Nov. 2, 1965 R. M. HOFFMANN 3,215,089

VALVED EJECTOR PUMP

Filed Aug. 22, 1963 2 Sheets-Sheet 1

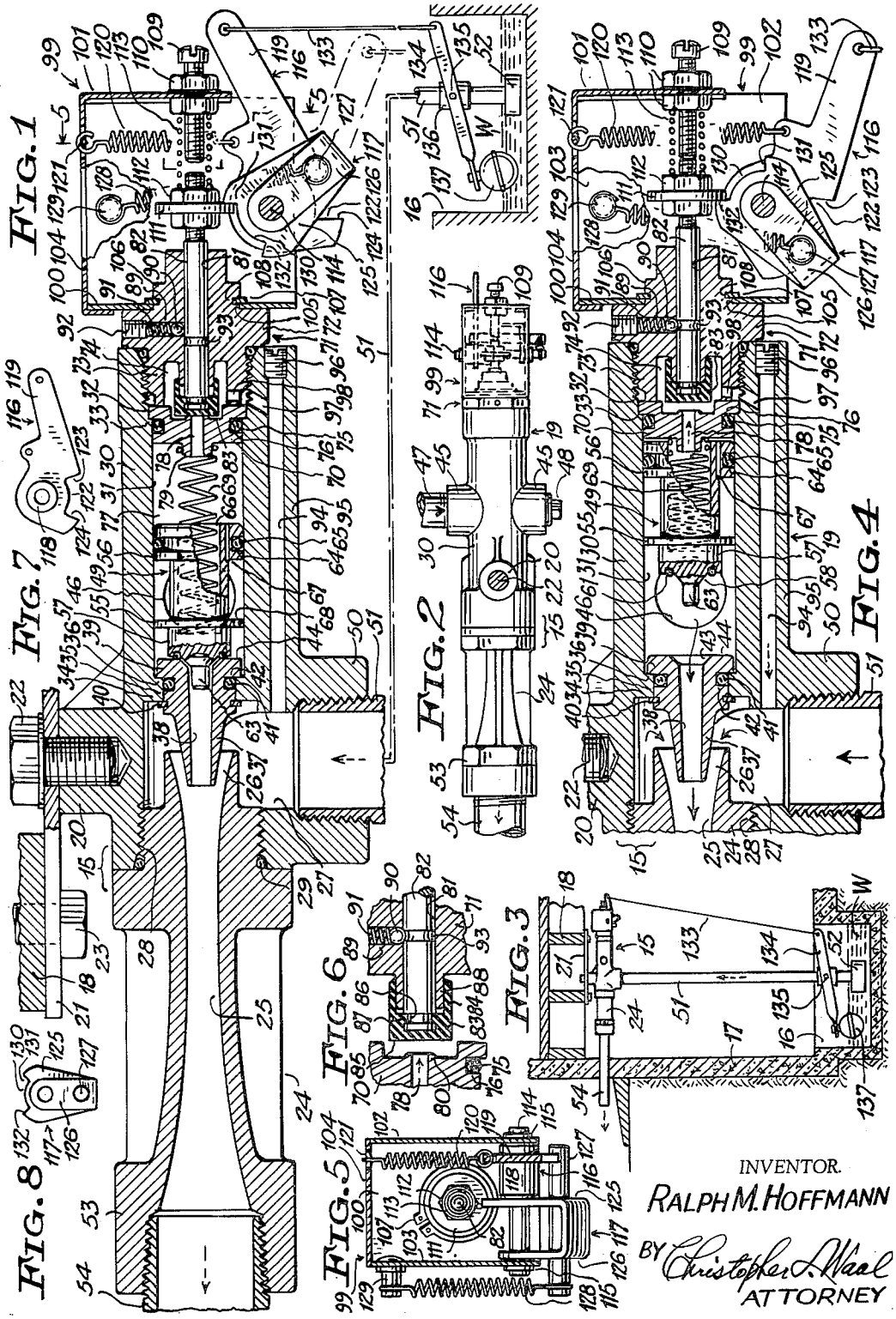

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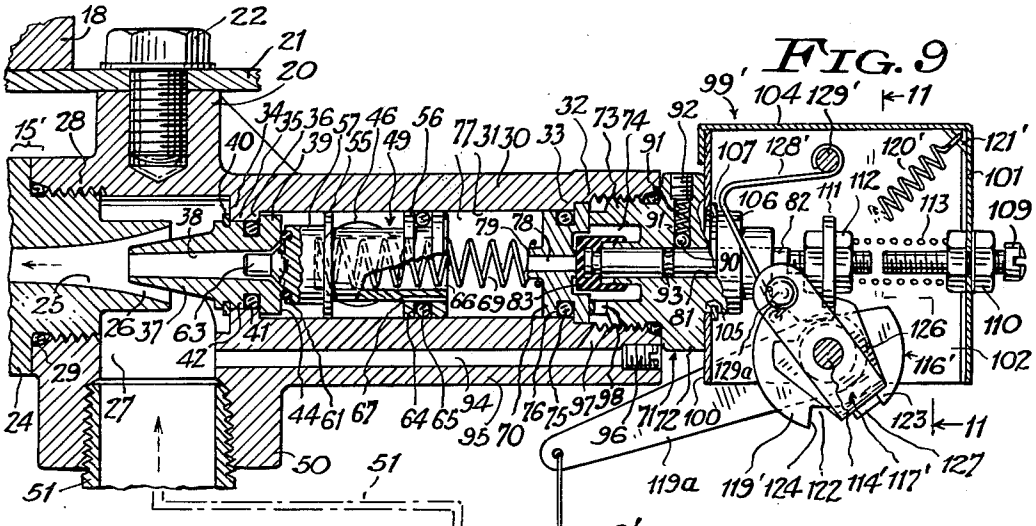
FIG. 9



