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(54) CONDENSER FOR A MOTOR VEHICLE AIR CONDITIONING SYSTEM

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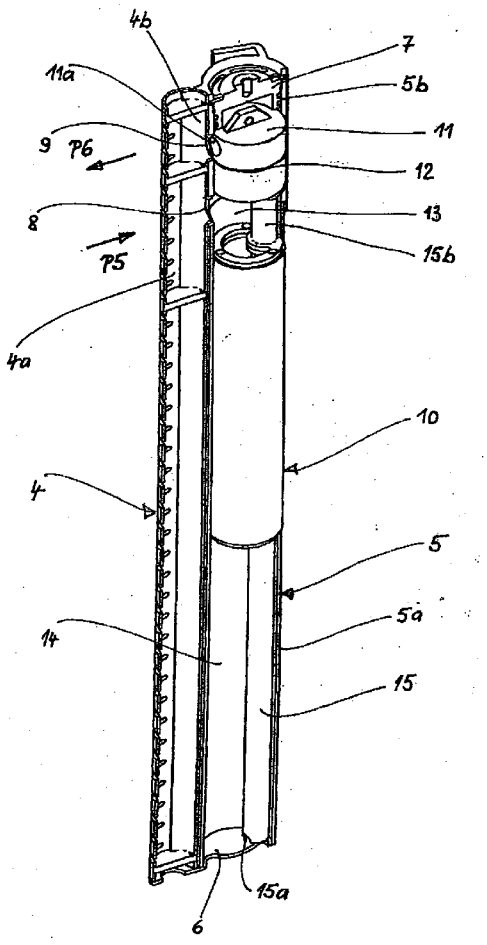
(57) **ABSTRACT**

A condenser (**1**) for a vehicle air conditioning system comprises a finned tube block (**2**) and laterally arranged header tubes (**3, 4**). The finned tube block (**2**) has horizontally running tubes forming a condensing section (P**1** to P**5**) and a supercooling section (P**6**) arranged above the condensing section. A collector (**5**) arranged parallel to one of the header tubes accommodates a dryer-filter insert (**10**) and an ascending pipe (**15**). The collector is connected for refrigerant flow via a first overflow opening (**8**) to the condensing section (P**5**) and via a second overflow opening (**9**) to the supercooling section (P**6**). An inflow chamber (**13**) can be formed in the region of the first overflow opening (**8**) in the collector (**5**) and can be upwardly bounded by a stopper (**11**) and downwardly bounded by the dryer-filter insert (**10**), or a downward flow pipe **21** can transport refrigerant from the first overflow opening to the dryer-filter.



