July 12, 1938. F. W. WALCH 2,123,346

STEAM JET PUMP

Filed March 10, 1937 2 Sheets-Sheet 1

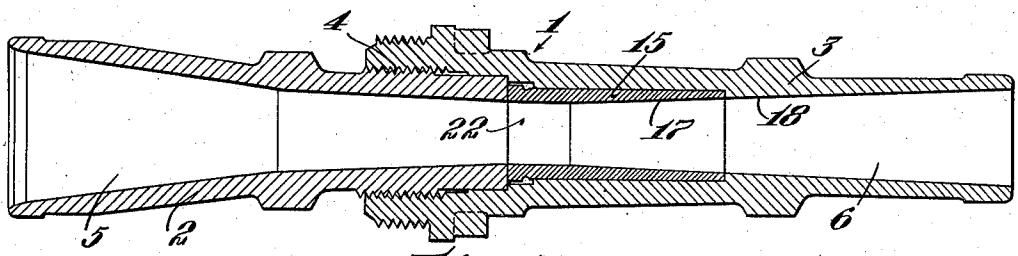

Fig. 1

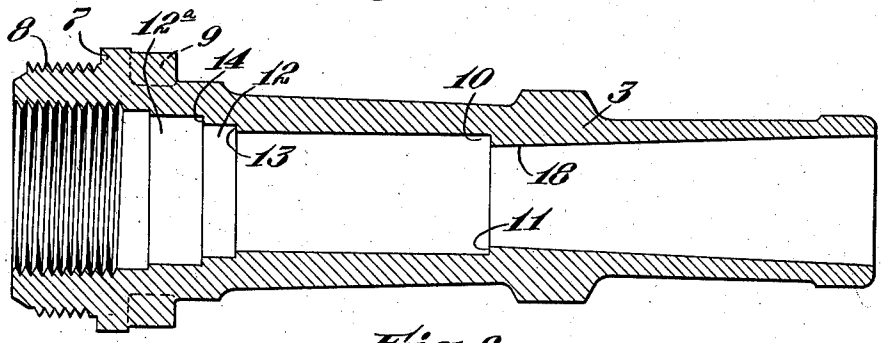

Fig. 2

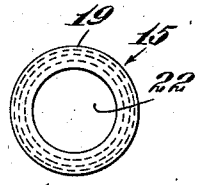

Fig. 4

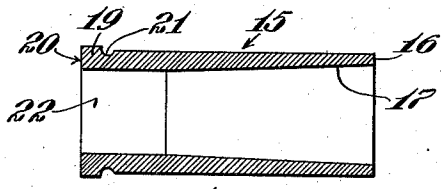

Fig. 3

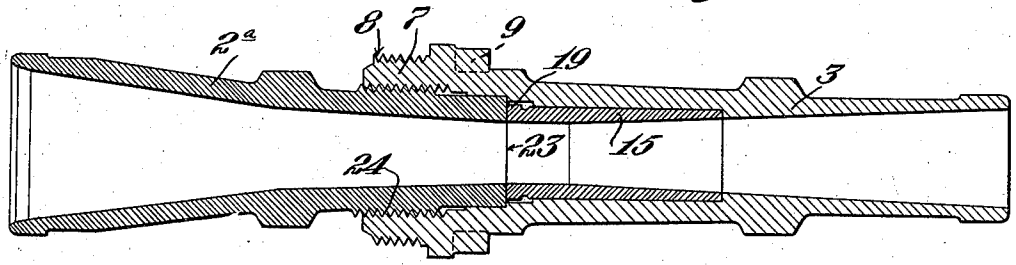

Fig. 5

Inventor
Frederick W. Walch
by Roberts Cushman & Woodbury
Att'ys.

