No. 849,482. PATENTED APR. 9, 1907.

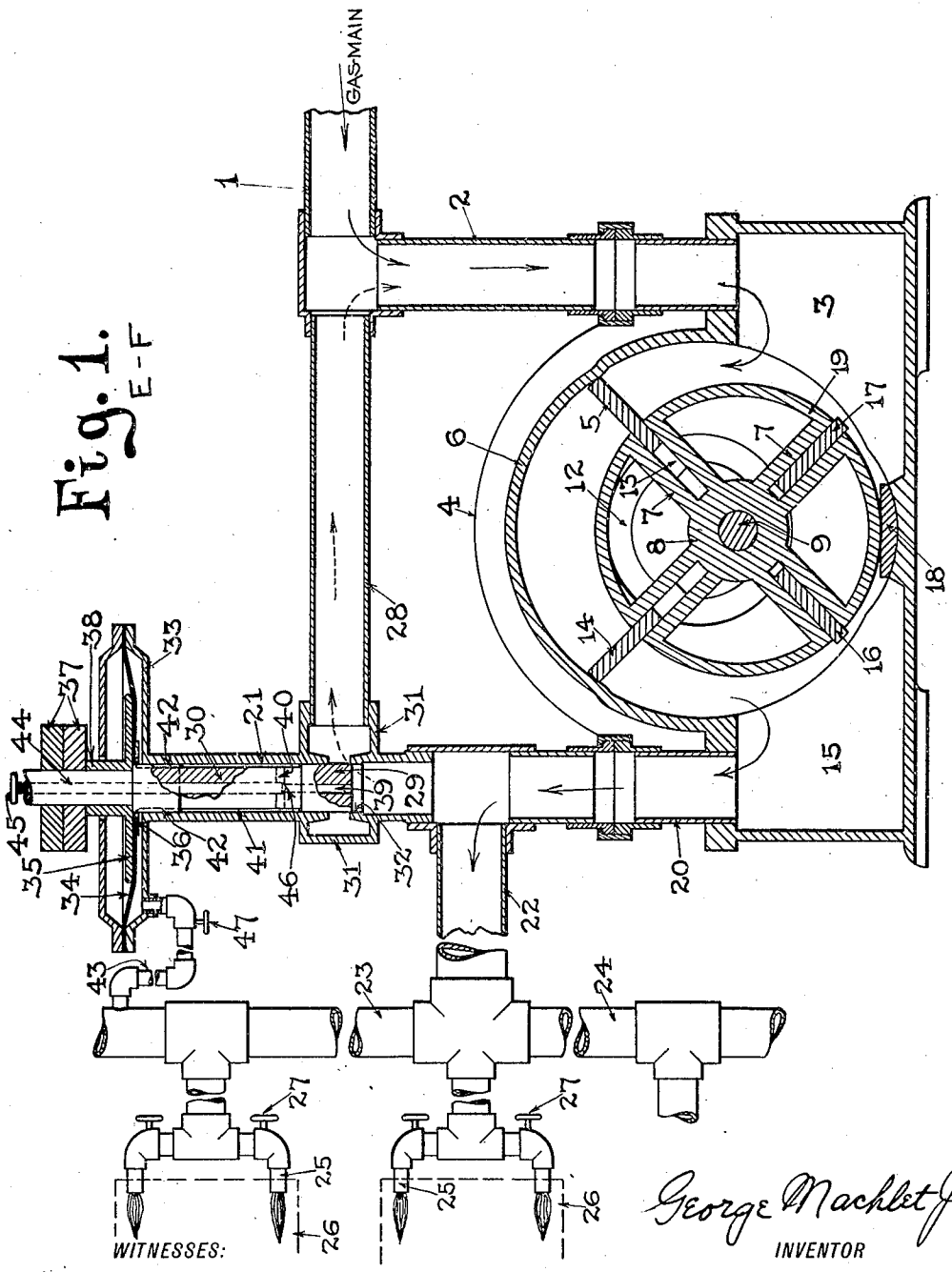
G. MACHLET, JR.

AIR OR GAS PUMP, &c.

APPLICATION FILED NOV. 23, 1904.

3 SHEETS—SHEET 1.

Fig. 1.



