

May 6, 1952

R. VON ROTZ
JET PUMP

2,595,737

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2 SHEETS—SHEET 1

Fig. 4.

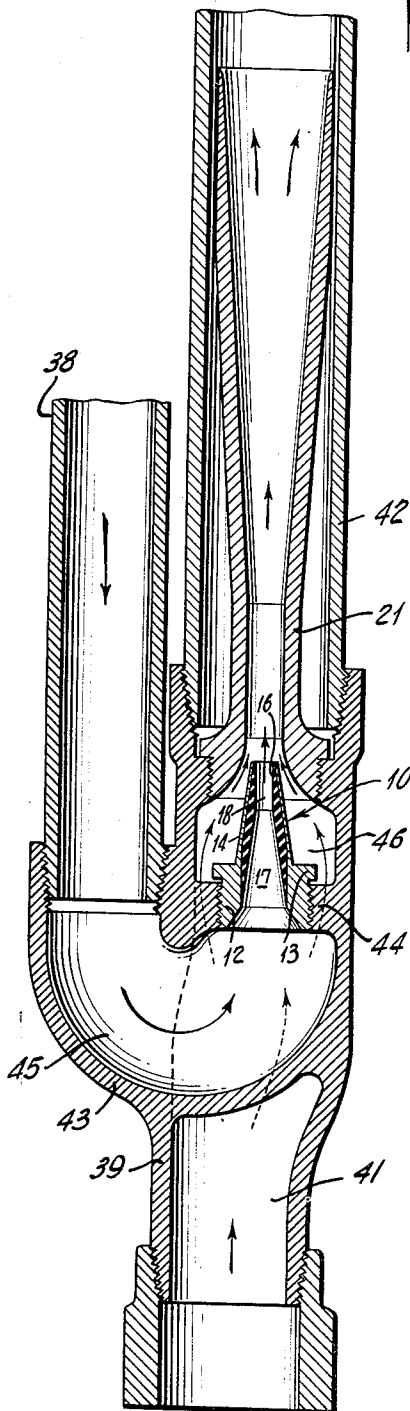


Fig. 1.

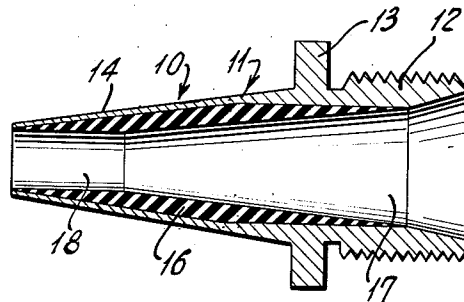
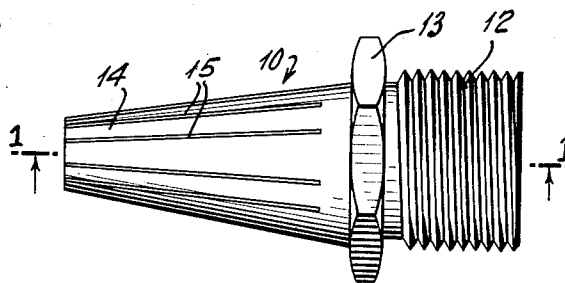


Fig. 2.



