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J. MULDER ET AL

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EJECTOR FOR THE DELIVERY OF GAS AND AIR IN LARGE QUANTITIES

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Fig. 1.

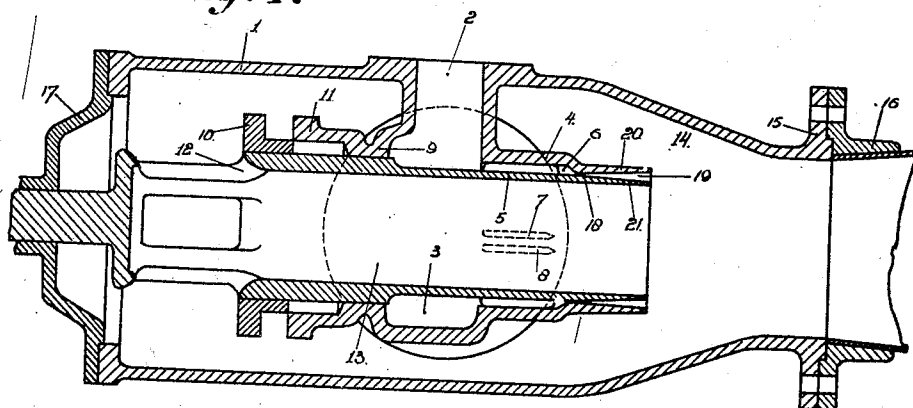


Fig. 2.

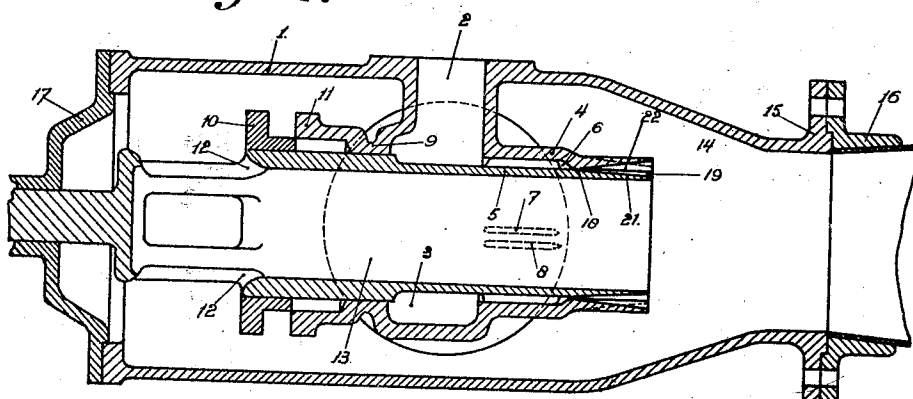


Fig. 3.

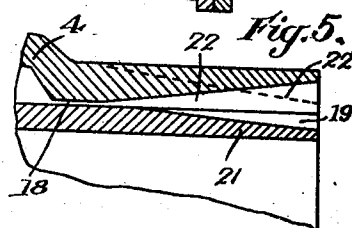
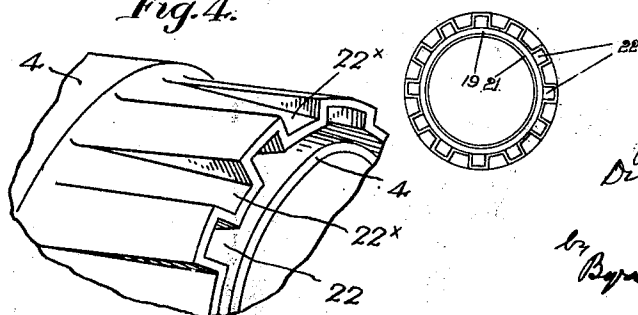


Fig. 4.



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## UNITED STATES PATENT OFFICE.

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EJECTOR FOR THE DELIVERY OF GAS AND AIR IN LARGE QUANTITIES.

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*To all whom it may concern:*

Be it known that we, JAKOB MULDER and DIRK CHRISTIAAN ENDERT, subjects of the Queen of the Netherlands, residing at Rotterdam, in the Province of South Holland, in the Kingdom of the Netherlands, have invented certain new and useful Improvements in Ejectors for the Delivery of Gas and Air in Large Quantities, of which the following is a specification.

The operation of the gas and air ejectors hitherto in use have been based on the principle of a massive jet of steam or several separate steam jets arranged in a circle, being blown centrally through diverging tubes. Ejectors with annular jets of steam are also used, but they are only suitable for supplying small quantities of air or gas at a high vacuum.

Neither apparatus with massive steam jets nor apparatus with several separate steam jets arranged in a circle permit the delivery of large quantities of air or gas with the consumption of a relatively small quantity of steam. The consumption of steam has always proved to be large, relatively to the quantity of air or gas delivered, so that in the case of large deliveries, economic working was impracticable.

The object of this invention is to considerably improve the useful effects when dealing with the delivery of very large quantities of air or gas.

It should be observed that an annular steam jet has already been applied by Parsons, but only on a small scale, when dealing with large deliveries, the extraordinarily high consumption of steam rendered its practical application almost impossible.