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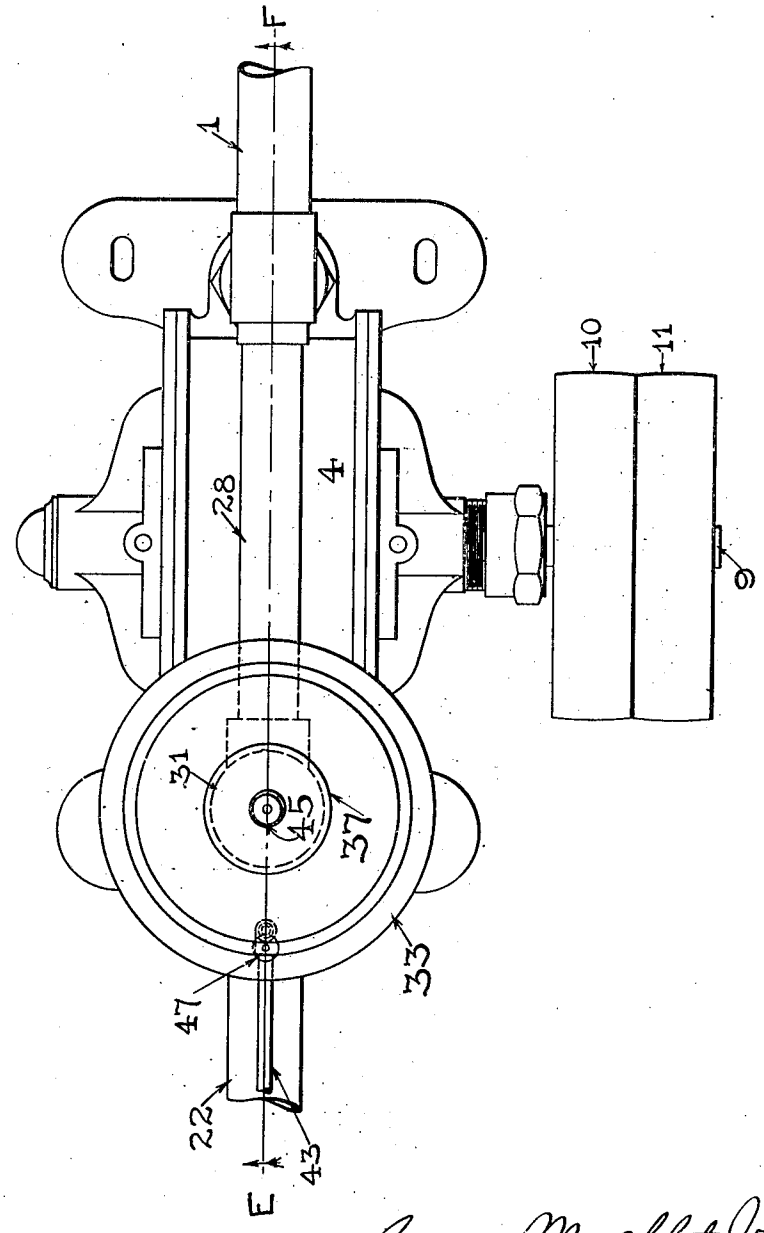
3 SHEETS—SHEET 2.

Fig. 2.



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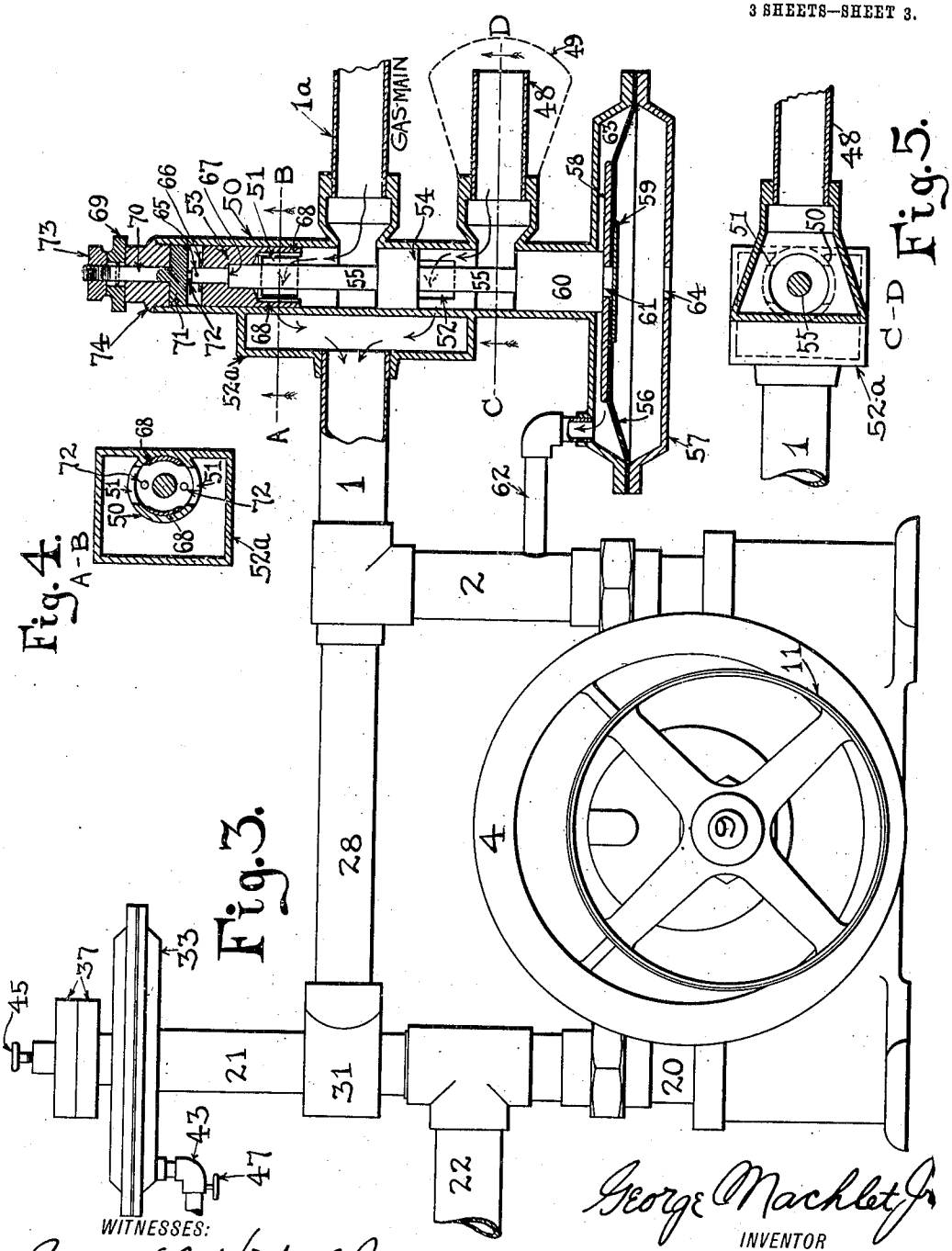
3 SHEETS—SHEET 3.



