W. J. FRAME.

HYDRAULIC AIR AND OTHER GAS SUCTION APPARATUS.

APPLICATION FILED NOV. 10, 1908.

924,335. Patented June 8, 1909.

Fig. 1.

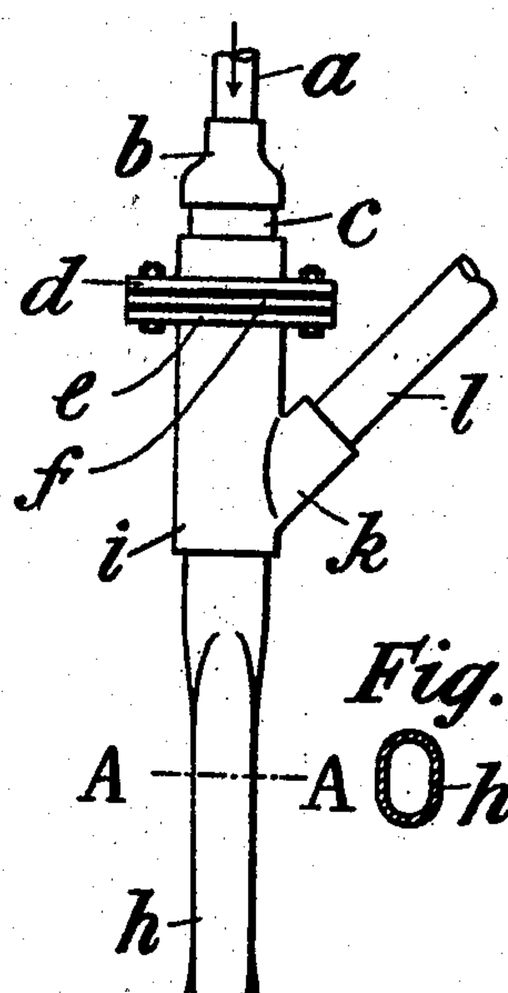


Fig. 2.

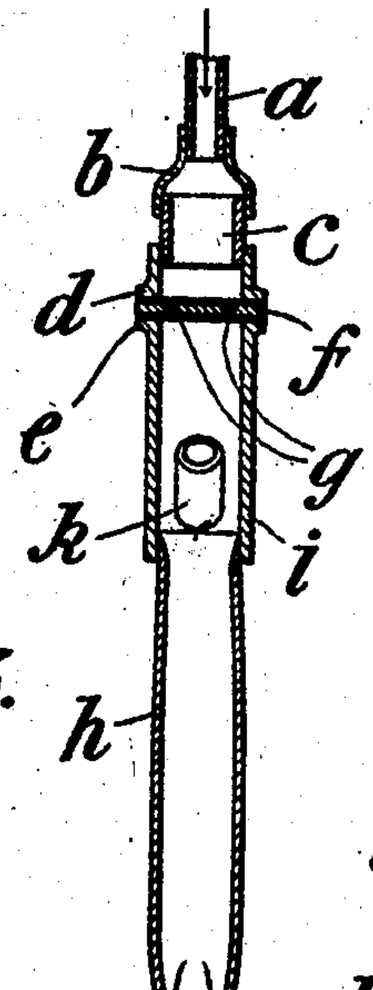


Fig. 3.

Fig. 4.

Fig. 6.

