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(73) Patenthaver: **Firma DILO Armaturen und Anlagen GmbH, Frundsbergstrasse 36, 87727 Babenhausen, Tyskland**

(72) Opfinder: **KOHLER, Robert, Heckenweg 4, 89297 Roggenburg, Tyskland**
GESTLE, Mathias, Gartenstraße 17, 89293 Kellmünz, Tyskland
Sieber, Peter, Neue Straße 2, 89281 Altenstadt, Tyskland

(74) Fuldmægtig i Danmark: **Plougmann Vingtoft A/S, Strandvejen 70, 2900 Hellerup, Danmark**

(54) Benævnelse: **SERVICEINDRETNING TIL ANVENDELSE VED VEDLIGEHOLDELSE AF ELEKTRISKE FORDELINGSANLÆG ISOLERET MED EN ISOLERENDE GAS MED FLERE KOMPONENTER**

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SERVICE DEVICE FOR USE DURING MAINTENANCE OF ELECTRICAL SWITCHGEARS INSULATED USING A MULTI-COMPONENT INSULATING GAS

The invention relates to a service device for a multi-component insulating gas, in particular for use in the maintenance of electrical switchgears. The invention further relates to a method for handling a multi-component insulating gas, in particular for the maintenance of electrical switchgears.

In electrical switchgears, arcs, which can occur during switching operations with higher voltages, pose a problem for the durability of such systems. The switching elements are quickly damaged or destroyed by arcs. For this reason, insulating gases are used in so-called gas-insulated switchgears, which reduce or prevent the occurrence of arcs. Gas-insulated switchgears have a hermetically delimited plant room, from which the air is first removed during start-up and the plant room is then filled with the insulating gas.

When servicing gas-insulated switchgears, the insulating gas located in the plant room must be removed from the plant room before the maintenance can be carried out. After maintenance, the insulating gas must then be transported back into the plant room. Various service devices are commercially obtainable for handling insulating gases in this way.

Sulphur hexafluoride (SF6) is a very inert gas, which due to its electrically insulating properties is ideal as an insulating gas for switchgears. However, sulphur hexafluoride is also a greenhouse gas. For this reason, the use of sulphur hexafluoride should be reduced. Recently, various gas mixtures with similarly good insulating properties have been known as replacements for sulphur hexafluoride as the insulating gas. Such gas mixtures still partly contain sulphur hexafluoride as a partial component, while other gas mixtures are already completely free of sulphur hexafluoride. The exact mixing ratio is important for the function of all these gas mixtures.

A system is known from JP 2000 059 934 A with which an insulating gas consisting exclusively of sulphur hexafluoride can be removed from an electrical switchgear and returned to it. In this system, the sulphur hexafluoride is compressed during removal, cooled and supplied in liquid form from the cooler to a storage container. During the recirculation, the sulphur hexafluoride is first brought in liquid form from a storage container to an evaporator, where it is processed and converted into a gaseous state. A disadvantage of this system is that it is unsuitable for insulating gases which consist of a gas mixture. Individual components of the gas mixture can condense before other components both during removal from the switchgear and during recirculation, so that separation takes place and the insulating gas no longer has the same composition after recirculation as when it was removed from the switchgear.

From WO 2014/037396 A1 a device and a method are known with which an electrical switchgear can be filled with an insulating gas consisting of a gas mixture. With the technology disclosed here, a switchgear can be filled with insulating gas mixed for the first time. However, this technology does not allow maintenance of switchgears that are already filled with an insulating gas consisting of a gas mixture, since it is not possible to remove and recirculate a gas mixture that is already located in the switchgears.

It is the object of the invention to create a possibility for handling multi-component insulating gases.

This object is achieved by a service device for a multi-component insulating gas according to claim 1.

The service device for a multi-component insulating gas for use in the maintenance of electrical switchgears with a plant room includes

- a compressor with a downstream cooler,
- a storage container,
- wherein the service device is connected or connectable to a plant room,

wherein the compressor compresses the insulating gas when it is removed from the plant room, wherein all components of the insulating gas in the compressor remain in the gaseous state and the cooler is regulated by a controller so that the insulating gas is condensed, if possible, only in the storage container and a storage heating device is provided for the storage container and when filling the plant room the storage heating device heats the insulating gas to a temperature above the critical temperature of all components of the insulating gas, wherein in particular a line heating device is provided which at least partially heats the pipeline between the storage container and the plant room and/or elements in the pipeline, such as filter housings or the like. A service device according to the invention for the maintenance of electrical switchgears is connected or connectable to a plant room of the switchgears. The service device can either be fixedly installed on the switchgear, wherein a fixedly and permanently connected flange connection between the switchgear and the service device is provided, or the service device can be designed as a mobile device which is only connected to the switchgear during maintenance. In the case of a mobile service device, an easily detachable coupling between the service device and the switchgear is more suitable as a connection in order to keep the working time required to connect the service device to a minimum. Of course, mobile service devices can also be connected to permanent flange connections and fixedly installed service devices using quick couplings to the switchgear.

A service device according to the invention also has a compressor with a downstream cooler. When the insulating gas is removed from the plant room, the compressor sucks in the insulating gas and then compresses it. The downstream cooler is used to cool the insulating gas heated during the compression in the compressor. When the pressure in the compressor increases, it could happen that one or more components of the insulating gas change from the gaseous to the liquid state. This phase transition occurs with certain combinations of temperature and pressure. The phase transition also occurs with different gases, and thus also with the different components of the insulating gas, at different points. These points are each defined by pressure and temperature. A service device according to the invention is suitable for removing and filling a wide variety of insulating gases from or into a switchgear. A service device according to the invention can thus be used to move the sulphur hexafluoride known from the prior art. In the case of such a one-component insulating gas, the problem described above of the separation of individual components does not exist. To reduce climate-damaging sulphur hexafluoride, there are gas mixtures which only contain a portion of sulphur hexafluoride and the remaining portion of which is formed by another gas. The problem of separation of the components already arises as soon as a component liquefies when the insulating gas mixture is removed or filled from a switchgear. Accordingly, a service device according to the invention is advantageous even when handling insulating gas mixtures which contain sulphur hexafluoride to a certain proportion. For some time now, insulating gases that are free of sulphur hexafluoride have also been used. These gases are also made up of multiple components. With these gases in particular, it is particularly important to maintain the exact mixing ratio of the individual components. A service device according to the invention is therefore particularly suitable for such multi-component insulating gases which are free from sulphur hexafluoride. Such insulating gases mostly use N_2 or CO_2 as the carrier component. For this purpose, they contain one or more insulating gases as additional components. C5 ketone, HFO1234ze, HFO1234yf or fluoronitrile, for example, is suitable as such an additional component. Some gas mixtures suitable as insulating gas, which are free of sulphur hexafluoride, are listed below together with suitable mixing ratios:

Carrier component		Additional component	
N_2	97%	C5 ketone	3%
N_2	67%	HFO1234ze	33%
N_2	97%	HFO1234yf	3%
N_2	70%	HFO1234yf	30%
N_2	47%	HFO1234yf	53%
CO_2	47%	HFO1234yf	53%
CO_2	84.2%	Fluoronitrile	15.8%
CO_2	90%	Fluoronitrile	10%

