

R. SUCZEK.
EJECTOR APPARATUS.

APPLICATION FILED FEB. 9, 1916. RENEWED JAN. 31, 1919.

1,296,567.

Patented Mar. 4, 1919.

2 SHEETS—SHEET 1.

FIG. 1.

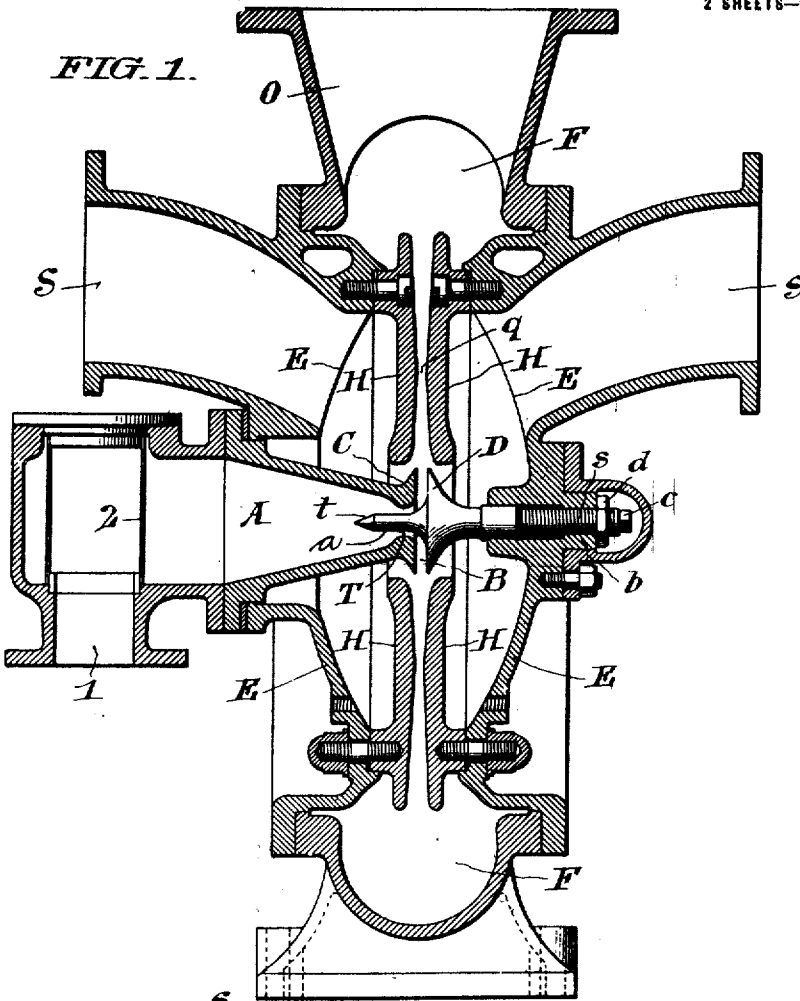
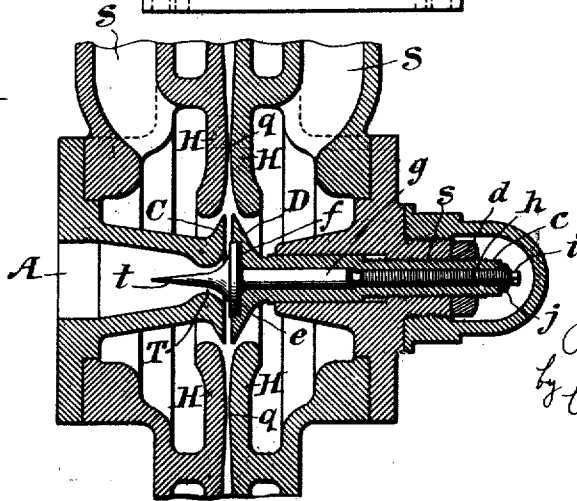


FIG. 2.



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2 SHEETS--SHEET 2.

