No. 828,432. PATENTED AUG. 14, 1906.

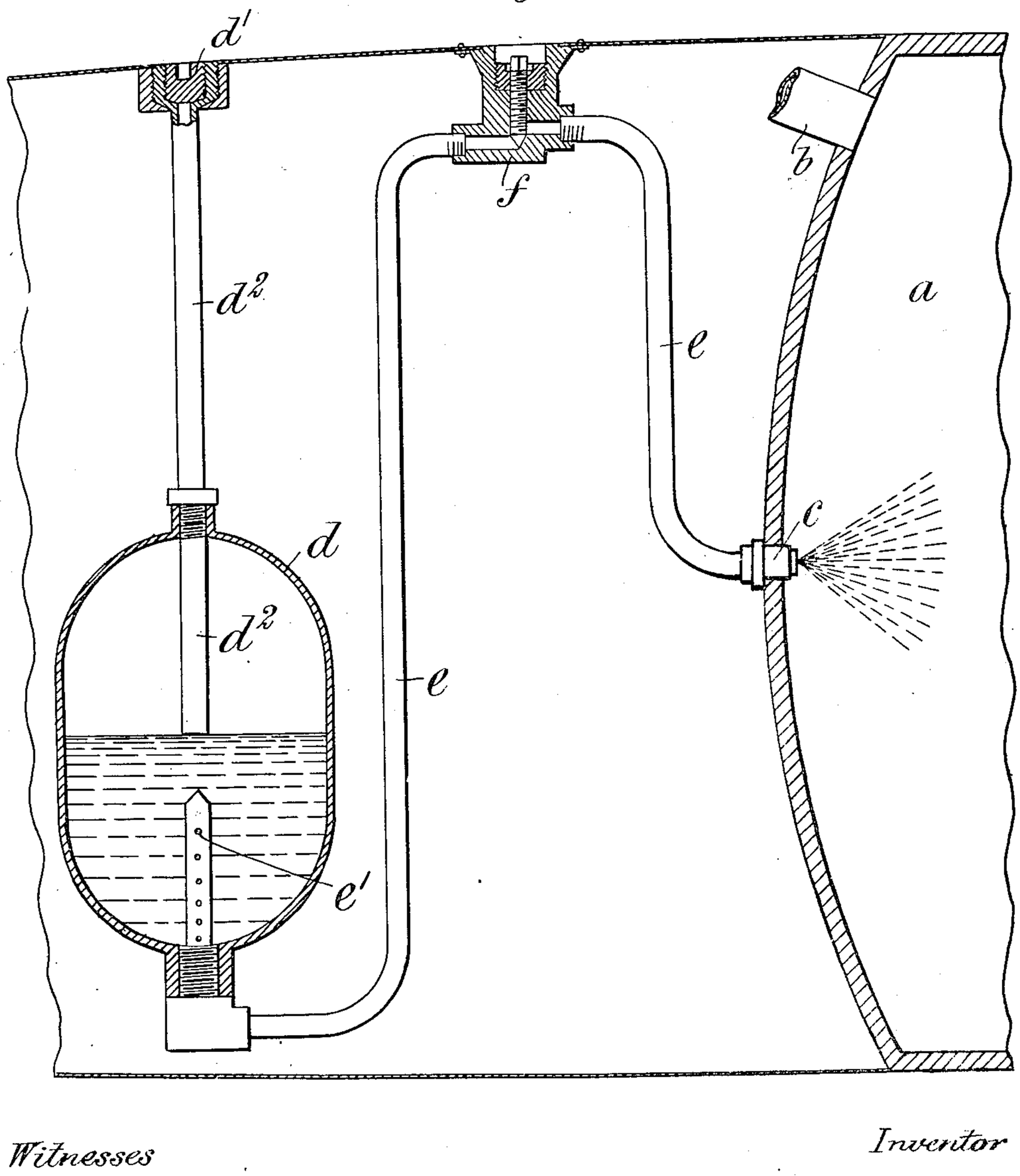
W. H. SODEAU.

MEANS FOR INCREASING THE WORK OBTAINABLE FROM A CHARGE OF COMPRESSED AIR.

APPLICATION FILED MAY 9, 1905.

2 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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2 SHEETS—SHEET 2.

Fig. 2.

