No. 687,169. Patented Nov. 19, 1901.

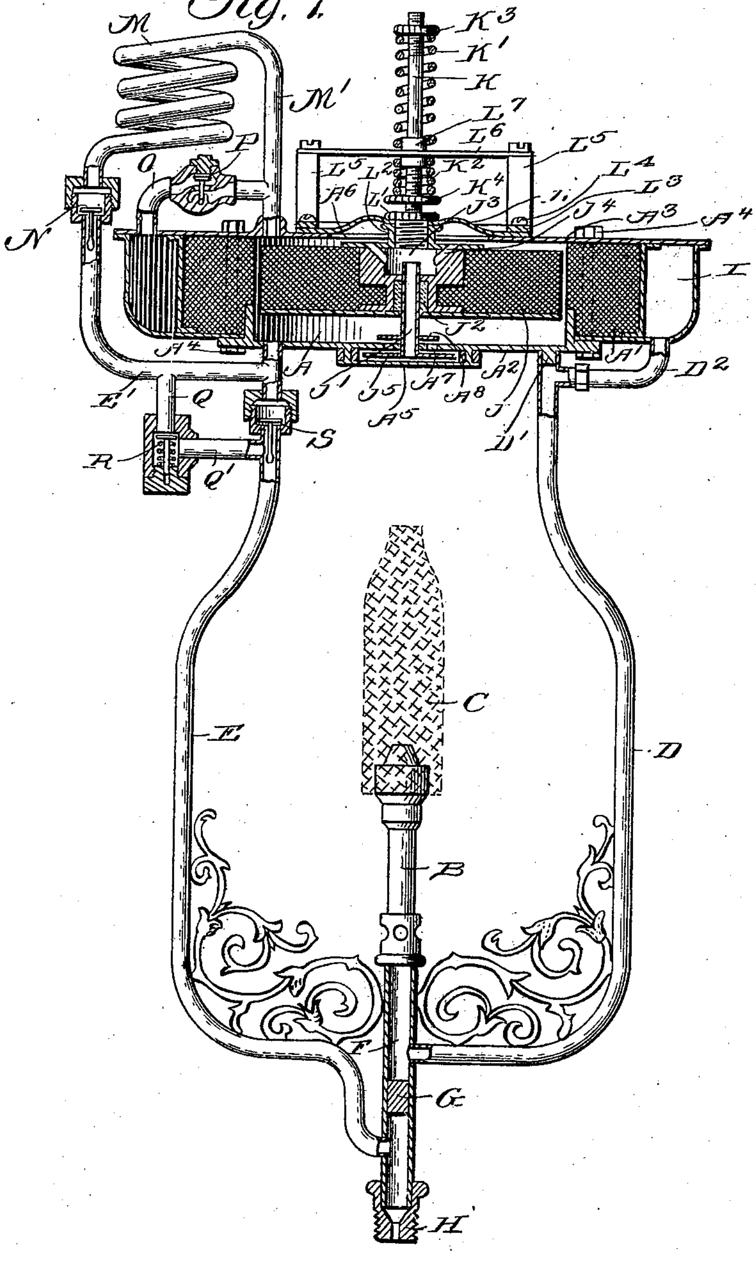
C. S. SNELL.

APPARATUS FOR COMPRESSING GAS, AIR, &c.

(Application filed Feb. 5, 1900.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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(No Model.) 3 Sheets—Sheet 2.

Fig. 2.