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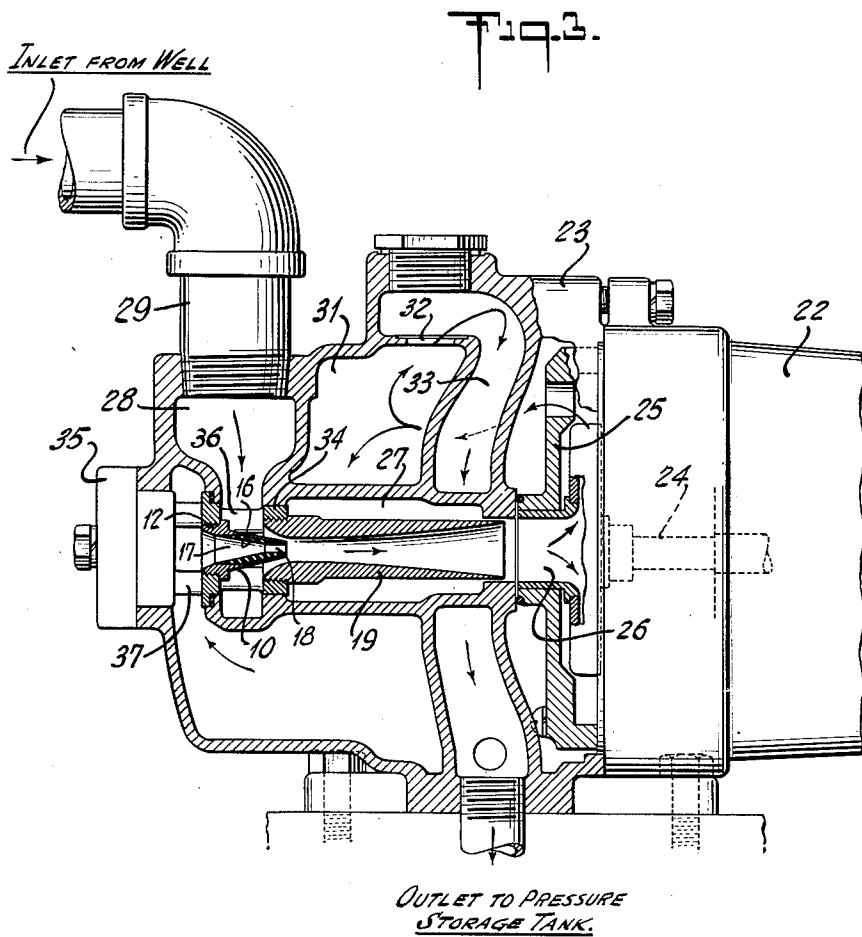
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2 SHEETS—SHEET 2



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JET PUMP

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This invention relates to injector pumps of the kind presenting a jet nozzle and a Venturi tube, the nozzle discharging a fluid under pressure through the Venturi tube to induce by suction an external flow into the tube.

It is customary so to construct the jet nozzle and Venturi tube as to arrive at a ratio between the area of the jet opening and the area of the Venturi throat which will produce maximum pumping efficiency at some value representing an average of the nozzle pressure and suction differentials likely to be encountered. This means that for combinations of pressure and suction above and below the average the pump is not operating at its best efficiency.

An object of the instant invention is to obviate this disadvantage of injector pumps, it being proposed that for every combination of pressure and suction the ratio of jet area to Venturi throat area shall be automatically adjusted for maximum efficiency under all conditions of operation.

The invention has particular, although not limited, application to combination rotary-jet pumps as used in domestic water systems. These pumps present a rotary, usually centrifugal, pump operating to draw water from a well and supply it under pressure to a storage tank. The pump is automatic in operation, being under the control of a pressure switch associated with the storage tank in such wise that operation of the pump is initiated at a predetermined low tank pressure, for example 20 pounds, and is discontinued at a predetermined high pressure, for example 40 pounds. Operating in conjunction with the rotary pump is a jet pump energized by fluid supplied from the rotary pump. That is, a part of the discharge of the rotary pump is recirculated through the jet pump back to the inlet of the rotary pump, the jet pump being placed in the suction line from the well so as to supplement the rotary pump in inducing flow from the well. Factors affecting nozzle pressure and suction value at the jet pump are the pressure head established by the rotary pump and the water level in the well. The suction lift may vary 20 feet or more during the operating cycle of the pump while the pump pressure, as seen, fluctuates within a twenty pound range.

With a rigid jet structure, the point of maximum operating efficiency of the rotary-jet combination is obtained at only one value of the total head, by which is meant all of the possible combinations of pump pressure and suction lift. Utilizing the instant automatic jet control, however, a much higher operating efficiency is

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achieved over the complete range of suction lift and discharge pressure. This results in a more economical pump operation with lower power consumption under all normal operating conditions. It moreover makes unnecessary or limits the practice of substituting one jet pump for another, as is frequently done in response to a falling water level, in the interests of greater efficiency. Thus, in the operation of the automatically controlled jet there is an expansion or enlargement of the jet opening in response to and corresponding to increased differential between pump pressure and suction. This provides a greater effective nozzle area for a greater quantity of discharge fluid from the rotary pump to be recirculated through the Venturi tube. The increased flow improves the suction action, resulting in a higher pressure discharge from the venturi and consequently an increase in performance efficiency at high pressure-suction differentials. Conversely, with the automatic nozzle control, in response to reduced effective pressure the area of the jet is correspondingly reduced so that a smaller volume of fluid is recirculated. This results in improved pump efficiency at low pressure-suction differentials.

