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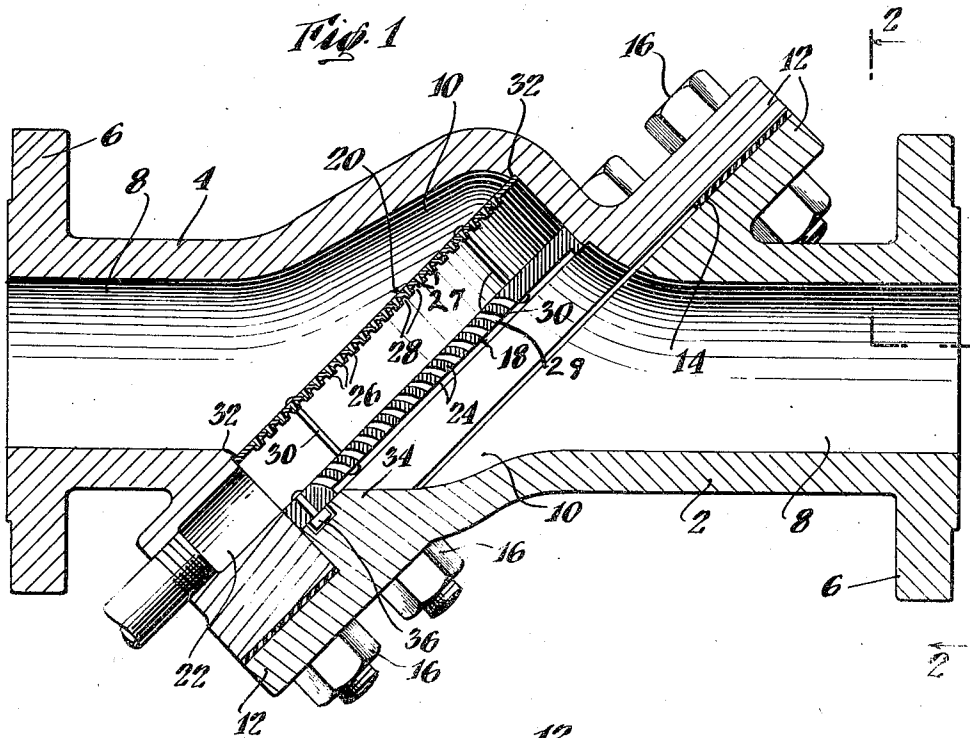
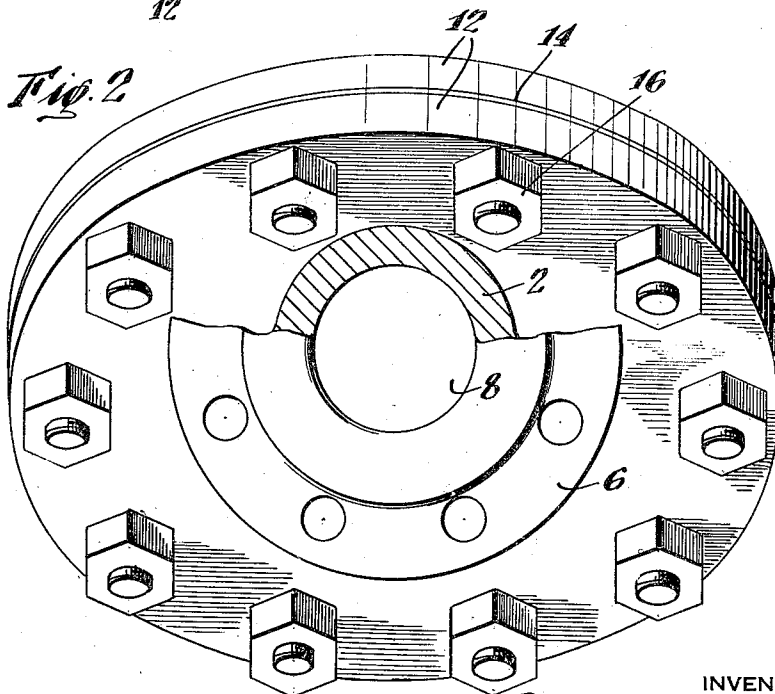
P. PASCALE

2,178,240

SEPARATOR

Filed May 15, 1937

2 Sheets-Sheet 1



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Oct. 31, 1939.

