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STERILIZATION OF CLEAR AND TURBID LIQUIDS BY MEANS OF ULTRA VIOLET RAYS PRODUCED IN VACUUM TUBES BY HIGH VOLTAGE ELECTRIC CURRENT

Filed Oct. 24, 1925 2 Sheets-Sheet 1

Fig. 1.

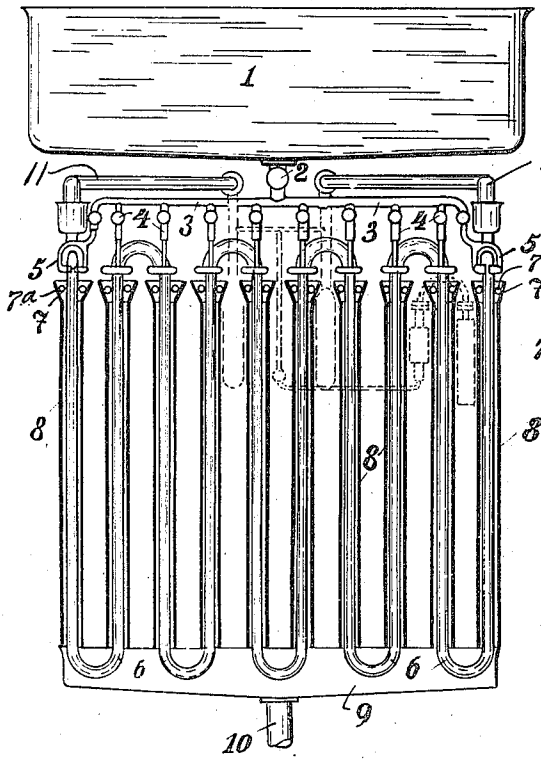


Fig. 2.

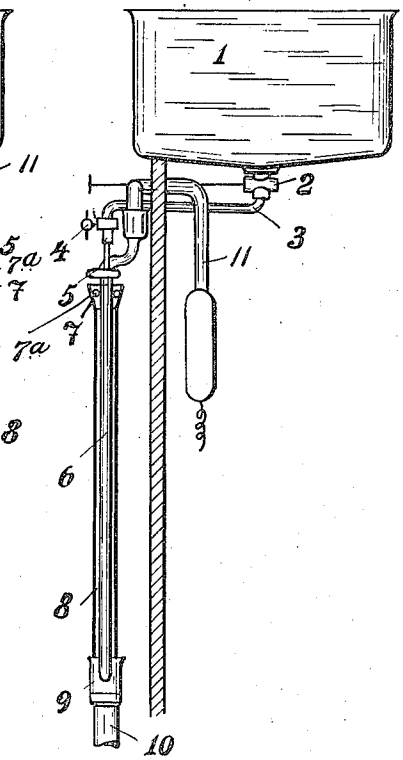


Fig. 3.

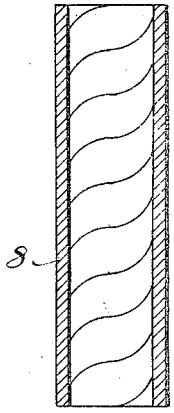
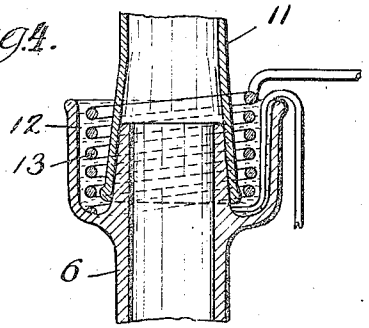


Fig. 4.



