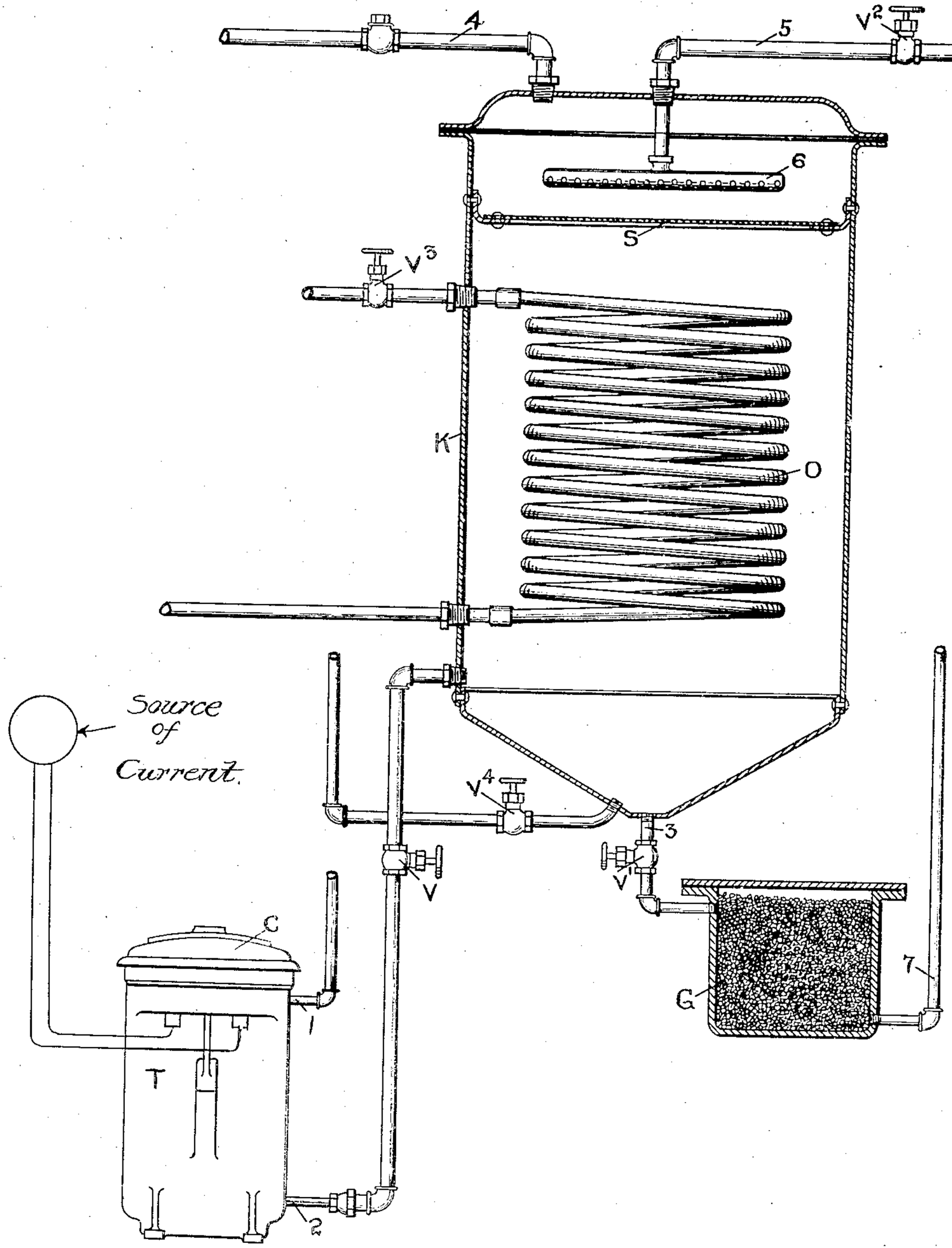
No. 806,696. PATENTED DEC. 5, 1905.

W. S. MOODY.

METHOD OF INSULATING.

APPLICATION FILED APR. 26, 1902.



Witnesses:

Robt. C. Chapman.

Helen Orford

Inventor.