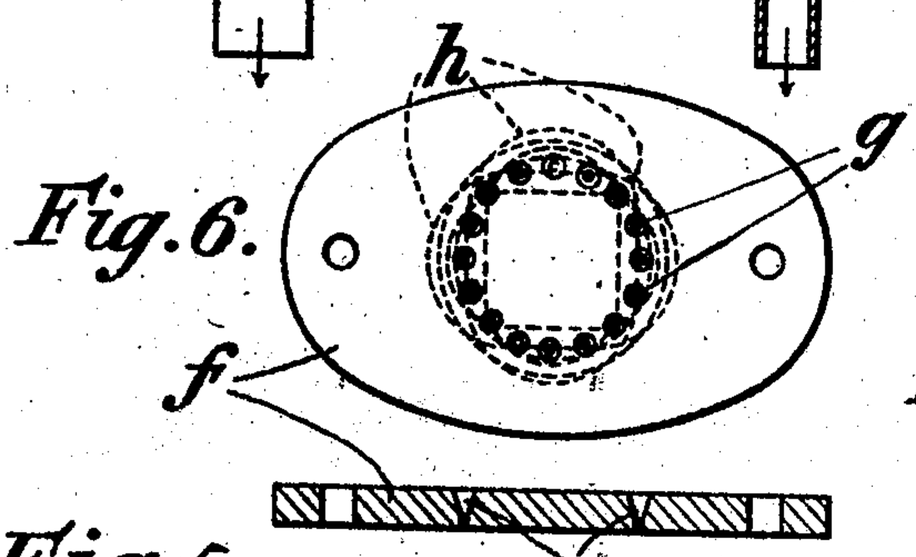
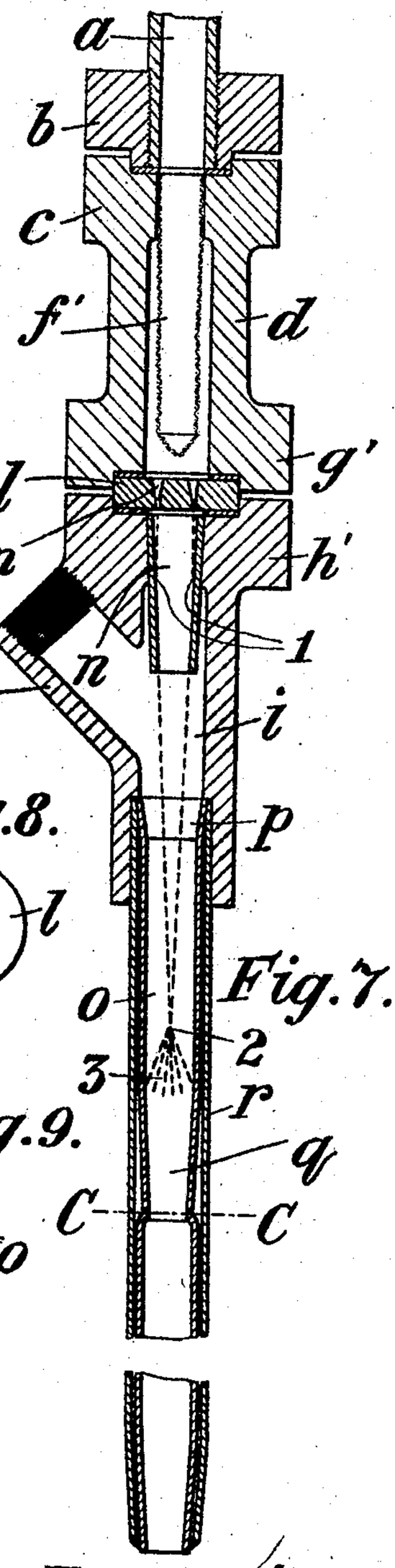


Fig. 5.

Fig. 8.

Fig. 9.

Fig. 7.



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UNITED STATES PATENT OFFICE.

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HYDRAULIC AIR AND OTHER GAS SUCTION APPARATUS.

No. 924,335. Specification of Letters Patent. Patented June 8, 1909.

Application filed November 10, 1908. Serial No. 461,959.

To all whom it may concern:

Be it known that I, WILLIAM JOHNSTON FRAME, a subject of the King of Great Britain, residing at Glasgow, Scotland, have invented certain new and useful Improvements in Hydraulic Air and other Gas Suction Apparatus, of which the following is a specification.

This invention relates to that type of suction apparatus wherein a liquid jet or jets is or are employed as the motive power to create a partial vacuum within the apparatus, and more particularly to apparatus of this type which is used in the so-called vacuum cleaning process. The volumetric efficiency of apparatus of this type hitherto in use is very low, because the working jets of liquid travel down through the combining tube of the apparatus without being finely broken up or diffused among the air which is between these jets and which it is required to carry down through the combining or diffusing tube of the apparatus.

The primary object of this invention is to increase the volumetric efficiency of the hydraulic jet apparatus, another object being to simplify and cheapen the construction of this form of vacuum cleaning apparatus so that it can be readily fitted into domestic and other buildings for cleaning purposes.