Liquefying individual components of the insulating gas in the compressor would have several disadvantages. On the one hand, the almost incompressible liquid phase in the compressor would be disruptive to its operation and would have to be removed from the compressor via additional, complex measures. On the other hand, the liquefaction of individual components of the insulating gas would lead to a change in the mixing ratio of the components. The liquefied components would be lost to the insulating gas and only the remaining gaseous components would be transported further in the service device. It has been found that a changed mixing ratio of the components leads to changed insulating properties of the gas mixture, which can have serious consequences for the function of the switchgear. A maintenance method in a gas-insulated switchgear in which there is a change in the mixing ratio of the insulating gas therefore represents a deterioration in the insulating effect of the gas and thus the function of the entire switchgear. Such a change in the mixing ratio of the components of the insulating gas would have a serious effect on the electrical properties of the insulating gas and should therefore be avoided at all costs. To avoid these problems, the compressor of a service device according to the invention is operated such that all components of the insulating gas remain in the gaseous phase during the entire compression process. A service device further comprises a cooler, which is arranged downstream of the compressor in the flow direction of the insulating gas. This cooler has the task of cooling the insulating gas heated during the compression process. Cooling, like an increase in pressure, could lead to a phase transition of one or more components of the insulating gas into the liquid state. The cooler of a service device according to the invention is therefore regulated in such a way that cooling only takes place to such an extent that all components of the insulating gas are still in the gaseous phase when they leave the cooler. The cooler can be provided at various locations or positions in the course of the line along the path of the insulating gas from the compressor to the storage container. Since many compressors obtainable commercially have a fixedly installed cooler on their outlet side, it is particularly simple to use this cooler, which is arranged directly after the compressor, in a service device according to the invention. However, it is also possible to place the cooler further away from the compressor. An arrangement of the cooler further away from the compressor in turn has the advantage that the insulating gas heated up after the compression is particularly far away from the condensation point of all its components due to its elevated temperature. This distance to the condensation point offers great security against the liquefaction of individual components on the way from the compressor to the storage container, where further system components, such as filters or the like, can be arranged.

It is therefore advantageously provided that the cooler is integrated with the compressor, in particular is designed in a common frame or housing, or that the cooler is separated from the compressor, in particular is provided in the vicinity of the storage container.

Near the storage container is to be understood to mean that the cooler is located between the storage container and the compressor at least in the half of the line which faces the storage container, in particular in the last 5, 10, 20 or 30% of this line length.

A service device according to the invention also has or can be connected to a storage container, which is also included in the invention. The insulating gas is (temporarily) stored in the storage container after it has been removed from the plant room of the switchgear.

Space-saving storage in the liquid physical state is particularly favourable for storing the insulating gas. It is therefore desirable to ensure that the insulating gas changes to the liquid state when it reaches the storage container. According to the invention, the gaseous transport of the insulating gas and the subsequent liquid storage are achieved by regulating the pressure and temperature of the insulating gas in the compressor or cooler in such a way that the insulating gas and all its components are located just before the condensation point after leaving the cooler. On the last part of the route and in the storage container, the insulating gas then cools further, which ultimately leads to condensation of all components in the storage container. The service device is regulated in such a way that the transition from the gaseous to the liquid phase, the condensation, if possible, only takes place in the storage container. However, it is of little importance for the mixing ratio of the insulating gas if one or more components are already condensed in the line system between the cooler and the storage container. At this point, the line system is designed so that even liquefied components get into the storage container in liquid form, where then a renewed admixture with the remaining components condensing there takes place.

It is particularly advantageous in the case of a service device according to the invention that the compressor is operated by a corresponding regulation in the optimum working range without the creation of a liquid component, and at the same time there is no separation of the insulating gas by the removal process from the plant room of a switchgear.

A service device according to the invention for a multi-component insulating gas has, in addition to a compressor and a storage container, a storage heating device which heats the storage container if necessary. As already described above, the service device is connected or connectable to a plant room of an electrical switchgear. The service device can be fixedly connected to the switchgear or can be designed as a mobile device which is connected or attached to the plant room only for maintenance of the switchgear. The insulating gas is (temporarily) stored in a storage container of the service device or, in the case of using a freshly supplied insulating gas, transferred to this storage container before filling the plant room of the switchgear. The insulating gas is stored in the storage container in the liquid state. This has the advantage that the volume of the insulating gas is significantly less than in the gaseous phase and so significantly less space is required for storage. The storage of the insulating gas in the storage container can, however, also take place in two phases, namely with part of the insulating gas in liquid form and another part of the insulating gas in the gaseous state. This state can occur, for example, if there is only a small amount of insulating gas in the storage container and the pressure and/or temperature in the storage container is close to the evaporation point of one or more components of the insulating gas.

Before or during the filling of the plant room with insulating gas using a service device according to the invention, the storage heating device heats the insulating gas stored in liquid form to a temperature which is above the critical temperature of all components of the insulating gas. Critical temperature, in accordance with current specialist literature, is to be understood as the temperature above which no liquid phase of a substance or mixture of substances can occur regardless of the prevailing pressure. The fact that a service device according to the invention heats the insulating gas to a temperature above the critical temperature of all components of the insulating gas before it is transported into the plant room of the switchgear ensures that no component changes to the liquid state during transport and thus does not lead to a change in the mixing ratio of the individual components of the insulating gas towards each other. A service device according to the invention therefore offers the advantage that the insulating gas arrives in the plant room with the same, unchanged mixing ratio of its individual components to one another, based on the mixing ratio in the storage container. This ensures that the actual electrical properties of the insulating gas after filling the plant room correspond to the properties that are required for the safe operation of the switchgear.

It is possible to design a service device according to the invention in accordance with the described embodiments as a pure removal device for insulating gas from the plant room of a switchgear. In addition, from the described embodiments, a service device can also be designed, which only serves to fill a plant room with insulating gas. Finally, it is also possible to combine different embodiments with one another and thus design a service device, which, in a single embodiment, is both suitable for extracting multi-component insulating gas from a switchgear and is equally suitable for filling or returning insulating gas to the plant room of a switchgear.

In a preferred embodiment of the proposal it is provided that the storage container is designed as an exchangeable gas cylinder or that the storage container is arranged fixedly on the service device. In this embodiment, an exchangeable gas cylinder is used as the storage container. This has the advantage that larger quantities of insulating gas can be distributed over several gas cylinders that can be exchangeable quickly and easily. The use of a common or standardised type of gas cylinder, which is readily commercially obtainable, is particularly favourable. As a result, additional storage space can be easily obtained on site if there is an unplanned need for more space, without having to rely on special parts. The use of an exchangeable gas cylinder as a storage container also facilitates the transport or exchange of insulating gas between different switchgears. The gas can then be transported independently of the service device. As an alternative to the exchangeable gas cylinder, the insulating gas in the service device can also be (temporarily) stored in a fixedly attached storage container. The provision of a fixedly attached storage container has the advantage that all the necessary components of the service device are compactly installed in one device, which is particularly practical in the case of service devices used in mobile applications. It is also possible to provide one or more connections for exchangeable gas cylinders in addition to a fixedly installed storage container. In this combination, the advantages of both embodiments for the storage container are combined in a single device.