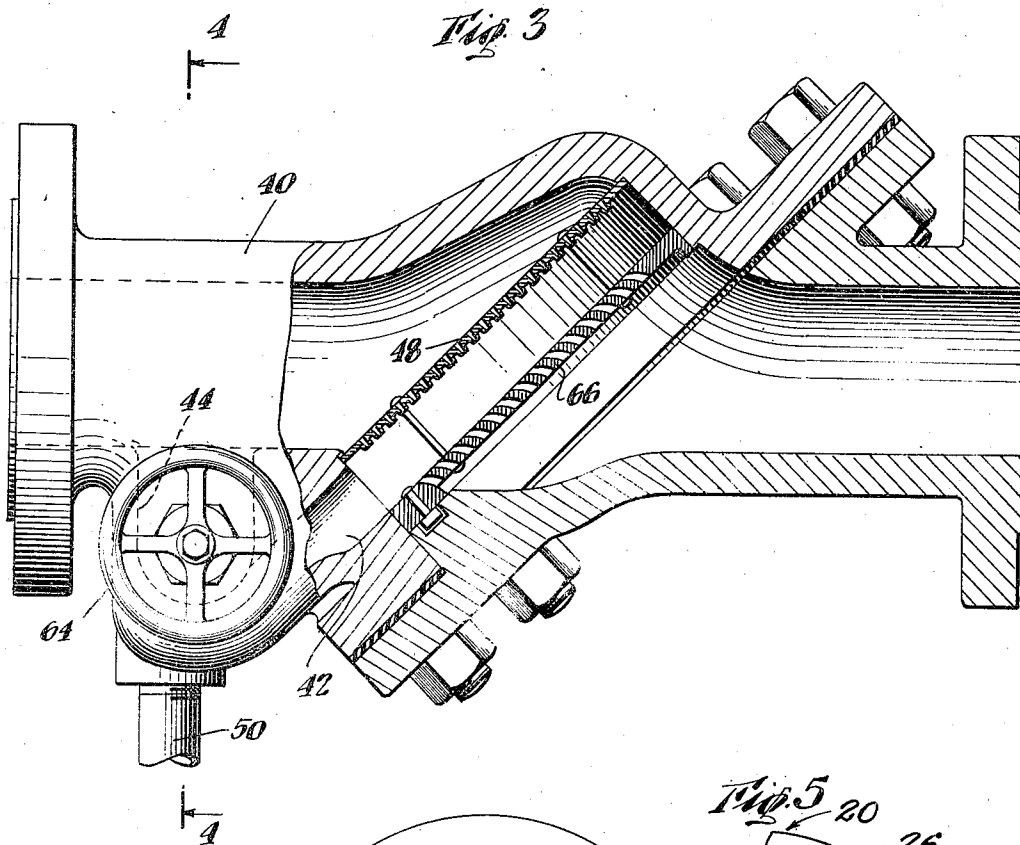
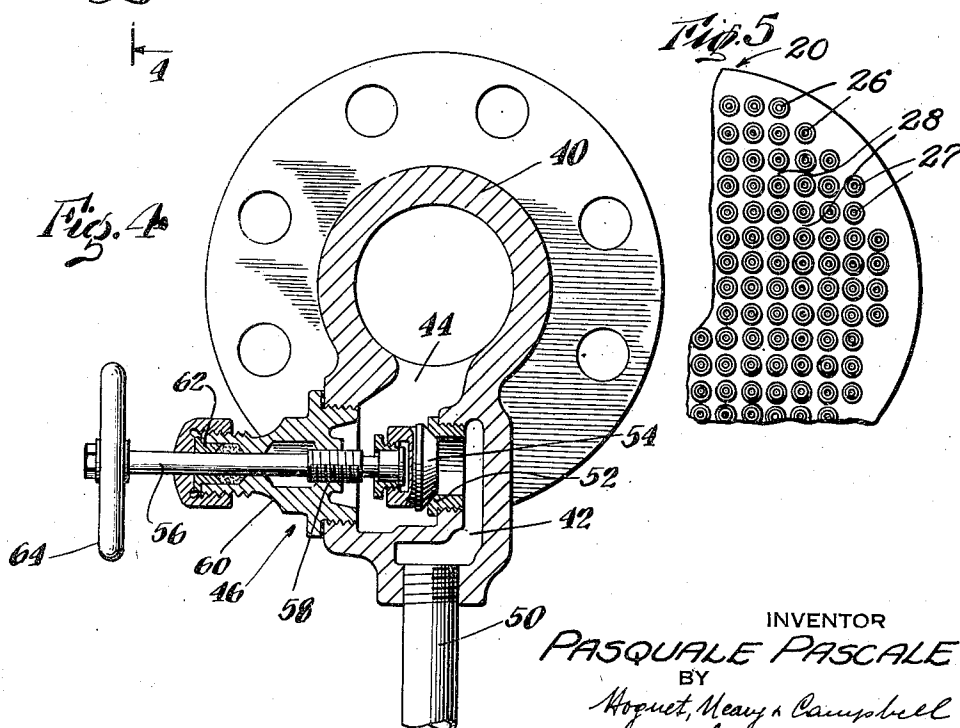
P. PASCALE

