Dec. 14, 1965 H. STERN 3,223,288

HANDLING OF GRANULAR MATERIAL

Filed June 16, 1964 3 Sheets-Sheet 1

Fig 1.

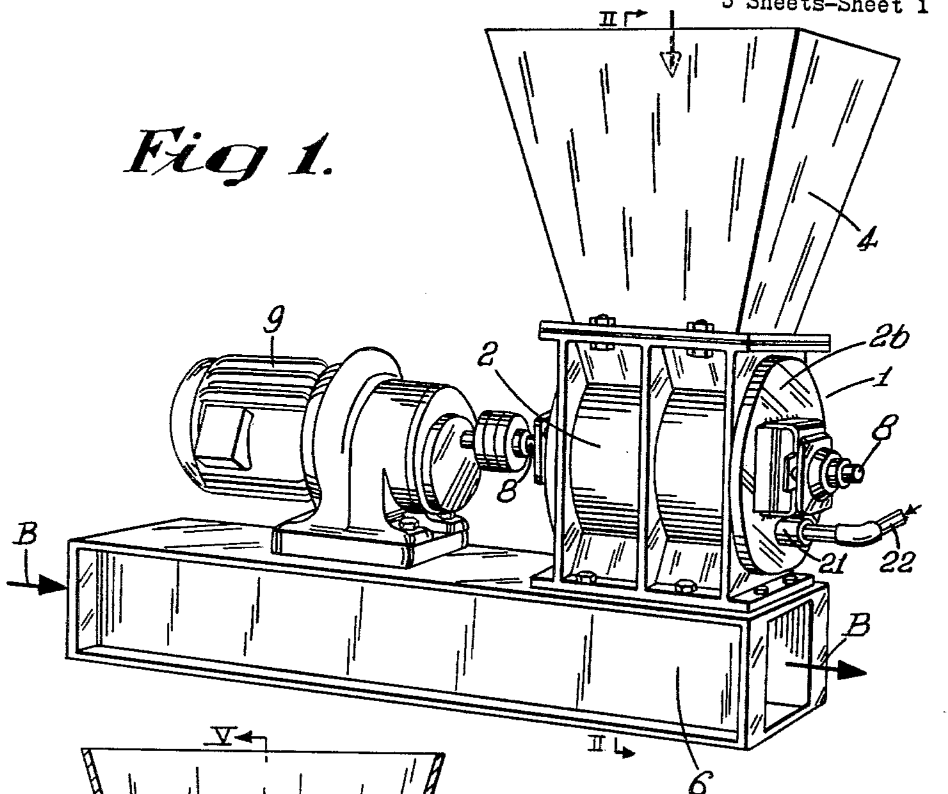
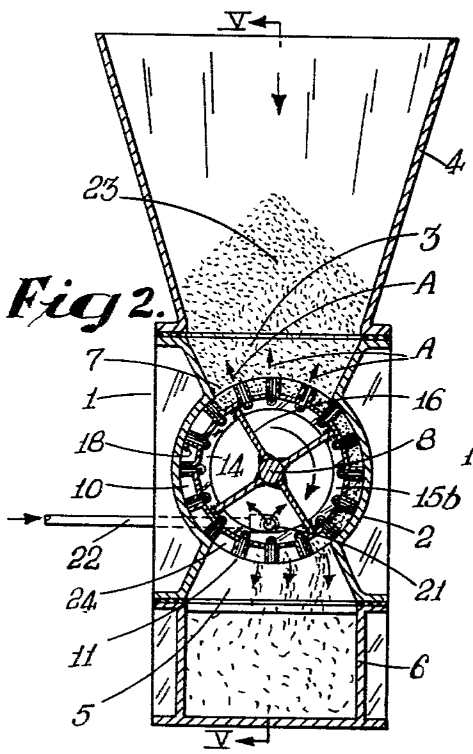


Fig 2.