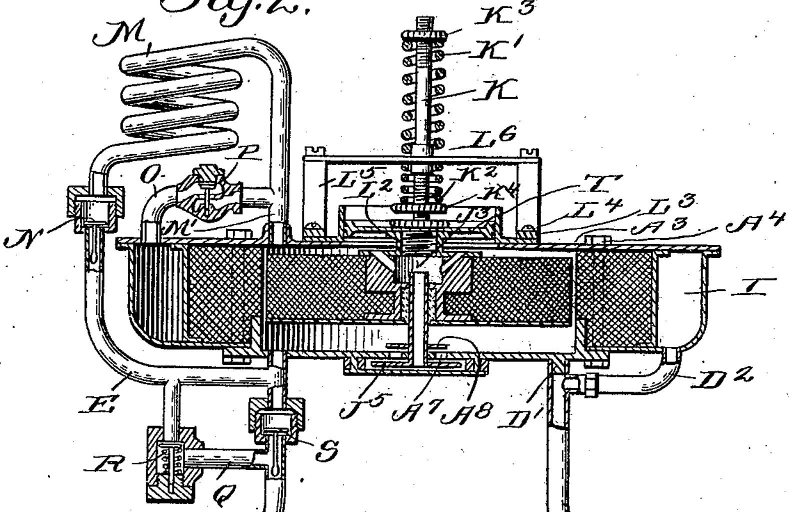
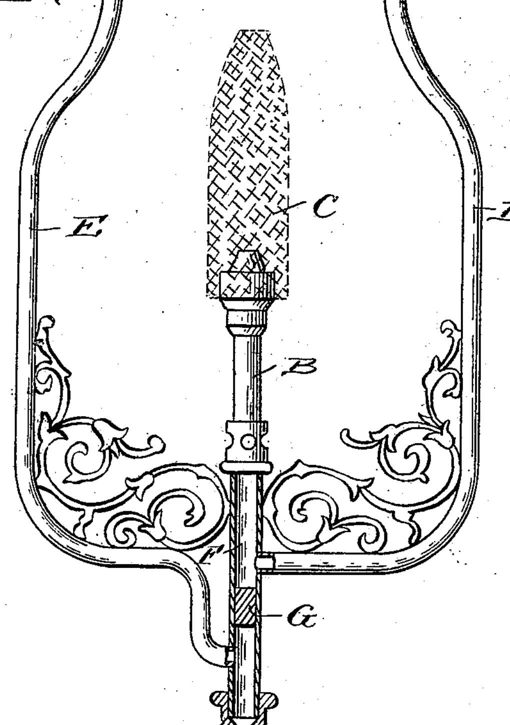
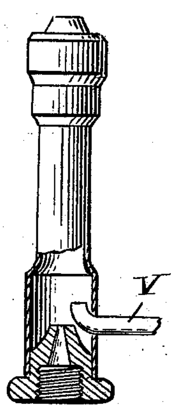



Fig. 4.



