A flow constriction device (14) typically for drainage of steam condensate, is provided with a tubular nozzle (32) inserted within a bore (24) formed in the body (16) of the device (14). The removable tubular nozzle (32) provides convenient variation in flow constriction dimensions which can be employed with a generally standardized bore (24) dimension.
FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

<table>
<thead>
<tr>
<th>Code</th>
<th>Country Name</th>
<th>Code</th>
<th>Country Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>Austria</td>
<td>KP</td>
<td>Democratic People's Republic of Korea</td>
</tr>
<tr>
<td>AU</td>
<td>Australia</td>
<td>LI</td>
<td>Liechtenstein</td>
</tr>
<tr>
<td>BR</td>
<td>Brazil</td>
<td>LL</td>
<td>Luxembourg</td>
</tr>
<tr>
<td>CF</td>
<td>Central African Republic</td>
<td>MC</td>
<td>Monaco</td>
</tr>
<tr>
<td>CG</td>
<td>Congo</td>
<td>MG</td>
<td>Madagascar</td>
</tr>
<tr>
<td>CH</td>
<td>Switzerland</td>
<td>MW</td>
<td>Malawi</td>
</tr>
<tr>
<td>CM</td>
<td>Cameroon</td>
<td>NL</td>
<td>Netherlands</td>
</tr>
<tr>
<td>DE</td>
<td>Germany, Federal Republic of</td>
<td>NO</td>
<td>Norway</td>
</tr>
<tr>
<td>DK</td>
<td>Denmark</td>
<td>RO</td>
<td>Romania</td>
</tr>
<tr>
<td>FI</td>
<td>Finland</td>
<td>SE</td>
<td>Sweden</td>
</tr>
<tr>
<td>FR</td>
<td>France</td>
<td>SN</td>
<td>Senegal</td>
</tr>
<tr>
<td>GA</td>
<td>Gabon</td>
<td>SL</td>
<td>Soviet Union</td>
</tr>
<tr>
<td>GB</td>
<td>United Kingdom</td>
<td>TD</td>
<td>Chad</td>
</tr>
<tr>
<td>HU</td>
<td>Hungary</td>
<td>TG</td>
<td>Togo</td>
</tr>
<tr>
<td>JP</td>
<td>Japan</td>
<td>US</td>
<td>United States of America</td>
</tr>
</tbody>
</table>
CONDENSATE REMOVAL DEVICE FOR STEAM LINES AND THE LIKE

This invention relates to liquid drainage devices for fluid conduit systems. More particularly, this invention relates to devices for removing condensate from steam lines.

Steam piping systems must be provided with equipment to remove the condensate which accumulates as heat is lost from the steam. Generally, condensate removal equipment is located at low points or pockets in the steam piping and at regular intervals in the extended runs of the steam piping, as well as at steam-driven equipment which could be damaged by condensate. Older equipment, such as the widely employed inverted bucket condensate trap, has increasingly been replaced with more simplified orifice devices; for example, those devices described in United States Patents 3,715,870 and 3,877,895, in which a plate having an orifice is positioned in steam lines enabling condensate to be forced through the small diameter orifice by the high pressure steam; when the orifice is properly sized, condensate obstructs passage of steam through the orifice in order to minimize steam loss while permitting drainage of the condensate.

United States Patent 4,171,209, describes a device in which an orifice plate is unitarily formed in the body of a fitting which can be conveniently connected directly into the steam line, preferably downstream from a conventional Y-strainer which removes particulate debris from the
accumulated condensate. While such unitarily formed orifice plate devices have been effective and proven to be commercially successful, the drilling of the small orifice required is a difficult process, and because the resulting fitting has an orifice of fixed length and diameter, a multiplicity of variously drilled bodies of fittings are employed to accommodate variation in steam pressures in order to minimize steam loss through the orifice.
SUMMARY OF THE INVENTION

According to this invention, the body of a device for liquid drainage is provided with a bore into which a tubular nozzle structure is inserted for constriction of fluid flow through the device. The body of the device can also be provided with an entrance formation for the bore which provides a seat for a terminal flange formation on the tubular nozzle structure to correctly position it within the bore.

Tapering in the flow constriction of the tubular nozzle structure can be provided in a configuration approximating the configuration of a venturi tube.

