

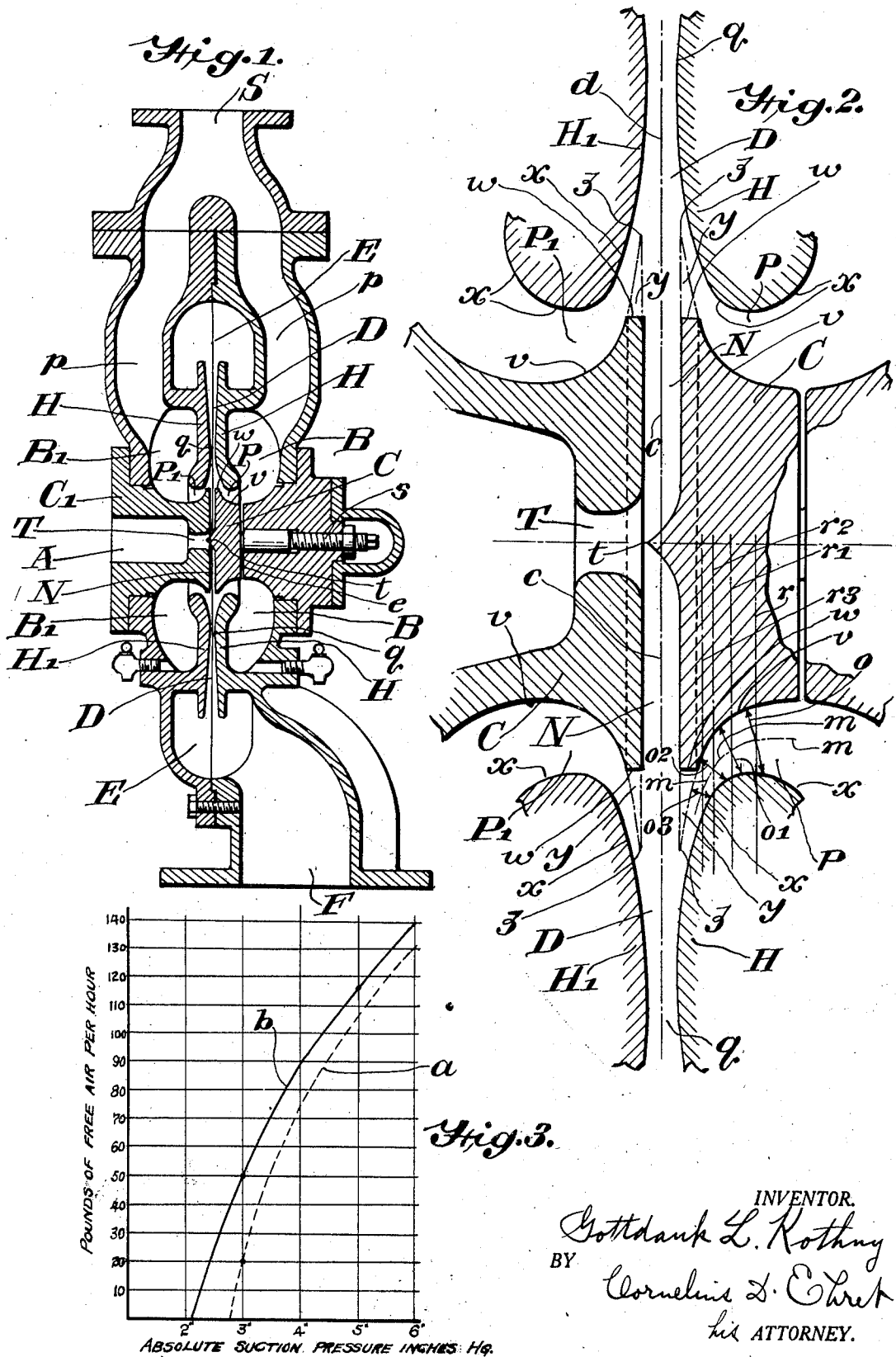
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G. L. KOTHNY

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EJECTOR

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UNITED STATES PATENT OFFICE.

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EJECTOR.

