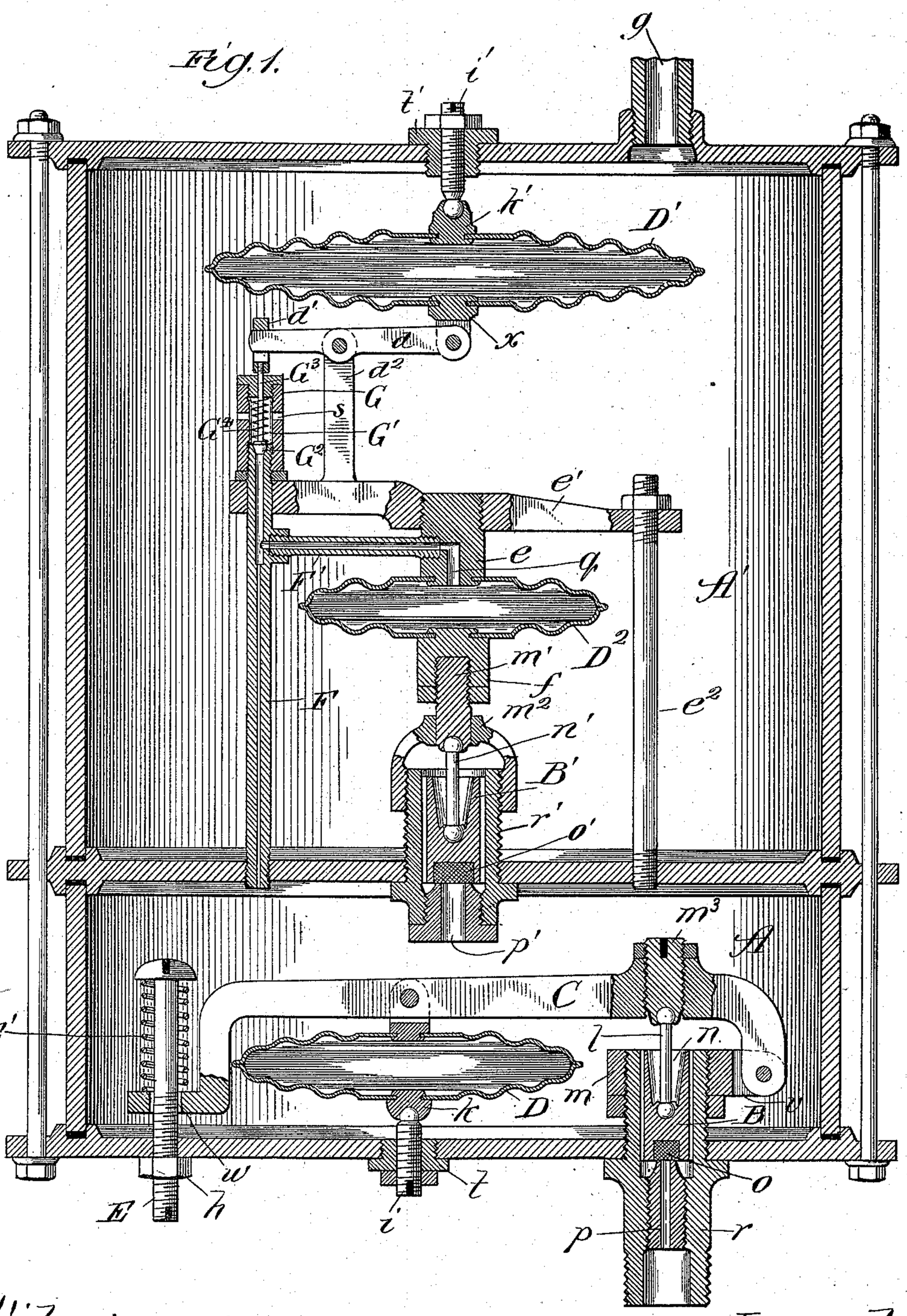
(No Model.) 2 Sheets—Sheet 1.

H. F. FULLER.

FLUID PRESSURE REDUCING APPARATUS.

No. 573,213. Patented Dec. 15, 1896.

Fig. 1.



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(No Model.) 2 Sheets—Sheet 2.

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FLUID PRESSURE REDUCING APPARATUS.