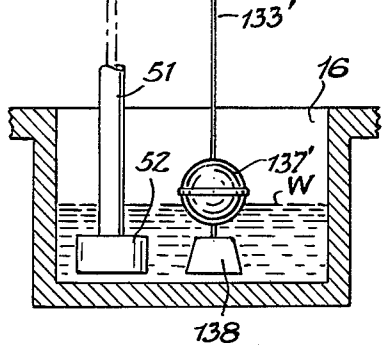


FIG. 11

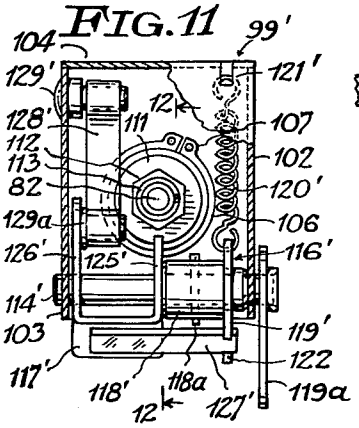


FIG. 13

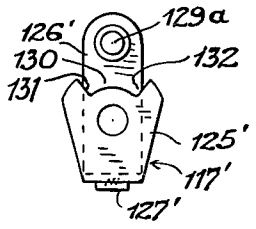


FIG. 10

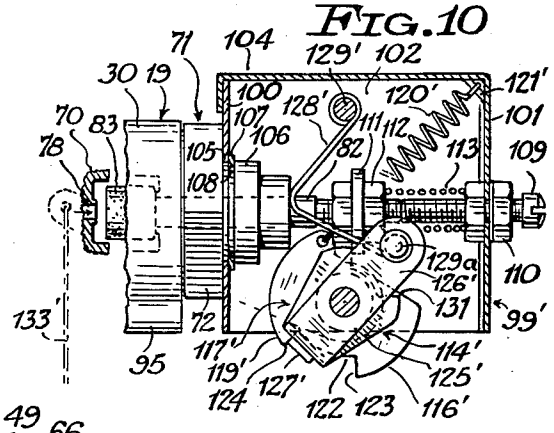
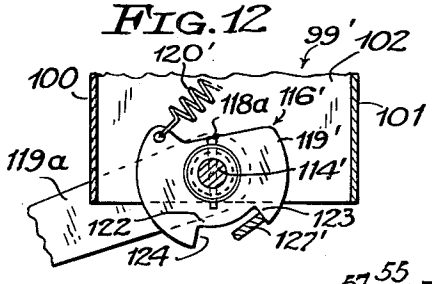


FIG. 12



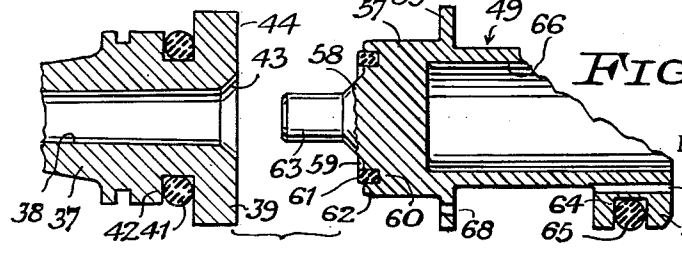


FIG. 14

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VALVED EJECTOR PUMP

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17 Claims. (Cl. 103—276)

This invention relates to jet pumps and to control valve means for the same.

Jet pumps have been used as ejectors or eductors for drawing water from basement drainage sumps, tanks and other containers, and in some cases have been automatically controlled in response to liquid level.

One of the objects of the invention is to provide an improved jet pump adapted for use in removing basement drainage or other liquids and including novel control valve means for automatically starting and stopping the pumping action, as in response to liquid level in a drain sump or other container.

Another object is to provide improved control valve means adapted for use with a jet pump and operable by the pressurized water or other liquid which actuates the pump.

A further object is to provide control valve means of this character including a snap action pilot or venting valve.

A further object is to provide a jet pump having improved means for discharging venting liquid from hydraulically operated valve means of the pump, and in which suction is utilized to assist in holding a main inlet valve in open condition.

A further object is to provide a jet pump which is efficient, reliable and relatively quiet in operation, which is capable of easy installation, and which is of simple, durable and inexpensive construction.

A further object is to provide improved hydraulically operated valve means capable of starting and stopping the flow of a relatively large volume of pressurized liquid by pilot control of a very small quantity of the same liquid.

The invention further consists in the several features hereinafter described and claimed.

In the accompanying drawing, illustrating certain embodiments of the invention:

FIG. 1 is a longitudinal vertical sectional view of an ejector-forming jet pump constructed in accordance with the invention, a drive water inlet valve thereof being closed, and parts of a sump-evacuating suction conduit and liquid-level-responsive valve control means being shown schematically;

FIG. 2 is a top plan view of the jet pump;

FIG. 3 is a diagrammatic elevational view of the sump pump installation, parts being shown in section;

FIG. 4 is a longitudinal vertical sectional view of a part of the pump, showing the drive water inlet valve thereof in open position;

FIG. 5 is a transverse vertical sectional view of a snap-acting pilot valve mechanism, taken generally on the line 5—5 of FIG. 1;

FIG. 6 is a sectional detail view of pilot valve parts;

FIG. 7 is a detail view of a rock lever of the pilot valve mechanism;

FIG. 8 is a detail view of a toggle-forming rock lever;

FIG. 9 is a sectional view similar to FIG. 1 showing the pump provided with a modified form of snap-action pilot valve mechanism;

FIG. 10 is a side elevation, partly in section, showing the pilot valve mechanism in vent-opening position;

FIG. 11 is a vertical sectional view taken generally on the line 11—11 of FIG. 9;

FIG. 12 is a detail sectional view taken generally on the line 12—12 of FIG. 11;

FIG. 13 is a detail view of a toggle-forming rock lever, and

FIG. 14 is a fragmentary axial sectional view of an inlet valve member for each form of pump.

Referring to FIGS. 1 to 8 of the drawings, 15 designates generally a valved jet pump of the invention. While the pump is of general application, it is here shown to be arranged as an ejector or eductor for removing water from a drainage sump 16 in a house basement. The basement has the usual foundation wall 17 supporting floor joists 18 forming a basement ceiling, and the pump is mounted on the underside of the ceiling and is preferably located directly over the sump.

The pump 15 includes a tubular pump body or housing 19, preferably in the form of a metal casting, and desirably extending horizontally, as shown. An upwardly projecting boss 20 is formed on an end portion of the pump body in the axial plane thereof and is secured to the underside of a mounting bar 21, such as of metal or wood, by a screw 22, the bar in turn being rigidly fastened to the lower edge portions of one or more of the joists 18 by screws 23.