According to the invention it is provided that a line heating device is provided which at least partially heats the pipeline between the storage container and the plant room and/or elements in the pipeline, such as filter housings or the like. In a further embodiment of a service device, a line heating device is provided in addition to the storage heating device. This line heating device heats at least parts of the pipeline system, which runs in the service device from the storage container to the plant room of the switchgear to be filled. The line heating device can also be designed such that it additionally or alternatively heats elements in the pipeline. Such elements can be, for example, filter housings, pressure reducers, valves, couplings or the like. The task of such a line heating device is to ensure that the insulating gas heated in the storage container to a temperature above the critical temperature of all its components does not cool down on its way to the switchgear to a temperature below the critical temperature of all components. A cooling of the insulating gas to a temperature below this critical point could again lead to liquefaction of individual components, which in turn would result in a change in the mixing ratio of the components of the insulating gas and should be avoided. For example, it is possible to provide several temperature sensors on the way from the storage container to the plant room, which report the current temperature of the insulating gas to a controller. If it is determined that the temperature drops to near a critical temperature, the line heating device is activated and the temperature of the insulating gas is increased again. Of course, it is also possible to provide several line heating devices, which is advantageous, for example, in cold climatic conditions. Furthermore, it is possible to make the connecting pipelines heatable in themselves.

It is skilfully provided that a controller is provided which regulates the operating point of the compressor and/or cooler as a function of at least one current parameter of the insulating gas measured by a sensor and/or the controller regulates the operating point of the storage heating device as a function of at least one current parameter of the insulating gas measured by a sensor. In this embodiment of the invention, a controller is provided in the service device, which takes over various regulating tasks. Such a controller regulates, for example, the operating point of the compressor when the insulating gas is removed from the plant room. At least one parameter of the multi-component insulating gas is used as the input variable for regulating the compressor. This at least one parameter is detected by one or more sensors and transmitted to the controller via signal lines. Of course, it is also possible to use several parameters of the insulating gas as input variables for a regulation. Possible parameters are pressure, temperature, density, flow rate or the like. The parameters determined can also be used to regulate the operating point of the cooler downstream of the compressor. It is particularly advantageous in such a regulation that the operating points of the compressor and/or cooler are always adjusted to the currently measured parameters. This ensures that the mixing ratio of the individual components of the insulating gas is kept constant even when environmental conditions, such as the outside temperature, change. Through the regulation, all operating points are continuously and optimally adapted to the environmental conditions and this ensures a safe and stable function of the service device. In the same way, a storage heating device can be regulated in its operating point using a controller. The storage heating device is used to heat the insulating gas in the storage container to a temperature above the critical temperature of all components. This heating can be carried out particularly favourably with the aid of a regulating circuit, in that one or more temperature sensors are provided in the storage container and a controller regulates the heating power or the operating point of the storage heating device as a function of the data determined by the temperature sensors. Of course, it is also possible to connect further components or units of the service device to the controller and thus to form further regulation loops. In addition, it is possible to connect components to the controller that are simply controlled. These could be valves, for example, for which no separate sensor is provided for the feedback of actual information.

Furthermore, it is provided that an evacuation pump is provided, which serves to evacuate the plant room. In this embodiment of the invention, an evacuation pump is provided which evacuates the plant room of the electrical switchgear before it is filled with insulating gas. This means that this evacuation pump removes the air from the plant room. The insulation properties of air are significantly worse than those of insulating gas. If the air were to remain in the plant room before it was filled with insulating gas, it would dilute the filled insulating gas and thus impair its insulation properties. The evacuation pump therefore first creates a vacuum in the plant room, so that no or only a very small proportion of air remains in it. The insulating gas is then filled into the plant room using the service device. The evacuation pump is arranged in the service device in such a way that part of the pipeline system of the service device can be blocked by valves so that the evacuated air can only take the route to the evacuation pump and cannot flow in the direction of the compressor, cooler or storage container. After the evacuation method, the route to the evacuation pump in the pipeline system of the service device can be closed again using valves so that there is no longer any access to the evacuation pump while the switchgear is being filled with insulating gas.

It is advantageously provided that an in particular dry-running, oil-free vacuum pump is provided, which is arranged upstream of the compressor in the flow direction of the insulating gas. In this embodiment, a vacuum pump is provided, which serves to extract the insulating gas from the plant room. This vacuum pump is arranged between the plant room and the compressor and is therefore located in the flow direction of the insulating gas in front of the compressor. When removing the insulating gas from the plant room, it is important that the insulating gas is removed as completely as possible from the plant room of the electrical switchgear. On the one hand, this is necessary for the protection of the service personnel, since used insulating gas can contain degradation products which are harmful to health and with which the persons commissioned with the service should not come into contact. On the other hand, completely removing the insulating gas from the plant room has economic advantages, since the same, completely removed insulating gas can be filled back into the plant after servicing and therefore no new insulating gas has to be used. A vacuum pump upstream of the compressor offers the advantage that a greater vacuum can be generated to extract the insulating gas than would be possible with the compressor alone. The vacuum pump is technically designed in such a way that it develops the greatest possible negative pressure on the suction or inlet side. The output pressure of the vacuum pump, on the other hand, is designed to ensure that the compressor functions as optimally as possible and is therefore adapted to its optimal suction pressure. The compressor can thus be used optimally for its actual task, namely the compression of the insulating gas. The provision of a vacuum pump is advantageous as a division of functions when the insulating gas is removed from the plant room. The vacuum pump ensures that the insulating gas is removed from the plant room as residue-free as possible, the compressor then ensures optimal compression of the insulating gas, which is important for safe and space-saving storage of the gas. The provision of a dry-running, oil-free vacuum pump is particularly advantageous. A dry-running vacuum pump ensures that the insulating gas is not contaminated by lubricants from the vacuum pump during the extraction process from the plant room, but reaches the compressor without changing its composition.

In a preferred embodiment of the proposal it is provided that a filter is provided which is arranged in the flow direction of the insulating gas upstream of the vacuum pump. In this embodiment, a filter is arranged between the plant room and the vacuum pump. This filter is used to remove contaminants in the insulating gas, which may arise during or from the operation of the electrical switchgear, from the insulating gas. This ensures that these impurities in the vacuum pump and in the following units such as the compressor or cooler cannot cause any damage.

Furthermore, it is advantageously provided that a drying filter and/or a particle filter is/are provided, wherein this/these filter(s) is/are arranged downstream of the compressor in the flow direction. In this embodiment, one or more filters are arranged downstream of the compressor in the flow direction. These filters can be of various types. For example, a drying filter can be provided that removes moisture from the insulating gas.

Additionally or alternatively, a particle filter can be provided that removes particles from the flowing insulating gas. The filters arranged downstream of the compressor and cooler in the flow direction serve to remove unwanted substances from the sucked off, used insulating gas before the intermediate storage in the storage container. This cleaning of the insulating gas during the extraction process from the plant room ensures that the gas stored in the storage container can be reintroduced into the plant room of an electrical switchgear without any further cleaning steps, and that the gas can function reliably as an insulating gas again.

