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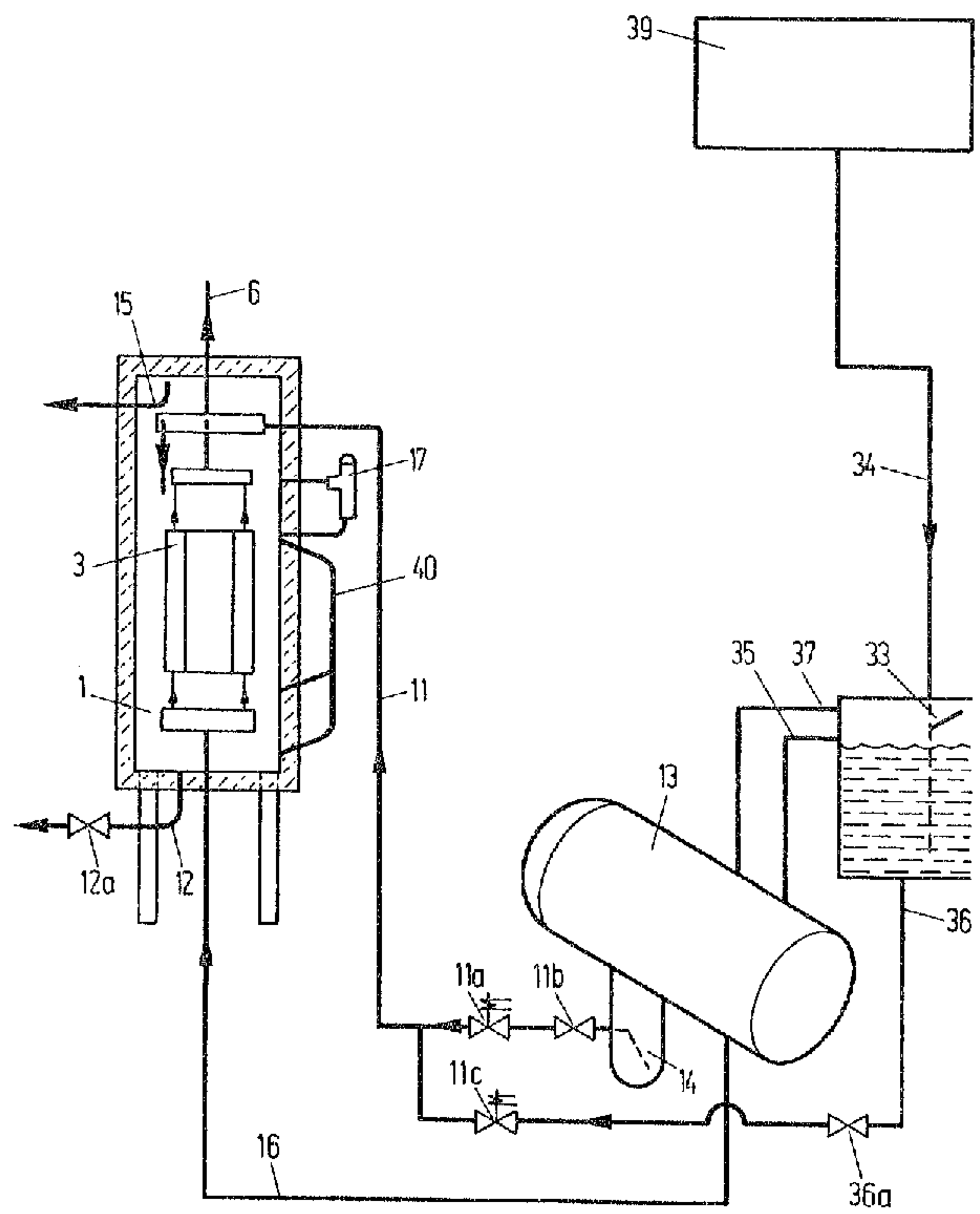
(54) INSTALLATION FRIGORIFIQUE A COMPRESSION AVEC SEPARATEUR D'HUILE

(54) COMPRESSION REFRIGERATING SYSTEM WITH OIL SEPARATOR



(57) Compression refrigerating system with an oil and air separator (1) inserted between the refrigerant receiver (13) and the evaporators (1) of the system, and in which the refrigerant in the mixture of oil and refrigerant by its evaporation in the oil separator (1) contributes to the cooling of the refrigerant circulating towards the evaporators. In a specially advantageous embodiment, the separation of air and oil is fully automatic.

A B S T R A C T

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COMPRESSION REFRIGERATING SYSTEM WITH OIL SEPARATOR

The invention relates to a compression refrigerating system of the kind described in the preamble of claim 1. It is necessary in refrigerating systems of this kind to supply lubricating oil to the compressor from which a certain amount of the oil will be carried through the system by the circulating refrigerant. By continuous supply of lubricant considerable amounts of oil may occur in the refrigerant which results in a reduced cooling capacity. It is therefore of great importance to the economical running of the system to maintain an effective separation of oil and undesired materials from the refrigerant.

US patent specification no. 3.850.009 describes a compression refrigerating system which is provided with an oil separator which in two steps separates the oil from the gaseous refrigerant. This has proved to be less efficient than separating the oil from the liquid refrigerant.

US patent specification no. 2.285.123 describes a refrigerating system in which the oil is separated from the liquid refrigerant by passage through heat exchangers which in a complicated way by means of thermostat valves control the temperature of the mixture of oil and refrigerant in such a way that the oil is separated more easily.

