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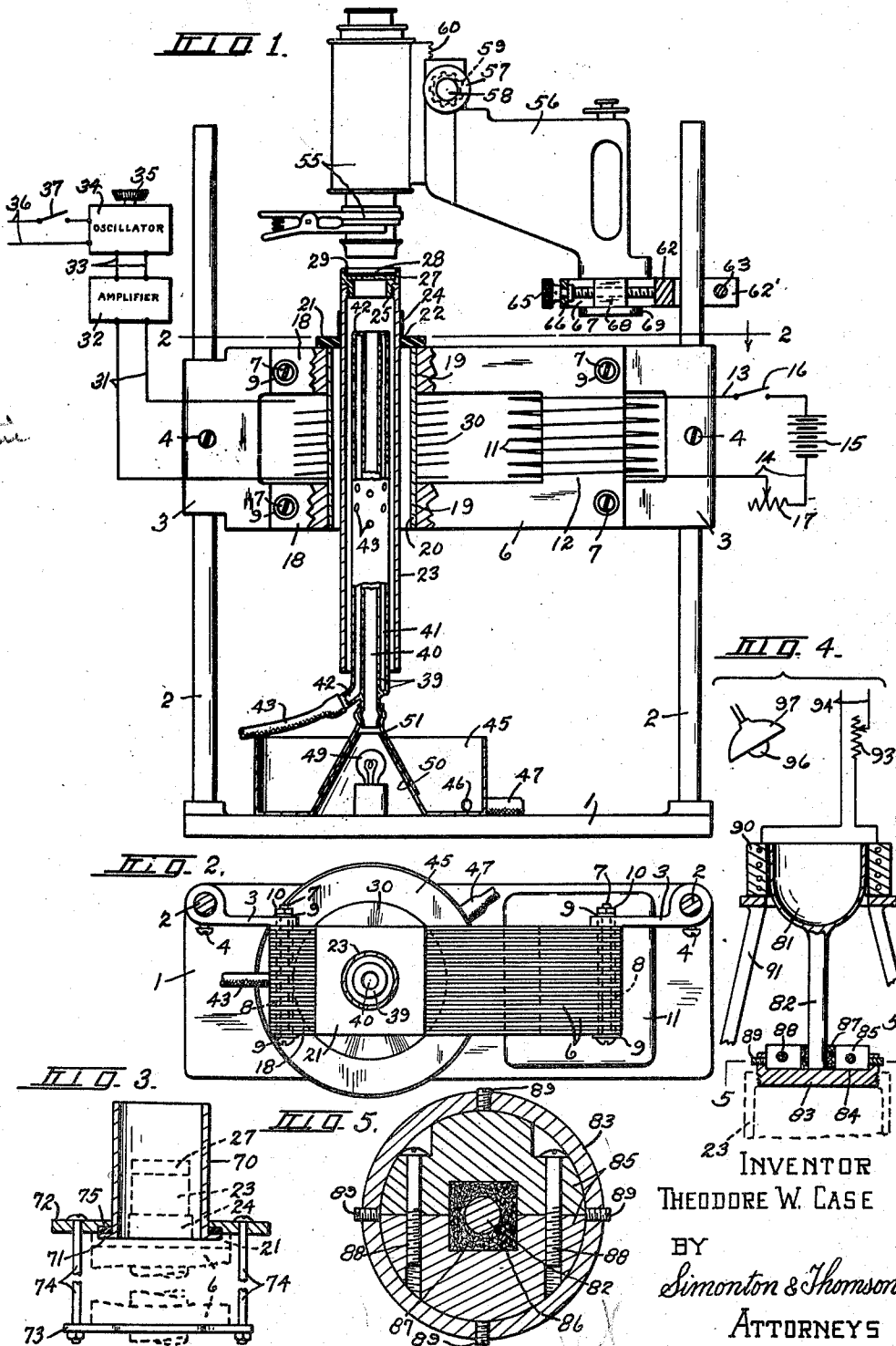
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APPARATUS FOR PRODUCING HIGH FREQUENCY MECHANICAL VIBRATIONS

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APPARATUS FOR PRODUCING HIGH FREQUENCY MECHANICAL VIBRATIONS

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5 Claims. (Cl. 73—51)

This invention relates to an apparatus for producing high frequency mechanical vibrations.