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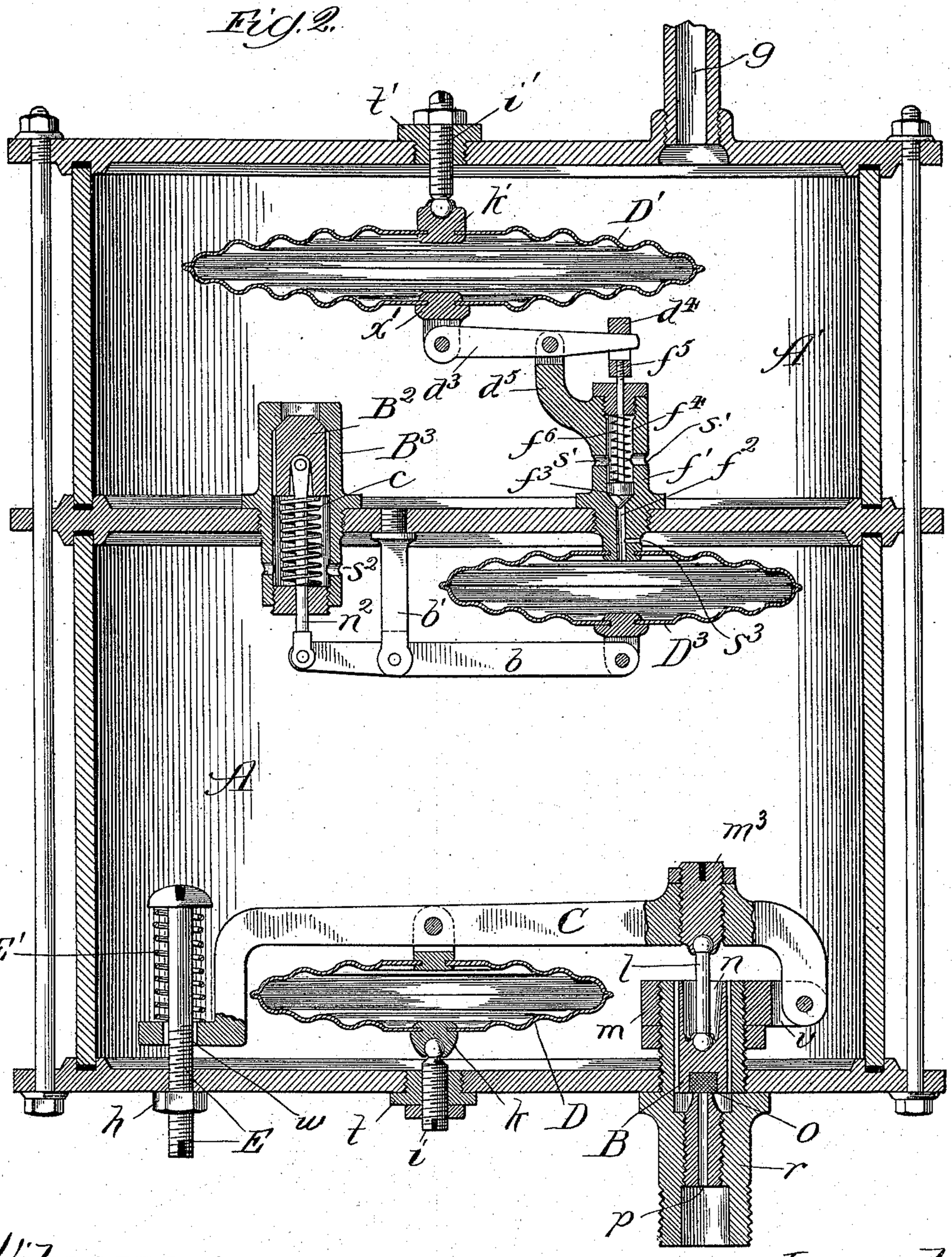
Fig. 2.



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UNITED STATES PATENT OFFICE.

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FLUID-PRESSURE-REDUCING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 573,213, dated December 15, 1896.

Application filed June 12, 1896. Serial No. 595,255. (No model.)

To all whom it may concern:

Be it known that I, HENRY F. FULLER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Fluid-Pressure-Reducing Apparatus, of which the following is a specification.

My invention relates to an improvement in the class of apparatus for automatically reducing the pressure of fluid (gas or liquid) from a high degree at the head or holder to a low pressure at or near the point or points of consumption.