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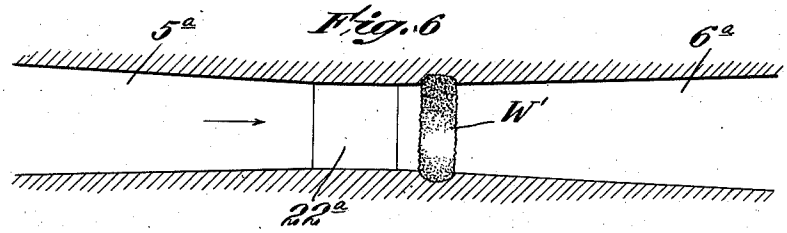
Fig. 6



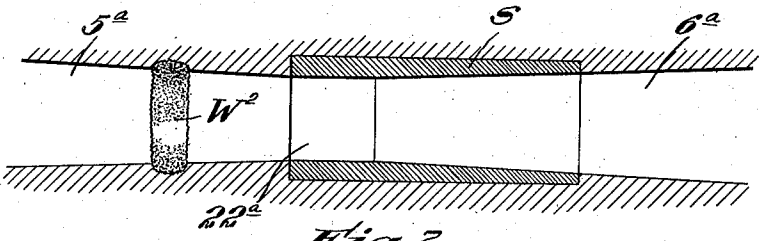


Fig. 7

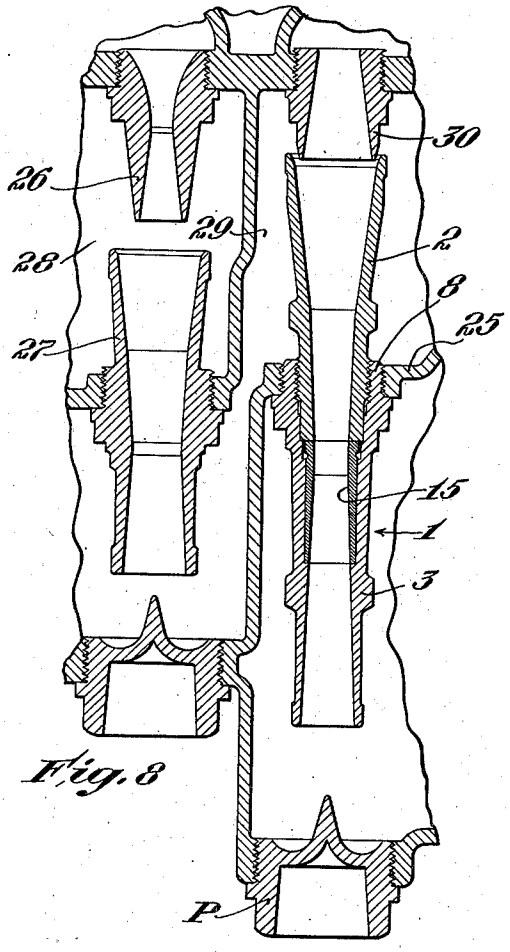


Fig. 8

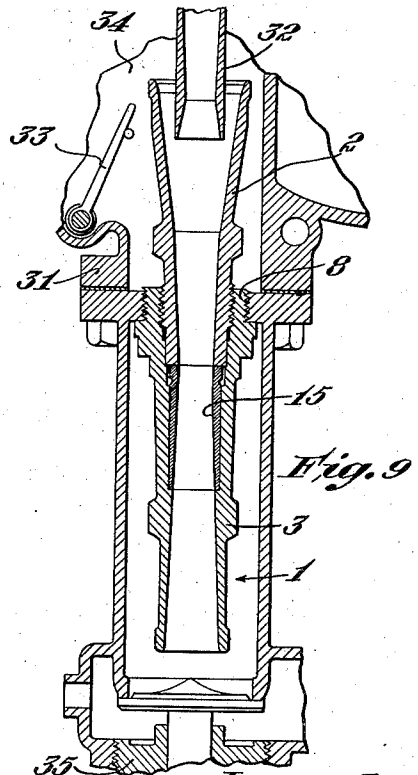


Fig. 9

Inventor
Frederick W. Walch
by Roberts Cushman & Woodberry
Atty's.

