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JET CLEANER

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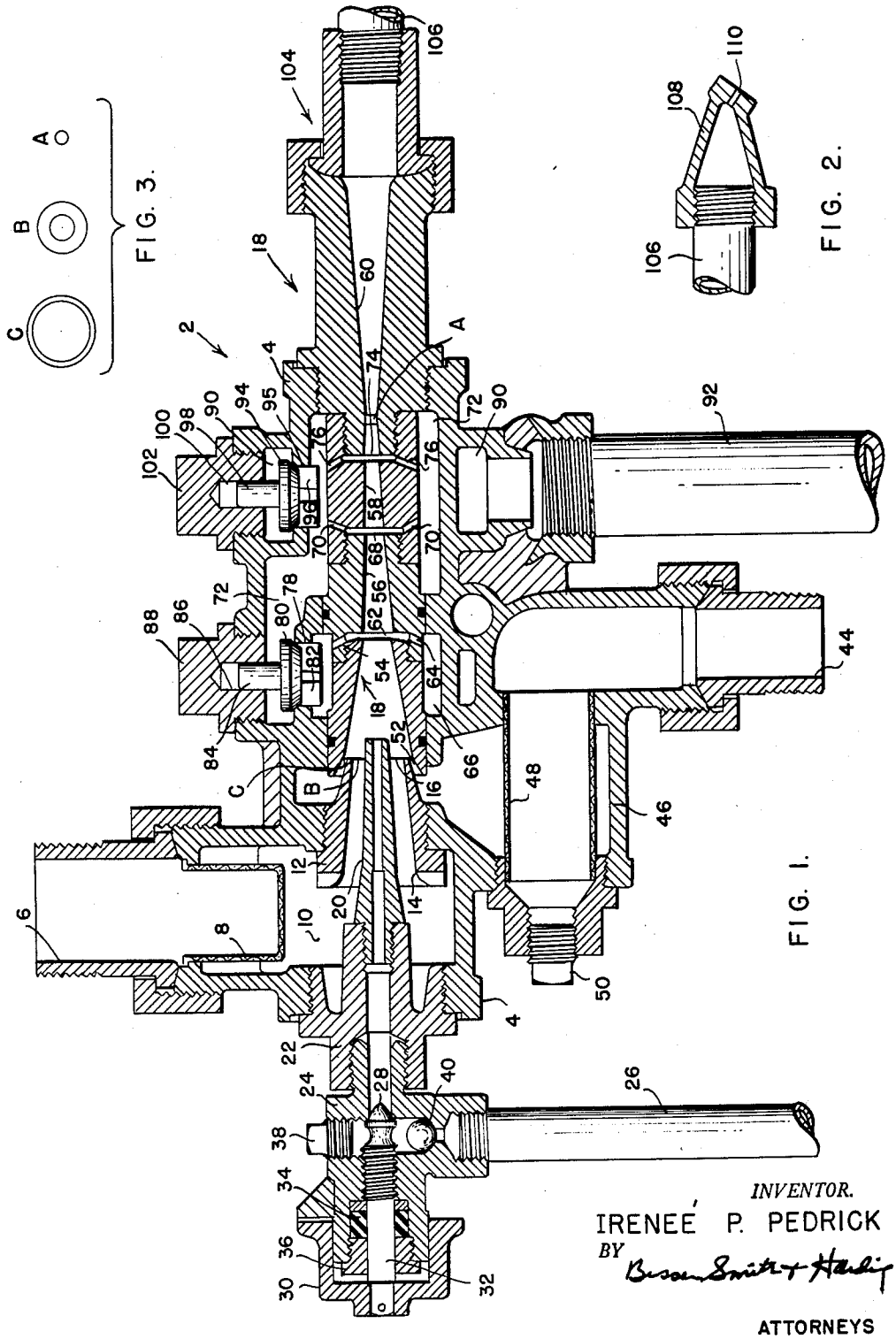



FIG. 1.




FIG. 2.




FIG. 3.

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# JET CLEANER

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1 Claim. (Cl. 261—18)

This invention relates to jet cleaners of the general organization, and in the specific embodiment, of the apparatus disclosed in my co-pending application, Serial Number 431,081, filed May 20, 1954, now abandoned, of which this application is a continuation.

In its broader and more general aspects the invention constitutes an especial improvement over that of my earlier issued patent, U.S. 2,176,682 (October 17, 1939). More particularly, the invention here provides novel structure making possible the production of a high pressure outlet stream of hot water (which may, for example, carry detergent, solvent or the like) developed from a relatively low inlet steam pressure source. The necessary, co-incident introduction of water normally is at relatively low pressure also.

My earlier issued patent, U.S. 2,176,682, provides an effective apparatus for producing an outlet jet of hot water at high pressure—but only with inlet steam available at high pressures. In order to develop such high outlet pressure jet with very low steam inlet pressure, I have discovered that it is necessary to make certain fundamental changes in my earlier structure. These consist in:

(*a*) Critical proportioning of specific annular or cross-sectional areas—as hereinafter more particularly explained.

