

July 26, 1938.

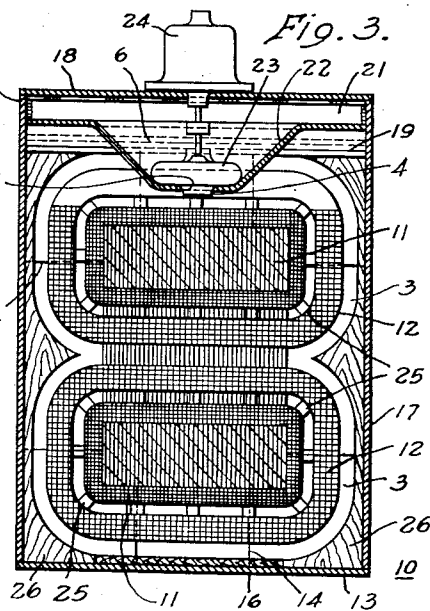
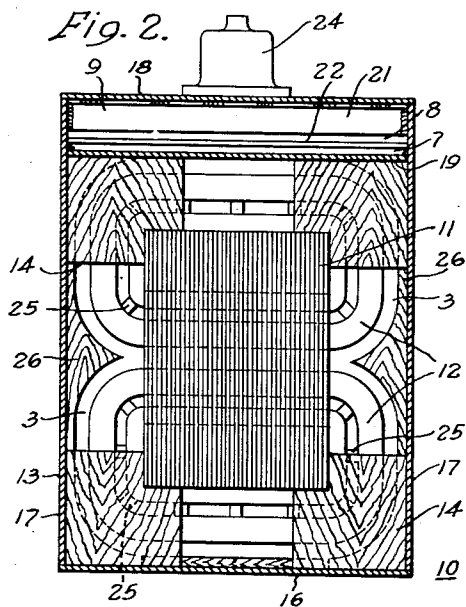
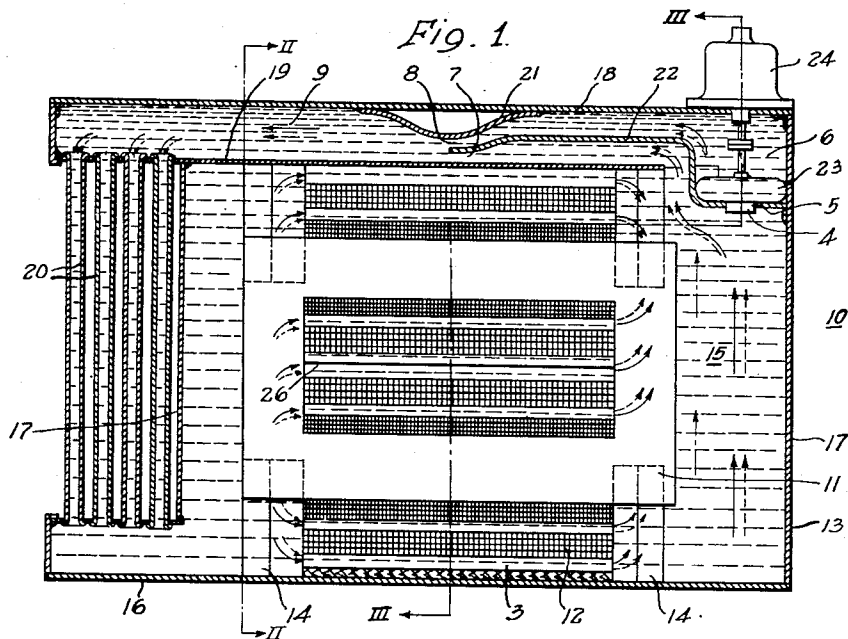
F. J. VOGEL

2,125,138

TRANSFORMER COOLING SYSTEM

Filed May 29, 1936

2 Sheets-Sheet 1



WITNESSES:

Michael Stark
James H. Ely

INVENTOR

Fred J. Vogel.
By
Gray & Savage
ATTORNEY

July 26, 1938.