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To all whom it may concern:

Be it known that I, GOTTDANK L. KOTHNY, a citizen of the United States, residing in Strafford, county of Chester, State of Pennsylvania, have invented certain new and useful Improvements in Ejectors, of which the following is a specification.

My invention relates to ejectors utilizable for raising the pressure of one fluid by another, and particularly for raising the pressure of elastic fluid, as air or vapor exhausted from a steam condenser, by elastic motive fluid, as steam.

My invention relates more particularly to improvements in ejectors of the type comprising annular or radial nozzle and diffuser structures, of the character described and claimed in prior Letters Patent of the United States No. 1,282,595, October 22, 1918.

In accordance with my invention, the spaced nozzle members have at their peripheries considerable or substantial width or thickness, effecting a surrounding region or zone into which neither the motive fluid nor the fluid to be compressed enters, and in any event, in which the motive fluid and fluid to be compressed do not come into contact, mixture or entraining relation with each other; and causing the motive fluid jet and fluid to be compressed to come into contact or entraining relation at a substantial distance radially outward from the peripheries of the nozzle members, thereby preventing disturbance or surface rupture of the jet immediately adjacent the outlet of the nozzle, and in general, effecting improvement in character of approach to each other of the motive fluid and the fluid to be compressed, with resultant increase in the amount of fluid compressed, for a given amount of motive fluid utilized.

Further in accordance with my invention, I provide for the fluid to be compressed an annular passage, between each of the nozzle members and the associated diffuser member, which is itself in effect a convergent nozzle passage, whose cross section is always decreasing as the passage progresses axially and radially, the change of cross section preferably being substantially uniform, and in any event not increasing in cross section after a preceding decrease in cross section.

My invention resides in the features of structure, proportionment and combination of the character hereinafter described and claimed.

For an understanding of my invention, and for an illustration of one of the various forms it may take, reference is to be had to the accompanying drawing, in which:

Fig. 1 is a cross sectional view of ejector apparatus embodying my invention.

Fig. 2 is a fragmentary cross sectional view, on enlarged scale.

Fig. 3 is a curve illustrating a characteristic of my improvement.

Referring to Figs. 1 and 2, C and C¹ are members spaced from each other to form between their adjacent faces the nozzle passage N of the annular nozzle structure with which coacts the diffuser structure comprising the annular diffuser members H and H¹ spaced axially from each other to form the diffuser passage D, which is convergent-divergent, outwardly, with the throat or region of smallest cross section at g.

The motive fluid, as steam or equivalent, is introduced into the passage A within the nozzle member C¹, within which is formed also the throat T of the motive-fluid-expanding nozzle structure, beyond which the nozzle passage N increases in cross section outwardly to the nozzle outlet at the periphery of the members C and C¹. Upon the opposing nozzle member C may be provided the central tip or point t.

The cross section of the throat T is constant, therefore passing, at a given pressure, a constant amount of motive fluid. However, the point t may be of such length as to project into or be adjustable into the throat T, in which latter case the amount of motive fluid is variable.

The motive fluid passes outwardly radially in all directions in the form of a disk or sheet, emerging from the nozzle passage N in a free jet directed into the diffuser passage D.

The air, vapor or mixture of them, or other fluid to be compressed or raised in pressure, enters at the suction port S, and is delivered through the passages p, p to the annular chambers B and B¹, which have the annular convergent outlet or delivery passages P and P¹, respectively.

The motive fluid and fluid to be com-

pressed come into contact or entrained relation and pass outwardly in combination or in mixture through the diffuser passage D, within which they lose in velocity and gain in pressure. The mixture is eventually discharged into the circumferential or annular discharge passage or casing E, from which it emerges through the discharge port F.

The nozzle-forming members C and C¹ have at their peripheries substantial widths or thickness as indicated at *w*, from which the peripheral surfaces of the nozzle members fall away in the curves *v*, the peripheries of the nozzle members in their portions indicated at *v* being of relatively great diameters, and considerably greater than in the case of the corresponding members of the aforesaid Patent 1,282,595.