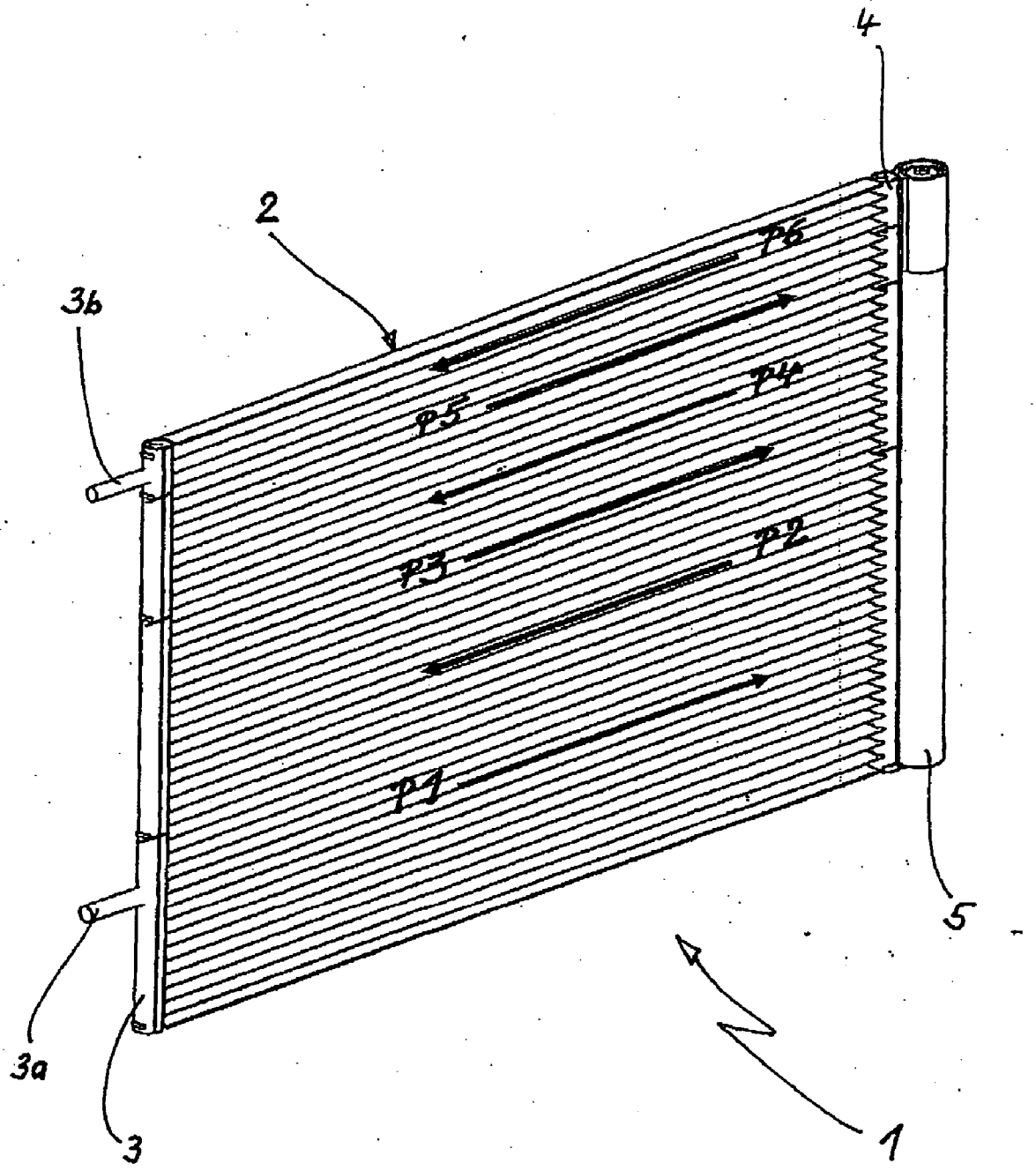


Fig. 1

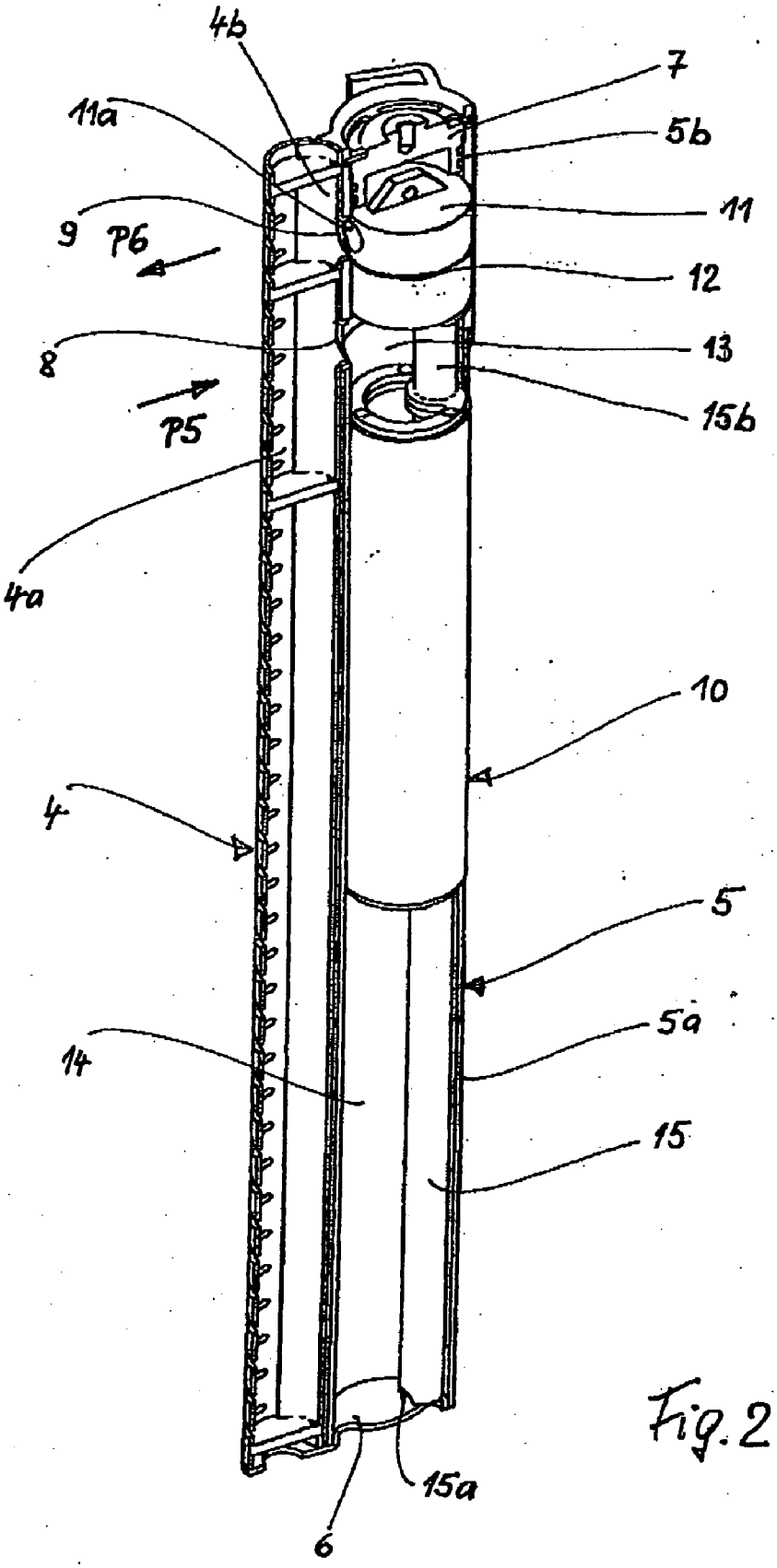


Fig. 2

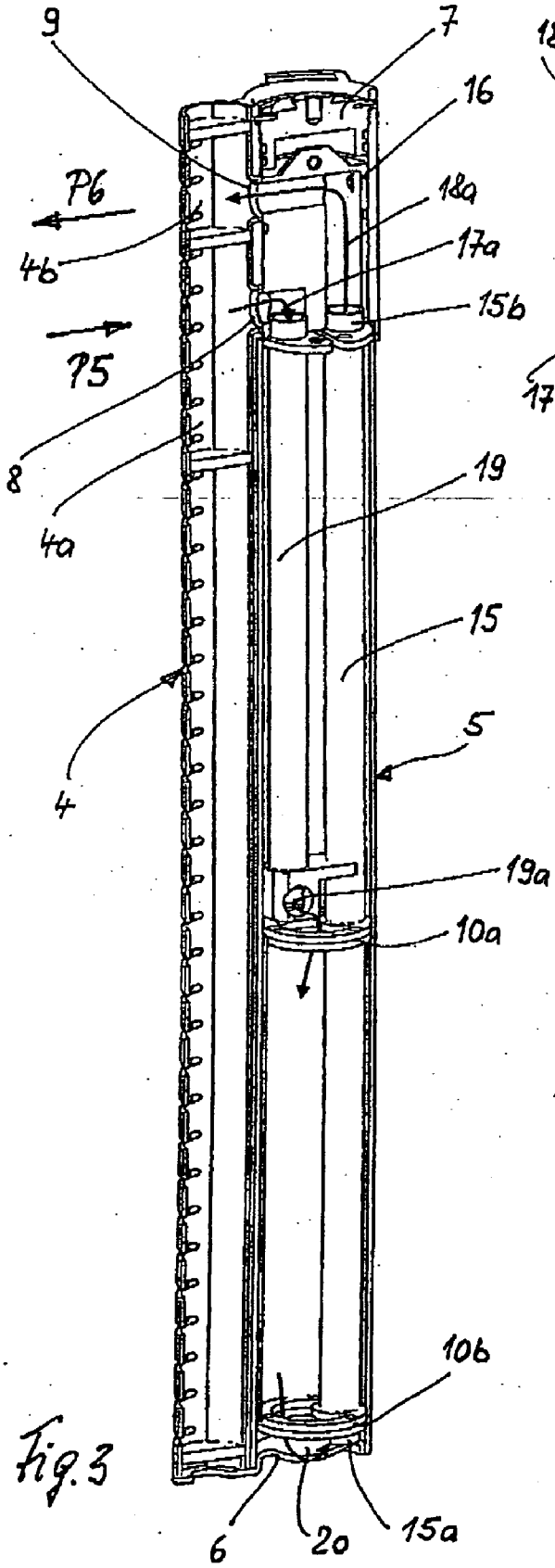

9
7
16
P6
18a
46
17a
15b
P5
8
4a
19
15
4
5
19a
10a
10b
6
20
15a

Fig. 3

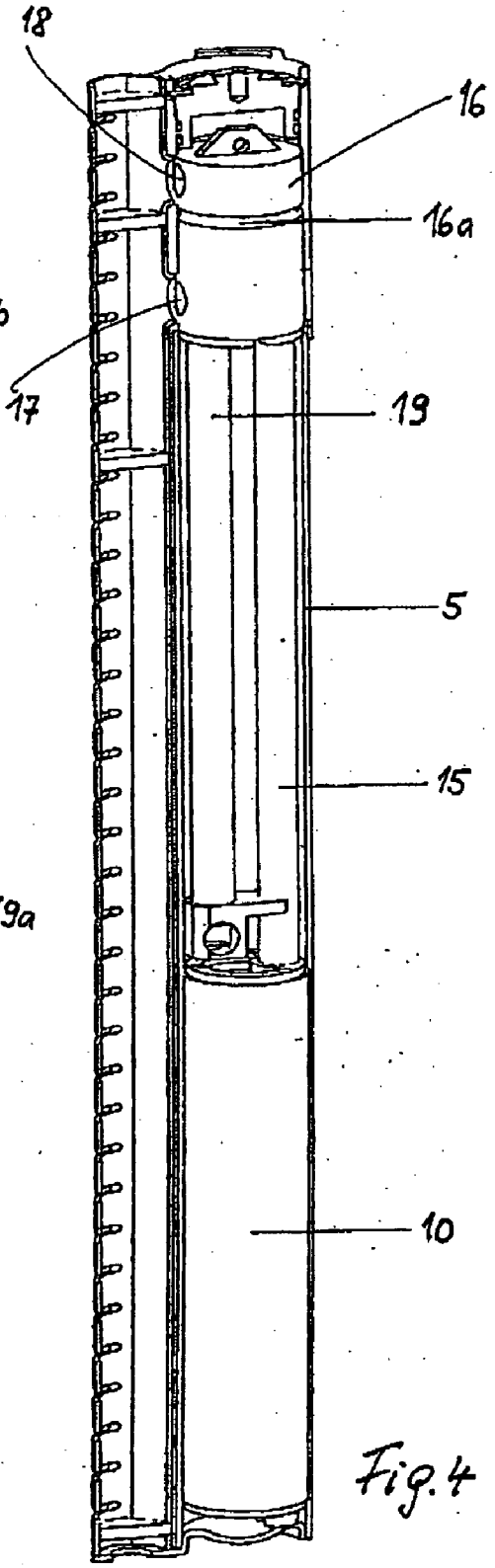

18
16
16a
17
19
5
15
10

Fig. 4

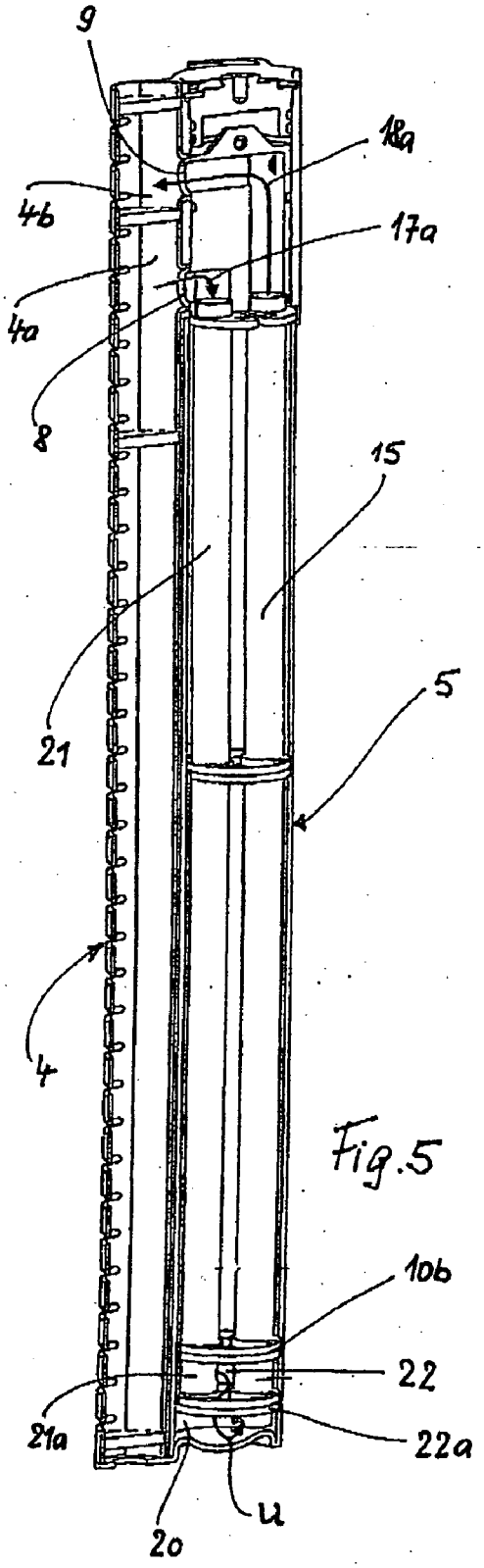

9
18a
