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FLUID CATCHER FOR JET PIPES

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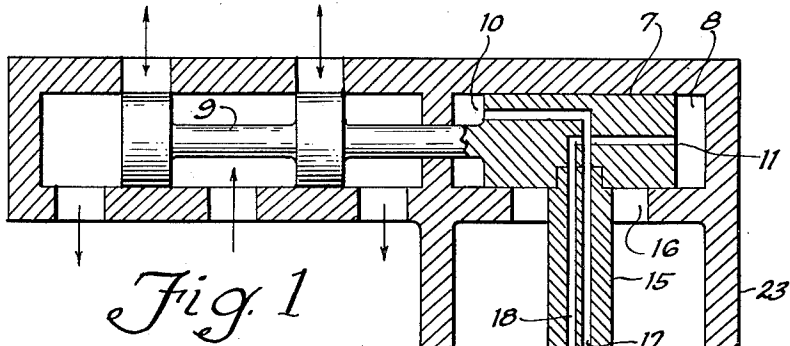


*Fig. 1*

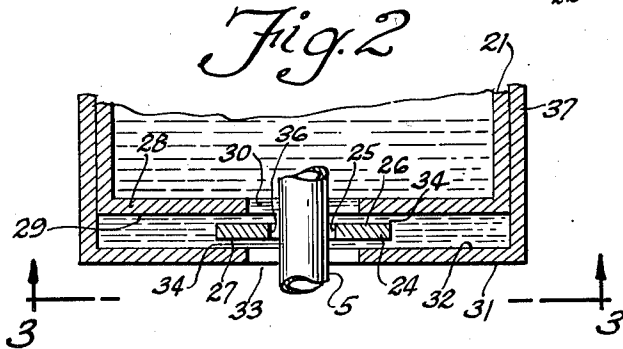


*Fig. 2*

*Fig. 4*

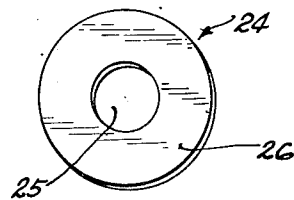
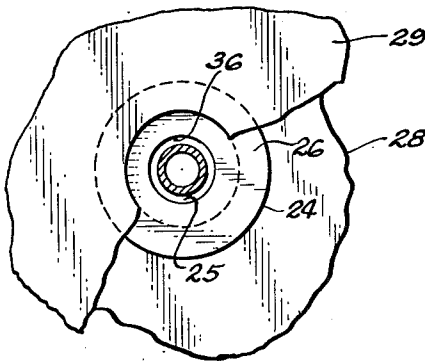


*Fig. 3*

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## FLUID CATCHER FOR JET PIPES

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7 Claims. (Cl. 137—83)

The present invention relates to liquid catchers for jet pipe regulators, of the general type disclosed by United States Patent to Neukirch, No. 2,228,015, dated January 7, 1941.

A jet pipe regulator is a signal-responsive device for developing a variable pressure in a receiver port, or a variable differential between pressures developed in a pair of receiver ports, by swinging of a jet pipe that delivers a stream of liquid under pressure, usually oil, from a discharge orifice, and that is mounted pivotally to swing in response to variation of an applied signal, to change the degree of registration with the single port, or its relative degrees of registration with the two ports, so that the liquid impinging on the port openings develops a pressure that changes in magnitude as a function of changing jet pipe position. If the jet discharge takes place in air, air is entrained with the jet and injected into the port, upsetting the relationship between pressure and jet pipe position. Additionally, if the discharge is in air, the liquid assumes a turbulent condition about the port structure, interferes with proper jet delivery and may affect the position of the jet pipe. Still further, the liquid splashes against the jet pipe, also affecting its position. As suggested by the identified patent, a liquid catcher corrects these conditions by enclosing the jet and receiver ports, providing drainage of a character to maintain the enclosed space full of liquid and sufficiently non-turbulent to permit a uniform condition of delivery of the jet to the receiver ports by the jet pipe.