2,178,240

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2 Sheets-Sheet 2



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2,178,240

SEPARATOR

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Application May 15, 1937, Serial No. 142,767

7 Claims. (Cl. 183—112)

This invention relates to separators for removing condensate or separate from steam or other gases and particularly to separators adapted for use in pipe-lines for drying steam or other gases passing therethrough.

It is common practice to provide separators in pipe-lines, such as steam lines, but heretofore such constructions have not been capable of use interchangeably in either vertically or horizontally extending lines. Moreover, the separators used frequently have imposed considerable back pressure on the line because of their complicated construction and the tortuous paths through which the steam or gases have been forced to pass. In most constructions it also is difficult, if not impossible, to remove or replace the drying elements without removing the complete separator and entailing a more or less extended shut-down of the flow through the line. In many installations as soon as clogging of any of the drying elements takes place to any extent it is necessary to install a new separator or shut-down for a more extended time to permit dismantling and cleaning of the clogged elements; otherwise back pressure may be set up to interfere with the normal operation.

In accordance with the present invention, these objections to constructions of the prior art are overcome by providing a simple form of separator in which drying elements and the usual condensate draw-off or drain are so disposed that they have the same functional relation and effectiveness when connected either in horizontally or vertically extending pipe-lines. The invention also includes a novel construction and arrangement of drying elements capable of being assembled into and removed from the separator housing very readily so that cleaning, repair and replacement thereof can be accomplished with a minimum of delay and expense.

In some instances it is not necessary that steam or other gas be subjected to as thorough drying treatment and sufficient drying will result if it is passed through only one or part of the drying elements. Moreover, it may become desirable or necessary to relieve back pressure on the line due to clogging of a drying element so as to increase the flow of steam to the point of use and at the same time effect a cleaning operation of the drying element. The present invention, therefore, includes means for by-passing steam or gases about a part of the drying elements embodied in a separator in such a manner as to dislodge solid separate therefrom.

One of the objects of the invention is to pro-

vide a simple form of separator adapted for use in either vertically or horizontally extending pipe lines.

Another object of the invention is to provide a steam separator or the like with a novel arrangement of drying elements that may be removed or replaced with a minimum of delay and expense.

A further object of the invention is to provide a separator for pipe lines with means operable at will to relieve back pressure on the line due to clogging of a drying element of the separator.

A still further object of the invention is to provide a separator for steam lines or the like, including means for by-passing steam about one of a plurality of drying elements of the separator in such a manner as to dislodge and remove solid separate adhering thereto.

These and other objects and features of the invention will appear from the following description thereof in which reference is made to typical embodiments of the invention illustrated in the accompanying figures in the drawings.

In the drawings:

Fig. 1 is a longitudinal sectional view of a form of separator embodying the present invention;

Fig. 2 is a view partly in section and partly in elevation, taken on the line 2—2 of Fig. 1;

Fig. 3 is a side elevation, partly in section, illustrating a modified form of the invention;

Fig. 4 is a transverse sectional view taken on the line 4—4 of Fig. 3, and

Fig. 5 is a perspective on an enlarged scale of a portion of one of the drying elements as seen from that side thereof against which steam or gases impinge.

Referring to that form of the invention illustrated in Figs. 1 and 2 of the drawings, the separator is shown as comprising a housing made up of an inlet section 2 and an outlet section 4, each provided with a flange 6 for connecting the sections to adjacent members of a pipe-line in any suitable location and in either vertical or horizontal portions. The sections are provided with coaxial passages 8 for the flow of steam therethrough and are formed at their adjacent ends with enlarged portions 10 surrounded by flanges 12 which lie in parallel planes inclined with respect to the direction of flow of steam through the passages 8. They are shown as disposed substantially at an angle of 45° to the axis of the passages 8. A gasket 14 is located between the flanges 12 and the sections are drawn together by bolts 16, or are otherwise suitably constructed to prevent the escape of steam from between the sections.

