

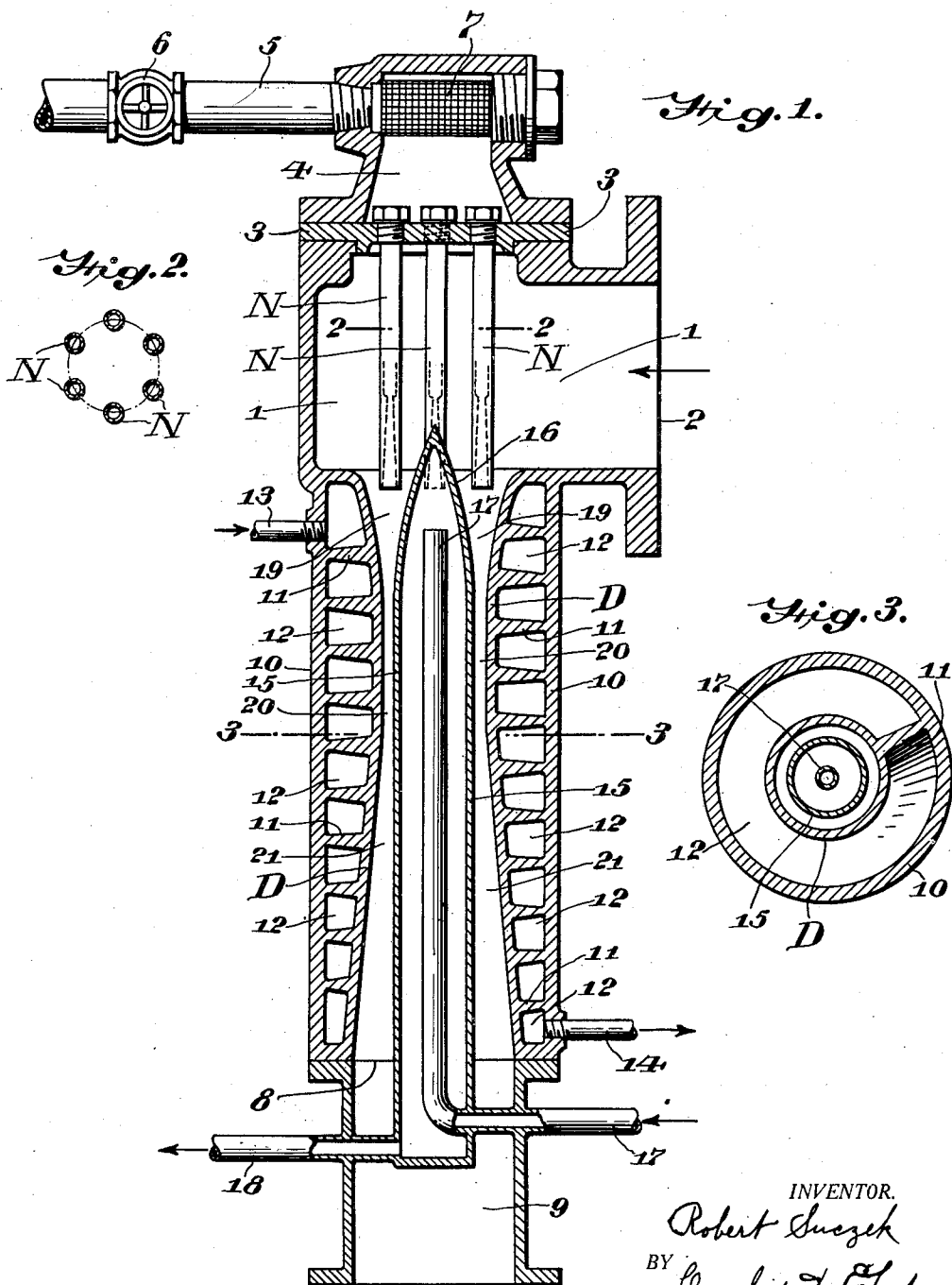
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METHOD OF AND APPARATUS FOR COMPRESSING FLUID

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METHOD OF AND APPARATUS FOR COMPRESSING FLUID.