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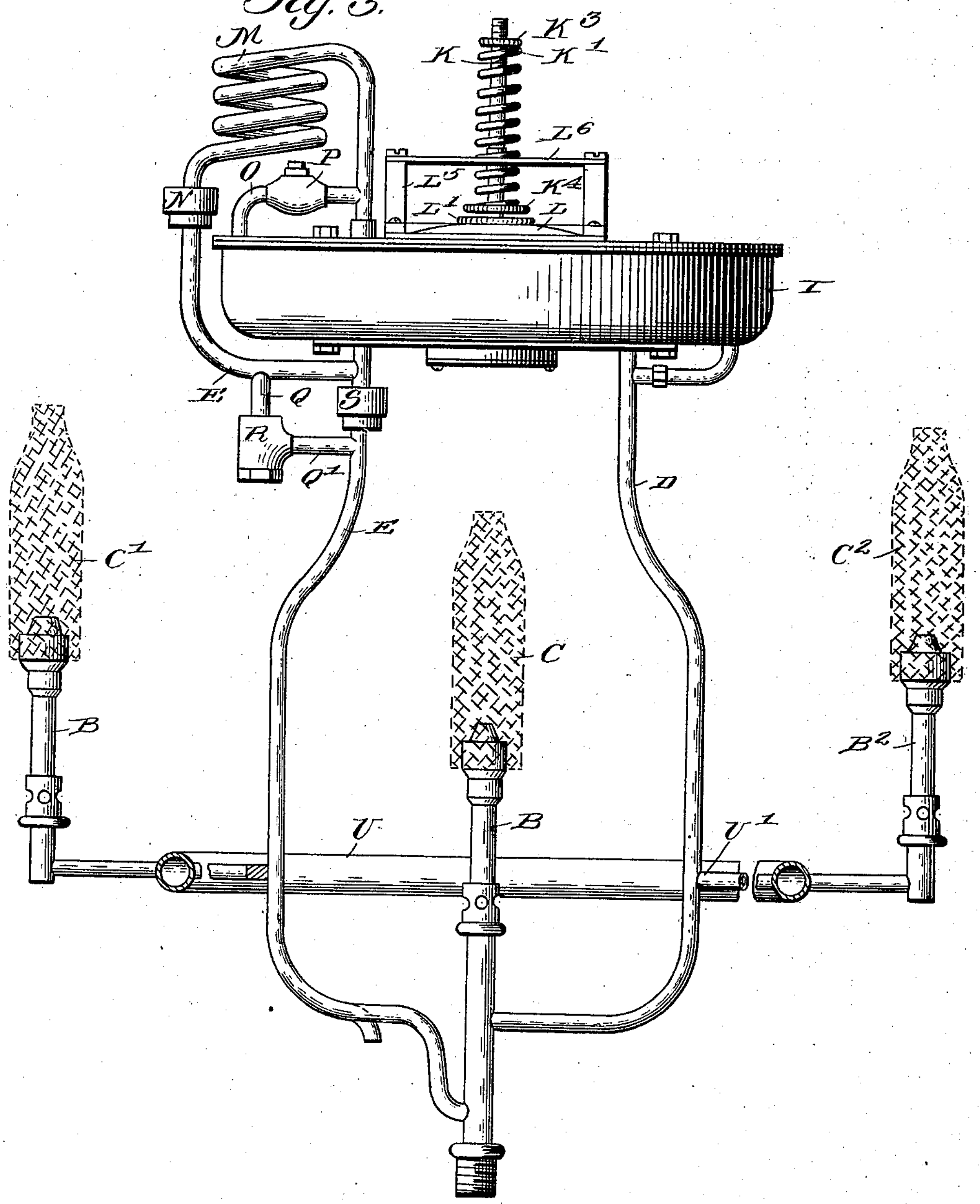
(No Model.) 3 Sheets—Sheet 3.

Fig. 3.



Witnesses:
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UNITED STATES PATENT OFFICE.

CHARLES SCOTT SNELL, OF SALTASH, ENGLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE SCOTT-SNELL SELF-INTENSIFYING GAS LAMP COMPANY, LIMITED, OF LONDON, ENGLAND.

APPARATUS FOR COMPRESSING GAS, AIR, &c.

SPECIFICATION forming part of Letters Patent No. 687,169, dated November 19, 1901.

Application filed February 5, 1900. Serial No. 4,070. (No model.)

To all whom it may concern:

Be it known that I, CHARLES SCOTT SNELL, a subject of the Queen of Great Britain, residing at Culver Park, Saltash, in the county of Cornwall, England, have invented certain new and useful Improvements in Apparatus for Compressing Gas, Air, and the Like, of which the following is a specification.

This invention relates to improvements in apparatus for compressing gas, air, or the like for consumption at a Bunsen burner and for incandescent gas-lighting, whereby a greater brilliancy of light from the mantle is insured with the ordinary consumption of gas.

The main object of the invention is to provide a simple device capable of being inclosed within part of a lamp or lantern, which device is operated by the waste heat from the mantle-flame, and automatically raises the pressure of the gas or air supplying the flame, to any desired extent within the limits of its power, automatically maintaining the pressure at any predetermined point.

The invention consists in an automatically-operating direct-acting hot-elastic-fluid pump without fly-wheel, which comprises a displacer moving in a chamber, one part of which is heated and another cooled, a diaphragm or a piston connected to the displacer, a spring or springs suspending the diaphragm, with its attached displacer, in an intermediate position, to which the spring action tends to return it, an inlet-valve admitting gas or air to the elastic-fluid chamber, an outlet-valve permitting discharge of gas or air from the elastic-fluid chamber, and a gas or air reservoir for containing the gas or air compressed by the hot-elastic-fluid pump and feeding it to the Bunsen burner.

