Feb. 11, 1941. E. G. ROSS 2,231,090

EJECTOR

Filed April 14, 1939 3 Sheets-Sheet 1

Fig. 1

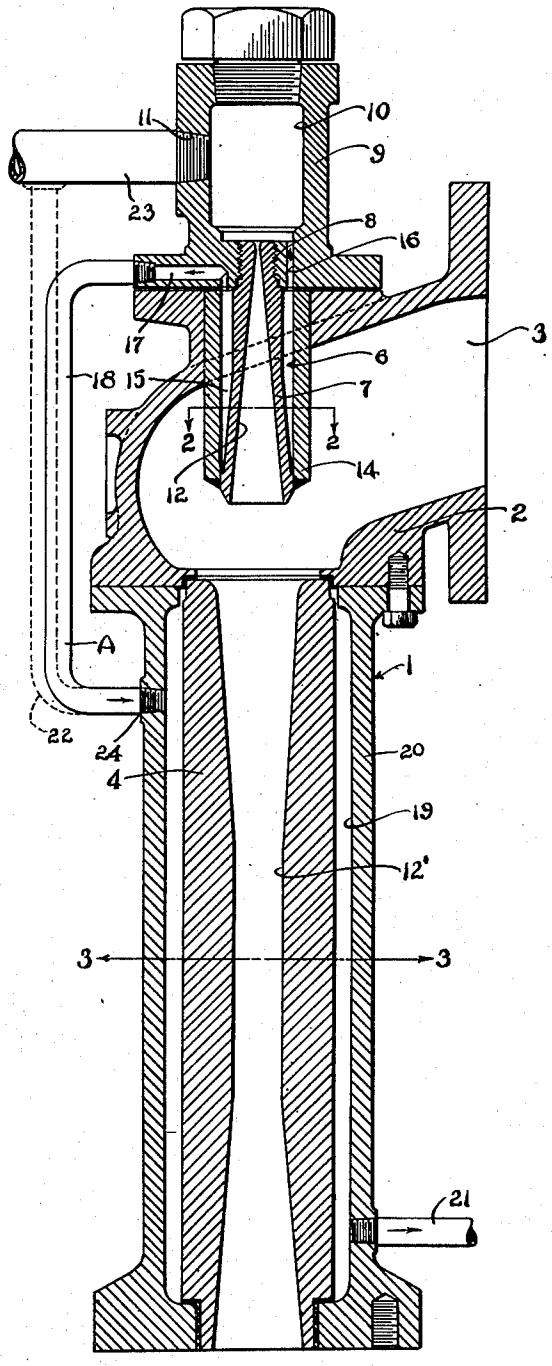


Fig. 2

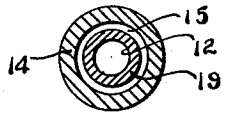
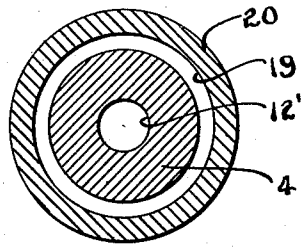


Fig. 3



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Feb. 11, 1941. E. G. ROSS 2,231,090

