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Description



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Ultraviolet Liquid Treatment Apparatus

5 Technical Field:

The present invention relates generally to ultraviolet liquid treatment apparatus and methods which use ultraviolet irradiation to perform liquid treatment, such as sterilization or disinfection of liquid, killing of bacteria in the liquid, oxidation-decomposition of a very small
10 amount of organic substances in the liquid or decomposition of decomposition-retardant (hard-to-decompose) organic substances in the liquid. More particularly, the present invention relates to improvement in placement, in the ultraviolet liquid treatment apparatus, of a ballast for illuminating an ultraviolet lamp.

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Background Art:

Ultraviolet liquid treatment apparatus or systems for performing liquid treatment, such as sterilization or disinfection of liquid and killing of bacteria in the liquid by ultraviolet irradiation, have been used extensively
20 in a variety of fields including pure water production lines in the semiconductor industry, sterilized water production lines in the pharmaceutical industry, water sterilization lines in the food industry, water sterilization lines in marine product processing and cultivation of fishes, shellfishes etc., and waste water/sewage treatment lines.
25 Generally, each ultraviolet lamp used in such liquid treatment is accommodated in a hard, transparent lamp protecting pipe, made of quartz glass, in a liquid-tight manner, and each of the lamp protecting pipes with

the respective ultraviolet lamps accommodated therein is soaked in a liquid to be treated. Such ultraviolet liquid treatment apparatus or systems are classified into two major types: an open-water-path type where each ultraviolet lamp is placed in an open water path through which the liquid to
5 be treated is caused to flow; and a closed-water-path (sealed tube) type where each ultraviolet lamp is placed in a closed water path or sealed tube through which the liquid to be treated is caused to flow. The ultraviolet lamp is lit or illuminated by being supplied with predetermined high-frequency signals that are produced from a commercial A.C. power
10 supply via a lamp illuminating ballast.

In the conventionally-known ultraviolet liquid treatment apparatus, a plurality of the lamp illuminating ballasts are provided within a power supply box in spaced-apart relation to the corresponding ultraviolet lamps. The high-frequency signals output via the individual lamp illuminating
15 ballasts, provided in corresponding relation to the ultraviolet lamps, are fed via respective electric wires to the corresponding ultraviolet lamps. In the apparatus of the above-mentioned sealed tube type where the ultraviolet lamps are placed in the sealed tube, maintenance covers are provided at opposite ends of the sealed tube where the liquid to be treated is caused to
20 flow, and each of these maintenance covers defines an interior space that is shut off from the interior of the sealed tube in a liquid-tight manner but kept in communication with an interior space of each of the lamp protecting pipes. Within the space defined by the maintenance covers, the electric wires extending from the ballasts are electrically connected via sockets to
25 the corresponding ultraviolet lamps accommodated in the protecting pipes. Further, each of the ultraviolet lamps can be replaced with another one by detaching/attaching the sockets at the positions of the maintenance covers.

Because the lamp illuminating ballasts produce considerable heat during energization of the ultraviolet lamps, reliable measures must be taken to permit heat radiation. For this purpose, it has been conventional to provide a heat radiating fin or plate for each of the illuminating ballasts and also provide a cooling fan within the power supply box accommodating these illuminating ballasts. The provision of the radiating fins or plates would unavoidably increase the respective sizes of the ballasts, and, in addition, the provision of the cooling fan would unavoidably increase the overall size of the power supply box to a considerable degree. Further, the cooling fan, designed to blow air into the power supply box, tends to produce dirt due to dust, which would thus require periodic maintenance. Such periodic maintenance are also essential for a longer life of the cooling fan. Furthermore, the electric wires extending from the power supply box to the individual ultraviolet lamps, which are externally-exposed high-frequency output lines from the illuminating ballasts, would produce undesired high-frequency noise.

Disclosure of the Invention

It is therefore an object of the present invention to provide an ultraviolet liquid treatment apparatus and method which can solve at least one of the above-discussed prior art problems.

An ultraviolet ray liquid treatment apparatus in accordance with the present invention comprises a tubular path for passing therethrough liquid to be treated, a light-transmissive lamp protecting pipe provided within the tubular path to contact the liquid to be treated and an ultraviolet lamp accommodated in the lamp protecting pipe, so as to treat the liquid with ultraviolet rays irradiated by the ultraviolet lamp. The ultraviolet