In a further preferred embodiment it is provided that a weighing device is provided which determines the current weight of the gas cylinder. Such a weighing device determines the current weight of the gas cylinder and thus indirectly the mass of the insulating gas located in the gas cylinder. The quantity of the insulating gas stored can then in turn be determined via this mass of the insulating gas. Knowing how much insulating gas is in the gas cylinder can be used, for example, to determine when the capacity of the gas cylinder has been reached. It can also be determined whether there is still sufficient insulating gas in the gas cylinder currently connected to fill the plant room of an electrical switchgear. A connection of the weighing device to the controller of the service device is particularly favourable. Such a connection could take place, for example, via a sensor line or else via a radio link. The information provided by the weighing device about the current weight of the gas cylinder can then also be used by the controller to regulate a cylinder heating device. The function of such a cylinder heating device is analogous to that of the storage heating device already described and it is used to heat the insulating gas located in the gas cylinder to a temperature above the critical temperature of all components of the insulating gas. It is of course also possible to provide a weighing device on a storage container fixedly installed on or in the service device and to use it in the same way as was described in connection with the weighing device for a gas cylinder.

The object of the invention is also achieved by a method for removing a multi-component insulating gas from a plant room according to claim 8.

The method for the removal of a multi-component insulating gas from the plant room, in particular for the maintenance of electrical switchgears, and for refilling the plant room with a multi-component insulating gas is characterised by the sequence of the following steps:

- removal of the insulating gas from the plant room,
- compression of the insulating gas in a compressor, wherein the compressor is operated so that all components within the compressor remain in the gaseous phase,
- condensation of at least the majority of the compressed insulating gas in a storage container,
- storage of the liquid insulating gas in the storage container
- heating of the insulating gas in the storage container to a temperature above the critical temperature of all components of the insulating gas before filling the plant room,
- and transport of the gaseous insulating gas, in particular through the compressor into the plant room.

A method according to the invention is proposed in order first to remove an insulating gas consisting of several components from a plant room and (temporarily) to store it in liquid form in a storage container. A method according to the invention is preferably used in the maintenance of electrical switchgears in order to remove the insulating gas from the plant room before the maintenance and to store it temporarily for refilling after the maintenance. The method comprises several steps. First, the insulating gas is removed from the plant room of the electrical switchgear. For example, a vacuum pump can be used to remove the insulating gas. When removing the insulating gas, it is particularly advantageous to remove the gas from the plant room as completely and residue-free as possible. This ensures that no residual insulating gas interferes with the maintenance of the plant room. In addition, no insulating gas is lost, so that no new insulating gas has to be procured when the plant room is refilled. In a next step of the method, the removed insulating gas is compressed. For this compression, a compressor is used, which is operated in such a way that all components of the insulating gas remain in the gaseous phase during the entire compression process. This remaining in the gaseous phase has advantages when operating the compressor. If, during its operation, parts of the insulating gas change to the liquid phase due to the pressure increase, these liquefied components would have to be removed continuously from the compressor. This removal of the liquid components should be avoided since it represents a technical and therefore also a financial outlay. Furthermore, the liquefaction of individual components of the insulating gas in the compressor would result in the mixing ratio of the components changing with respect to one another. The liquefied components would remain in the compressor and only the gaseous components would be transported further in the direction of the next method steps. For the insulating function of the insulating gas in the electrical switchgear, however, it is precisely this mixing ratio of the individual components to one another that is essential. The fact that the compressor is operated in such a way that all components of the insulating gas remain in the gaseous phase ensures that the mixing ratio of the components to one another remains constant during the compression process and the electrical properties of the insulating gas do not change. In a further method step, at least the majority of the compressed insulating gas is condensed in a storage container. The insulating gas is transported to a storage container in the gaseous phase. Only in the storage container is the insulating gas then condensed with all of its components. This condensation takes place by reducing the temperature of the insulating gas. It is possible that a smaller part of the insulating gas already condenses in the last piece of the pipeline in front of the storage container. In this case, too, there is no change in the mixing ratio of the individual components of the insulating gas to one another, since the pipeline system in front of the storage container is designed such that parts or components of the insulating gas liquefied therein are likewise supplied into the storage container, and when there mix again with the remaining, also liquefied parts or components.

In a further method step, the insulating gas, which is now in liquid form, is stored in the storage container. Storage in liquid form has the advantage that significantly less space is required for storing the same amount of insulating gas than would be the case in the gaseous state. The stored insulating gas can then either be filled back into the same electrical switchgear after maintenance has been carried out, or it can be transported in the storage container and used elsewhere.

With the aid of the method according to the invention, an insulating gas consisting of several components is then filled into the plant room of an electrical switchgear. The starting point is the stored insulating gas which is present in a storage container under pressure in liquid form. The method according to the invention is particularly suitable for refilling a plant room after maintenance. Of course, the method can also be used for initial filling after the switchgear has been manufactured. In a first method step of the filling method, the insulating gas in the storage container is heated. The heating takes place up to a temperature which is above the critical temperature of all components of the insulating gas. The critical temperature denotes the temperature above which a gas no longer passes into the liquid phase. A gas heated to a temperature above the critical temperature no longer changes into the liquid phase even at high pressures. The heating of the insulating gas to a temperature above the critical temperature of all components ensures that none of the components liquefies again during the filling process of the plant room, in which pressure differences can occur. This ensures that the mixing ratio of the individual components of the insulating gas to one another remains constant during the filling method. In a further method step, the gaseous insulating gas, which has been heated to a supercritical temperature, is transported into the plant room of an electrical switchgear. A compressor is particularly suitable for generating the pressure required for this transport. This transport of the insulating gas to the plant room takes place exclusively in the gaseous phase. If the environmental conditions make it necessary, parts of the pipeline system or the units through which the insulating gas flows on its route can be provided with a heating device which ensures that the insulating gas does not cool down to subcritical temperatures on its route. By transporting the insulating gas at a temperature above the critical temperature of all of its components, it is ensured that the mixing ratio of the components to one another remains constant during the transport. This also ensures that the electrical properties of the insulating gas remain unchanged and that safe functioning during operation in an electrical switchgear is ensured.

In a preferred embodiment of the proposal, it is provided that the compressed insulating gas is cooled in a cooler connected downstream of the compressor in the flow direction, in such a way that no part of the insulating gas condenses in the cooler. In this embodiment of a method according to the invention it is provided that the insulating gas heated during the compression in the compressor is cooled in a cooler located downstream of the compressor in the flow direction. The cooler is operated in such a way that no part or component of the insulating gas condenses as a result of the cooling. The cooler has the task of reducing the temperature again after compression, since the insulating gas and all of its components are to be condensed in the storage container located nearby. However, the condensation should only take place in the storage container, but not already in the cooler. Condensation in the cooler would lead to the change in the mixing ratio of the individual components of the insulating gas relative to one another, which has already been described several times. Such a change in the mixing ratio of the insulating gas should therefore be prevented as far as possible by the described operating point of the cooler.

It is skilfully provided that the insulating gas passes through a filter when it is extracted from the plant room in the flow direction in front of the compressor or a vacuum pump provided in the flow direction. In this embodiment of a method, a filter step is provided in which contaminants are removed through a filter before passing through the compressor or the vacuum pump. This is particularly advantageous since it prevents damage to the compressor or the vacuum pump due to contamination in the sucked off insulating gas.