My primary object is to provide such an apparatus which shall reduce the pressure from hundreds of pounds to the square inch at the head to one of a few ounces to the square inch at or near the point of consumption, and there automatically regulate the pressure to a uniform, or practically uniform, degree irrespective of variation in the consumption, and which shall, further, in case of accident, absolutely shut off the supply.

The general plan of construction involved in my improved apparatus adapts it for use in reducing the pressure of any kind of gas or liquid. As it is shown and described herein, however, it is especially intended for reducing the pressure of acetylene gas from the tank in which it is usual to supply that gas to consumers in liquid form under high pressure (six hundred to eight hundred pounds to the square inch) to the supply-pipe leading to the burners and for automatically regulating the reduced pressure to the latter in accordance with variation in the number of burners in use.

In the accompanying drawings, Figure 1 shows my improvement by a view in sectional elevation, and Fig. 2 is a similar view of a modified construction.

A is a chamber of circular or other shape and which, by the use it subserves in my improved apparatus, affords a pressure-chamber. In an opening in the base of the chamber A is inserted a nipple *r* for connecting the chamber with the holder containing the head of pressure to be reduced—in the present instance a tank of liquid acetylene (not shown) at a pressure of, say, six hundred to eight hundred pounds to the square inch. The nipple *r* contains the inlet *p*, the upper end of which affords a seat for a valve B, shown as a solid cylindrical body loosely confined in the chamber formed in that portion of the nipple which projects into the pressure-chamber, the lower end of the valve having let into it a plug *o*, of vulcanite fiber or the like, to afford a close fit of the valve against its seat, and the upper end of the valve containing the recess *n*. About the inner externally-threaded end of the nipple *r* is screwed a collar *m*, having projecting from it a lug *v*, to which is fulcrumed at one end a lever C, containing near one end a plug m^3 in the form of a screw to render it adjustable, and connected from its base with the valve B in the recess *n* thereof by a rod *l*.

D is a hollow close-chambered diaphragm formed, by preference, of sheet metal corrugated to increase the elasticity of the diaphragm, which is pivotally connected at or near the center of its upper wall with the lever C between the ends of the latter and at a head *k* on its lower wall, with a plug *i* entering the chamber A through a bushing *l* in its base, and formed as a screw for readily raising and lowering it to adjust the tension of the hollow diaphragm. The end of the lever opposite that at which it is fulcrumed, where it may be bent, as shown, contains an eye *w*, through which passes a headed screw-stem E, working in the base of the pressure-chamber, below which it carries a nut *h*, and between the lever and the head of the screw-stem is confined about the latter a spiral spring E′.

The foregoing describes the mechanism of the primary chamber in my improved apparatus, and its operation is as follows: With the hollow diaphragm set to resist collapsion up to a given pressure (say ten pounds to the square inch) in the chamber A, which setting of the diaphragm may be adjusted at the plug *i*, or by inflating it and maintaining it inflated to or above normal atmospheric pressure, or by both, and by also, if desired, supplementing it by suitably setting the tension of the spring E′, and with the apparatus coupled at the nipple *r* with the head of pressure (say a tank of liquid acetylene under high pressure, as hereinbefore suggested,) the valve B will be open and will remain open to admit gas

from the tank into the chamber A until the pressure in the latter reaches the predetermined point, (say ten pounds, as aforesaid,) when the pressure will collapse the diaphragm sufficiently to close the valve B against its seat by pulling down the lever and shut off the supply. If the gas in the chamber A be led off immediately to one or more points of consumption (say burners) as the pressure is reduced by the consumption, the expansion of the hollow diaphragm will effect opening of the valve to replenish the pressure-supply in the pressure-chamber.

By the use of the flexible valve-lever controlling hollow diaphragm inclosed in a pressure-chamber, in which it is subjected to equal pressure against both its walls, the lower fastened wall, being immovable relatively to the opposite wall, causes the latter to move about twice the extent by a given pressure against both, thus rendering the action of the diaphragm more delicate. Moreover, if the hollow diaphragm should become punctured the fluid-pressure in the surrounding chamber A would equalize with that in the diaphragm-chamber, and if the diaphragm be normally inflated beyond the predetermined or normal degree of pressure in the chamber A its consequent collapse by the equalization of pressure will close the valve which the diaphragm controls.