Another object of the invention, therefore, is to obtain the advantageous results noted, in a combination rotary-jet pump.

Other objects and structural details of the invention will appear from the following description when read in connection with the accompanying drawings, wherein:

Fig. 1 is a view in longitudinal section of a jet nozzle in accordance with the instant invention; Fig. 2 is a view in side elevation of the nozzle of Fig. 1;

Fig. 3 is a view in longitudinal section of a rotary-jet pump embodying the instant invention and adapted for shallow well operation; and

Fig. 4 is a view in longitudinal section of an injector assembly, as used in a deep well system, the assembly shown being used as a submerged element in a system further including a pump on the surface which is the same unit shown in Fig. 3, with the jet pump removed.

Referring to the drawings, a jet nozzle in accordance with the invention is shown in Figs. 1 and 2, indicated generally at 10. It comprises a substantially cylindrical body 11 formed with a relatively thick base portion 12 externally threaded for installation purposes. A flange 13 is in advance of the base portion, serving as a limit stop and peripherally machined to receive a wrench. Projecting forwardly from the region of the flange 13 is a cone-shaped relatively thin

portion 14 which, as shown in Fig. 2, is split longitudinally by a plurality of cuts 15. Under internal pressure, therefore, the cone portion 14 will expand radially, and, in the absence of sufficient pressure for expansion will normally assume the position illustrated. The body 11 is lined by an internal sleeve 16 made of a flexible material, for example, natural or synthetic rubber. The sleeve is in intimate, contacting relation to the internal wall of the nozzle body and, in the present instance, is bonded to the body rearwardly of the base 12. The liner sleeve has a varying thickness in order that the passage through the nozzle will have the customary relatively wide mouth 17 and restricted discharge opening 18. In accordance with the instant invention, however, the area of the opening 18 is variable because of the radial flexibility of the nozzle so that the rate of flow out of the nozzle is also variable and not constant.

Using such a nozzle in conjunction with a Venturi tube, as indicated at 19 in Fig. 3 and at 21 in Fig. 4, will be apparent that the ratio of the area of the opening 18 to the throat area of the venturi is a function of the differential between the pressure of the fluid supplied mouth 17 and the suction pressure at the inlet to the Venturi tube. The nozzle and Venturi tube constitute a jet pump, with the inlet to such pump being represented by the area surrounding the jet nozzle at the inlet to the tube. Thus a falling pressure at the inlet, particularly if accompanied by a rising pressure of the fluid supplied the nozzle, serves to increase the pressure differential internally and externally of the nozzle with the result that the tip of the nozzle expands allowing a greater volume flow to take place from the nozzle through the Venturi tube. An increase in suction force accordingly results. Similarly, a decrease in the pressure differential allows the nozzle tip to contract, with a converse effect.

Utilizing a jet pump, as described, in a combination rotary-jet domestic water pumping system the arrangement of parts and general mode of operation are the same as is customary in such systems. The change in accordance with the instant invention resides merely in the substitution of the present flexible nozzle for the rigid one heretofore used.

Considering the alteration in specific mode of operation accomplished, however, there is shown in Fig. 3 a combination rotary-jet pump adapted for shallow well operation. The pump illustrated is or may be the same as that illustrated and described in Patent No. 2,475,118 issued July 5, 1949 for Deep and Shallow Well Pump. Reference is made to that patent for a disclosure of a complete system of a kind in which the present invention may be embodied.