It is advantageously provided that the compressor is regulated by a controller during the compression of the insulating gas so that all components of the insulating gas remain in the gaseous phase during the compression process. In this embodiment of a method, a controller is used which regulates the operating point of the compressor continuously and in a manner adapted to the environmental conditions so that all components of the insulating gas remain in the gaseous phase during the entire compression process. It is possible that the controller for regulating the compressor uses various information that is provided by sensors. The operating point of the compressor is then regulated in such a way that it is guaranteed at all times that all components remain gaseous during the compression. Such a regulation is able to compensate for changes, for example due to changed environmental conditions. This ensures that liquefaction of one or more components of the insulating gas during compression is avoided at all times. As a result, the insulating gas is compressed to the required extent without its electrical properties being changed by the compression.

Furthermore, it is advantageously provided that the weight of the gas cylinder is measured with the aid of a weighing device during the heating of the insulating gas located therein and the measured value is supplied to the controller. In this embodiment, the weight of the gas cylinder and thus indirectly also the weight of the insulating gas contained therein is measured using a weighing device. The measured value is then supplied to the controller and used therein, for example, as input information for regulating the cylinder heating. The weight of the insulating gas located in the gas cylinder also provides information about the amount of insulating gas that is still available to fill the plant room. For example, it can be recognised whether a further gas cylinder with insulating gas is required or not, until the filling of the plant room is completed.

Furthermore, provision is advantageously made for the air to be sucked out of the plant room with the aid of an evacuation pump before the supercritically heated insulating gas is transported into the plant room. In this embodiment of a method, the air located there is removed before the insulating gas is transported into the plant room. An evacuation pump is used for this evacuation of the plant room. The removal of the air from the plant room before filling with the insulating gas serves to achieve the optimal possible insulating properties of the insulating gas in the plant. Air clearly has poorer insulation properties than the multi-component insulating gas. If air were to remain in the plant room before filling with insulating gas, this air and the insulating gas would mix during filling. The consequence of this dilution of the insulating gas would be significantly poorer electrical insulation properties of the gas mixture. The removal of air from the plant room thus makes an important contribution to the safe functioning of the electrical switchgear after it has been refilled with insulating gas.

The object of the invention is also achieved by using a service device according to one of the described embodiments, which is used in particular for carrying out a method according to one of the described embodiments, in particular during maintenance of switchgears which are filled with an insulating gas which consists of several different components, wherein said different components have different physical properties, such as, for example, different critical points. The use of a service device according to one of the described embodiments is particularly advantageous during or for the maintenance of a gas-insulated switchgear. In such gas-insulated switchgears, the use of insulating gases composed of several gases or components has recently become established. Naturally, different gases also have different physical properties, such as liquefaction pressures, liquefaction temperatures or critical temperatures. During maintenance of the electrical switchgears filled with such multi-component insulating gases, it must be ensured that the properties of the insulating gas do not change due to removal and refilling from or into the plant room. A service device according to one of the described embodiments has proven to be particularly advantageous for such a use, since no changes in the properties of the insulating gas result from the maintenance process when such a device is used. A service device of this type is designed so that all components remain in the gaseous phase during the transport of the multi-component insulating gas through the service device and so none of the components are partially or completely removed from the gas mixture by separate liquefaction. This liquefaction of individual components often results in unwanted separation when using service devices that are designed for handling single-component insulating gases, which is particularly critical for the function of switchgears if this separation is not detected. It is of course also possible to use a service device according to the invention for the maintenance of switchgears which contains an insulating gas consisting of only one component. In general, however, the use of a service device according to one of the described embodiments is also suitable for handling different gas mixtures, in which a constant mixing ratio between the individual components of the gas mixture is to be ensured via the handling method.

In a preferred embodiment of the proposal it is provided that the multi-component insulating gas with which the switchgears to be serviced is filled does not contain SF6 (sulphur hexafluoride) and this insulating gas has at least one carrier component which is formed by N_2 or CO_2. When using a service device and method, the agitated insulating gas contains no sulphur hexafluoride. This use is particularly favourable for environmental protection, since the agitated insulating gas promotes the greenhouse effect to a much lesser extent than sulphur hexafluoride and thus gas that escapes unintentionally does much less damage. As a replacement for sulphur hexafluoride, at least one carrier component is provided which is formed by N_2 or CO_2. Such a multi-component insulating gas contains at least one additional component in addition to the carrier component.

Furthermore, it is provided that the multi-component insulating gas contains, in addition to the carrier component, an additional component which is formed from C5 ketone, HFO1234ze, HFO1234yf, fluoronitrile or a combination of these gases. In this embodiment of the use of a service device and method, a multi-component insulating gas contains, in addition to the carrier component, an additional component which is formed by at least one of the insulating gases C5 ketone, HFO1234ze, HFO1234yf or fluoronitrile. Of course, this additional component can also be formed from a mixture or combination of the gases mentioned, or contain an alternative component with favourable properties. Practically applicable mixing ratios of carrier component and additional component are described above.

In this context, it is pointed out in particular that all the features and properties, but also processes, described in relation to the service device are also analogously applicable with regard to the wording of the method according to the invention or of the use according to the invention and can be used in the sense of the invention and are also disclosed. The reverse also applies, which means that structural features that are mentioned only in relation to the method or use, that is to say device features, can also be taken into account and claimed within the scope of the claims for the service device and also count towards the disclosure. The same also applies between the method according to the invention and the use according to the invention.

In the drawing, the invention is shown schematically in one exemplary embodiment in particular. In the figure:

Fig. 1 a schematic representation of an embodiment of a service device according to the invention.

Fig. 1 shows a schematic representation of an embodiment of a service device. In the lower right corner is the plant room 1 of the switchgear, which is filled with a multi-component insulating gas when the switchgear is in operation. The remaining elements in Fig. 1 show parts or components of an embodiment of a service device. This service device can be fixedly and permanently connected to the electrical switchgear and the plant room 1, or the service device can be designed as a mobile device which is connected to the plant room 1 only when required or during maintenance. In any case, the service device is connected to the plant room 1 via the coupling 11. This coupling 11 can be designed in various ways. Quick couplings are conceivable, which are connected or separated from one another with the aid of easy-to-operate sliding or rotating elements. In addition, flange connections are possible, which are screwed, welded or otherwise connected and sealed together. The selection of a suitable coupling 11 depends on whether the service device is a fixedly installed device or a mobile device. In the case of a mobile device, quick couplings are preferred for reasons of user-friendliness.

For better understanding of the following description of the service device, terms for three different routes of the insulating gas through the service device are introduced. The insulating gas is removed from the plant room 1 on a removal route 50 and transferred to the storage container 6 or the glass cylinder 5 for intermediate storage. On the return route 60, the insulating gas is then transported in the other direction from the storage container 6 or the gas cylinder 5 back into the plant room 1 of the switchgear. The bypass route 70 has the same function and largely the same course as the removal route 50, but the vacuum pump 4 is bypassed on the bypass route 70.