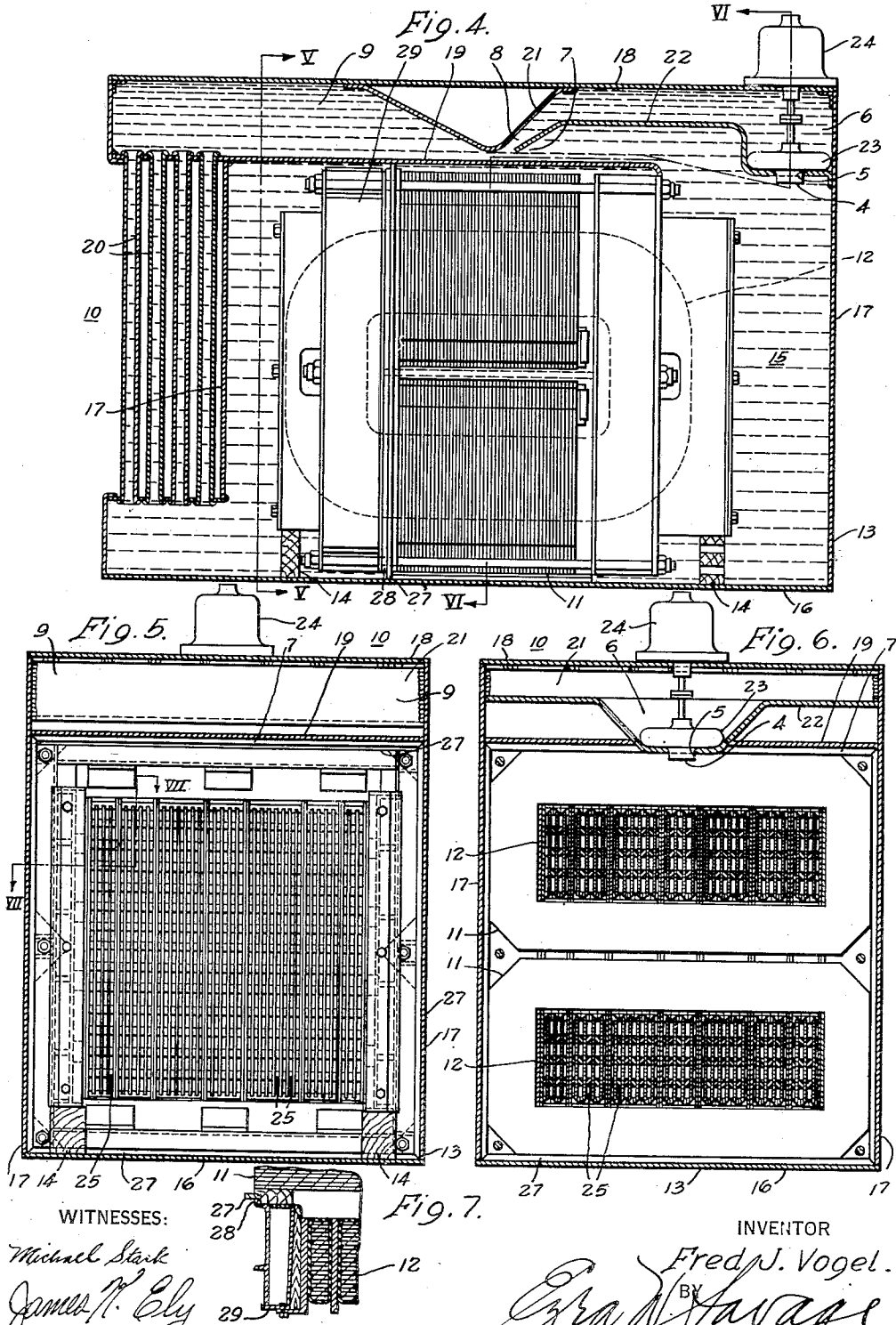
F. J. VOGEL

2,125,138

TRANSFORMER COOLING SYSTEM

Filed May 29, 1936

2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

2,125,138

TRANSFORMER COOLING SYSTEM

Fred J. Vogel, Sharon, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application May 29, 1936, Serial No. 82,437

3 Claims. (Cl. 175—361)

This invention relates to transformers and particularly to cooling systems for transformers.

In power transformers, large quantities of heat are generated in the core members and coils. The heat generated is generally transferred to a cooling means by the circulation of an insulating and cooling medium between the core member and the coils and the cooling means.

Since the heat generated in the windings of the transformer varies with the load on the transformer, it is desirable to provide for varying the rate of flow of the cooling medium to effectively dissipate the heat generated under the different loads. Further it is desirable to circulate the cooling medium directly through the coils under pressure to effectively cool the unit, since the heat is mainly generated in the coils.

An object of this invention is the provision of a cooling system for obtaining circulation of a cooling medium through the coils of a transformer.