The liquid catcher disclosed by the patent is a shell structure stationarily mounted and having an outer tubular side wall that surrounds the end portion and discharge orifice of the jet pipe and the receiver ports. From an annular rear or outer end wall an inner tubular structure extends inside the outer side wall toward the receiver port, and the jet pipe extends into the space enclosed by the shell through this inner tubular structure which is made as small as permitted by the necessary swing path of the jet pipe. One or more drainage openings are provided in the shell for escape of liquid, the total escape path having a cross sectional area so related to the volume rate of liquid delivery by the jet pipe as to keep the shell filled with liquid, but with development of minimum back pressure exerted against jet discharge. Liquid also flows through the tubular inner structure about the jet pipe, thereby forming a seal against entry of air through the tubular structure to the space surrounding the jet and the receiving port structure.

It is evident that the opening in a liquid catcher shell through which the jet pipe extends into the space enclosed by the shell must be large enough in the directions of the jet pipe swing path to not interfere with movements of the jet pipe. It is also obvious that the narrower the space filled with liquid to provide a liquid seal against air passage, the more effective the seal will be.

In jet pipe regulators as originally developed, the receiver structure was stationary and the receiver ports

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were spaced very closely so that the overall angular distance of jet pipe swinging could be limited sufficiently to make the opening in the inner tubular structure providing clearance for jet pipe swinging sufficiently small to provide a quite effective liquid seal. Subsequent jet pipe regulator developments have provided arrangements wherein the receiver is movable in the directions of the path of swing of the discharge orifice, and these require clearance openings of increased sizes which, at least in certain cases, permit air to enter the discharge space enclosed by the shell, also provide a path for a liquid flow of sufficient volume and turbulence to affect the jet pipe position, and to some extent permit splashing of sufficient violence to upset the jet pipe position.

Another jet pipe development has been arrangement of the receiver element as a stem-like extension into the jet pipe housing, which permits a desirable shortening of the jet pipe, but sometimes results in such decrease of space available for a liquid catcher as to preclude use of a catcher of the patented type that is of sufficient length to provide an effective seal against air entry.

The present invention provides a liquid catcher that solves these problems, by a novel arrangement for sealing the clearance opening, more positively and by a physical seal member, but practically without presenting frictional resistance to movements of the jet pipe. The basic concept of the device is the arrangement of one seal member in closely surrounding relation to, and for movement with the jet pipe and relative to a second sealing member provided by the catcher shell wall structure surrounding the clearance opening, and closely overlapped by a portion of the first seal member surrounding the area thereof that is registered with the opening. The overlapping opposed surfaces are closely spaced and the overlap sufficiently extended to provide an escape path presenting substantial resistance to flow of liquid through it, and the liquid that does flow through maintains a floating relation between the surfaces that practically completely eliminates frictional resistance to their relative movement. The first seal member, which moves with the jet pipe, may be arranged outside and facing an outward facing wall surface of the catcher shell, inside and facing an inner wall surface of the shell, or, preferably, between spaced outward and inward shell wall surfaces, with opposite surfaces facing both and providing a liquid seal with each.

In the accompanying drawings:

Fig. 1 is a partial horizontal section through a typical jet pipe regulator unit equipped with a liquid catcher arranged according to the invention.

Fig. 2 is an enlarged fragmentary section on the same plane as Fig. 1, showing the mode of operation of the device.

Fig. 3 is a fragmentary end elevation of the oil catcher of Figs. 1 and 2, from the plane of line 3—3 of Fig. 2.

Fig. 4 is a perspective view of the sealing member used in the catcher.

Describing the drawings, and first referring to Fig. 1, the jet pipe relay regulator chosen to illustrate the invention comprises a jet pipe 5 pivoted for swinging in radial fashion about a fixed pivot axis spaced from its discharge end 6, in which is an axial end-opening discharge orifice for delivering a jet of fluid supplied through the interior of the pipe. A relay operated by the discharged fluid jet may comprise the illustrated so-called "auxiliary piston" which comprises a piston body 7 enclosed and axially slidable in a cylinder structure 8, and the piston may drive a device such as the illustrated spool type control valve body 9. Ports 10, 11 in the ends of piston 7 are connected with a pair of receiver ports 12, 13, that are narrowly spaced in the directions of piston movement and that are arranged in the end surface 14