The invention may be modified in various ways; but its essential parts are as I have stated.

The invention acts as follows: Assume the diaphragm and displacer to be in the intermediate position controlled by the springs and the apparatus to be used for compressing the inflammable gas to be supplied to a Bunsen burner heating an incandescent mantle. The mantle is heated, in the first instance, by gas supplied from the mains at the ordinary pressure. The products of combustion rising from the mantle impinge upon the lower surface of the elastic-fluid chamber. The contents of the chamber are heated and tend to expand. The pressure within the chamber thus rises, and this pressure acts against the diaphragm and moves it to compress the springs. This motion continues until the pressure upon the diaphragm is sufficiently resisted by the increased compression or extension of the springs. The increase of pressure within the elastic-fluid chamber opens an outlet-valve and causes the contents of the chamber to discharge into the reservoir. When this discharge has proceeded to a sufficient extent, the pressure within the elastic-fluid chamber fails to balance the tension of the springs and the displacer begins to move downward. The gas passes from the hot end to the cold end of the elastic-fluid chamber, and the cooling of the gas accelerates the fall of pressure, so that once the movement of the displacer begins it continues until the diaphragm moves to the other extreme of its central position and strains the springs in the opposite direction. The outlet-valve meantime has closed and the inlet-valve opens. A charge of gas then rushes into the elastic-fluid chamber and returns the pressure to atmosphere once more. The springs then tend to return the diaphragm and displacer to their central position, and thus the cold gas from the upper side of the displacer is forced to the hot end and pressure again rises. The diaphragm and displacer then complete their upstroke, increasing the gas-pressure by heating within the elastic-fluid chamber until the discharge through the discharge-valve to the reservoir reduces pressure once again and permits the spring to overpower the diaphragm. This action proceeds continuously and diaphragm and displacer oscillate up and down alternately, taking in gas, heating it, and discharging it from the elastic-fluid chamber into the gas-reservoir.

It will be readily understood that by the device of suspending diaphragm and displacer in an intermediate position by a spring suspension the apparatus is maintained in unstable equilibrium—that is, any heat applied to the lower part of the elastic fluid chamber at once increases the pressure upon the diaphragm and tends to lift the displacer. This lifting of the displacer forces further cold air to the hot end, and thus further increases the rise of pressure. The momentum acquired, due to the weight of the displacer, diaphragm, and connecting parts, also tends to strain the springs beyond the point of exact equilibrium of pressure within the diaphragm against the spring-pressure from without. This stores up energy sufficient to give considerable recoil action at each end of the stroke. This same instability applies to the opposite movement. Immediately the downward movement begins from any cause it tends to continue, because the hot gas is passed around to the cold end, and thus the pressure falls more and more rapidly. This causes the springs to rapidly act on the other stroke also. It will be readily seen that the action of this reciprocating apparatus is automatic. The discharge-valve can be set to such resistance that the diaphragm pauses at the upper end of its stroke until the pressure is sufficiently relieved to allow the springs to act again. Adjustment can also be made by choking the inlet.

The apparatus above described, and the action above indicated, is an entirely novel one, and my invention at once overcomes the difficulties hitherto found in attempting to raise gas-pressure for use in incandescent gas-lighting and other purposes.

The invention will be more fully understood by reference to the following description, aided by the accompanying drawings.

Figure 1 is a section through an apparatus constructed in accordance with my invention. Fig. 2 shows a similar section, but showing the diaphragm replaced by a piston. Fig. 3 shows a side elevation of the device used in combination with a cluster of lights. Fig. 4 shows a modified burner for the apparatus when it is arranged for delivering air under pressure.