The invention consists in applying to a hydraulic jet air and other gas suction apparatus, means for causing the liquid of the jet or jets to impinge upon itself so as to break it up into very small globules or particles which are free to pass and force air or gas down the diffusing tube.

The invention also consists in breaking up the jets of water or other liquid employed, by directing them on to inclined surfaces within the diffusing tube so that they are deflected from said surfaces toward one another, and in coming into contact with one another, are broken up into liquid globules or particles.

In the accompanying drawings, Figures 1 and 2 are respectively a front elevation and a side sectional elevation of one form of hydraulic multiple jet air suction apparatus according to the invention, suitable for creating a partial vacuum capable of being utilized for vacuum cleaning purposes in domestic or other buildings. Figs. 3 and 4 being cross sections on the lines A—A B—B, respectively. Figs. 5 and 6 are respectively a sectional elevation and plan of a perforated plate which may be used to form the jets in a combining or diffusing tube of circular cross section, for instance as shown in Figs. 1 and 2. Fig. 7 is a sectional elevation of another construction of the hydraulic jet suction apparatus. Fig. 8 is a plan view of the perforated plate *l*. Fig. 9 is a cross section on the line C—C Fig. 7.

In carrying out the invention according to one mode, as for instance illustrated in Figs. 1 to 6, water from the ordinary supply main is led into a supply tube *a*, connected by an adapter *b*, and short piece of tube *c*, to a flange *d*. Between this flange and another *e*, is inserted a plate *f* which is provided with a series of perforations *g*. The arrangement of these perforations is varied according to the form of combining or diffusing tube employed. In the example illustrated, a diffusing tube *h*, of circular cross section is used and, consequently, the perforations *g*, are arranged in a circular series as clearly shown in Figs. 5 and 6 the perforations being arranged comparatively close to the inner cylindrical surface of the tube so that as the jets descend therein, they will travel downwardly for some distance quite close to the inner surface of the tube. The flange *e* is preferably cast in one with a sleeve *i*, provided with a branch *k* to which the air suction inlet pipe *l* is connected.

In order to break up the jets into small globules or particles for the purpose hereinbefore set forth, the combining or diffusing tube *h*, is provided with a number of deflecting surfaces upon which the jets strike and are then deflected so that they are thrown together or sprayed against each other, and are thereby broken up. These surfaces are preferably so arranged that the jets, after striking are deflected together in the form of a V and they may be conveniently formed by indenting the tube, as indicated for instance, in Figs. 2 and 3 and at the section lines A—A, and B—B. By thus indenting the tube, the jets are deflected by the indentations toward the center of the tube, where they come into contact with one another and are thereby broken up into small globules or particles, the water being thus thoroughly diffused among the air, and the particles positively driving the air which is in front of them down the tube. The indentations are preferably arranged opposite to one another in the tube but this arrangement is not necessary as the indentation on one side may be

lower than that on the other. Obviously, one or more pairs of indentations may be employed and it is preferred, when more than one pair is used, to arrange the succeeding pairs at such angles to the preceding as to insure that all the jets will be deflected. Four indentations may be arranged on the same level thus forming a tube of square cross section at this point, but any number of indentations may be so arranged at the same level so that any other polygonal, or even circular cross section, is formed, that is to say, in the last case mentioned, the deflecting surfaces may be in the form of cones formed in the combining tube or inserted therein.

As before stated, the series of perforations in the plate *f* is arranged to conform to the shape of the diffusing tube. Obviously, when a tube of oval, square or other cross section than circular is employed, the series of perforations are arranged to correspond. In Figs. 5 and 6 a circular series of perforations is shown suitable for the tube of circular cross section shown in Figs. 1 and 2, the circular cross section of this tube *h* being indicated in dotted circles in Fig. 6 and the oval forms, due to the indentations, being indicated also in dotted lines in the same figure. The actual form and size of the perforations may be varied as desired.

Although the perforations in the example referred to have been shown and described as near the inner surface of the diffusing tube and conforming to the latter, additional perforations may be made inside the circular series. When the pressure of the water supply is low beveled slots may be made in the plate *f*, instead of the circular perforations shown, these slots always being arranged with regard to the form of diffusing tube used so that as large a volume as possible of the liquid forming the vertical jets will receive an inclined flow, while passing down through the contractions formed by the indentations in the diffusing tube used.