EJECTOR

Filed April 14, 1939 3 Sheets-Sheet 2

Fig. 4

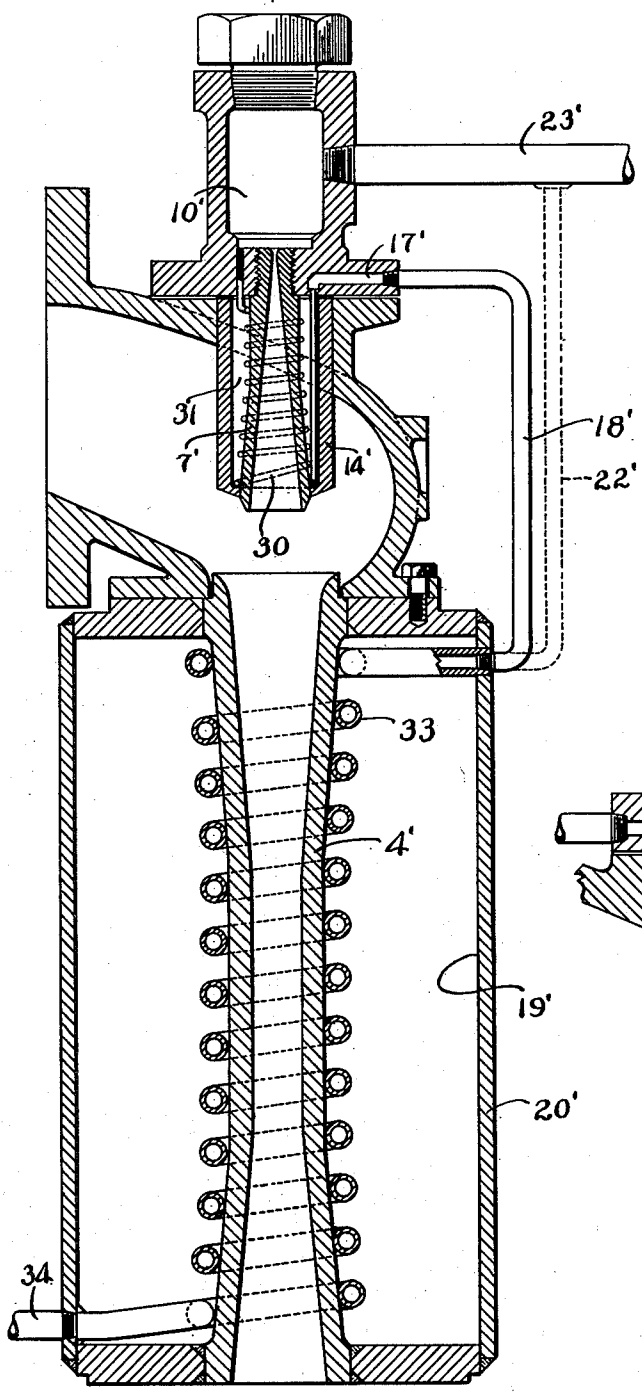


Fig. 5

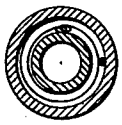
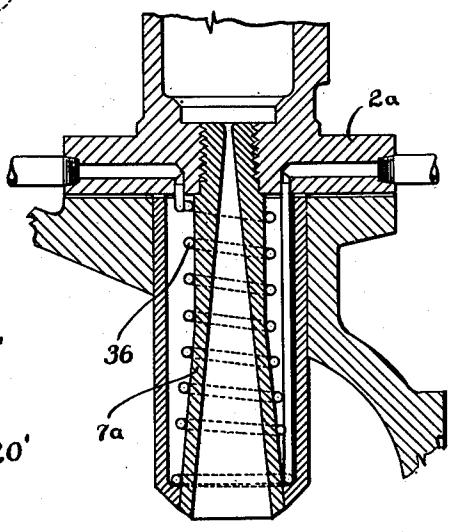


Fig. 6



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Feb. 11, 1941. E. G. ROSS 2,231,090