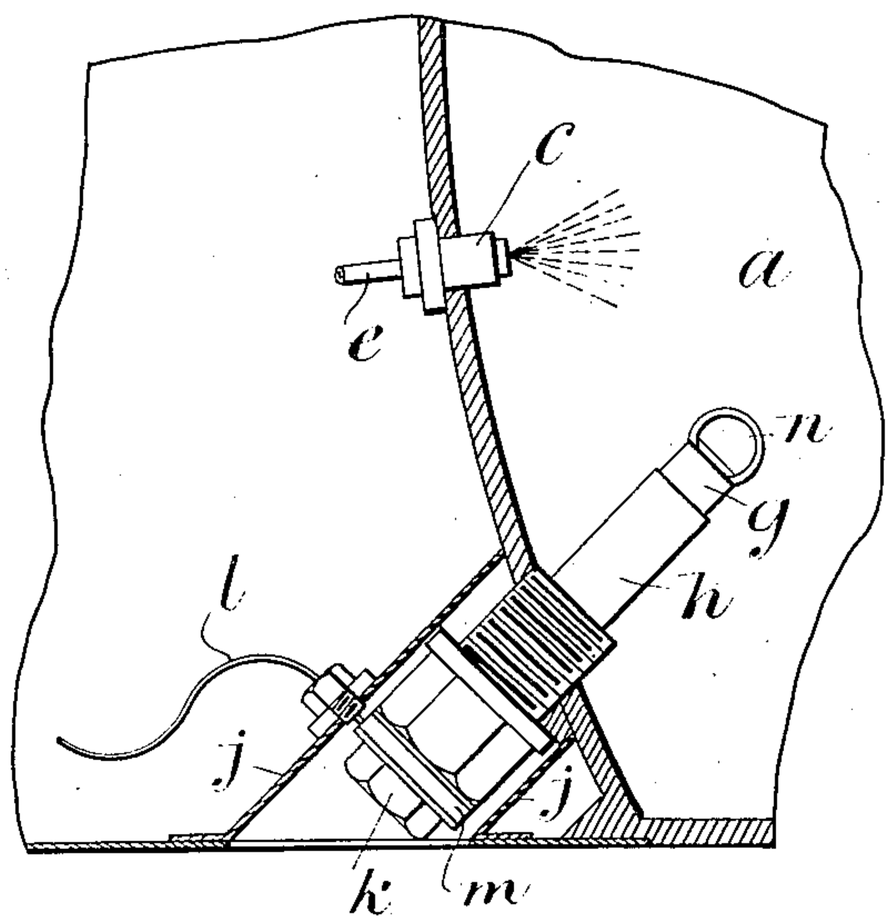
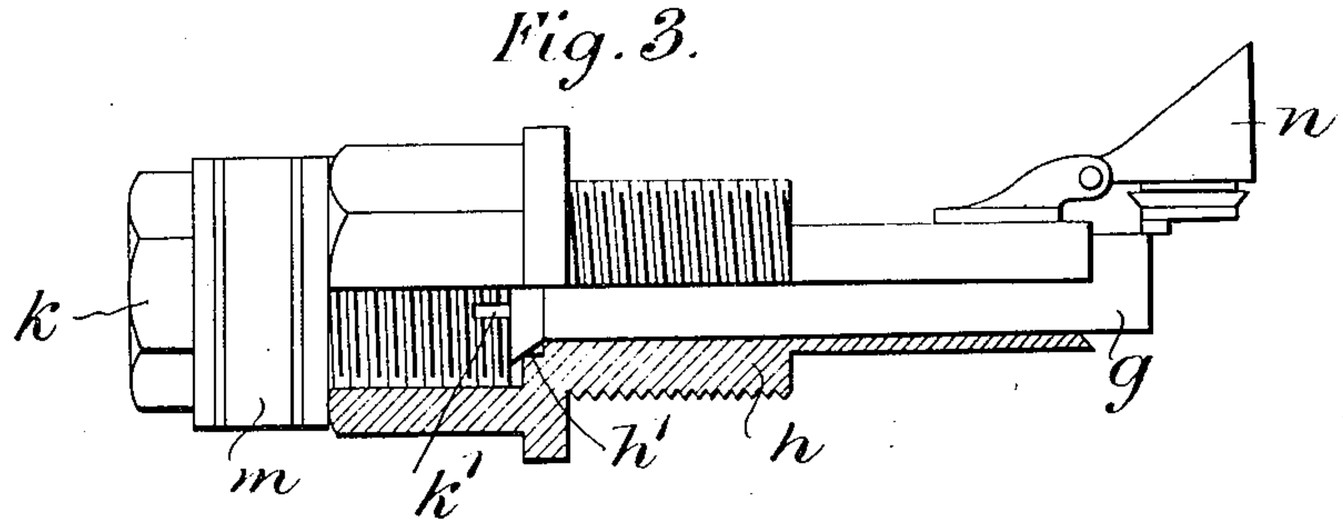


Fig. 3.



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MEANS FOR INCREASING THE WORK OBTAINABLE FROM A CHARGE OF COMPRESSED AIR.

No. 828,432. Specification of Letters Patent. Patented Aug. 14, 1906.

Application filed May 9, 1905. Serial No. 259,581.