4b
17a
4a
8
15
21
5
4
10b
22
21a
22a
20
u

Fig.5

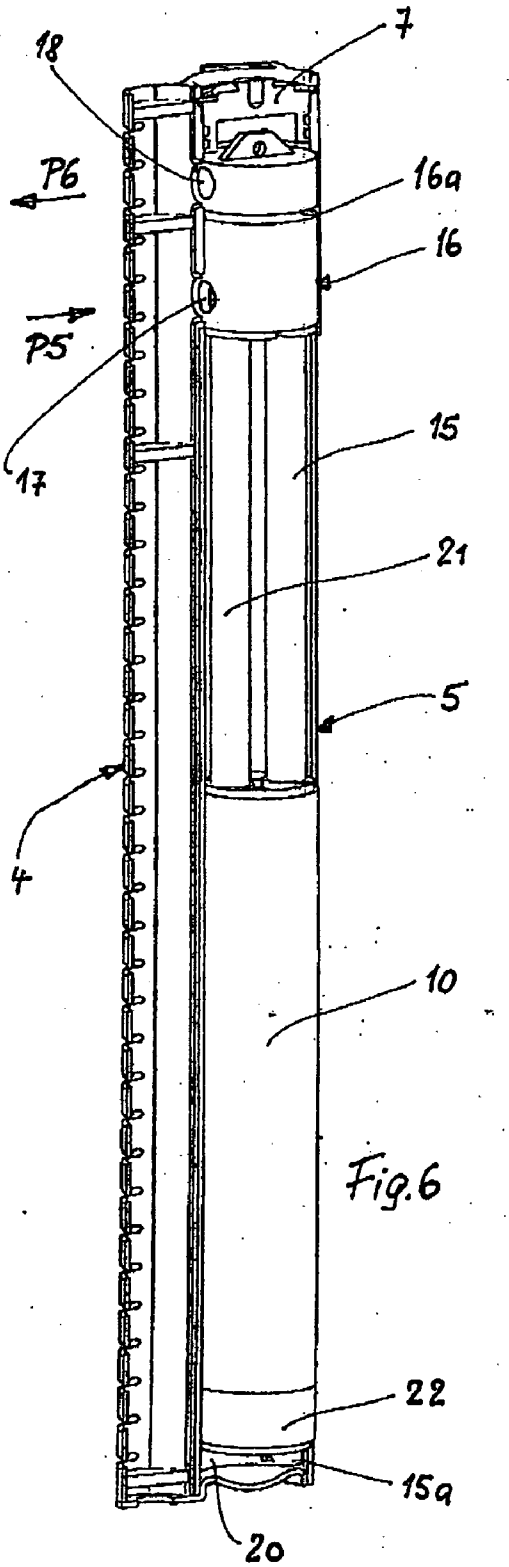

18
7
P6
16a
16
P5
17
15
21
5
4
10
22
15a
20

Fig.6

CONDENSER FOR A MOTOR VEHICLE AIR CONDITIONING SYSTEM

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

[0001] The right of foreign priority is claimed under 35 U.S.C. § 119(a) based on Federal Republic of Germany Application No. 10 2005 005 187.1, filed Feb. 3, 2005, the entire contents of which, including the specification, drawings, claims and abstract, are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to a condenser for an air conditioning system of the type generally disclosed in commonly-owned DE 199 12 381 A1.