European patent specification no. 0016509 describes an apparatus for separation of oil from a refrigerant in the gaseous phase in which the oil separator is mounted in the refrigerating system between the pressure side of the compressor and the condenser.

DK printed specification no. 148546B describes a freezing or refrigerating system with an oil separator which is characteristic in that the separator is situated under an evaporator and therefore in spite of a complicated construction is able to service only a part of the refrigerating system.

It is an object of the invention to provide a refrigerating system in which the refrigerant is purified in an economical way while it is in the liquid state and during the normal operation of the system. This is obtained according to the invention by a refrigerating system of the kind described in the preamble of claim 1, which is characteristic in details described in the characterizing part of claim 1.

It is by this construction of the refrigerating system achieved that the oil separator in a simple way can be fitted into the system and that the temperature drop achieved in the heat exchanger vessel of the oil separator, and which results from the evaporation of the refrigerant of the oil and refrigerant mixture during the oil separation, is used for cooling the liquid refrigerant which flows to the evaporators of the system through the primary heat exchanger.

An advantageous embodiment of the refrigerating plant according to the invention is constructed in such a way that the separation can take place in several steps in which the first step takes place in a primary vessel which by a supply pipe is connected to the outlet of the condenser for liquid refrigerant and by a discharge pipe is connected to the refrigerant receiver, and besides by an oil discharge pipe with an inserted shut-off valve is connected to the oil sump pipe connection; and in which the last step of the oil separation takes place in the vessel of the heat exchanger. Hereby an almost complete separation of the lubricating oil supplied to the compressor may be obtained.

A further embodiment of the refrigerating plant according to the invention is characteristic in that the heat exchanger vessel of the oil separator is divided into two parts separated by a heat transmitting wall. The first part, which contains the primary heat exchanger, functions as oil separator while the other part, which functions as an air and non-condensable gas separator, contains a secondary heat exchanger, one side of which is connected to the primary heat exchanger in such a way that liquid refrigerant coming from the primary heat exchanger passes through the secondary heat exchanger before it progresses to the evaporators of the system. The other side is connected to the oil sump of the refrigerant receiver and to the first part of the heat exchanger vessel in such a way that the liquid mixture of oil and refrigerant passes from the oil sump through the secondary heat exchanger to the first part of the heat exhanger vessel , while the second part of the heat exchanger vessel has a supply pipe and a return pipe to the refrigerant receiver as well as an air discharge pipe towards the atmosphere. This embodiment of the refrigerating system according to the invention is specially advantageous in systems in which the refrigerant is frequently filled up or exchanged, since the cooling which the 20 - 30 °C hot mixture of refrigerant and air in the container for separating air and noncondensable gas receives from the about -10 °C cold refrigerant, which is separated from the mixture of oil and refrigerant through the heat transmitting wall, causes a quick separation of air and non-condensable gas and thereby a better economy of the entire system. Moreover, the transport of the mixture of oil and refrigerant through the secondary heat exchanger causes that the mixture is introduced into the oil separator part through a comparatively large free fall which, because of the difference in specific gravity between the oil and the refrigerant, contributes to a quick and effective separation.

A further embodiment of the refrigerating system according to the invention is characteristic in that the separation may take place in several steps as in the previous mentioned embodiment and that the heat exhanger vessel of the separator is divided in two parts of which the first part functions as oil separator and the second part functions as separator for air and noncondensable gas as in the previously mentioned embodiment. Hereby both the above mentioned advantages, an enhanced oil separation and a quick and efficient separation of air and noncondensable gas, is achieved. Further embodiments, which are described in the claims, all concern appropriate details of the construction of the refrigerating plant according to the invention.

The invention will be further explained in the following with reference to the drawings, in which

fig. 1 shows schematically an embodiment of the refrigerating plant according to the invention with an oil separator with one step,

fig. 2 shows schematically a second embodiment of the refrigerating plant according to the invention with an oil separator with several steps,

fig. 3 shows schematically a third embodiment of the refrigerating system according to the invention with a combined oil and air separator, and

fig. 4 shows schematically an embodiment of the refrigerating system according to the invention with an oil separator with several steps and with a combined separator for oil and air with equipment for automatic separation of oil and air and noncondensable gas.

Fig. 1 shows schematically a part of the refrigerating plant according to the invention with the connections between the condenser, the refrigerant receiver (13) and the oil separator (1) and a vertical section through the latter. From this it will be apparent the the oil separator is constructed as a vessel (1) which is provided with a layer of heat insulating material (19) which is enclosed in a metallic outer lining (20). In the vessel (1) a primary heat exchanger (3) is mounted, which heat exchanger consists of tubes through which flows liquid refrigerant coming from the refrigerant receiver (13) through a primary pipe connection (16) and continuing through a secondary pipe connection (16') to the supply pipe (6) for the evaporators of the system.

The refrigerant receiver (13) is in the bottom part provided with an oil sump (14) in which the oil containing part of the refrigerant is collected and from where it is conducted to the upper part of the oil separator (1) through an oil sump pipe connection (11) with a shut-off valve (11a) and a magnet valve (11b), the function of which will be explained in the following. By the free fall through the vessel , oil and refrigerant is separated and the oil is collected at the bottom of the vessel from which it may be discharged through an oil discharge pipe (12) with a discharge valve (12a). The refrigerant in the mixture evaporates whereby the temperature in the container drops to about -10 °C. This temperature drop is used to cool the refrigerant flowing towards the evaporators through the primary heat exchanger (3). The refrigerant evaporated from the mixture is conducted from the vessel (1) to the suction side of the compressor through a suction pipe connection (15) and in this way returns to the refrigerating system.

