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(71) Applicant: **BIRTON A/S**
DK-8260 Viby J (DK)

(72) Inventor: **Johansen, Bent**
8220 Brabrand (DK)

(74) Representative: **Nielsen, Leif et al**
Patrade A/S
Fredens Torv 3A
8000 Aarhus C (DK)

(54) Refrigerating system

(57) The invention relates to a refrigerating system where a refrigerant is conducted in piping by means of pressure produced by at least one compressor, the system including a condenser that may discharge refrigerant into at least two receivers through each their pipe branch provided with respective check valves, the receivers being arranged to supply refrigerant to at least one evaporators through a check valve associated with each receiver, where at least one compressor is arranged for supplying gas refrigerant at a first pressure level to the condenser.

Therefore, it is the purpose of the invention to provide a refrigerating system that is suitable for a refrigerant circulation without using circulation pumps in refrigeration systems.

This can be achieved with a system as described in the opening paragraph if the system contains pressure generating means supplying refrigerant gas to the receivers at a second pressure level higher than the first pressure level, and where the refrigeration system is provided with a control circuit arranged to control a solenoid valve at the inlet of each receiver for alternatingly supplying refrigerant gas to the receivers.

In this way can be achieved that the use of pumps can be avoided by generating a pressure difference from the compressor, at using that pressure difference to generate a force to pres refrigerant out of a receiver and further through the refrigeration system.

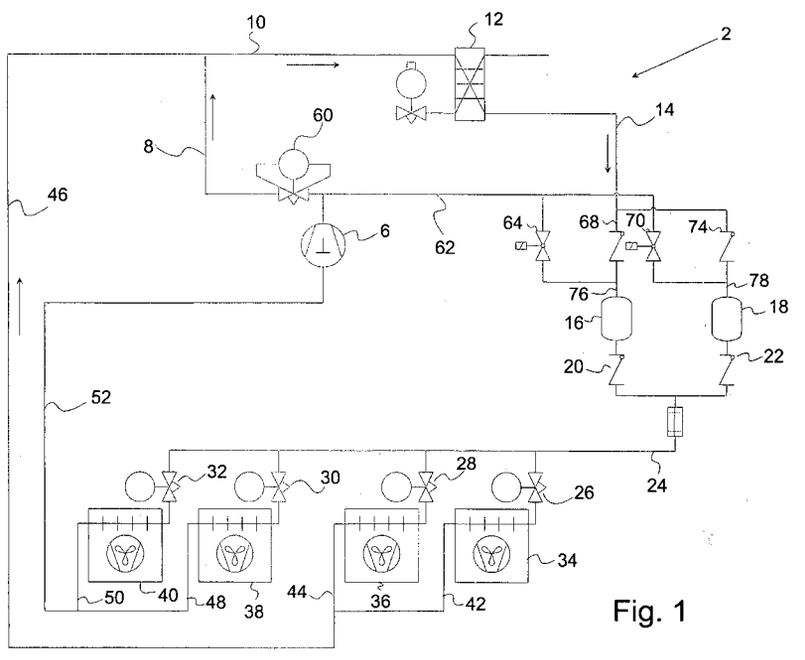

Fig. 1

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Description

Background of the Invention

[0001] The invention relates to a refrigerating system where a refrigerant is conducted in piping by means of pressure produced by at least one compressor, the system including a condenser that may discharge refrigerant into at least two receivers through each their pipe branch provided with respective check valves, the receivers being arranged to supply refrigerant to at least one evaporators through a check valve associated with each receiver, where at least one compressor is arranged for supplying gas refrigerant at a first pressure level to the condenser.

[0002] Such a system is prior art and disclosed in GB 1,146,428, which relates to improvements in a flooded coil refrigerant system where tanks are designed for collecting a recirculating excess refrigerant from the evaporators, to eliminate slugging of the compressor. The driving force of the prior art system is the pressure difference between the compressor discharge or condenser pressure and the suction pressure of the compressor, similar to most other refrigerant systems.. In operation one of the receivers are connected to the condenser, and liquid refrigerant is filling the first receiver, which at the same time is connected through restriction means to flooded evaporators, from which refrigerant is led to the second receiver, where liquid is remaining and gas is led to the suction side of the compressor. When the first receiver is empty or the second receiver is full, valves are opened and closed in order to change the operation of the receivers.