(*b*) Streamlining of the annular steam entry passage at a constant-rate taper from inlet end to the discharge end located within a combining tube.

(*c*) Provision of a steam screen between the original inlet source of steam and the annular steam entry passage.

(*d*) A vacuum-holding valve preceding the water overflow valve of my patented structure and located adjacent the combining tube where low pressure steam and water meet to create the high vacuum resulting in high outlet jet stream pressure.

The combining of steam with water to provide a stream of hot water is known to the art. The apparatus in accordance with this invention, however, appears to have exceptional merit due to the fact that exceptionally high pressures are developed using relatively low pressure inputs of water and steam. Thus, for example, with an input of steam at 5 p.s.i. an output jet of water of 100 p.s.i. can be produced.

The broad object of this invention is to provide a jet cleaner which will produce a relatively high pressure hot water jet utilizing relatively low pressure inputs of steam and water and which can incorporate in the delivered jet of water a detergent, solvent, or the like.

This and other objects of this invention will become apparent on reading the description in conjunction with the drawings in which:

Figure 1 is a vertical cross-section of a jet cleaner in accordance with this invention.

Figure 2 is a view, partly in section, of a nozzle adapted for connection with the apparatus shown in Figure 1.

Figure 3 is a diagrammatic view illustrative of relative areas of parts of the apparatus shown in Figure 1.

As shown in Figure 1, a jet cleaner **2** in accordance with this invention has a casing **4** which may be made of any suitable material, such as iron or other metal or alloy and may, for example, be a casting.



Steam is introduced through an inlet **6** and passes through a screen **8** into chamber **10**. A nozzle **12**, threadably secured in casing **4**, tapers at a constant rate from a point adjacent the inlet of nozzle **12** to the discharge end **16**. Discharge end **16** of nozzle **12** is located within a combining tube **18**.

A nozzle **20** for the delivery of a detergent or solvent is centered within nozzle **12** and has its discharge end projecting beyond nozzle **12** and into combining tube **18**. Nozzle **20** is supplied by a centrally bored member **22** which is threadably secured to casing **4** and centrally bored member **24**, to which is attached a supply pipe **26** which provides a lead from a source of detergent or solvent (not shown). The flow from pipe **26** to nozzle **20** is controlled by needle valve **28** which is manipulated by a handle **30** secured to valve stem **32**. Valve stem **32** is surrounded by packing **34** which is retained by gland **36**. A valve clean-out plug **38** is threadably secured in member **24** and a ball check valve **40** acts to prevent reverse flow from the jet cleaner **2** through pipe **26**.

Cold water from any suitable source is introduced through inlet opening **44** and passes into a chamber **46** through a screen **48**. A clean-out plug **50** is provided for flushing out screen **48**. Water flows from chamber **46** past the opening **52** between nozzle **12** and combining tube **18** to form a thin annular sheet of water adjacent the inner surface of combining tube **18**.

Referring again to combining tube **18**, it is formed by members **54**, **56**, **58** and **60**, which are threadably secured together in series, the member **60** in addition being threadably secured to casing **4**. It will be noted that combining tube **18** is in the form of a Venturi.

The adjoining ends of members **54** and **56** are spaced apart to form a slot **62** in communication with openings **64**, which in turn lead to overflow chamber **66**. Similarly a slot **68** is formed between members **56** and **58**, slot **68** being in communication with openings **70**, which in turn are in communication with overflow chamber **72**. Similarly a slot **74** is formed between members **58** and **60**, slot **74** communicating with openings **76** which communicate with overflow chamber **72**. Flow from overflow chamber **66** through opening **78** into overflow chamber **72** is controlled by a valve **80**. Valve **80** has a cross-shaped web **82** which bears on the sides of opening **78** and a stem **84** in opening **86** of a screw cap **88**.

Discharge from overflow chamber **72** into chamber **90**, which is shown connected to a discharge pipe **92**, is achieved through valve **94** which can seat in opening **95**. Valve **94** has a cross-shaped web **96** which bears against the sides of opening **95** and a stem **98** which rides in opening **100** of screw cap **102**.

A coupling **104** is utilized to provide a connection with hose **106**, which is provided at its discharge end with a nozzle **108** having a restricted opening **110**.

Certain proportions of the jet cleaner in accordance with this invention are critical. If the cross-sectional area of the interior of the combining tube **18** at its smallest point indicated at A is X, the cross-sectional area at B between the inner surface of the discharge end of nozzle **12** and the outer surface of nozzle **20** will be from 10 to 12 times X, and preferably 11.5 times X; and the cross-sectional area at C between the exterior surface of the discharge end of nozzle **12** and the interior surface of combining tube **18** will be from 3.25 to 3.75 times X, and preferably 3.5 times X. The circumference of the exterior of the discharge end of nozzle **12** at C will be from 3.75 to 4.25 times, and preferably 4 times, the circumference of the interior of the combining tube **18** at A.