It is highly desirable, however, to supplement the action of the hollow diaphragm with that of the regulable spring E′, since the latter affords safety, for if the diaphragm shall burst or fail for any reason to act and thus nullify its resistance against the lever C the spring will cause the diaphragm to close the valve. Then the spring prevents vibration of the diaphragm in its adjustment under the variations of pressure in the surrounding pressure-chamber, and besides the spring renders possible the use of a smaller and more flexible, and therefore more sensitive, hollow diaphragm, thus saving space, because it supplements the surrounding pressure against the diaphragm to close the valve.

I provide a chamber containing secondary reducing mechanism, which, though it may be used alone (that is, without the chamber A and the reducing mechanism therein) to advantage for connection with the head of pressure to be reduced, affords the best results, especially for a large range of variation in the consumption, in connection with the chamber A and its contained mechanism. One form of the secondary reducing mechanism referred to is illustrated in Fig. 1, and following is a description thereof.

Above the chamber A is a second chamber A′, having an outlet g or supply-pipe leading to the point or points of gas consumption (burners not shown) and an inlet p' communicating controllably with the lower chamber. This inlet is shown to be formed like the inlet p in a nipple r', containing a valve B′, having a plug o' let into its base, all constructed like the corresponding parts in the chamber A, already described. On a screw-stem m', slidingly supported in a perforated cap m^2, surrounding the nipple r', and which is connected by a rod n' with the valve B′, is fastened, preferably by screwing, a head f, between which and a head e, supported immediately above it to depend from a cross-bar e', carried by a post e^2 and a tube F, (hereinafter described,) is a hollow or chambered diaphragm D^2, like the diaphragm D. The tube F forms another outlet from the pressure-chamber A, and it has a branch F′, leading into the diaphragm D^2 through a port q in the head e. At its upper end the tube F enters a valve-chamber G′ in a cylinder G, closed at its upper end and provided with outlets s, below which is supported in the valve-chamber, to seat against the upper end of the enlarged section of the passage through the tube F, a valve G^2 on a stem G^3, about which is confined against the valve a spring G^4. The stem G^3 is connected at its outer end with a slotted head d', engaged by one end of a lever d, fulcrumed between its ends on a post d^2, rising from the cross-bar e'. The opposite end of the lever d carries pivotally a plug x, on which is fastened, at its base or lower wall, a hollow or chambered diaphragm D′, like the diaphragm D, and connected from its upper wall by a head k' with a screw-stem i', like the part i, connected with the diaphragm D, and working in a bushing t' in the top of the chamber A′.

In the secondary pressure-chamber A′ the pressure from the supply is further reduced below that in the primary chamber A to and maintained at the pressure required for feeding the supply-pipe g, say to two ounces to the square inch. This is accomplished as follows: The normal adjustment of the diaphragm D′ is such as to tend to maintain open the valve G^2 against the resistance of its spring, this adjustment being attained through the medium of the regulating-plug i' or through inflating the diaphragm with air, or both, and the normal condition of the diaphragm D^2 is such as to tend to open the valve B′. Fluid-pressure enters the chamber A′ from the chamber A past the valves B′ and G^2 (and it also enters the diaphragm-chamber D^2 through the branch F′ of the tube or by-passage F) until the aforesaid predetermined pressure (two ounces to the square inch) is attained in the secondary pressure-chamber, whereby the resistance of the diaphragm D′ is overcome, causing it to collapse and thereby actuate the lever d to descend at its end in the slotted head d' and permit the spring G^4 to act to close the valve G^2. Meantime the fluid-pressure in the diaphragm D^2 will have attained to the degree thereof in the chamber A, thereby causing expansion of the diaphragm to depress the valve B′ against its seat and also there shut off the supply. In case the pressure in the diaphragm D^2 shall have attained that in the chamber A be-

fore the predetermined degree of pressure in the chamber A′ shall have been attained, so that the valve B′ will thus be prematurely closed, the supply to the secondary pressure-chamber will be had through the tube F until the diaphragm D′ closes the valve G^2.

Whenever the pressure in the secondary chamber falls by consumption below that predetermined therein, the diaphragm D′ will expand to open the valve G^2, past which sufficient of the gas under pressure in the diaphragm D^2 will escape into the chamber A′ to effect, by collapsion of the last-named diaphragm, opening of the valve B′.