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of a distributor member 15. In the specific form shown, distributor 15 is a stem like member that projects from piston 7 through a clearance opening 16 in cylinder structure 8. The invention, however, may be equally well employed with an auxiliary piston assembly having the port-carrying distributor surface 14 flush with the piston side, as shown in United States Patent to Herbert Ziebolz No. 2,380,357, July 10, 1945, and in fact it presents considerable advantage in relays wherein the distributor is stationary and the distributor ports are connected through passages in stationary structure with opposite ends of a cylinder, as shown for example in Patent No. 2,254,098 to the same patentee. Distributor member 15 has its axis disposed along the plane in which the axis of jet pipe 5 moves as the jet pipe is swung, and receiver ports 12, 13 also have their axes arranged in that plane. Ports 10, 12 and 11, 13 are cross connected in the sense of directions of opening of ports 10, 11 and of directions of spacing of ports 12, 13, by internal passages 17, 18. By this arrangement, which is well known in jet pipe regulators, equal registration between the discharge orifice of jet pipe 5 and the two receiver ports results in development of equal pressures at opposite ends of piston 7, and in a stationary condition of the latter. When the jet pipe swings to a position of greater and less registration with the different receiver ports, correspondingly greater and lesser pressures are developed at the different ends of the piston, with which respectively the different receiver ports are connected. Due to the mentioned cross connection, the resulting movement of the piston is in the direction of the receiver port having greater registration with the jet pipe discharge orifice, and it continues until equal registration is re-established and the pressures again are balanced. Thus piston 7 follows swinging movements of the jet pipe discharge orifice.

The liquid catcher 20 forming the subject of the present invention comprises a shell having tubular side wall 21 that is suitably mounted to the cylinder structure 8, as by an end flange 22 secured to a tubular extension 23 of that structure. The catcher 20 has also an end wall structure provided with a clearance opening through which jet pipe 5 extends, so that its discharge end is enclosed by the catcher, and which forms a part of the novel liquid sealing arrangement provided by the invention.

One element of the seal, which is carried by and movable with the jet pipe, comprises an annular element 24 having a central opening 25 through which the jet pipe is extended and having opposite faces 26, 27 at least one of which, and preferably both of which as shown, cooperate with opposed surfaces of end wall structure of catcher 20. This end wall structure comprises at least one, and preferably both, as shown, of an end wall 28 having an outer surface 29 that surrounds a clearance opening 30, and/or an end wall 31 having an inner surface 32 surrounding a clearance opening 33. In the assembly, either or both the face 26 and/or face 27 of annular member 24 overlie the opposed surface 29, 32, of the end wall structure, in such spacing as to provide a clearance 34 sufficient to permit member 24 to move with the jet pipe, but also sufficiently narrow to provide substantial resistance to flow of the fluid. The diameter of member 24 is sufficient as compared to the diameter of the clearance aperture or apertures in the end wall structure with which it is cooperative, to insure overlap of the opposed wall structure surfaces and annular member faces sufficient to provide this resistance to fluid flow in all positions of the jet pipe. A drainage or escape opening 35 is provided in the catcher, preferably in its side wall structure. The cross sectional area of opening 35 is so related to the preselected volume rate of jet pipe liquid delivery as to insure maintenance of the catcher full of liquid and flow of liquid through the clearances of the seal, but without development of back

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pressure of sufficient magnitude to materially impede liquid jet delivery by the jet pipe.

Preferably the end wall structure of catcher 20 comprises both an inner wall 28 and an outer wall 31 in axially spaced disposition, and between outer and inner surfaces 29, 32 respectively of which the annular member 24 is arranged. This not only provides a more extended restricted escape passage for liquid through clearances 34, but also permits floating mounting of member 24 on jet pipe 5, by making the diameter of opening 25 of the former slightly larger than the outside diameter of the jet pipe, and providing a clearance 36 between the inner periphery of member 24 and the outer surface of the jet pipe.