An exteriorly ribbed discharge or venturi nozzle 24 projects from the boss-carrying end portion of the tubular pump body in alignment therewith and is provided with a longitudinal discharge passage 25 flaring in downstream direction. The passage includes an entrance throat 26 which is preferably convergent in downstream direction, the entrance throat extending into a suction chamber 27 formed in the pump body. The discharge nozzle 24 is here shown to have a rigid screw-threaded connection 28 with the pump body and to be sealed by a packing ring 29. However, in some instances the discharge nozzle may be integral with the pump body. The other end portion of the pump body forms a valve barrel 30 with a cylindrical bore 31 therein aligned with the discharge nozzle, the bore having an enlarged outer end portion 32 to receive various fittings hereinafter described and to form an outwardly facing annular shoulder 33 at the outer end of the main bore.

The pump body is formed with a partition 34 separating the suction chamber 27 from the inner end of the barrel bore 31 and provided with a bore 35 coaxial with the barrel bore and discharge nozzle, the partition presenting an annular shoulder 36 surrounding the inner end of the bore 35. A jet nozzle member 37 with a through bore or passage 38 is secured in the partition bore 35 and projects into the suction chamber 27, the tapered downstream end of the jet nozzle member extending a short distance into the entrance throat 26 of the discharge nozzle. In a typical household sump pump, the diameter of the jet nozzle bore 38 may be about 3/16", and the small diameter of the discharge nozzle passage may be about 5/16". The jet nozzle member includes an annular flange 39 within the barrel bore 31 abutting against the annular shoulder 36. The jet nozzle member is retained in position by a snap ring 40 abutting against the outer side of the partition. An O-ring 41 is seated in a peripheral groove 42 formed in the nozzle member near the flange 39 and engages the partition bore 35. The jet nozzle bore 38 has a conical entrance 43, and the jet nozzle member presents a flat valve seat 44 around the entrance.

Adjacent to the inner end of the jet nozzle member the valve barrel 30 is provided at opposite sides with a pair of selectively usable aligned inlet bosses 45, FIG. 2, defining inlet ports 46 at the pump body bore 31, FIGS. 1 and 4. One of the inlet bosses is connected to a supply pipe 47 for admitting pressurized water into the valve barrel bore 31 from the house water system, and the other inlet bore is closed by a pipe plug 48.

A spool-shaped valve member 49, hereinafter more fully described, is reciprocable in the barrel bore 31 and

forms a main valve cooperating with the valve seat **44** to control flow of pressurized water through the jet nozzle member **37**. By way of example, the water at the pump inlet port **46** may have a pressure ranging from about 30 to 70 p.s.i., although much higher pressures can be applied.

Formed on the lower side of the pump body **19** is a downwardly projecting interiorly threaded suction inlet boss **50** communicating with the suction chamber **27** and forming a wrench-hold. The axes of the suction inlet boss **50** and attaching boss **20** are aligned and intersect the axis of the pump body **31**. A vertical suction pipe **51** is screwed into the boss **50** and depends therefrom, the lower end of the pipe extending into the sump **16** and preferably being provided with a combined strainer and foot valve **52**. The suction lift is, of course, limited to 32 feet, but preferably does not exceed 20 feet, being controlled by the static pressure available, the dynamic inlet pressure, and other factors.

The outlet end of the discharge nozzle **24** has an interiorly threaded boss **53** which forms a wrench-hold. A horizontal outlet pipe **54** is screwed into the discharge nozzle boss **53** and extends outwardly through the basement wall **17** to a point of disposal.

The discharge nozzle passage **25** forms an expansion chamber, but instead of having the conventional long conical shape with a straight flare it is provided with a horn-shaped or curved flare which is arranged to provide a substantially uniform rate of decrease in water velocity and a substantially uniform rate of increase in pressure during operation of the pump. This configuration also permits a considerable reduction in the length of the discharge nozzle, thus saving material and facilitating casting.

The spool-shaped piston valve member **49** includes a pair of axially spaced front and rear heads, lands, or annular flanges **55** and **56** which slidably fit in the pump body bore **31** with a small clearance. The piston valve member includes a cylindrical front portion **57** with a central conical projection **58** surrounded by a flat annular face **59** in which is formed a concentric annular groove **60**. A valve ring or deformed O-ring **61**, such as of neoprene, is confined in the groove **60** and is retained therein by cementing or by inwardly crimping an annular rib **62** defining the outer wall of the groove. The valve ring **61** is adapted to engage the flat valve seat **44** formed on the jet nozzle member **37** and thus prevent flow of pressurized water from the pump body bore **31** through the jet nozzle member. The effective diameter of the valve ring **61** is preferably about one-half the diameter of the pump body bore **31**. The conical front projection **58** of the valve member is also provided with a cylindrical tip or nose **63** adapted to enter loosely into the entrance end of the jet nozzle bore **38** so as to prevent hydraulic shock or water hammer when the valve closes.

The front land or flange **55** of the piston valve member is spaced rearwardly from the flat front face **59** of this member a sufficient distance to expose a small front portion of the inlet port **46** when the valve member is closed, so that line pressure will be present in the space between this flange and the inner end of the jet nozzle member **37**. If the flange **56** is placed farther forward, leakage around the periphery of the flange will still provide line pressure in front of the flange. The rear land or flange **56** of the piston valve member is spaced rearwardly from the front land and is provided with an annular groove **64** receiving an O-ring **65** bearing against the walls of the pump body bore **31** at a region spaced rearwardly of the inlet port **46**. A rearwardly opening pocket-forming bore **66** is coaxially formed in the piston valve member, and a small axial bleed opening **67** is formed in the rear flange **56** of the hollow piston valve member, thus providing communication between the inlet port **46** and the rear end portion of the cylinder bore **31**, as seen in FIG. 1. When the piston valve member is in its retracted position, as seen in FIG. 4, the front flange **55** thereof is rearward of the inlet port **46**, but water is free to flow rearwardly at a restricted rate past the periphery of the loosely fitting front flange. In addition, the front flange may have a small axial water port **68**, as seen in FIG. 14.