EJECTOR

Filed April 14, 1939 3 Sheets-Sheet 3

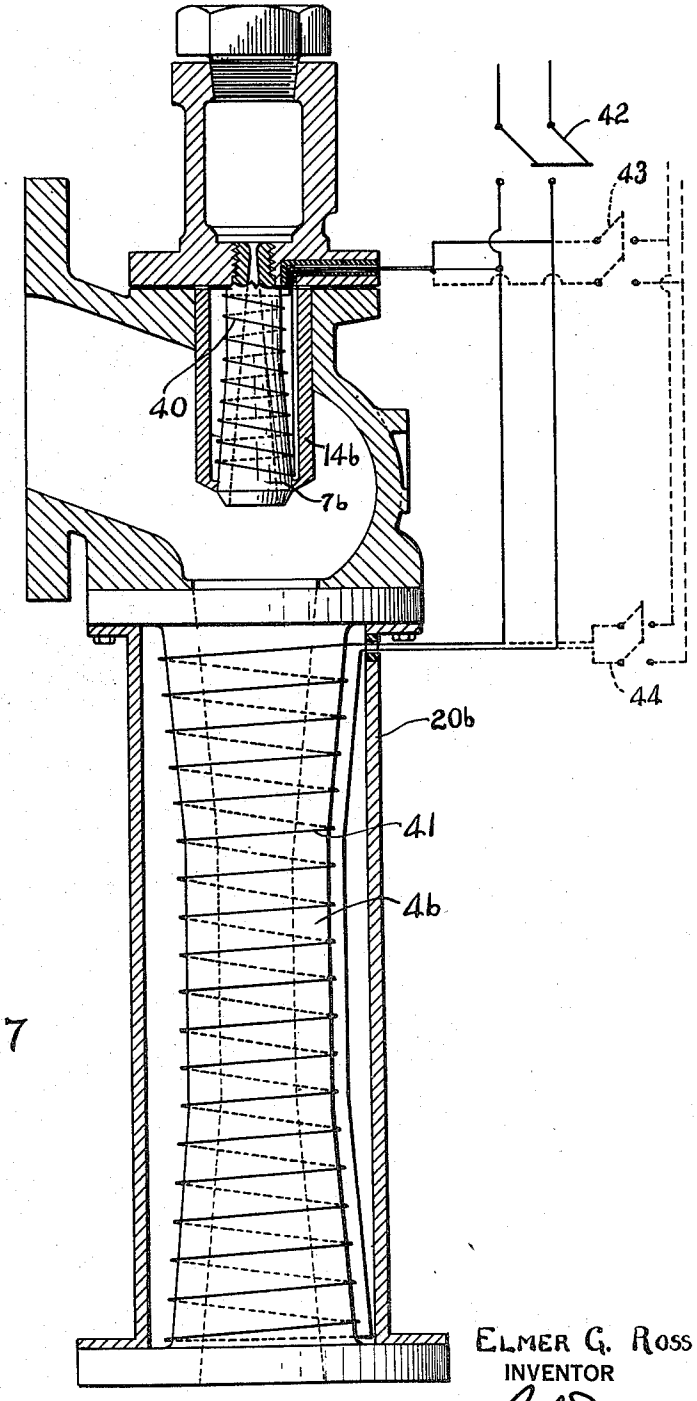


Fig. 7

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UNITED STATES PATENT OFFICE

2,231,090

EJECTOR

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Application April 14, 1939, Serial No. 267,936

18 Claims. (Cl. 230—95)

This invention relates to ejectors, preferably of the steam jet type, operating at exceedingly high vacuums or at low absolute pressures.

During the operation of steam jet ejectors, when operating at low absolute pressures such as less than 4½ mm., or when handling a gas that will freeze at relatively low pressures and temperatures, ice forms on the inside of the steam nozzle and/or on the inside of the diffuser, choking the passageways and interfering with the efficiency of the ejectors.

An object of the present invention is to provide means for heating the nozzle or diffuser or both, as conditions may require, to prevent the formation of such ice and the consequent reduction of the efficiency of the ejectors.

With these and other objects in view, as may appear from the accompanying specification, the invention consists of various features of construction and combination of parts, which will be first described in connection with the accompanying drawings, showing an ejector of the preferred form embodying the invention, and the features forming the invention will be specifically pointed out in the claims.

In the drawings:

Figure 1 is a longitudinal section through an ejector constructed in accordance with the present invention.

Figure 2 is a cross-section taken on the line 2—2 of Figure 1.

Figure 3 is a cross-section taken on the line 3—3 of Figure 1.