Advantageously, the end wall 28 is formed integral with sidewall 21, forming a cup-like inner structure, and outer end wall 31 is integral with a sidewall 37 that is telescopically mounted on side wall 21. Drainage opening 35 preferably opens through both of the telescoped sidewalls 21, 37, and these walls may be relatively rotatable to adjust the effective cross sectional area of the drainage opening. It may be noted that such an adjustment may be made after the catcher is mounted since the overlapping type of seal provided by annular member 24 and the catcher end wall structure requires no rotative orientation between the end wall structure and the plane of swing of the jet pipe axis.

In operation, with jet pipe 5 discharging liquid and the catcher full of liquid, in addition to escaping through drainage opening 35, the liquid will flow through the seal clearances as 34 between the opposed faces of member 24 and the opposite surfaces of the end wall structure of the catcher shell, and clearance 36 in the case of the preferred floating mounting of member 24 on jet pipe 5. This escaping fluid forms films between the faces 25, 26 of movable member 24 and the opposite fixed surfaces 29, 32 of the shell end structure, as well as between member 24 and jet pipe 5 if clearance 35 is provided in the particular installation. These films of moving fluid prevent direct contact between relatively movable surfaces of the seal, and thus prevent frictional resistance to movement of the jet pipe. This is of extreme importance in respect to sensitivity of response of the regulator to signal variations of minute magnitudes. Furthermore, the complete masking of the opening in the end of the catcher shell by the overlapping member 24, and the moving films of escaping fluid, serve completely to eliminate the entrainment of air by the jet, and also completely eliminate irregular splashing of liquid alongside and into contact with the jet pipe outside the catcher shell, as well as surging of escaping liquid through a tubular clearance structure through which the jet pipe is extended. Thus the seal herein disclosed avoids characteristics of previously used liquid catchers that have in certain instances impaired accuracy of jet pipe regulator operation.

The width of clearances provided in the seal whether between opposite relatively movable surfaces of member 24 and catcher shell end wall structure, or between a loosely mounted annular member and the jet pipe it surrounds, as well as degree of overlap of shell end wall structure by the annular member, obviously are not critical. Clearances of the order of five one-thousandths of an inch in width have proven satisfactory, as well as an annular member diameter of three-quarters of an inch and diameters of shell end wall openings 30, 33 of one-half inch have proven satisfactory in a jet pipe regulator using conventional oil and having a jet pipe orifice swing of the order of one-eighth inch. Such clearances in the specific form illustrated may be provided by spacing the facing surfaces 29, 32 of end walls 28, 31 at a distance greater than the thickness of annular member 24 by a distance of the order of ten one-thousandths inch, and by making the opening of member 25 of a diameter greater than the outside diameter of jet pipe 5 by a length of the same order.

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From the foregoing the principles of structural arrangement of oil catchers embodying the invention, and their mode of operation, will be apparent, and it is to be understood that changes in and modifications of the exemplary disclosure herein contained may be resorted to without departing from the invention as defined by the appended claims.

I claim:

1. In a liquid catcher for a jet pipe regulator of the type that includes a jet pipe pivoted for swinging and a receiver port-providing structure facing said jet pipe, and said catcher comprising a shell sidewall structure laterally surrounding said port-providing structure for enclosing the discharge end of said jet pipe; seal means comprising a pair of shell walls attached to said sidewall structure and spaced apart to provide opposite spaced surfaces and said walls having registered openings smaller than and surrounded by said surfaces, and a seal member of thickness slightly less than the distance spacing said surfaces, interposed between the latter and having therein an opening for penetration by a jet pipe for support of said member by said jet pipe, said opening being located to provide overlapping relation between said member and said surfaces in all positions of said jet pipe.

2. Seal means for a liquid catcher for a jet pipe regulator of the type including a jet pipe having preselected outside cross dimensions and pivoted for swinging and a receiver port-providing structure facing said jet pipe, and said catcher comprising a shell sidewall structure laterally surrounding said port-providing structure; said seal means comprising a pair of shell walls attached to said sidewall structure and spaced apart to provide opposed spaced surfaces, said walls having therethrough registered openings of dimensions sufficiently larger than said jet pipe cross dimensions to permit such a jet pipe that is extended through them to swing in an arcuate path of preselected length, and said openings being surrounded by said surfaces, and a seal member movable between said surfaces, said member having a central hole for penetration of a jet pipe extended through said openings, said member being of a size and having said hole so located as to provide throughout swing of said jet pipe in said path a substantial area of overlap between its different faces and the respective said surfaces, and said member being of a thickness sufficiently less than the distance spacing said surfaces to permit liquid films to flow between said surfaces and faces.