Application filed May 13, 1921. Serial No. 469,164.

To all whom it may concern:

Be it known that I, ROBERT SUCZEK, a citizen of the Czechoslovak Republic, residing in the city and county of Philadelphia, State of Pennsylvania, have invented certain new and useful Improvements in Methods of and Apparatus for Compressing Fluid, of which the following is a specification.

10 My invention relates to a method of and apparatus for raising the pressure of or compressing elastic fluid, as gas, such as air, or vapor, such as steam, or a mixture of gas and vapor, by entraining the fluid to be compressed in a jet or jets of motive fluid, more particularly gas, vapor, or a mixture of them, the mixture of entrained and motive fluids then decreasing in velocity and increasing in pressure, as is characteristic of ejectors or aspirators.

15 In accordance with my invention, the mixture of motive and entrained fluids is delivered into a tubular combining tube structure or diffuser structure within which is disposed a hollow member, containing or traversed by cooling medium, and forming a core structure spaced from the inner walls of the combining tube or diffuser structure to form a preferably convergent-divergent passage through which the mixture of motive and entrained fluids passes, preferably in the form of a thin walled tubular jet from which heat is transferred into the cooling medium within the core structure; and by preference heat is also transferred from the tubular sheet or jet of mixture of motive and entrained fluids into cooling medium in a jacket surrounding the combining tube or diffuser structure.

20 Furthermore, in accordance with my invention, the cooling medium in the external jacket is compelled to take a helical or circuitous path, the structure forming the helical or circuitous channel for the cooling medium being comprised in part of heat-transferring ribs or flanges upon the exterior of the diffuser or combining tube structure.

My invention resides in the method and apparatus hereinafter described and claimed.

25 For an illustration of one of the various forms my apparatus may take, and for an understanding of my method, reference is

to be had to the accompanying drawing, in which:

Fig. 1 is a longitudinal sectional view, 55 parts in elevation, of ejector apparatus embodying my invention.

Fig. 2 is a section on the line 2—2 of Fig. 1, showing one arrangement of the nozzles.

Fig. 3 is a cross sectional view on the line 60 3—3 of Fig. 1.

Referring to the drawing, 1 is a suction chamber having the port 2 through which the fluid to be compressed enters the chamber 1. Forming a wall of the suction chamber is the deck or plate 3 carrying the nozzle structure, as a circular series of nozzles N, disposed as indicated in Fig. 2, or any other suitable nozzle structure, as a plurality of series of nozzles, disposed in circles concentric with the axis of the herein described diffuser structure. The upper ends of the nozzles communicate with the chamber 4, to which steam or any other suitable motive fluid is delivered through the pipe 5, controlled by valve 6, the motive fluid preferably passing through a strainer 7 into the chamber 4. D is a tubular diffuser or combining tube, of circular or other suitable cross section, having its inlet end in communication with the suction chamber 1 and delivering at its discharge 8 directly to the atmosphere, or, as indicated, into any suitable passage 9 which may communicate with the suction chamber of a later stage ejector, or which may deliver to the suction of any suitable type of compressor or pump. The wall of the diffuser D is of metal and preferably thinned to afford high heat conductivity.

Surrounding the diffuser or combining tube D is a jacket 10, between which and the wall of the diffuser D is disposed the helical dividing flange or wall 11 forming a helical passage 12 for cooling medium, as fluid or liquid, generally water, delivered into the passage 12 by pipe 13 and carried off by the pipe 14. While it is preferred that the cooling medium enter the jacket at its end adjacent the entry to the diffuser or combining tube D, it will be understood that the cooling medium may be delivered through the pipe 14 and discharged by the pipe 13. The flange or wall 11 is preferably

integral with the wall of the diffuser D, and forms in effect cooling ribs or flanges for more readily conducting heat from the diffuser wall to the medium in or traversing the passage 12. As indicated, the ribs 11 preferably are thicker adjacent the diffuser and decrease in thickness outwardly. By the structure described, the cooling medium is compelled to take a helical or circuitous path longitudinally and circumferentially of the diffuser or combining tube structure while in the form of a stream of relatively small cross section, and therefore increased superficial area, for more readily absorbing heat from the diffuser wall and the ribs or flanges 11. By so using the cooling medium in a stream of small cross sectional area, for a given amount of cooling medium employed, the stream flows at higher velocity, which is of advantage in that a higher heat transmission co-efficient is obtained.