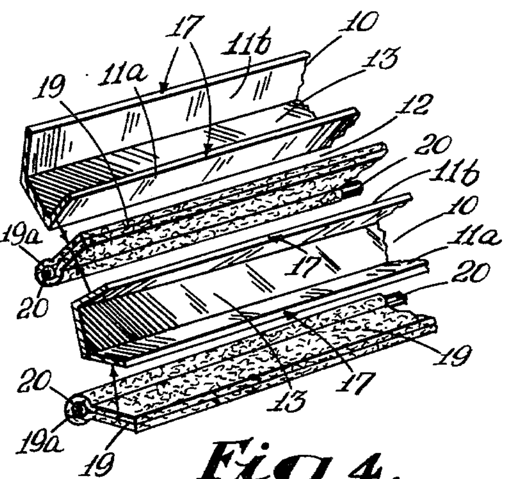
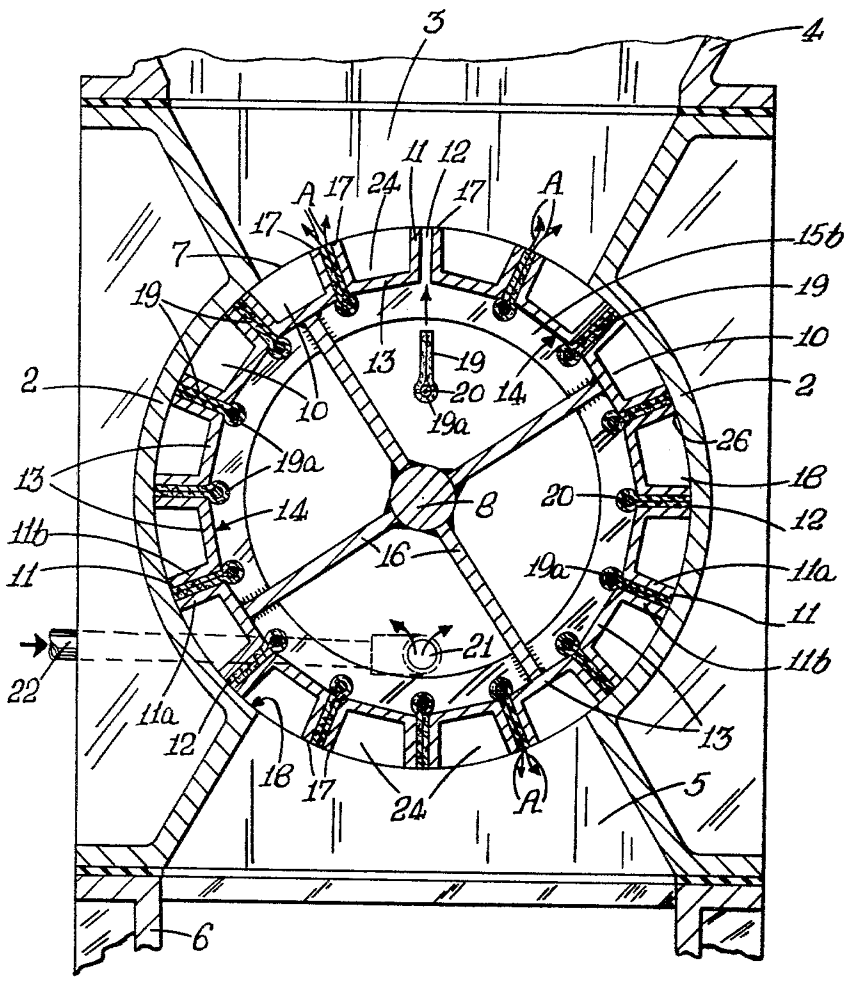


Fig 4.

Fig 3.