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UNITED STATES PATENT OFFICE

2,123,346

STEAM JET PUMP

Frederick W. Walch, Newton Center, Mass., assignor, by mesne assignments, to Manning, Maxwell & Moore, Incorporated, New York, N. Y., a corporation of New Jersey

Application March 10, 1937, Serial No. 130,053

3 Claims. (Cl. 103—278)

This invention pertains to improvements in steam jet pumps of the type commonly known as injectors or inspirators, and relates more particularly to improvements in that element of such a pump known as the forcer tube, from which the water, in the form of a high pressure jet, is delivered to the feed pipe leading to the boiler. Forcer tubes ordinarily comprise parts collectively providing an elongate passage including axially aligned converging and diverging portions, and usually these converging and diverging portions of the passage are formed in separate members of the forcer tube, known respectively as the combining and delivery tube sections.

As pointed out and more fully described in the patent to F. W. Walch, No. 2,032,674, dated March 3, 1936, injectors are of two general types, to wit, axial flow injectors and non-axial flow injectors, but in both types a forcer tube is an essential element, and the present invention is applicable to and useful in either type of injector.

In the Walch patent just referred to it is shown how certain advantageous results follow from the use of a forcer tube which is wholly devoid of lateral outlets from its receiving end to its delivery end and wherein the bore is as smooth as it is practicable to make it. It was also pointed out that in such tubes wear first begins to show itself in a zone just forward of the section of smallest diameter, and it was suggested that the useful life of the tube might be prolonged by the provision of a wear-resistant inner surface at this part of the tube where wear first begins to develop, it being noted that forcer tubes of this type usually, for ease in manufacture, are made from a relatively soft material such as brass or bronze.

Further experiment and practical experience with such tubes has shown that when such a wear-resistant lining is provided at the point just referred to where wear normally first begins to show itself, the life of the tube is in fact greatly prolonged as compared with that of the ordinary tube, but that wear eventually begins to take place in the combining section of the tube, for example, adjacent to the point at which the taper of the tube merges with the usual cylindrical portion of minimum diameter. If, in an attempt to avoid the occurrence of wear at this latter point, a wear-resistant lining be inserted in this part of the tube, injurious wear is put off for a further period, but eventually begins to appear at points nearer and nearer to the receiving end of the combining tube so that the ultimate solution would seem to lie in making the entire combining tube of wear-resistant material. However, by reason of the fact that in the usual tube the attaching flange or enlargement, by means of which the tube is supported in the casing of the injector, is an integral part of the combining tube section, it is, as a practical matter, impossible to make the entire combining tube of hard material like stainless steel on account of the difficulty of machining such a tube so as to provide the necessary attaching elements and the usual wrench-receiving parts. On the other hand, due to the generally tapering section of the tube, it is difficult, if not impossible, as a practical matter, to use a hard, wear-resistant lining sleeve, for example, of stainless steel, extending from end to end of the combining section.

One object of the present invention is to provide a forcer tube of simple construction which may be made at a cost such that it is practical, from the commercial standpoint, but which will be highly wear-resistant and have a long useful life regardless of the conditions under which it is employed. To this end it is proposed, in accordance with the present invention, to make the delivery tube section of any usual material, for example, brass or bronze, which may readily be machined, and to form the attaching elements and wrench-receiving parts integral with this section of the tube. Within this part of the tube is placed a removable wear-resistant liner at the zone at which wear normally first begins, and to make the entire combining tube section of a hard, wear-resistant material such as stainless steel, the simple threading of the combining tube necessary to attach it to the delivery tube being relatively easy to perform even on this hard material. Thus the life of the tube may be prolonged very greatly as compared with that of the ordinary tube, nor is it necessary to resort to such expensive and difficult prior proposed devices for solutions of the problem as the use of an elongate wear-resistant liner comprising substantial portions of both the convergent and divergently tapered parts of the bore.

Heretofore, when a removable wear-resistant liner sleeve has been employed, for example, in the delivery tube section, such liner tube has been of substantially cylindrical shape having substantially the same external diameter from end to end, although its bore properly diverges from its rear end toward its forward end. These liner sleeves are commonly removed for inspection and replacement by employees of the rail-

road on which the injector is used,—sometimes by persons who are not especially careful or of high discernment, with the result that it frequently happens that in reinserting the liner it is placed in the delivery tube section with the smaller end of its bore forward. In consequence of such improper assembly of the liner with the tube the injector refuses to work, perhaps at a time when greatly needed. The injector must then again be dismantled and the liner tube removed and correctly replaced and the injector parts reassembled, all of which causes annoyance, loss of time, and unnecessary expense.