Another object of this invention is the provision of apparatus for obtaining a thermal circulation and a forced circulation of a cooling medium through the coils of a transformer.

A more specific object of this invention is the provision of apparatus for obtaining a thermal circulation and a forced circulation of a cooling medium through the coils of a transformer, the thermal circulation being adapted to function independently of the forced circulation.

A further object of this invention is the provision in a transformer case of a high velocity discharge orifice for discharging a cooling medium to a cooling means whereby the cooling medium is delivered to and passes through the transformer coils under pressure.

This invention, together with other objects, may be better understood by the following description when taken in conjunction with the accompanying drawings, in which:

Figure 1 is a sectional elevational view of a core type transformer in a case constructed in accordance with the teachings of this invention;

Fig. 2 is a cross-section of the transformer and case taken along the line II—II of Fig. 1;

Fig. 3 is a cross-section of the transformer and case taken along the line III—III of Fig. 1;

Fig. 4 is a sectional elevational view of a shell type transformer in a case constructed in accordance with the teachings of this invention;

Fig. 5 is a cross-section of the transformer and case taken along the line V—V of Fig. 4;

Fig. 6 is a similar view of Fig. 4 taken along the line VI—VI; and

Fig. 7 is an enlarged cross-sectional view of

the coils and core members of the transformer shown in Fig. 5 taken along the line VII—VII.

Referring to the drawings, and particularly to Fig. 1, this invention is illustrated by reference to a core type transformer 10. The transformer 10 comprises a core 11 and spaced coils 12 disposed in spaced relation to and in a case 13. The core and coil assembly is supported in spaced relation in the case by means of suitable supports 14, such as wood or other insulating material, and is immersed in oil, chlorinated diphenyl or some other suitable cooling and insulating medium 15.

The enclosing case 13 comprises a bottom 16, side walls 17 and a top 18 welded together to provide a sealed unit.

In order to provide a definite circulating path for the circulation of the cooling medium, a depending wall 19 is disposed in the case 13 above the core and coil assembly. The depending wall 19, as shown in Fig. 2, is positioned across the case 13 near its top, and, as shown in Fig. 1, extends from one end of the case to a point approximately near the end of the core and coil assembly providing a channel 9 above the core and coil assembly.

In order to effectively cool the cooling medium, cooling means, such as a plurality of radiator tubes 20, are so carried by one end of the case 13 that one end of the tubes communicates with the channel 9, and the other end of the tubes communicates with the lower portion of the case 13 to effect a circulation path for the cooling medium from the channel to the lower part of the case.

In order to provide for a high velocity discharge of the insulating medium into the channel 9 for forcing the cooling medium through the radiator tubes 20 to the lower portion of the case under pressure, a depending curved plate 21, as illustrated in Figs. 1 and 2, is positioned on the underside of the top 18 of the case between the top 18 and the depending wall 19. The plate 21 extends across the width of the case providing a constricted area across the case through which the insulating medium flows. A plate 22 carried by the side wall 17 and so shaped as to form a well 6 having an opening 5 therein, as shown in Figs. 1 and 3, is provided near the top of the case and projects outwardly from the side wall 17 into the constricted area between the depending wall 19 and the depending plate 21. The outer ends of the plate 22 and the depending plate 21 are in spaced relation and cooperate to provide a constricted high velocity discharge orifice 8 for discharging the cooling medium into channel 9.

A pump 23 is disposed in the well 6 with its in-

take orifice 4 positioned in the opening 5 formed in the plate 22 and is mechanically connected to and designed to be operated by a motor 24 carried on the case 13 for providing a forced circulation of the cooling medium through the high velocity discharge orifice 8, channel 9, and radiator tubes 20 to the lower portion of the case 13.

The motor 24 is adapted to be actuated by some suitable means (not shown) in response to predetermined temperatures within the windings of the transformer. If the temperature of the core and coil assembly is not high enough to cause an operation of the motor 24, a thermal or convection circulation of the insulating medium in the case is accomplished by means of a thermo-syphon discharge orifice 7 disposed between the outer end of plate 22 and the depending wall 19.

Since most of the heat in the transformer is generated within the coils, it is desirable to provide for circulating the cooling medium through the coils to effectively cool them. The coils 12 are mounted in spaced relation about the core, spacers 25 being provided between the coils in the usual manner for permitting a circulation of the cooling medium between the coils.