In practice it has been found extremely difficult, especially when working with water at high pressure, to so make the small jet orifices that the water issuing therefrom will strike the deflecting surfaces, in such manner that the jets will thereafter accurately impinge upon one another and be thoroughly broken up and diffused. In order to overcome this difficulty and also to insure a better spread and diffusion of the water particles I arrange, in proximity to the jet orifices or nozzles, a hollow water deflecting and directing device, preferably a short hollow cone or the equivalent thereof, and for the purpose of repeatedly deflecting and combining or concentrating the traveling mass of air and water as it passes through the diffusing or combining tube I arrange, at intervals therein, a number of conic indentations or contractions or hollow cones. There may according to the pressure and quantity of water used and to the vacuum or suction desired, be two, four, or as many as eight or nine of these conic contractions in the combining tube. In this second case water or other suitable liquid, from any convenient source of supply, is led to a tube *a* (see Figs. 7 to 9) which may be screwed to a flange *b* which latter is bolted or otherwise fastened to a flange *c* on a casing *d* provided, at its lower end, with a flange *g'* which latter is bolted or otherwise secured to the flange *h'* of the suction chamber *i*. In the casing *d* I preferably arrange a gauze filter *f'* which prevents particles being carried by the water and choking the nozzles. Fitted between the flanges *g'* and *h'* is a disk *l* which is suitably packed and has orifices *m* for producing the water jets. As shown the two orifices *m* are tapered at their inlet side and are in line. Fitted in the flange *h* of the suction chamber *i* is a short hollow deflecting and directing cone *n*, the upper end of this cone being somewhat larger in diameter than the distance apart of the jet orifice *m* while the lower part thereof is of slightly smaller diameter than the distance apart of these jet orifices so that the water as it issues from the two orifices *m* strikes against the cone at opposite sides thereof and the jets spread out more or less toward one another taking the curve of and being deflected and directed downward by the cone to the point where it is desired that the jets should impinge upon one another (see dotted lines) and by their impact be finely broken up or atomized and, at the same time, be spread more or less completely over the whole bore of the tube. The suction chamber *i* has a branch *k* through which the air or gas or vapor being drawn or extracted is sucked by the action of the said jets. Inserted into the lower end of the suction chamber is a pipe *r* within which is inserted a combining tube *o* which, as shown, is cylindrical for a certain part of its length and is then indented into a conical form thus forming a conic contraction at *q* and is then enlarged again to its original diameter and thereafter again contracted to form a second cone and so on, the conic contractions being arranged in the pipe *o* at suitable intervals and to the number desired.

If so desired instead of using a tube *o* with conic indentations or contractions made therein, I may fit hollow cones, at suitable intervals apart, into a cylindrical combining tube.

The tube *o* which is preferably made, at its upper end, with a coned inlet *p* may be made of copper or other non-corrodible material and is fitted air tight within its outer protecting tube *r* which latter may be made of steel. The number of conic indentations or contractions in the tube *o* and the length of

said tube can be increased or diminished to suit the pressure and quantity of water passing through the apparatus, and the vacuum required. With this form of apparatus the water jets issuing from the orifice *m* strike the deflecting cone *n* at about 1 and are spread out and, especially when water at high pressure is used, broken up to a certain extent, and are then deflected and directed by the cone *n* so that the liquid of the jets impinges upon itself in the tube *o*, at about the point 2, the water being completely broken up into a fine spray 3 which spreads over the bore of the tube and is intimately mixed with and diffused through the air therein.

The conic contractions *q* or indentations in tube *o* direct the moving and homogeneous mass of water and air toward the center of the tube and not only insures that the same shall, when passing the contraction, be concentrated and, at the same time, fill up the bore of the tube completely and so prevent back rush of air from outside, but, causes any water which may get on to the surface of the tube to be thrown back into the center thereof thereby reducing skin friction between the water and the inner surface of the tube. Any number of perforations may be made in the plate *l* and some of the number may be bored so that the jets issuing therefrom do not strike the cone *n;* say for example that a third perforation is bored in plate *l* at its center, the jet of water issuing from this central perforation will be broken up by the other two deflected jets impinging on it.