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11 12
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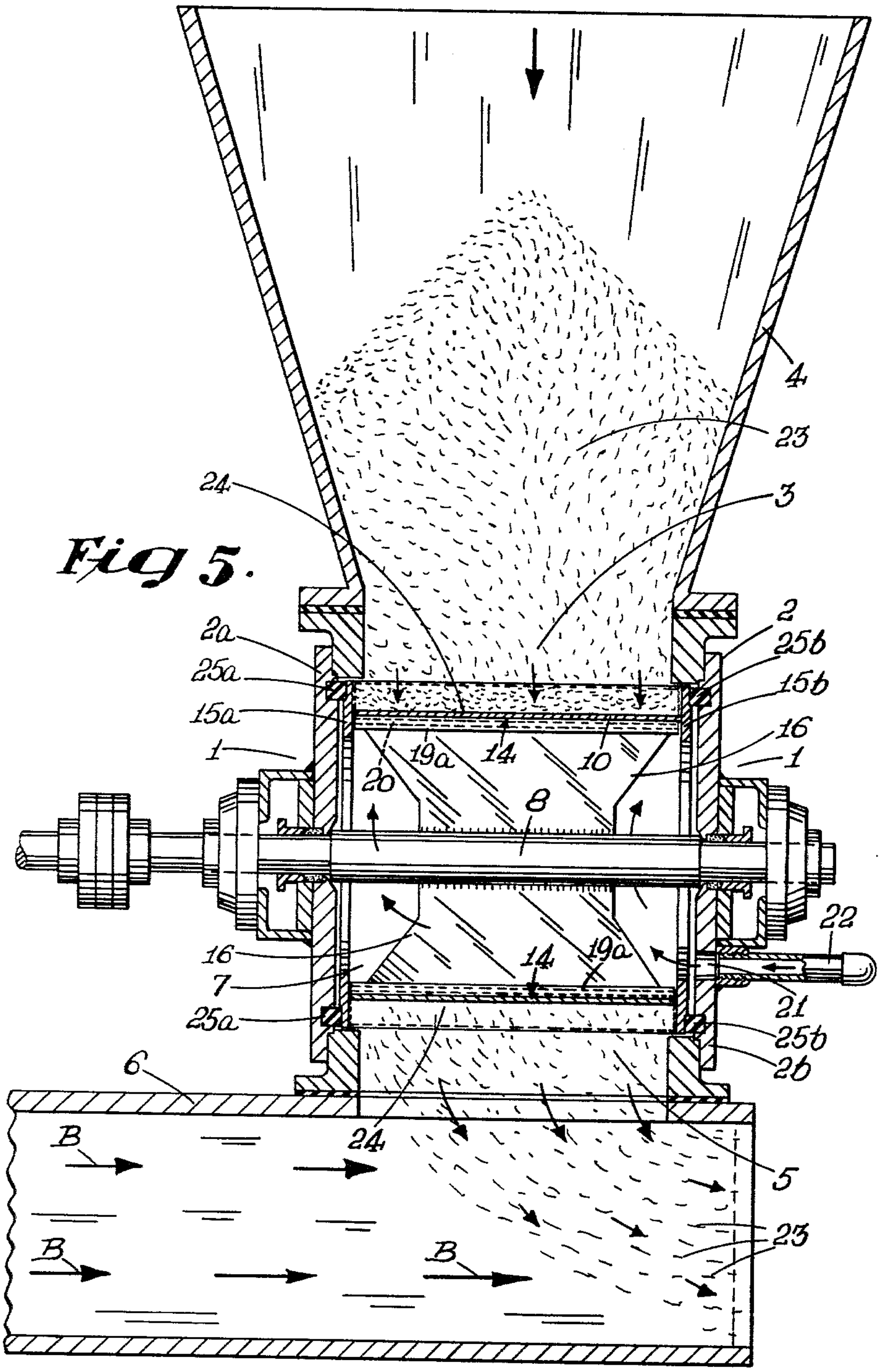
Fig 5.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HANDLING OF GRANULAR MATERIAL

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This invention relates to the handling of granular material.

For the purposes of this specification, the term "granular material" is intended to include any material comprising discrete particles. The particles may be in powdered or granulated form or may be amorphous in character or may be in the nature of flakes.

It is well known to convey granulated material in finely powdered form by fluidizing the material with gaseous medium under pressure to permit flow of the material along a conduit in similar manner to a fluid. In order to feed the granular material into a conduit carrying fluidizing gaseous medium under pressure, it is known to provide apparatus including a cylindrical casing; a rotor with a plurality of radially extending vanes rotatable within the casing; a material inlet into the casing through its peripheral wall; and a material outlet from the casing through its peripheral wall into the conduit, the outlet being circumferentially spaced from the inlet. Each pair of adjacent vanes forms a pocket which during rotation of the rotor carries material entering the casing, from the inlet to the outlet where it enters the conduit. The clearances between the edges of the rotor vanes and the casing are as small as possible so as to minimize any tendency for gaseous medium to pass between the outlet and the inlet. The feeding apparatus therefore also acts as a fluid seal.

