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(54) **BISTABLE ELECTROMAGNETIC VALVE**

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(76) Inventors: **Hubert Ott, Ravensburg (DE); Thomas
Grau, Argenbuehl (DE)**

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Correspondence Address:

**William D. Breneman, Esq.
BRENNEMAN & GEORGES
3150 Commonwealth Avenue
Alexandria, VA 22305 (US)**

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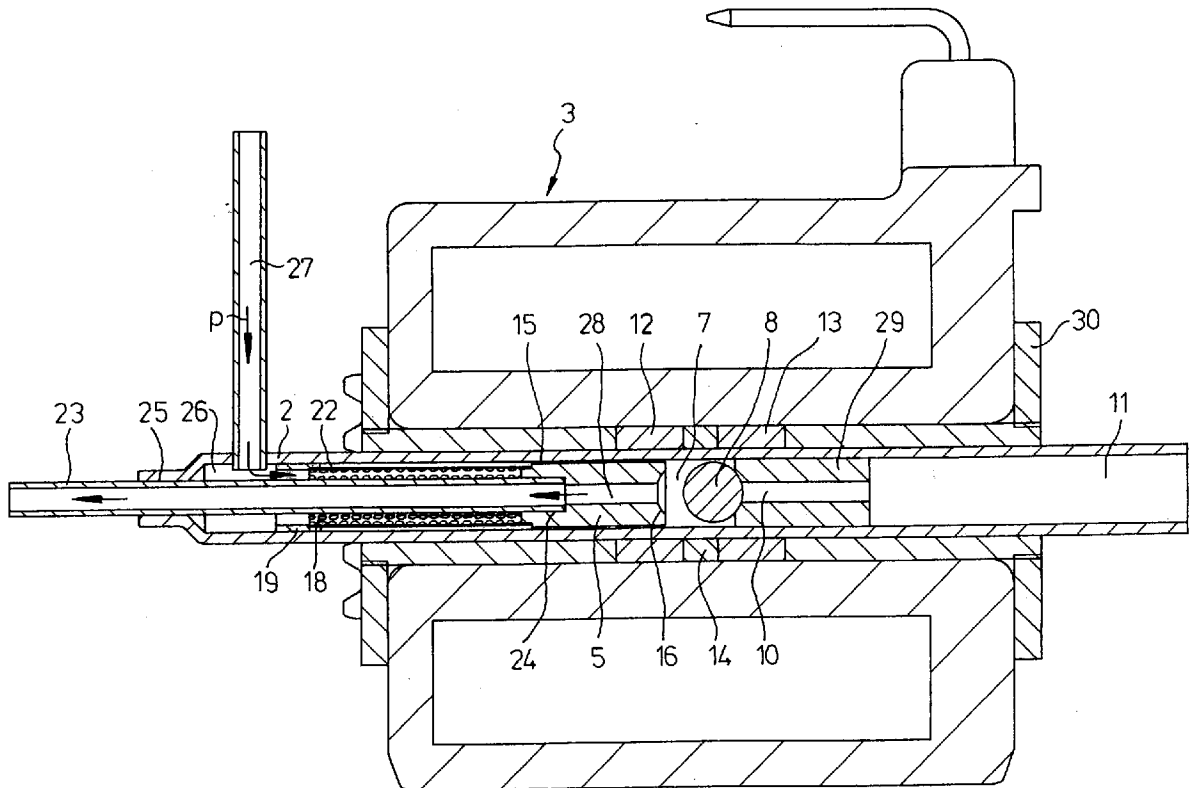
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(57) **ABSTRACT**

Proposed herein is a bistable electromagnetic valve with a valve chamber arranged between two pole pieces and a valve body displaceable therein between two end positions, which is designed as a magnet armature for at least one permanent magnet and for at least one control coil, which is less susceptible to faults in comparison to known valves for refrigerant circuits. This object is achieved by having the valve (1) encompass a dirt filter (18, 19).