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Fig. 5

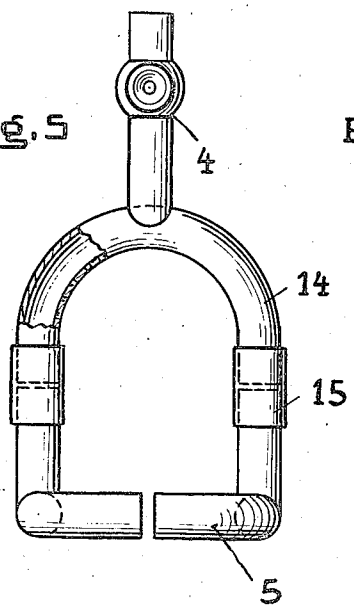


Fig. 6

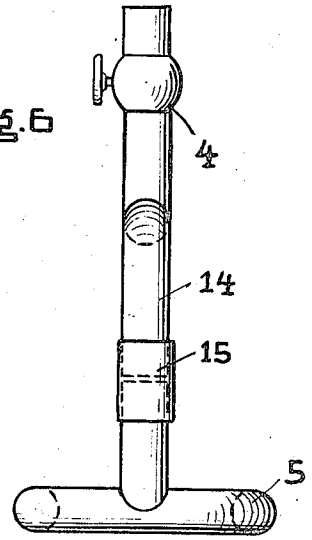
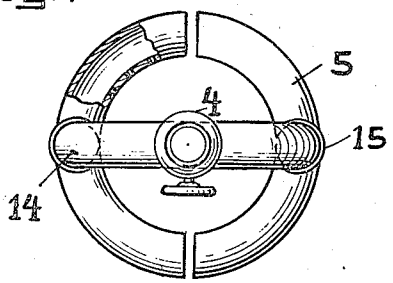


Fig. 7



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UNITED STATES PATENT OFFICE.

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STERILIZATION OF CLEAR AND TURBID LIQUIDS BY MEANS OF ULTRA-VIOLET RAYS PRODUCED IN VACUUM TUBES BY HIGH-VOLTAGE ELECTRIC CURRENT.

Application filed October 24, 1925, Serial No. 64,676, and in Germany September 5, 1925.

My invention relates to the sterilization of clear and turbid liquids by means of ultra-violet rays produced in vacuum tubes by high voltage electric current.

The sterilizing action of ultra-violet rays (chemically acting waves) is known. Hitherto a mercury vapor lamp made of quartz has been employed for the sterilization of liquids and also in therapeutics. In therapeutics the ultra-violet rays have found extensive application, whereas they have been employed to only a limited extent in the industries. The reason may be that the mercury vapor lamp made of quartz is too sensitive for industrial purposes and that the consumption of current is too great as compared with the results obtained.

The object of my invention is to eliminate this drawback and to make the ultra-violet rays available for general use and for any manner of application by reducing the consumption of electric energy, thus making its use economical.

According to my invention the well-known process according to Moore and disclosed in his United States Patent No. 702,315, dated June 10, 1902, in which vacuum tubes containing attenuated gases, of which argon, carbon dioxide, hydrogen and oxygen are examples, are subjected to the passage of high frequency alternating current stepped up by appropriate transformers from the ordinary alternating current. House-lighting circuit is used for the production of ultra-violet rays, which light rays are produced by the transformation of high-voltage alternating current.

For the purpose of obtaining a sterilizing action the sterilizing tubes, hereinafter designated as tubes 6, are filled with an appropriate gas according to whether they should produce stronger or weaker ultra-violet rays, the generation of heat rays being almost perfectly avoided, while ultra-violet rays are developed in large quantities.

In certain of the adaptations of the Moore system as known, the vacuum tube is apportioned into two bulbous portions in each of which terminates an electrode, said bulbous portions being connected by an elongated glow tube. The apparatus of the present invention is conveniently combined with the Moore apparatus by substituting the sterilizing coil hereinafter more fully described for the elongated portion of the Moore glow tube.

Instead of tubes of glass employed in Moore's system, tubes of pure mountain crystal or pebble-crystal are employed through which the chemically acting rays may pass unobstructedly.

I have ascertained that, by using such tubes with the correct composition of gas for the generation of the rays the sterilization of clear or turbid liquids may be carried out within a few seconds, whereas the mercury vapor lamp heretofore employed requires several minutes up to one hour for the sterilization, according to whether clear or turbid liquids are to be treated. A much larger quantity of liquid can therefore be treated during a given time interval by the new process than with the known mercury vapor lamp.