For the control of the level of the mixture of oil and refrigerant in the vessel (1) of the oil separator this container is provided with an electric level regulator (17) which by means of a relay controls a magnet valve (11b) in the oil sump pipe connection (11) in such a way that a suitable amount according to the circumstances is supplied to the vessel (1) of the oil separator.

In the refrigerating system shown schematically in fig. 2 the oil separator is according to the invention constructed in such a way that the separation may take place in two steps of which the first step takes place in a primary vessel (33) which through a supply line (34) is connected to the outlet of the condenser (39) for liquid refrigerant, and through a discharge line (35) is connected to the refrigerant receiver (13). The supply line (34) is passed through the primary container and according to the circumstances, on to a point at a suitable distance above the bottom, while the discharge line (35) is connected at a certain high level in the upper third of the primary vessel (33), which level is sufficient to make room for the oil and the refrigerant to separate in layers by gravitation before the separated refrigerant with a lesser content of oil flows over and is conducted to the bottom of the refrigerant receiver (13).

The oil collected at the bottom of the primary vessel (33) may be conducted to the oil sump pipe connection (11) through a primary oil discharge line (36) with an inserted shut-off valve (36a) and a magnet valve (11c), in such a way that the second step of the oil separation may take place in the heat exchanger vessel (1) in the same way as in the embodiment of the refrigerating plant according to the invention shown in fig. 1. The level of the mixture of oil and refrigerant in the heat exchanger vessel (1) is maintained by the electric level regulator (17) which by means of a time clock controls the two magnet valves (11b, 11c) in the primary oil discharge line (36) and the oil sump pipe connection (11), respectively, in such a way that the discharge of the mixture from the refrigerant receiver (13) and from the primary vessel (33) is adjusted according to the circumstances.

Fig. 3 shows schematically an embodiment of the refrigerating system according to the invention in which the heat exchanger vessel of the oil separator is divided in two separate parts (1a, 2) by a heat transmitting wall (18), of which the first part (1a), which contains the primary heat exchanger (3), functions as an oil separator, while the second part (2), which functions as separator for air and noncondensable gas, contains a secondary heat exchanger (4) which through the secondary and primary pipe connections (16', 16) is connected to the primary heat exchanger (3) and the refrigerant receiver (13) in such a way that the liquid refrigerant passes from the refrigerant receiver (13) through the primary heat exchanger (3) and the secondary heat exchanger (4) and further on to the supply pipe (6) of the evaporators of the system.The other side of the secondary heat exchanger is through the oil sump pipe connection (11) connected to the oil sump (14) of the refrigerant receiver and through a downpipe connection (4a) to the first part of the heat exchanger vessel (1a) in such a way that the liquid mixture of oil and refrigerant passes from the oil sump (14) through the secondary heat exchanger (4) and by a free fall through the downpipe (4a) to the first part of the heat exchanger vessel , which otherwise functions in the same way as the oil separator shown in fig. 1.

The second part of the heat exchanger vessel (2) is at the lower part connected to the upper part of the refrigerant receiver (13) through a line (9) with an inserted shut-off valve (9a), and it is furthermore at the upper part through a water filter (7) connected to the atmosphere by means of an air discharge line (8) with a discharge valve (8a). The lower part is furthermore by a return pipeline (10) connected to the lower part of the refrigerant receiver (13). Hereby the mixture of air, noncondensable gas, if any, and refrigerant passes from the refrigerant receiver to the air separator part in which the air is separated owing to the cooling from the secondary heat exchanger (4) and the cooling through the heat transmitting wall between the two parts (1a, 2) of the vessel. The refrigerant collects at the bottom of part (2) and is conducted back to the refrigerant receiver, while the air and noncondensable gas rises and is discharged into the atmosphere.

The embodiment of the refrigerating system according to the invention shown schematically in fig. 4 is a combination of the embodiments shown in figs. 2 and 3, as the oil separation may take place in two steps and the heat exchanger vessel is divided in two parts (1a, 2) so that both oil and air and noncondensable gas may be separated. In this combination the second part of the heat exchanger vessel (2) is connected to the upper part of the primary vessel (33) by a line (9') with an inserted shut-off valve (9a'), in stead of being connected to the upper part of the refrigerant receiver (13), while this receiver on the other hand is connected to the upper part of the primary vessel (33) by means of the connecting line (37). Thereby the mixture of air and refrigerant may pass from the refrigerant receiver (13) to the primary vessel (33) and together with mixture of air and refrigerant which is collected in this vessel , pass on to the air separator, which functions as explained above.

This embodiment is furthermore arranged in such a way that the separation both of oil and of air and noncondensable gas may take place automatically. The automatic oil separation is obtained by providing the first part (1a) of the heat exchanger vessel with an uninsulated steel standpipe (40) for the indication of the level of the liquid in the vessel together with a differential thermostat (21) with two detectors (22, 23) mounted in such a way on the standpipe that the variation of the oil level which at the same time produces a perceptible difference in temperature of the liquid in the standpipe, may control the opening and the closing of a magnet valve (24) in the oil discharge pipe (12).