Within the space provided by the adjacent enlarged portions 10 of the sections 2 and 4 are arranged spaced drying elements 18 and 20 provided with apertures so arranged as to promote the removal of separate or condensate from the steam or other gas passed through the line. The outlet section 4 is shown as formed with a drain 22 for conducting separate removed from the steam out of the separator.

The drying elements illustrated are arranged to lie in parallel planes disposed at a suitable angle to the direction of flow of the gases through the separator and are inclined toward the drain 22 so that separate impinging on the drying elements as it is carried along with the steam or gas is directed toward the drain. The drying element 18, although differing in shape, is similar in type to that shown and described in my Patent No. 1,647,465 and embodies parallel turbine blades 24 spaced apart to permit steam to pass between the same. This element is shown as positioned in advance of the drain 22 and the blades 24 thereof are curved generally toward the drain to direct the steam or gases and separate carried thereby toward the drain.

The drying element 20 is similar in type to that shown and described in my copending application, Serial No. 744,518, filed September 18, 1934, and embodies a plate having nozzles 26 projecting from that face thereof against which steam impinges in passing through the separator. The nozzles are formed with openings 27 which are generally conical in shape tapering from a relatively small opening in the front and being larger in the rear of the plate 20. This element is located rearwardly of the drain 22 so that separate impinging thereon and removed from the steam or gases will flow over its surface along the channels 28 between the projecting nozzles toward the drain 22.

The steam entering through the openings 29 defined by the turbine blades will to a considerable extent, varying with the angle of inclination of plates 18 and 20, impinge directly upon the protruding nozzles 26 and sweep across the face of the plate 20, in this way being subjected to a combing action tending to separate condensate present. Since the steam cannot escape through the drain 22, a turbulence with swirling of the steam currents will be set up in the space intervening the plates 18 and 20 furthered by the baffling or combing action of the protruding nozzles, thus affording more opportunity for entrained condensate to separate out, collect at the bottom of the space and pass off through the drain 22. The steam thus denuded of its moisture or condensate passes through the apertures 27 in the plate 20 and on through the passage 8. Condensate that shall have been caught by the turbine blades 24 will travel across the face of the plate 18 or drip to the bottom of the enlarged space 10 in the section 2 whence it may pass on to the drain 22 either through the lowermost of the openings 29 or through a separate passage not shown.

The drying elements 18 and 20 are secured together and held in spaced relation by means of spacers 30 which are riveted or otherwise secured to the drying elements and cooperate therewith to form a drying unit formed separately from the sections of the housing and adapted to be inserted into and removed from the housing very easily and quickly. With this construction clogging or damage to either of the drying elements of the unit does not require replacement of the whole

separator, but can be corrected or repaired quickly and easily, or another unit may be substituted for one which is impaired with a minimum loss in time, labor and expense.

The outlet section 4 is formed with a recess in the enlarged portion 10 thereof for receiving the drying unit and presents an annular shoulder 32 against which the drying element 20 bears. A boss 34 projects from the inlet section 2 into the recess in the outlet section 4 adjacent the drain 22 and bears against the face of the element 18 of the drying unit to hold the unit in position within the recess in the enlarged portion of the outlet section. A dowel pin 36 carried by the member 18 projects into a complementary recess in the boss 34 to position the drying unit so that the turbine blades 24 of the drying element 18 will direct steam and separate toward the drain 22.

While the drying unit and its elements 18 and 20 may be located in any desired baffling position in the separator, it is of great advantage to have them disposed substantially at an angle of 45° to the axis of the passages 8 in the inlet and outlet sections, for when so positioned their action in denuding steam of separate and in draining the separate from the separator will be equally effective whether the separator is located in a horizontal position or in a vertical position with the steam passing downward therethrough. When in either position the steam and separate are directed forward and downward toward the drain 22 by the turbine blades of drying element 18 and the separate flows forward and downward over the surface of the element 20 and along the channels 28 between the nozzles on the face thereof toward the drain 22.