Figure 4 is a longitudinal section through a modified form of the invention.

Figure 5 is a cross-section on the line 5—5 of Figure 4.

Figure 6 is a fragmentary section of a further modified form of the invention, being a modification of the structure shown in Figures 4 and 5.

Figure 7 is a longitudinal section through a still further modified form of the ejector and its heating means.

Referring more particularly to the drawings, and with particular reference to the preferred form of the invention shown in Figures 1 to 3 inclusive, the ejector comprises the diffuser body 1 having the nozzle head 2 attached thereto in any suitable manner, and the nozzle head 2 has the air or gas inlet or suction passage 3 formed therein which opens into the inlet of the diffuser 4, as is usual in the construction of ejectors.

The nozzle head 2 carries the steam nozzle structure 6, which discharges into the inlet of the diffuser in the usual manner. The nozzle structure 6 includes the nozzle 7, which is detachably connected in any suitable manner, as shown at 8, to the steam inlet connection 9, which may or may not have an inlet chamber 10 therein, as desired. The steam employed for operating the ejector comes from any suitable source (not shown) through the steam inlet 11 and passes through the diverging bore 12 of the nozzle 7 into the diffuser 4.

Ejectors operating at low absolute pressures, such as less than 4½ mm. or handling a gas that will freeze at relatively low pressures and temperatures, have been found subject to impairment of their efficiency by the formation of ice in the bore 12 of the nozzle 7 near its outlet and/or in the diverging, converging bore 12' of the diffuser 4. To prevent the formation of such ice, the present invention embodies means for heating the nozzle 7 and/or the diffuser 4.

In the structure shown in Figures 1 to 3 of the drawings, a heating jacket 14 is formed about the nozzle 7 providing a chamber 15 which has communication with the steam inlet of the nozzle 7 through a passage 16, so that live steam entering the chamber 10 or the inlet passage of the ejector will pass through the passage 16 into the chamber 15 and have direct contact with the exterior of the nozzle 7 for heating it to prevent the accumulation of ice on its inner surface or the walls of the bore 12. The steam circulates through the chamber 15 and passes therefrom through an outlet passage 17. In Figure 1 of the drawings the outlet passage 17 is connected by a pipe 18 with the heating or steam chamber 19 which surrounds the diffuser 4. The chamber 19 is formed between the diffuser 4 and the jacket-forming, diffuser-carrying jacket 20. The chamber 19 has an outlet 21 for the steam which may be opened to atmosphere or may be connected to any desired point.

If it is so desired, the outlet 17 may open directly to atmosphere or to any other suitable point, and a separate pipe, as indicated in dotted lines at 22, may have direct connection with the steam supply pipe 23 and the steam inlet 24 of the chamber 19.

In the modified form of the invention shown in Figures 4 and 5 of the drawings the nozzle 7' is heated by means of a steam coil 30, which is coiled about the nozzle in contact therewith, and is enclosed in the heating chamber 31 formed within the jacket 14'. The inlet end of the coil 30 opens into the chamber or steam inlet passage 10', so that live steam from the steam inlet will be delivered directly into the coil. The outlet end

of the coil is connected to the passage 17', which may be open to atmosphere, or as shown in Figure 4, may be connected to the inlet end of the coil 33. The coil 33 is coiled about and contacts the outer wall of the diffuser 4', and is enclosed within the heating chamber 19' formed about the diffuser 4' by the jacket 20'. The outlet of the coil 33 is preferably at the lower end of the chamber 19', as shown at 34.

As in the form of the invention shown in Figures 1 to 3 inclusive, the coil 33 may receive its steam direct from the steam inlet pipe 23' through a pipe connection such as the dotted line connection 22', at which time of course the outlet 17' of the coil 30 will not be connected to the inlet of the coil 33 by means of the pipe 18'.