The automatic separation of air and noncondensable gas is achieved by providing the second part (2) of the heat exchanger vessel with a differential thermostat (25) which has its first detector (26) mounted in the second part (2) of the heat exchanger vessel , while its second detector (27) is mounted in the primary pipe connection (16) between the refrigerant receiver (13) and the primary heat exchanger (3). By means of a relay this thermostat controls a third magnet valve (28) which is mounted in the air discharge pipe connection (8), in such a way that the valve opens when the air or noncondensable gas acts upon the first detector (26) and closes again when the space has been ventilated, by the warmer refrigerant in the primary pipe connection (16) acting upon the the second detector (27).

By the embodiments shown in figs. 3 and 4 it is possible, when the system is sufficiently ventilated, to achieve that the oil separator alone will be functioning by closing the shut-off valves (9a, 10a) in respectively the pipe connection (9) between the primary vessel (33) and the second part (2) of the heat exchanger vessel and the pipe connection (10) between the said part of the vessel and the refrigerant receiver (13). Hereby a more economical running of the system may be achieved as the cooling, which is produced by the evaporation of the refrigerant in the mixture of oil and refrigerant, will be employed fully for cooling the refrigerant which flows towards the evaporators of the system through the primary heat exchanger.

CLAIMS

1. Compression refrigerating system with a compressor which is driven by a motor and compresses a refrigerant, which is condensed in a condenser (39) and collected in a refrigerant receiver (13), from which it is passed to evaporators placed in parts of the system which are to be cooled, which system is furthermore provided with devices for separating undesired materials in the refrigerant, characterised in that it has an oil separator with a heat exchanger vessel (1) comprising a primary heat exchanger (3) whose supply side is connected through a primary pipe connection (16) to an outlet for liquid refrigerant of the refrigerant receiver (13), and whose discharge side is connected to a supply pipe (6) of the evaporators of the system; while the vessel (1) is connected through an oil sump pipe connection to an oil sump (14) in a bottom part of the refrigerant receiver (13) and through a suction pipe connection (15) to a suction side of the compressor, and in a lower part is provided with an oil discharge pipe (12) and an oil discharge valve (12a).

2. Refrigerating system according to claim 1, characterised in that the oil separator is constructed in such a way that the separation may take place in several steps of which the first step takes place in a primary vessel (33) which through a supply line (34) is connected to the outlet for liquid refrigerant of the condenser, and through a discharge line (35) is connected to the refrigerant receiver (13), and besides through an oil discharge pipe (36) with an inserted shut-off valve (36a) is connected to an oil sump pipe connection (11), and in that the last step of the oil separation takes place in the heat exchanger vessel (1).

3. Refrigerating system according to claim 1, characterised in that the oil separator's heat exchanger vessel (1) is divided in two parts (1a, 2) sepa-

rated by a heat transmitting wall, of which the first part (1a), which contains the primary heat exchanger (3), functions as oil separator, while the second part (2), which functions as a separator for air and noncondensable gas, contains a secondary heat exchanger (4) one side of which is connected to the primary heat exchanger (3) in such a way that refrigerant coming from this heat exchanger passes through the second heat exchanger (4) before it proceeds to the evaporators of the system, while the other side of the secondary heat exchanger through the oil sump pipe connection (11) is connected to the oil sump (14) of the refrigerant receiver and through a down-pipe connection (4a) is connected to the first part of the heat exchanger vessel (1a) so that the liquid mixture of oil and refrigerant flows from the oil sump (14) through the secondary heat exchanger (4) to the first part (1a) of the heat exchanger vessel , while the second part (2) of the heat exchanger vessel through a line (9) in the lower part is connected to the upper part of the refrigerant receiver, and in the upper part through an air discharge line is connected to the atmosphere and through a return pipeline (10) to the refrigerant receiver (13).

4. Refrigerating system according to claim 3, characterised in that the oil separator is arranged so that the separation may take place in several steps of which the first step takes place in a primary vessel (33), which through a line (34) is connected to the outlet for liquid refrigerant from the condenser, and through a discharge line (35) is connected to the refrigerant receiver (13), and besides through an oil and refrigerant discharge line (36) for the separated mixture of oil and refrigerant is connected to the oil sump pipe connection (11), and in that the last step of the oil separation takes place in the heat exchanger vessel (1a) of the oil separator.

5. Refrigerating system according to claim 4, characterised in that the primary vessel (33) of the oil

separator is placed above the refrigerant receiver (13) and that the supply line (34) is passed through the vessel (33) towards its lower part, and that its discharge line (35) from the upper third of the vessel is passed through the refrigerant receiver (13) to the lower part of this vessel , that the upper parts of the primary vessel (34) and the refrigerant receiver (13) are connected through a line (37) for the separation of air and noncondensable gas, and that the second part (2) of the heat exchanger vessel is connected to the upper part of the primary vessel (33) through a line (9') with an inserted valve (9a').

6. Refrigerating system according to claims 1, 2, 3, and 4 characterised in that the heat exchanger vessel (1) is insulated with a heat insulating material (19) which has a metallic outer lining (20).

7. Refrigerating system according to claims 1, 2, 3, and 4, characterised in that the heat exchanger vessel (1) has an uninsulated standpipe (40) for the indication of the level of the liquid in the vessel .

