

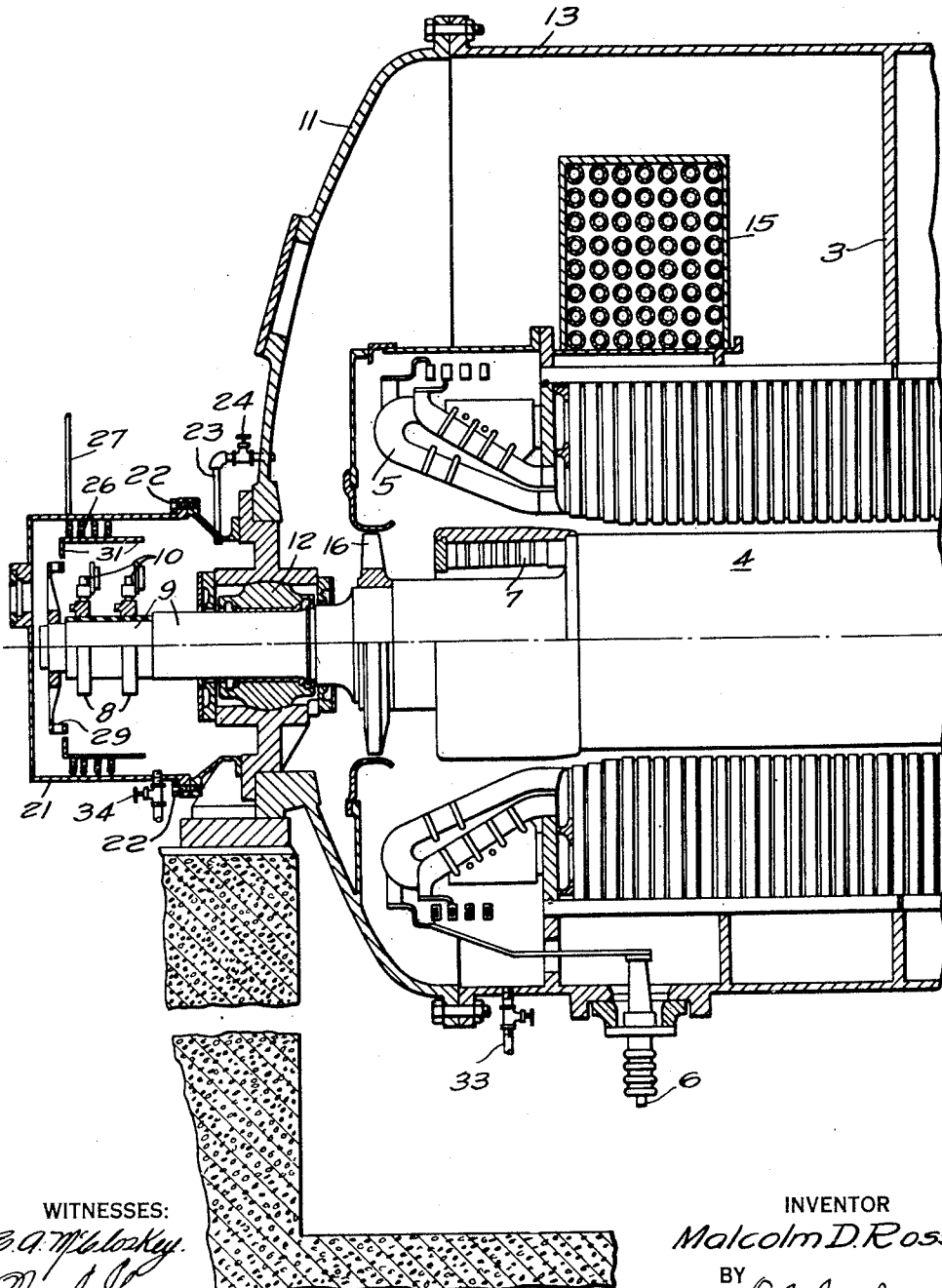
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HYDROGEN-COOLED DYNAMO-ELECTRIC MACHINE

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HYDROGEN-COOLED DYNAMO-ELECTRIC MACHINE

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My invention relates to the cooling of totally enclosed dynamo-electric machines, and it has more particular relation to hydrogen-cooled machines of a type having current-collecting devices and having no shaft extending through the overall enclosure, such machines including syn-

5 chronous condensers and frequency-changer sets.

It has been known for some time that the ratings of large dynamo-electric machines may be considerably increased by causing the machines to operate in an atmosphere of substantially pure hydrogen, the increased rating being obtained principally by reason of the superior heat-conducting properties of the hydrogen which enters into the interstices of the various insulations, facilitating the heat-transfer from the copper or current-conducting parts of the machine. Large dynamo-electric machines of the type to which hydrogen-cooling has been heretofore applied have invariably been of a type having a current-collecting device, specifically a pair of slip rings, mounted on the shaft, and as it is necessary for access to be had to said current-collecting devices once in a while, say once a year, or the like, it has been customary to mount said current-collecting devices, including the carbonaceous brushes which bear on the slip rings, in a separate, hydrogen-filled casing.