Disposed within the combining tube or diffuser is the hollow core member or jacket 15, preferably of brass, copper or other material of high heat conductivity, and preferably decreasing in cross section towards its upper end, as indicated at 16. The jacket or core member 15 may terminate, as indicated, within the suction chamber 1, at any suitable distance therein, or it may terminate at the entrance to the diffuser D or within the diffuser. Fluid of any suitable character as water, may be introduced into the interior of the jacket 15 through the pipe 17, which preferably extends adjacent the distant or upper end of the jacket 15, where it is discharged and then flows in reverse direction and is discharged through the pipe 18.

By the arrangement shown, in fluid traversing the jacket 15 first absorbs heat when coolest adjacent the upper end of the jacket 15, though it will be understood that the reverse or any other suitable arrangement may be employed.

Between the exterior of the jacket 15 and the inner wall of the diffuser structure is formed the diffuser or combining tube passage which, as indicated, is preferably convergent-divergent, the first part of the passage 19 being convergent to the throat passage 20 which may, as indicated, be of substantially constant cross section for a substantial distance longitudinally of the diffuser, and finally the passage may be divergent, as indicated at 21.

While the nozzles N are shown as projecting into the convergent passage 19, it will be understood that they may terminate at or short of the entrance of the passage 19.

The operation is as follows:

The motive fluid, as steam, is expanded by the nozzles N, which deliver the motive fluid in high velocity jets passing into the diffuser passage between the diffuser wall

and the internal jacket member 15. The jets entrain the elastic fluid, as air, steam, etc., to be compressed, and the mixture passes longitudinally of the diffuser passage. While in the converging passage 19 the mixture preferably loses in velocity and gains in pressure, and simultaneously heat is extracted from both the inner and outer sides of the tubular or cylindrical jet by the cooling media in the cooling jackets 15 and 10. And as the mixture continues through the throat passage 20 and divergent passage 21, further heat is abstracted from both the inner and outer sides of the tubular or cylindrical jet.

The mixture of motive and entrained fluids while losing in velocity and undergoing compression tends to increase in temperature; and the work of compression is, as represented by expenditure of heat units in the motive fluid, more readily accomplished when the mixture of motive and entrained fluids is suitably cooled. To prevent the rise in temperature incident to compression, or to even further decrease the temperature of the mixture of motive and entrained fluids, the cooling described is resorted to, with the result that the work of compression is accomplished with less motive fluid than if the mixture of motive and entrained fluids were not cooled or chilled.

When the cooling jacket 15 extends beyond the outlets of the nozzles N, as indicated, the fluid to be compressed is to some extent cooled before coming into contact with the motive fluid jets. It will be understood that the end 16 of the cooling jacket 15 may extend further into the suction chamber 1 to effect a higher degree of cooling of the fluid to be compressed, or it may terminate at or below the outlets of the nozzles N.

It will further be understood that the outer cooling jacket may also extend into the suction chamber 1 to effect cooling of the fluid to be compressed.

Generally, the greater part of the entire increase of pressure within the diffuser is accomplished within the convergent passage 19 or that passage and the throat passage 20, while a lesser portion of the compression takes place in the divergent passage 21. However, it will be understood that my invention is not limited in this regard, and that the diffuser passage may be convergent and then continue throughout its length at substantially constant cross section.

By the arrangement described, more effective cooling is possible than by the employment of only one of the cooling jackets; and the cooling is the more effective because the inner jacket in association with the diffuser forms a diffuser passage compelling the mixture of motive and entrained

fluids to assume the form of a thin walled tube or cylinder, whereby the cooling is the more effective.