Referring to Fig. 3, the pumping unit comprises an electric motor 22 mounted on a pump body 23 and driving a shaft 24 to which is secured one or more rotary impellers 25 defining a centrifugal pump. The hub of the impeller 13 constitutes an eye or inlet opening 26 registering with a longitudinal bore 27 adjacent the outer end thereof and receives one end of a suction pipe line 29, the other end of which extends into the well. Water entering chamber 28 through line 29 flows by way of bore 27 to inlet eye 26 where it is picked up by the impeller 25 and discharged into a chamber 31. The chamber 31 is in surrounding relation to the bore 27 and communicates through an opening 32 with a vertical passage 33 opening at the lower end into the storage pressure tank.

The back pressure against which the impeller 25 works accordingly corresponds to the pressure of the tank which pressure drops in response to demand and rises as operation of the pump restores the pressure to its predetermined normal value.

The jet pump, comprising a nozzle 10 and the Venturi tube 19 is located within the bore 27 with the outer end of the Venturi tube registering with and lying closely adjacent to the inlet 14 of the rotary pump. The nozzle and Venturi elements are rigidly mounted in a bushing 34 extending into the outer end of bore 27 and formed with a unitary closure cap 35. A first set of radial ports 36 in the bushing communicate with chamber 28, and, being located between the nozzle and the inlet end of the Venturi tube define the suction inlet of the jet pump. A second set of radial openings 37 in the bushing communicate with chamber 31 and are located rearwardly of the nozzle 10. Accordingly, a part of the water under pressure which flows into chamber 31 from the rotary pump enters jet nozzle 10 and is discharged through the Venturi tube back to the rotary pump inlet 26.

In the operation of the pump, chamber 31 normally is full of water by reason of the overlying position of opening 32 so that the rotary and jet pumps are flooded. Rotation of impeller 13 produces a suction effect through inlet 26, Venturi tube 19, radial ports 36, chamber 28 and pipe line 29 upon the water in the well, inducing a flow of water through the path traced. The water taken into the rotary pump is discharged thereby under pressure into the chamber 31. From the chamber 31 a major part of the pump fluid passes out opening 32 and goes to the pressure storage tank to replace the water drawn therefrom and to raise the pressure in the tank. A smaller part of the water entering chamber 31 has access to the jet nozzle 10 through bushing openings 37 and is returned by way of the Venturi tube 19 to the rotary pump. Such recirculation of fluid has the effect of maintaining a steady air-free flow to the impeller 25 and further of supplementing or increasing the suction action exerted upon the water in the well.

In the operation of the pump, the storage tank pressure regularly fluctuates in a given range. The water in the well ordinarily drops to progressively lower levels. As a result, the pressure in chamber 31 may rise while the suction or absence of pressure in the region of bushing ports 36 becomes more pronounced. In response to this changing pressure differential, the tip of nozzle 10 expands. A greater volume flow through the jet pump thus takes place, adding to the suction lift and insuring an adequate supply of water to the rotary impeller. An infinite number of adjustments in the area of the nozzle opening is possible so that for each combination of pump pressure and suction there is an optimum ratio of jet area to Venturi throat area, giving maximum efficiency.

In the case of a deep well installation, the jet pump is submerged in the well instead of being directly associated with the rotary pump. In this instance, therefore, the bushing 34 of Fig. 3 is removed from bore 27 and replaced by an adaptor closing chamber 31 from direct communication with chamber 28 but permitting communication of chamber 31 with a pipe line extending from the adaptor into the well. The opposite end of such pipe line, indicated at 38 in Fig. 4 is connected to a fitting 39 submerged

in the well. The fitting 39 is formed with an open vertical inlet passage 41, the upper end of which receives a delivery pipe 42 corresponding to the pipe 29 of Fig. 3. Also mounted in the outer end of passage 41 is the Venturi tube 21. Transverse walls 43 and 44 in the fitting 39 intersect passage 41 and define chambers 45 and 46. Return pipe line 33 is connected into chamber 45. A jet nozzle 10 is mounted in wall 44 and extends through chamber 46 toward co-operative relation with the Venturi tube. In response to operation of the rotary pump on the surface, water is drawn up through passage 41, chamber 46, tube 21 and pipe 42 to the rotary pump. A part of the output of the pump then is returned to the fitting 39 in the well by way of pipe 38. The recirculated fluid passes from chamber 45 in the fitting through the jet nozzle 10 and into tube 21 with the effects noted in the arrangement of Fig. 3. In response to the differential between the pressure of the fluid in chamber 45 and the suction in chamber 46, the opening in nozzle 10 is automatically adjusted for optimum jet and Venturi throat area, also in the manner described in connection with claim 3.