To all whom it may concern:

Be it known that I, WILLIAM HORACE SODEAU, engineering chemist, a subject of the King of Great Britain, residing at Elswick Works, Newcastle-upon-Tyne, England, have invented certain new and useful Improvements in or Relating to Means for Increasing the Work Obtainable from a Charge of Compressed Air, more particularly applicable to the propulsion of torpedoes and the like, of which the following is a specification.

This invention relates to improvements in the apparatus described in the United States Patents Nos. 693,871 and 693,872, dated the 25th of February, 1902. According to these patents the amount of work obtainable from a charge of compressed air stored in a reservoir—as, for example, in the reservoir of a Whitehead torpedo—is increased by burning inside the reservoir alcohol, petroleum, or other suitable combustible liquid, so that the temperature of the air is raised and the volume which it will occupy at a given pressure consequently increased.

The invention could of course be applied to a reservoir containing instead of air any other gas or gases capable of supporting combustion.

With a single fuel-reservoir arranged as described in the above-mentioned patents the rate at which the combustible liquid is fed into the air-reservoir, owing to the expansion of the air contained in the upper part of the fuel-reservoir, increases very greatly as the pressure decreases, assuming the pressure to fall at a constant rate. The rate of feed is, in fact, approximately proportional to the square of the reciprocal of the pressure in the air-reservoir. Consequently dangerously-high temperatures are apt to be produced in the later stages if the air-space in the fuel-reservoir is large enough to cause the delivery of combustible liquid to take place at a rate sufficiently great to produce a rapid rise of tempertaure during the early stages of the discharge of the air from the reservoir. Conversely there will at first be a relatively slow rise of temperature if the air-space is proportioned to produce a reasonable temperature toward the termination of the discharge.

According to this invention the progressive feeding of the combustible liquid into the air-reservoir is dependent upon the fall of pressure in the latter. For this purpose I so arrange the pipe connecting the fuel-reservoir with the air-reservoir that instead of being simply connected to the bottom of the former it extends internally throughout the whole or a fair portion of the vertical height of the fuel-reservoir and has two or more openings at different heights, permitting communication between the interior of the pipe and that of the vessel. Appropriate strainers may be provided for the purpose of preventing blockage of these openings. When the level of the combustible liquid has fallen sufficiently to expose one or more of these openings, the air confined in the air-space of the fuel-reservoir will begin to pass through the exposed opening or openings, while the combustible liquid will continue to flow through those openings which remain submerged. The rate of feed will thus be diminished at the moment at which the flow of air commences to take place through one of the openings. The air-space will of course increase to a less extent for a given reduction of pressure than it would have done had no air been allowed to escape from the fuel-reservoir. Consequently the continuance of the discharge from the air-vessel will not increase the rate of feed to the same extent as in the former case. The successive exposure of other openings in the fuel-feed pipe will bring about such checks upon the rate of feed as may be desired.

I arrange the primer or cartridge in such a manner that it can be withdrawn and replaced, if desired, without allowing any large amount of compressed air to escape from the reservoir. I accomplish this by inserting it through a tube provided with a non-return valve opening into the air-reservoir and forced open by the introduction of the primer or cartridge, which is forced into position by means of a screw-plug, which prevents any great leakage from taking place during the short interval between the lifting of the valve and the forcing of the primer or cartridge against the seating prepared for it. The mode of withdrawing the primer or cartridge after firing will be readily understood from the above description of the mode of introducing a fresh one. The above mode of introducing a primer or cartridge can also be employed when a compressed combustible

gas or combustible solid is employed instead of a combustible liquid for heating the compressed air.

Figure 1 is a part longitudinal section of a torpedo constructed according to this invention. Fig. 2 is a local section showing the method of arranging the primer-holder, and Fig. 3 is a sectional elevation showing the details of the latter to a larger scale.

a is the air reservoir or flask from which compressed air is supplied to the engines through the pipe *b*. Combustion may be effected in the dish-like furnace described in the said former specifications; but in the arrangement preferably employed an appropriately-constructed spraying-nozzle *c* passes through the after end of the air-reservoir and is connected to the fuel-reservoir *d* by means of a pipe *e*, interrupted by a valve or cock *f*, which may conveniently be attached to the skin of the torpedo, so as to be operated from the exterior. The pipe *e* communicates with the interior of the fuel-reservoir *d* through two or more holes *e'*. The upper end of the pipe *e* is closed unless one of the holes *e'* is situated thereat. One of these holes should be close to the bottom of the reservoir. The reservoir *d* has a removable cap or filling-plug *d'*, which may conveniently open outside the skin of the torpedo, as shown in Fig. 1, and from which a tube d^2 leads down into *d* to a suitable depth, so that an air-space remains after the combustible liquid has been introduced.