The advantage of employing the two pressure-chambers, each with its separate hollow-diaphragm equipment, instead of a single diaphragm in one pressure-chamber is that in the latter case the diaphragm would have to be of too great dimensions to be practical—say a foot or more in diameter—to reduce from six hundred or eight hundred pounds or more down to two ounces or thereabout, and by enabling small diaphragms to be used, in case greatly-excessive pressure, as that of the head (tank) entering by accident the pressure-chambers or either of them, the smaller size of diaphragm will resist it, while the large size might be crushed. Moreover, the small hollow diaphragms (which need not exceed, say, one to three inches in diameter) enable the pressure-chambers to be accordingly small, and the smaller these chambers are the more effectually will the material out of which they are formed resist the excessive pressure referred to, which may accidentally enter them, and besides by this double construction of the reducer no excessive pressure can ever enter the supply-pipe *g*, so that liability to leakage at the burners is practically avoided.

In the modification illustrated in Fig. 2 the construction of the two pressure-chambers A and A′ and of the valve with its lever controlled by the hollow diaphragm and by the supplemental spring device are shown to be precisely the same and to be identified by the same reference-letters as their counterparts in Fig. 1. The diaphragm D′ and its means of adjustment are also the same as described in Fig. 1. The diaphragm D^3, however, which corresponds with the diaphragm D^2 of Fig. 1, is supported in the chamber A from a nipple f', extending through the base of the secondary pressure-chamber and containing an inlet-passage f^2, against the upper end of which there seats a valve f^3 below ports s' in the valve-chamber f^4, formed in the upper portion of the nipple, and the valve is carried by a stem f^5, having confined about it in the valve-chamber a spring f^6, and projecting beyond the closed upper end of the valve-chamber, where the stem carries a slotted head d^4, engaged by one end of a lever d^3, fulcrumed between its ends on an arm d^5, extending from the nipple f', and pivotally connected at its opposite end with the lower wall of the hollow diaphragm D′ at x'. In the lower portion of the nipple f' is provided a port s^3, opening into the inlet f^2 from the chamber A. The valve B^2, which corresponds with the valve B′ of Fig. 1, fits loosely in a valve-chamber B^3, extending through the top of the lower pressure-chamber A and seats against the upper end of the valve-chamber, being given a normal tendency to seat by a spring *c*, confined about the valve-stem n^2, which works through the lower closed end of the valve-chamber, just above which are provided the ports s^2, opening into the chamber A′.

The valve-stem n^2 is connected with the lower wall of the hollow diaphragm D^3 by a lever *b*, fulcrumed between its ends to a post *b′*, depending from the top of the lower pressure-chamber.

With this last-described construction the diaphragm D′ is set to tend normally to open the valve f^3, while in the normal condition of the diaphragm D^3 the spring *c* maintains the valve B^3 closed, as does also the normal tension of the diaphragm. When the predetermined pressure in the secondary pressure-chamber has been attained, it compresses or collapses the diaphragm D′ sufficiently to cause its lever d^3 to free the slotted head d^4 and permit the recoil of the spring f^6 to close the valve f^3, and the fluid-pressure which enters the chamber of the diaphragm D^3 through the port s^3 expands that diaphragm to raise the end of the lever *b*, connected with the stem of the valve B^2, and seat the latter more firmly, being supplemented by the pressure from the chamber A against the valve B^2. When the consumption through the pipe *g* exceeds the supply through the port s^3, the inlet f^2 being of greater diameter than the port, the pressure inside the diaphragm D^3 will be relieved and the pressure against this diaphragm in the chamber A will collapse it, thereby opening the valve B^2 to quickly replenish the chamber A′. In this arrangement of the mechanism when the pressure in the chamber A is at rest it is always equal against both walls of the diaphragm D^3, with the advantage that no damage to the diaphragm can ensue as the result of excessive pressure entering by accident the chamber A.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a pressure-reducer, the combination of a primary pressure-chamber having an inlet equipped with a valve, a flexible diaphragm inclosed in said chamber and affording a close chamber exposed about its exterior to the pressure therein and controllably connected with said valve, a secondary pressure-chamber having an outlet, and an inlet equipped with a valve for controlling communication between the two said chambers, and a flexible diaphragm inclosed in said secondary pressure-chamber under exposure to the pressure therein and connected with said valve in the

secondary chamber to operate it by the movement of said diaphragm, substantially as described.