The piston valve member **49** is normally urged to closed position by differential water pressure, as hereinafter described, and by a compressed coil spring **69** one end portion of which extends in the rearwardly opening pocket-forming bore **66** of the valve member, and the other end of which is seated on a cup-like annularly shouldered valve block **70** fitting in the outer end of the housing bore **29**. A flanged closure bushing **71** is screwed into the outer end of the housing bore **31** and includes a hexagonal medial flange **72**. The bushing has a cupped inner portion **73** which retains the shouldered valve block against or adjacent to the annular shoulder **33** of the bore and forms a venting chamber **74**, the valve block being sealed by an O-ring **75** fitting in an annular groove **76** formed in the reduced front portion of the block and bearing against the walls of the bore **31**. A back pressure chamber **77** of variable volume is formed in the pump body bore between the valve block and the rear end of the piston valve. The valve block has an axial vent port **78** surrounded at its front or inner end by an annular boss **79** which centers the adjacent end of the coiled spring **69**. The outer end of the vent port is surrounded by an annular bead-like valve seat **84**. The cross-sectional area of the vent port **78** is substantially larger than that of the bleed opening **67** in the piston valve member **49**. The biasing spring **69** is selected to prevent the piston valve member from opening should the inlet or supply pressure be insufficient to provide satisfactory pump operation. This occurs when the supply pressure is about 20 p.s.i. The biasing spring **69** will also assist in preventing accidental momentary opening of the piston valve member by surges in line pressure.

The closure bushing **71** has an axial bore **81** in which is slidable a valve stem **82**, the valve stem being normally urged inwardly as hereinafter described. The inner end portion of the valve stem carries a cup-like valve member **83** of neoprene or other rubber-like material which includes a sleeve portion **84** and presents a flat end wall **85** adapted to engage the annular seat **80** of the vent port **78** to close this port. The flat end wall of the valve member avoids the need for accurate alignment of the valve stem with the vent port. The valve stem has an annular groove **86** at its inner end to receive an inner bead **87** on the sleeve, and the rear portion of the sleeve slidably fits over a forwardly projecting tubular boss **88** formed on the bushing, thus providing a seal to prevent leakage along the stem. The cup-like valve member may either be molded about the inner end of the valve stem or be slipped thereon.

The medial flange **72** of the closure bushing **71** is provided with a radial bore **89** in which is housed a detent ball **90** urged inwardly by a compressed coil spring **91** confined by a screw plug **92**. The detent ball is engageable in an annular groove **93** formed about the valve stem when the valve stem is in its open or retracted position, as seen in FIGS. 4 and 6, so as to releasably retain the valve stem in its retracted position.

A vent passage **94** extends longitudinally in the lower portion of the pump body within a rib **95** formed on the body, the outer end of the passage being closed by a screw plug **96**, and the other end opening at the suction chamber **27**. Near its outer end the vent passage has a lateral port **97** which communicates with the bushing chamber **74** by way of a radial port **98** formed in the cup-shaped inner end of the closure bushing.

Secured to the outer end portion of the closure bushing **71** is a rectangular open-bottom casing **99**, such as of sheet metal, having vertical end walls **100** and **101**, opposite parallel side walls **102** and **103**, and a top wall **104**. The end wall **100** has a circular aperture **105** in which

fits a cylindrical boss **106** of the closure bushing, this wall being anchored on the bushing by a snap ring **107** engaging in a peripheral groove **108** in the boss. An axially adjustable stop screw **109** aligned with the valve stem is clamped to the outer end wall **101** of the casing by nuts **110** and is engageable by the outer end of the valve stem to limit the open position of the cup-like valve member **83**. A shoulder-forming washer or disk **111** is adjustably clamped on the outer end portion of the valve stem by flanking nuts **112** threaded on the stem. A coiled compression spring **113** coaxial with the valve stem is interposed between the outer washer-clamping nut **112** and the inner nut **110** for the stop screw **109** and normally urges the valve stem inwardly to closed position.

A horizontal shaft **114** extends transversely below the valve stem approximately in the vertical plane of the washer **111** and is secured in the opposite vertical side walls of the casing, as by snap rings **115**, FIG. 5. The shaft **114** has pivoted thereon a pair of rock levers **116** and **117** disposed in side-by-side relation and forming parts of a snap-acting mechanism. The rock lever **116** comprises a hub **118** carrying a flat lever arm **119** near the casing side wall **102** and is upwardly biased in counterclockwise direction, as viewed in FIG. 1, by a coiled spring **120**, one spring end being hooked onto the lever arm and the other end being hooked onto a cut-out bar portion **121** of the casing top wall **104**. The hubbed rock lever **116** has a concentric lower arcuate recess **122** presenting a pair of angularly spaced shoulders **123** and **124**. The rock lever **117**, which forms a toggle member, comprises a U-shaped metal strap having parallel arm portions **125** and **126** which are journalled on the shaft **114** and which carry near their yoke-connected outer ends a cross pin **127** extending parallel to the shaft **114**. One end of the cross pin **127** extends in the arcuate recess **122** of the rock lever **116** for alternate engagement with the spaced shoulders **123** and **124**, thus providing a lost motion connection between the two rock levers. The other end of the cross pin is connected by a coiled spring **128** with a stud **129** anchored on the upper portion of the casing side wall **103**, FIG. 5, so as to provide a toggle or overcenter snap action, the stud being disposed substantially in the vertical plane of the valve stem washer **111**. The upper end of the rock lever arm **125** is provided with a concentric arcuate recess **130** presenting a pair of angularly spaced shoulders **131** and **132** engageable with the opposite faces of the valve stem washer **111** to reciprocate the valve stem.

The free end of the rock lever arm **119** is connected by a flexible vertical cord or chain **133** with an arm of a float lever **134** swingably carried at an intermediate point on a horizontal pivot pin **135** projecting from a collar **136** which is secured to the lower end of the suction pipe **51**, the other arm of the lever **134** carrying a float **137** resting on the water W in the sump **16**.

In operation, when the sump water is at its lower level, as seen in FIG. 1, the valve stem **82** is normally urged inwardly by the action of the springs **113**, **120** and **128** to close the vent port **78**. The piston valve member **49** is urged to closed position against the jet nozzle valve seat **44** by differential water pressure acting forwardly on the valve member, aided by the spring **69**, thus preventing pressurized water admitted to the valve chamber or bore **31** from flowing through the jet nozzle. The water in the bore **31** seeps through the bleed opening **67** in the piston valve member into the then closed back pressure chamber **77** behind the piston valve member, building up a static pressure which provides the differential closing pressure on the valve member, the effective area of the rear end of the piston valve member being greater than that at the front end of the piston valve member around the periphery of the valve ring **61**.