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GEORGE MACHLET, JR., OF ELIZABETH, NEW JERSEY.

AIR OR GAS PUMP, &c.

No. 849,482. Specification of Letters Patent. Patented April 9, 1907.

Application filed November 23, 1904. Serial No. 234,026.

To all whom it may concern:

Be it known that I, GEORGE MACHLET, Jr., a citizen of the United States, residing in Elizabeth, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Air or Gas Pumps, &c., of which the following is a specification.

This invention relates, primarily, to means for enabling a gas-main to deliver more than its normal volume of gas. In some instances—as, for instance, in using gas-furnaces for annealing, hardening, brazing, forging, &c.—the gas must be delivered to the furnaces in larger quantities than the gas-mains are usually capable of supplying. It is often the practice to mix air with the gas supplied to the burners, and by compression of the air and the employment of suitable apparatus to mix the air with the gas a sufficient quantity of the latter can be forced into the furnaces—that is, compressed air has been utilized to draw gas in abnormal quantities from the gas-main and introduce it into the furnaces. It often happens, however, that the gas is of such low grade that it would be a detriment to mix any air with it, and hence it becomes impracticable to utilize compressed air for introducing the gas into the furnaces.

It will be understood that in order to employ a gas-furnace economically it must have a contracted heating-space in proportion to the article to be heated and in order to obtain sufficient heat a large volume of gas must be burned within this contracted space, and hence the gas must be forced in under a pressure which in practice is considerably greater than that commonly found in gas-mains.

The principal object of my invention, therefore, is to provide practicable means for supplying gas in the required volume or at the required pressure in excess of the normal volume or pressure of the gas-main.

Gas is also quite extensively used at the present day in Bunsen burners for heating, cooking, and other domestic purposes and in both small and large manufacturing establishments, and owing to the rapidly-growing demand for gas for these purposes it often happens that the gas-mains that are already laid in the streets of a city are found to be wholly inadequate, with the result that the gas is supplied under insufficient pressure to the many consumers. My invention has for one of its objects the enabling of gas-mains to meet such unforeseen demands and supply the required volume of gas at normal pressure.

In carrying out my invention I employ a pump, which may be driven by a belt, an electric motor, or other means, by which the gas is drawn from the main and supplied to the burners under increased pressure and in greater volume than could be supplied by the main if unaided. The problem of keeping the pump in constant operation without on the one hand causing great fluctuations in the pressure at the burners, owing to the variable rate of consumption of the gas due to turning on and off burners from time to time, and without on the other hand incurring waste of surplus gas delivered by the pump I have solved by means presently to be described.

The invention also includes means for increasing or diminishing at will the pressure of the gas delivered by the pump, which will be found useful in many situations.

In the accompanying drawings, Figure 1 is a diagrammatic sectional elevation of a pump connected to a gas-main and also connected by a service-pipe to burners of gas-furnaces, and Fig. 2 is a plan of the pump, Fig. 1 being taken at about the line E F of Fig. 2. Fig. 3 illustrates the use of the pump for pumping gas and mixing air therewith, the valve being shown in section which controls the mixture. Fig. 4 is a sectional view on the line A B of Fig. 3. Fig. 5 is a sectional view on the line C D of Fig. 3.

