

March 5, 1946.

M. F. WHITE

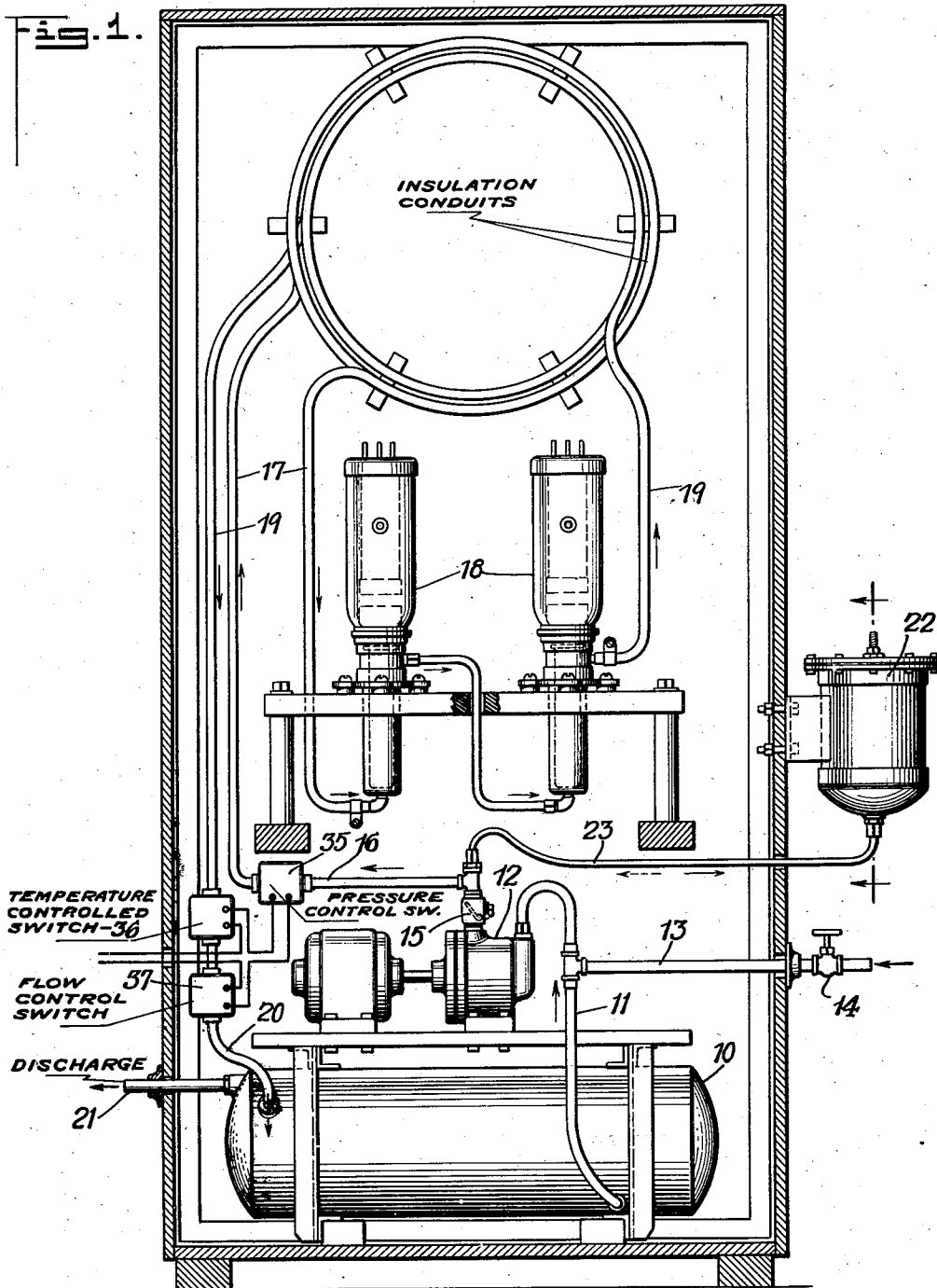
2,396,033

COOLING SYSTEM

Filed July 13, 1944

2 Sheets-Sheet 1

Fig. 1.



INVENTOR.
MELBOURNE FREEMAN WHITE.
BY *ward, Crosby & Neal*
ATTORNEYS

March 5, 1946.