The high consumption of steam is due to the fact that, with the existing arrangements, it was not possible owing to the variations in shape to which the material is subjected to obtain an accurate centering of the concentric walls of the annular nozzles which are surrounded on the opposite sides by the cold air or gas and by the hot steam. The fact that the medium flowing out of the nozzle with a great velocity is in contact with a comparatively small surface of the air or gas to be delivered is also one of the main reasons of the low useful effect of such apparatus. It is evident that the greater the diameter of the nozzle, the smaller in comparison with said diameter the surface over which the work-

ing medium is in contact with the gas or air to be delivered.

Experiments have shown that the outer and inner walls of an annular nozzle, when the apertures of such nozzle are normal, always came into contact with one another, so that the passage of the steam at the said points in contact was completely prevented, whilst on the diametrically opposite side of the nozzle the width of the annular orifice was doubled. The consequence of such a deviation is naturally that no closed "steam-cone" can be formed and therefore the action of the ejectors fails or is incomplete. Nevertheless, in order to produce under such circumstances a delivery of air or gas an aperture had to be provided on the side where the outer and inner walls of the nozzle touch each other, so that there should be there also an adequate flow of steam from the nozzle. On the diametrically opposite side where the walls were at too great a distance from each other, the enlarged cross section remained, so that there was always a very considerable flow of steam which was wasted. This explains the extraordinary high consumption of steam with the present devices.

Now the object of this invention is to reduce this consumption of steam in ejections for large deliveries and such result is obtained by an absolutely exact centering of the outer and inner walls of an annular nozzle and the extension of the surface of contact between the active medium and the gas or air to be delivered.

According to this invention the outer and the inner walls of the annular nozzle which are independent run concentrically for a considerable distance up to the point of smallest cross section. The annular space between said walls is divided into a circle of channels by radial ribs extending in an axial direction which ribs may be helically arranged whilst the two cylindrical nozzle walls are centered relatively to each other by said ribs. Hence a reliable centering of the nozzle walls under all circumstances is obtained, whilst a longitudinal displacement of said walls, with reference to each other is also possible.

Further and according to the invention, the outer nozzle wall or the inner one or both on that portion of the annular nozzle which widens towards the orifice can be provided with grooves extending in an axial

direction. The said grooves give to the jet of effective medium issuing from the nozzle an undulated surface, consequently a large contact surface is provided between the effective medium and the medium to be delivered.

The cross section of the grooves provided in the nozzle walls may conveniently be gradually enlarged towards the outlet orifice of the nozzle. For instance with the same width, the depth of the groove may be gradually increased in the direction of the orifice of the nozzle.

A nozzle made in accordance with this invention is illustrated by way of example, in the accompanying drawing.

Fig. 1 shows a longitudinal section of an ejector according to this invention.

Fig. 2 is a similar longitudinal section showing a modified construction.

Fig. 3 is an end elevation of the discharge end or nozzle of the ejector shown in Fig. 2.

Fig. 4 is a partial perspective view of the end of the nozzle drawn to a larger scale.

Fig. 5 is a longitudinal section through one of the nozzle passages also drawn to a larger scale.

The usual arrangement of ejectors with an annular nozzle may be regarded as known. In the construction shown in Fig. 1 of the drawing 1 is the casing of the ejector which is provided with an inlet 2 for the active medium (steam). The passage 2 leads to an annular chamber 3 to which is connected the cylindrical outer wall 4 of the nozzle. The inner wall of said nozzle is formed by a tube 5 which is arranged concentrically with the wall 4. Between the outer wall 4 and the inner wall 5 there remains an annular space 6 which is divided into a circle of passages 8 running in an axial direction by radial ribs 7 extending in an axial direction and if desired helically arranged. The ribs 7 extend across the annular space 6 so that the nozzle walls are centered by said ribs which may be made in one piece with the inner wall 5 or with the outer wall 4. The ribs may also be connected to the outer and inner walls alternately. The tube 5 forming the inner wall is also supported at 9 by the body of the casing and made tight against the steam chamber by a stuffing box 10, 11. The admission of the gas delivered or of the air to be delivered occurs in two places, centrally through the inside of the tube 5 by means of the apertures 12 at the rear end thereof to which it gains access through the flanged inlet 13.

The portion of the gas to be delivered which does not flow through the aperture 12 reaches the annular space 14 and comes into contact with the outer surface of the conical steam jet issuing from the end of the nozzle. At the front end of the casing

1 a flange 15 is provided by means of which the ejector casing is coupled in the usual way with a conical ejector tube 16. At the rear end the ejector casing is closed by means of a cover 17.

It is evident that in the construction adopted a very accurate centering of the walls of the annular nozzle is obtained and that there is no longer any danger of any deviation or any inequality arising in the cross section of the passage or of even any contact of the walls with the nozzle at point 18 where the cross section of the nozzle is smallest. It will be seen, that the inner diameter of the outer wall widens conically at 20 from the point 18 of the narrowest cross section towards the orifice 19, whilst the outer surface of the inner wall 21 gradually decreases.