As considerable energy is lost in the current-collecting device, amounting, in a large machine, to something like 4 kilowatts, it is necessary to provide means for cooling the current-collecting element. Heretofore this cooling has been effected by causing a circulation of hydrogen between the two chambers, that is, between the main machine-housing and the current-collector casing, so that the temperature of the current-collector casing is kept down to reasonable limits.

For a number of years, this intercirculating system, for cooling the current-collector casing, has been a source of considerable trouble, because it has resulted in a gradual depositing of carbon from the brushes onto the insulating surfaces of the machine-parts within the main machine-housing, causing a reduction in the insulating-strength of the machine, and finally necessitating the dismantling of the machine and the hand-wiping of the carbon-covered surfaces. This wiping operation has been a very serious handicap, because, in order to make the main machine-housing not only explosion-proof but also impervious to the leakage of hydrogen; (the most readily leakable of all gases, because of its low molecular weight), it has been necessary to build the machine-housing rather sturdily, and to

make its joints unusually tight, so that it is not readily dismantled, to say nothing of the cost of the hydrogen which is lost when the machine-housing has to be opened. It was originally intended that the provision of the separate current-collector casing would preclude the necessity for opening the main machine-housing for many decades, or substantially for the life of the machine, and the aforesaid difficulties resulting from carbon-deposits have been quite serious.

An attempt has been made to overcome the aforesaid difficulties by the utilization of a filter, interposed in the circulating system between the current-collector casing and the machine-housing, but this attempt has not been altogether successful because of the impossibility of securing a sufficiently perfect filter which will not require an impossibility large gaseous pressure-head to drive the hydrogen through it. The result of the foregoing is that the difficulties have heretofore remained unsolved, with the result that the dismantling of the main machine-housing for the purpose of wiping off the carbon deposits had to be tolerated, for lack of any equipment which would successfully avoid this difficulty.

In accordance with my present invention, I mount the current-collector casing in such a way that there is no circulation of hydrogen between said casing and the main machine-housing, and I provide a separate cooler, and a separate internal circulating system, for the current-collector casing, so as to carry away the heat caused by the losses in the current-collecting device.

An exemplary embodiment of my invention is shown in the drawing, the single figure of which is a sectional view of the slip-ring end of a synchronous condenser embodying my invention.

The synchronous condenser is a dynamo-electric machine having a stator member 3 and a rotor member 4. The stator member 3 carries the main windings 5 of the machine, one terminal of which is indicated at 6. The rotor member 4 carries the exciting windings 7, the terminals of which are connected to two slip rings 8, which are mounted near the end of the rotor-shaft 9, said slip rings being engaged by stationary brushes 10.

The machine is enclosed in a machine-housing 11 which is made gas-tight, and which supports the shaft-bearings 12. In order to secure the necessary strength for an explosion-resistant construction, the body portion 13 of the machine-housing 11 is made cylindrical in shape. In accordance with an invention of B. A. Rose, this cylindrical housing-barrel 13 is mounted eccen-

trically with respect to the machine, so as to provide an enlarged space, preferably at the top, within which is mounted a main cooler-element 15 through which the hydrogen of the main casing 11 is circulated, as by means of a fan 16 carried by the rotor member.

The end of the shaft 9 which carries the current-collecting device 8-10 extends through the bearing 12 and thus extends outside of the machine-housing 11. It is enclosed by a separate gas-tight casing 21, which is detachably secured to the main machine-housing 11, as by means of bolts 22. The oil of the bearing 12 operates as a hydrogen-seal so long as there is no great difference in pressure between the hydrogen in the machine-housing 11 and the hydrogen in the current-collector casing 21, so that, in normal operation, the effect of the bearing 12 would be to cause the gaseous pressures to substantially equalize each other, after which there would be no transfer of hydrogen between the two chambers, so far as the bearing 12 is concerned. I usually find it convenient to provide a closable equalizing-pressure means, in the form of a small pipe 23 communicating between said two chambers, and containing a valve 24 which can be closed to permit access to the current-collecting device, as will subsequently be described.

The current-collector casing 21 is provided with a separate cooler element 26 which is associated with pipe-means 27 for circulating a cooling medium from an external source through said current-collector cooler 26. The current-collector casing 21 is also provided with means, such as a fan 29, for causing an internal circulation of hydrogen within the current-collector casing, suitable baffles 31 being provided for causing the internally circulated hydrogen to pass in heat-exchanging relation to the cooler 26.