Interchangeable tubular nozzle structures provide variation in diameter and length of the constriction which can be employed with a given size bore for service in a range of steam pressures.

The invention enables provision of a standardized body for a constriction device having a standardized bore configuration so that the nozzle structure can be made available as separate items for convenient installation within the standardized bore in accordance with nozzle dimension requirements for proper drainage.
BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a steam condensate removal line including an embodiment of the flow constriction device according to this invention;

Figure 2 is a side elevation view of the constriction device shown in Figure 1, with partial cross-section showing an inserted tubular nozzle structure;

Figure 3 is an end view of the device shown in Figure 2 having the tubular nozzle structure removed;

Figure 4 is a side elevation view of a modified embodiment of a constriction device according to this invention with partial cross-section showing modifications in the flow conduit;

Figure 5 is a side elevation of the constriction device shown in Figure 2, with partial cross-section showing the tubular nozzle structure removed;

Figure 6 is an enlarged cross-sectional view of the tubular nozzle structure shown in Figure 2;

Figure 7 is a side elevation view of a modified constriction device according to this invention, with partial cross-section showing a replaceable bore housing;

Figure 8a-8d are cross-sectional side views of tubular nozzle structures according to this invention, showing modifications of dimensions of portions of the flow constriction;

SUBSTITUTE SHEET
Figure 9 is a side elevation view of a modified embodiment of the constriction device according to this invention with partial cross-section showing a modified tubular nozzle structure and a filter element arrangement;

Figure 10 is an enlarged cross-sectional view of the filter element arrangement shown in Figure 9;

Figure 11 is an enlarged, cross-sectional side view of the tubular nozzle structure shown in Figure 9.
DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the condensate removal line as shown in Figure 1, a mixture of condensate liquid and some steam is directed under generally high pressure from pipe 10 into a conventional Y-strainer device 12 from right to left as indicated by the direction of the arrow. The strainer unit within Y-strainer 12 filters the condensed liquid to remove debris particles entrained in the mixture, prior to flow of the mixture into an embodiment of the constriction device of this invention, generally designated by reference character 14, which is threaded into the left-hand outlet of Y-strainer 12. Condensate is forced through constriction device 14, as described hereinafter, and drained through condensate return line 15 typically for delivery to a steam boiler (not shown).

Referring to Figure 2, constriction device 14 includes a generally cylindrical body 16 having an externally threaded male end 18, and having a preferably integrally formed female end 20 housing a threaded socket 22. Male end 18 is designed for preferably threading directly into Y-strainer 12, and female end 20 is designed to receive condensate return line 15, as shown in Figure 1.

The body 16 houses a preferably coaxially aligned and generally cylindrical bore 24. Bore 24 preferably has a conically formed entrance 26 leading to a generally
cylindrical passage 28 forming a somewhat recessed opening in male end 18 of the embodiment shown in Figure 2. A preferably conically formed exit formation 30 from bore 24 leads to socket 22. Removably inserted within bore 24 is a generally elongate tubular nozzle structure, designated by general reference character 32 in Figure 2.

As shown in Figure 2, nozzle structure 32 has the general configuration of a venturi tube with a substantially cylindrical vena contracta 34 joined between converging entrance formation 36 and diverging exit formation 38. Cylindrical inlet 40 and outlet 42 joining entrance 36 and exit 38, respectively, are substantially equal in outer diameter to the diameter of cylindrical bore 24 and cap allow frictional press fit of nozzle structure 32 within bore 24. Preferably, inlet formation 40 is provided with an outward flange 44 which engages conical entrance 26 to properly position the insertion of nozzle structure 32 within bore 24. Riveting of flange 44 against conical entrance 26 can be employed to further secure such insertion.

The insertion of nozzle structure 32 into bore 24 allows the drilling of bore 24 to a conveniently large diameter without the difficulty of sizing the bore diameter to the required dimension of the condensate constriction; thus, the nozzle structure 32 can be separately fabricated and then inserted to provide a vena contracta of desired diameter.
and length to serve as the condensate constriction in a variety of sizes suitable for service under a range of steam pressures with a single bore diameter. Suitably, vena contracta 34 can be fabricated with inner diameter in the range of approximately 0.2-0.9 of the diameter of bore 24, so that substitution of various nozzle structures can allow convenient reduction in the diameter of vena contracta 34 for service under increasing steam pressure. In addition the vena contracta can be conveniently fabricated in a range of lengths as shown in the nozzle structures 32 and 32a-32d drawn enlarged in Figures 6 and 8a-8d.