A portion of the gas-main or of a pipe leading thereto is seen at 1, and a short vertical pipe 2 leads therefrom to an admission or suction chamber or port 3 in a pump 4. Any sort of pump, whether rotary or reciprocating or in the nature of either a blower or a compressor, may be used for the purpose of my invention, that chosen for illustration being of a rotary piston-pump of a type suitable for producing pressures up to a few pounds per square inch, beyond which it is seldom desired to increase the pressure of gas for consumption. Gas is being drawn through the chamber 3 by piston 5, which is one of a set of four equidistant pistons revolving in a cylinder 6 and carried around by four symmetrically-disposed arms 7, projecting from a hub 8, fixed upon a shaft 9, provided with fast and loose pulleys 10 11. In this type of pump the shaft 9 is eccentric to the

casing 6 and the pistons are guided around within said casing or cylinder by means of projections upon the pistons which engage annular grooves 12 in the heads of the cylinder, the grooves being concentric with cylinder 6. The pistons slide radially in grooves 13, formed in the arms 7. The space between piston 5 and the piston 14 in advance thereof is filled with gas that has just been drawn from the main. At the same time the gas in advance of piston 14 is being discharged into or through a delivery chamber or port 15. The remaining pistons 16 and 17, shown at the lower portion of the pump, are temporarily idle, and to prevent escape of gas from chamber 15 to chamber 3 a saddle or partition 18 is provided at the bottom of the pump, in constant contact with which runs a drum 19, which contains and is formed integral with the arms 7, within which the pistons retire when swinging around in the bottom of the pump.

Upon the delivery side of the pump is erected a vertical pipe structure, the lower part of which is designated as 20 and the upper part as 21. From the part 20 is led a service or delivery piping 22 with branches at 23 24 to the burners, some of which are seen at 25, projecting within gas-furnaces 26, each burner being usually provided with a valve 27 for opening and closing the same. It will be understood, however, that the invention is adapted for all kinds of burners used for all sorts of purposes.

It will be perceived that the apparatus so far described is capable of drawing an abnormal supply of gas from the main and delivering it to the burners under pressure greatly above that of the normal pressure in the main. So long as the quantity consumed by the burners kept pace with the capacity of the pump nothing more would be needed; but owing to the necessity of regulating the burners and at one run time using a few burners and at another time using many the quantity of gas consumed in practice varies greatly, while for most purposes it is important that the pressure in the service-pipe 22 or at the burners should be uniform wholly regardless of the quantity of gas being consumed. The pump of course should be of a capacity to supply the maximum quantity under the maximum pressure needed at the burners, and since it would be desirable to keep the pump in constant operation during the time that one or more burners are being used provision is made for disposing of the surplus gas delivered by the pump. This surplus escapes through a pipe or passage 28, which leads from the pipe structure 20 on the delivery side of the pump to the pipe 2 on the admission or intake side thereof. Through this pipe 28, therefore, the delivery and admission sides of the pump are in communication, and it will also be understood that not only the admission side but also the delivery side of the pump is in communication with the gas-main. In using the terms "admission side" and "delivery side" reference is had to the operation of the pump, and it is not intended that the physical structure of the pump is necessarily such that the suction and delivery ports or chambers are upon opposite sides of the pump, since in some pumps they are upon the same side or upon the top or bottom or one within the other, and any of these pumps may be used for the purpose of my invention, provision being made for communication between the delivery and suction ports, since the operation of the pump is such that the excess gas delivered is immediately drawn in at the suction-port, the pump hence running idly so far as this excess of gas is concerned.

At any suitable point in the passage between the delivery and suction sides or ports of the pump is placed a relief-valve, which opens whenever the pressure upon the delivery side is in excess and permits the excess gas to escape, thus making it practicable to deliver the gas to the service-pipe at substantially uniform pressure regardless of the quantity being used at the burners, the escaping gas of course returning to the suction side or port of the pump, so that there is no loss of gas. The valve may be of any suitable kind and operated in any suitable manner and placed at any desired point between the intake and delivery of the pump. I prefer, however, to form a cylindrical valve 29 upon the bottom end of a rod 30, which fits within the upper portion 21 of the vertical pipe structure, this portion forming a casing or cylinder within which the rod may move up and down.

Between the parts 20 and 21 is formed a chamber 31, into which each of said parts projects, the top of the lower part forming a seat 32 for said valve, whereby the passage between the delivery and admission of the pump is normally closed. The casing 21 is surmounted by a head 33, in which is mounted a diaphragm or flexible disk 34, usually made of soft rubber. To this diaphragm the rod 30 is connected by means of upper and lower disks 35 36, between which the central portion of the diaphragm is securely held, the rod extending up through the head and carrying removable weights 37 and the disk 35 having a hub or boss 38, whereby it is secured to the rod. By the movements of the diaphragm the valve 29 is opened and closed, and in order to admit gas from the delivery side of the pump to the under side of the diaphragm a passage may be formed in the rod 30 and may comprise a central vertical perforation 39 in the end of the rod, a cross-perforation 40 in the rod just above the valve, a long recess 41, formed by reducing the rod in diameter, and opposite outlets or passages

42, formed in the sides of the upper bearing portion of the rod above said recess and communicating therewith, said passages 42 opening into the head 33. It will be seen that while the gas pressing up against the valve itself may tend to raise the same still owing to the low pressure at which the gas is delivered this lifting power would be so slight as to be ineffectual, while the diaphragm 34 presents a great area to the pressure of the gas, and hence is enabled to control the valve, which, it will be noted, opens an orifice which is small or undersized in proportion to the area of the diaphragm. The pipe 28 is shown attached directly to the chambered portion 31 of the structure.