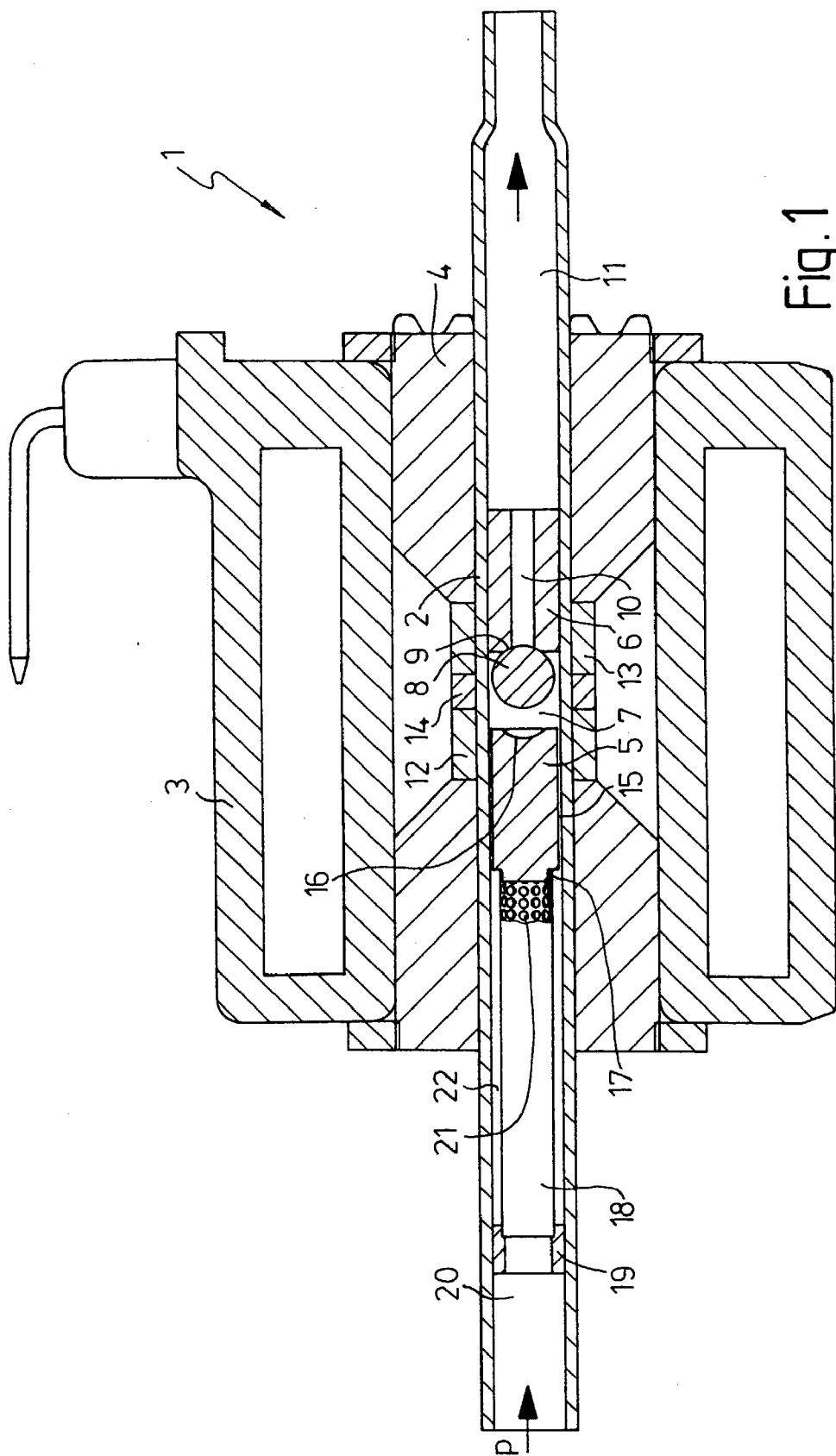


Fig. 1

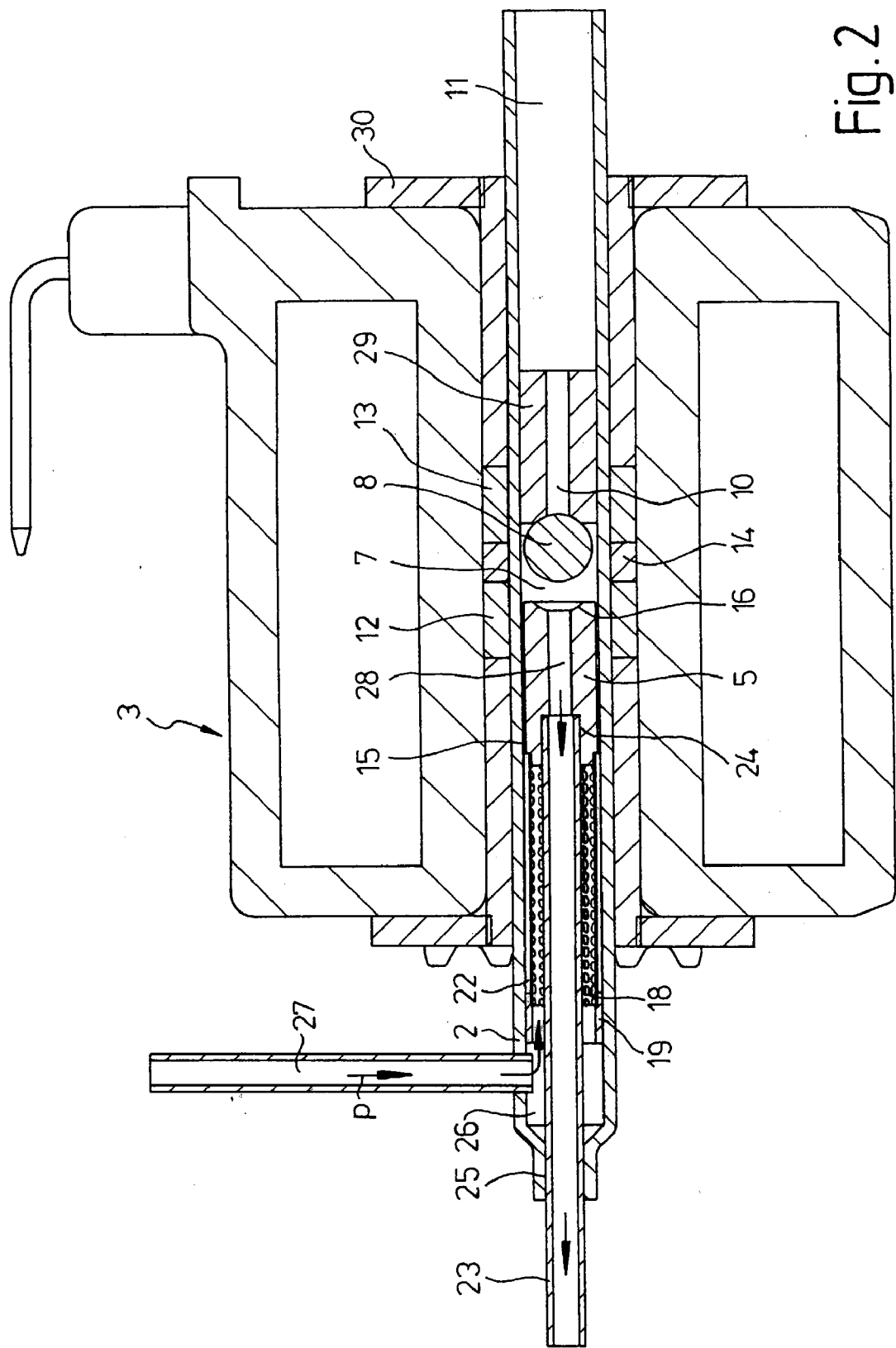


Fig. 2

BISTABLE ELECTROMAGNETIC VALVE

BACKGROUND OF THE INVENTION

[0001] 1. Field Of The Invention

[0002] The invention relates to a bistable electromagnetic valve (1) having a valve chamber arranged between two pole pieces and a valve body displaceable between two end pistons which is designed as a magnet armature for at least one permanent magnet and at least one control coil which novel valve includes a dirt filter (18,19).