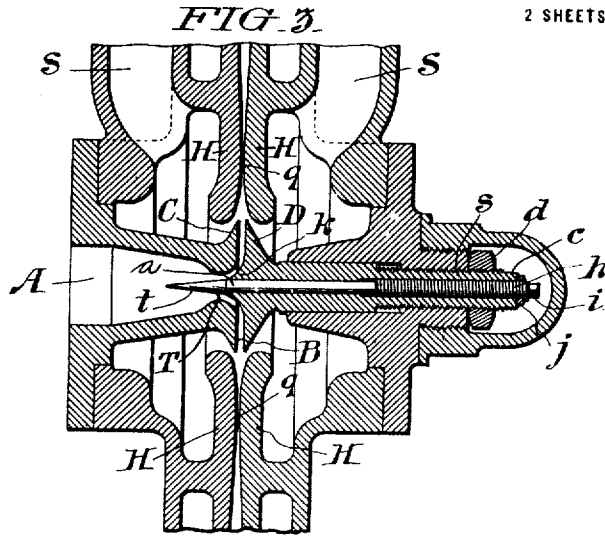
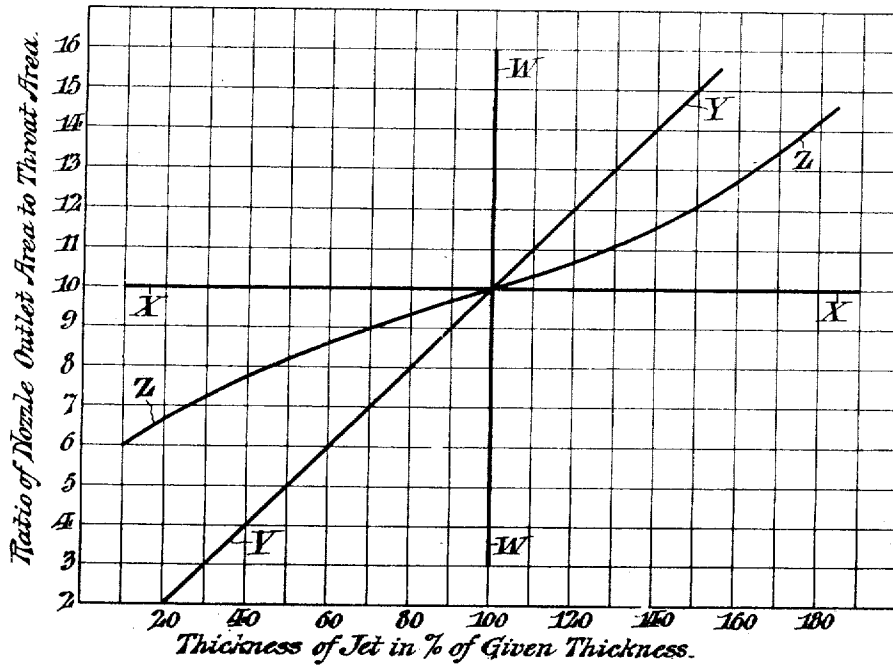


FIG. 4.



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EJECTOR APPARATUS.

1,296,567.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, ROBERT SUCZEK, a subject of the Emperor of Austria-Hungary, residing in the city of Philadelphia, county of Philadelphia, and State of Pennsylvania, have invented certain new and useful Improvements in Ejector Apparatus, of which the following is a specification.

My invention relates to ejector apparatus wherein elastic motive fluid is employed to entrain and raise to higher pressure other elastic fluid, as gas, vapors, etc., particularly such as are withdrawn from a steam condenser at pressure below atmospheric and raised to higher pressure.

My invention relates more particularly to ejector apparatus comprising annular or similar nozzle structure for producing a motive fluid jet in the form of a thin sheet, either as a substantially flat disk or conical, cooperating with an annular diffuser, the motive fluid jet entraining the elastic fluid to be compressed, and the mixture being raised in pressure by loss of velocity in the diffuser.

My invention resides in nozzle structure for a combination of the character above described wherein the throat of the motive fluid nozzle is formed wholly within one of the nozzle members between which the nozzle passage is formed, with a member or projection on the other nozzle member projecting into or through the throat, such member having constant cross section through a considerable portion of its length, whereby notwithstanding adjustment of the nozzle members to and from each other the effective throat area remains constant, and therefore effects constant steam consumption with varying ratio of expansion in the nozzle and varying lateral area or entrainment surface of the jet.

My invention resides also in nozzle structure wherein the nozzle members are adjustable as to their spacing from each other, and a member or projection adapted to extend into or through the throat in one member is carried and is adjustable with respect to the other nozzle member, whereby not only may the throat area be adjusted, but the ratio of expansion is variable, as is also the extent of entrainment surface and thickness of the jet.

For an illustration of some of the various forms my invention may take, reference is to be had to the accompanying drawing, in which:

Figure 1 is a cross sectional view, some parts in elevation, of ejector apparatus embodying my invention.

Fig. 2 is a fragmentary cross sectional view of a form of apparatus embodying my invention wherein the nozzle members are adjustable with respect to each other, and in addition, a member carried by one of those nozzle members is adjustable with respect thereto and with respect to the throat in the other member.

Fig. 3 is a fragmentary cross sectional view of a modification of Fig. 2.

Fig. 4 is a graphic representation illustrative of character of relations between ratio of nozzle outlet area to throat area and thickness of the jet at the outlet of the nozzle.