Figure 6 of the drawings shows a construction which is similar to the upper half or nozzle heating part of the structure shown in Figure 4, including a coil 36, which is coiled about the nozzle 7a, in contact therewith, for heating the nozzle to prevent formation of ice on the nozzle. Unlike the structure shown in Figure 4, however, the inlet of the coil 36 is shown as passing out through the head 2a, and it has connection with any suitable supply (not shown) of a heating medium, which may be steam, hot water, or any available and suitable medium for imparting the necessary heat to the nozzle 7a to prevent the formation of ice therein. A similar arrangement may be employed in connection with the coil 33 shown in Figure 4 by merely connecting the pipe 22' to any suitable source of heating medium other than to the steam supply 23', without departing from the spirit of the present invention.

Figure 7 shows a still further modification of the means of heating the nozzle and/or the diffuser of the ejector. In this modified form an electrical heating coil 40 is coiled about the nozzle 7b and a second heating coil 41 is coiled about and in contact with the diffuser 4b. These coils 40 and 41 may be of any approved type of electrical heating coil, and they are enclosed in suitable jackets 14b and 20b to prevent their engagement with the steam, air and/or gas passing through the ejector. The energizing of the coils 40 and 41 may be through any suitable medium, and the coils may be simultaneously energized, such as by the closing of a single switch as indicated in solid lines at 42, or they may be independently energized by independent switches and circuits, as shown in dotted lines at 43 and 44.

From the foregoing description taken in connection with the accompanying drawings it will be apparent that various types of heating means have been provided for heating either the nozzle or the diffuser or both of an ejector operating at low absolute pressures so as to prevent the formation and accumulation of ice on the walls of the passages of the nozzle and diffuser and the consequent interference or impairment of the efficiency of operation of the ejector.

It will be understood that the invention is not to be limited to the specific construction or arrangement of parts shown, but that they may be widely modified within the invention defined by the claims.

What is claimed is:

1. In an ejector, a nozzle, a diffuser, a steam jacket about said nozzle having an inlet and an outlet for heating steam, and a steam jacket about said diffuser having an inlet for steam whereby said nozzle and diffuser may be heated to prevent formation of ice therein when the ejector is operating at low absolute pressures the inlets of said steam jackets receiving steam independently from the steam entering the inlet of the ejector.

2. In an ejector, a nozzle, a diffuser, a steam jacket about said nozzle having an inlet and an outlet for heating steam, and a steam jacket about said diffuser having inlet for steam whereby said nozzle and diffuser may be heated to prevent formation of ice therein when the ejector is operating at low absolute pressures, the outlet of said nozzle enclosing steam jacket being connected to the inlet of the diffuser enclosing steam jacket.

3. In an ejector, a nozzle, said ejector comprising an inlet passage for steam to said nozzle, a steam jacket about said nozzle having an inlet for steam opening into said steam inlet passage whereby the nozzle may be heated to prevent formation of ice therein when the ejector is operating at low absolute pressures said jacket having a steam outlet opening out independently of the steam passages of the ejector.

4. The method of preventing lowering of the efficiency of an ejector operating at low absolute pressures by the formation of ice within the ejector which consists in applying heat to the parts of the ejector subject to excessive cooling action when the back pressure in the ejector is reduced below the ice point.

5. The method of preventing lowering of the efficiency of an ejector operating at absolute pressures equal to or lower than four and one-half millimeters (4½ mm.) by formation of ice within the ejector which consists in utilizing part of the operating steam delivered to the ejector as a heating medium to heat the parts of the ejector subject to excessive cooling action when the back pressure in the ejector is reduced sufficiently to permit formation of ice in the ejector.

6. The method of preventing lowering of efficiency of an ejector operating at low absolute pressures by the formation of ice within the ejector which consists in utilizing part of the operating steam delivered to the ejector as a heating medium to heat the surfaces of the ejector swept by the steam.