Upon rise of water level in the sump **16**, the float **137** correspondingly rises and through the float lever **134** and tensioned cord **133** swings the rock lever **116** clockwise, as viewed in FIG. 1, against the tension of the coiled spring **120**. The snap-acting rock lever **117** is thereby also swung clockwise by the driving abutment of the rock lever shoulder **123** against the cross pin **127** on the rock lever **117**, retracting the rock lever shoulder **131** from the outer or rear face of the valve stem washer **111**. However, the compressed coil spring **113** continues to hold the valve stem in closed position. After a further rise in liquid level the float-actuated rock lever **116** assumes the angular position seen in FIG. 4, causing the spring-biased toggle-forming rock lever **117** to snap over center and to effect engagement of its shoulder **132** with the opposite or front face of the valve stem washer **111**, thus displacing the valve stem outwardly to its open position against the action of the spring **113**, as seen in FIG. 4. In the open or retracted position of the valve stem, the spring-pressed detent ball **90** engages in the annular groove **93** formed in the valve stem. The opening of the venting valve **78**, **83** causes the water pressure in the back pressure chamber **77** of the pump body bore to drop and as a result, the line or supply pressure acting on the front area of the piston valve member around the valve ring **61** displaces this valve member rearwardly in the bore **31**, unseating the valve ring from the jet nozzle valve seat **44** against the action of the spring **69**, and allowing water under pressure to flow through the jet nozzle **37**, the flow increasing as the front flange **55** of the valve member further exposes the inlet or supply port **46**. The water pressure on the front area of the piston valve member also increases, and the valve member finally assumes the retracted position seen in FIG. 4, the rear flange or head **56** being close to or in abutment with the valve block **70**. The water behind the piston valve member passes through the vent port **78** and the venting passage **94** and is discharged into the suction chamber **27** of the pump. The water jet issuing from the jet nozzle **37** flows into the discharge nozzle passage **25** and by conversion of the pressure head into a velocity head creates a partial vacuum in the suction chamber **27**, raising water from the sump **16** through the suction pipe **51**. The aspirated sump water mixes with the jet water and flows through the discharge nozzle **24**, gradually decreasing in velocity and increasing in pressure to provide maximum flow and being discharged through the outlet pipe **54**. The suction exerted on the rear end of the retracted piston valve member by way of the venting passage **94** provides an additional holding action on this valve member. The higher the lift, the more positively will this valve member be held open. Also, since the rear flange **56** of the piston valve member, with its axial bleed opening **67**, is close to or in abutment with the venting valve block **70**, the relatively small flow of bleed water occurring during the retracting travel of the valve member is either substantially reduced or completely shut off.

When the water in the sump drops to its normal level after a pumping operation, the float **137** correspondingly drops, permitting the retractile coil spring **120** to swing the rock lever **116** in a counterclockwise direction from the position of FIG. 4 toward the position of FIG. 1. The rock lever or toggle lever **117** is urged in a counterclockwise direction by the shoulder **124** of the rock lever **116** engaging the cross pin **127** of the toggle lever, retracting the shoulder **132** of the toggle lever from the valve stem washer **111**. However, the valve stem is temporarily retained in its retracted position by the engagement of the spring-pressed detent or latching ball **90** in the peripheral groove **93** of the valve stem. After a further angular travel of the rock lever **116**, the toggle lever **117** snaps over center, whereupon the shoulder **131** of the toggle lever strikes the outer or rear face of the valve stem washer **111**, releasing the valve stem from the detent ball **90** and driving the valve stem to closed position, aided by the action of the spring **113**, the valve member **83** on the inwardly displaced valve stem closing the vent port **78**. The pressurized liquid in front of the piston

valve member seeping through the bleed opening **67** of this valve member then builds up a pressure in the back pressure chamber **79** and forces the valve member forwardly to closed position, aided by the pressure of the spring **69**. As the piston valve member approaches its closed position, the tip or nose **63** of the valve member enters the entrance of the jet nozzle **37**, thus restricting the inflow of pressurized water into the valve bore **31** and preventing water hammer. Even in the absence of the flow-restricting tip the water flow will be restricted by the forwardly moving front piston flange **55** as soon as it approaches the front edge of the inlet or supply port **46**. The aspirating action on the sump water then ceases, and the foot valve **52** will retain a column of sump water in the suction pipe **51**. If the foot valve is omitted, the water in the suction pipe will drop to the sump level, but will again rise in the suction pipe when a subsequent pumping action commences. The foot valve has the advantage of reducing noise and insuring prompt starting of the pump.

It has been found that with 55 p.s.i. supply water at about 60° F., and with a jet nozzle having a bore diameter of 3/16 inch, a vacuum of 20 inches of mercury can be continuously maintained in the suction or mixing chamber **27** of the pump if the suction flow is completely shut off. This corresponds to a suction lift which is considerably higher than that usually required for removing basement drainage. During normal operation of the pump the vacuum in the suction chamber **27** is of course identical with the head of water lifted from the sump to the pump.

The jet pump is disposed well above the sump so that foreign matter in the sump water will not adversely affect the operation of the valve means. Also, any foreign matter aspirated with the sump water will pass through the open discharge nozzle of the pump without danger of clogging.

As hereinbefore described, the restricted water flow through the axial bleed opening **67** in the piston valve member will be further restricted or stopped when the retracted valve member is close to or in abutment with the centrally ported valve block **70**. It is also possible to provide a restricted communication between the front and rear portions of the barrel bore **31** by omitting the O-ring **65** from the rear flange or head **56** of the piston valve member, in which event bleed water will be free to seep rearwardly past the periphery of this flange. In this case the bleed opening **67** may or may not be provided.

The pump of the invention is of simple, reliable and inexpensive construction, and since no electric power is required for operation it is not affected by electrical failures, and there is no danger of electrical shock.