[0003] It is known from state of the art to use gravity force or pumps for generating flow of the refrigerant. Gravity force systems can be difficult to install on site because of physical restriction of installation components and piping in the buildings.

[0004] It is also known from state of the art to use pumps for circulating refrigerant instead of using gravity force fore generating flow. Pumps are power consuming and operation in a refrigerant might lead to pressure drop and formation of gas bobbles inside the pumps, which lead to a malfunction or a pour pumping function. Also the maintenance or the reliability of pumps is an issue to be observed.

[0005] The purpose of the invention to provide a simple and energy efficient refrigerating system, that is suitable for refrigerant circulation, without using circulation pumps in refrigeration systems.

Explanation of the invention

[0006] This can be achieved with a system as described in the opening paragraph if the system contains pressure generating means supplying refrigerant gas to the receivers at a second pressure level higher than the first pressure level, and where the refrigeration system is provided with a control circuit arranged to control a solenoid valve at the inlet of each receiver for altematingly supplying refrigerant gas to the receivers.

[0007] In this way, it can be achieved that the use of pumps can be avoided by generating a pressure difference from the compressor, and by using that pressure difference to generate a force to pres refrigerant out of a receiver and further through the refrigeration system.

[0008] The refrigerating system according to the invention differs from prior art in having at least one compressor delivering refrigerant at a higher pressure and bypassing the condenser before entering the receivers. The high pressure refrigerant is then used for pressing liquid refrigerant out of the receiver which is not being filled with a cooled refrigerant from the condenser. The pressure difference between the high pressure gas and the normal condensing pressure must be high enough to provide a driving force for the refrigerant through a subsequent number of valves and evaporators before returning to compressors or the condenser.

[0009] In order to enable bypassing at least the first compressor, the piping coming from the outlets of the first and the second compressors may be interconnected through a valve, which valve generates a pressure difference.

[0010] In order to achieve optimal efficiency in the refrigerating system according to the invention, the system may be arranged in a preferred embodiment so that the evaporators are divided into a first group of evaporators for cooling at relatively high temperature and a second group of evaporators for cooling at a relatively low temperature, where the piping is arranged so as to conduct discharged refrigerant from the first group of evaporators directly to the condenser and to conduct discharged refrigerant from the second group of evaporators directly to the inlet of the compressors.

[0011] The system might instead comprise at least a first compressor for generating a first higher pressure level, and at least a second compressor for generating a second lower pressure, where the second compressor is connected to the receivers through controllable valves, and where at least the second compressor is connected to the condenser.

The drawings

[0012] In the following the refrigerating system is described according to figures, where

fig. 1 shows a first embodiment of the invention comprising one compressor, and

fig. 2 shows a second embodiment of the invention.

[0013] Fig. 1 shows a refrigerating system 2 comprising at one compressor 6 where the outlet from the first compressor 6 is through valve 60 connected through piping 8 for supply of warm refrigerant further into piping

10 which leads to a condenser 12, from which piping 14 is connected through valves 68,74 which valves 68,74 are no-return valves for which piping 76,78 leads to receivers 16,18. The outlet of the receivers 16,18 are connected through no-return valves 20,22 to piping 24 which leads to flow restriction means 26,28,30,32 which restriction means might be electronically controlled expansion valves. From the restriction means, the refrigerant is led further to evaporators 34,36,38,40. From the outlet 42,44 from the evaporators 34,36, piping 42,44 are combined in a gas pipe 46 connected to the piping 8 and forming a warm gas pipe 10, which is led to the condenser 12. The outlets 48,50 of the evaporators 38,40 are combined in a piping 52, which contains a cold gas that is led to the inlet of the compressors 6. The compressor 6 at its outlet reaches a pressure P1 where the gas reaches a pressure P2 after passage of valve 60, where P1 is higher than P2. From the compressor 6, a pressure line 62 is connected to a magnetic valve 64,70 so that pressure from the compressor 6 where the pressure is P1 can be delivered through the magnetic valves 64,70 over piping 76,78 to the receivers 16,18.