By means of the weights 37 or any other suitable device the pressure may be regulated of the gas delivered by the pump to the burners, since by the addition of a weight the resistance offered by the diaphragm to the gas pressure is increased, and hence a greater pressure of gas must be produced by the pump in order to lift the diaphragm and the valve, while if weights are removed from the rod 30 the valve is more easily lifted and the gas hence more readily escapes into the passage 28, so that the pressure of the delivered gas cannot rise so high.

In case the burners or the discharge portion of the service-pipe is removed from the pump a pipe 43 may be led from such discharge portion back to the head 33, containing the diaphragm, so that the movements of the valve shall be determined by the pressure of the gas in this remote portion of the system, where it is weaker than at the pump itself, owing principally to the friction of the gas flowing through the delivery-piping. The passage for gas through the valve-rod may be closed by a central rod 44, having at its upper end a handle 45 and at its lower end a cone 46, adapted to fit a seat in the upper end of passage 39 in the valve. This passage may therefore be closed when return-pipe 43 is in use. The latter may also be provided with a valve 47, so that it may be closed whenever it is desired to admit gas directly to the head 33 through the valve-rod 30.

It will be perceived that by this invention gas may be forced into gas-furnaces and other apparatus at a pressure much above that normal to the gas-main and also in numerous cases where the demand for gas at normal gas-main pressure has outgrown the capacity of the main the pump, with its appurtenances, may be introduced for the purpose of supplying normal pressure service in a hotel, factory, or other building inadequately supplied by the unaided main. In some cases the appliance may be connected between two portions of the gas-main itself—that is, the parts 1 and 22 may be regarded as adjoining sections of a single gas-main—and it will be seen that by this means the efficiency of the main upon the delivery side of the pump will be increased, so that the invention has special advantages where several towns or manufacturing plants are supplied from a single gas plant and elsewhere in cases involving the flow of gas for a great distance from its origin to the point where it is used, and the necessity of laying gas-mains of undue size or of taking up old mains and replacing them with mains of larger size or of laying supplemental mains is avoided. Again, where a gas-main has been laid for supplying a rich quality of gas and it becomes desirable to use the main for a low-grade gas the main is found to be too small to supply the low-grade gas in such increased volume as to compensate for its deficiency in quality; but this difficulty is overcome by my invention, which makes it practicable to supply the gas to consumers at any desired pressure, the uniformity of which is preserved without regard to the fluctuations in the rate of consumption.

It will be understood that the pump is constantly delivering gas whether the valve 29 works or not, and hence that the maximum desired pressure is uniformly maintained, said valve simply compensating for variations in consumption. This uniformity of pressure is a matter of considerable importance, particularly in gas-furnaces, where it is not permissible for the intensity of the flames to vary.

So long as the pump is doing the work for which it is intended—*i. e.*, so long as the consumption of gas does not overtax the pump—the delivered gas is constantly divided into two streams of varying proportions, one stream flowing through 22, the other returning through by-pass 28 to the admission side of the pump, the volume passing through the by-pass decreasing as that passing through 22 increases, and vice versa, whereby either increase or reduction in the consumption of gas at the burners fails to cause a perceptible fluctuation in the pressure at the burners. These fluctuations are caused, it should be remembered, without interruption (stoppage) in the flow of the gas through the by-pass so long as the pump is running, and the diaphragm is effective constantly throughout the entire flow of gas from the pump into pipe 20. It will be understood that there must always be a reserve which can be drawn upon at any time for supplying increased demand at the burners which may occur. This reserve may be regarded as existing in the stream of surplus gas always flowing through the by-pass. At any time this by-pass stream can be drawn upon or reduced to afford a larger supply to the burners, and hence the pressure at the burners is uniform during all fluctuations in the rate of consumption. Infinitesimal variations in

the gas-pressure are sufficient to operate the diaphragm and operate the valve. The weight or weights 37 offer uniform resistance regardless of the extent to which valve 29 is open, permitting wide variations in the volume passing through 28 without perceptible variation in pressure at 22.

While my improvements are specially adapted to gas, still some features thereof are well adapted to air-pumps, blowers, or compressors, particularly the means for regulating the pressure at which air is delivered and maintaining the pressure uniform at the point desired. The excess air flows back to the admission side of the pump, thus avoiding the disagreeable noise heard when excess of air is allowed to escape into the room in which the pump is set up and also to some extent avoiding waste of power used in driving the pump.

It is not essential in all cases that means be employed for regulating the pressure at which the gas or air is delivered by the pump.