[0003] Condensers for air conditioning systems of motor vehicles generally have the flow passing through them from the top to the bottom in multiple flow paths or passes, with the lower region of the condenser having a supercooling section in which the refrigerant is cooled to below the condensation temperature. Cross-flow condensers of this type, which also typically have an integrated collector with a dryer, are disclosed in commonly-assigned DE 103 06 192 A1; DE 103 38 526 A1 and DE 198 48 744 A1. In the case of certain installation situations in the vehicle, this design with the supercooling section situated at the bottom is less advantageous, namely, if a further heat exchanger, for example, a charge air cooler, is connected upstream of the condenser (in terms of air-flow) in the lower end surface region. In this case, the supercooling section of the condenser is not sufficiently cooled. Condensers with a supercooling segment situated at the top have therefore already been proposed, as disclosed in commonly-assigned DE 198 30 329 A1 and DE 199 12 381 A1, the disclosures of which are also incorporated herein by reference. In the first case, the known cross-flow condenser has a condensation section, which is situated in the lower portion and through which the flow passes from the top to the bottom, and a supercooling section, which is situated at the top and is connected to the lower region of the collector via a refrigerant line arranged in the collector or in the collecting pipe. In the second case, the condenser developed by the present assignee has a condensing section, which is situated in the lower region and through which the flow passes from the bottom to the top, i.e., the refrigerant leaves the condensing section in the upper region and then passes into a collector which accommodates a dryer-filter insert which has an ascending pipe passing through it. The dryer-filter insert is arranged in the lower region of the collector, while there is space in the central region of the collector to receive liquid and gaseous refrigerant. Arranged below the dryer is a deflecting space from which liquid refrigerant passes, via the ascending flow pipe and via an upper chamber in the collector, into the supercooling segment situated at the top.

SUMMARY OF THE INVENTION

[0004] It is one object of the present invention to provide an improved condenser of the general type mentioned at the beginning, particularly regarding its collector, the refrigerant flow path in the collector and the degassing of the refrigerant.

[0005] In accordance with one aspect of the invention, there is provided a condenser for use in a vehicle air conditioning system, comprising: a finned tube block having horizontally running tubes, and a header tube at each end of the tubes in the tube block, the finned tube block comprising a condensing section and a supercooling section arranged above the condensing section; and a collector arranged parallel to one of the header tubes, wherein the collector includes a dryer-filter insert, a stopper and an ascending flow pipe, the collector being connected for refrigerant flow via a first overflow opening communicating with the condensing section and via a second overflow opening communicating with the supercooling section, wherein an inflow chamber is defined in the region of the first overflow opening in the collector and is bounded by the stopper on the upper side and is bounded by the dryer-filter insert on the lower side.

[0006] In accordance with another aspect of the invention, there is provided a condenser for use in a vehicle air conditioning system, comprising: a finned tube block having horizontally running tubes, and a header tube at each end of the tubes in the tube block, the finned tube block comprising a condensing section and a supercooling section arranged above the condensing section; and a collector arranged parallel to one of the header tubes and being connected for refrigerant flow via a first overflow opening communicating with the condensing section and via a second overflow opening communicating with the supercooling section, wherein the collector includes a dryer-filter insert, an ascending flow pipe and a downward flow pipe having a first inlet pipe end connected to the first overflow opening.

[0007] According to another aspect of the invention, there is provided a condenser for use in a vehicle air conditioning system, comprising: a finned tube block having horizontally running tubes, and a header tube at each end of the tubes in the tube block, the finned tube block comprising a condensing section and a supercooling section arranged above the condensing section; a collector arranged parallel to one of the header tubes, wherein the collector includes a dryer-filter insert, a stopper and an ascending flow pipe, the collector being connected for refrigerant flow via a first overflow opening communicating with the condensing section and via a second overflow opening communicating with the supercooling section; and a refrigerant flow arrangement located in the collector for decreasing the flow velocity of the refrigerant, after it exits the first overflow opening, by an amount sufficient to permit at least some gaseous phase refrigerant to separate from liquid refrigerant.

[0008] Further objects, features and advantages of the present invention will become apparent from the detailed description of preferred embodiments that follows, when considered together with the accompanying figures of drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] In the drawings:

[0010] **FIG. 1** is a perspective view showing a cross-flow condenser with a supercooling segment situated at the top and with a laterally arranged, integrated collector;

[0011] **FIG. 2** is a cut-away view showing the collector with an adjacent collecting pipe;

[0012] **FIG. 3** is a cut-away view showing the collector with a down pipe (second exemplary embodiment of the invention);

[0013] **FIG. 4** is a cut-away view showing the collector according to **FIG. 3**, with views of the stopper and dryer-filter;

[0014] **FIG. 5** is a cut-away view showing the collector with the down pipe passing through the dryer-filter (third exemplary embodiment of the invention); and

[0015] **FIG. 6** is a cut-away view showing the collector according to **FIG. 5**, with views of the stopper and dryer-filter.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] According to one preferred embodiment the invention, an inflow chamber is situated in the collector in the region of the overflow opening for the refrigerant from the condensing section. The inflow chamber is upwardly bounded by a stopper and downwardly bounded by the dryer. The refrigerant entering the inflow chamber is therefore distributed uniformly over the entire cross section of the collector and then enters the dryer, through which the refrigerant inevitably passes from the top to the bottom. In the process, the refrigerant is dried and filtered. The dryer is therefore situated in the central to upper region of the collector, i.e., directly below the overflow opening from the condensing section. An effective drying of the refrigerant is therefore achieved.

[0017] In one preferred embodiment of the invention, a storage space for the refrigerant is provided below the dryer-filter insert and serves not only to store refrigerant but also to degas the refrigerant. Owing to the retarded flow velocity of the refrigerant, gas bubbles can separate from the liquid and can rise upwardly.