2. In a pressure-reducer, the combination of a primary pressure-chamber having an inlet equipped with a valve, a hollow flexible diaphragm inclosed in said chamber and affording a close chamber exposed about its exterior to the pressure therein and controllably connected with said valve, a secondary pressure-chamber having an outlet, and an inlet equipped with a valve for controlling communication between the two said chambers, and a hollow flexible diaphragm inclosed in said secondary pressure-chamber under exposure to the pressure therein and connected with said valve in the secondary chamber to operate it by the movement of said diaphragm, substantially as described.

3. In a pressure-reducer, the combination of a primary pressure-chamber having an inlet equipped with a valve, a hollow flexible diaphragm inclosed in said chamber and affording a close chamber exposed about its exterior to the pressure therein, a lever connected with said valve and with the diaphragm to be actuated by its movement to operate the valve, a secondary pressure-chamber having an outlet, and an inlet equipped with a valve for controlling communication between the two said chambers, and a hollow flexible diaphragm inclosed in said secondary pressure-chamber under exposure to the pressure therein and connected with said valve in the secondary chamber to operate it by the movement of said diaphragm, substantially as described.

4. In a pressure-reducer, the combination of a primary pressure-chamber having an inlet equipped with a valve, a hollow flexible diaphragm inclosed in said chamber and affording a close chamber exposed about its exterior to the pressure therein, a lever connected with said valve and with the diaphragm to be actuated by its movement to operate the valve, a supplemental actuating-spring confined against said lever, a secondary pressure-chamber having an outlet and an inlet equipped with a valve for controlling communication between the two said chambers, and a hollow flexible diaphragm inclosed in said secondary pressure-chamber under exposure to the pressure therein and connected with said valve in the secondary chamber to operate it by the movement of said diaphragm, substantially as described.

5. In a pressure-reducer, a pressure-chamber having an outlet and two inlets each equipped with a valve, a hollow flexible diaphragm inclosed in said pressure-chamber, under exposure to the pressure therein and connected with the valve of one of said inlets, and a hollow flexible diaphragm communicating with the other of said inlets, substantially as described.

6. In a pressure-reducer, a pressure-chamber A having an outlet and two inlets, each equipped with a valve, a hollow flexible diaphragm D′ inclosed in said pressure-chamber and connected with the valve of one of said inlets, and a hollow flexible diaphragm D^2 communicating with the inlet controlled by the valve connected with said diaphragm D′ and connected with the valve of said other inlet, substantially as described.

7. In a pressure-reducer, the combination of a primary pressure-chamber having an inlet equipped with a valve, a hollow flexible diaphragm inclosed in said chamber and exposed to the pressure therein, a lever connected with said valve and with the diaghragm to be actuated by its movement to operate the valve, a secondary pressure-chamber having an outlet and two inlets each equipped with a valve, a hollow flexible diaphragm inclosed in said secondary pressure-chamber under exposure to the pressure therein and connected with the valve in one of said inlets, and a third hollow flexible diaphragm communicating with the other of said inlets, substantially as described.

8. In a pressure-reducer, the combination of a primary pressure-chamber having an inlet equipped with a valve, a hollow flexible diaphragm D inclosed in said chamber, a lever connected with said valve and with the diaphragm to be actuated by its movement to operate the valve, a supplemental actuating-spring confined against said lever, a secondary pressure-chamber having an outlet and two inlets each equipped with a valve, a hollow flexible diaphragm D′ inclosed in said secondary pressure-chamber and connected with the valve in one of said inlets, and a third flexible hollow diaphragm D^3 in said primary pressure-chamber, communicating therewith and with the inlet controlled by the valve connected with said diaphragm D′, and connected with the valve of said other inlet, substantially as described.

9. A pressure-reducer comprising, in combination, a primary pressure-chamber A having an inlet equipped with a valve, a hollow flexible diaphragm D inclosed in said chamber, a lever connected with said valve and with the diaphragm to be actuated by its movement to operate the valve, a supplemental actuating-spring confined against said lever, a secondary pressure-chamber A′ having an outlet and two inlets, said inlets being equipped respectively with the spring-valves B^2 and f^3, a hollow flexible diaphragm D′ inclosed in said secondary chamber and having a lever connection with the valve f^3, and a hollow flexible diaphragm D^3 in and communicating with the primary pressure-chamber and with said inlet controlled by the valve f^3 and having a lever connection with the valve B^2, the whole being constructed and arranged to operate, substantially as described.

HENRY F. FULLER.

In presence of—
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R. T. SPENCER.