The hereinbefore-described apparatus may also be employed for the purpose of pumping a mixture of air and gas, (or a mixture of gases,) particularly for use in gas-furnaces and elsewhere in cases where the quality of gas is high and it is desired to use mixed air and gas under pressure greater than the gas-main pressure.

While in some cases a plain air-inlet valve may be provided upon the admission side of the pump or inserted in the gas-main, so that the pump may draw in gas mixed with air, manual regulation of the valve being depended upon for the purpose of securing the proper mixture, still I prefer to provide automatic means for determining the relative proportions of gas and air admitted to the pump. One form of such automatic means is illustrated at Figs. 3, 4, and 5, inserted between sections 1 1^a of the gas-main. Air for mixing with the gas is drawn in through an inlet 48, which may be protected by a screen 49. Both the gas-main and the air-inlet open into a vertical tube 50, the opposite walls of which are perforated to form gas-outlet ports 51 and air-outlet ports 52, the former being shown above the latter. The portion of the tube which is provided with said ports is confined within a chamber or box 52^a, in which the gas and air entering the box through ports 51 and 52 may mix and flow through the section 1 of the gas-main and pipe 2 to the pump 4.

The flow of gas through ports 51 is regulated by a valve 53, and the flow of air through ports 52 is regulated by a valve 54. Said valves are formed cylindrically to fit in the tube or valve-chest 50 and are movable vertically therein for the purpose of opening and closing the ports. A single stem 55 is provided, being connected to both valves, for moving them simultaneously and positively up or down, said stem being preferably integral with valve 54. When the stem moves up, more air and more gas are admitted to the pump. When it moves down, less air and less gas are admitted. Thus no matter whether the pump is delivering a large quantity or a small quantity of gas and air through the service-pipe 22 the proportion of gas and air in the mixture is uniform as long as the pump is in operation, which is a matter of much importance where gas and air are employed in gas-furnaces and elsewhere. It will be understood that the gas and air are delivered at uniform pressure regardless of the quantity being consumed, while the proportions of gas and air in the mixture do not vary, so that if the burners in a gas-furnace, for instance, are being supplied the heat can be depended upon to remain practically uniform as long as the furnace is in operation, which is a matter of prime importance in that art.

It would be within the scope of the invention seen at Figs. 3, 4 and 5 to regulate the movement or position of the valves 53 and 54 manually; but I prefer to provide automatic means for the purpose. To this end I provide a flexible or elastic (usually rubber) diaphragm 56 within a head 57, provided upon the bottom of the tubular valve-chest 50 and positively connected to valve-stem 55. It will be seen that the diaphragm is clamped between a large upper plate 58 and a small lower plate or washer 59, the stem 55 being formed with a guiding-head 60, that fits in the tube 50, and washer or clamp 59 being secured upon a nipple 61, depending from said head and penetrating the plate 58 and the diaphragm, said plate and diaphragm being held rigidly against said head. Thus when the diaphragm is either lifted or depressed the valves 53 and 54 move therewith and open or close the ports 51 and 52 accordingly.

The movements of the diaphragm and valves controlled thereby are made to depend upon the volume of mixed gas and air being delivered by the pump—that is, the quantity of the mixture flowing from the mixer to the pump depends upon the volume delivered to the service-pipe and consumed, the rotation of the pump being of course at uniform speed throughout all variations in the volume of mixture taken in thereby and forced through the service-pipe. To this end a pipe 62 furnishes an open communication from the suction pipe or inlet 2 of the pump to the upper side of the diaphragm 56—that is, to the upper chamber 63, formed by said diaphragm in the head 57. Assuming the diaphragm to be at its lowest position and both ports 51 and 52 closed, if the pump is started into action a partial vacuum is produced by its action in the inlet-pipe 2 and by reason of the communication 62 to the upper chamber 63 in head 57 a partia

vacuum is produced in the latter, while below said diaphragm there is normal atmospheric pressure, the lower chamber being in open communication with the outside atmosphere through an opening 64. Said diaphragm is consequently raised by atmospheric pressure, thus opening said ports 51 and 52 and permitting the pump to draw air and gas therethrough.

If during the operation of the pump a large proportion of the burners 25 should be turned off, thus reducing the volume of mixture being consumed, the pressure in the service-pipe and in the vertical valve-pipe or structure 20 would increase, causing the valve 29 to open, so that the pressure in pipe 28 and inlet 2 would be brought to normal or at least increased. In consequence the vacuum in chamber 63 would be diminished and the diaphragm and valves would fall by gravity, thus cutting off the supply of gas and air to an extent corresponding to the reduction in its consumption at the burners. On the other hand, if the consumption at the burners should be increased at any time the pressure in pipe 20 would become diminished, the valve 29 would close, a greater vacuum would be produced in pipe 2 and chamber 63, the diaphragm 56, with the valves, would be raised by atmospheric pressure, and the supply of gas and air to the pump be increased to an extent corresponding to the increased consumption at the burners. Of course during the operation of the pump the volume of gas being consumed is subject to both great and small fluctuations, and by the described means the admission of gas and air is under constant automatic regulation, so that the flame at each burner is kept uniform, regardless of the use of many or few other burners at the same time. It will be understood that it is of great importance to supply proper portions of gas and air to the pump and that by the described means the proper mixture is assured during all fluctuations in the rate at which the gas and air are drawn in by the pump, the principal function of the diaphragm 56 and its connections being not merely to permit the pump to draw in more or less of the mixed air and gas, as required, but to insure that whether the quantity drawn in be great or small at any time and whether the consumption of the mixture be uniform or variable the proportion of air to gas shall always be uniform.