Referring to Fig. 1, the elastic-fluid chamber A is mounted above the Bunsen burner B, carrying the incandescent mantle C, by means of the pipes D and E. The pipes D and E join to the tube F, carrying the Bunsen burner, at points respectively above and below the plug G. The screw-nipple H, terminating in the tube F, is connected to the source of gas-supply. An annular chamber A′ surrounds the elastic-fluid chamber, but it is closed off entirely from the latter and is filled with non-conducting material. A reservoir I surrounds A′ and serves to contain the gas or air when compressed. The elastic-fluid chamber A is closed on its lower surface by a plate or cover A^2, suitably fastened by screws to A′. The plate or cover A^3 closes the upper part of the elastic-fluid chamber A and also closes the annular chamber A′ and the reservoir I. The upper and lower covers are connected by the screw-bolts A^4. The lower surface of the cover A^2 carries a cylindrical chambered recess A^5, to be more fully described hereinafter. The elastic-fluid chamber A incloses a displacer J, which displacer is suspended by a screwed rod K. A diaphragm L is attached to the displacer J by means of screws L′ L^2. This diaphragm L, which may be of leather, is clamped to the cover A^3 by means of a ring L^3 and screws L^4. An aperture A^6 within the cover A^3 allows the pressure within the elastic-fluid chamber A to be communicated to the inner surface of the diaphragm L. Pillars L^5 support a cross-bar L^6, carrying rings L^7 above and below, through which freely passes the rod K. Springs K′ K^2 above and below the bar L^6, pressing against the fixed cross-bar, are compressed to any desired extent by the adjustable nuts K^3 K^4, against which they abut, and they maintain the displacer J in an intermediate position within the elastic-fluid chamber A when uninfluenced by forces acting on the diaphragm. The displacer J works freely in the elastic-fluid chamber A without contact at the sides, and it is supplied with a central tube J′, which passes through a stuffing-gland J^2, loosely packed. The tube J′ at its upper end opens into a cylindrical space J^3, which space communicates with the upper or cold side of the elastic-fluid chamber A by means of holes J^4. This tube is fixed and slides freely in the stuffing-gland J^2, and it carries at its lower end a disk J^5. In its up-and-down movement the displacer J thus slides on the tube J′. Holes A^7 are provided in the cover A^2, which communicate between the interior of the chamber A^5 and the interior of the elastic-fluid chamber A. A loose plate A^8 surrounds the tube J′, but is not moved by it. Normally this valve-plate covers the holes A^7. The tube D is firmly secured to a projection D′ from the cover A^2; but the said tube does not communicate with the interior of the elastic-fluid chamber A at that point. A branch tube D^2 is provided, connected with D on the one side and on the other with the reservoir I, into which it opens. A branch tube E′ passes from the tube E and connects with a coil M, which terminates in a tube M′, opening to the upper side of the elastic-fluid chamber. The tube E′ is provided with a lift-valve N, opening upward into the coil M. A tube O opens into the reservoir I on the one end and to the pipe M′ on the other end. This tube is provided with a non-return valve P, which valve opens in the direction of the reservoir. Tubes Q Q′ connect the tubes E E′ by way of a non-return valve R, which opens toward Q′. A non-return valve S is provided upon the tube E between the points of junction of the tubes E′ and Q′. This valve opens toward the elastic-fluid chamber A. The Bunsen burner B contains the usual gas-nozzle and air-holes, and the gas-nozzle is screwed into the tube F and is supplied with gas from the pipe D by way of F.

In Fig. 2 is illustrated a modification in which all the parts are exactly as shown in Fig. 1, except that the diaphragm L in Fig. 1 is replaced by a piston T, which piston may be provided with rings or other well-known forms of packing. Further description is unnecessary.

Fig. 3 is an external elevation of an apparatus in every way similar to that shown in section in Fig. 1; but in this figure in addition to the central Bunsen burner B a ring-pipe U is provided, coupled by a pipe U′ with the pressure-supply pipe D. This ring-pipe carries separate Bunsen burners B′ B^2, having mantles C′ C^2. By this device the waste heat from one central burner and mantle supplies power to light a cluster of mantles supplied from the ring-pipe U.