[0014] In operation, compressors 6 will operate and deliver hot gas at the outlet line 62 at the pressure P1 and also hot gas with a pressure P2 at the line 8 after passage of valve 60. The warm gas in the piping 8 is combined with gas coming from evaporators 34,36 which could be supermarket cooling equipments operating at a temperature which is over zero degrees, which means that a relatively low pressure drop has occurred over the evaporators 34,36 so that the pressure at the outlet from these evaporators are approximately equal to the pressure leaving the compressor 6 after passage of valve 60. Piping 46 is led to a mixing point where piping 46 is combined with piping 8. Gas with a temperature which may be 5 degrees are combined with a warmer gas which may be 40 degrees warm, and a combined flow of warm gas through piping 10 is led to the condenser 12. The outlet from the condenser through line 14 is mostly liquid refrigerant with a pressure, which is still P2. This liquid refrigerant might be led through the line 14 towards the no-return valve 68 and directly into the receiver 16. This receiver 16 is in this situation filled with liquid refrigerant, and in the meantime, pressure at P1 is led through the magnetic valve 70 towards the receiver which also has a no-return valve 74 connected to the liquid refrigerant line 14 but where this return valve is closed because of the pressure situation, high pressure is through line 78 led to the receiver 18 where this pressure P1 is activating the content of liquid refrigerant to flow to the outlet of the receiver 18, and through the no-return valve 22 to the piping 24 and from here to the evaporators 34,36,38,40.

[0015] This situation continues until the receiver 18 is empty which could be detected by detection means or by using a timer (not shown). The detection or the timer means might communicate to an electronic system (also not shown), and when the receiver 18 is empty, the receiver 16 is probably more or less full of a liquid. In this situation, the magnetic valve 70 is closed and the magnetic valve 64 is opened. This leads to a change in the situation so liquid refrigerant is now pressed out by the pressure P1 from the receiver 16 through the one-way valve 20 and further to the evaporators 34,36,38,40 just as described with reference to the other receiver. In this way, the system can operate by changing between an active and an inactive receiver during the whole operation of the system 2.

[0016] In this way, a highly effective refrigeration system is built that has a very limited power demand according to the refrigeration effect that is achieved by the evaporators.

[0017] Fig. 2 shows a refrigerating system 2 comprising compressors 4,5,6 where the outlet from the first compressor 4 is connected through piping 8 for supply of warm refrigerant further into piping 10 which leads to a condenser 12, from which piping 14 is connected through valves 68,74 which valves 68,74 are no-return valves for which piping 76,78 leads to receivers 16,18. The outlet from the receivers 16,18 are connected through no-return valves 20,22 to piping 24 which leads to flow restriction means 26,28,30,32 which restriction means might be electronically controlled expansion valves. From the restriction means, the refrigerant is led further to evaporators 34,36,38,40. From the outlet 42,44 from the evaporators 34,36, piping 42,44 are combined in a gas pipe 46 connected to the piping 8 and forming a warm gas pipe 10 which is led to the condenser 12. The outlets 48,50 from the evaporators 38,40 are combined in a piping 52, which contains a cold gas that is led to the inlet of the compressors 4, 5, 6. The compressor 4 at its outlet reaches a pressure P2 where the compressor 6 at its outlet reaches a pressure P1 where P1 is higher than P2. From the 1 compressor 6, a pressure line 62 is connected to a magnetic valve 64,70 so that pressure from the compressor 6 where the pressure is P2 can be delivered through the magnetic valves 64,70 over piping 76,78 to the receivers 16,18. Magnetic valves 66,72 are connected to the inlet 76,78 to the receivers 16,18, where the magnetic valves 66,72 are connected to tubing 10 leading hot gas towards the condenser 12. Opening magnetic valves 66,77 is used to avoid critical pressure build up in the receiver.