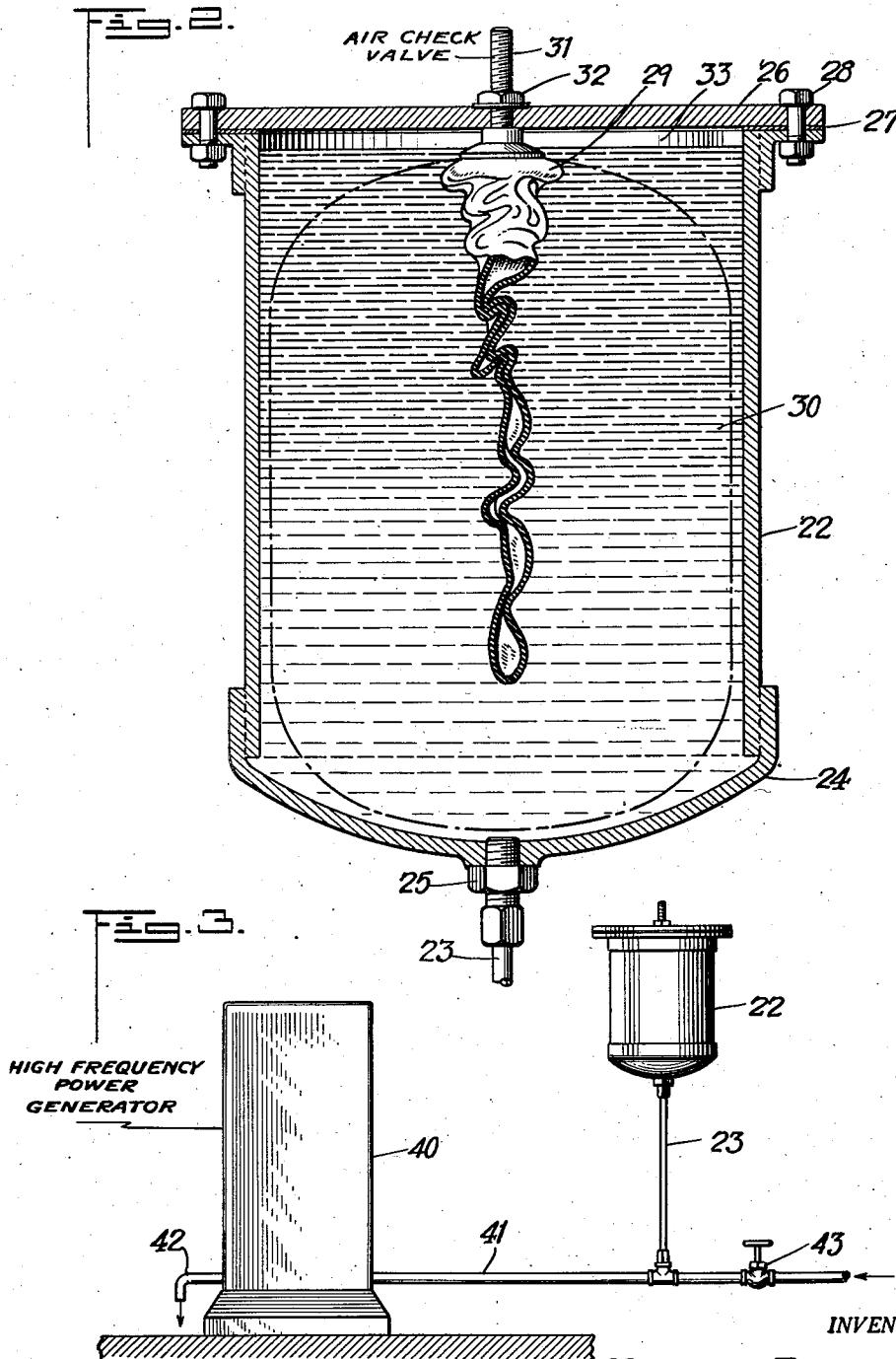
M. F. WHITE

2,396,033

COOLING SYSTEM

Filed July 13, 1944

2 Sheets-Sheet 2



INVENTOR.

MELBOURNE FREEMAN WHITE.

