the flow of air taking place through the piston-socket valve and around the bottom edge of the piston. This air passes from the cylinder *h* to the delivery-valve *l*, as indicated by the arrows *s*, into the casing *m*, whence it flows by the delivery-pipe into the reservoir *g*. As soon as the piston overruns the cylinder the pressure of air inside the casing is reduced practically to that of the atmosphere. The displacer then begins to drop under the combined action of gravity and the resistance of the buffer-spring *x*, and as the displacer moves downward it displaces the hot air from the bottom of the casing to its cold upper part. Contraction in volume immediately ensues and a vacuum is produced in the casing. The vacuum in conjunction with the momentum of the displacer causes the latter to drop so far downward that the top flange of the piston rests upon the ledge in the cylinder and the socket-valve opens. A sudden inrush of air then takes place into the casing through the socket-valve. This air is supplied from the atmosphere through the tube *t* by lifting the valve *k* and flowing, as indicated by the arrows *u*, into the cylinder *h*. The displacer now rises under the tension of the spring *v* and the resistance of the buffer-spring *x*, and as it rises upward it displaces the cold air in the upper part of the casing downward to the heated portion of the casing, thus causing an immediate expansion in its volume and a corresponding rise in its pressure, the piston thereby being forced upward until it again overruns the edge of the cylinder. Further, as the inlet and outlet valves are permanently in direct communication with the space at the top of the piston every reciprocating movement of the piston, whether it be great or small, produces either a suction from the atmosphere or a useful discharge of air. After the first or initial impulse the motion is continuously maintained by the alternations of plenum and vacuum, thus causing outflowing and inflowing of the elastic fluid to act upon the piston. It will be readily seen that by this method of working with a piston in a closed cylinder the losses which, as hereinbefore described, occur when a piston or diaphragm open to the atmosphere is employed are avoided and the lamp is rendered more efficient and even more reliable than has hitherto been the case. By employing a cylinder closed to the atmosphere in this manner the losses due to leakage are reduced to a minimum. The closed cylinder also enables me to satisfactorily use a much larger diameter of piston in relation to the diameter of the displacer than has hitherto been possible.

A further advantage obtained by my invention is that I may successfully use considerably lower pressures than are usually employed in self-intensifying lamps.

In addition to employing the buffer-spring *x* I may use two separate by-pass passages 16 and 17. (Seen in Figs. 3, 4, 6, and 7.) I provide the by-pass 16 with a valve 18 and the by-pass 17 with a valve 19, each valve being of suitable weight to insure that only a certain difference of pressure can exist under any circumstances between the elastic fluid above and below the piston. By these means the upstroke may be put under a different condition in respect to pressure to the downstroke. The upward flow of fluid takes place through the passage 16 and valve 18 and the downward flow takes place through the passage 17 and valve 19.

The elastic fluid employed may be air or gas, according to the requirements of the case. When gas is employed, the suction-valve may open into a gas-reservoir or to a main gas-pipe, as desired, or the compressor may be arranged to deliver air through a carbureter, thus giving a combustible mixture for the lamp.

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

1. In an elastic-fluid compressor operated by heat, a spring-suspended piston operatively connected with a displacer and working in a cylinder closed from atmosphere at both ends, such closure preventing loss of elastic fluid by leakage, and inlet and outlet means for the fluid, substantially as described.

2. In a self-intensifying gas-lamp employing a displacer operating within an unequally-heated casing, a cylindrical extension on the end of the displacer-casing, a cover closing the cylindrical extension from the atmosphere, and inlet and outlet valves automatically operated by the varying pressures of elastic fluid at the top of the piston, substantially as described.

3. In a self-intensifying gas-lamp operated within an unequally-heated casing, a cylindrical extension on the end of the displacer-casing, a piston operating within the extension, a cover on the extension, an air-tight tubular spring-support carried by the cover, a spring within and depending from this support, the piston and displacer being carried by the spring, and inlet and outlet valves

automatically operated by the varying pressures of elastic fluid at the top of the piston, substantially as described.