Experiments made with large quantities of milk showed a reduction of exceedingly numerous bacteria up to 0, 3% after a radiation exposure of only 6 seconds, the spore-formation agents having been destroyed entirely.

The apparatus of my invention is formed mainly of quartz, porcelain and glass and therefore from a hygienic standpoint can hardly be excelled. Attendance on the device is required only for switching in the current and for opening the cocks or taps through which the liquid is poured over the tubes. The liquid flows down the quartz tubes and streams around them in a circle in a thickness of about ½ mm. The quartz tubes are surrounded by porcelain jackets or shells between which and the tubes there is a space of only about ½ mm., in which space there is enclosed a jacket of liquid closed at the top around the quartz tube. The liquid which drips off the tubes at the lower ends of the jackets is caught by a porcelain gutter and is discharged at the lower end of the latter. During the process of sterilization the temperature of the liquid rises by about 3 to 5° C. only. The nutrition value of the milk is not only maintained but it has been ascertained that the vitamines are increased by the radiation.

Special attention has been paid to the joining of the glass of the Moore tube designated by the reference character 11 in the accompanying drawings with the quartz of

the sterilizing tubes in this device. The two materials cannot be united by welding. They are therefore provided with conically ground joints. It is necessary that the ground glass of the Moore tube should be placed over the ground quartz of the sterilizing tube because quartz hardly expands at all, whereas glass expands to a greater degree when slightly heated. The joint is surrounded by mercury indicated at 12 in the drawing. Even with the ground seats the ground joint would not keep tight in spite of the mercury seal since the expanding glass loosens the ground joints and the mercury would pass through the ground joints into the tube. The mercury is therefore cooled, for which purpose a cooling coil 13 is provided in the mercury. This coil is traversed by cold water and thus the ground joint is kept permanently tight.

The uniform distribution of the liquid over the quartz tubes is attained by delivering it around the tube in uniform jets by means of two semi-annular tubes perforated at the inner circumference. Small balls of glass located in the charging funnel effect in any case a perfectly uniform covering of the sterilization tube with the liquid to be sterilized.

An apparatus for carrying out my invention is illustrated by way of example in the accompanying drawing.

In the drawing is:

Fig. 1, a sectional front elevation,

Fig. 2, a side elevation,

Fig. 3 is a longitudinal section through a portion of one of the porcelain jackets, showing the internal spiral groove of said jacket,

Fig. 4 is a longitudinal section through one of the mercury sealed joints between a Moore tube and the quartz tube over which the liquid to be treated flows,

Fig. 5 is a side elevation of one of the cocks controlling the flow of the liquid to be treated over the quartz tube and the semi-annular tubes associated with said cock,

Fig. 6 is an elevation of the parts shown in Fig. 5 at a right angle to Fig. 5, and

Fig. 7 is a plan view of the parts shown in Figs. 5 and 6.

The liquid to be sterilized, such as milk, is poured into the container 1 and flows through the cock 2 into the distribution pipe 3. Cocks 4, connected at their upper ends with the liquid distribution pipe 3, have at their lower ends forked branches 14 which at their lower ends are connected to the semi-annular tubes 5 perforated along their inner circumferences which distribute the liquid over the sinuous quartz tubes 6. The perfectly uniform distribution of the liquid over the tubes 6 is effected by the glass balls 7^a located in the charging funnels 7. The liquid is now caught by the porcelain tubes 8 having internal spiral surfaces (see particularly Fig. 3) and which surround the quartz tubes 6. The tubes 8 are internally gilded for the purpose of reflecting the rays. The liquid thus flows around and descends along the sterilization tubes 6. The lower turns of the quartz coils dip into a catch gutter 9 made of porcelain in which the liquid treated by radiation is collected to be discharged through the discharge pipe 10. If milk is sterilized in the apparatus it may be filled directly into bottles by means of suitable bottle filling devices or it may be caught in larger containers for further treatment.