BY

Ward, Crosby & Neal

ATTORNEYS.

UNITED STATES PATENT OFFICE

2,396,033

COOLING SYSTEM

Melbourne F. White, New York, N. Y., assignor to
Induction Heating Corp., New York, N. Y., a
corporation of New York

Application July 13, 1944, Serial No. 544,794

3 Claims. (Cl. 250—27.5)

This invention relates to fluid cooling systems and, among other possible uses, the same is particularly adapted for use in cooling systems for electronic tube apparatus and the like.

In order to cool electrical apparatus such as power oscillator tubes, it is a common practice to connect the cooling fluid cavities either directly with a municipal or public water supply, or with a pump to which water is supplied from a tank. If the electric power is cut off from the tubes at the same time or substantially concurrently with the shutting off of the flow of cooling fluid, then the heat remaining in the tube filaments and other parts may be sufficient to cause destruction or injury of the tubes, since the temperature of some of the parts which normally require cooling, may become quite high within a short interval during which no cooling fluid is flowing. It has therefore become highly desirable to provide some simple means for automatically and positively insuring that the cooling water or other fluid will continue to flow at least for a predetermined short interval, even though the operator may cut off the water supply or stop the pump at the same time that the electric power supply is cut off. For similar reasons it has been found desirable to provide means for automatically continuing the water supply for a time, to protect the tubes in case the municipal water supply is momentarily interrupted or unduly restricted, or, where a water pump is used, to continue the cooling fluid flow for a short interval even though the power for either the pump or the tubes, or both, should be interrupted.

Since the cooling fluid is usually required to be supplied under substantial pressure, it will not ordinarily be conveniently possible within a reasonable expense, to provide a gravity feed tank at the necessary high elevation to prolong the cooling fluid supply after the normal source is cut off, particularly with portable apparatus. Efforts were made to solve the problem by connecting the cooling fluid inlet conduit with a closed rigid walled tank which would normally become partially filled with cooling water under pressure, the remaining space being filled by entrapped air under pressure, which would have the effect of expelling cooling water from the tank to continue the cooling action temporarily after the main supply is cut off. However, this expedient did not prove practical, since after a time, the volume of entrapped air or gases in the tank would become dissolved in the cooling water and hence not be available when needed.

According to the present invention, the prob-

lem has been solved in a manner which has proven to be highly dependable, simple and otherwise quite satisfactory in practical operation. In the preferred form of the invention, a closed tank or reservoir of substantial size is connected in communication with the conduit which runs from the source of cooling fluid pressure to the device being cooled. This tank has contained therein a closed flexible walled inner container filled with a volume of gas. Consequently the cooling fluid is normally free to enter the tank, causing the flexible walled container therein to be maintained partially collapsed under the fluid pressure and against the gas pressure within the inner container. Then when the supply pressure is reduced or the cooling fluid supply is cut off, the inner container is adapted to expand, thereby expelling cooling fluid from the tank to the device being cooled during a sufficient period to offer the desired protection.

Instead of placing a gas-filled bag within the tank, the tank itself of course might be formed with flexible walls subjected internally to the normal cooling fluid pressure and externally to the pressure of the atmosphere. That is, such a construction might be in the form of bellows of metal or other material. However, such a tank of necessary size and which will be rugged and dependable for the purpose, will usually involve excessive expense and other difficulties.

Various further and more specific objects, features and advantages of the invention will more clearly appear from the detailed description given below taken in connection with the accompanying drawings which form a part of this specification and illustrate merely by way of example, preferred forms of the invention. The invention consists in such novel features, arrangements and combinations of parts as may be shown and described in connection with the apparatus herein disclosed.

In the drawings,

Fig. 1 is a view showing cooling apparatus and associated control devices as applied to power oscillator tubes according to the preferred embodiment of the invention;

Fig. 2 is an enlarged vertical sectional view of the tank or reservoir with enclosed flexible bag or container as above referred to; and

Fig. 3 is a diagram of another simple embodiment of the invention.