[0018] In a further preferred embodiment of the invention, the ascending pipe passing through the dryer-filter insert is connected at a lower end to the storage space and is connected at its upper end to a stopper which causes the refrigerant to be deflected into the supercooling section. The stopper is inserted into the collector and is sealed circumferentially via an O-ring, between the two overflow openings. This prevents refrigerant, which enters the collector from the condensing section, from passing directly into the supercooling section, i.e., without being dried, filtered and degassed.

[0019] According to a further preferred aspect of the invention, a downward flow pipe is provided in the collector and is connected—indirectly—via a stopper to the overflow opening of the condensing section and conducts the refrigerant as far as the dryer-filter. This affords the advantage that a mixing of gaseous and liquid phase of the refrigerant is restricted.

[0020] In a further advantageous embodiment of the invention, the down pipe is guided through the dryer-filter into a chamber which receives the refrigerant with a reduced flow velocity and while simultaneously being degassed. The flow through the dryer-filter, i.e., the molecular sieve, takes place in this case owing to differences in the density of the refrigerant, rather than inevitably. It is advantageous in this case that, by extending the down pipe, the possibility of mixing gaseous and liquid refrigerant is further restricted or suppressed, and therefore better degassing of the refrigerant supplied to the supercooling segment is obtained.

[0021] In a further advantageous embodiment of the invention, the stopper, the ascending pipe and/or the downward flow pipe may be formed integrally and may advantageously also be connected to the dryer-filter insert to form a constructional unit which is inserted as a pre-manufactured part or sub-unit into the collector. This sub-unit can also be more easily exchanged for maintenance purposes. The cooler is provided with a releasable closure for maintenance.

[0022] Turning now to the drawings, **FIG. 1** shows a cross-flow condenser **1** through which the flow can pass in multiple paths or passes and which has a finned tube block **2**, laterally arranged collecting tubes or headers **3**, **4** and an integrated collector **5**. The arrows P**1**, P**2**, P**3**, P**4**, P**5** and P**6**, which point in alternating directions, illustrate the directions of flow of the refrigerant in individual passes or tube sub-groups (not illustrated in detail) of the finned tube block **2**. The refrigerant enters via a connector **3***a* situated at the bottom and exits via a connector **3***b* situated at the top. The finned tube block **2** comprises a condensing section, which corresponds to arrows P**1** to P**5**, and a supercooling section which is arranged above the condensing section and is indicated by arrow P**6**. Essentially, liquid refrigerant flows in the supercooling section and is cooled to below the condensation temperature of the refrigerant by the ambient air which acts upon the condenser **1**. The refrigerant subsequently leaves the condenser **1** via the connector **3***b*.

[0023] **FIG. 2** shows the collector **5** with the header tube **4** of the condenser **1**, in a 3-D cut-off or sectional illustration. Only the two upper chambers **4***a*, **4***b* are illustrated of the header **4**, with these chambers being respectively connected to the last tube sub-group forming pass P**5** of the condensing section of the condenser and to the supercooling pass P**6**. The collector **5** typically comprises—as known from the publications mentioned at the beginning—a cylindrical container which is composed of a pipe **5***a* and an extruded profiled piece **5***b*. The collector **5** is preferably permanently closed (nonreleasably) at the bottom by a base **6**, which is typically soldered in, and is closed at the top by a releasable closure stopper **7**. The header chamber **4***a* is connected on the refrigerant side to the interior of collector! via a first overflow opening **8**, and the chamber **4***b* is connected via a second overflow opening **9** to the interior of the collector **5**. In the interior of the collector **5**, a dryer-filter **10** (also called dryer-filter insert) is arranged and is conventionally filled with a dryer material, e.g., a molecular sieve. On its upper and lower sides, i.e., the refrigerant inlet and refrigerant outlet sides, the collector **5** has a sieve, for example, in the form of a fleece (not illustrated in detail), for filtering the refrigerant. Arranged above the dryer **10** is a stopper **11** which is sealed circumferentially in relation to the interior of the profiled piece **5***b*, e.g., via an O-ring **12** in the region between the two overflow openings **8**, **9**. Between the stopper **11** and the dryer **10**, an inflow chamber **13** is formed in the region of the overflow opening **8**. Below the dryer **10**, there is a storage chamber **14** which serves to store liquid and/or gaseous refrigerant. Furthermore, within the collector **5**, an ascending pipe **15** is arranged eccentrically and preferably in the vicinity of the wall and is guided through the dryer-filter **10**. Pipe **15** enters the storage space **14** at the bottom or reaches as far as the base **6** and extends upwardly into the stopper **11**, which connects the ascending pipe **15** via an opening **11***a* to the chamber **4***b* and therefore to the supercooling section P**6**. A deflection (not shown in detail here) of the refrigerant from the ascending pipe **15** into the

chamber **4***b* therefore takes place in the stopper **11**. In the region of the base **6**, the ascending pipe **15** has an opening **15***a*, via which refrigerant can enter the ascending pipe **15**.

[**0024**] The function of the previously described collector **5** with dryer-filter **10** is as follows: the refrigerant emerging from the last pass P**5** of the condensing section of the condenser **1** passes via the overflow opening **8** into the inflow chamber **13**, where the refrigerant is uniformly distributed over the cross section of the collector **5** and its flow velocity is therefore reduced. From the inflow chamber **13**, the refrigerant flows (inevitably) through the dryer-filter **10** by means of which it is filtered and dried. After exiting from the dryer-filter **10**, the refrigerant passes into the storage space **14**, where its flow velocity is further reduced. In the process, gaseous constituents of the refrigerant can separate, these constituents rising upwardly and collecting in the upper region of the storage space **14**. In the lowermost region of the storage space **14**, e.g., at the base **6**, the refrigerant passes via the inlet opening **15***a* into the ascending pipe **15** and flows through the latter from the bottom to the top, i.e., it traverses the dryer-filter **10** in the ascending pipe **15** and passes into the stopper **11**, where it is deflected into the chamber **4***b* and enters from there into the supercooling section P**6**.