Since the gas itself varies in quality, I prefer to make provision for proportioning the gas-supply to the air-supply, poor gas permitting the addition of but little air, while rich gas may have a relatively larger quantity of air mixed with it. The valve 53 is accordingly made manually adjustable, independently of its automatic adjustment, already adverted to. It is mounted revolubly upon the stem 55, but confined thereto, so as to move vertically therewith, by means of a cross-pin or cotter 65 and washer 66, the valve resting upon a shoulder 67, formed near the top of the stem. This valve 53 is in the form of a cylinder, which at its lower end is cut away by first chambering and then slotting the same, so as to leave two shell-like sides 68, (seen best at Fig. 4,) at which figure said sides occupy positions between the gas-ports 51 in the valve-chest 50. By turning said valve 53, however, said sides may be turned around so as to cover said ports, and hence prevent or diminish the flow of gas therethrough, thereby to regulate the mixture of gas and air in proportion to the richness of the gas or to secure a mixture of any desired quality, this regulation being manual and independent of the automatic movement of the valve up and down, already described. The valve 53 may be rotatively adjusted by means of a head or finger piece 69, surmounting the valve-chest 50 and pinned to a short vertical stem 70, the latter being formed at its lower end with a head 71 within the valve-chest and provided with a pair of pendent vertical pins 72, Figs. 3 and 4, fitting into holes in valve 53, the pins enabling the head 71 to turn the valve around and being of sufficient length to accommodate the vertical movements of the latter, head 71 being immovable vertically. It will be understood that the attendant may adjust the finger-piece 69 until by experimenting with the burners he perceives that he has a mixture of the richness desired, and then he may secure the head-piece by a jam-nut 73, threaded upon the top of stem 70, so that so long as the pump is in use and during all fluctuations in the quantity of the mixture used its richness shall have this predetermined quality. The top of the valve-chest is shown closed by a cap 74, which is threaded into the chest and centrally perforated to receive the stem 70.

Usually where a mixture of gas and air is burned individual air-inlets are provided at the burners, as in the Bunsen system, or else air is supplied under pressure and caused to draw in a supply of gas. In either case the burner is somewhat complicated, because of the provision for mixing the gas and air, and where the air is supplied under pressure it is necessary to have both air-pipes and gas-pipes to the burners, making a double system of piping. By the apparatus seen at Fig. 3, however, all complication is avoided, as a single pipe-line conveys the mixed air and gas in proper proportions from the pump to the burner.

In many cases where it is desired to use Bunsen burners, but where the pressure of gas in the main is so weak that it is incapable of drawing in a sufficient volume of air (at the burner) to make a proper mixture it will be seen that the Fig. 3 apparatus can be used for the purpose of mixing at least a small portion of air with the gas, leaving it in such

condition that more air can be drawn in at the burner itself, if desired. The apparatus may therefore not only increase the pressure of gas delivered to a set of Bunsen burners, but may also mix a small quantity of air with the gas to advantage.

If the gas is either overcharged or undercharged with air, poor combustion results; but by this apparatus exactly the right proportion can be secured and maintained. For use with Bunsen burners the apparatus may be regulated to mix in some air, which is a benefit, but not so much as to create danger of an explosion occurring in the service-pipes, the remaining air that is necessary being taken in by the burners. The apparatus is of advantage for Welsbach lamps, in which it is usually found difficult to get the proper mixture of air, owing generally to the low pressure of gas at the burner, since not only may the pressure be increased, but air may be positively mixed with the gas in the service-pipes whether or not the mixture is supplied at high pressure to the burners.

Many variations may be resorted to in the mixture-governor, (seen at Fig. 3,) as well as in the remaining portions of the pumping apparatus—as, for instance, the lower chamber in the head 57 may be closed to the atmosphere and put into communication with the gas-main at 1^a.

Having thus described my invention, I claim—

1. An air or gas pump provided with a by-pass between its admission and delivery sides, and having means unintermittently dependent upon the pressure of gas during the delivery thereof by the pump, for maintaining substantially uniform the pressure of the gas at the point or points of consumption during substantial fluctuations in the rate of consumption; said means including a valve in said by-pass, and a valve-controller always operable by the minimum useful pressure of the delivered gas, to cause said valve to be constantly open during the consumption of the gas, to permit unintermitting return through said by-pass of gas in varying proportions during the flow thereof out of the pump.