Fig. 4 shows a modified burner, which is applied when air is compressed instead of gas. The air-pipe is shown at V, and in this case the air-holes usual in Bunsen burners are omitted, the gas being supplied at the usual nozzle V′.

The action of the apparatus is as follows, assuming the inflammable gas used to be compressed: To start the apparatus, the gas is supplied to the screw-nipple H at the ordinary pressure of the mains. It passes into the tube F, but is stopped by the plug G, and thus is caused to pass through the pipe E by way of the valve S into the elastic-fluid chamber A. Thence it flows through the pipe M′ by way of the valve P to the reservoir I. From the reservoir I it passes by way of the pipe D^2 to the pipe D, and thence it enters the tube F above the plug G and supplies the jet or nozzle in the Bunsen burner B. The mantle C is thus heated to incandescence by a supply of gas delivered at the ordinary pressure of the mains. The heated gases from the Bunsen flame pass upward and impinge upon the cover A^2 and also the projecting cylindrical chamber A^5. The contents of the elastic-fluid chamber A are thus heated up on the lower side of the displacer J, and the pressure within the whole chamber rises and is communicated to the flexible diaphragm L. The diaphragm then moves upward and carries with it the displacer J. The spring K^2 is thus compressed and the spring K′ allowed to extend. The upward movement of the displacer meantime causes the cooler gases from its upper side to pass around its circumference and through the holes J^4 to the cylindrical space J^3, then through the tube J′, underneath the disk J^5 in contact with surfaces exposed to the heat, then around the disk J^5 into the lower side of the elastic-fluid chamber A by way of the holes A^7 and the valve-plate A^8. It will thus be seen that the pipe J′, with its disk J^5, remains fixed in the position shown in the drawings, and the displacer J moves easily upon it, contact being made only by the loose packing J^2. The valve A^8, however, is free to rise and fall around the tube J′ and is but lightly loaded. The cold gas thus passing to the hot side of the displacer becomes heated and the pressure continues to rise. This increase takes place during the whole upward stroke of the displacer, or would continue to take place but for the discharge of the gases by way of the pipe M′, the valve P, and the pipe O to the gas-reservoir I. The gas thus passes into the reservoir I under a pressure above atmosphere, and after a time the pressure in the elastic-fluid chamber A becomes less than the spring compression and the weight of the displacer J. The displacer then begins to fall again and a reverse action takes place. In the fall, however, the hot gas from the lower side is not allowed to pass back by way of the pipe J′, because the valve A^8 closes and the gas cannot attain admission to the holes A^7. The hot gas therefore passes around by the annular space between the displacer J and the cylindrical walls inclosing it. The gas also passes by the pipe E′ and the check-valve N through the coil M and the pipe M′ to the upper or cold side of the chamber. In the arrangement shown the displacer J so nearly fits the chamber A′ that the greater part of the gases pass through the coil M, as described. The pressure within the elastic-fluid chamber then falls because of the cooling effect, and the spring K^2 thrusts the displacer to the farther end of its stroke. The pressure meantime falls below atmosphere, and then the valve S in the pipe E lifts and a fresh supply of gas is drawn in by way of the pipe E from the supply-nipple H. When the displacer reaches the bottom of its stroke, it rebounds slightly, and thus begins a transference of gas from the upper side to the lower side, as already described. The pressure begins to rise and continues rising with the ascent of the displacer, as before. In this manner the apparatus acts as a compressing-pump, compressing the gas automatically by the aid of a displacer and the use of hot and cold surfaces. Gas is thus supplied under pressure to the Bunsen burner B, and the pressure continues to rise until the limit of the power of the apparatus is reached. This occurs when the reservoir-pressure attains such a height that the complete upward movement of the displacer is unable to sufficiently increase the pressure to cause a discharge into it. In this condition the displacer movement is slowly checked by the increasing resistance, and the discharge from the elastic-fluid chamber regulates itself in accordance with the discharge from the reservoir-chamber. In this way a balance of forces is attained and the automatic apparatus supplies gas to the reservoir just as it is wanted.