[0018] In operation, at least one of the compressors 4, 5, 6 or maybe further compressors will operate and deliver hot gas at the outlet line 8 at the pressure P2 and also hot gas with a pressure P1 at the line 62. The warm gas in the piping 8 is combined with gas coming from evaporators 34,36 which could be supermarket cooling equipments operating at a temperature which is over zero degrees, which means that a relatively low pressure drop has occurred over the evaporators 34,36 so that the pressure at the outlet from these evaporators are approximately equal to the pressure leaving the compressor 4. Piping 46 is led to a mixing point where piping 46 is combined with piping 8. Gas with a temperature

which may be 5 degrees are combined with a warmer gas which may be 40 degrees warm, and a combined flow of warm gas through piping 10 is led to the condenser 12. The outlet from the condenser through line 14 is mostly liquid refrigerant with a pressure, which is still P2. This liquid refrigerant might be led through the line 14 towards the no-return valve 68 and directly into the receiver 16. This receiver 16 is in this situation filled with liquid refrigerant, and in the meantime, pressure at P1 is led through the magnetic valve 70 towards the receiver which also has a no-return valve 74 connected to the liquid refrigerant line 14 but where this return valve is closed because of the pressure situation, high pressure is through line 78 led to the receiver 18 where this pressure P1 is activating the content of liquid refrigerant to flow to the outlet of the receiver 18, and through the no-return valve 22 to the piping 24 and from here to the evaporators 34,36,38,40.

[0019] This situation continues until the receiver 18 is empty which could be detected by detection means or by using a timer (not shown). The detection or timer means might communicate to an electronic system (also not shown), and when the receiver 18 is empty. The receiver 16 is probably more or less full of a liquid. In this situation, the magnetic valve 70 is closed and the magnetic valve 64 is opened. This leads to a change in the situation so liquid refrigerant is now pressed out by the pressure P2 from the receiver 16 through the one-way valve 20 and further to the evaporators 34,36,38,40 just as described with reference to the other receiver. In this way, the system can operate by changing between an active and an inactive receiver during the whole operation of the system 2.

[0020] Between the outlet of the compressor 6, the pressure line 62 and the outlet of the compressor 4, a valve 60 is placed which in an open situation is shunting between the pressure P1 and P2 so these two pressures are equalised. In this way, also the compressor 6 can be used for producing warm gas for the condenser, and in this way, increase the flow to the condenser if necessary. The valve 60 might be a modulated solenoid valve or a pressure controlled valve where only part of the hot gas delivered from the compressor 6 is delivered through the valve 60. In this way, the pressure P1 is still achieved but most of the hot gas that is produced by the compressor 6 is led through the valve 60 towards the line 8.

[0021] In this way, a highly effective refrigeration system is built, that has a very limited power demand according to the refrigeration effect that is achieved by the evaporators.

Claims

1. A refrigerating system (2) where a refrigerant is conducted in piping by means of pressure produced by at least one compressor (4,5,6), the system including a condenser (12) that may discharge refrigerant into at least two receivers (16,18) through each their pipe branch provided with respective check valves (70,74), the receivers (16,18) being arranged to supply refrigerant to at least one evaporator (34, 36, 38, 40) through a check valves (20, 22) associated with each receiver (16, 18), where at least one compressor (4,6,8) is arranged for supplying gas refrigerant at a first pressure level to the condenser (18), **characterised in that** the system (2) contains pressure generating means (6,60) is supplying refrigerant gas to the receivers (16,18) at a second pressure level higher than the first pressure level, and where the refrigeration system (2) is provided with a control circuit arranged to control a solenoid valve (64,70) at the inlet of each receiver (16,18) for alternatingly supplying refrigerant gas to the receivers (16,18).

2. System according to claim 1, **characterised in that** the piping coming from the outlets of the first compressors (6) is interconnected through a solenoid valve (60) for generating gas at a first higher pressure level and a second lower pressure level.

3. System according to claim 1 or 2, **characterised in that** the evaporators (34,36,38,40) are divided into a first group of evaporators (34, 36) for cooling at relatively high temperature and a second group of evaporators (38,40) for cooling at a relatively low temperature, where the piping is arranged so as to conduct discharged refrigerant from the first group of evaporators (36,38) directly to the condenser (12) and to conduct discharged refrigerant from the second group of evaporators (38,40) directly to the inlet of the compressors (4,5,6).