[0003] 2. Description of the Related Art Including Information Disclosed under 37 C.F.R. 1.97 and 1.98

[0004] Prior art valves of this type are used, for example, in refrigerant circuits of the kind described in publications DE 37 18 490 or EP 10 54 200.

[0005] In such valves, a bistable situation is achieved by arranging permanent magnets outside the valve housing, next to the valve chamber or next to the pole pieces, so that the valve body has two end positions at the pole pieces, in which it is held by these permanent magnets.

[0006] Stringent requirements are placed on such valves in terms of tightness and long-term stability. After manufactured at the production facility, the valves are generally incorporated into the refrigerant circuit at another facility, making it difficult to determine the cause of any malfunction.

BRIEF SUMMARY OF THE INVENTION

[0007] The object of the invention is therefore to provide a valve, in particular for a refrigerant circuit, which is less susceptible to faults.

[0008] This object is achieved proceeding from a valve (1) having a valve chamber arranged between two pole pieces and a valve body displaceable between two end pistons which is designed as a magnet armature for at least one permanent magnet and at least one control filter which novel valve includes a dirt filter (18, 19).

[0009] The measures specified in the following description of the invention including drawings and dependent claims enable advantageous embodiments and further developments of the invention.

[0010] Accordingly, the invention is distinguished by the fact that the novel valve encompasses a dirt filter.

[0011] The invention is hence based on the knowledge that malfunctions are often caused by dirt that enters the valve after installation in the refrigerant circuit. According to the invention, the dirt filter prevents this dirt from reaching the critical locations of the valve, i.e., the area of the valve body and its seal seat.

[0012] The dirt filter is advantageously arranged on the inflow side of the valve chamber in the valve housing. In this way, dirt is reliably prevented from entering the critical components, i.e. the valve body and valve seats or the entire valve chamber containing the valve body, after the fluid circulation has been completed, since only cleansed fluid can get into the valve chamber.

[0013] The dirt filter is advantageously situated immediately adjacent to a pole piece for this purpose. This position

represents the arrangement lying closest to the valve chamber for a dirt filter separate from the valve chamber, so that all fluid that gets into the valve chamber during startup of the fluid circuit is actually largely filtered.

[0014] A dirt filter according to the invention can be permanently installed into the valve casing, i.e., so that it only be replaced with the entire valve or not at all, provided the filter capacity is sufficient for a one-time cleansing of the fluid circuit.

[0015] Filters in fluid circuits are usually designed in such a way as to be replaceable or washable, since the filters become clogged over time. However, the invention is based on the additional knowledge that, when this type of valve is always used in circuits that generally remain closed for the life of the valve, the dirt filter can be permanently installed in the valve. However, this filter must here exhibit a filter capacity sufficient for a one-time cleansing of the entire fluid in the circuit.

[0016] Since no more dirt accumulates on the filter after this one-time cleansing, clogging can be prevented, so that the filter need not be replaced or cleaned.

[0017] In a further development of the invention, a magnetic dirt filter is provided. A magnetic dirt filter is able to retain magnetic or magnetizable dirt particles, such as those that are rinsed away from the inner wall of the tubes of the refrigerant circuit, or can get inside the circuit during assembly of the fluid circuit, e.g., via soldering. Precisely these magnetic or magnetizable dirt particles are especially critical with respect to malfunctions, however, since they stay behind in the valve chamber if no measures are taken to trap them in advance owing to the permanent magnets required for the bistable design, permanently impairing the tightness of the valve there, while at the same time increasing the wear.

[0018] A magnetic dirt filter is especially effective if in direct contact with fluid. For this reason, a permanent magnet is arranged inside the valve housing or inside its connecting line in a particularly advantageous embodiment of the invention.