In order to allow some adjustment of volume independently of the resistance offered by the reservoir, I introduce a by-pass valve R between the pipes Q and Q′. This by-pass valve is loaded to the maximum pressure required in the reservoir, and in the event of the apparatus generating a higher pressure it simply lifts the valve R and discharges back into the gas-inlet.

In some circumstances I cool the coil M in a vessel of water; but where sufficient radiating-surface can be provided I dispense with any cooling other than air cooling. In some circumstances I also dispense with the coil M and with the cylindrical chamber A^5 and its pipe J' and connections and use a plain elastic-fluid chamber, in which all the transfer of gas from top to bottom and bottom to top passes by way of the annulus between the displacer and its inclosing cylindrical displacer-walls. In this case I make the annulus sufficiently large to pass the gas with ease.

The description I have given of the action applies equally well to Fig. 2. Here, however, the diaphragm L is replaced by the piston T.

I prefer in my apparatus to compress the inflammable gas; but I also arrange it to compress air, in which case I cause the pipe E to open to the atmosphere and I arrange the Bunsen burner as shown in Fig. 4. Here the air is admitted by the side jet V and the ordinary air-holes are closed. The gas is admitted by the nozzle V' shown in the figure.

I claim—

1. An apparatus for compressing elastic fluid by the agency of heat, consisting of a direct-acting hot-elastic-fluid pump without fly-wheel, comprising in combination; a displacer moving in a chamber, one part of which is heated and another cooled; spring-controlled means for operating said displacer by the rise and fall of pressure of said elastic fluid, said means coupling directly to the displacer without rotating parts; inlet-valve admitting elastic fluid to the chamber, and outlet-valve permitting discharge of elastic fluid from said chamber, as herein set forth.

2. An apparatus for compressing combustible elastic fluid for combustion at increased pressures, in which the waste heat from the combustion is employed to automatically effect the increase of pressure, consisting of a direct-acting hot-elastic-fluid pump without fly-wheel, comprising in combination a displacer moving in a chamber, one part of which is heated, and another cooled; spring-controlled means for operating said displacer by the rise and fall of pressure of the said elastic fluid, said means coupling directly to the displacer without rotating parts; inlet-valve connected to the low-pressure supply-pipe, and outlet-valve permitting discharge of elastic fluid for combustion, as herein set forth.

3. An apparatus for compressing combustible elastic fluid for incandescent lighting in which the waste heat from the incandescent burner is employed to automatically effect the increase of pressure, consisting of a direct-acting hot-elastic-fluid pump without fly-wheel, comprising in combination; a displacer moving in a chamber, one part of which is heated, and another cooled; spring-controlled means for operating said displacer by the rise and fall of pressure of the said elastic fluid, said means coupling directly to the displacer without rotating parts; inlet-valve connected to low-pressure supply-pipe; and outlet-valve permitting discharge of elastic fluid to the incandescent burner, as herein set forth.

4. In an apparatus for compressing elastic fluid by the agency of heat, a direct-acting hot-elastic-fluid pump without fly-wheel; a displacer moving in a chamber, one part of which is heated and another cooled; a diaphragm operating said displacer by the rise and fall of pressure of the said elastic fluid, said diaphragm coupled directly to the displacer; a rod secured to said diaphragm and displacer, and springs each adjustably connected to said rod at one end and abutting at the other end against a fixed point; an inlet-valve admitting elastic fluid to the chamber, and an outlet-valve permitting discharge of elastic fluid from said chamber; as herein set forth.