Referring to Fig. 1, live or exhaust steam, or other elastic motive fluid of suitable character and pressure, as compressed air or gas, is delivered from a source thereof, not shown, through the inlet 1 and through the strainer 2 into the passage A to the throat T disposed wholly within one of the circular disks or nozzle members C between which and the associated circular nozzle disk or member D is the annular nozzle passage B, from which issues a jet of motive fluid directed into the diffuser passage formed between the diffuser walls H, H, said passage having a throat at *g* and delivering into the circumferentially extending discharge passage F having the outlet O. The nozzle structure and the diffuser are disposed within the casing E with which communicate the suction inlets S, S communicating with a condenser or separate condensers, or in general with the space or spaces from which the elastic fluid, as air or uncondensable vapors, is to be removed, so as to maintain therein a suitably high vacuum.

Secured to or integral with the circular nozzle member D is the central projection *t* extending completely through the throat T into the passage A, when the nozzle member D is adjusted to the position indicated. For a considerable portion of its length this projection *t* has, as indicated at *a*, a uniform

diameter, whereby it has a constant cross section, of circular or other shape, for a considerable portion of its length. The projection t may terminate in any suitably shaped point.

With this construction the diameter of the throat T may be made larger for a given steam consumption than would be the case were this projection t omitted or too short to extend into the throat. Furthermore, with the throat diameter so enlarged for a given effective throat area, and therefore a given steam consumption, the distance from the outer border of the throat to the periphery of the members C and D , namely the outlet of the nozzle, is slightly shortened.

The nozzle member D is adjustable toward and away from the companion nozzle or disk C in virtue of the screw threads s on the stem of the member D engaging in the boss b on the casing E . The end of the stem is squared or otherwise formed as indicated at c , for the application of a wrench, whereby upon turning the stem the member D is screwed toward or away from the member C . It may be locked in any adjusted position by the lock nut d .

By adjusting the member D as described, the width of the nozzle passage B is varied, and therefore the thickness of the jet issuing therefrom; and the ratio of expansion within the nozzle C, D is also varied by such adjustment, as is also the area of the nozzle outlet. The change in thickness of the jet changes the extent of the lateral surfaces thereof, namely, the entraining surfaces, because of the tapering of the diffuser passage. With these adjustments of the member D , however, within reasonably wide range, the area of the throat is not changed, and therefore the steam consumption remains substantially constant, so long as the portion a of the projection t is within the throat T .

The steam or other motive fluid delivered to the nozzle issues therefrom in a jet in whose lateral surfaces between the periphery of the nozzle and the diffuser walls is entrained the elastic fluid delivered to both sides of the jet through the suction orifices S, S . The mixture is delivered at high velocity into the diffuser passage, where it loses its velocity and gains in pressure and is delivered into the discharge passage and through the discharge opening at higher pressure. For example, the apparatus may be used for withdrawing air or uncondensable vapors from a steam condenser for maintaining therein a vacuum of suitable degree.

In Fig. 2 the projection t , which extends into or through the throat T , increases in cross section from its free end to its base at the disk e movable in a recess f in the face of the nozzle member D . The disk e is se-

cured to or integral with the stem g , which extends through the stem of the nozzle member D and is screw threaded therein, as indicated by the threads h , and terminates in a square or other suitably shaped part i , whereby it may be turned by a wrench and thereby adjust the projection t with respect to the nozzle member D . A nut j locks the stem g in adjusted position with respect to the stem of the nozzle member D which, as in Fig. 1, is itself adjustable by the screw threads s .

By this construction the nozzle member D may be adjusted to any suitable or desired position with respect to the nozzle member C , thereby varying the ratio of expansion in the nozzle, the thickness of the jet, and therefore its length before impact with the walls of the diffuser H , and therefore the extent of the lateral entraining surfaces of the jet. And for any position of the nozzle member D the projection t may be adjusted to any desirable distance into the throat T to vary the effective throat area and therefore the steam consumption. In other words, with a given thickness of jet, determined by the distance of the members C and D from each other, the throat area may be adjusted and therefore the steam consumption varied, at a given steam pressure. And where the steam pressure varies, the steam consumption may nevertheless be maintained constant by adjusting the projection t , and yet obtain any desired thickness of jet by adjustment of the member D .

In Fig. 3 the arrangement is similar to that of Fig. 2 in that the projection t is again adjustable with respect to the adjustable nozzle member D . In this case, however, the nozzle member D is curved approximately its center, as indicated at k , to form a curved projection or boss through the center of which the projection t is adjustable. As shown, the outer end of the projection t is conical, and this part thereof may be used for varying the throat area, for any given position of the nozzle member D ; or by adjusting the projection t further to the left, the portion a of constant cross section will be brought into the throat T so that a constant throat area may be maintained with different positions of the member D .

In Fig. 4 there are shown four plots, the ordinates being ratios of nozzle outlet area to throat area, the nozzle outlet area being found by multiplying the width of the nozzle passage B at the periphery of the members C and D by the circumference of either of the member D or C ; and the abscissae are thicknesses of jet at outlet of the nozzle, that is, widths of the nozzle passage B at its outlet, in per cent. of a given jet thickness.