In order to insure a circulation of the cooling medium through the spaced coils, a barrier 26 is provided around the inside of the case 13, as shown in Fig. 3. In general, the barrier 26 conforms to the shape of the core and coil assembly and is so disposed that there is only a slight space 3 between the outer periphery of the coils 12 and the inner surface of the barrier 26 for the circulation of the cooling medium between the coils and the barrier. The barrier 26 may be of wood or any other suitable material, and preferably extends throughout the length of the coils for insuring a circulation of the cooling medium in close contact with, and through the coils.

A modification of this invention is shown in Fig. 4 in which this invention is illustrated as applied to a shell type transformer. In this modification, the case construction is substantially the same as that illustrated in Fig. 1.

In practice, the coils 12 are mounted in spaced relation in order to permit a circulation of the cooling medium therethrough. This may be accomplished by providing spacers 25 between the coils. When assembled, the core and coil assembly is so positioned in the case that the cooling medium will tend to flow through the spaced coils when circulated in the case. The core and coil assembly may be supported in position by means of suitable supports, such as wood blocks 14.

In order to insure a circulation of the cooling medium 15 through the spaced coils 12, an oil-tight barrier 27 is so disposed around the core of the transformer as to effectively block the space between the core and the case. In this modification, the barrier comprises a strip of medium hard felt or other suitable material carried by the wood block 28 positioned between the core 11 and the end frame 29 of the transformer as shown in Fig. 7, and tightly engages the bottom 16, side walls, and depending wall 19 of the case.

In operation, when the transformer is constructed as explained hereinbefore, a thermal or convection circulation of the cooling medium is accomplished under normal operating conditions through the thermo-syphon discharge orifice 7. The warm insulating medium rises from one end of the core and coil assembly and passes through the thermo-syphon orifice 7 and channel 9 to the radiator tubes 20 as shown by the dotted arrows

in Fig. 1. The heat of the cooling medium is effectively dissipated in the radiator tubes since they are exposed to the surrounding atmosphere. Where desirable, some suitable means such as a fan (not shown) may be employed to force a blast of air over the radiator tubes to assist in dissipating the heat.

The cooled insulating and cooling medium is discharged from the lower ends of the radiator tubes into the lower portion of the transformer case to the other end of the coils of the transformer. Because of the barrier sleeve 26 provided in the core type transformer, as illustrated in Fig. 1, or the barrier 27 positioned about the core member of the shell type transformer, illustrated in Fig. 4, the cooling medium is caused to circulate only through the coils of the shell type transformer, and in close contact with and through the coils of the core type transformer, thus effectively cooling the coils.

Under heavy load conditions, the thermo-syphon circulation of the cooling medium is ineffective for dissipating all of the heat generated in the core and coils of the transformer. When the temperature of the coils is increased to a predetermined value, the motor 24 is energized to actuate the pump 23 and cause a forced circulation of the insulating and cooling medium.

As illustrated by the solid arrows in Fig. 1 of the drawings, the warm cooling medium is pumped from one end of the core and coil assembly through the pump 23. The pump forces the cooling medium through the high velocity orifice 8 into the channel 9 under pressure. The cooling medium passes from the channel 9 through the radiator tubes 20 to the lower portion of the case 13 and the other end of the coils under pressure.

The forced discharge of the cooling medium from the high velocity orifice 8 causes an increase in the thermo-syphon discharge of the cooling medium from the thermo-syphon orifice 7. Under these conditions, both the thermo-syphon and the forced circulation of the cooling medium for delivering the cooling medium under pressure to the coils is the same for both the core and shell type transformers.

By providing a forced circulation of the cooling medium through the coils of the transformer, the transformer is efficiently cooled. The thermo-syphon circulation of the cooling medium is effective for satisfactorily dissipating the heat generated in the coils under partial load conditions while the forced circulation of the cooling medium is effective for dissipating the heat generated under heavy load conditions. The cooperation between the thermo-syphon discharge orifice and the high velocity discharge orifice gives a more thorough circulation of the cooling medium than heretofore obtained. These features, together with the provision of the barrier sleeve about the core and coil assembly, insure a forced circulation of the cooling medium through the transformer coils.

Although this invention has been described with reference to a particular embodiment thereof, it is, of course, to be understood that other and various modifications thereof are possible. It is, therefore, not to be restricted except insofar as is necessitated by the prior art and the scope of the appended claims.