5. In an apparatus for compressing elastic fluid by the agency of heat, a direct-acting hot-elastic-fluid pump without fly-wheel, a displacer moving in a chamber, one part of which is heated and another cooled; a diaphragm operating said displacer by the rise and fall of pressure of the said elastic fluid, said diaphragm coupled directly to the displacer; a rod secured to said diaphragm and displacer, and springs each adjustably connected to said rod at one end and abutting at the other end against a fixed point; a by-pass forming a cooling-coil connecting the hot side of the chamber with the cold side of the chamber said by-pass controlled by a non-return valve; an outlet-valve-controlled pipe connecting the cold side of the chamber with the pressure-reservoir; and an inlet-valve admitting elastic fluid to the chamber; as herein set forth.

6. In an apparatus for compressing elastic fluid by the agency of heat, a direct-acting hot-elastic-fluid pump without fly-wheel; a displacer moving in a chamber, one part of which is heated and another cooled; a diaphragm operating said displacer by the rise and fall of pressure of the said elastic fluid, said diaphragm coupled directly to the displacer; a rod secured to said diaphragm and displacer, and springs each adjustably connected to said rod at one end and abutting at the other end against a fixed point; a tube fixed to said chamber, provided with a disk at its bottom, within a cylindrical inclosure secured to the hot side of said chamber; valve-controlled openings connecting said inclosure with the hot side of said chamber; a stuffing-gland on said displacer preventing communication between the cold and the hot sides of the chamber, except by way of said tube; a by-pass forming a cooling-coil connecting the hot side of the chamber with the cold

side of the chamber, a non-return valve controlling said by-pass; an outlet-valve-controlled pipe connecting the cold side of the chamber with the pressure-reservoir; and an inlet-valve admitting elastic fluid to the chamber; as herein set forth.

7. In an apparatus for compressing elastic fluid by the agency of heat a direct-acting hot-elastic-fluid pump without fly-wheel; a displacer moving in a chamber, one part of which is heated and another cooled; a diaphragm operating said displacer by the rise and fall of pressure of the said elastic fluid, said diaphragm coupled directly to the displacer; a rod secured to said diaphragm and displacer, and springs each adjustably connected to said rod at one end and abutting at the other end against a fixed point; a tube fixed to said chamber, provided with a disk at its bottom, within a cylindrical inclosure secured to the hot side of said chamber, valve-controlled openings connecting said inclosure with the hot side of said chamber; a stuffing-gland on said displacer preventing communication between the cold and hot sides of the chamber, except by way of said tube; a by-pass forming a cooling-coil connecting the hot side of the chamber with the cold side of the chamber, a non-return valve controlling said by-pass an outlet-valve-controlled pipe connecting the cold side of the chamber with the pressure-reservoir; and an inlet-valve admitting elastic fluid to the chamber; a spring-controlled relief-valve adapted to permit discharge of part of supply taken into compressor; as herein set forth.

8. In an apparatus for compressing elastic fluid by the agency of heat, a direct-acting hot-elastic-fluid pump without fly-wheel; a displacer moving in a chamber one part of which is heated and another cooled; a diaphragm operating said displacer by the rise and fall of pressure of the said elastic fluid, said diaphragm coupled directly to the displacer, a rod secured to said diaphragm and displacer, and springs each adjustably connected to said rod at one end and abutting at the other end against a fixed point; a tube fixed to said chamber, provided with a disk at its bottom, within a cylindrical inclosure secured to the hot side of said chamber; valve-controlled openings connecting said inclosure with the hot side of said chamber; a stuffing-gland on said displacer preventing communication between the cold and the hot sides of the chamber, except by way of said tube; a by-pass forming a cooling-coil connecting the hot side of the chamber with the cold side of the chamber, a non-return valve controlling said by-pass; an outlet-valve-controlled pipe connecting the cold side of the chamber with the pressure-reservoir; and an inlet-valve admitting elastic fluid to the chamber; a spring-controlled relief-valve adapted to permit discharge of part of supply taken into compressor; a ring connected to the high-pressure supply-pipe, on which a number of burners are mounted; as herein set forth.

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

CHARLES SCOTT SNELL.

Witnesses:
WM. O. BROWN,
HUGH HUGHES.