In operation, it is usually desirable to operate the dynamo-electric machine in a hydrogen atmosphere which is maintained at a considerable pressure, such as 15 pounds per square inch over atmospheric pressure, in order to obtain the advantage of the higher rating which is made possible by the superior heat-conducting properties of the higher-pressure hydrogen. The communicating valve 24 is normally open, so that both the machine-housing 11 and the current-collector casing 21 are filled with hydrogen at exactly the same pressure. With no pressure-difference between the gas in the two chambers, the bearing 12 operates as a perfect seal, thus preventing any movement of the hydrogen gas in either direction through the bearing. As both chambers are gas-tight, there is no leakage, and hence there is normally no movement or circulation of the hydrogen through the pressure-equalizer pipe 23 or valve 24.

At rare intervals, it may be necessary to replace the brushes 10, or to obtain access to the current-collector chamber for some other purpose, and when this occurs, it is necessary, first, to close the valve 24. It is then desirable to reduce the pressure of the hydrogen in the main chamber substantially to atmosphere pressure, in order to prevent hydrogen from escaping or blowing through the bearing 12, as this escaping action may be more violent than is desirable, particularly if the gas at the inner end of the bearing is at a pressure which is very much greater than the gas at the outer end thereof. Cocks are provided, as shown at 33 and 34, for permitting the escape of hydrogen from both the ma-

chine-housing 11 and the current-collector casing 21. The hydrogen which escapes from the machine-housing 11 may entail a loss of something like \$10.00 worth of hydrogen from the main machine-housing 11, but as the opening of the current-collector chamber is ordinarily not necessitated oftener than once in a year or more, it is usually not economical to trouble to save this hydrogen by pumping it into a tank.

When the hydrogen in both the machine-housing 11 and the auxiliary casing 21 is at substantially atmospheric pressure, the fastening bolts 22 are removed, and the auxiliary casing 21 can then be removed from the current-collecting device.

To restore service conditions, it is only necessary to replace the auxiliary casing 21, and to refill the main machine-housing 11 with hydrogen up to the desired working-pressure, the pressure-equalizer valve 24 being opened slightly before the exhaust valve 34 of the auxiliary casing 21 is closed, so as to blow the air out of the current-collector chamber.

I claim as my invention:

1. A dynamo-electric machine having stationary and rotatable members, a gas-filled machine-housing substantially hermetically enclosing said members, a current-collecting device associated with said rotatable member, a gas-tight casing enclosing said current-collecting device, means for so segregating said current-collector casing from said machine-housing as to substantially prevent the circulation of gas from one chamber to the other, a cooler for said machine-housing, a separate cooler element having a heat-exchanging surface associated with said current-collector casing, means for circulating a cooling medium from an external source over the heat-exchanging surface of said current-collector cooler, and means for causing an internal circulation of gas within said current-collector casing in heat-exchanging relation to its cooler.

2. A dynamo-electric machine having stationary and rotatable members, a gas-filled machine-housing substantially hermetically enclosing said members, a current-collecting device associated with said rotatable member, a gas-tight casing enclosing said current-collecting device, means for so segregating said current-collector casing from said machine-housing as to substantially prevent the circulation of gas from one chamber to the other, closable equalizing-pressure means communicating between said two chambers, a cooler for said machine-housing, a separate cooler element having a heat-exchanging surface associated with said current-collector casing, means for circulating a cooling medium from an external source over the heat-exchanging surface of said current-collector cooler, and means for causing an internal circulation of gas within said current-collector casing in heat-exchanging relation to its cooler.

3. A dynamo-electric machine having stationary and rotatable members, a hydrogen-filled machine-housing substantially hermetically enclosing said members, a current-collecting device associated with said rotatable member, a gas-tight hydrogen-filled casing enclosing said current-collecting device, means for so segregating said current-collector casing from said machine-housing as to substantially prevent the circulation of hydrogen from one chamber to the other, a cooler for said machine-housing, a separate cooler element having a heat-exchanging surface associated with said current-collector casing, means for cir-

5 culating a cooling medium from an external source over the heat-exchanging surface of said current-collector cooler, and means for causing an internal circulation of hydrogen within said current-collector casing in heat-exchanging relation to its cooler.

10 4. A dynamo-electric machine having stationary and rotatable members, a hydrogen-filled machine-housing substantially hermetically enclosing said members, a current-collecting device associated with said rotatable member, a gas-tight hydrogen-filled casing enclosing said current-collecting device, means for so segregating said current-collector casing from said machine-hous-

ing as to substantially prevent the circulation of hydrogen from one chamber to the other, means whereby the hydrogen in the two chambers may normally be maintained at approximately the same pressure, a cooler for said machine-housing, 5 a separate cooler element having a heat-exchanging surface associated with said current-collector casing, means for circulating a cooling medium from an external source over the heat-exchanging surface of said current-collector cooler, and means 10 for causing an internal circulation of hydrogen within said current-collector casing in heat-exchanging relation to its cooler.

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