In the example of the invention shown in Fig. 1, an elongated tank 10 of substantial capacity is shown having an outlet connection 11 running to an electrical motor-operated pump 12. An

intake pipe 13 is provided for connection for example to a municipal water supply through a control or shut-off valve 14. It is noted that the pipe 13 is connected into conduit 11 at a point between the tank and the pump, so that the pump immediately receives such supplies of fresh cold water as may be necessary to supplement water available from tank 10, and which has been recirculated in a manner hereinafter explained. A check valve 15 is provided at the outlet of the pump and from which conduits 16 and 17 run to the cooling cavities of oscillator tubes as at 18. From the latter, conduits 19 and 23 carry the warmed cooling fluid back to the end of tank 10 remote from the pump inlet conduit 11. A small portion of the warmed cooling fluid may be discharged from tank 10 through outlet 21, the remaining portion being recirculated by the pump together with the necessary small supply of fresh make-up water coming in through pipe 13.

The conduits 17 and 19 are preferably formed of suitable plastic or other insulation tubing and are of sufficient length so that the electrical resistance of the body of water therein will be sufficient to effectively insulate the tube cavities against the flow of current into the cooling system.

A closed tank 22 of substantial volume, and preferably substantially hermetically sealed, is brought into communication with conduit 16 at a point subsequent to the check valve 15, by a conduit 23. As shown in Fig. 2, the tank 22 may comprise a cylindrical rigid metal walled reservoir having a bottom end 24 welded or otherwise sealed in place and formed with coupling means as at 25 for the tube 23. This tank may be formed with a removable cover 26 adapted to be sealed in place by a gasket as at 27 and bolts 28.

Within the tank 22 a flexible walled impermeable inner container in the form of a bag or the like is provided as shown at 29. This bag may, for example, be formed of sheet rubber or rubberized material, the rubber being either natural or of the various artificial forms, such as "neoprene," or rubber substitutes. The bag is filled with a volume of gas under such pressure that in the absence of surrounding water pressure, the bag will for example assume substantially the shape and size indicated by the dot and dash lines of Fig. 2. However, as shown in full lines in Fig. 2, the bag is in its collapsed condition as subjected to the pressure of the body of water 30 which has passed into the tank through conduit 23 under the pressure supplied by the pump 12. It will be apparent that the gas pressure within the collapsed bag will be substantially equal to the water pressure supplied by the pump. Consequently if the pump is stopped or if the water supply is otherwise restricted or diminished in pressure, the gas pressure within the bag will cause the latter to expand in volume, thereby expelling a corresponding volume of water from the tank through conduits 23, 16 and 17 to the cooling cavities of the oscillator tubes.

With apparatus such as used, for example, in a 20 kilowatt induction heating installation, it was found that the tank 22 may advantageously have a capacity of about twelve gallons, the pump normally supplying cooling fluid at the rate of six gallons per minute. Assuming that power to the tubes and for the pump is cut off concurrently, it was found with this equipment, having a tank of the above specified size, that the flow of cooling fluid would be prolonged for a time

which was adequate and safe for protecting the tubes against any danger of injury.

As indicated in Fig. 2, the bag 29 may be arranged to communicate with and be suspended by an air check valve 31 of a type such as used for example for automobile tires and enabling the bag to be inflated to a desired amount from a suitable source of air pressure. This air valve as shown may extend up through the cover 26 in sealed relation therewith and may be held in place as by nut 32. With the valve in this position it will be apparent that the bag may be inflated to the desired degree or its pressure may be checked or altered without opening the tank 22. However, if the bag is made of a good grade of rubber or "neoprene," it will retain a substantially constant amount of gas for a long period and consequently if desired, same may be sealed without an air valve and the bag need not necessarily be suspended from the cover as shown.

As indicated in Fig. 2, there may normally be a small air space as at 33 within the top of the tank 22 and outside of the bag 29. Ordinarily, such air after a considerable period will become wholly or largely dissolved in the water and its presence or non-presence within the tank is immaterial to the operation of the arrangement.

The air valve 31 may be secured and arranged to communicate with the bag 29 in a manner similar to the attachment of air valves to automobile inner tubes.