The radially flowing free jet issuing from the nozzle passages N is projected a considerable distance beyond the peripheral portions *w* of the nozzle members, and, as indicated, well into the mouth of the diffuser passage D. Surrounding the portions *w* of the nozzle members are formed the regions *y*, of high vacuum or practically devoid of fluid, the surfaces *v* being so directed as to guide the incoming air or other fluid to be compressed past the peripheries *w* of the nozzle members, the motive fluid jet and the fluid to be entrained coming into entraining relation or contact as at *z*, preferably well within the mouth of the diffuser passage. In other words, the tangent to the curve *v* at the periphery *w* is inclined to the inner face of the nozzle member, whereby the fluid passing along the surface *v* and beyond the periphery *w* will come into entraining relation with the free jet only as a substantial distance radially beyond the periphery *w*. The radial jet issuing from the nozzle N is free and undisturbed as it issues from the nozzle passage, and the fluid to be entrained is guided in such path into contact or entraining relation with the jet that on the whole an appreciable improvement in economy or operation of the ejector is attained.

Correlated with the exterior nozzle surfaces *v* are the surfaces *x* on the diffuser members H and H¹, forming with the surfaces *v* the annular passages P and P¹, which, while they advance axially and radially outwardly, decreases in cross section, forming substantially an annular convergent nozzle passage in which the air or other fluid to be entrained increases in velocity and thereafter comes into contact or entraining relation with the motive fluid jet.

The passages P and P¹ may be said to have stream lines, of which, for example, the medium stream line is indicated at *m*, Fig. 2, normal to which are the passage widths *o*, *o*¹,

etc. at various different points along the line *m*, the radii of these points being indicated at *r*, *r*¹, etc. The cross section of the passage P at the radius *r* is found by multiplying the circumference whose radius is *r* by the passage width *o* at that radius. These cross sectional areas of the passage diminish along the line *m*, and preferably at a uniform rate, though it will be understood that the rate of change of cross section of the passage P may be somewhat other than uniform. It is desirable, however, that nowhere along the line *m* shall the cross sectional area of the passage P increase as compared with any preceding position along the line *m*.

With the blunt or thick edges *w* at the peripheries of the nozzle members, effecting the dead or empty zones or regions *y*, and by additionally employing the stream line passages such as P and P¹, diminishing continuously or substantially uniformly in cross sectional area along a medium stream line, it is possible for a given sized ejector or utilizing a given amount of steam or motive fluid materially to increase the number of pounds of air compressed, as will become apparent from an examination of the example indicated in Fig. 3, in which abscissæ are absolute suction pressures in inches of mercury and whose ordinates are pounds of free air per hour raised in pressure by the ejector. The dotted curve *a* is the characteristic or indicates the performance of an ejector of the type disclosed in the aforesaid prior Patent 1,282,595, and the full line curve *b* is the characteristic or indicates the performance of an ejector of the same type and size, under the same operative conditions and utilizing the same amount of motive fluid, but modified in accordance with my present invention.

It is apparent that the improved ejector in accordance with this present invention will operate from a lower suction pressure as of the order of two inches, while the ejector without my improvement will operate only from a suction pressure substantially higher. Of more importance, however, is the fact that at the various suction pressures the improved ejector compresses a greater number of pounds of air per hour. For example, with a suction pressure of three inches, the old ejector compresses about twenty pounds of air per hour, while with my improvement, with the same suction pressure, about fifty pounds of air are compressed per hour. And throughout a range of suction pressures up to six inches and even higher, the improved ejector will compress a greater amount of air per hour for the same motive fluid consumption. Accordingly, with my improvement the efficiency or economy of the ejector is materially or substantially improved.

Furthermore, in accordance with my improvement described, the center plane *c* of the nozzle passage N and the center plane *d* of the diffuser passage D are and may remain coincident, and the adjustment of the nozzle member C, as effected by the adjusting screw *s*, is of small magnitude, and so small that the gap *e* is so short as to have substantially no effect upon the passage P.

Further in accordance with my invention, the passages, particularly P and P¹, are symmetrical on opposite sides of the median planes *c* and *d*, which is not true of the apparatus disclosed in the aforesaid Letters Patent 1,282,595, in which also there was generally an offset of the motive fluid jet to one side of the median line or plane of the diffuser passage.