Apparatus similar to that described above may be used to transfer granular material from a low pressure zone to a high pressure zone. Alternatively, the apparatus may be used to convey granular material from a high pressure zone to a low pressure zone.

Conventional apparatus as described above suffers from the disadvantage that no matter how small the clearances between the rotor vanes and the casing, solid particles are inclined to enter between the vanes and the casing, thus causing wear. Such wear occurs even where the granular material is not considered to be abrasive.

It is an object of the present invention to minimize the above disadvantage.

According to the invention apparatus for handling granular material includes a first surface; at least one vane disposed transversely to the first surface and presenting a second surface disposed in opposed, spaced relationship to the first surface, the vane and the first surface being relatively movable; and a fluid passage in the vane adapted to discharge fluid under pressure into the space between the two surfaces.

A gas or a liquid may be discharged into the space between the two surfaces.

Fluid discharged into the space between the two surfaces acts to blow away small particles of material from between the two surfaces. This reduces wear. This also permits the clearance between the two surfaces to be smaller than has been possible hitherto, without fear of the vane seizing on the first surface. Where different pressures exist on opposite sides of the vane, the smaller clearance that can be achieved minimizes leakage of fluid through the clearance from one side of the vane to the other.

The first surface may be plane or curved.

The vane may be disposed in any suitable angular relationship transversely to the first surface. It may be disposed not only substantially at right angles to the first surface, but may also be disposed at a suitable acute angle to the first surface.

Preferably, the vane is movable along the first surface. During movement along the first surface, the vane can displace granular material from one zone to another.

The vane may be constituted by a pair of juxtaposed elements which are spaced apart to provide a fluid passage between them through which fluid can be discharged into the space between the two surfaces.

Rotary apparatus according to the invention may include a casing; a material inlet into the casing; a material outlet from the casing spaced from the inlet; and a rotor rotatably located within the casing, the rotor including a hollow drum arranged for fluid under pressure to be introduced thereinto, and a plurality of circumferentially spaced vanes extending radially from the drum towards the casing with each pair of adjacent vanes forming a pocket for transferring material from the inlet to the outlet, each vane presenting a surface disposed in opposed, spaced relationship to an inner surface of the casing and each vane further including a fluid passage which communicates with the interior of the drum and has an outlet at the vane surface.

The rotor may be constituted by a plurality of substantially similar, juxtaposed and axially extending segments of substantially channel-shaped cross-section, the segments being mounted in circumferentially spaced relationship about the rotational axis of the rotor so that the bases of the segments form the drum, and so that opposed flanges of each pair of adjacent segments are spaced apart and form a vane with a fluid passage between the opposed flanges.

Preferably, a fluid pervious packing is located in the fluid passage in the or each vane.

A preferred embodiment of the invention will now be described by way of example with reference to the accompanying drawings in which:

FIGURE 1 is a perspective view of granular material handling apparatus including a rotary feeder according to the invention.

FIGURE 2 is a section on line II—II in FIGURE 1.

FIGURE 3 is an enlarged sectional view of the rotor and outer casing of the feeder of FIGURES 1 and 2.

FIGURE 4 is an enlarged, exploded perspective view of portion of the elements constituting the rotor of the feeder of FIGURES 1 and 2.

FIGURE 5 is a section to an enlarged scale on the line V—V in FIGURE 2.

Feeder **1** includes casing **2** having material inlet **3** in communication with hopper **4** and material outlet **5** in communication with conduit **6**. Rotor **7** is rotatably mounted within casing **2** on shaft **8** which is coupled to driving motor **9**.

Rotor **7** is constituted by a plurality of similar, juxtaposed and axially extending segments **10** of channel-shaped cross-section. As will be clear from FIGURES 2, 3 and 4, segments **10** are arranged in circumferentially spaced relationship about shaft **8** so that the spaced, opposed flanges **11*a***, **11*b*** of each pair of adjacent segments **10** form a radial vane **11** providing a fluid passage **12** and so that the bases **13** of segments **10** form a hollow drum **14**.

Segments **10** are secured at opposite ends, as by welding, between end rings **15*a***, **15*b*** which act as end closures for segments **10** so that between each pair of adjacent vanes **11** a pocket **24** is formed for transferring material from inlet **3** to outlet **5**. Segments **10** and end rings **15*a***, **15*b*** are mounted on shaft **8** for rotational movement therewith, by means of spokes **16**.