Fig. 2 illustrates a modified form of construction where the portion of the outer wall of the nozzle which lies between the point of the smallest cross section 18 and the orifice 19 is provided with longitudinal grooves 22. The said longitudinal grooves are made of uniform width, whilst their depth increases gradually towards the orifice of the annular nozzle. The inner wall of the annular nozzle is constructed in the same manner as in Fig. 1 i. e. with a smooth surface. However in accordance with the invention the inner walls of the nozzle instead of the outer ones may be provided with similar grooves. If desired, both walls of the nozzle may be provided with such grooves.

Owing to the particular form of the walls of the nozzle, the issuing jet of the active medium (steam) assumes an undulated surface and thus provides a considerably larger surface of contact with the gas to be delivered. In consequence of this arrangement the useful effect of the delivery is considerably augmented so that for a given large quantity of air or gas to be delivered the consumption of steam i. e. the working medium is comparatively small.

What we claim is:

1. A steam gas or vapour operated gas or air ejector for the delivery of large quantities having an annular nozzle centrally arranged in the casing of the ejector for the inlet of the working medium, characterized by the fact that in rear of the smallest cross section (18) of the annular nozzle the outer wall (4) and the inner wall of the nozzle (5) which is independent of the former run concentrically for a considerable distance and the space (6) between them is divided into a circle of passages (8) by radial or helical ribs (7) extending in an axial direction whilst both walls of the nozzle are centered relatively to each other by said ribs.

2. The invention as claimed in claim 1,

wherein one of the opposed and nozzle-defining walls is provided with axially extending grooves, which grooves provide an undulating surface for the jet issuing from the nozzle.

3. The invention as claimed in claim 1, wherein both of the opposed and nozzle-defining walls are provided with axially extending grooves, which grooves provide an undulating surface for the jet issuing from the nozzle.

4. In a large capacity ejector for delivering air or gases, coaxial tubular walls defining therebetween an annular space for the passage of a motive fluid, the cross section of said annular space at an intermediate section being smaller than at either end thereof, a plurality of ribs between said tubes and in rear of the smaller cross section for maintaining the coaxial alignment of said tubes.

5. In a large capacity ejector for delivering air or gases, a casing, coaxially arranged tubes in said casing and having opposed walls defining therebetween an annular space for the passage of a motive fluid, the cross section of said space contracting from the outer ends of said tubes to an intermediate section thereof, means in rear of said intermediate section for maintaining said tubes in coaxial alignment, means permitting the delivery of motive fluid to said annular space at the rear thereof, and means permitting the delivery of air or gases to the inside of the inner tube and around said outer tube.

6. In an ejector for delivering gas or gases, a casing, a motive fluid passage leading into said casing and terminating in an annular chamber, a wall extending forwardly from said chamber providing a cylindrical outer nozzle member, a second cylindrical nozzle member within said outer member and ribs between said members for maintaining the same in coaxial alignment, said ribs terminating in rear of the outlet end of said nozzle, whereby an annular stream of motive fluid may be delivered therefrom.

7. In an ejector, a casing, a motive fluid chamber within said casing, a passage extending from the exterior of said casing to said chamber for delivering motive fluid thereto, a cylindrical wall extending forwardly of said chamber to provide an outer nozzle member, a second cylindrical member having the rear portion thereof supported

by and in fluid tight engagement with the rear wall of said chamber, and spacing ribs between said members adjacent said chamber for maintaining the same in coaxial alignment, the opposed walls of said members diverging from each other towards the outlet end of said nozzle to provide space of increasing cross-section for the passage of the motive fluid.

8. In an ejector, a nozzle having inner and outer members defining an annular passage through which motive fluid may be delivered, one of the opposing walls provided by said members being grooved, whereby the jet of motive fluid assumes an undulating surface.

9. In an ejector, a pair of tubular members defining a nozzle, the passage through said nozzle being of smallest cross-section at an intermediate section thereof, spacing means between said members in rear of the smallest cross-section for maintaining said members in coaxial alignment, one of the opposing walls provided by said members being formed with grooves which gradually increase in cross-section from the smallest cross-section of said nozzle towards the outlet end thereof.

10. The invention as claimed in claim 9, wherein said grooves are of uniform width throughout their length and of gradually increasing depth towards the nozzle end.

11. In an ejector for air or gases, a nozzle comprising an inner member having an outer wall of gradually increasing diameter from the nozzle end towards the rear thereof, and an outer member having an inner wall provided with spaced axial grooves opposing the tapering wall of said inner member.

12. In an ejector for air or gases, a nozzle comprising a pair of tubular members, longitudinally extending ribs between said members for maintaining the same in coaxial alignment, said ribs terminating short of the outlet end of the nozzle to provide an unobstructed annular outlet for said nozzle, axial grooves of increasing cross section extending along the wall of one of said members from a point in front of said ribs to the end of said nozzle, the wall of the other member gradually diverging from said grooved wall.

In testimony whereof we have hereunto set our hands.

JAKOB MULDER.

DIRK CHRISTIAAN ENDERT.