[0019] In a further development of this embodiment, an annular magnet is provided as the dirt filter. Annular magnets are inexpensive to buy, and exhibit a large surface loadable with dirt particles while being readily mountable inside a circular tube, wherein a sufficiently high flow cross-section is simultaneously available for the fluid, e.g., refrigerant.

[0020] In another embodiment of the invention, a mechanical filter is provided, either alone or in combination with a magnetic filter. A mechanical filter is also able to retain nonmagnetic or non-magnetizable dirt particles, and hence provide for a more complete cleansing of the refrigerant.

[0021] It is particularly advantageous to combine a mechanical filter with magnet filter situated upstream relative to the direction of flow, since preliminarily filtering the magnetic or magnetizable dirt particles reduces the load on the mechanical filter, so that it can be given smaller dimensions.

[0022] In an advantageous embodiment, the magnet filter is simultaneously used as a mount for the mechanical filter, so that a separate mount need not be provided at the location of the magnet filter.

[0023] In particular when combined with an annular magnet, the mechanical filter is preferably designed as a tubular sieve. Such a tubular sieve can have attached to it an annular magnet, for example, which tightly abuts the inner wall of the inflow to the valve chamber. This fixes the tubular sieve in place on the one hand, and seals the inflow cross-section outside the tubular sieve via the annular magnets on the other, so that fluid can only flow into the tubular sieve.

[0024] In particular when combined with the aforementioned features, the interior space of the tubular sieve is connected with the inflow of fluid, e.g., the refrigerant, and the exterior space of the tubular sieve is connected with the valve chamber. The retained dirt particles here accumulate inside the tubular sieve, wherein magnetic or magnetizable particles are already retained at the permanent magnet, as indicated above.

[0025] The sieve holes of such a mechanical filter are designed with a diameter measuring between $50\ \mu$ and $80\ \mu$, for example. Tests performed on valves in refrigerant circuits showed this type of magnetic filter configuration to be a particularly favorable design in terms of good filtering properties and sufficient flow.

[0026] In addition to enabling an arrangement (viewed in the direction of flow) in front of the valve chamber as described above, the use of a tubular sieve as the mechanical filter makes it possible to choose a high enough filter capacity by providing the tubular sieve with a corresponding axial length.

[0027] Further, the filter capacity of a tubular sieve can be improved by appropriately configuring the cross-section, specifically by making the cross-section larger. For example, such a tubular sieve can be designed with a corrugated or folded cross-section.

[0028] One particularly advantageous embodiment is a tubular sieve with a star-shaped cross-section, since a uniform all-around flow can be established here with a good surface enlargement.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] One exemplary embodiment of the invention is shown in the drawing, and will be explained in greater detail below based on the figures, in which:

[0030] FIG. 1 is a cross-section through a 2/2-way valve according to the invention, and

[0031] FIG. 2 is a cross-section through a 3/2-way valve according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0032] Valve 1 according to FIG. 1 encompasses a tubular valve housing 2 interspersed with a control coil 3. Here, adapter pieces 4 ensure the good fit in the valve housing 2, and are simultaneously designed as flow conducting elements for an increased magnetic flux through pole pieces 5, 6 and through a valve chamber 7. Situated inside the valve chamber 7 is a spherical valve body 8, which sits on the spherical seat 9 of the pole piece 6 in the position shown, sealing a through hole 10 in the process. The through hole 10 empties out in the outflow line 11 of valve 1.

[0033] Annular magnets 12, 13 lying outside the valve housing 2 ensure the bistable behavior of the valve, and are fixed between the adapter pieces 4 by a spacer ring 14.

[0034] The outer periphery of the pole piece 5 exhibits recesses or smoothened surfaces that produce the fluid channels 15 between the pole piece 5 and valve housing 2 into the valve chamber 7. The fluid channels could also be realized via holes in the pole piece 5, whose openings on the inflow side lie in a circular area between a tubular sieve 18 and the outer wall of the valve housing 2. The pole piece 5 also exhibits a spherical seat 16 to bring about a defined end location of the valve body 8 in the second end position (not shown).