2. An air or gas pump provided with a by-pass between its admission and delivery sides, a valve to control the flow of gas through said by-pass, and a valve-actuator of far greater area than said valve and constantly subjected to the pressure of gas while it is flowing out of the pump, and movable by the minimum useful pressure of the delivered gas, to permit varying proportions of the gas flowing out of the pump to return in an unintermitting flow through said by-pass, to maintain approximately uniform the pressure of the delivered gas-stream that does not return through said by-pass.

3. An air or gas pump provided upon its delivery side with a valve-seat, a rod having at one end a valve to fit said seat, a casing in which said rod fits, a head upon said casing, a diaphragm in said head and connected to said rod and of far greater area than said valve, and a by-pass between the delivery and admission sides of the pump and controlled by said valve; said diaphragm being constantly exposed to the pressure of gas delivered from the pump, and of such area that the minimum useful pressure of the gas thereon keeps said valve constantly open.

4. An air or gas pump provided with a by-pass between its admission and delivery sides, and having means unintermittingly dependent upon the pressure of gas during the delivery thereof by the pump, for maintaining substantially uniform the pressure of the gas at the point or points of consumption during substantial fluctuations in the rate of consumption; said means including a valve in said by-pass, a valve-controller always operable by the minimum useful pressure of the delivered gas, to cause said valve to be constantly open during the consumption of the gas, to permit unintermitting return through said by-pass of gas in varying proportions during the flow thereof out of the pump, and means for regulating the resistance of said pressure-maintaining means to the pressure of the outflowing gas, thereby to regulate the minimum pressure of the gas to suit varying requirements.

5. An air or gas pump provided with a by-pass between its admission and delivery sides, a valve to control the flow of gas through said by-pass, a valve-actuator of far greater area than said valve and constantly subjected to the pressure of gas while it is flowing out of the pump, and movable by the minimum useful pressure of the delivered gas, to permit varying proportions of the gas flowing out of the pump to return in an unintermitting flow through said by-pass, to maintain approximately uniform the pressure of the delivered gas-stream that does not return through said by-pass, and means for changing at will the resistance of said actuator to said gas-pressure, thereby to regulate the minimum pressure of the gas to suit varying requirements.

6. An air or gas pump provided upon its delivery side with a valve-seat, a rod having at one end a valve to fit said seat, a casing in which said rod fits, a head upon said casing, a diaphragm in said head and connected to said rod and of far greater area than said valve, a by-pass between the delivery and admission sides of the pump and controlled by said valve; said diaphragm being constantly exposed to the pressure of gas delivered from the pump, and of such area that the minimum useful pressure of the gas thereon keeps said valve constantly open, a weight-holder connected to said diaphragm,

and a set of movable weights for resting upon said holder to vary the resistance of said diaphragm to the gas-pressure, thereby to regulate the minimum pressure of the gas to suit varying requirements.

7. The combination with an air or gas pump having a by-pass from its delivery side to its admission side, of a valve associated with said by-pass, a head, a diaphragm in said head and having far more extensive area than said valve, a rod passing through said head and connected to the diaphragm; a set of weights to act upon said rod to vary at will the resistance of said diaphragm to the gas-pressure; said valve being connected to said rod, and said diaphragm being constantly subject to the pressure of gas as it flows out of the delivery side of the pump, and of sufficient area to enable the minimum useful gas-pressure to hold said valve open.

8. The combination with an air or gas pump having a by-pass from its delivery side to its admission side, of a valve for said by-pass, a head, a diaphragm in said head and connected to said valve, a delivery or service pipe leading from the delivery side of the pump to a device which consumes the gas, and a connection leading from the consumption end of said delivery-pipe back to said head; said diaphragm being of such area that it is caused by the minimum useful gas-pressure to hold said valve constantly open during the flow of gas through said delivery-pipe.

9. An air or gas pump provided upon its delivery side with a valve-seat, a rod having at one end a valve to fit said seat, a casing in which said rod fits, a head upon said casing, and a diaphragm of relatively great area mounted in said head and connected to said rod, the rod being provided with a passage for the fluid to said head, and the pump being also provided with means for conducting the escaping fluid from said valve to the admission side of the pump.

10. The combination with an air or gas pump having a passage from its delivery side to its admission side, of a valve in said passage, a service-pipe leading from said delivery side and having a remote discharge portion, and means for enabling said valve to be controlled by the pressure of the fluid either immediately at the delivery side of the pump or at said remote discharge portion of the service-pipe at will.

11. The combination with an air or gas pump having a passage from its delivery side to its admission side, of a valve in said passage, a head, a diaphragm in said head and connected to said valve, a service-pipe leading from said delivery side and having a remote discharging portion, a valved connection leading from the discharging portion of said service-pipe to said head, and a valved passage directly from the delivery side of the pump to said head.

GEORGE MACHLET, JR.

Witnesses:
PHILIP C. OSTERMAN,
GEORGE L. HIRTZEL, Jr.