The main object of the invention is to produce a highly efficient apparatus adapted to produce a magnetostriction effect which is peculiarly adapted to subject numerous products, such as metals in either a solid or molten state, liquids, various forms of animal or plant life, cell structures produced by disease, etcetera, to the action of high frequency mechanical vibrations. My improved apparatus is also adapted to treat materials or bodies which are in a liquid state and which may become solid irrespective of temperature, for instance, a material which solidifies through the evaporation of a liquid or from any other cause.

Another object of the invention is to provide a simply constructed apparatus of the above mentioned class whereby not only a molten mass may be subjected to high frequency mechanical vibrations while normally and naturally solidifying but the mass may also be maintained at a desired temperature or state of semi-solidity during the action of said vibrations thereon.

A further object of the invention resides in so arranging the mechanism of the apparatus for producing the high frequency mechanical vibrations that a microscope may be mounted in co-operative relation therewith and changes in the structures or textures or other characteristics of the product being subjected to such high frequency vibrations may be observed thereby.

Other objects reside in providing the apparatus with a simple efficient cooling device and with means for illuminating the products being subjected to the mechanical vibrations while under microscopic observation.

I attain these objects by mechanism illustrated in the accompanying drawing, in which:

Figure 1 is a side elevation of an apparatus embodying the various features of this invention, certain mechanical portions thereof being shown broken away and in section and the electrical units which are incorporated therein being shown diagrammatically.

Figure 2 is a horizontal sectional view taken substantially in the plane of line 2—2, Figure 1.

Figure 3 is a longitudinal sectional view of a container adapted to be mounted on the apparatus illustrated in Figure 1 for maintaining a quantity of liquid in position to be subjected to the high frequency mechanical vibrations.

Figure 4 is a vertical sectional view illustrating a crucible adapted to be connected with the apparatus shown in Figure 1 when it is desired

to subject molten metal to the action of high frequency mechanical vibrations, said crucible being illustrated associated with a suitable furnace of the electric type whereby the temperature of the material contained in the crucible may be maintained substantially constant or varied at will to maintain such material in a molten state, or to transform the same from a solid to a molten state or to increase the cooling period thereof.

Figure 5 is an enlarged transverse sectional view taken on line 5—5, Figure 4.

The structure shown in the drawing for carrying out my invention comprises a base 1 having a pair of posts 2 extending upwardly therefrom. Upon the posts 2 are adjustably mounted a pair of supporting brackets 3 which may be secured in the adjusted position by screws 4 mounted in the brackets and which have engagement with the posts. The brackets 3 extend inwardly from the posts 2 toward each other and have connected thereto a laminated supporting frame 6 which is fixedly secured to the brackets by bolts 7 as illustrated in Figures 1 and 2. The frame 6 is preferably electrically insulated from the brackets 3 as by tubes 8 and washers 9 composed of rubber or other insulating material. The tubes 8 are mounted upon the bolts 7 to extend through the adjacent portions of the frame 6 and brackets 3, while the washers 9 are mounted between the heads of the bolts and the frame 6 and between the nuts 10 and brackets 3.

The frame 6 is a substantially U-shaped member having a magnetizing coil 11 wound upon the transverse portion 12 thereof. This coil 11 is shown connected by wires 13 and 14 to a suitable source of low voltage potential such as the battery 15. A switch 16 may, as shown, be connected in one of the wires, as 13, for opening and closing the circuit. The current passing through the coil 11 from the battery 15 magnetizes the frame 6 and in order that the magnetic field thus produced may be adjusted to produce the required magnetism for obtaining maximum mechanical vibrations, an adjustable resistance or rheostat 17 may be connected in one of the wires, as 14, whereby the voltage of the current may be readily controlled. It will thus be seen that the yoke portion 12 of the frame 6, when magnetized, forms the core of an electro-magnet and that the arms 18 of the frame, which extend in spaced substantially parallel relation with each other, form the pole pieces of the magnet.