7. The method of preventing lowering of the efficiency of an ejector operating at low absolute pressures by the formation of ice within the ejector which consists in utilizing part of the operating steam delivered to the ejector as a heating medium to heat the nozzle of the ejector and subsequently utilizing the nozzle heating steam to heat the diffuser of the ejector structure.

8. In an ejector, means to prevent the formation of ice on the surfaces of the ejector swept by operating steam when the ejector is operating at absolute pressures lower than four and one-half millimeters (4½ mm.), said means comprising steam jackets about the steam swept surfaces and having connection with the steam supply of the ejector, said jackets connected in series whereby the steam will pass successively from one jacket to the next in the series.

9. The combination with an ejector including a steam nozzle and a diffuser, of means to prevent the formation of ice on the surfaces of the ejector swept by the operating steam when the ejector is operating at absolute pressures lower than four and one-half millimeters (4½ mm.), said means carried by the ejector and arranged to deliver heat to the steam swept surfaces.

10. The combination with an ejector including a steam nozzle and a diffuser, of means to pre-

vent the formation of ice on the surfaces of the ejector swept by the operating steam when the ejector is operating at low absolute pressure, said means comprising means for delivering heat from a source other than the steam passing through the nozzle and diffuser to the surfaces swept by the steam flowing through the nozzle and diffuser.

11. The method of preventing lowering of the efficiency of an ejector operating at low absolute pressures by formation of ice within the ejector which consists in circulating part of the operating steam of the ejector about the exterior surfaces of the parts of the ejector subject to excessive cooling action when the back pressure in the ejector is reduced sufficiently to permit formation of ice.

12. In an ejector, a nozzle, a diffuser, means to prevent the formation of ice in the ejector when the ejector is operated at low absolute pressure comprising a jacket about said nozzle, and means within said jacket for heating the nozzle to counteract the chilling thereof effected by the low pressure operation of the ejector.

13. In an ejector, a nozzle, a diffuser, means to prevent the formation of ice in the ejector when the ejector is operated at low absolute pressure comprising a jacket about said nozzle, means within said jacket for heating the nozzle to counteract the chilling thereof effected by the low pressure operation of the ejector, and a second jacket about the diffuser, and heating means within the jacket surrounding the diffuser for heating the diffuser to counteract the chilling thereof effected by the low pressure operation of the ejector.

14. The combination with an ejector including a steam nozzle and a diffuser, of means to prevent the formation of ice on the surfaces of the ejector swept by the operating steam when the ejector is operating at low absolute pressure, said means comprising heating coils coiled about said nozzle and diffuser for delivering heat to the surfaces swept by the steam flowing through the nozzle and diffuser, said heating coils connected in series to permit flow of a heating medium from one coil to the other.

15. The combination with an ejector including a steam nozzle and a diffuser, of means to prevent the formation of ice in the ejector when the ejector is operating at low absolute pressures, said means comprising electrical heating coils coiled about said nozzle and diffuser for heating the parts of the ejector subject to excessive cooling action when the back pressure in the ejector is reduced sufficiently to permit formation of ice.

16. The combination with an ejector including a steam nozzle and a diffuser, of means to prevent the formation of ice within the ejector, said means including electrically operated heating means about the nozzle for heating the nozzle when the back pressure in the ejector is reduced sufficiently to permit the formation of ice.

17. The combination with an ejector including a steam nozzle and a diffuser, of means to prevent the formation of ice within the ejector, said means comprising electrically operated heating means about the nozzle and the diffuser for heating the nozzle and the diffuser and prevent the formation of ice in the ejector when the back pressure in the ejector is reduced sufficiently to permit the formation of ice.

18. The combination with an ejector including a steam nozzle and a diffuser, of means to prevent the formation of ice in the ejector, said means comprising steam coils coiled about the nozzle and about the diffuser for delivering heat to the nozzle and the diffuser to prevent the formation of ice when the back pressure in the ejector is reduced sufficiently to permit the formation of ice therein.

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