A further object of the invention is to provide a forcer tube wherein the removable liner sleeve and the associated parts are so devised that the liner sleeve can not be inserted incorrectly, either by reason of ignorance or carelessness.

Further objects and advantages of the invention will be made manifest in the following more detailed description and by reference to the accompanying drawings, wherein

Fig. 1 is a longitudinal diametrical section illustrating a forcer tube embodying certain desirable features of the present invention;

Fig. 2 is a longitudinal diametrical section, to larger scale, showing the improved delivery tube section alone, with the liner sleeve removed;

Fig. 3 is a longitudinal diametrical section of the wear-resistant liner removed from the tube;

Fig. 4 is an end elevation of the sleeve of Fig. 3;

Fig. 5 is a longitudinal diametrical section illustrating another embodiment of the invention;

Figs. 6 and 7 are diagrammatic views, to large scale, indicating places where wear commonly occurs in tubes of previous constructions;

Fig. 8 is a fragmentary vertical section through an injector of the non-axial flow type showing the improved forcer tube of the present invention installed therein; and

Fig. 9 is a fragmentary vertical section through an injector of the axial flow type showing a forcer tube in accordance with the present invention embodied therein.

Referring to the drawings, the numeral **1** designates a forcer tube embodying certain aspects of the present invention, such tube comprising the combining section **2** and the delivery tube section **3**. The combining and delivery sections are separably united by screw-threaded connections at **4** and are furnished respectively with converging and diverging bores **5** and **6** which are axially aligned, with their small ends adjacent to each other, and form a continuous passage devoid of any lateral outlets from the inlet end to the delivery end of the tube. As illustrated in Figs. 1 and 2, the delivery section **3** is provided with an integral enlargement or flange portion **7** near its rear end, such flange portion adjoining an externally screw-threaded nipple portion **8** designed for engagement with a complemental screw-threaded opening in a part of the injector casing in which the tube is to be mounted. While screw threads are here shown as the elements by which the delivery tube section is secured to the casing, it is contemplated that other and equivalent means may be employed. Preferably the enlargement or flange **7** is also furnished with integral elements **9** for engagement by a suitable wrench or equivalent tool whereby the section **3** may be screwed into place or removed.

As illustrated in Fig. 2, the bore of the delivery section **3** is provided with a cylindrical enlargement **10** constituting an elongate chamber for the reception of a liner sleeve and terminating at its forward end at a shoulder **11**. This chamber has an enlargement or recess **12** at its rear end, the forward end of which is defined by a shoulder at **13**. To the rear of this recess **12** there is a further enlargement of the bore, indicated at **12a**, designed for the reception of the forward smoothly cylindrical end of the combining tube section **2**, the extreme forward end of said latter section abutting the shoulder **14**.

The elongate cylindrical chamber **10** is designed to receive a removable wear-resistant liner sleeve **15** (Fig. 3). This liner sleeve has a substantially cylindrical body portion of an external diameter substantially equalling the diameter of the chamber **10** and terminating at its forward end in a radial surface **16** adapted to abut the shoulder **11** of the tube section **3**. This wear-resistant liner **15** is provided with a forwardly divergent bore **17** whose inner surface, at its forward end, is designed to merge smoothly with the inner surface **18** of the forwardly divergent bore **6** of the tube section **3**. At its rear end the liner **15** is provided with an enlargement **19** of somewhat greater external diameter than the body portion of the liner, and adapted to be received within the recess **12** of the tube section **3**. The extreme rear end of the liner **15** is faced off at **20** to provide a radial surface against which the forward end of the combining tube section **2** abuts when the parts are assembled. Between the enlargement **19** and the main body of the liner **15** there may be formed a peripheral groove **21** for convenience in the machining of the parts.