8. Refrigerating system according to claims 1 and 3, characterised in that the first part (1a) of the heat exchanger vessel of the oil separator is provided with an electric level regulator (17) which by means of a relay controls a magnet valve (11b) in the oil sump pipeline (11) in order to maintain a previously determined liquid level in the vessel part (1a).

9. Refrigerating system according to claim 1 and 3, characterised in that the first part (1a) of the heat exchanger vessel of the oil separator is provided with a float valve in order to maintain a previously determined liquid level in the vessel part (1a).

10. Refrigerating system according to claims 2 and 4,

characterised in that the first part (1a) of the heat exchanger vessel of the oil separator is provided with an electronic level regulator (17) which through a relay by means of a time clock controls two magnet valves (11b, 11c), respectively in the oil sump pipe connection (11) and in the oil discharge pipe (36) of the primary vessel , so that in order to maintain a previously determined liquid level in the vessel part (1a) a mixture of oil and refrigerant is alternately supplied from the primary vessel of the oil separator and from the oil sump (14) of the refrigerant receiver.

11. Refrigerating system according to claims 1, 2, 3 and 4, characterised in that the heat exchanger vessel (1a) of the oil separator is provided with a standpipe (40) for the indication of the oil level in the vessel , and a differential thermostat which has a first detector (22) and a second detector (23) mounted in such a way on the standpipe that the thermostat by variations of the oil level in the pipe by means of a relay may control the opening and closing of a magnet valve (24) in the oil discharge pipe (12).

12. Refrigerating system according to claims 3, 4 and 5, characterised in that the second part (2) of the heat exchanger vessel of the oil separator is provided with a differential thermostat (25) which has a first detector (26) placed inside the vessel (2) at a level determined according to the circumstances, and a second detector (27) mounted in the primary pipe connection (16) between the refrigerant receiver (13) and the primary heat exchanger (3) in such a way that the thermostat by means of a relay may control the opening and the closing of a magnet valve (28) which is mounted in the air discharge pipe connection (8).

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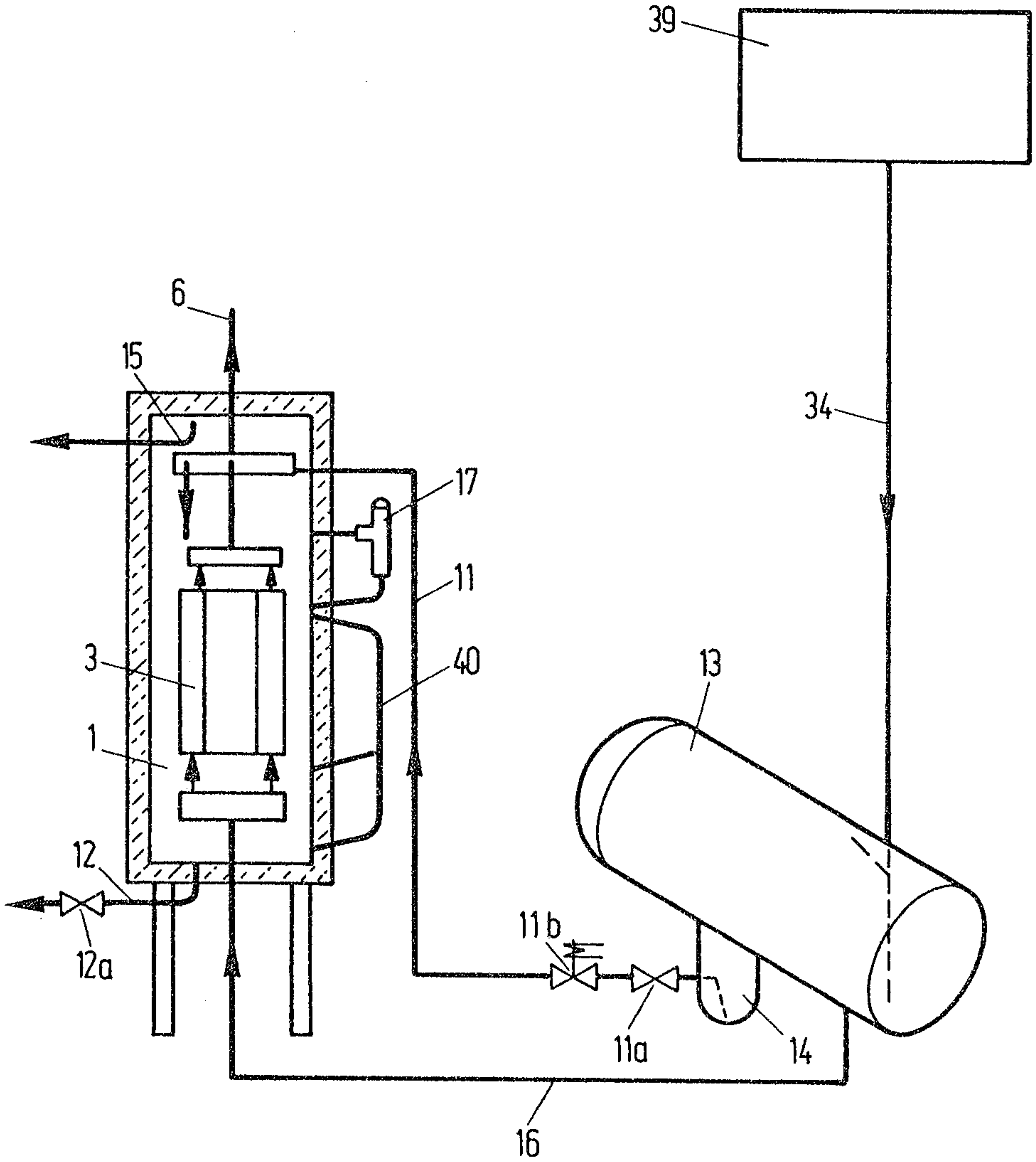