In accordance with my improvement, the need for adjustment of the nozzle member C is materially less, and such adjustment as is made is merely to effect the correct width of nozzle passage N, and with this adjustment made, even prior to operation or test, it generally will be found upon operation or test that no further adjustment is necessary and the apparatus will operate at its best.

The practically complete or perfect symmetry of the passages P and P¹ on opposite sides of the median planes *c* and *d*, and the substantially perfect coincidence of the median planes *c* and *d* of the nozzle and diffuser passages is of practical importance in utilizing the motive fluid to maximum advantage.

While I have shown and described my invention in its preferred form in which the nozzle and diffuser passages are normal to the axis of the annular nozzle and annular diffuser, it will be understood that my invention is applicable also to the case where these passages are not normal to the axis, but are more or less inclined with respect thereto, as described as a possible arrangement or construction in the aforesaid Letters Patent No. 1,282,595.

It will be understood also that a plurality of ejectors of the character herein described may be connected in series or tandem with each other to form a multi-stage ejector of any suitable number of stages, and that any suitable number of the stages of the multiple stage arrangement may comprise a tubular ejector.

It will be understood further that the width of the nozzle passage N and the width of the diffuser throat *g* may be related to each other in any suitable way, the width of the throat *g*, however, preferably being smaller than the width of the nozzle passage N, as described in the aforesaid Letters Patent. It is preferred also that the area of the nozzle passage N at its outlet be greater than the cross sectional area of the diffuser

passage at its throat *g*, as described in the aforesaid Letters Patent, though it will be understood that any other suitable relations are comprehended within my present invention.

What I claim is:

1. A member of an annular nozzle having its periphery of greatest diameter adjacent that face thereof which forms a wall of the nozzle passage, and having a peripheral fluid-guiding surface of relatively great diameter curving axially and outwardly and terminating at said periphery of greatest diameter.

2. A member of an annular nozzle having its periphery of greatest diameter adjacent that face thereof which forms a wall of the nozzle passage, and having a peripheral fluid-guiding surface of relatively great diameter curving axially and outwardly and terminating at said periphery of greatest diameter, said periphery of greatest diameter having substantial axial width or thickness.

3. A member of an annular nozzle having its periphery of greatest diameter adjacent that face thereof which forms a wall of the nozzle passage, and having a peripheral fluid-guiding surface of relatively great diameter curving axially and outwardly and terminating at said periphery of greatest diameter, the tangent to the curve of said fluid-guiding surface at said periphery being substantially inclined with respect to said face, said periphery of greatest diameter having substantial axial width or thickness.

4. An annular motive fluid nozzle comprising members spaced from each other to form a nozzle passage, said nozzle members having at their peripheries of maximum diameter substantial width or thickness axially, and each of said members having curved fluid-guiding surfaces of relatively great diameter disposed symmetrically on opposite sides of the median plane of the nozzle passage, said surfaces at said peripheries being inclined to the walls of the nozzle passage to effect dead spaces beyond said peripheries of maximum diameter.

5. Ejector apparatus comprising annular diffuser and nozzle structures, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, said nozzle members having exterior fluid-guiding surfaces disposed at relatively great distances from the nozzle axis, said diffuser structure comprising annular diffuser members spaced from each other and having adjacent the inlet end of the diffuser passage curved fluid-guiding surfaces which with said surfaces on said nozzle structure form stream line passages delivering the fluid to be entrained to the jet issuing from said nozzle passage.

6. Ejector apparatus comprising annular

diffuser and nozzle structures, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, said nozzle members having exterior fluid-guiding surfaces disposed at relatively great distances from the nozzle axis, said diffuser structure comprising annular diffuser members spaced from each other and having adjacent the inlet end of the diffuser passage curved fluid-guiding surfaces which with said surfaces on said nozzle structure form stream line passages delivering the fluid to be entrained to the jet issuing from said nozzle passage, the median planes of the nozzle and diffuser passages being substantially coincident and said fluid-guiding passages being symmetrical on opposite sides of said planes.