The frame 6 is mounted on the brackets 3 with the arms 18 thereof arranged one above the

other while the outer end portions of these arms are provided with holes 19 which are adapted to align with each other. In these holes 19 is fixedly secured a tubular core 20 composed preferably of rubber, Bakelite or other non-conducting material.

Mounted upon the upper surface of the upwardly disposed arm 18 is a holding pad 21 composed of non-conducting resilient material such as soft sponge rubber. This pad may be secured to the frame 6 in any suitable manner as by glue. The pad 21 is arranged over the hole 19 and is provided with an aperture 22 extending therethrough in substantially coaxial relation with the tube 20. The aperture 22 is of less diameter than the interior of the tube 20 and slidably receives therethrough a vibratile member 23. This member 23, as illustrated in the drawing, is of tubular form and is preferably composed of nickel or other suitable magneto-strictive material which when subjected to high frequency oscillating electric current will be caused to vibrate longitudinally. The tube 23 is preferably provided with a close sliding fit in the aperture 22 so that said tube may be readily removed from said aperture or be inserted therein.

The tube 23, as shown in Figure 1, is slightly enlarged in diameter adjacent the upper end thereof by a winding of friction tape 24, said tape being arranged to engage the pad 21 for releasably maintaining said tube in a predetermined vertical position with respect to the frame 6 and tube 20. The upper end of the vibratile member or tube 23 is preferably arranged to extend a short distance above the frame 6 and is provided with screw-threads 25 in the interior thereof.

Mounted on the upper end of the tube 23 is a cap 27, which has screw-threaded engagement with the screw-threads 25. The outer end portion of the cap 27 is closed by a diaphanous wall or window 28 composed preferably of quartz, glass or the like mounted in said cap. The wall or window 28 is maintained in operative position by an angular flange or bezel 29 formed on the cap and which preferably projects a short distance above the wall 28 for maintaining objects being treated on the wall.

Mounted on the tube 20 intermediate the arms 18 is a vibrating or inductive coil 30 which is electrically connected by wires 31 with an amplifier 32. The amplifier 32 in turn is connected by wires 33 with an oscillator 34. The oscillator 34 and amplifier 32 may be of any suitable construction for producing high frequency electrical vibrations in the current passing through coil 30 and which is in accordance with the frequency at which the vibratile member or tube 23 will most efficaciously oscillate. The oscillator 34 may, as indicated, be provided with a suitable control 35 by which it may be tuned to the required frequency.

The oscillator 34 is connected by wires 36 with a suitable source of potential such as the usual 110 volts 60 cycle lighting circuit (not shown). A switch 37 may be incorporated in the circuit 36 for opening and closing said circuit.

Within the vibrator 23 is mounted a cooling tube 39 which has a central aperture 40 extending longitudinally therethrough providing an unrestricted light passage through the tube 39. Surrounding the passage 40 is a fluid chamber 41 having an inlet 42 adapted to be connected as by a flexible tube 43 with a suitable source of water or other cooling medium. The upper end of the

chamber 41 is closed by a wall, as indicated at 42, while the outer peripheral wall of said chamber is provided with a plurality of perforations 43 through which the cooling medium may pass from the chamber 41. The cooling medium passing through perforations 43 comes into contact with the inner wall of the vibratile member 23 for cooling said latter member. The tube 39 is of less diameter than the interior of the vibratile member 23 while the lower end of said vibratile member is open so that the cooling medium sprayed against the wall thereof may flow downwardly and out at said lower end and be collected in a suitable receptacle or catch-basin 45 mounted upon the base 1 beneath the vibratile member. The receptacle or catch-basin 45 is provided with an outlet 46 which has a drain tube 47 connected therewith.