What is claimed is:

1. An injector nozzle of the type described comprising an outer body having a thin walled part tapering inwardly toward one end, a plurality of cuts through the wall of said thin part extending inwardly from the said one end, and a resilient rubber-like liner in said body forming a jet passage, said liner and the thin part of said body being expansible by pressure within the jet passage.

2. An injector nozzle of the type described comprising an outer body having a thin walled part tapering inwardly toward one end, a plurality of cuts through the wall of said thin part extending inwardly from the said one end, and a resilient rubber-like liner in said body forming a jet passage, said liner and the thin part of said body being expansible by pressure within the jet passage, said liner and body being attached together at the end of the liner remote from the said one end of the body.

3. An injector nozzle of the type described comprising an outer body having a thin walled part tapering inwardly toward one end, a plurality of cuts through the wall of said thin part extending inwardly from the said one end, and a resilient rubber-like liner in said body forming a jet passage, said liner and the thin part of said body being expansible by pressure within the jet passage, said liner having thicker walls over the intermediate region thereof than at the said one end of said body.

4. An injector nozzle of the type described comprising an outer body having a thin walled part tapering inwardly toward one end, said body having a male thread at its other end for mounting the nozzle in a pump body in operative relation with a venturi, a plurality of cuts through the wall of said thin part extending inwardly from the said one end, and a resilient rubber-like liner in said body forming a jet passage, said liner and the thin part of said body being expansible by pressure within the jet passage.

5. An injector nozzle of the type described comprising an outer body part having a bore with an inlet section tapering inwardly from the inlet end of the body, a cylindrical intermediate section of the bore, and an outlet section tapering inwardly from the end of said cy-

lindrical section, said outlet section having a thin wall and there being a plurality of axially extending circumferentially spaced splits in the wall of said outlet section extending from the outlet end of the body toward said cylindrical section, and a flexible rubber-like liner in said body forming a jet passage therethrough, said liner having thin walls at its ends and thicker walls over the intermediate section thereof.

6. An injector nozzle of the type described comprising an outer body part having a bore with an inlet section tapering inwardly from the inlet end of the body, a cylindrical intermediate section of the bore, and an outlet section tapering inwardly from the end of said cylindrical section, said outlet section having a thin wall and there being a plurality of axially extending circumferentially spaced splits in the wall of said outlet section extending from the outlet end of the body toward said cylindrical section, and a flexible rubber-like liner in said body forming a jet passage therethrough, said liner having thin walls at its ends and thicker walls over the intermediate section thereof, said liner extending from the outlet end of the body to the inner end of said inlet section.

7. An injector nozzle of the type described comprising an outer body part having a bore with an inlet section tapering inwardly from the inlet end of the body, a cylindrical intermediate section of the bore, and an outlet section tapering inwardly from the end of said cylindrical section, said outlet section having a thin wall and there being a plurality of axially extending circumferentially spaced splits in the wall of said outlet section extending from the outlet end of the body toward said cylindrical section, and a flexible rubber-like liner in said body forming a jet passage therethrough, said liner having thin walls at its ends and thicker walls over the intermediate section thereof, said liner extending from the outlet end of the body to the inner end of said inlet section and being secured to said body only adjacent said inlet section.

8. The combination in a jet pump of a supporting element, providing a flow passage, a venturi mounted in said element, and a jet nozzle mounted in said element so as to discharge into the inlet end of said venturi, said jet nozzle comprising an outer body part having its end adjacent the venturi formed with a relatively thin wall and tapering inwardly toward the venturi, a plurality of circumferentially spaced axially extending splits in said wall extending from the end thereof adjacent the venturi part-way down the length of said body part, and a resilient rubber-like sleeve member in said body part forming a jet passage, said sleeve member and the split end of said body part being expansible by pressure in the jet passage to vary the ratio between the jet opening area and the Venturi throat area.

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The following references are of record in the file of this patent:

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