7. Ejector apparatus comprising annular diffuser and nozzle structures, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, said nozzle members having exterior fluid-guiding surfaces disposed at relatively great distances from the nozzle axis, said diffuser structure comprising annular diffuser members spaced from each other and having adjacent the inlet end of the diffuser passage curved fluid-guiding surfaces which with said surfaces on said nozzle structure form stream line passages extending axially and outwardly and decrease in cross section for delivering the fluid to be entrained to the jet issuing from said nozzle passage.

8. Ejector apparatus comprising annular diffuser and nozzle structures, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, said nozzle members having exterior fluid-guiding surfaces disposed at relatively great distances from the nozzle axis, said diffuser structure comprising annular diffuser members spaced from each other and having adjacent the inlet end of the diffuser passage curved fluid-guiding surfaces which with said surfaces on said nozzle structure form stream line passages extending axially and outwardly and decrease in cross section for delivering the fluid to be entrained to the jet issuing from said nozzle passage, the median planes of the nozzle and diffuser passages being substantially coincident and said fluid-guiding passages being symmetrical on opposite sides of said planes.

9. Ejector apparatus comprising annular diffuser and nozzle structures, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, said nozzle members having exterior fluid-guiding surfaces disposed at relatively great distances from the nozzle axis, said diffuser structure comprising annular diffuser members spaced from each other and having adjacent the inlet end of the diffuser passage curved fluid-guiding surfaces which with

said surfaces on said nozzle structure form stream line passages delivering the fluid to be entrained to the jet issuing from said nozzle passage, said nozzle members having their maximum peripheral diameters adjacent the nozzle passage and having substantial axial width or thickness at their said maximum diameters, whereby there are formed annular dead spaces surrounding each of said nozzle members at their portions of maximum diameter.

10. Ejector apparatus comprising annular diffuser and nozzle structures, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, said nozzle members having exterior fluid-guiding surfaces disposed at relatively great distances from the nozzle axis, said diffuser structure comprising annular diffuser members spaced from each other and having adjacent the inlet end of the diffuser passage curved fluid-guiding surfaces which with said surfaces on said nozzle structure form stream line passages delivering the fluid to be entrained to the jet issuing from said nozzle passage, the median planes of the nozzle and diffuser passages being substantially coincident and said fluid-guiding passages being symmetrical on opposite sides of said planes, said nozzle members having their maximum peripheral diameters adjacent the nozzle passage and having substantial axial width or thickness at their said maximum diameters, whereby there are formed annular dead spaces surrounding each of said nozzle members at their portions of maximum diameter.

11. Ejector apparatus comprising annular diffuser and nozzle structures, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage, said nozzle members having exterior fluid-guiding surfaces disposed at relatively great distances from the nozzle axis, said diffuser structure comprising annular diffuser members spaced from each other and having adjacent the inlet end of the diffuser passage curved fluid-guiding surfaces which with said surfaces on said nozzle structure form stream line passages extending axially and outwardly and decrease in cross section for delivering the fluid to be entrained to the jet issuing from said nozzle passage, said nozzle members having their maximum peripheral diameters adjacent the nozzle passage and having substantial axial width or thickness at their said maximum diameters, whereby there are formed annular dead spaces surrounding each of said nozzle members at their portions of maximum diameter.

12. Ejector apparatus comprising annular diffuser and nozzle structures, said nozzle structure comprising nozzle members spaced from each other to form a nozzle passage,

said nozzle members having exterior fluid-guiding surfaces disposed at relatively great distances from the nozzle axis, said diffuser structure comprising annular diffuser members spaced from each other and having adjacent the inlet end of the diffuser passage curved fluid-guiding surfaces which with said surfaces on said nozzle structure form stream line passages extending axially and outwardly and decrease in cross section for delivering the fluid to be entrained to the jet issuing from said nozzle passage, the median planes of the nozzle and diffuser passages being substantially coincident and said fluid-guiding passages being symmetrical on opposite sides of said planes, said nozzle members having their maximum peripheral diameters adjacent the nozzle passage and having substantial axial width or thickness at their said maximum diameters, whereby there are formed annular dead spaces surrounding each of said nozzle members at their portions of maximum diameter.

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