Walter S. Moody.

by Allen & G. Davis

Atty.

UNITED STATES PATENT OFFICE.

WALTER S. MOODY, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

METHOD OF INSULATING.

No. 806,696. Specification of Letters Patent. Patented Dec. 5, 1905.

Application filed April 26, 1902. Serial No. 104,891.

To all whom it may concern:

Be it known that I, WALTER S. MOODY, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Methods of Insulating, of which the following is a specification.

This invention relates to improvements in insulating the conductors or windings of electrical apparatus, more especially of electrical transformers, wherein the insulation is furnished by a fluid, such as oil, which also serves as a vehicle for the heat generated in the conductors. This fluid serves as an auxiliary insulation to the solid insulation with which the conductors are usually covered, and the fluid is contained in the casing in which the windings are located.

The object of the invention is to introduce into the transformer-casing or other receptacle an insulating fluid, which at the conclusion of the operation shall be free from any air or moisture, which would greatly reduce the effectiveness of the fluid as an insulator.

A thickness, roughly speaking, of two-tenths of an inch of the oil ordinarily used will begin to permit a leakage of current at about twenty thousand to twenty-two thousand volts, and this thickness of oil will be punctured and broken down at about twenty-eight thousand to thirty thousand volts. I have found that the absence of moisture and air in the oil in the casing greatly increases the insulation resistance of the oil, which is a most valuable feature in high-voltage transformers.

Treatment of the oil before introducing it into the transformer-casing to free it from air and moisture does not result in the desired absence of air and moisture in the oil after its introduction into the casing, and this is probably due not to the fact that the oil may not have been previously entirely freed from them nor because the apparatus may not have been thoroughly dry when the oil was introduced into the casing, but to the facts that the introduction of the oil did not force all the air containing moisture out of the casing and that bubbles of such air by the operation of filling became incorporated with the body of oil or remained lodged on the solid insulation of the conductors. By maintaining a partial vacuum in the transformer-casing during the time that previously dried and de-aerated oil is being introduced, as described hereinafter, I find that moisture and air are no longer present in the oil after the completion of the operation of introducing the oil into the transformer-casing or other receptacle.

The drawing shows the manner in which the invention may be practiced.

The transformer-casing T is provided with a cover C, which is constructed and arranged in any desired manner to close the casing air-tight after the core and windings have been placed inside. The pipe 1 may be connected to an ordinary vacuum-pump and the interior of the casing be then exhausted, after which the oil, freed from air and moisture in the tank K, is caused to flow through the pipe 2 and valve V into the casing T by means of the low pressure therein, aided or not by gravity or any other means. The transformer-coils and core should be dry before the oil is admitted into the casing T, and to this end I connect the coils in circuit with a suitable source of current, whereby the conductors are kept hot and all moisture is evaporated and carried off by the vacuum-pump.

It is possible to remove the air and moisture from the oil after it is introduced into the casing T; but it is usually not practicable, owing to the difficulty in raising it to the desired temperature, except in instances where a very large transformer is provided with coils intended for the normal passage of a cooling fluid, which coils can be used for the passage of steam to raise the oil to the temperature required to expel the air and moisture. In practice I prefer to conduct the treatment of the oil in the tank K, from which the supply of prepared oil can be led to any desired number of transformer-casings and in which tank the treatment of the oil can be much more effectively carried out. It is also possible to dry the oil by treatment with calcium chlorid or other chemical having an affinity for water; but I have found that oil so treated is not safe to use commercially, because a little residue of the chemical may be more dangerous than air or moisture.

The tank K is provided with a steam-pipe coil O, by which the oil after having been accumulated in a considerable body can be raised to the desired temperature. A pipe 3 is provided at the bottom or other suitable part of the tank, and through this pipe air passes up through the body of boiling oil in the tank. The air is heated by the hot oil, so that its

capacity for absorbing the moisture in the oil is increased, and in its upward passage it acts as a vehicle to carry off the moisture. I have found that a froth will form on the top of the body of boiling oil, which froth by entrapping the air hinders its free disengagement from the oil. To prevent this result, a pipe 4 is connected between the tank K and a suitable vacuum-pump, so that a partial vacuum can be maintained in the tank. I have found that this vacuum will prevent the formation of froth and serve also to cause or assist the air to rise through the body of oil.