4. System according to claim 1-3**, characterised in that** the system comprises at least a first compressors (6) for generating a fist higher pressure level, and at lest second compressor (4,5) for generating a second lower pressure, where the first compressor (6) is connected to the receivers (16,18) through controllable valves (64,70), and where at least the second compressor (4,5) is connected to the condenser (12).

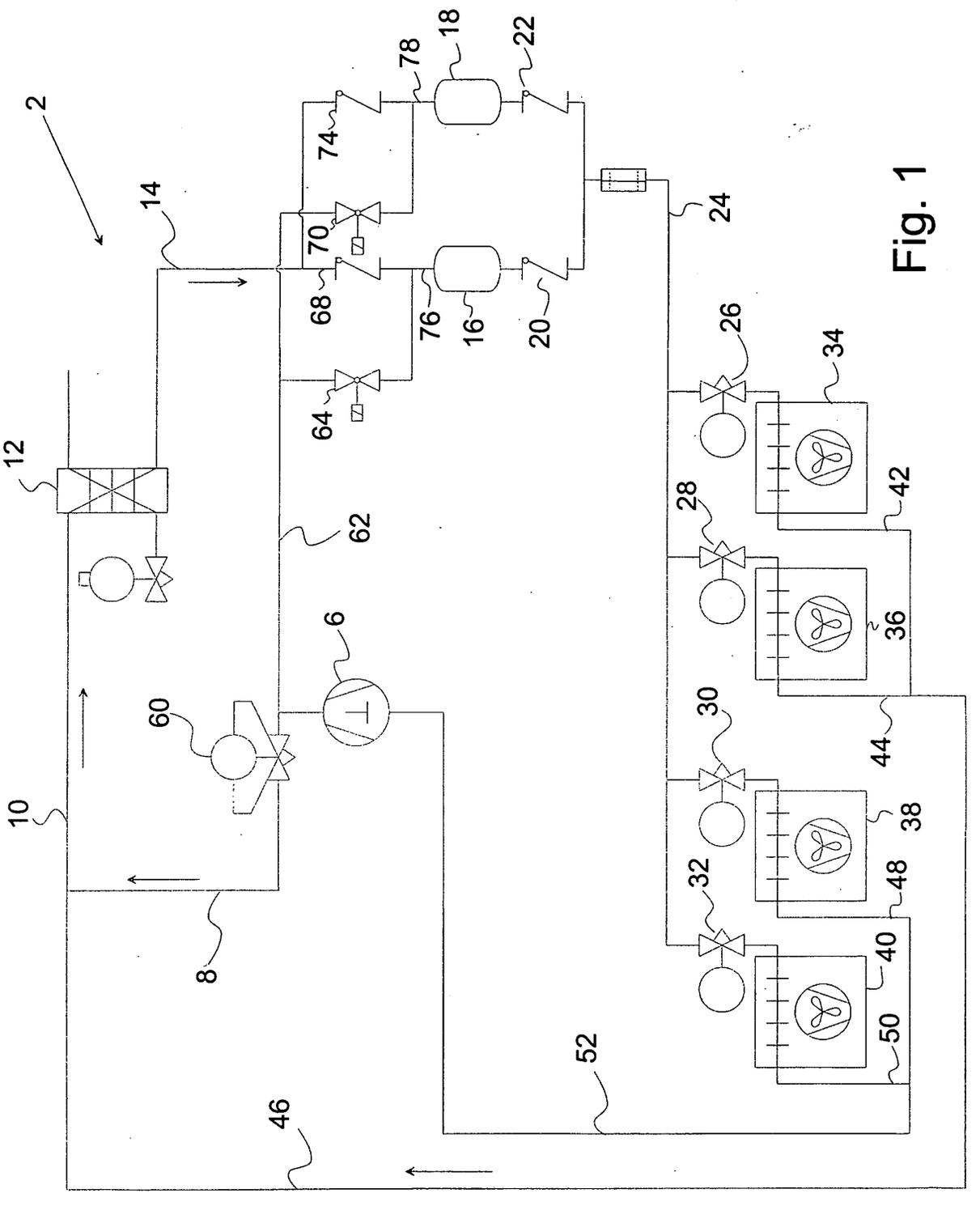
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Fig. 1