Fig. 2 shows the method of arranging the primer-holder, details of which latter are shown in Fig. 3. The primer *g* is inserted through a holder *h*, which passes through the end of the air-reservoir, preferably in a direction inclined toward the axis of the spraying-nozzle *c*. It is convenient to cut a hole in the skin of the torpedo and attach a watertight partition *j*, connecting the skin with the end of the air-reservoir in such a manner that the primer can be readily inserted from the exterior. When an electric primer is employed, the contact-plug *k* is preferably connected to the firing-switch by means of a spring contact-piece *l*, passing through the partition *j*; but any other appropriate means of connection may be employed, if desired.

Fig. 3 shows one form of the type of primer-holder preferably employed. The primer *g* slides freely into the body *h* of the holder and makes an air-tight joint with it at *h'* owing to the pressure exerted by the plug *k*, which is provided with an insulated wire pressing against the contact-disk of the primer and connected with the insulated band *m*, which in turn makes contact with the electrical contact-piece *l*, connected to a battery or other firing device. The opposite end of the primer-holder is provided with a valved lid *n*, preferably closing by its own weight when the primer is removed and having a stop preventing it from swinging back to an undesirable extent. The valved lid may, however, be furnished with a spring, if desired. In use the primer is placed in the tube and the plug *k* screwed in. After a few turns the end of the primer begins to force *n* open; but no great escape of compressed air takes place, as the head of the primer is forced against the inner end of the plug *k*. The end of the primer finally presses the lid back out of the direct blast of the flash. After firing the primer can be withdrawn by unscrewing the plug *k*, the valved lid *n* closing, so as to prevent any serious escape of compressed air. I sometimes cut a short slot or groove *k'* in the inner portion of the plug *k*, so that the pressure within the primer-holder may be relieved before the thread has been disengaged in the process of withdrawing the primer.

The above-described heating arrangement may be operated in the following manner: After the torpedo has been recovered from a previous run the fired primers are withdrawn and fresh ones inserted, as above described. The valve *f* is closed, plug *d'* removed, and a fresh charge of fuel poured into the reservoir *d* without the necessity of discharging the air remaining in the air-reservoir *a*. The presence of the internal pipe d^2 insures the existence of a definite air-space above the fuel. Meanwhile the air-reservoir *a* may be charged to its working pressure. Before placing the torpedo in the tube the firing device is set and the valve *f* opened, so as to equalize the pressure in *a* and *d*. As soon as the engine is started the pressure in the air-reservoir *a* begins to fall, and in consequence the air in the space in *d* expands, thereby driving combustible liquid through the spraying-nozzle *c*, so that it enters the air-reservoir in a condition suitable for rapid combustion. After an appropriate interval the spray is ignited by the firing of a primer and the fuel burns fiercely in the compressed air, so that hot air is supplied to the engine through the pipe *b*. The rate at which the combustible liquid is fed into the air-reservoir will increase as the air-space becomes larger until the level of the liquid has fallen sufficiently to expose the uppermost of the holes *e'*, when air will pass through the exposed hole; but the combustible liquid continues to flow through those holes which are still submerged. This passage of air through the exposed hole reduces the stream of combustible liquid and obviously also lessens the growth of the air-space, thereby decreasing the rate at which the feed increases. When more than two holes *e'* are provided, the intermediate ones become successively exposed and bring about further checks to the increase of the rate of feed.

What I claim is—

1. The combination of a reservoir for com-

pressed air, a reservoir for fuel, a pipe having one end in the air-reservoir and the other end standing up in the lower part of the fuel-reservoir, the latter end being perforated with two or more holes at different heights, and means for igniting and burning the fuel in the air-reservoir.

2. The combination of a reservoir for compressed air, a reservoir for fuel, a pipe having one end in the air-reservoir and the other end standing up in the lower part of the fuel-reservoir, the latter end being perforated with two or more holes at different heights, a valve on the pipe, and means for igniting and burning the fuel in the air-reservoir.

3. The combination of a reservoir for compressed air, a reservoir for fuel, a pipe having one end in the air-reservoir and the other end standing up in the lower part of the fuel-reservoir, the latter end being perforated with two or more holes at different heights, a spraying-nozzle on the end of the pipe in the air-reservoir, and means for igniting and burning the fuel in the air-reservoir.

4. The combination of a reservoir for compressed air, a reservoir for fuel, a pipe having one end in the air-reservoir and the other end standing up in the lower part of the fuel-reservoir, the latter end being perforated with two or more holes at different heights, a valve on the pipe, a spraying-nozzle on the end of the pipe in the air-reservoir, and means for igniting and burning the fuel in the air-reservoir.

5. The combination of a reservoir for compressed air, a tubular holder fixed to the wall of the reservoir for receiving a primer, a lid hinged to the inner end of the holder, and a plug screwing into its outer end.

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Witnesses:
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