As shown in Fig. 1, the outlet conduit from the pump preferably has a pressure controlled switch device as at 35, interposed therein at a point subsequent to the check valve and subsequent to the connection to tank 22. This pressure-operated switch, which may be of a suitable known type, is arranged to cut off the supply of power to the oscillator tubes whenever the cooling water pressure falls below a predetermined value which might result in injury to the tubes. If desired, the pressure switch and the arrangement of tank 22 may be such that upon merely momentary interruptions of the pump or upon merely slight temporary reductions of the pressure supply by the pump, check valve 15 may close and tank 22 continue to supply momentarily sufficient water pressure, so that the pressure switch will not be thrown unless the abnormal pressure supply condition is continued.

In normal operation of the equipment, the check valve 15 will be open, allowing the flow at pump pressure to be applied to the cooling conduits. However, if the pump is stopped or its pressure falls below that within tank 22, it will be apparent that the check valve will be closed so that the water which will then be expelled under pressure from tank 22 will all travel through the cooling conduits rather than going back through the pump to the sources of supply.

The return conduit connection from the vacuum tubes may preferably, as shown, have interposed therein a temperature control switch device as at 36 and also a flow control switch device as at 37. These may be of suitable known types, whereby when either the return water reaches an unsafe temperature or its flow is abnormally diminished, the electric power to the tubes will be cut off.

In Fig. 3 a simplified arrangement is shown wherein a high frequency power generator 40 is provided with cooling water inlet pipe 41 and outlet pipe 42. The inlet pipe may be connected for example to a municipal water supply through a control or stop valve 43. At a point subsequent

to this valve a tank arrangement 22 such as above described may be connected through its pipe 23. The operation of this arrangement will be apparent from the above description of Fig. 1.

While the invention has been described in detail with respect to certain preferred examples, it will be understood by those skilled in the art after understanding the invention that various changes and modifications may be made without departing from the spirit and scope of the invention, and it is intended therefore in the appended claims to cover all such changes and modifications.

What is claimed as new and desired to be secured by Letters Patent is:

1. In combination with a liquid cooled electrical device of a type having portions which become heated in operation and are subject to injury upon brief interruption or restriction of the flow of cooling liquid therethrough when heated, cooling liquid supply means therefor comprising a supply conduit arranged for connecting said device with a source of cooling liquid under pressure, a check valve in said conduit, a switch for controlling the electric power to said device, pressure-responsive means located in said conduit between said valve and said device for controlling said switch, a closed reservoir connected into said conduit also at a point between said valve and said device, a closed container filled with gas under pressure within said reservoir and having impervious flexible walls normally deflected substantially inwardly of the container by the pressure of the surrounding cooling liquid in the reservoir, the container consequently being adapted to expand under the pressure of the gas therein, to force cooling liquid from the reservoir to sustain the pressure in said conduit for preventing operation of said pressure-responsive means during brief reductions of the pressure from said source of cooling liquid.

2. In combination with a liquid cooled electrical device of a type having portions which become heated in operation and are subject to injury upon brief interruption or restriction of the flow

of cooling liquid therethrough when heated, cooling liquid supply means therefor comprising a supply conduit arranged for connecting said device with a source of cooling liquid under pressure, valve means in said conduit, a closed reservoir connected into said conduit at a point between said valve means and said device, a closed container filled with gas under pressure within said reservoir and having impervious flexible walls normally substantially collapsed by the pressure of the surrounding cooling liquid in the reservoir, the container consequently being adapted to expand under the pressure of the gas therein, to force cooling liquid from the reservoir to and through said device upon substantial restriction of the flow through said valve.

3. Apparatus for supplying and circulating water for a water-cooled power vacuum tube, comprising a circulating pump and mixing tank, and conduits for circulation of water to and from spaced points in the tank, through the pump and the cooling cavities of the vacuum tube, a cool water inlet to the system connected between said tank and the pump whereby the pump directly receives all of the cool water as supplied through said inlet together with supplemental supplies of water as needed from the tank, a warm water outlet connection for discharging water from the tank, said pump and circulating connections being constructed and arranged to circulate water through the tube cavities at a rate substantially greater than the rate of supply of cool water to the system, a check valve in the connection between the pump and the tube cavities, and a closed reservoir means connected into the system between said valve and the tube cavities, said means normally including therein a volume of gas under pressure and being of sufficient capacity to maintain a flow of cooling water therefrom through the tube cavities after the electric power is shut off to the tube and the pump is stopped, for a period sufficient to cool the tube to a safe temperature.

MELBOURNE F. WHITE.