Again referring to Figure 2, cylindrical passage 28 can be circumferentially grooved to receive a retaining ring 45 for a filter element 46 to remove any debris particles which have passed through Y-strainer 12 and prevent plugging of nozzle device 32. Alternatively, as shown in Figure 4, cylindrical passage 28' can be provided with a shoulder 29 providing a seat for filter element 46'. Additionally, as shown in Figure 4, nozzle structure 32' can be provided with a flange 48 which engages concial exit formation 30'.

Figures 3 and 5 show end and side views, respectively, of nozzle device 14 shown in Figure 2 with tubular nozzle structure 32 removed from bore 24. Figure 3 also shows the opposing flat seats 16a formed in the surface of body 16 for
engagement by a wrench.

Referring to Figure 7, modified nozzle device 114 is shown with body 116 provided with a removable bore housing 123 for bore 124. Body 116 is circumferentially grooved to receive a retaining ring 131 for engageably positioning conically formed exit formation 130 on bore housing 123, leading from bore 124. Similarly, a removable annular passage 128 engages a conical entrance formation 126 on bore housing 123. Body 116 is circumferentially grooved to receive retainer ring 145 which is engaged between annular passage 128 and a filter element 146. A tubular nozzle structure 132, having configuration similar to nozzle structure 32 shown in Figures 2 and 6, is removably inserted within bore 124. Removable bore housing 123 allows even greater flexibility in design because a range in the diameter of bore 124 can be conveniently employed with a single body 116.

In a modified embodiment shown in Figure 9, constriction device 214 includes body 216 in which bore 224 has conical entrance 226 and exit 230 formations. In this embodiment, tubular nozzle structure 232 rearwardly projects from bore 224; as shown in Figure 9, nozzle structure 232 can extend entirely through the conical exit formation 230 from bore 224 to a point within the cylindrical exit passage 231 from body 216. The rearward projection of the inserted nozzle device 232 from bore 224 permits greater extension.
of the length of the constriction 234 shown in Figure 11, completely independent of the length of the bore 224, as shown in Figure 9. Thus, the extended length of constriction 234 permits increased restriction in the flow of condensate with a reduction in the passage of escaping steam, commonly expressed as the ratio of the rate of discharge for liquid mass to the rate of discharge for vapor mass. While the length of small diameter orifices which are drilled in the prior art devices is restricted, typically to a maximum of approximately 0.250 inch, (0.635 cm) the insertable tubular nozzle structure of this invention enables easier fabrication of the flow constriction as well as convenient variation in both the diameter and length of the flow constriction employed, with the added practical advantage of a single bore diameter.

Referring now to Figure 9, nozzle structure 232 includes an outwardly flanged entrance formation 236 on the tubular body 238; flange formation 236 engages the conically formed bore entrance 226 for positioning the insertion of nozzle structure 232 within bore 224. Preferably, at least a portion of tubular body 238 adjoining flange entrance 236 has an outer diameter approximately equal to the diameter of bore 224 to provide a frictional press fit upon the insertion of nozzle structure 232 within bore 224. As best shown in Figure 11, flow constriction 234 provided in nozzle structure 232 is tapered in the configuration of a modified substitute sheet.
venturi tube; a substantially cylindrical constriction can also be employed in the tubular nozzle structure of this invention. Most preferably, the terminus 240 of constriction 234 is positioned in rearward projection from bore 224 as described with reference to Figure 9.

Referring again to Figure 9, a cylindrical passage 242 leading to conical bore entrance 226 can be provided with an annular shoulder 244 having an annular corner 244a. A generally circular filter member 246 can be positioned adjacent the shoulder 244; the central portion 246a of filter element 246 can be inwardly bent toward bore 224 and secured by a similarly bent annular retainer ring 248, which pinches filter member 246 against corner 244a as best shown in Figure 10. Filter member 246 is positioned upstream from nozzle structure 232 in order to remove debris from condensate prior to its passage through nozzle structure 232 within constriction 234. The retainer ring 248 is of suitable diameter to frictionally engage against the inner circumference 250 for sealing function.