Mounted upon the base 1 beneath the passage 40 in the tube 39 is an incandescent lamp 49 arranged so that light rays radiating therefrom will pass upwardly through the passage 40 and the diaphanous wall 28. Any suitable means such as the usual house circuit (not shown) may be employed for lighting lamp 49. The receptacle 45 is provided with a conical wall 50 extending upwardly from the bottom thereof and which surrounds said lamp 49. The central portion of the tube 39 is extended a short distance below the inlet opening 42 and has secured thereto a flexible shield 51 composed of rubber, leather or the like. This shield 51 is of substantially conical formation adapted to extend over the upper end portion of the conical wall 50. It will thus be observed that the shield 51 operatively connects the cooling tube 39 with the receptacle wall 50 and coacts with said wall for preventing the cooling medium coming into contact with the lamp 49 and at the same time maintaining a continuous light passageway from the lamp to the diaphanous wall 28.

Mounted over the upper end of the vibratile member 23 and frame 6 is a microscope 55 which may be of any suitable construction. This microscope is mounted upon a bracket 56 and may be adjusted vertically with respect to the bracket 56 to bring the lens thereof into focus with the product positioned upon the wall 28 of the vibratile member 23 by means of a finger knob 57 secured to a shaft 58 journaled in the bracket 56. The shaft 58 may, as indicated by broken lines in Figure 1, be provided with a pinion 59 which is in meshing engagement with a rack 60 associated with the microscope 55. The bracket 56 is secured to a base 62 which in turn is mounted on one of the posts 2. The base 62 is preferably releasably clamped to the post as by a screw 63 passing through a split extension 62' so that the bracket may be adjusted longitudinally of the posts to bring the microscope to the correct elevation with respect to the vibratile member 23.

Furthermore, the microscope 55 may be swung about the post 2 to bring the same into and out of cooperative alignment with the vibrating member 23 when the base 62 is released from clamping engagement with the post 2.

The bracket 56 is adjustable lengthwise of the base 62 toward and from the post 2 by means of a screw 65 which is rotatably mounted in a plate 66 secured to the outer end of the base 62. The screw 65 extends inwardly through an elongated slot 67 provided in the base 62 and has screw-threaded engagement with a pendant portion 68 formed on the lower end of the bracket 56. Portion 68 extends downwardly through the

slot 67 and a guide plate 69 may, as indicated in Figure 1, be secured to the lower end of the extension for holding the bracket 56 in cooperative relation with the base 62.

The operation of the apparatus thus far described will now be understood to be substantially as follows:

A quantity of the material to be treated may be placed upon the wall or window 28, after which electric current may be supplied to the oscillator 34 and vibrating coil 30 by closing switch 37. Likewise, electric current may be supplied to the magnetizing coil 11 by closing switch 16. The oscillator 34 may next be tuned by manipulation of suitable controls, as indicated at 35, to the frequency at which the nickel tube 23 will vibrate most efficiently, that is, to the mechanical resonant frequency of said tube. It will be understood that the high frequency vibrating current supplied to coil 30 from oscillator 34 and amplifier 32 will produce mechanical vibration or oscillation of the nickel tube 23 in the direction of its axis. This vibration of the tube 23 will occur even though the frame 6 is not magnetized. However, when the frame 6 is properly magnetized, the vibration of tube 23 is appreciably enhanced. This vibratory action of tube 23 seems to be produced by the elongating and shortening in rapid succession of the tube from a position or nodal point substantially midway between the ends thereof toward and from said ends. The natural frequency of mechanical vibration of the tube 23 will vary somewhat in tubes of different lengths and diameters, but in a tube similar to the one illustrated in Figure 1 having a diameter of about one inch and a length of approximately six and one-half inches, the natural frequency of oscillation or vibration thereof is substantially fourteen thousand per second. It, therefore, follows that in order to cause the tube to oscillate at this high frequency, the oscillator 34 must be tuned to produce a similar high frequency vibration in the electric current supplied therefrom to the vibrating coil 30.

It thus follows that if a vibrating tube of another size is utilized, the oscillation in the current passing through coil 30 may be readily varied to bring the same into accord with the natural frequency of vibration of the tube by tuning the oscillator accordingly. This high frequency mechanical vibration of the tube 23 operates with a very great force and will act accordingly on any material deposited upon the wall or window 28, although the degree of axial movement of the tube is relatively slight. The maximum axial movement of the tube seems to be obtained when said tube is at a normal, comparatively cool temperature and, therefore, it is desirable that said tube be maintained at substantially atmospheric temperature to attain the highest degree of efficiency of the tube. For this purpose, a cooling medium, as water, may be sprayed as by means of the cooling tube 39 against the inner wall of the vibrating tube 23 which, as hereinbefore stated, is collected as it escapes from tube 23 in the receptacle 45 and passes from said receptacle by flowing through the outlet tube 47.