[**0025**] Since the collector **5** has a realeasable closure stopper **7**, the dryer-filter **10**, the ascending pipe **15** and the stopper **11** may be exchanged for maintenance purposes. This is particularly simple to handle if dryer-filter **10**, ascending pipe **15** and stopper **11** are designed as a prefabricated, cohesive constructional unit.

[**0026**] **FIG. 3** and **FIG. 4** show a further exemplary embodiment of the invention having collector **5** with a header tube **4**. The same reference numbers as previously are used for the same parts. The chambers **4***a* and **4***b* of the header **4** are connected to the collector **5** via the overflow openings **8**, **9**. The dryer-filter **10**, which is only partially illustrated in **FIG. 3**, i.e., by an upper end flange **10***a* and a lower end flange **10***b*, is arranged in the lower region of the collector **5**. The ascending flow pipe **15** penetrates and passes through the dryer-filter **10**. In the region of the overflow openings **8**, **9**, a stopper **16** is arranged in the collector **5**, the stopper having two duct openings **17**, **18** which are aligned with the overflow openings **8**, **9** and between which an O-ring **16***a* is arranged for sealing purposes. The duct opening **17** is connected via an inflow duct **17***a* to a down pipe **19**, the upper pipe end of which opens into the inflow duct **17***a* and is accommodated by the stopper **16**. The down pipe **19** extends downwardly into the vicinity of the end flange **10***a* of the dryer-filter **10** and has diametrically opposite outflow openings **19***a* at the lower pipe end. Below the dryer-filter **10**, i.e., between the lower end flange **10***b* and the base **6**, a deflecting chamber **20** for the refrigerant is provided, and the lowermost end **15***a* of the ascending pipe projects into it with an inlet opening (not illustrated in detail). The upper end **15***b* of the ascending pipe **15** is accommodated in the stopper **16** and is connected to a deflecting duct **18***a* which leads to the duct outlet opening **18** and therefore into the chamber **4***b* of the supercooling segment P**6**.

[**0027**] The collector **5** with down pipe **19** operates as follows: the refrigerant passes out of the last flow path P**5** of the condensing section via the chamber **4***a* and the inflow duct **17** directly into the downward flow pipe **19**, in which it flows downwardly. The refrigerant exits from the down pipe **19** through the outflow openings **19***a* on both sides and is therefore distributed over the internal cross section of the collector **5**, causing the flow velocity to be retarded. The refrigerant then enters the dryer-filter **10** and (inevitably) flows through it from the top to the bottom. In the process, a filtering of the refrigerant takes place at the inlet and outlet by means of fleeces (not illustrated in detail). After leaving the dryer-filter **10**, the dried refrigerant passes into the lower deflecting chamber **20**, then enters the lower pipe end **15***a* of the ascending pipe **15** and flows through the latter from the bottom to the top as far as the stopper **16**, in which it is deflected and conducted into the chamber **4***b* to the supercooling segment P**6**. The retardation of the refrigerant flow when it leaves the down pipe **19** makes it possible for gaseous constituents to be precipitated from the liquid refrigerant, with these constituents rising upwardly. A further degassing takes place on the path through the dryer-filter **10**. The down pipe **19** and its direct connection to the chamber **4***a* prevent separated gas constituents from mixing with the liquid refrigerant fed in from the condensing section. Below the stopper, it is therefore possible to form a gas space for separated gas bubbles. This gas space is separated and sealed off from the condensing section and the refrigerant flowing into it.

[**0028**] **FIG. 5** and **FIG. 6** show a third exemplary embodiment of the invention with collector **5** with header pipe **4** (the same reference numbers are again used for the same parts) and having a continuous down pipe **21**, i.e., passing through the dryer-filter **10**. The arrangement and design of the stopper **16** corresponds to the stopper in the previous exemplary embodiment according to **FIGS. 3 and 4**. Similarly, the upper pipe ends of down pipe **21** and ascending pipe **15** are accommodated in the stopper **16** and are connected via deflecting ducts in the stopper **16** to the chambers **4***a*, **4***b* of the header **4**. A chamber **22** is arranged below the dryer-filter **10** and the lower end flange **10***b*, and lower pipe end **21***a* of the down pipe **21** opens into chamber **22**. The chamber **22** is bounded below by an end flange **22***a* but is downwardly open. The deflecting space **20** is situated at the lower pipe end **15***a* of the ascending pipe **15**. The dryer-filter has filters or sieves (not illustrated in detail), which are designed as fleeces, on both sides in the region of the end flanges **10***a*, **10***b*.

[**0029**] The embodiment of the collector **5** with a continuous down pipe **21** in **FIGS. 5 and 6** operates as follows: the refrigerant enters (analogously to the previous exemplary embodiment) directly into the down pipe **21** and flows through the latter from the top to the bottom, and only exits from the down pipe **21** in the chamber **22** at the lower pipe end **21***a*. In the chamber **22**, the refrigerant is distributed to the cross section of the collector, thus resulting in a retardation of the flow velocity and therefore in the possibility of gaseous constituents separating. Some of the refrigerant therefore flows upwardly through the dryer-filter **10** and thereby comes into contact with the dryer substance, as a result of which drying takes place. In this case, the flow therefore does not inevitably pass through the dryer-filter **10**, i.e., its dryer substance. The other part of the refrigerant flows (corresponding to the arrow U) into the deflecting chamber **10** and then enters the lower pipe end **15***a* of the ascending pipe **15**. The refrigerant subsequently flows (as in

the preceding exemplary embodiment) via the ascending pipe **15** and the stopper **16** into the supercooling section P**6**.