Fig. 1

By: Rogers, Bereskin & Parr

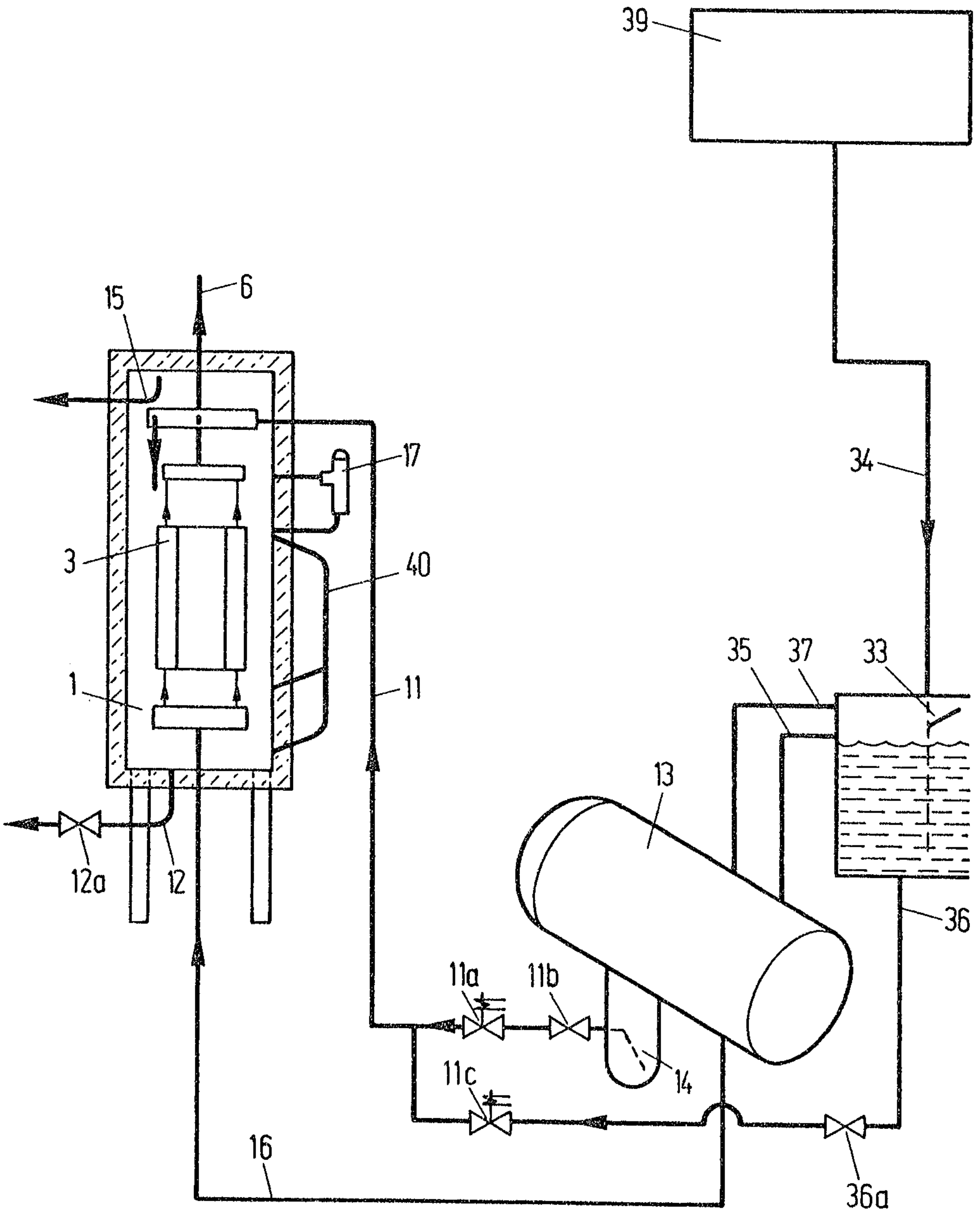

Fig. 2