The oil or other suitable fluid is introduced into the top of the tank K through a pipe 5, to the lower end of which is attached a sprayer 6, through which the oil is sprayed into the vacuum, thereby removing whatever air is in the oil and such portions of the moisture as may be contained in the air. A screen or filter S is preferably placed below the sprayer 6 in order to retain the solid impurities in the oil and also to serve as an auxiliary sprayer.

In practice the valves V and V′ are closed when the tank K contains no oil and it is desired to commence operations. The tank K is then exhausted through the pipe 4, and the valve V^2 is opened to permit the influx of oil through the sprayer 6. When the oil has accumulated in the tank so that the steam-coil O is partially or wholly submerged, the valve V^3 may be opened to fill the coil with steam and heat the body of oil in the vacuum so that some more of the moisture will be driven off. The valve V^4 may then be opened to permit atmospheric air to be drawn by the vacuum at the top of the body of oil up through the oil. The atmospheric air is of course saturated with moisture to a greater or less degree; but it can be used profitably at first to carry off considerable of the moisture in the oil, for the reason that the heat imparted to it by the oil increases its capacity for absorbing moisture. Finally the valve V^4 may be closed and the valve V′ opened to admit dried air to the tank K. This valve V′ communicates with an air-tight receptacle G, which contains a suitable drying agent, such as calcium chlorid, and is provided with a pipe 7, communicating with the atmosphere directly or through an ordinary force-pump. The air is thoroughly dried in its passage through the receptacle G, and its capacity for absorbing moisture is still further increased by its rise in temperature, effected by the hot oil in the tank K. Even without this heating, but with a longer continuation of the operation, the passage of the dried air up through the body of oil would remove all traces of moisture therefrom. The valve V′ may then be closed and the oil be kept hot until all the air is forced up and out into the vacuum. The oil is then ready to pass into the casing T, as previously described. After the casing T has been filled with the prepared oil the cover C may be removed at any time, as there is little chance that the air at the surface of the oil will pass downwardly to the submerged conductor-windings. I have found in practice that the oil thus prepared will remain dry for an indefinitely long period of time if kept in a body. To prevent all possible chance of the entrance of moisture into the oil in the casing T, a suitable chemical drying agent, such as calcium chlorid, may be placed inside the casing in the air-space above the body of oil in order to dry the air and keep it dry in case the cover is removed or air enters through crevices.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in removing the air and moisture from the casing and introducing into the casing an insulating fluid also freed from air and moisture.

2. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in maintaining a vacuum in the casing and introducing therein a normally fluid insulating material.

3. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in maintaining a vacuum in the casing, and introducing therein oil freed from moisture and air.

4. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in heating the conductors by passing current through them, and introducing an insulating fluid into the casing while maintaining a vacuum therein.

5. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in freeing oil from air and moisture, and introducing the oil into the casing while maintaining a vacuum therein.

6. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in heating oil while passing air through it, and then introducing the oil into the casing while a vacuum is maintained therein.

7. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in heating oil while passing dry air through it, and then introducing the oil into the casing while maintaining a vacuum therein.

8. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in heating oil in a vacuum while passing air through it, and then introducing the oil into the casing while maintaining a vacuum in the latter.

9. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in heating oil

in a vacuum while passing dry air through it, and then introducing the oil into the casing while maintaining a vacuum therein.

10. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in spraying oil into a vacuum, heating the oil therein, and then introducing the oil into the casing while maintaining a vacuum therein.

11. The method of insulating the conductors of an electrical apparatus provided with an inclosing casing, which consists in spraying oil into a vacuum, heating the oil while passing air through it, and then introducing the oil into the casing while maintaining a vacuum therein.

12. The method of improving the insulating properties of an insulating fluid which consists in spraying the fluid into a vacuum and heating it in the vacuum while passing air through the fluid into the vacuum thereby removing air and moisture from the fluid.

In witness whereof I have hereunto set my hand this 25th day of April, 1902.

WALTER S. MOODY.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.