The effect of the high frequency mechanical vibrations produced by the tube 23 upon the material carried thereby may, of course, be readily observed by means of microscope 55 which may be readily adjusted to bring the same into proper relation with the material carried by the

vibrating tube in the manner hereinbefore described.

A suitable amount of light may be directed upon the material being treated by means of the incandescent lamp 49, as illustrated in Figure 1. However, it will be understood that other means may be utilized for illuminating the material being carried by the vibrating tube 23.

If the material to be treated is a liquid, the receptacle or container illustrated in Figure 3 may be mounted over the upper end of the tube 23 for maintaining the liquid or a portion thereof in operative relation with said end of the tube to be subjected to the mechanical oscillations of the tube. This receptacle or container 70, as illustrated in Figure 3, is a tubular member adapted to be mounted over the upper end of the tube 23 as indicated by broken lines in Figure 3. The lower end of the tube 70 is provided with an outwardly extending annular flange 71 adapted to rest upon the pad 21. The tube 70 is clamped to the frame 6 by means of an upper plate 72 and a lower plate 73 arranged adjacent the upper and lower surfaces, respectively, of the arms 18 of frame 6, said plates being connected by bolts or screws 74 arranged at either side of the frame arms. A suitable packing 75 may, as shown, be positioned between the upper clamping plate 72 and the flange 71 of the tube 70 for causing the clamping plate to yieldingly engage said flange.

It will be understood that when the clamping bolts 74 are drawn tightly against the plates 72 and 73 the lower end of the tube 70 will be held tightly against the resilient pad 21 which surrounds the tube 23 and coacts with said pad for preventing the escape of the liquid between the pad 21 and the lower end of the tube 70 and the adjacent portion of the tube 23. When using the container 70, a sufficient amount of liquid is poured therein to cover the upper end of the tube cap 27 so that the portion of the liquid lying over the upper end of the tube 23 will be subjected directly to the vibratory action of said tube.

In Figures 4 and 5, I have illustrated a crucible 81 adapted to be used with the vibrating tube 23 when it is desired to subject a material to the mechanical vibrations while said material is under the influence of a more or less high degree of temperature. This crucible 81 may be composed of quartz, metal or other suitable material and is provided with an elongated stem 82 projecting downwardly from the bottom thereof. This stem 82 is of considerably less diameter than the crucible 81 and has the lower end thereof removably connected with the upper end of the vibrating tube 23 in the following manner:

A nut or plug 83, adapted to be screw-threaded into the upper end of the vibratile tube 23 in place of the cap 27, is provided with a recess 84 in the upper surface thereof. In this recess 84 is mounted a clamp 85 provided with a central opening 86 adapted to receive the lower end of the stem 82 therein. This opening 86 is preferably of considerably greater cross sectional area than that of the lower end of the stem 82 for the reception of a packing 87 composed of asbestos or other heat-resisting material for yieldingly connecting the stem 82 with the clamp 85. The clamp 85, as illustrated in Figure 5, is composed of two sections secured together by screws 88. The clamp 85 is releasably secured in the recess 84 by screws 89 screw-threaded

in the plug or nut 83 to operatively engage the peripheral wall of the clamp.

The stem 82 extends downwardly through the opening 86 and has the lower end thereof in direct contact with the inner or bottom wall of the recess 84, as illustrated in Figure 4, so that mechanical vibrations of the nickel tube 23 longitudinally thereof will be directly transmitted by the nut or plug 83 and stem 82 to the crucible 81. Surrounding the crucible 81 is an electric furnace 90 which may be of any suitable construction and may be supported in cooperative relation with the crucible in any suitable manner as by a standard 91 mounted upon the frame 6 in spaced relation to the vibratile tube 23. The furnace 90 is preferably arranged in slightly spaced relation to the crucible 81 so that mechanical vibrations of said crucible produced by the vibratile tube 23 will not be transmitted to the furnace 90. The temperature of the furnace 90 may be controlled in any suitable manner as by a rheostat 93 connected in the circuit 94 for said furnace.