The removal route 50 begins at the coupling 11 and initially runs upwards through the filter 7 and the valve 41 to the vacuum pump 4. The vacuum pump 4 is used to draw off the insulating gas from the plant room 1 almost completely by generating a strong negative pressure. For high-quality maintenance of a switchgear, it is important to remove the insulating gas located therein as completely as possible, whereby the insulating gas should not escape into the environment if possible. The vacuum pump 4 therefore has the task of emptying the plant room 1 as residue-free as possible, and on the other hand the vacuum pump 4 has the task of providing a suitable working pressure on its output side which enables the insulating gas to be transported on to the compressor 3. A first filter 7 is located between plant room 1 and vacuum pump 4. The insulating gas is chemically changed during operation of the switchgear through diverse processes and contaminated thereby. These processes, which lead to changes in the insulating gas, include, for example, arcs that occur briefly during switching operations. These arcs have a thermal and electrical effect on the insulating gas and can sometimes produce toxic degradation products. For this reason, the insulating gas is filtered several times during maintenance of the switchgear, which means that changes and degradation products are removed from the insulating gas. The filter 7 represents a first filter stage for cleaning the insulating gas before it enters the vacuum pump 4. On the removal route 50, the insulating gas leaves the vacuum pump 4 on the left-hand side and next comes into the compressor 3. The insulating gas is then compressed there to enable space-saving storage during maintenance of the switchgear. As described above, modern insulating gases, the greenhouse effect of which is much less than the SF6 long established on Earth, are made up of several components. With a composition of this type consisting of several components, there is a risk that one of the components will initially change from the gaseous to the liquid phase when the pressure in the compressor rises, whereas the remaining components of the insulating gas still remain in the gaseous phase. Such a transition of the individual components into the liquid phase, offset in time or spatially from one another, would lead to a change in the mixing ratio of the individual components to one another. The first liquefying components of the gas mixtures would virtually be lost and remain in the compressor, whereas the remaining components would be transported in gaseous form on the removal route 50. To solve this problem, the compressor 3 is operated in such a way that the pressure of the insulating gas is increased only to such an extent that all of the components are still in the gaseous state when leaving the compressor 3. The outlet pressure of the compressor 3 is therefore set so that it is below the liquefaction pressure of the component which has the lowest liquefaction pressure of all components. The insulating gas therefore leaves the compressor 3 completely in a gaseous form and next enters the cooler 32.

In the cooler 32, the insulating gas heated in the compressor 3 during the compression process is cooled again. The cooler 32 is operated in such a way that all components of the insulating gas at the outlet of the cooler 32 are still in the gaseous state. However, the cooling process brings the gas mixture close to the liquefaction point, namely a combination of the critical temperature and the critical pressure. In the further course of the removal route 50, the insulating gas passes the valve 31 as well as the dry air filter 12 and the particle filter 13. After passing the valve 62 arranged after the particle filter 13, the insulating gas finally reaches the storage container 6 via the connection coupling 63. Alternatively, the insulating gas can be supplied into a gas cylinder 5 via a cylinder coupling 51. The temperatures and pressures on the removal route 50 are set and regulated in such a way that a liquefaction of the insulating gas takes place only in the storage container 6 or the gas cylinder 5. The liquefaction in the storage container 6 or the gas cylinder 5 then takes place by a temperature which is again slightly reduced there in comparison with the pipeline of the removal route. Storage or intermediate storage of the multi-component insulating gas in liquid form offers enormous space savings compared to storage in the gaseous state.

The transport of the insulating gas in the gaseous state on the removal route 50 and a subsequent liquefaction of the multi-component insulating gas in the storage container 6 or a gas cylinder 5 offers a very high level of security against an unwanted change in the mixing ratio of the individual components of the insulating gas with simultaneous, space-saving storage in the liquid state. The controller 8 has the task of regulating the individual components or units of the service device in such a way that the insulating gas is in the desired state in all parts of the plant. Several sensors are connected to the controller 8, which are shown in Fig. 1 by arrows pointing in the direction of the controller 8. Furthermore, the controller 8 has several manipulated variables, which are shown as arrows pointing in the direction of the corresponding component to be set. A state sensor 33 is provided on the removal route 50 after the cooler 32 and is connected to the controller 8 via the sensor line 85. This state sensor 33 determines pressure and/or temperature and/or the physical state of the insulating gas after leaving the cooler 32.

The controller 8 then uses the information from the state sensor 33 to regulate the compressor 3 and the cooler 32. For this purpose, the controller 8 is connected to the units via the control lines 81 and 86. It would also be possible here to provide further state sensors on the removal route 50. For example, a further state sensor could be installed between the compressor 3 and the cooler 32 in order to be able to analyse the insulating gas when leaving the compressor 3. A further state sensor 64 is provided on the removal route, which determines the state of the insulating gas on its way from the cooler 32 to the storage container 6 after passing through the valve 31, the dry filter 12, the particle filter 13 and the valve 62. The information provided by the state sensor 64 also flows into the regulation of the compressor 3 and the cooler 32 which is carried out by the controller 8.

The controller is also connected to the valves of the service device, for example valves 31 and 62. The controller can detect the state of the valves, in particular whether they are open or closed, and can also change the state of the valves. For reasons of clarity, the sensor and control lines between the controller 8 and the valves are not shown in Fig. 1.

After carrying out maintenance work on the switchgear or on plant room 1, the insulating gas is transported back into plant room 1 using the service device. During this return transport, the insulating gas is converted from its liquid storage state back into the gaseous operating state for use in the switchgear. With this conversion and during transport by the service device, it is particularly important that the mixing ratio of the individual components of the insulating gas to one another does not change. At the beginning of the return of the insulating gas to the plant room 1, the gas mixtures in the storage container 6 or a gas cylinder 5 are heated to a temperature which is above the evaporation temperature of all components of the insulating gas. The insulating gas is thus already returned to the gaseous state in the storage container 6 or the gas cylinder 5. The storage heating device 61 and/or the cylinder heating device 52 are provided to increase the temperature. These heating devices are regulated by the controller 8 via the control lines 82 and 83. In addition, sensors and sensor lines are provided for determining the current temperature, which are not shown in Fig. 1 for reasons of clarity. The weighing unit 53 is provided for determining the current weight of the gas cylinder 5, and thus indirectly for determining the weight of the insulating gas located in the gas cylinder 5.

This weighing unit 53 is connected to the controller 8 via the sensor line 87. The controller 8 uses the information determined by the weighing device 53 to regulate the cylinder heating device 52.

The insulating gas is guided through the service device on the return route 60 when it is returned to the plant room 1. Before the insulating gas is returned, the valves 62, 71, 41 and 21 are closed in order to open the return route 60 and to delimit it from the other paths. The insulating gas then first passes through a pressure reducer and the opened valve 65. The return route 60 is symbolised in Fig. 1 by arrows. The compressor 3 is used on the return route 60 to generate the required conveying pressure for the transport of the insulating gas back into the plant room 1. After passing the valve 65, the insulating gas is passed through a pressure reducer and sucked in by the compressor 3. After leaving the compressor 3, the insulating gas passes the cooler 32, but in this case it is not cooled. The insulating gas is then passed through the valve 31 through the two filters 12 and 13. The insulating gas then passes the opened valve 66 and a further pressure reducer. The line heating device 90 is provided on the return route 60. This line heating device 90 is used when the insulating gas is cooled down on the return route 60 to such an extent that individual components of the gas liquefy. As already described, this liquefaction of individual components would lead to a change in the mixing ratio of the insulating gas in plant room 1. The risk of possible liquefaction of individual components is countered by reheating the insulating gas on the return route using the line heating device 90. The line heating device 90 is regulated by the controller 8 via the control line 88. The information required for this regulation is made available to the controller 8 by sensors, such as the state sensor 33. Further sensors, which are not shown in Fig. 1, can also be provided for regulating the line heating device 90. Furthermore, it is possible to provide several line heating devices 90 on the return route 60. At the end of the return route 60, the insulating gas is supplied back into the plant room 1 via the coupling 11. On the return route of the service device, it is possible to provide a plurality of connections or couplings for connection to plant rooms of switchgears, such as the replacement coupling 14. In Fig. 2, therefore, in addition to the coupling 11 used, a further coupling 51 is provided, to which, however, no switchgear is connected in the case shown.