I claim as my invention:

1. In a cooling system for transformers provided with a case having a top, bottom, end and side walls, coils mounted in the case, and a cool-

ing medium for circulating through the coils, in combination, radiator tubes for controlling the temperature of the cooling medium associated with the case, a depending wall in the case extending across the case between the side walls from one end wall above the coils providing a channel within the case for delivering the cooling medium to the radiator tubes, a depending plate extending across the case between the side walls and projecting downwardly from the top of the case towards the depending wall to cooperate with the depending wall and the side walls to provide a constricted opening into the channel, a plate projecting outwardly from the other end wall and extending across the case above the coils substantially into the constricted opening, the plate cooperating with the depending plate, the depending wall and the side walls to provide a plurality of orifices extending across the case between the side walls for discharging the cooling medium through the constricted opening into the channel, means for drawing the cooling medium from one end of the coils and discharging it through one of the orifices into the channel to force it through the radiator tubes and deliver it to the other end of the coils under pressure, the cooling medium being thereby caused to circulate through the coils under pressure, another of the orifices providing for a syphon discharge of the cooling medium into the channel while the cooling medium is being discharged under pressure from the other orifice, said syphon discharge being disposed for a syphon circulation of the cooling medium through the coils independently of the pressure discharge when the pressure discharge fails, and a barrier disposed about the core and coil assembly between the assembly and the depending wall and case for insuring circulation of the cooling medium through the coils when delivered to said other end of the coils.

2. In a cooling system for transformers provided with a case having a top, bottom, end and side walls, coils mounted in spaced relation in the case, and a cooling medium for circulating through the coils, in combination, a barrier sleeve in spaced relation to the coils, radiator tubes for controlling the temperature of the cooling medium associated with the case, a depending wall in the case projecting outwardly from one end wall of the case and extending across the case between the side walls above the coils providing a channel within the case for delivering the cooling medium to the radiator tubes, a depending plate extending across the case between the side walls and projecting downwardly from the top of the case towards the depending wall to cooperate therewith and with the side walls to provide a constricted opening into the channel, a plate projecting outwardly from the other end wall and extending across the case above the coils substantially into the constricted opening, the plate cooperating with the depending plate, the depending wall and the side walls to provide a plurality of orifices extending across the case between the side walls for discharging the cooling medium through the constricted opening into the channel, one of the orifices disposed to provide

a high velocity discharge into the channel, means for drawing the cooling medium from one end of the coils and discharging it through said one of the orifices into the channel to force it through the radiator tubes and deliver it to the other end of the coils under pressure, another of the orifices providing a syphon discharge for a thermal circulation of the cooling medium from the coils to the channel independently of the functioning of said one of the orifices, the high velocity discharge from said one of the orifices functioning to increase the syphon discharge of the cooling medium from the other orifice into the channel and increase the circulation of the cooling medium, the cooling medium being thereby caused to circulate under pressure between the spaced coils and between the coils and the barrier sleeve.

3. In a cooling system for transformers provided with a case having a top, bottom, end and side walls, a shell type core and coil assembly mounted in spaced relation in the case, and a cooling medium for circulating through the coils, in combination, radiator tubes for controlling the temperature of the cooling medium associated with the case, a depending wall in the case projecting outwardly from one end wall of the case and extending across the case between the side walls above the coils providing a channel within the case for delivering the cooling medium to the radiator tubes, a depending plate extending across the case between the side walls and projecting downwardly from the top of the case towards the depending wall to cooperate therewith and with the side walls to provide a constricted opening into the channel, a plate projecting outwardly from the other end wall and extending across the case above the coils into the constricted opening, the plate cooperating with the depending plate, the depending wall and the side walls to provide a plurality of orifices extending across the case between the side walls for discharging the cooling medium through the constricted opening into the channel, one of the orifices providing a high velocity discharge of the cooling medium into the channel, means for drawing the cooling medium from one end of the coils and discharging it through said one of the orifices into the channel to force it through the radiator tubes and deliver it to the other end of the coils under pressure, another of the orifices providing a syphon discharge for a thermal circulation of the cooling medium from the coils to the channel independently of the functioning of said one of the orifices, the high velocity discharge from said one of the orifices functioning to increase the syphon discharge of the cooling medium from the other orifice into the channel and increase the circulation of the cooling medium, and a barrier disposed about the core and coil assembly between the assembly and depending wall and case for preventing a circulation of the cooling medium between the core assembly and the case, the cooling medium being thereby caused to circulate under pressure through the coils.

FRED J. VOGEL.