In operating the jet cleaner 2, water from a conventional cold water line is supplied to the jet cleaner through inlet 44 at from 5 to 25 p.s.i., flows through strainer 48 and into combining tube 18 through opening 52. After the water is turned on, steam is turned on and enters inlet 6 at from 5 to 25 p.s.i., passes through screen 8, chamber 10 and nozzle 12 into combining tube 18. The steam will be at a pressure of from 5 to 25 p.s.i., the steam and water pressure being preferably the same.

As the steam issues from nozzle 12, it is enveloped by the thin cone of cold water, which results in the rapid condensation of the steam. This produces a high vacuum with a resultant increase in the velocity of the entering low pressure steam and water and the ultimate velocity of the delivered jet.

During the period that the water and steam are forming a jet in the combining tube, overflow will occur through slots 62 and opening 64 into the chamber 66 and through slots 68 and 74 and related openings 70 and 76 into chamber 72. When a vacuum is built up within combining tube 18, the valves 80 and 94 will be closed by the vacuum.

After a proper jet of water has been developed, needle valve 28 is opened and a detergent will be introduced from nozzle 20 into the combining tube 18 since the discharge end of nozzle 20 is located within the vacuum area formed by the discharge of steam through nozzle 12 around nozzle 20 and by the condensation of steam issuing from nozzle 12. The detergent is intimately mixed in a finely divided state with water in the combining tube.

The jet of water which is discharged from the combining tube 18 has a high velocity and has been highly heated by the steam which has largely condensed. The highly heated water together with the detergent passes through hose 106 and issues through nozzle 108.

The operative effectiveness of the apparatus of this invention, as just generally outlined, is made possible by the cooperative combination of the four novel structural elements referred to earlier herein.

Thus, it is necessary that the defined area ratios be adhered to. It is necessary also that the steam injection or entry passage provide streamlined flow through a constant-rate taper annulus.

In combination these provide a substantial low-pressure volume of steam to emit in direct, smooth-flow immediate contact with a thin and enveloping curtain of water effective to the immediate creation of a high vacuum at the throat of the combining tube. For this combination to work its useful part in the apparatus, as a whole, with a low pressure steam source, it is also required that such steam be introduced through the screen 8 which provides the necessary muzzling or gathering effect necessary to maintain a steady and full-volume steam flow into the annulus for steam injection into the combining tube 18.

Finally, in order to maintain the high, created vacuum, to enable ready starting without trial-and-error manipulation of steam and water valves and to make possible automatic restarting in the event of a vacuum break, valve 80 must be included and be operative.

The worthwhile utility and unexpectedly advantageous results obtainable, at low inlet steam pressures, with the structure of the present invention in contrast



with the structure of my earlier issued patent, U.S. 2,176,682, are pointedly demonstrated by the following comparative test results.

In these tests, an apparatus constructed specifically in accordance with the teachings of the patent (hereinafter referred to as "2,176,682 structure") and an apparatus constructed specifically in accordance with the teaching of this patent application (hereinafter referred to as "New structure") were used. Test conditions were the same, and the two structures had the below indicated cross-sectional areas at the points A, B and C of the patent drawing and the application drawing respectively:

| | A | B | C |
|---|---|---|---|
| 2,176,682 structure | 16.98 | 65.18 | 81.09 |
| New structure | 19.635 | 228.77 | 66.00 |

Using the indicated varying low inlet steam pressures, outlet hot water discharge pressures obtained were:

| Inlet steam | Discharge pressures | |
|---|---|---|
| | 2,176,682 structure | New structure |
| 5 | Inoperative | 100 |
| 10 | 15 | 120 |
| 20 | 25 | 160 |
| 30 | 75 | 175 |

What is claimed is:

A jet cleaner effective to provide a high outlet pressure stream from a relatively low pressure source of inlet steam which comprises a casing, a combining tube in Venturi form in said casing, a steam nozzle in said casing having a discharge end within the inlet end of the combining tube, means in said casing for the co-incident introduction of water at the steam nozzle discharge end, means connected to said casing for maintaining a full-volume flow of low pressure steam into said nozzle, a solvent nozzle in said casing passing through said steam nozzle and having a discharge end extending into said combining tube beyond the discharge end of said steam nozzle, automatic valve controlled water overflow means and additional automatic valve controlled vacuum maintenance means connected to said casing; the cross-sectional area between the outer surface of the discharge end of the steam nozzle and the interior surface of the combining tube being from 3.25 to 3.75 times the minimum cross-sectional area of the interior of the combining tube, the cross-sectional area between the inner surface of the discharge end of the steam nozzle and the outer surface of the solvent nozzle being from 10 to 12 times the minimum cross-sectional area of the interior of the combining tube.

**References Cited** in the file of this patent

UNITED STATES PATENTS

2,176,682 Pedrick ---------- Oct. 17, 1937

OTHER REFERENCES

The Steam Injector, V. A. B. Hughes, 1912, The Technical Publishing Company Limited, London, pages 14, 15 and 57.