The longitudinal tips of vanes **11** present radially outwardly facing surfaces **17** which are opposed to, and are located in closely spaced relationship to the inner peripheral surface 18 of casing 2. The fluid passage 12 in each vane 11 communicates with the interior of drum 14 and has a longitudinally extending, radially facing outlet between the surfaces 17 of the vanes 11.

A fluid pervious packing 19 in the nature of a sheet of felt which is folded double and contains a retaining pin 20 in fold 19*a* is inserted into each fluid passage 12 in a vane 11 from the interior of drum 14 so that the folds 19*a* containing retaining pins 20 seat against the inner periphery of drum 14. Folds 19*a* round pins 20 are larger than the width of passages 12 and prevent packings 19 being displaced outwardly from passages 12.

End plate 2*b* of casing 2 is provided with fluid inlet 21 connected to supply pipe 22. Fluid inlet 21 is in communication with the interior of drum 14 through the aperture of end ring 15*b*.

In use, any suitable fluid is introduced under pressure into the interior of drum 14 through supply pipe 22. The fluid under pressure percolates through the pervious packings 19 and discharges through the outlets of fluid passages 12 as indicated by arrows A.

Granular material 23 which is required to be conveyed, is fed into hopper 4. During rotation of rotor 7, the material 23 gravitates into successive pockets 24 formed by adjacent vanes 11 which pass material inlet 3 in casing 2. In the result, successive pockets 24 carry batches of material 23 from material inlet 3 to material outlet 5 where the material drops out of pockets 24 into conduit 6. Any suitable fluid under pressure is introduced into conduit 6 as indicated by arrows B, thereby to fluidize material 23 in known manner to permit flow of material 23 along conduit 6 in similar manner to a fluid.

Feeder 1 acts as a seal between conduit 6 and feed hopper 4 to prevent conveying fluid under pressure from blowing out through hopper 4 from conduit 6.

As described above, fluid which is introduced under pressure into drum 14 discharges radially outwardly through fluid passages 12 in vanes 11 as indicated by arrows A. The fluid outlets in vane tips facing inner periphery 18 of casing 2 discharge fluid under pressure into the spaces 26 between periphery 18 and vane tip surfaces 17 opposed to periphery 18. The spaces 26 between the vane tips and the inner periphery 18 of casing 2 are small so that the escaping fluid produces sufficient pressure and velocity to blow away small particles of material from between the vane tips and inner periphery 18 of casing 2. This reduces wear. This also permits the clearances between the vane tips and inner periphery 18 of casing 2 to be smaller than has been possible hitherto, without fear of vanes 11 seizing on casing 2. The smaller clearances that can be achieved minimizes leakage of conveying fluid through the clearances from conduit 6 to hopper 4 so that an improved fluid seal can be obtained.

Fluid discharged from the vane tips facing material inlet 3 in casing 2 tends to fluidize material 23 entering from hopper 4. This minimizes choking of inlet 3 and also assists the fluidization occurring in conduit 6.

Annular seals 25*a*, 25*b* are provided to prevent escape of fluid from the interior of drum 14 between the end plates 2*a*, 2*b* of casing 2 and the end rings 15*a*, 15*b* of rotor 7.

With the arrangement illustrated in the accompanying drawings, end rings 15*a*, 15*b* are continuous and close off the transverse ends of fluid passages 12 in vanes 11 which face end plates 2*a*, 2*b* of casing 2. In other words, it is only the radially facing, longitudinal surfaces 17 of vanes 11 which are opposed to the inner periphery 18 of casing 2 in accordance with the invention. The inner periphery 18 of casing 2 constitutes a first surface of the invention which is curved.

It is also possible to arrange vanes 11 to present longitudinally facing, transverse end surfaces opposed to end plates 2*a*, 2*b* of casing 2, the transverse ends of fluid passages 12 being open to discharge fluid into the spaces between the ends of vanes 11 and end plates 2*a*, 2*b*. End plates 2*a*, 2*b* will then each constitute a first surface of the invention which is plane.