It is to be noted that by reason of the enlargement **19** at the rear end of the liner sleeve **15** it is impossible to insert the liner rear-end-foremost into the section **3**, that is to say to so insert the liner that the small cylindrical portion **22** of its bore shall be directed forwardly. This feature is of very considerable importance from the practical standpoint, since it makes it impossible for anyone, either through carelessness or lack of knowledge, to assemble the parts improperly. Since considerable time is consumed in removing the parts from the injector and reassembling them, the improper assembly of the parts means loss in time and sometimes great annoyance, if the error is not discovered until it is necessary to use the injector, for the injector will not start unless the liner is properly positioned. While as here illustrated the liner **15** and the chamber which receives it are of cylindrical contour, it is contemplated that the liner **15** might be externally tapered from its rear end toward its forward end and that the chamber **10** might likewise be tapered, thus preventing the insertion of the liner wrong-end-foremost and without necessitating the provision of the special recess **12** and enlargement **19**.

In the structure shown in Figs. 1 to 4, it may be assumed that the tube section **3** is of some material which is readily cast or machined such, for example, as brass, bronze or cast iron so that the attaching elements **8** and the wrench-engaging parts **9** may readily be formed therein. Likewise the combining tube section **2** may be of a similar material, if desired, but the liner **15** is of a hard corrosion-resistant material such for example as stainless steel. Since this part **2** is of simple form it is practical to make it from such a refractory material, as the dimensioning

operations may, if necessary, be performed by grinding.

It may be noted that the rear portion of the bore in the lining 15 is, as shown at 22, substantially cylindrical, it being common in forcer tubes of this type to provide a short substantially cylindrical bore between the adjacent small ends of the convergent and divergent bores 5 and 6, respectively. It is, at this point, or just forward of this point, at which wear commonly takes place. This is indicated diagrammatically in Fig. 6 where the convergent and divergent portions 5^a and 6^a of a forcer tube are indicated, and also the cylindrical portion 22^a of the bore intervening between them. When a forcer tube of this general type is made of material such as brass or bronze, as has heretofore been common, a short period of use will develop minute pits and eventually an annular zone W^1 which is rough and which eventually may actually constitute an annular recess. The presence of such roughness or recess greatly impairs the efficiency of the tube and may eventually cause it to fail to operate.

As previously pointed out, it has been proposed to prolong the life of the tube by inserting a wear-resistant element at the point where this first zone or wear W^1 usually develops. In Fig. 7 the ultimate result of introducing such a wear-resisting sleeve S at this point is diagrammatically indicated. When such a sleeve is used, the life of the tube is greatly prolonged, as compared with ordinary tubes, but eventually wear begins to show itself in the combining tube at some point, for example, W^2 to the rear of the cylindrical portion 22^a of the bore and quite commonly at a point where the taper of the bore changes, such slight changes in taper being usually present in view of the difficulty of making a single continuous smoothly curved tapering passage from one end to the other of the tube section. If another wear-resistant liner be inserted so as to protect the area of wear at W^2, other areas of wear will show themselves at points nearer and nearer to the entering end of the combining tube. Thus the logical procedure would be to make the entire combining tube section of wear-resistant material. Such an arrangement is illustrated by way of example in Fig. 5 wherein, in general, the forcer tube is of the type disclosed in Fig. 1 and wherein like numerals indicate the same parts as in Fig. 1. However, in the construction shown in Fig. 5 the entire combining tube section 2^a is of a hard wear-resistant material, such as stainless steel or other erosion and corrosion-resistant alloys. However, since this tube section, as here shown, requires little machine work, except that necessary to form the attaching screw threads at 24 and for facing off the forward end of the tube section at 23, it is practical to make such a tube section from this hard wear-resistant material, it being noted that the elements 8 by which the tube structure is supported in the casing and also the parts 9 which receive the wrench, are formed in the section 3 which, as above noted, may be made of a relatively soft material capable of being cast and/or machined.

While it may not be necessary under all circumstances to make the entire combining tube section of wear-resistant material, it has been found that under extremely adverse conditions of use, the extra cost of making such a wear-resistant section is justifiable by reason of the greatly prolonged life of the forcer tube. However, the construction shown in Fig. 1 may provide a sufficiently long life under usual and ordinary conditions.