The modified ejector pump **15'** shown in FIGS. 9 to 13 is similar to the pump of FIG. 1 except for the liquid level controlled snap acting valve mechanism. A rectangular open bottom casing **99'**, generally similar to the casing **99** of FIG. 1, is fixed to the closure bushing **71**, as in FIG. 1, and the spring-pressed pilot or venting valve stem **82** carries a shoulder-forming washer **111**, as in FIG. 1, the opening travel of the valve stem being adjustably limited by a stop screw **109**, as in FIG. 1. A horizontal shaft **114'** extends transversely below the valve stem approximately in the vertical plane of the valve stem washer **111** and is journalled in the opposite parallel side walls of the casing. The shaft **114'** supports thereon a pair of rock levers **116'** and **117'** in side-by-side relation. The rock lever **116'** comprises a hub **118'** having fixed thereto a flat lever plate **119'** disposed near the casing side wall **102**, the hub being secured to the shaft by a cross pin **118***a*. A float-actuated lever arm **119***a* is fixed to the projecting end of the shaft **114'** and projects toward the suction inlet boss **50**. The lever arm **119***a* forms, in effect, a part of the rock lever **116'**. The rock lever **116'** is upwardly biased in clockwise direction, as viewed in FIG. 9, by a coiled spring **120'**, one spring end being hooked onto the lever plate **119'** and the other spring end being hooked onto a cut-out bar portion **121'** formed at an outer upper corner of the casing. The hubbed rock lever **116'** has a lower concentric arcuate recess **122** presenting a pair of angular spaced shoulders **123** and **124**, as in the device of FIG. 1. The rock lever or toggle lever **117'** comprises a U-shaped metal strap having parallel arm portions **125'** and **126'** which are journalled on the shaft **114'**. A finger **127'** is rigidly carried by the yoke portion of the U-shaped rock lever **117'** and extends parallel to the shaft. The free end of the finger **127'** extends in the arcuate recess **122** of the rock lever **116'** for alternate engagement with the spaced shoulders **123** and **124**, thus providing a lost motion connection between the two rock levers. Near its free end the upwardly projecting arm portion **126'** of the rock lever **117'** carries a stud **129***a* which is pivotally connected to an eyed end of a V-shaped leaf spring **128'**. The other eyed end of the spring is pivotally carried on a stud **129'** fixed on the upper portion of the side wall **103** of the casing **99'**, the stud being disposed approximately in the projected vertical plane of the valve stem washer **111**. The spring **128'** thus provides a toggle or over-center action for the U-shaped rock lever **117'**. The other and shorter arm of the rock lever **117'** is provided at its free end with an arcuate concentric recess **130** presenting a pair of angularly spaced shoulders **131** and **132**, as in the device of FIG. 1, engageable with opposite faces of the valve stem washer **111** to reciprocate the valve stem.

The free end of the rock lever arm **119***a* is connected by a cord or chain **133'** with a float **137'** carrying a suspended weight **138**, the float resting on the water W in the sump and the weight being submerged in the water.

The operation of the ejector pump of FIG. 9 is generally similar to that of FIG. 1. Rise of liquid level in the sump effects a corresponding rise of the weighted float **137'**, permitting the coil spring **120'** to swing the rock lever **116'** clockwise, as viewed in FIG. 9, the finger **127'** on this rock lever driving the toggle-forming rock lever **117'** clockwise over center with a snap action, and the shoulder **132** on the toggle-forming rock lever thereupon striking the front face of the valve stem washer **111** and retracting the pilot valve stem to its open position against the pressure of the coil spring **113**, as seen in FIG. 10. The spool-shaped main valve member **49** is thereby hydraulically opened, and a pumping operation takes place, as in the device of FIG. 1. After the pumping operation, the weighted float descends to the position of FIG. 1, swinging the rock lever **116'** counterclockwise, as viewed in FIG. 9, and thereby driving the toggle-formed rock lever **117'** over center with a snap action, the shoulder **131** on this rock lever striking the rear face of the valve stem washer **111** and displacing the pilot valve stem inwardly to closed position. The main valve member **49** is thereupon hydraulically closed, and the pumping action ceases.

In the pump control of FIG. 9, the float-carrying weight **138** actuates the pilot valve to closed position, making it unnecessary to provide the float-carrying reversing lever **134** and mounting therefor included in the pump control of FIG. 1.

I claim:

1. In a jet pump having an inlet, a jet nozzle and a suction chamber; hydraulically operated valve means controlling the flow of pressurized liquid through said jet nozzle from said inlet and including a reciprocable main valve movable to open and closed positions and a pressure chamber at the rear side of said valve member, the front side of said valve member being exposed to the pressure of said liquid for urging said main valve to open position, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said pressure chamber, biasing means normally urging said main valve to closed posi-

tion, means providing a venting passage between said pressure chamber and said suction chamber to discharge bleed liquid from said pressure chamber and to impose a suction on the rear side of said main valve when said main valve is open, and a pilot valve in said venting passage movable to open and closed positions for controlling the opening and closing of said main valve, said pilot valve when open relieving the liquid pressure in said pressure chamber to permit opening of the main valve by liquid pressure acting on the front side of said main valve, and said pilot valve when closed permitting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said main valve by said biasing means.

2. In a jet pump having an inlet, a jet nozzle and a suction chamber; hydraulically operated valve means controlling the flow of pressurized liquid through said jet nozzle from said inlet and including a reciprocable main valve movable to open and closed positions and a pressure chamber at the rear side of said valve member, the front side of said valve member being exposed to the pressure of said liquid for urging said main valve to open position, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said pressure chamber, biasing means normally urging said main valve to closed position, means providing a venting passage between said pressure chamber and said suction chamber to discharge bleed liquid from said pressure chamber, and a snap-acting pilot valve in said venting passage movable to open and closed positions for controlling the opening and closing of said main valve, said pilot valve when open relieving the liquid pressure in said pressure chamber to permit opening of the main valve by liquid pressure acting on the front side of said main valve, and said pilot valve when closed permitting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said main valve by said biasing means.

3. In a jet pump having an inlet, a jet nozzle and a suction chamber; hydraulically operated valve means controlling the flow of pressurized liquid through said jet nozzle from said inlet and including a reciprocable main valve movable to open and closed positions and a pressure chamber at the rear side of said valve member, the front side of said valve member being exposed to the pressure of said liquid for urging said main valve to open position, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said pressure chamber, biasing means normally urging said main valve to closed position, means providing a venting passage between said pressure chamber and said suction chamber to discharge bleed liquid from said pressure chamber, a pilot valve in said venting passage movable to open and closed positions for controlling the opening and closing of said main valve, and releasable detent means holding said pilot valve in open position, said pilot valve when open relieving the liquid pressure in said pressure chamber to permit opening of the main valve by liquid pressure acting on the front side of said main valve, and said pilot valve when closed permitting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said main valve by said biasing means.