The apparatus of my invention may be modified by those skilled in the art without departing from the spirit or the ambit of my invention and it is intended that these be covered by the appended claims:

What I claim is:—

1. An apparatus for sterilizing liquids by means of ultra-violet rays generated by high-voltage electric current, comprising a long sinuous quartz tube which by being charged to an attenuated degree with an appropriate attenuated gas, known for the purpose produces in the vacuum tube purely chemically acting ultra-violet rays, said quartz tube being connected at its ends with a glass tube, similarly charged with attenuated gas and carrying the opposite electrodes of a source of high frequency current.

2. An apparatus for sterilizing liquids by means of ultra-violet rays generated by high-voltage electric current, comprising a long sinuous quartz tube which by being charged to an attenuated degree with an appropriate attenuated gas, known for the purpose produces in the tube purely chemically acting ultra-violet rays, said quartz tube being connected at its ends with a glass tube, similarly charged with attenuated gas and carrying the opposite electrodes of a source of high frequency current, and semi-annular tubes perforated at their inner circumferences located at the upper bends of said quartz tube for applying the liquid to said quartz tube in such a manner that the said quartz tube is covered by a film of liquid along its entire length.

3. An apparatus for sterilizing liquids by means of ultra-violet rays generated by high-voltage electric current, comprising a long sinuous quartz tube which by being charged to an attenuated degree with an appropriate attenuated gas, known for the purpose produces in the tube purely chemically acting ultra-violet rays, said quartz tube being connected at its ends with a glass tube, similarly charged with attenuated gas and carrying the opposite electrodes of a source of high frequency current, and a porcelain tube surrounding said quartz tube and provided

on its inner surface with spiral grooves to impart a rotating motion to the liquid descending around said quartz tube and to produce a closed jacket of liquid in the space between said two tubes by adhesion and to obtain a longer exposure of the liquid to the radiation.

4. An apparatus for sterilizing liquids by means of ultra-violet rays generated by high-voltage electric current, comprising a long sinuous quartz tube which by being charged to an attenuated degree with an appropriate attenuated gas, known for the purpose produces in the tube purely chemically acting ultra-violet rays, said quartz tube being connected at its ends with a glass tube, similarly charged with attenuated gas and carrying the opposite electrodes of a source of high frequency current, semi-annular tubes perforated at their inner circumference located at the upper bends of said quartz tube, a porcelain tube surrounding said quartz tube and provided on its inner surface with spiral grooves, a charging funnel at the upper end of said porcelain tube and small glass balls within said funnel for uniformly distributing the liquid over the surface of said quartz tube.

5. An apparatus for sterilizing liquids by means of ultra-violet rays generated by high-voltage electric current, comprising a long sinuous quartz tube which by being charged to an attenuated degree with an appropriate attenuated gas, known for the purpose produces in the tube purely chemically acting ultra-violet rays, said quartz tube being connected at its ends with a glass tube, similarly charged with attenuated gas and carrying the opposite electrodes of a source of high frequency current, semi-annular tubes perforated at their inner circumferences located at the upper end of said quartz tube, a porcelain tube surrounding said quartz tube and having its inner surface provided with spiral grooves and gilded for reflecting the rays, a charging funnel at the upper end of said porcelain tube and small glass balls within said funnel for uniformly distributing the liquid over the surface of said quartz tube.

6. An apparatus for sterilizing liquids by means of ultra-violet rays generated by high-voltage electric current, comprising a long sinuous quartz tube which by being charged to an attenuated degree with an appropriate attenuated gas, known for the purpose produces in the tube purely chemically acting ultra-violet rays, said quartz tube being connected at its ends with a glass tube, similarly charged with attenuated gas and carrying the opposite electrodes of a source of high frequency current, semi-annular tubes perforated at their inner circumferences located at the upper end of said quartz tube, a porcelain tube surrounding said quartz tube and having its inner surface provided with spiral grooves and gilded for reflecting the rays, said quartz tube and said glass tube being joined by means of ground surfaces surrounded by mercury, a coil traversed by cold water for cooling said ground joint, a charging funnel at the upper end of said porcelain tube and small glass balls within said funnel for uniformly distributing the liquid over the surface of said quartz tube.

In testimony whereof I have hereunto set my hand.

ERNST OTTO SCHEIDT.