In Figs. 8 and 9 the improved forcer tube is shown as installed in injectors of non-axial flow type and of the axial flow type respectively. In Fig. 8 the injector of non-axial flow type is shown as comprising the lifter nozzle 26, the lifter tube 27 and the intervening water inlet chamber 28. The tube 27 delivers into a chamber 29 in which is mounted the forcer nozzle 30 and the forcer tube 1, the latter comprising the combining tube section 2, the delivery tube section 3, and the wear-resistant lining 15, the tube being of either of the forms illustrated in Fig. 1 or 5 of the drawings. It will be noted that the nipple 8 of the tube section 3 has screw-threaded engagement with an opening in a web 25 forming a part of the injector casing and that the tube 1 as a whole may be withdrawn from the injector casing in an axial direction by first removing the plug P.

In Fig. 9 the improved forcer tube 1 is shown as mounted in the casing 31 of an injector of the axial flow type. This injector comprises the forcer nozzle 32 which draws water from the water chamber 34 having the inlet check valve 33. The forcer tube 1 comprises the combining tube section 2, the delivery tube section 3 and the wear-resistant lining 15, and its nipple 8 has threaded engagement with an opening in a septum forming a part of the casing 31. The entire tube structure may be removed axially from the casing by first removing the plug 35 which supports the boiler check valve.

While certain desirable embodiments of the invention have been shown by way of example, it is to be understood that the invention is not necessarily limited thereto but is to be regarded as broadly inclusive of all equivalent elements falling within the terms of the appended claims.

I claim:

1. A forcer tube for injectors comprising a combining tube section and a delivery tube section, said sections having converging and diverging bores, respectively, disposed with their smaller ends adjacent to each other and collectively forming a passage devoid of lateral outlets from its receiving to its delivery end, the delivery tube section having integral attaching means for cooperation with complemental attaching means of an injector casing thereby to support the entire tube structure in the casing, the bore of the delivery tube section being enlarged at its rear part to provide a liner receiving chamber, said chamber being enlarged in diameter twice in succession at its rear end, and a tubular liner of hard, wear-resistant material disposed in said chamber, said liner having a bore which comprises a cylindrical rear portion and a forwardly flaring front portion and which merges smoothly with the inner wall of the delivery tube proper, the external configuration and dimensions of the liner being such that it can be entered into the receiving chamber only when the wider end of its bore is directed forwardly, the forward end of the combining tube being housed in the rearward enlargement of the bore of the delivery tube and abutting the rear end of the liner.

2. A forcer tube for injectors comprising a combining tube section and a delivery tube section, said sections having converging and diverging bores, respectively, disposed with their smaller ends adjacent to each other and collectively forming a passage devoid of lateral outlets

from its receiving to its delivery end, one of said tube sections having an integral enlargement provided with attaching elements for cooperation with complemental attaching elements of an injector casing thereby to support the tube structure in the casing, the bore of the delivery tube section being diametrically enlarged at its rear part to provide an elongate liner receiving chamber, said chamber being enlarged in diameter twice in succession at its rear end to furnish two annular recesses, and a liner sleeve of hard, wear-resistant material having a bore which comprises a cylindrical rear portion and a forwardly flaring front portion and which merges smoothly with the inner wall of the delivery tube proper, said lining sleeve being of an external dimension such as to fit snugly in the aforesaid receiving chamber of the delivery tube section and having an external radial enlargement at its rear end which is housed within the annular recess of lesser diameter, the forward end of the combining tube being received within the recess of greater diameter, said enlargement of the liner being of too great diameter to enter the main portion of the elongate chamber, thereby to prevent insertion of the liner sleeve into the delivery section with its rear end foremost.

3. A forcer tube for injectors comprising a combining tube section and a delivery tube section, said sections having converging and diverging bores, respectively, disposed with their smaller ends adjacent to each other and collectively forming a passage devoid of lateral outlets from its receiving to its delivery end, the delivery tube section having integral attaching means for cooperation with complemental attaching means of an injector casing thereby to support the entire tube structure in the casing and also having integral wrench-engaging parts, the delivery tube section being of a material easily machined, wear-resistant material forming a lining for the delivery tube section at that portion of the latter at which wear normally first appears, the entire combining tube section being of hard, wear-resistant material, and means operative removably to unite the combining tube to the delivery tube.

FREDERICK W. WALCH.