In using the construction described, the outlet section of the housing is secured in the pipe line and the drying unit, consisting of the drying elements 18 and 20 and the spacers 30, is positioned in the recess in the enlarged portion 10 of the outlet section so as to be seated against the shoulder 32 therein. The inlet section 2 is then positioned so that the boss 34 thereof engages the element 18 of the drying unit and dowel 36 enters the complementary recess in the boss 34 to position the unit and hold the same in position. The bolts 16, which secure the sections of the housing together, are then tightened so that the drying unit is secured firmly in place.

Steam in passing through the separator enters the inlet section 2 and flows through the passages 29 between the turbine blades 24 in the drying element 18, being directed by the blades downwardly across the face of the plate 18 toward the drain 22. The streams of steam passing between the turbine blades are broken up by reason of the baffling and combing action of the nozzles 28 and intermingle with steam similarly previously directed toward the lower end of the space which must return and pass through the apertures 27 in order to pass on through the passage 8. The resulting turbulence or kneading action facilitates the separation of any entrained condensate.

While the turbulence and drying action produced by the drying elements takes place between the drying elements 18 and 20, the path of flow of the steam is not in fact tortuous, so that back pressure normally presented by the drying unit is relatively small. Furthermore, since the unit is located in the enlarged portions 10 of the separator sections, the cross sectional area of the apertures through which the steam passes may be relatively large and approach or exceed the

cross sectional area of the passages 8 and the pipe line through which the steam passes.

By locating the drying elements of the separator at an angle of substantially 45° to the axis of the passages 8, the action of the separator is substantially the same when the unit is located in either a horizontal position or in a vertical position with steam flowing downward there-through. Furthermore, by positioning the drying elements so that they are inclined toward the drain, separate or condensate impinging on the drying elements and traveling on over the surfaces thereof toward the drain is carried out of the path of the steam as it flows through the separator so that re-entraining of the separate is avoided.

In some instances the steam or other gas will be sufficiently denuded of moisture or other liquid without passing it on through the second separating element 20. Moreover, the drying elements or particularly one having relatively small apertures therein, as element 20, may become clogged during operation. In either of the above situations, it may be desired to by-pass one of the drying elements to relieve back pressure on the pipe-line so as to increase the flow of steam and at the same time effect a cleaning operation of the drying element.

In the construction illustrated in Figs. 3 and 4 of the drawings a separator of the type shown in Figs. 1 and 2 is provided with a by-pass for these purposes and is formed with an outlet section 40 having a drain 42 provided with a passage 44 controlled by a valve 46 for permitting steam to flow through the drain and back into the outlet section in the rear of the drying element 48. A connection 50 communicates with the passage 44 in advance of the valve 46 to conduct separate out of the separator under all conditions of operation and whether steam is being by-passed about the drying element 48 or is passing therethrough.

Any suitable type of valve may be used for controlling the flow of steam through passage 44, that shown having a valve seat 52 adapted to be engaged by a valve member 54. The valve member is movable into and out of engagement with the valve seat by a valve stem 56 threaded at 58 to engage a complementary thread on the valve body 60. The valve stem 56 extends through a packing gland 62 and an operating handle 64 is secured thereto for manipulation in opening and closing the valve.

In the operation of this form of the invention, steam passing from the pipe-line through the separator is deflected by the turbine blades of the drying element 66 toward the drain 42. If the valve 46 is closed, the steam impinges more directly upon the drying element 48 and the protruding nozzles thereon depositing further separate thereon, and finally passes through the nozzles and on through the outlet section 40 to the pipe-line as in the construction of Figs. 1 and 2.

When the valve 46 is open the by-pass operates to relieve the back pressure within the line and thereby increase the flow of steam to the point of use. The flow of steam to the by-pass tends to relieve the pressure upon solid separate lodged on the outer surfaces of the nozzles of the plate 48 and at the same time dislodge such separate and direct same toward the drain 42. Separate carried into the drain 42 with the steam is withdrawn periodically or continuously through the connection 50.

The construction illustrated in Figs. 3 and

4, like that of Figs. 1 and 2, embodies a drying unit which may be easily removed for cleaning or repair and which may be replaced by another unit without alteration or replacement of the separator sections. Furthermore, the construction of Figs. 3 and 4 may be used in either horizontally or vertically extending pipe-lines to remove separate from steam flowing therethrough without change in the construction of the separator.