The embodiments described and shown in the drawings are illustrative of this invention but do not indicate limitation upon the scope of the appended claims.

I CLAIM:

SUBSTITUTE SHEET
1. In a device for drainage of condensate from steam systems without passage of live steam, said device including a body structure having a fluid flow conduit there-through for condensate receiving communication with a pressurized steam system; the combination of an enlarged elongated bore forming at least a portion of said conduit, and a plurality of interchangeable difference size nozzles each independently receivable in said bore for a constriction of said bore and for varying constriction of the bore in accord with pressure in the individual system.

2. The device as claimed in Claim 1, wherein said conduit includes a conical formation enlarging and opening outward from an entrance to said bore; and each of said nozzles including a terminal flange receivable within and engageable with said conical formation.

3. The device as claimed in Claim 1, wherein each of said nozzles includes a constriction having at least one tapered section.

4. The device as claimed in Claim 1, wherein each of said nozzles includes a constriction having a substantially cylindrical formation joined between converging and diverging formations providing said said constriction with a configuration.
approximating the configuration of a venturi tube.

5. The device as claimed in Claim 1, or 2, wherein said conduit includes an exit formation located at an exit from said bore and at least one of said nozzles being of a length to project beyond said bore into said exit formation.

6. The device as claimed in Claim 5, wherein each of said nozzles includes a constriction having a substantially cylindrical formation joined between converging and diverging formations providing said constrictions with a configuration approximating the configuration of a venturi tube.

7. The device as claimed in Claim 1, further including a housing member having said bore therethrough, said housing member being separate from and removably inserted within said body structure.

8. The device as claimed in Claim 7, wherein said housing member includes a conical formation located at an entrance into said bore and each of said nozzles includes a terminal flange engaging said conical formation.

9. The device as claimed in Claim 8, wherein each of said nozzles includes a constriction having at least one
tapered section.

10. The device as claimed in Claim 8, wherein each of said nozzles includes a constriction having a substantially cylindrical formation joined between converging and diverging formations providing said constriction with a figuration approximating the configuration of a venturi tube.
AMENDED CLAIMS
(received by the International Bureau on 1 April 1982 (02.04.82))

1. In a device for drainage of condensate from steam systems without passage of live steam, said device including a body structure having a fluid flow conduit there-through for condensate receiving communication with a pressurized steam system; the combination of an enlarged elongated bore forming at least a portion of said conduit, and a plurality of interchangeable difference size nozzles each independently receivable in said bore for a constriction of said bore and for varying constriction of the bore in accord with pressure in the individual system.

2. The device as claimed in Claim 1, wherein said conduit includes a conical formation enlarging and opening outward from an entrance to said bore, and each of said nozzles including a terminal flange receivable within and engageable with said conical formation.

3. The device as claimed in Claim 1, wherein each of said nozzles includes a constriction having at least one tapered section.

4. The device as claimed in Claim 1, wherein each of said nozzles includes a constriction having a substantially cylindrical formation joined between converging and diverging formations providing said constriction with a configuration SUBSTITUTION SHEET
approximating the configuration of a venturi tube.

5. The device as claimed in Claim 1, or 2, wherein said conduit includes an exit formation located at an exit from said bore and at least one of said nozzles being of a length to project beyond said bore into said exit formation.

6. The device as claimed in Claim 5, wherein each of said nozzles includes a constriction having a substantially cylindrical formation joined between converging and diverging formations providing said constrictions with a configuration approximating the configuration of a venturi tube.

7. The device as claimed in Claim 1, further including a housing member having said bore therethrough, said housing member being separate from and removably inserted within said body structure.

8. The device as claimed in Claim 7, wherein said housing member includes a conical formation located at an entrance into said bore and each of said nozzles includes a terminal flange engaging said conical formation.

9. The device as claimed in Claim 8, wherein each of said nozzles includes a constriction having at least one
tapered section.