It will be understood that my method and apparatus are of general application regardless of the initial and final pressures of the fluid undergoing compression. For example, the port 2 of the suction chamber may connect by piping with the interior of a steam condenser for producing or maintaining therein a high vacuum in accordance with common practice. In general, the fluid to be compressed may have an initial pressure less than, equal to or higher than atmospheric pressure, and is compressed to correspondingly higher pressure and discharged to atmosphere or into a region at, below or above atmospheric pressure.

While I have shown the internal and external cooling jackets as extending throughout the length of the diffuser structure, it will be understood that either cooling jacket may have lesser longitudinal extent and be positioned at any desired part of the longitudinal extent of the diffuser.

What I claim is:

1. Ejector apparatus comprising nozzle structure, cooperating diffuser structure, and a plurality of helical heat-conducting ribs on the outer wall of said diffuser.

2. Ejector apparatus comprising nozzle structure, cooperating diffuser structure, a plurality of helical heat-conducting ribs on the outer wall of said diffuser, said ribs decreasing in thickness from the diffuser wall outwardly.

3. Ejector apparatus comprising nozzle structure, a tubular diffuser, a cooling jacket surrounding said diffuser and comprising a helical passage for the cooling medium, and a second cooling jacket disposed within said diffuser and spaced therefrom to form a passage for the mixture of motive and entrained fluids.

4. Ejector apparatus comprising nozzle structure, cooperating diffuser structure, a plurality of heat-conducting ribs on the outer wall of said diffuser, and a second cooling jacket disposed within said diffuser and spaced therefrom to form a passage for the mixture of motive and entrained fluids.

5. Ejector apparatus comprising nozzle structure, cooperating diffuser structure, a plurality of heat-conducting ribs on the outer wall of said diffuser, said ribs decreasing in thickness from the diffuser wall outwardly, and a second cooling jacket disposed within said diffuser and spaced therefrom to form a passage for the mixture of motive and entrained fluids.

6. Ejector apparatus comprising divergent nozzle structure, co-operating divergent diffuser structure, and a cooling jacket forming a passage for cooling medium around said diffuser structure, said passage diminishing in depth radially of the diffuser structure toward the discharge end of said diffuser structure.

7. Ejector apparatus comprising divergent nozzle structure, convergent-divergent diffuser structure, and a cooling jacket having a passage for cooling medium, said passage diminishing and then increasing in depth radially of said diffuser structure.

8. Ejector apparatus comprising divergent nozzle structure, co-operating divergent diffuser structure, and a cooling jacket forming a helical passage for cooling medium around said diffuser structure, said passage diminishing in depth radially of the diffuser structure toward the discharge end of said diffuser structure.

9. Ejector apparatus comprising divergent nozzle structure, convergent-divergent diffuser structure, and a cooling jacket having a helical passage for cooling medium, said passage diminishing and then increasing in depth radially of said diffuser structure.

10. Ejector apparatus comprising divergent nozzle structure, a co-acting diffuser having a convergent portion, and a helical passage for cooling medium surrounding and disposed longitudinally of said convergent portion of said diffuser.

11. Ejector apparatus comprising a group of divergent motive fluid nozzles, co-operating diffuser structure, and a cooling jacket member disposed within said diffuser structure and terminating within said group of nozzles beyond their discharge outlets.

12. Ejector apparatus comprising a diffuser having a convergent portion, divergent nozzle structure extending into said convergent portion, and a cooling water passage surrounding said convergent portion of said diffuser.

13. Ejector apparatus comprising a diffuser having a convergent portion, divergent nozzle structure extending into said convergent portion, and a cooling water passage surrounding said convergent portion of said diffuser and extending longitudinally of said convergent portion to a point adjacent the outlet of said nozzle structure.

In testimony whereof I have hereunto affixed my signature this 9th day of May, 1921.

ROBERT SUCZEK.