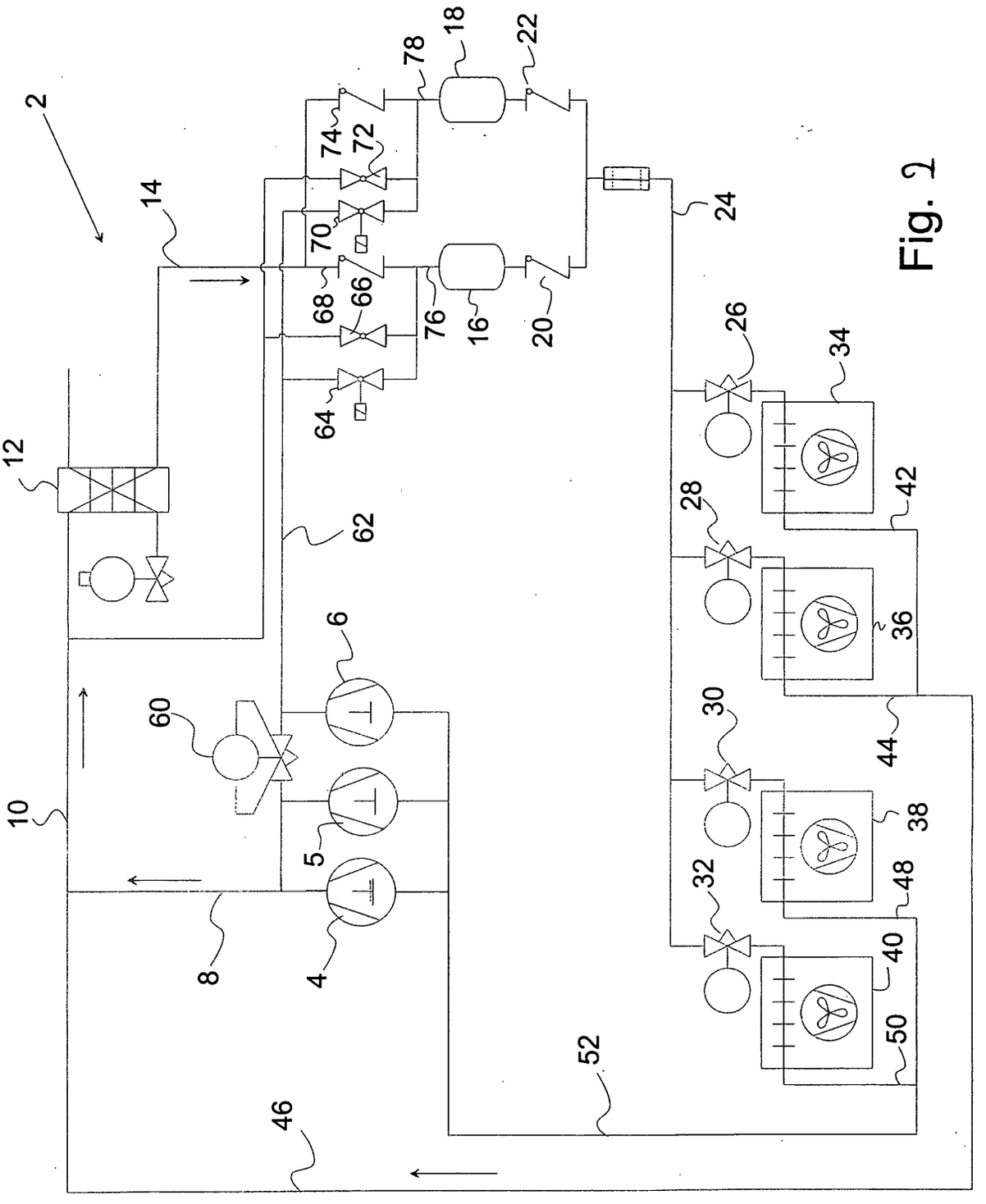
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Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 03 02 7254

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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F25B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 May 2004	Yousufi, S

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