4. In a self-intensifying gas-lamp employing a displacer operated within an unequally-heated casing, a closed cylindrical extension on the displacer-casing, a piston operated within the extension, an abrupt enlargement in the diameter of the extension at a position near the end of the upstroke of the piston, whereby direct communication between the elastic fluid on both sides of the piston is effected just before the end of the upstroke, guides on the piston, and inlet and outlet valves automatically operated by the varying pressures of elastic fluid at the top of the piston, substantially as described.

5. In a self-intensifying gas-lamp employing a displacer operating within an unequally-heated casing, a closed cylindrical extension on the displacer-casing, a piston operating within the extension, an abrupt enlargement in the diameter of the extension at a position near the end of the stroke of the piston, whereby direct communication between the elastic fluid on both sides of the piston is effected just before the end of the upstroke, a buffer-spring between the piston and the cover of the extension, guides on the piston, and inlet and outlet valves automatically operated by the varying pressures of elastic fluid at the top of the piston, substantially as described.

6. In a self-intensifying gas-lamp employing a displacer operating within an unequally-heated casing, a cylindrical extension on the displacer-casing, a piston operating within the extension, a socket-bearing on the under side of the piston, a piston-rod passing through the piston and having a supporting-spring connected to one of its ends, a spherical head formed on its other end, which head forms a socket-joint with the socket-bearing of the piston, and also carries the displacer, and a flange on the top edge of the piston to suddenly stop the piston when it reaches the bottom of its stroke, whereby the momentum of the displacer and piston opens the socket-joint and equalizes the fluid-pressure on both sides of the piston, substantially as described.

7. In a self-intensified lamp, a casing unequally heated, a displacer within the casing, said casing having an extension under cover, a piston connected with the displacer, a buffer-spring situated between the piston and the cover of the casing, said buffer-spring being operative at both ends of the piston-stroke, and inlet and outlet means for the fluid, substantially as described.

8. In a self-intensifying gas-lamp employing a displacer operating within an unequally-heated casing, a hand starting device, comprising a supporting-tube carried by the top of the displacer-cylinder, a long tubular cap passed over the supporting-tube, a displacer-supporting spring carried by the tubular cap, an adjustable nut on the supporting-tube, upon which nut the edge of the tubular cap normally rests, a forked lever pivoted at one end to the cap, the lever having a projection forming a fulcrum with the nut, a hand connection at its other end, whereby the cap may be lifted and the movement of the piston commenced, substantially as described.

9. In a self-intensifying gas-lamp employing a displacer operating within an unequally-heated casing, in combination with a displacer-casing extension and piston closed to the atmosphere, a valve-controlled passage between the top of the extension and the top of the displacer-casing, a passage serving the double purpose of inlet and delivery pipe—connecting the top of the extension with a valve-casing—situated in the delivery-pipe to the air-reservoir; a delivery-valve in the valve-casing, said valve consisting of a flanged disk supported upon the edge of a circular and raised delivery-passage of small area in relation to the diameter of the delivery-valve, and a delivery-passage to the air-reservoir; and an inlet-valve in the same valve-casing consisting of a disk of small diameter in relation to the delivery-valve, the disk being supported concentrically within the raised delivery-passage upon a tube which is open at one end to the atmosphere, substantially as set forth.

10. In a self-intensifying gas-lamp employing a displacer operating within an unequally-heated casing, in combination with cylindrical extension of the casing closed to the atmosphere, a piston operating within the casing, a valve-controlled passage between the casing and the top of the extension to permit flow of fluid from the former to the latter, a valve-controlled passage between the casing and the top of the extension to permit flow of fluid from the latter to the former, and inlet and outlet valves automatically operated by the varying pressures of elastic fluid at the top of the piston, substantially as set forth.

In witness whereof I have hereunto set my hand in presence of two witnesses.

CHARLES SCOTT-SNELL.

Witnesses:

FRED W. KEMP,

HECTOR C. MUNRO.