The plot or curve W , in this case a straight line, represents at 100% jet thickness that

the jet thickness is constant but that the ratios of nozzle outlet area to throat area vary from 2 to 16.

This plot W, or a plot similar to it, represents the case where with a given desired jet thickness, as determined by a given setting of the nozzle member D, the throat area is adjusted, as by the projection t of Fig. 2 or the conical part of the projection t of Fig. 3.

The plot X, in this case a horizontal straight line, represents the relation between various thicknesses of jet with a constant ratio of nozzle outlet area to throat area of 10. This relation may exist in the case where the area at the outlet of the nozzle varies at the same rate as the change in area of the throat. Thus when varying the distance between the members C and D, thus changing the nozzle outlet area, the throat area is simultaneously varied, as by adjusting both the member D and the projection t in Figs. 2 and 3.

The plot or curve Y, in this case again a straight line, represents changes in thickness of jet with possible simultaneous changes in ratio of nozzle outlet area to throat area. But this is a particular case where the throat area remains constant, but the area of the outlet of the nozzle varies as well as the thickness of the jet. This is accomplished by an arrangement such as shown in Fig. 1, where the throat area is not varied, but the distance between the members C and D is varied; or is accomplished also by structure such as shown in Figs. 2 and 3, where the member D is adjusted with respect to the member C, but the projection t remaining in fixed position with respect to the throat T.

The plot Z, in this case a curve, represents a possible relation for varying jet thicknesses and for varying ratios of nozzle outlet areas to throat areas. Such a relation is available by the structures illustrated in Figs. 2 and 3 by adjusting the nozzle members D with respect to the members C, and suitably adjusting also the position of the projections t to suitably vary the throat areas. A relation of this character is also possible with the structure shown in Fig. 1 if the conical point of the projection t is employed to vary the throat area.

From the foregoing discussion of Fig. 4, it will be understood that the plots or curves therein are illustrative merely of the character of possible relations, and that my invention is in no way limited to the particular relations indicated.

While the adjacent faces of the members C and D of Figs. 1 to 3 inclusive are indicated as parallel with each other, it will be understood that they may either diverge or converge toward their peripheries so long as they produce a motive fluid expanding passage.

What I claim is:

1. Ejector apparatus comprising a diffuser and cooperating nozzle structure, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, said nozzle passage having a throat, and means for varying the throat area with a given separation of said nozzle members.

2. Ejector apparatus comprising a diffuser and cooperating nozzle structure, said nozzle structure comprising members spaced from each other to form a nozzle passage, said nozzle passage having a throat, and means for changing the ratio of the throat area to the nozzle outlet area for a given separation of said members.

3. Ejector apparatus comprising a diffuser and cooperating nozzle structure, said nozzle structure comprising members spaced from each other to form a nozzle passage, said passage having a throat, means for adjusting said nozzle members with respect to each other, and means for adjusting the area of said throat independently of adjustment of said nozzle members with respect to each other.

4. Ejector apparatus comprising a diffuser and cooperating nozzle structure, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, a throat formed within one of said members, and a member supported by the other nozzle member and having a portion of constant cross section extending into said throat.

5. Ejector apparatus comprising a diffuser and cooperating nozzle structure, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, a throat disposed in one of said members, and a member adjustable independently of another of said members longitudinally in said throat.

6. Ejector apparatus comprising a diffuser and cooperating nozzle structure, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, a throat disposed in one of said members, and a member carried by the other of said nozzle members and adjustable independently thereof with respect to said throat.

7. Ejector apparatus comprising a diffuser and cooperating nozzle structure, said nozzle structure comprising members spaced from each other to form a nozzle passage, a throat in one of said members, means for adjusting the other of said members, and a third member carried by said other of said members and adjustable with respect thereto and with respect to said throat.

8. Ejector apparatus comprising a diffuser and cooperating nozzle structure, said nozzle structure comprising members spaced from each other to form a nozzle passage, a throat in one of said members, means for adjusting the other of said members, and a third member

ber carried by said other of said members and adjustable with respect thereto and with respect to said throat, said third member having different cross sections at different points in its length.

9. Ejector apparatus comprising a diffuser and cooperating nozzle structure, said nozzle structure comprising members spaced from each other to form a nozzle passage, a throat in one of said members, means for adjusting the other of said members, and a third member carried by said other of said members and adjustable with respect thereto and with respect to said throat, said third member having a portion of substantially con-

stant cross section adjustable into said throat.

10. Ejector apparatus comprising a diffuser and cooperating nozzle structure, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, said nozzle passage having a throat, means for varying the distance between said members, and means for independently varying the ratio of throat area to nozzle outlet area.

In testimony whereof I have hereunto affixed my signature this 8th day of February 1918.

ROBERT SUCZEK.