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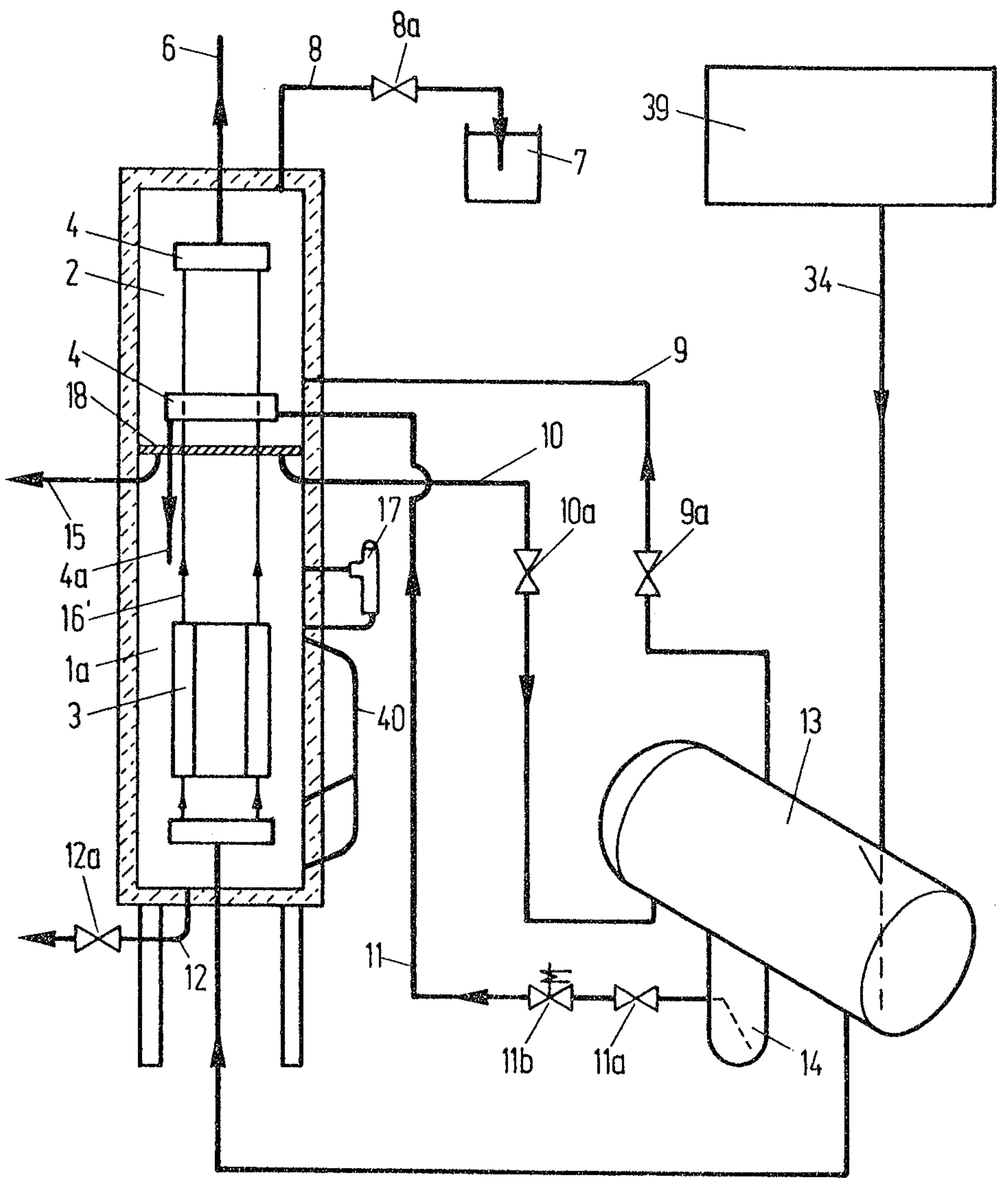