4. In a jet pump having an inlet, a jet nozzle and a suction chamber; hydraulically operated valve means controlling the flow of pressurized liquid through said jet nozzle from said inlet and including a reciprocable main valve movable to open and closed positions and a pressure chamber at the rear side of said valve member, the front side of said valve member being exposed to the pressure of said liquid for urging said main valve to open position, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said pressure chamber, biasing means normally urging said main valve to closed position, means providing a venting passage between said pressure chamber and said suction chamber to discharge bleed liquid from said pressure chamber, and a pilot valve in said venting passage movable to open and closed positions for controlling the opening and closing of said main valve, said pilot valve when open relieving the liquid pressure in said pressure chamber to permit opening of the main valve by liquid pressure acting on the front side of said main valve, and said pilot valve when closed permitting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said main valve by said biasing means, said main valve when in open position providing an additional restriction in said bleed passage to limit the flow of bleed liquid through said venting passage.

5. In a jet pump having an inlet, a jet nozzle and a suction chamber; hydraulically operated valve means controlling the flow of pressurized liquid through said jet nozzle from said inlet and including a reciprocable main valve movable to open and closed positions and a pressure chamber at the rear side of said valve member, the front side of said valve member being exposed to the pressure of said liquid for urging said main valve to open position, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said pressure chamber, biasing means normally urging said main valve to closed position, means providing a venting passage between said pressure chamber and said suction chamber to discharge bleed liquid from said pressure chamber, a pilot valve in said venting passage movable to open and closed positions for controlling the opening and closing of said main valve, said pilot valve when open relieving the liquid pressure in said pressure chamber to permit opening of the main valve by liquid pressure acting on the front side of said main valve, and said pilot valve when closed permitting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said main valve by said biasing means, and liquid level responsive means for actuating said pilot valve.

6. In a jet pump having an inlet, a jet nozzle and a suction chamber; hydraulically operated valve means controlling the flow of pressurized liquid through said jet nozzle from said inlet and including a reciprocable main valve movable to open and closed positions and a pressure chamber at the rear side of said valve member, the front side of said valve member being exposed to the pressure of said liquid for urging said main valve to open position, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said pressure chamber, biasing means normally urging said main valve to closed position, means providing a venting passage between said pressure chamber and said suction chamber to discharge bleed liquid from said pressure chamber, a pilot valve in said venting passage movable to open and closed positions for controlling the opening and closing of said main valve, said pilot valve when open relieving the liquid pressure in said pressure chamber to permit opening of the main valve by liquid pressure acting on the front side of said main valve, and said pilot valve when closed permitting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said main valve by said biasing means, actuating means for said pilot valve including a flexible tension member, and liquid level responsive means connected to said tension member.

7. In a jet pump, a pump body having a cylinder with a lateral inlet for pressurized liquid and having an axial outlet at an end of said cylinder including a jet nozzle, said body further having a valve seat surrounding the entrance of said outlet and a suction chamber communicating with the nozzle discharge, a piston valve reciprocable in said cylinder to open and closed positions and having a valve element engageable with said seat, said

cylinder forming a pressure chamber therein at the rear side of said piston valve, the front side of said valve being exposed to the pressure of said liquid for urging said piston valve in opening direction, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said pressure chamber, biasing means in said cylinder normally urging said piston valve in closing direction, means providing a venting passage between said pressure chamber and said suction chamber to discharge bleed liquid from said pressure chamber, and a pilot valve in said venting passage movable to open and closed positions for controlling the opening and closing of said piston valve, said pilot valve when open relieving the liquid pressure in said pressure chamber to permit opening of the piston valve by liquid pressure acting on the front side of said piston valve, and said pilot valve when closed permitting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said piston valve by said biasing means.

8. In a jet pump having an inlet for pressurized liquid, a jet nozzle, and a suction chamber adapted for connection to a liquid receptacle to be evacuated; hydraulically operated valve means controlling the flow of pressurized liquid from said inlet through said jet nozzle and including a reciprocable main valve movable to open and closed positions and a pressure chamber at the rear side of said valve, the front side of said main valve being exposed to the pressurized liquid for urging said main valve in opening direction, means providing a restricted bleed passage between said inlet and pressure chamber for admitting pressurized liquid to said pressure chamber, biasing means normally urging said main valve in closing direction, means providing a venting passage connecting said pressure chamber and said suction chamber, a pilot valve for opening and closing said venting passage, said pilot valve when open relieving the pressure in said pressure chamber to permit opening of said main valve by liquid pressure acting on the front side of said main valve, and said pilot valve when closed effecting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said main valve by said biasing means, and means responsive to liquid level in said receptacle for actuating said pilot valve.

9. In a valve structure, a valve body having a cylinder with a lateral inlet for pressurized liquid and a coaxial outlet at one end surrounded by a valve seat, a piston valve reciprocable in said cylinder to open and closed positions and having a valve element engageable with said valve seat, said cylinder having an end wall rearward of said piston valve and provided with an axial venting port, and said cylinder having a pressure chamber between the rear side of said piston valve and said end wall, the front side of said piston valve being exposed to the pressure of said liquid for urging said valve in opening direction, biasing means normally urging said piston valve in closing direction, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said pressure chamber, and a reciprocable pilot valve coaxial with said cylinder and movable to open and closed positions with respect to said venting port, means independent of the pressure of the liquid for actuating said pilot valve to open and closed positions, said pilot valve when open relieving the liquid pressure in said pressure chamber to permit opening of said piston valve by liquid pressure acting on the front side of said piston valve, and said pilot valve when closed effecting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of the piston valve by said biasing means.

10. In a valve structure, a valve body having an inlet and an outlet and a passage for pressurized liquid connecting said inlet and outlet, hydraulically operated valve means controlling the flow of pressurized liquid in said passage and including a reciprocable main valve movable to open and closed positions, the liquid passing from said inlet exerting a force against one side of said main valve urging said valve in opening direction, a pressure chamber at the other side of said valve adapted to be vented, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said chamber, biasing means normally urging said main valve in closing direction, means providing a liquid space in the outflow of the valve having an absolute pressure therein lower than the pressure in the vented pressure chamber, means providing a venting passage connecting said pressure chamber and said liquid space, a pilot valve for opening and closing said venting passage, means independent of the pressure of the liquid for actuating said pilot valve to open and closed positions, said pilot valve when open relieving the pressure in said pressure chamber to permit opening of said main valve by liquid pressure acting on the other side of said main valve, said low pressure liquid space exerting a suction action on the liquid in said pressure chamber when the pilot valve is open, and said pilot valve when closed effecting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said main valve by said biasing means.