3. Seal means according to claim 2, wherein said hole is of dimensions sufficiently larger than said jet pipe outside cross dimensions as to provide clearance for a flowing film of liquid when penetrated by such a jet pipe.

4. In a jet pipe regulator comprising a jet pipe pivoted for swinging of its discharge end along a preselected arcuate path, a receiver port-providing structure facing said path, and a liquid catcher including sidewall structure laterally surrounding said port-providing structure and jet pipe discharge end; seal means between said jet pipe and liquid catcher, comprising an end wall attached to said sidewall structure, disposed transverse to said jet pipe, and having therein a clearance opening of a size and location to provide free clearance for said jet pipe in swinging of its discharge end throughout said path, and said opening being surrounded by a surface of said end wall, and a seal member mounted on said jet pipe and having a face opposed to said end wall surface, of a size to overlap said surface throughout said jet pipe swinging, and spaced from said surface a distance to provide for flow of a thin film of liquid.

5. In a jet pipe regulator comprising a jet pipe pivoted for swinging of its discharge end along a preselected arcuate path, a receiver port-providing structure facing

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said path, and a liquid catcher including sidewall structure laterally surrounding said port-providing structure and jet pipe discharge end; seal means between said jet pipe and liquid catcher, comprising an end wall attached to said sidewall structure, disposed transverse to said jet pipe, and having therein a clearance opening of a size and location to provide free clearance for said jet pipe in swinging of its discharge end throughout said path, and said opening being surrounded by a surface of said end wall, and a seal member mounted on said jet pipe inside of said end wall and having a rear face opposed to the inner surface of said wall, of a size to overlap that said surface throughout the swinging path of said jet pipe, and spaced from said inner end wall surface a distance to provide for flow of a thin film of liquid.

6. In a jet pipe regulator comprising a jet pipe pivoted for swinging of its discharge end along a preselected arcuate path, a receiver port-providing structure facing said path, and a liquid catcher including a sidewall structure laterally surrounding said port-providing structure and jet pipe discharge end; seal means between said jet pipe and liquid catcher, comprising an end structure including a pair of end walls attached to said sidewall structure and spaced apart to provide a pair of spaced opposite surfaces, and said end walls having registered openings surrounded by said surfaces, through which said jet pipe is extended, and of sizes providing free clearance between said end walls and jet pipe throughout swinging of the discharge end of the latter through said path, and a seal member mounted on surrounding and projecting radially from said jet pipe between said walls, of a size to provide substantial areas of overlap of said surfaces surrounding said openings throughout swinging of said jet pipe through said path, said seal member being of a thickness sufficiently less than the distance spacing said surfaces to provide clearance for a flowing film of liquid but to present resistance to flow thereof.

7. In a jet pipe regulator comprising a jet pipe pivoted for swinging of its discharge end along a preselected arcuate path, a receiver port-providing structure facing said path, and a liquid catcher including a sidewall structure laterally surrounding said port-providing structure and jet pipe discharge end; seal means between said jet pipe and liquid catcher comprising an end structure including a pair of end walls attached to said sidewall structure and spaced apart to provide a pair of spaced opposite surfaces, and said end walls having registered openings surrounded by said surfaces, through which said jet pipe is extended, and of sizes providing free clearance between said end walls and jet pipe throughout swinging of the discharge end of the latter through said path, and a seal member located between said opposite wall surfaces, having a hole therethrough penetrated by said jet pipe and sufficiently larger than said jet pipe to provide clearance for a flowing film of liquid through said hole but to present resistance thereto, said seal member surrounding and projecting radially from said jet pipe, being of a size providing substantial areas of overlap of said surfaces surrounding said registered openings throughout swinging of said jet pipe end through said path, and said seal member being of a thickness sufficiently less than the distance spacing said surfaces to provide clearance for a flowing film of liquid but to present resistance to flow thereof.

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