[**0030**] The invention is not restricted to dryer-filters which are filled with granules of hygroscopic material. Other types of compact dryers, e.g., which are composed of a firm mass of plastic material with a molecular sieve embedded in it, as described in commonly-assigned DE 102 34 889 A1, are also within the scope of the invention.

[**0031**] The foregoing description of preferred embodiments of the invention has been presented for purposes of illustration and description only. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible and/or would be apparent in light of the above teachings or may be acquired from practice of the invention. The embodiments were chosen and described in order to explain the principles of the invention and its practical application to enable one skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto and that the claims encompass all embodiments of the invention, including the disclosed embodiments and their equivalents.

What is claimed is:

1. A condenser for use in a vehicle air conditioning system, comprising:

a finned tube block having horizontally running tubes, and a header tube at each end of the tubes in the tube block, the finned tube block comprising a condensing section and a supercooling section arranged above the condensing section; and

a collector arranged parallel to one of the header tubes, wherein the collector includes a dryer-filter insert, a stopper and an ascending flow pipe, the collector being connected for refrigerant flow via a first overflow opening communicating with the condensing section and via a second overflow opening communicating with the supercooling section, wherein an inflow chamber is defined in the region of the first overflow opening in the collector and is bounded by the stopper on the upper side and is bounded by the dryer-filter insert on the lower side.

2. A condenser according to claim 1, further comprising a storage space for the refrigerant is located below the dryer-filter insert in the collector.

3. A condenser according to claim 2, wherein the ascending flow pipe passes through the dryer-filter insert and has an inlet opening arranged in the storage space and an upper outlet end which is connected via the stopper to the supercooling section.

4. A condenser for use in a vehicle air conditioning system, comprising:

a finned tube block having horizontally running tubes, and a header tube at each end of the tubes in the tube block, the finned tube block comprising a condensing section and a supercooling section arranged above the condensing section; and

a collector arranged parallel to one of the header tubes and being connected for refrigerant flow via a first overflow opening communicating with the condensing section and via a second overflow opening communicating with the supercooling section, wherein the collector includes a dryer-filter insert, an ascending flow pipe and a downward flow pipe having a first inlet pipe end connected to the first overflow opening.

5. A condenser according to claim 4, further comprising a stopper which extends from the first to the second overflow opening, and wherein the inlet pipe end of the downward flow pipe is accommodated in the stopper.

6. A condenser according to claim 4, wherein the downward flow pipe comprises a pipe end on the outlet side which is arranged above the dryer-filter.

7. A condenser according to claim 4, wherein the downward flow pipe passes through the dryer-filter and opens in a chamber arranged below the dryer-filter

8. A condenser according to claim 6, wherein the pipe end on the outlet side of the downward flow pipe comprises diametrically opposite outlet openings.

9. A condenser according to claim 4, wherein the dryer-filter is arranged in the lower region of the collector and the ascending flow pipe passes through the dryer-filter.

10. A condenser according to claim 1, wherein the ascending flow pipe comprises an upper pipe end accommodated in the stopper and is connected on the refrigerant side to the second overflow opening.

11. A condenser according to claim 1, wherein the stopper comprises a deflecting duct from the ascending flow pipe to the second overflow opening.

12. A condenser according to claim 1, further comprising a circumferential seal comprising an O-ring on the stopper.

13. A condenser according to claim 1, wherein the stopper and the ascending flow pipe are formed integrally as a plastic injection-molded part.

14. A condenser according to claim 1, wherein the stopper, the ascending flow pipe and the dryer-filter insert comprise an exchangeable constructional unit.

15. A condenser according to claim 1, wherein the collector comprises a releasable closure member at its top end.

16. A condenser according to claim 4, wherein the stopper, the ascending flow pipe and the downward flow pipe are formed integrally as a plastic injection-molded part.

17. A condenser according to claim 4, wherein the stopper, the ascending **9** flow pipe, the downward flow pipe and the dryer-filter insert comprise an exchangeable constructional unit.

18. A condenser for use in a vehicle air conditioning system, comprising:

a finned tube block having horizontally running tubes, and a header tube at each end of the tubes in the tube block, the finned tube block comprising a condensing section and a supercooling section arranged above the condensing section;

a collector arranged parallel to one of the header tubes, wherein the collector includes a dryer-filter insert, a stopper and an ascending flow pipe, the collector being connected for refrigerant flow via a first overflow opening communicating with the condensing section and via a second overflow opening communicating with the supercooling section; and

a refrigerant flow arrangement located in the collector for decreasing the flow velocity of the refrigerant, after it exits the first overflow opening, by an amount sufficient

to permit at least some gaseous phase refrigerant to separate from liquid refrigerant.

19. A condenser according to claim 18, wherein the refrigerant flow arrangement comprises an inflow chamber defined in the region of the first overflow opening in the collector and is bounded by the stopper on the upper side and is bounded by the dryer-filter insert on the lower side

20. A condenser according to claim 18, wherein the refrigerant flow arrangement comprises a downward flow pipe having a first inlet pipe end connected to the first overflow opening.

* * * * *