When it is desired to use the crucible 81, it is only necessary to remove the cap 27 from the upper end of the vibratile tube 23 and mount in place thereof the plug or nut 83 having the crucible connected therewith. The furnace 90 may be maintained in cooperative relation with the crucible by means of the standard 91.

It will now be observed that material to be treated placed in the crucible 81 will be directly subjected to axial oscillations of the tube 23. Furthermore, the material placed in the crucible 81 may be changed from a solid to a molten or liquid state during the treatment thereof to the high frequency mechanical vibrations or be maintained at any desired temperature above atmosphere by means of the furnace 90. Also, it will be noted that chemical or other changes in the characteristics of the material being treated may be readily observed by means of the microscope 55 when using the liquid container 70 or the crucible 81 in the same manner as when the material is mounted upon the window or wall 28, carried by the tube 23. When using the crucible 81, light may be reflected upon the material in any suitable manner as by an incandescent lamp 96 and reflector 97 mounted in a plane at one side of the crucible 81 and furnace 90, as indicated diagrammatically in Figure 4.

Although I have shown and particularly described one embodiment of my invention, I do not wish to be limited to the exact construction shown as various changes, both in the form and relation of the parts thereof, may readily be made without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. In an apparatus of the class described, a vibratile tube, means for resiliently supporting said tube in substantially a vertical position, means for vibrating said tube by high frequency electrical vibrations, means including a container open at the top and having a diaphragm bottom wall providing a window connected with the upper end of said tube for maintaining material to be treated in cooperative relation with the tube, means including a spray tube mounted within the vibratile tube for supplying a cooling medium to said latter tube, said spray

tube having a light passageway extending longitudinally therethrough, and means for directing light rays through said passageway onto said window.

2. In an apparatus of the class described, a vibratile tube composed of material having a natural frequency of mechanical vibration, means for resiliently supporting said tube in substantially a vertical position, means associated with said supporting means independently of the tube for producing said vibration of said tube including an electric circuit having a frequency of vibration substantially equal to the natural frequency of mechanical vibration of the tube, means connected with the upper end of said tube including a diaphanous wall for supporting material to be subjected to the vibratory movement of said tube, and means mounted beneath said tube for directing light rays upwardly through said tube and diaphanous wall.

3. In an apparatus of the class described, a substantially U-shaped magnetic core having two legs provided with substantially aligned apertures, a vibratile tube composed of nickel or other material susceptible to magnetostriction effect extending through said apertures, means resiliently connecting said tube with said core, a vibrating coil surrounding a portion of the tube extending between said legs, means for supplying an electric current to said vibrating coil having a frequency of vibration substantially equal to the natural frequency of the mechanical vibration of the tube, and means including a magnetizing coil mounted on the magnetic core at one side of the vibratile tube for energizing said core.

4. An apparatus for producing high frequency mechanical vibrations comprising a tubular member characterized by its high susceptibility to magnetostriction effect, means for producing a magnetic field of fluctuating intensity, means for mounting said tubular member to permit free vibration thereof within said magnetic field, supporting means including a transparent table connected to the tubular member in alignment with the interior thereof for supporting material to be subjected to the vibratory movement of said member, and means arranged in spaced relation to the window longitudinally of the tubular member for directing light rays through said tubular member on to said transparent table.

5. An apparatus for producing high frequency mechanical vibrations comprising a tubular member characterized by its high susceptibility to magnetostriction effect, means for producing a magnetic field of fluctuating intensity, means for mounting said tubular member to permit free vibration thereof within said magnetic field, supporting means including a transparent table connected to the tubular member in alignment with the interior thereof for supporting material to be subjected to the vibratory movement of said member, means including a spray tube mounted within the tubular member at one side of the table for supplying a cooling medium to said tubular member, said spray tube having a light passageway extending longitudinally therethrough, and means adjacent the outer end of the spray tube for directing light rays through said passageway on to said transparent table.

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