The bypass route 70 is used to bypass the vacuum pump 4 when the insulating gas is removed from the plant room 1. After bypassing the vacuum pump 4, this bypass route 70 opens into the removal route 50 already described. When using the bypass route 70, the insulating gas is transported from the plant room 1 to the storage container 6 or the gas cylinder 5 only with the aid of the compressor 3. In this case, no further units are used to build up a pressure required for the transport of the multi-component gas. If the bypass route 70 is to be used, the valve 41 is closed and the valve 71 is opened.

The evacuation pump 2 is shown in Fig. 1 in the upper right area. This evacuation pump 2 serves to remove the air from the plant room 1 before it is filled with the insulating gas. For this purpose, valves 41 and 71 are closed and valve 21 is opened. The evacuation pump 2 then sucks the air out of the plant room 1 and releases it to the environment. The removal of the air from the plant room 1 also serves to maintain a constant mixing ratio of the individual components of the insulating gas to one another. If a significant amount of air remained in the plant room before filling, the insulating gas would be diluted by this air, which in turn would lead to an undesirable change in the properties of the gas mixtures.

In the figures, elements that are the same or correspond to one another are respectively identified by the same reference signs and are therefore not described again unless expedient. The disclosures contained in the entire description can be applied analogously to the same parts with the same reference signs or the same component names. The position information selected in the description, such as, for example, top, bottom, side, etc., is based on the figure directly described and illustrated and should be transferred to the new position in the event of a change in position. Furthermore, individual features or combinations of features from the different exemplary embodiments shown and described can also represent independent or inventive solutions or solutions according to the present invention.

It should also be noted that the configurations and variants of the invention described in the various embodiments and shown in the figures can be combined with one another as desired. Individual or multiple features can be interchanged with one another. These combinations of features are also disclosed.

The dependencies given in the dependent claims indicate the further development of the subject matter of the main claim through the features of the respective dependent claim. However, these are not to be understood as an abandoning of the achievement of independent, objective protection for the features of the related dependent claims.

Patentkrav

1. Serviceindretning til en isolerende gas med flere komponenter, til anvendelse ved vedligeholdelse af elektriske fordelingsanlæg med et anlægsrum, omfattende

- en kompressor (3) med en nedstrømskøler (32),

- en lagerbeholder (6),

- hvor serviceindretningen er forbundet med et anlægsrum (1),

hvor kompressoren (3) fortætter den isolerende gas ved udtagelse fra anlægsrummet (1), hvor alle komponenterne af den isolerende gas i kompressoren (3) forbliver i gasformig tilstand, hvor en ledningsopvarmningsindretning (90) er tilvejebragt, som mindst delvist opvarmer en rørledning mellem lagerbeholderen (6) og anlægsrummet (1) og/eller elementer i rørledningen, såsom, for eksempel, et filterhus eller lignende **kendetegnet ved, at** køleren (32) er reguleret af en styreenhed (8) således, at alle komponenter af den isolerende gas stadig er i gasformig tilstand, når de forlader køleren, og at en kondensering af den isolerende gas finder sted i lagerbeholderen (6) eller i ledningssystemet mellem køleren og lagerbeholderen (6), hvor ledningssystemet på dette punkt er udformet således, at selv kondenserede komponenter kommer ind i lagerbeholderen (6) i flydende form, hvor en ny blanding med tilbageværende komponenter, som der kondenserer, derefter finder sted, og en lageropvarmningsindretning (61) er tilvejebragt til lagerbeholderen (6), hvor lageropvarmningsindretningen (61) anvendes til at opvarme den isolerende gas i lagerbeholderen (6) til en temperatur over den kritiske temperatur for alle komponenter og ved fyldning af anlægsrummet (1) opvarmer lageropvarmningsindretningen (61) den isolerende gas til en temperatur over den kritiske temperatur for alle komponenter af den isolerende gas.

2. Serviceindretning ifølge krav 1, **kendetegnet ved, at** styreenheden (8) regulerer kompressorens (3) og/eller kølerens (32) arbejdspunkt som en funktion af mindst et aktuelt parameter af den isolerende gas målt af en sensor.

3. Serviceindretning ifølge et af de foregående krav, **kendetegnet ved, at** styreenheden (8) regulerer lageropvarmningsindretningens (61) arbejdspunkt som en funktion af mindst et aktuelt parameter af den isolerende gas målt af en sensor, og/eller lagerbeholderen (6) er udformet som en udskiftelig gasflaske (5), eller lagerbeholderen (6) er fast indrettet på serviceindretningen.

4. Serviceindretning ifølge et af de foregående krav, **kendetegnet ved, at** en udsugningspumpe (2) er tilvejebragt, som tjener til tømning af anlægsrummet (1) og/eller en især tørløbende, oliefri vakuumpumpe (4) er tilvejebragt, som er indrettet opstrøms for kompressoren (3) i strømningsretningen af den isolerende gas.

5. Serviceindretning ifølge et af de foregående krav, **kendetegnet ved, at** et filter (7) er tilvejebragt, som er indrettet opstrøms for vakuumpumpen (4) i strømningsretningen af den isolerende gas, og/eller et tørrefilter (12) og/eller et partikelfilter (13) er tilvejebragt, hvor dette filter/disse filtre er indrettet nedstrøms for kompressoren (3) i strømningsretningen.

6. Serviceindretning ifølge et af de foregående krav, **kendetegnet ved, at** en vejeanordning (53) er tilvejebragt, som bestemmer den aktuelle vægt af gasflasken (5), og/eller køleren (32) er integreret med kompressoren (3), og er især udført i en fælles ramme eller et fælles hus, eller køleren (32) er adskilt fra kompressoren (3), og er især tilvejebragt i nærheden af lagerbeholderen (6).

7. Serviceindretning ifølge et af de foregående krav, **kendetegnet ved, at** den isolerende gas er dannet som en isolerende gas, som omfatter eller består af en bærekomponent og mindst en yderligere komponent valgt fra gruppen bestående af C5-keton, HFO1234ze, HFO1234yf, fluornitril eller en kombination deraf.