[0035] The pole piece 5 encompasses a graduation 17 onto which the tubular sieve 18 is slipped. At the opposing end, the tubular sieve 18 is fixed in a magnetic filter 19 designed as an annular magnet. The tubular area of the valve housing 2 in which the tubular sieve 18 and magnet filter 19 are located serves as an inflow line 20 for the corresponding fluid, i.e., in particular for refrigerants.

[0036] Inflowing fluid (see arrow P) initially gets into the area of the magnet filter 19, which is designed as an annular magnet and comes into direct contact with the fluid. As a result, magnetic or magnetizable dirt particles already become permanently fixed at the magnet filter 19, spaced far away from the valve chamber 7.

[0037] The fluid subsequently gets inside the tubular sieve 18, which is frontally sealed at the opposing end by the pole piece 5 or its graduation 17. The fluid must hence flow in the tubular sieve 18 radially outward, during which dirt particles larger than the sieve openings 21 in the tubular sieve 18 are retained inside the tubular sieve 18. As a result, only cleansed fluid gets into the exterior space 22 between the tubular sieve 18 and valve housing 2. From there, the fluid passes through the fluid channels 15 and inside the valve chamber 7.

[0038] The flow naturally only takes place with the valve opened, i.e., in the switch setting where the valve body 8 sits on the spherical seat 16, and the through hole 10 is open.

[0039] The valve 1 according to the invention can be readily installed in a fluid circuit, e.g., a refrigerant circuit, which contains dirt particles arising from production that are incompatible with conventional refrigerant valves and trigger malfunctions.

[0040] The application of the valve 1 is geared toward closed fluid circuits that remain closed over the life of the valve 1 after production. The filter capacity of the filter system comprised of a tubular filter 18 and magnet filter 19 must here be designed in such a way that a one-time, complete cleansing of the fluid in the circuit can take place without clogging.

[0041] In this way, i.e., by using a filter 18, 19 in the inflow line 20 of the valve housing 2, and in particular via positioning right next to the valve chamber 7, dirt is reliably prevented from getting into the valve chamber 7 to an extent that can ensure the permanently tight and low-wearing function of the valve 1.

[0042] FIG. 2 essentially corresponds to the above exemplary embodiment, the difference now being that a second tubular outflow line 23 is guided into the valve casing 2 up

to the pole piece **5**, and there tightly fixed in a corresponding hole **24**. The valve housing **2** and the outflow line **23** are tightly sealed relative to each other at a sealing location **25**, e.g. press molded or soldered.

[0043] This yields an intermediate space **26** between the outflow line **23** and the valve housing **2**, to which an inflow line **27** is connected. The inflow line **27** can be soldered in a corresponding hole of the valve housing, for example.

[0044] In this embodiment, the pole piece **5** also encompasses a through hole **28**, which connects the valve chamber **7** with the intermediate space **26** via the fluid channels **15**.

[0045] The fluid or refrigerant can flow in the direction of arrow P into the intermediate space **26**, and from there through the magnet filter **19** into the now annular interior space between the tubular sieve **18** and outflow line **23**. The fluid then flows radially outward in the exterior space **22** between the tubular sieve **18** and valve housing **2**, from where it gets into the valve chamber **7** via the fluid channels **15**.

[0046] Depending on the switch setting of the valve body **8**, the fluid is then discharged via the outflow line **23** or outflow line **11**. In the switch setting shown, the through hole **28** of the pole piece **5** is open, i.e. discharge takes place via the outflow line **23**.

[0047] A control pulse for the control coil **3** makes it possible to move the valve body **8** to the opposing spherical seat **16**, as a result of which the through hole **28** is sealed, and the through hole **10** is opened. The fluid is discharged via outflow line **11** in this switch setting, which is described but not shown.

[0048] Instead of the adapter pieces **4**, which exhibit a conical outflow surface inside the control coil **3**, sleeve-shaped flow conducting plates **29** are here provided to guide the magnetic flux inside the control coil **3**, completely filling out the intermediate space between the valve housing **2** and control coil **3**. The flow conducting plates **29** are each connected with a cover plate **30**, which in turn is joined with or goes over into so-called yoke laminations (not shown in greater detail). The flow conducting plates **29** can be stamped and bent or wound from a single flat material along with the cover plate **30** and the entire yoke lamination arrangement (not shown in greater detail).