Fig. 3

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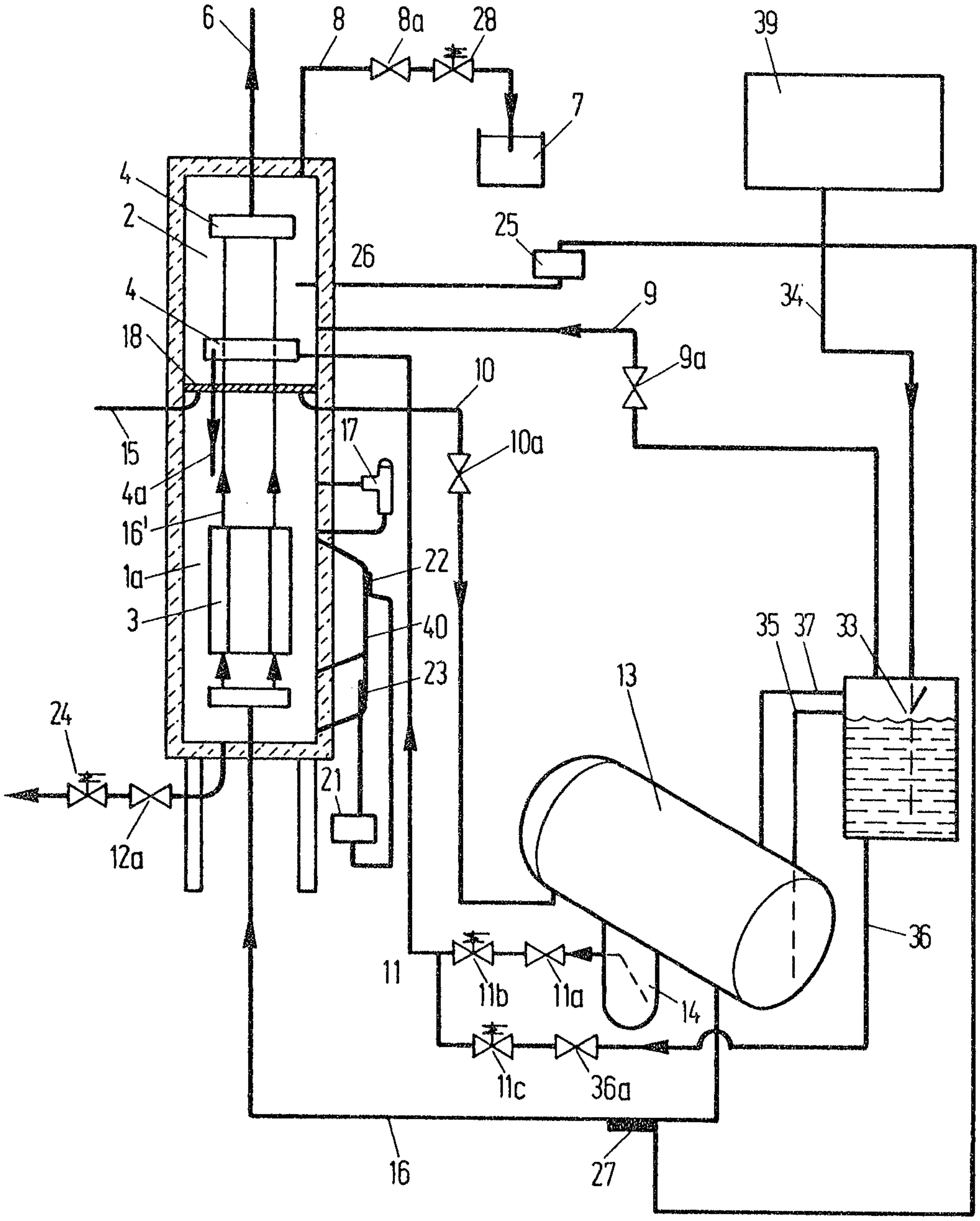
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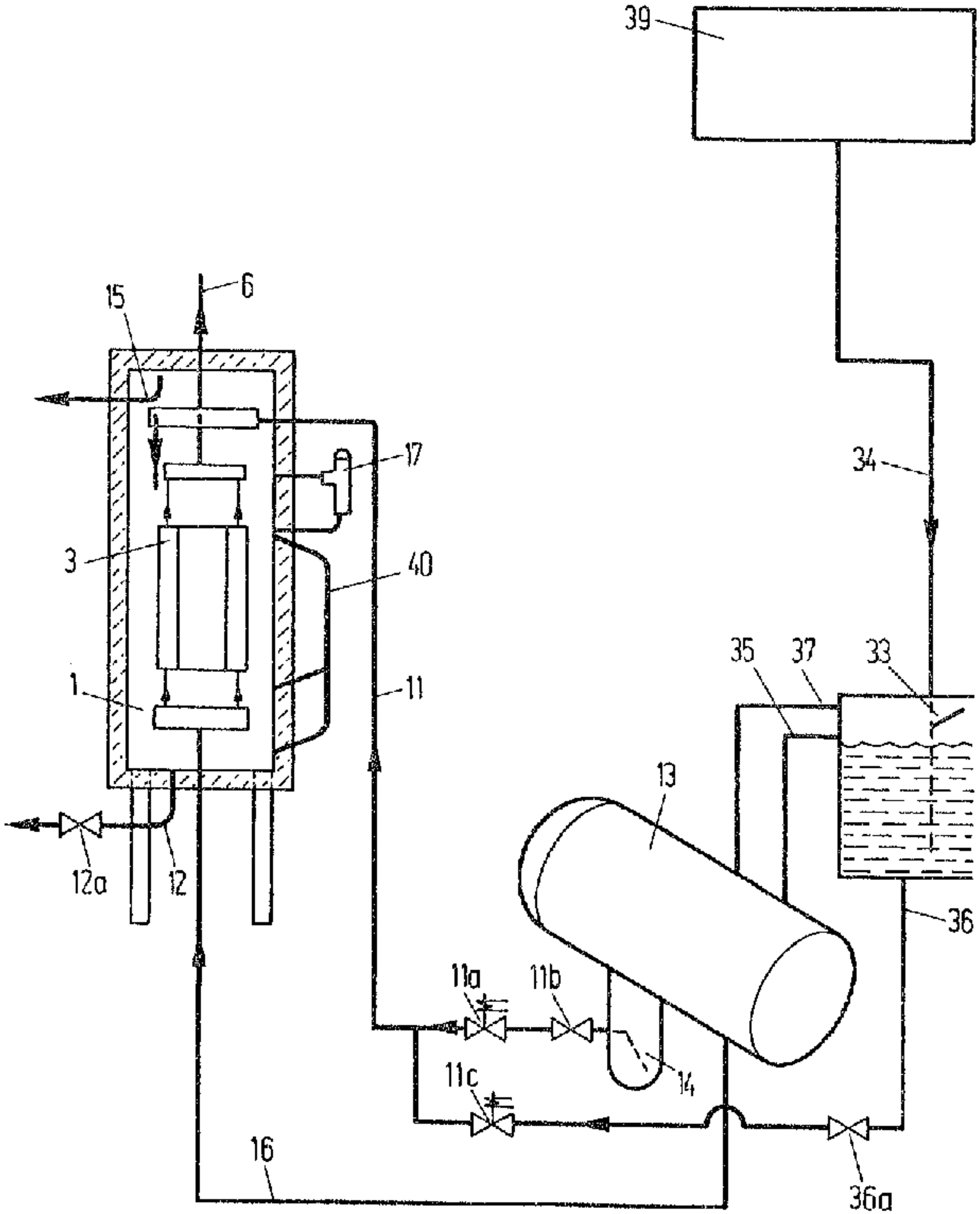
Fig. 4



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