8. Fremgangsmåde til håndtering af en isolerende gas med flere komponenter ved vedligeholdelse af elektriske fordelingsanlæg **kendetegnet ved** rækkefølgen af følgende trin:

- udtagning af den isolerende gas fra anlægsrummet (1),

- komprimering af den isolerende gas i en kompressor (3), hvor kompressoren (3) drives således, at alle komponenterne inde i kompressoren (3) forbliver i den gasformige fase,

- transport af den komprimerede isolerende gas i den gasformige fase til en lagerbeholder (6), hvor den isolerende gas først kondenseres i lagerbeholderen (6) eller i det sidste stykke af en rørledning opstrøms for lagerbeholderen (6), hvor rørledningssystemet er udformet opstrøms for lagerbeholderen (6) således, at deri kondenserede dele eller komponenter af den isolerende gas også føres til lagerbeholderen (6) og der blandes igen med de tilbageværende, også kondenserede dele eller komponenter,

- lagring af den flydende isolerende gas i lagerbeholderen (6),

- opvarmning af den isolerende gas i lagerbeholderen (6) til en temperatur over den kritiske temperatur for alle komponenterne af den isolerende gas forud for fyldning af anlægsrummet (1),

- og transport af den gasformige isolerende gas opvarmet til en overkritisk temperatur, især gennem kompressoren (3) til anlægsrummet (1).

9. Fremgangsmåde ifølge krav 8, **kendetegnet ved, at** den komprimerede isolerende gas køles i en køler (32) nedstrøms for kompressoren i strømnings-retningen på en sådan måde, at så vidt muligt kondenseres ingen bestanddel af den isolerende gas i køleren (32).

10. Fremgangsmåde ifølge krav 8 eller 9, **kendetegnet ved, at** forud for transporten af den overkritisk opvarmede isolerende gas til anlægsrummet (1) afsuges luften fra anlægsrummet (1) ved hjælp af en sugepumpe (2).

11. Fremgangsmåde ifølge et af kravene 8 til 10, **kendetegnet ved, at** kompressoren (3) reguleres af en styreenhed (8) ved fortætning af den isolerende gas således, at alle komponenterne af den isolerende gas forbliver i den gasformige fase under komprimeringsprocessen.

12. Fremgangsmåde ifølge et af de foregående krav 8 til 11, **kendetegnet ved, at** vægten af gasflasken (5) under opvarmningen af den deri anbragte isolerende gas måles ved hjælp af en vejeanordning, og den målte værdi sendes til styreenheden (8).

13. Fremgangsmåde ifølge et af kravene 8 til 12, **kendetegnet ved, at** den isolerende gas er dannet som en isolerende gas, som omfatter eller består af en bærekomponent og mindst en yderligere komponent valgt fra gruppen bestående af C5-keton, HFO1234ze, HFO1234yf, fluornitril eller en kombination deraf.

14. Anvendelse af en serviceindretning ifølge et af kravene 1 til 7, hvilken især anvendes til udførelse af en fremgangsmåde ifølge et af kravene 8 til 13, til vedligeholdelse af fordelingsanlæg, som er fyldt med en isolerende gas, hvilken består af en flerhed af forskellige komponenter, hvor disse forskellige komponenter har forskellige fysiske egenskaber, såsom, for eksempel, forskellige kritiske punkter.

15. Anvendelse af en serviceindretning ifølge krav 14, **kendetegnet ved, at** den isolerende gas med flere komponenter, med hvilken fordelingsanlægget, som skal vedligeholdes, er fyldt, intet SF6 svovlhexafluorid indeholder, og denne isolerende gas omfatter mindst en bærekomponent, hvilken er dannet af N_2 eller CO_2.

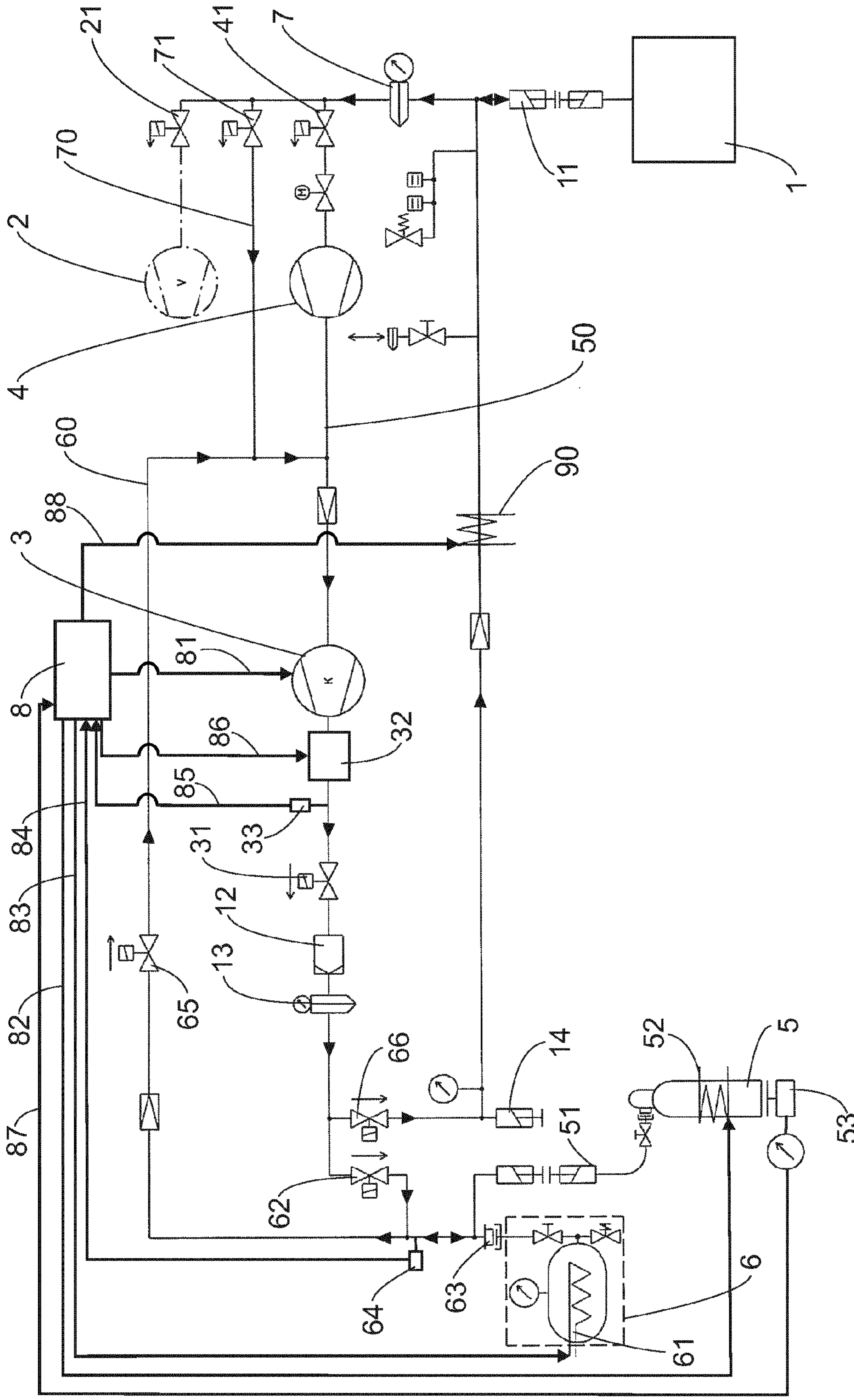
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Fig. 1

Dilo