Having now fully described my invention what I claim and desire to secure by Letters Patent is:—

1. An hydraulic-jet suction apparatus comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, means for causing the liquid of the jets to impinge and be finely broken up and means for the admission of air or gas to the device between the point where the water is broken up into jets and the point where the water jets impinge.

2. An hydraulic-jet suction apparatus comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, means for causing the liquid of the jets to impinge and be finely broken up, means for the admission of air or gas to the device and converging means for concentrating and combining the water and air or gas.

3. An hydraulic-jet suction apparatus comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, means for causing the liquid of the jets to impinge and be finely broken up, means for the admission of air or gas to the device and an inclined surface for deflecting the water and air or gas.

4. An hydraulic-jet suction apparatus comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, means for causing the liquid of the jets to impinge and be finely broken up, means for the admission of air or gas to the device and converging means for repeatedly concentrating and combining the water and air or gas.

5. An hydraulic-jet suction apparatus comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, means for causing the liquid of the jets to impinge and be finely broken up, means for the admission of air or gas to the device and inclined surfaces for repeatedly deflecting the water and air or gas.

6. An hydraulic-jet suction apparatus comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, means for causing the liquid of the jets to impinge and be finely broken up, means for the admission of air or gas to the device and inclined surfaces for deflecting and combining the water and air or gas.

7. An hydraulic-jet suction apparatus comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, means for causing the liquid of the jets to impinge and be finely broken up, means for the admission of air or gas to the device and a series of converging surfaces for repeatedly deflecting and combining water and air or gas.

8. An hydraulic-jet suction apparatus comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, an inclined surface for directing and deflecting the water jets so that they impinge, means for admission of air or gas, a converging combining tube having deflecting and combining surfaces therein.

9. An hydraulic-jet suction apparatus, comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, means for directing and deflecting the water jets so that they impinge, means for admission of air or gas, a converging combining tube and a conic contraction in said tube.

10. An hydraulic-jet suction apparatus, comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, means for directing and deflecting the water jets so that they impinge, means for admission of air or gas, a converging com-

bining tube and a conic contraction followed by an abrupt enlargement in said tube.

11. An hydraulic-jet suction apparatus, comprising, in combination, a device to which water is supplied, means in the perforated plate for breaking up the water into two or more jets, a cone in proximity to said plate, an air or gas suction chamber, a combining tube and means in the tube for combining and concentrating the air or gas and water and also deflecting the same so that the particles of water impinge upon themselves.

12. An hydraulic-jet suction apparatus, comprising, in combination, a device to which water is supplied, a perforated plate in the device for breaking up the water into two or more jets, a converging cone in proximity to said plate, an air or gas suction chamber, a combining tube and inclined surfaces in the tube for repeatedly combining and concentrating the mixture of air or gas and water and also deflecting the same so that the particles of water impinge upon themselves.

13. An hydraulic-jet suction apparatus, comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into two or more jets, a deflecting cone in proximity to said means, a suction chamber with air or gas inlet branch a combining tube fitted in said chamber said combining tube being contracted at intervals to form conic deflecting and combining surfaces.

14. An hydraulic-jet suction apparatus, comprising, in combination, a chamber to which water is supplied, a perforated plate at one end of said chamber, a suction chamber with air or gas inlet, a deflecting cone at one end of said chamber, a combining tube fitted in the chamber and having a series of conic contractions therein at intervals.

15. An hydraulic-jet suction apparatus, comprising, in combination, a cylindrical chamber to which water is supplied, a flat perforated plate at one end of said chamber, a cylindrical suction chamber with air or gas inlet, a jet deflecting cone at one end of said chamber, a combining tube fitted in the chamber and having a series of conic contractions therein at intervals and a protecting tube outside said combining tube.

16. An hydraulic-jet suction apparatus, comprising, in combination, a chamber to which water is supplied, a perforated plate at one end of said chamber, a suction chamber with air or gas inlet, a jet deflecting cone at one end of said chamber, a combining tube fitted in the chamber and having a series of conic contractions indented therein at intervals.

17. An hydraulic-jet suction apparatus, comprising, in combination, a device to which water is supplied, means in the device for breaking up the water into jets, means for admission of air or gas, a combining tube and a series of contractions indented in said tube.

In testimony whereof I affix my signature in presence of two witnesses.

WILLIAM JOHNSTON FRAME.

Witnesses:

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MARGARET F. YOUNG.