[0049] Reference List:

- [0050] **1** Valve
- [0051] **2** Valve housing
- [0052] **3** Star-shaped coils
- [0053] **4** Adapter pieces
- [0054] **5** Pole piece
- [0055] **6** Pole piece
- [0056] **7** Valve chamber
- [0057] **8** Valve body
- [0058] **9** Spherical seat
- [0059] **10** Through hole
- [0060] **11** Outflow line
- [0061] **12** Annular magnet

- [0062] **13** Annular magnet
- [0063] **14** Spacer ring
- [0064] **15** Fluid channel
- [0065] **16** Spherical seat
- [0066] **17** Smoothened surface
- [0067] **18** Tubular sieve
- [0068] **19** Magnet filter
- [0069] **20** Inflow line
- [0070] **21** Sieve opening
- [0071] **22** Exterior space
- [0072] **23** Outflow line
- [0073] **24** Hole
- [0074] **25** Sealing location
- [0075] **26** Intermediate space
- [0076] **27** Inflow line
- [0077] **28** Through hole
- [0078] **29** Flow conducting plate
- [0079] **30** Cover plate

What is claimed is:

1. Bistable, electromagnetic valve with a valve chamber arranged between two pole pieces and a valve body displaceable therein between two end positions, which is designed as a magnet armature for at least one permanent magnet and for at least one control coil, characterized in that the valve (1) encompasses a dirt filter (18, 19).

2. Valve according to claim 1, characterized in that the dirt filter (18, 19) is arranged on the inflow side (20) of the valve chamber (7) in the valve housing (2).

3. Valve according to one of the preceding claims, characterized in that the dirt filter (18, 19) is positioned right next to a pole piece (5).

4. Valve according to one of the preceding claims, characterized in that the dirt filter (18, 19) is permanently installed in the valve housing (2).

5. Valve according to one of the preceding claims, characterized in that a magnetic dirt filter (19) is provided.

6. Valve according to one of the preceding claims, characterized in that the magnetic dirt filter (19) is designed as a permanent magnet in direct contact with the fluid.

7. Valve according to one of the preceding claims, characterized in that the magnetic dirt filter (19) is designed as an annular magnet.

8. Valve according to one of the preceding claims, characterized in that a mechanical filter (18) is provided.

9. Valve according to one of the preceding claims, characterized in that a mechanical filter (18) and a magnet filter (19) are provided.

10. Valve according to one of the preceding claims, characterized in that the magnet filter (19) is designed as a mount for the mechanical filter (18).

11. Valve according to one of the preceding claims, characterized in that the mechanical filter (18) is designed as a tubular sieve.

12. Valve according to one of the preceding claims, characterized in that the interior space of the tubular sieve

(18) is connected with the inflow (20), and the exterior space (22) is connected with the valve chamber (7).

13. Valve according to one of the preceding claims, characterized in that the sieve openings (21) have a diameter ranging between 50μ and 80μ .

14. Valve according to one of the preceding claims, characterized in that the tubular sieve (18) has a corrugated or folded cross-section.

15. Valve according to one of the preceding claims, characterized in that the tubular sieve (18) has a star-shaped cross section.

16. Valve according to one of the preceding claims, characterized in that the magnet filter (19) is arranged on the inflow side (20) of the mechanical sieve (18).

17. Refrigerating circuit for a refrigeration system, in particular with several refrigerating compartments, a compressor, a condenser, several evaporators, which each are allocated to one of the refrigerating compartments, as well as at least one electric control valve for connecting the condenser with one or more of the evaporators based on predetermined operating modes, characterized in that the control valve (1) is designed according to one of the preceding claims.

18. Household appliance with a refrigerating circuit, in particular a refrigerator or freezer chest, characterized in that a refrigeration circuit is provided with a valve according to one of claims 1 to 16.

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