Instead of providing vanes 11 with fluid passages 12 extending continuously along the whole length and depth of the vanes, any other suitable fluid passage arrangement may be used. For example, vanes with one or more grooves or recesses in their tips constituting fluid outlets extending along the whole or part of the length of the vanes may be provided, one or more radial passages in the vanes placing the outlet grooves or recesses in communication with the interior of drum 14. It will be appreciated that the drum and radial vanes of the rotor may be constructed in any other suitable manner.

Many other variations in detail are possible without departing from the scope of the appended claims.

A feeder similar to that illustrated in the accompanying drawings may be used for transferring granular material between any two zones at different pressures.

I claim:

1. Apparatus for handling granular material comprising a casing; a material inlet into the casing; a material outlet from the casing spaced from the inlet; a rotor rotatably located within the casing, the rotor comprising a hollow reservoir for fluid under pressure, a fluid inlet into the reservoir, a plurality of circumferentially spaced vanes extending radially from the reservoir towards said casing with each pair of adjacent vanes forming a pocket for transferring material from the inlet to the outlet, each vane presenting a tip surface disposed in opposed spaced relationship to an inner surface of the casing, a fluid passage in each vane in permanent communication with the interior of the reservoir and with an outlet located substantially centrally in the tip surface in a transverse direction and extending substantially the whole length of the tip surface, and a fluid pervious packing in each fluid passage at and along the outlet.

2. Apparatus for handling granular material comprising a casing; a material inlet into the casing; a material outlet from the casing spaced from the inlet; a rotor rotatably located within the casing, the rotor comprising a hollow reservoir for fluid under pressure, a fluid inlet into the reservoir, a plurality of circumferentially spaced vanes extending radially from the reservoir towards the casing with each pair of adjacent vanes forming a pocket for transferring material from the inlet to the outlet, each vane presenting a tip surface disposed in opposed spaced relationship to an inner surface of the casing, a fluid passage in each vane in permanent communication with the interior of the reservoir and with an outlet located substantially centrally in the tip surface in a transverse direction and extending substantially the whole length of the tip surface, and a fluid pervious packing in each fluid passage at and along the outlet, each packing comprising a sheet of fluid pervious material which is folded double and contains an elongated retaining element in the fold, the folded sheet being located in the fluid passage with the fold containing the retaining element located within the reservoir against the inner periphery thereof.

3. Apparatus for handling granular material comprising a casing; a material inlet into the casing; a material outlet from the casing spaced from the inlet; a rotor rotatably located within the casing, the rotor being constituted by a plurality of substantially similar channel members mounted in circumferentially spaced, axially extending juxtaposition about the rotational axis of the rotor whereby the bases of the channel members form a hollow reservoir for fluid under pressure and opposed flanges of each pair of adjacent channel members are spaced apart and form a vane presenting a tip surface disposed in opposed, spaced relationship to an inner surface of the casing, the space between each pair of adjacent vane forming channel members constituting a fluid passage in the vane which is in permanent communication with the in-

terior of the reservoir and has an outlet located substantially centrally in the tip surface in a transverse direction and extending substantially the whole length of the tip surface, and a fluid pervious packing between opposed flanges of each pair of adjacent channel members in the communicating passage defined by such opposed flanges at and along the outlet.

4. Apparatus for handling granular material comprising a casing; a material inlet into the casing; a material outlet from the casing spaced from the inlet; a rotor rotatably located within the casing, the rotor being constituted by a plurality of substantially similar channel members mounted in circumferentially spaced, axially extending juxtaposition about the rotational axis of the rotor whereby the bases of the channel members form a hollow reservoir for fluid under pressure and opposed flanges of each pair of adjacent channel members are spaced apart and form a vane presenting a tip surface disposed in opposed, spaced relationship to an inner surface of the casing, the space between each pair of adjacent vane forming channel members constituting a fluid passage in the vane which is in permanent communication with the interior of the reservoir and has an outlet located substantially centrally in the tip surface in a transverse direction and extending substantially the whole length of the tip surface, and a fluid pervious packing between opposed flanges of each pair of adjacent channel members in the communicating passage defined by such opposed flanges at and along the outlet, each packing comprising a sheet of fluid pervious material which is folded double and contains an elongated retaining element in the fold, the folded sheet being located in the fluid passage with the fold containing the retaining element located within the reservoir against the inner periphery thereof.

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