While the separators herein shown and described are particularly adapted for use in steam lines, it will be apparent that the invention also may be used for separating condensate or liquids from compressed air and gases other than steam. Moreover, the form of the drying elements used may be varied considerably in adapting the invention for use in handling steam or gases under different pressures and flowing at different velocities through the separator. In view thereof it should be understood that the forms of the invention herein shown and described are intended to be illustrative of the invention and are not intended to limit the scope thereof.

I claim:

1. A separator adapted to be connected in a pipe line extending in either a vertical or horizontal position to remove separate or condensate from steam or the like passing therethrough comprising inlet and outlet sections, means providing a drain for conducting separate from said sections, a drying element adjacent said drain formed with passages shaped to direct steam downwardly toward said drain regardless of whether the separator is in a vertical or horizontal position, and an apertured drying element in the rear of said drain and inclined to the axis of the passage defined by said sections to conduct separate collected thereon toward said drain.

2. In a separator adapted to be connected in a pipe line extending in either a vertical or horizontal position to remove separate or condensate from steam or the like passing therethrough in either a downward or horizontal direction, inlet and outlet sections defining a continuous passage therethrough, conduit means providing a drain communicating with said passage to remove separate therefrom and spaced parallel drying elements located on opposite sides of said drain and inclined at an angle of substantially 45° to the axis of said passage, that element in front of said drain having openings therethrough that are so inclined to the plane of said element as to direct passing steam downwardly toward said drain and that element in the rear of said drain presenting an apertured surface upon which separate is adapted to collect and flow toward said drain when the separator is located with the axis of said passage either horizontal or with the axis vertical and the steam passing downward through the separator.

3. In a separator adapted to be connected in a pipe line extending in either a vertical or horizontal position to remove separate or condensate from steam or the like passing therethrough, means providing a passage through which steam may flow, a drying unit comprising spaced perforated plates extending across said passage and inclined with respect to the center line of said passage, a draw-off for separate on one side of said passage adjacent and communicating with the space between said plates, one of said plates having inclined passages therethrough directing currents of steam passing therethrough

obliquely toward the side of said passage contiguous said draw-off and across the face of an adjacent plate, said adjacent plate being provided with protruding nozzles on the side facing the first plate, whereby particles of moisture are effectively separated and removed from the flowing steam by centrifugal force and a combing action regardless of whether the separator is in a vertical or horizontal position.

4. In a separator adapted to be connected in a pipe line extending in either a vertical or horizontal position to remove separate or condensate from steam or the like passing therethrough, means defining a passage through which steam may flow, a pair of parallelly-aligned spaced foraminous walls extending across said passage and inclined with respect to the axis of said passage, the wall on the steam inlet side having a plurality of curved slots extending therethrough and the wall on the steam outlet side being provided with numerous projections extending toward the opposing wall, said slots being so disposed as to deflect currents of the passing steam laterally in the direction of the inclination of said walls across the surface of said opposing wall and over and about said projections, and means in communication with the space between said plates for withdrawing separate collecting therein.

5. A separator adapted to be connected in a pipe line extending in either a vertical or horizontal position to remove separate or condensate from steam or the like passing therethrough comprising inlet and outlet sections adapted to be connected together to form a continuous passage therethrough having an enlarged portion adjacent the connection, means providing a drain communicating with the enlarged portion of said

passage, a drying unit removably positioned in said enlarged portion and including spaced drying elements located on opposite sides of said drain and cooperating to impart to steam passing therethrough a laterally swirling motion toward said drain, and means engaging said unit to retain the elements thereof in the same relative position with respect to said drain.

6. A separator adapted to be connected in a pipe line to remove separate or condensate from steam or the like passing therethrough comprising inlet and outlet sections defining a continuous passage therethrough, means providing a drain for removing separate from said passage, a plurality of apertured drying elements located in said passage adjacent said drain for removing separate from steam passing therethrough, a by-pass about one of said drying elements and a valve controlling the flow of steam through said by-pass, said by-pass being so located with respect to said drying elements and said drain as to cause by-passing steam to flow crosswise of said elements toward said drain.

7. A separator adapted to be connected in a pipe line to remove separate or condensate from steam or the like passing therethrough comprising inlet and outlet sections defining a passage therethrough, a plurality of apertured drying elements extending across said passage in spaced relation, a separate draw-off in communication with the space between said elements, a by-pass extending from the said draw-off to said outlet section in the rear of said drying elements operable to relieve back pressure in said line and facilitate cleaning of said drying elements and a valve controlling the flow of steam through said bypass.

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