10. The device as claimed in Claim 8, wherein each of said nozzles includes a constriction having a substantially cylindrical formation joined between converging and diverging formations providing said constriction with a figuration approximating the configuration of a venturi tube.
11. In a device for drainage of condensate from steam systems without passage of live steam, the improvement wherein said device comprises:
   a. a body structure having a fluid flow conduit therethrough and including a generally cylindrical bore formed entirely within said body structure;
   b. a first tubular nozzle frictionally mounted within said bore, said first nozzle having an internal constricted passageway therethrough communicating with said conduit, said first nozzle being interchangeable with at least a second tubular nozzle having external configuration likewise for frictional mounting within said bore, said second nozzle having an internal constricted passageway which is selected to be different in configuration than that of said first nozzle in order to enable variation in the constricted passageways suitable for operation with different steam pressures and condensate drainage in said steam systems;
   c. said conduit including a conical formation within said body structure, said conical formation opening outwardly from an entrance to said bore; and
   d. said tubular nozzle including a terminal flange engaging said conical formation.

12. The device as claimed in claim 11, wherein at least said first nozzle includes at least two generally coaxial and cylindrical constrictions formed within said passageway, the second of said constrictions having a somewhat larger diameter than the diameter of the first of said constrictions, said nozzle further including a first generally truncated conical bore joining said constrictions.
(new) 13. The device as claimed in claim 12, wherein said tubular nozzle further includes a third generally coaxial cylindrical constriction having a diameter somewhat larger than the diameters of said first and second constrictions, said third cylindrical constriction communicated with the larger diameter of said constrictions through a second truncate conical bore joined therebetween, the axial alignment of said cylindrical constrictions being in sequential order of increasing relative diameter.

(new) 14. The device as claimed in claim 11, 12 or 13, wherein said body structure includes an exit formation at the opposite end from said entrance to said bore and wherein said tubular nozzle projects from said bore into said exit formation.
### INTERNATIONAL SEARCH REPORT

**International Application No:** PCT/US81/01504

#### I. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both National Classification and IPC

<table>
<thead>
<tr>
<th>INT. CL</th>
<th>BOID 46/10; F15D 1/02</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Cl.</td>
<td>55/466,502; 210/451,459; 138/44; 239/396</td>
</tr>
</tbody>
</table>

#### II. FIELDS SEARCHED

Minimum Documentation Searched

<table>
<thead>
<tr>
<th>Classification System</th>
<th>Classification Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. 55/466,502; 210/451,459; 138/44; 239/390,391,396,591</td>
<td></td>
</tr>
</tbody>
</table>

Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched

#### III. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of Document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to Claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US, A, 4,171,209, PUBLISHED 16 OCTOBER 1979, BROWN.</td>
<td>1-10</td>
</tr>
<tr>
<td>X</td>
<td>US, A, 3,894,562, PUBLISHED 15 JULY 1975, MOSLEY, JR., ET AL.</td>
<td>1-10</td>
</tr>
<tr>
<td>X</td>
<td>US, A, 4,252,741, PUBLISHED 11 NOVEMBER 1980, RAY, SR., ET AL.</td>
<td>1-10</td>
</tr>
<tr>
<td>X</td>
<td>US, A, 3,018,799, PUBLISHED 30 JANUARY 1962, VOLKMAN ET AL.</td>
<td>1-10</td>
</tr>
<tr>
<td>X</td>
<td>US, A, 394,590, PUBLISHED 04 JANUARY 1974.</td>
<td>2,8</td>
</tr>
</tbody>
</table>

* Special categories of cited documents:

- **A** document defining the general state of the art
- **D** document published prior to the international filing date but on or after the priority date claimed
- **E** earlier document but published on or after the international filing date
- **L** document cited for special reason other than those referred to in the other categories
- **O** document referring to an oral disclosure, use, exhibition or other means
- **T** later document published on or after the international filing date of priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention
- **X** document of particular relevance

#### IV. CERTIFICATION

- **Date of the Actual Completion of the International Search:** 23 DECEMBER 1981
- **Date of Mailing of this International Search Report:** 06 JAN 1982
- **International Searching Authority:** ISA/US
- **Signature of Authorized Officer:**

David L. Lacey

Form PCT/ISA210 (second sheet) (October 1977)