11. In a valve structure, a valve body having an inlet and an outlet and a passage for pressurized liquid connecting said inlet and outlet, hydraulically operated valve means controlling the flow of pressurized liquid in said passage and including a reciprocable main valve movable to open and closed positions, the liquid passing from said inlet exerting a force against one side of said main valve urging said valve in opening direction, a pressure chamber at the other side of said valve adapted to be vented, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said chamber, biasing means normally urging said main valve in closing direction, means providing a subatmospheric chamber, means providing a venting passage connecting said pressure chamber and said subatmospheric chamber, a pilot valve for opening and closing said venting passage, means independent of the pressure of the liquid for actuating said pilot valve to open and closed positions, said pilot valve when open relieving the pressure in said pressure chamber to permit opening of said main valve by liquid pressure acting on the other side of said main valve, said subatmospheric chamber exerting a suction effect on the liquid in said pressure chamber when the pilot valve is open, and said pilot valve when closed effecting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said main valve by said biasing means.

12. In a valve structure, a valve body having an inlet and an outlet and a passage for pressurized liquid connecting said inlet and outlet, hydraulically operated valve means controlling the flow of pressurized liquid in said passage and including a reciprocable main valve movable to open and closed positions, the liquid passing from said inlet exerting a force against one side of said main valve urging said valve in opening direction, a pressure chamber at the other side of said valve including an end wall, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said pressure chamber, biasing means normally urging said main valve in closing direction, means providing a venting passage communicating with said pressure chamber, and a pilot valve for opening and closing said venting passage, said pilot valve when open relieving the pressure in said pressure chamber to permit opening of said main valve by liquid pressure acting on the other side of said main valve, and said pilot valve when closed effecting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of said main valve by said biasing means, said main valve when in open position being close to said

end wall for providing an additional restriction in said bleed passage to substantially block the flow of bleed liquid through said venting passage.

13. In a valve structure, a valve body having a cylinder with a lateral inlet and a coaxial outlet at one end surrounded by a valve seat, a piston valve reciprocable in said cylinder to open and closed positions and having a valve element engageable with said valve seat, said cylinder having a pressure chamber at the rear side of said piston valve, a valve block forming the outer end of said pressure chamber and having an axial venting port, said cylinder having an end closure retaining said valve block, the front side of said piston valve being exposed to the pressurized liquid for urging said piston valve in opening direction, spring biasing means normally urging said piston valve in closing direction, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting pressurized liquid to said pressure chamber, a reciprocable pilot valve coaxial with said cylinder and movable to open and closed positions with respect to said venting port, said pilot valve including a valve stem slidable in said cylinder end closure, and means independent of the pressure of the liquid in said cylinder for actuating said pilot valve, said pilot valve when open relieving the liquid pressure in said pressure chamber to permit opening of said piston valve by liquid pressure acting on the front side of said piston valve, and said pilot valve when closed effecting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of the piston valve by said biasing means.

14. In a valve structure having a valve body with a passage for pressurized liquid and with an hydraulically operated main valve movable therein to open and closed positions with respect to said passage and normally biased to closed position, and said body further having a pressure chamber at the rear side of said main valve in restricted communication with the pressurized liquid and adapted to be vented through a vent port to permit the pressurized liquid acting on the front side of said valve to open said valve, a pilot valve reciprocable in said valve body and having a slidable valve stem with a valve element of rubber-like material at an end portion thereof for opening and closing said vent port, said valve body having a tubular boss surrounding said stem, and said valve element having a sleeve portion surrounding said tubular boss in slidable sealing engagement therewith.

15. In a valved jet pump for evacuating liquid from a receptacle through a suction pipe extending upwardly to the pump which is spaced above the liquid level in the receptacle, said pump including, a valve structure having a main valve movable to open and closed positions and control means therefor including a pilot valve movable to open and closed positions, and actuating means for said pilot valve including a flexible tension member and means responsive to liquid level in said receptacle connected to said tension member.

16. In a valved jet pump for evacuating liquid from a receptacle, a valve structure having a main valve movable to open and closed positions and control means therefor including a pilot valve movable to open and closed positions, and actuating means for said pilot valve including a flexible tension member and means responsive to liquid level in said receptacle connected to said tension member, said liquid level responsive means including a pivoted lever carrying a float at one side of its pivotal axis and having said tension member connected to said lever at the other side of the pivotal axis.

17. In a valve structure, a valve body having an inlet and an outlet and a passage for pressurized liquid connecting said inlet and outlet, hydraulically operated valve means controlling the flow of pressurized liquid in said passage and including a reciprocable main valve movable to open and closed positions, the liquid passing from said inlet exerting a force against one side of said main valve urging said valve in opening direction, a pressure chamber at the other side of said valve adapted to be vented, means providing a restricted bleed passage between said inlet and said pressure chamber for admitting liquid under pressure to said chamber, biasing means normally urging said main valve in closing direction, means providing in the outflow of the valve a suction chamber when said main valve is open, at least a portion of the liquid discharged through said outlet passing through said suction chamber, means providing a venting passage connecting said pressure chamber and said suction chamber, a pilot valve for opening and closing said venting passage, and means independent of the pressure of the liquid for actuating said pilot valve to open and closed positions, said pilot valve when open relieving the pressure in said pressure chamber to permit opening of said main valve by liquid pressure acting on the other side of said main valve, the pressure in said suction chamber during discharge of liquid through said outlet when said main valve and venting valve are open being less than the pressure in said vented pressure chamber, and said pilot valve when closed effecting restoration of liquid pressure in said pressure chamber through said bleed passage to permit closing of the main valve by said biasing means.

References Cited by the Examiner

UNITED STATES PATENTS

318,185	5/85	Haydn	103—276
2,142,903	1/39	King	251—75
2,333,522	11/43	Clifton	251—33 X
2,366,596	1/45	Clifton	251—33 X
2,388,820	11/45	Bonnell	251—33 X
2,453,812	11/48	Phelan	251—75 X

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