ray liquid treatment apparatus of the invention is characterized in that a ballast for operating the ultraviolet lamp is provided in close proximity to the outer surface of the tubular path in such a manner that heat can be radiated to the tubular path. With the arrangement that the ballast for
5 operating the ultraviolet lamp is provided in close proximity to the outer surface of the tubular path passing therethrough the to-be-treated liquid, a cooling effect attained by the ballast indirectly contacting the to-be-treated liquid can promote heat radiation from the ballast, although the ballast does not directly contact the to-be-treated liquid. This arrangement can
10 thereby either eliminate a need for separate means for radiating heat from the ballast or reduce the size of the heat radiation means if employed. As a result, the size of the ballast can be reduced. Further, such omission or size reduction of the heat radiation means can effectively avoid the necessity for the ballast to be provided within a power supply box, for the
15 purpose of heat radiation, as was the case with the conventionally-known techniques. That is, the present invention allows the ballast to be placed in or close to the tubular path apart from the power supply box, thereby considerably downsizing the power supply box as compared to the conventional counterparts. As a result, the present invention can provide
20 an improved ultraviolet liquid treatment apparatus which does not require a large installation area for the power supply box and which can be easily applied even to a small space and can achieve improved convenience of use. To supplement the cooling effect on the ballast, there may be provided, as necessary, a cooling fan at an appropriate position on the outside of the
25 tubular path, in which case too the cooling fan can be of a small size.

In one embodiment of the present invention, there are provided a plurality of the ultraviolet lamps, and at least one single-lamp-operating

ballast corresponding to at least one of the ultraviolet lamps is provided on the outer surface of the tubular path. In this case, the single-lamp-operating ballast indirectly contacts the to-be-treated liquid in the tubular path, although not directly, so that a considerable cooling effect
5 can be obtained without provision of a particular heat radiating fin or plate.

In another embodiment of the present invention, there are provided a plurality of the ultraviolet lamps, and at least one multi-lamp-operating ballast corresponding to at least two of the ultraviolet lamps is provided on the outer surface of the tubular path. In this case, the
10 multi-lamp-operating ballast indirectly contacts the to-be-treated liquid in the tubular path, although not directly, so that a considerable cooling effect can be obtained without provision of a particular heat radiating fin or plate.

In still another embodiment of the present invention, the ballast is provided, with an adhesive having good thermal conductivity interposed
15 between the ballast and the outer surface of the tubular path. In this case, the bottom surface of the ballast can be attached, via such a thermally conductive adhesive, to the outer surface of the tubular path in close contact therewith, so that heat of the ballast can be effectively radiated via the thermally conductive adhesive to the outer surface of the tubular path, and
20 thus the cooling of the ballast through the indirect contact with the to-be-treated liquid within the sealed tube can have a sufficient effect.

In still another embodiment of the present invention, the ballast is provided, with a soft cushioning member having good thermal conductivity interposed between the ballast and the outer surface of the tubular path.
25 In this case, the flat bottom surface of the ballast can be attached, via such a soft and thermally conductive adhesive, to the curved outer surface of the tubular path in close contact therewith, so that heat of the ballast can be

effectively radiated via the thermally conductive cushioning member to the outer surface of the tubular path, and thus the cooling of the ballast through the indirect contact with the to-be-treated liquid within the sealed tube can have a sufficient effect.

5 In still another embodiment of the present invention, the ballast is provided, with a heat radiating medium interposed between the ballast and the outer surface of the tubular path. As an example, a heat radiating medium container (such as a cooling liquid tank) may be provided, on the outer surface of the tubular path, to contain a cooling medium (such as a
10 cooling liquid), and the ballast may be provided in contact with the heat radiating medium container.

 An ultraviolet ray liquid treatment apparatus in accordance with another aspect of the present invention comprises a tubular path for passing therethrough liquid to be treated, a light-transmissive lamp
15 protecting pipe provided within the tubular path to contact the liquid to be treated, an ultraviolet lamp accommodated in the lamp protecting pipe, a heat radiating section containing a heat radiating medium, and a ballast for operating the ultraviolet lamp which is provided in contact with the heat radiating section in such a manner that heat can be radiated via the heat
20 radiating medium. In this ultraviolet ray liquid treatment apparatus, the heat radiating section is provided in close proximity to the outer surface of the tubular path in such a manner that heat can be radiated to the tubular path. This ultraviolet ray liquid treatment apparatus affords the same benefits as stated above. Namely, with the arrangement that the heat
25 radiating section is provided in close proximity to the outer surface of the tubular path passing therethrough the to-be-treated liquid, the heat radiating medium, having absorbed the heat of the ballast, can be cooled

efficiently by the cool to-be-treated liquid. As a consequence, the arrangement of the present invention permits more efficient heat radiation than the conventional heat radiating means, such as a heat radiating fin, arranged to radiate heat into the air.

5 Further, the present invention provides a method for placing a ballast for operating an ultraviolet lamp in an ultraviolet ray liquid treatment apparatus comprising a tubular path for passing therethrough liquid to be treated, a light-transmissive lamp protecting pipe provided within the tubular path to contact the liquid to be treated, and an
10 ultraviolet lamp accommodated in the lamp protecting pipe. The method of the invention is characterized in that the ballast is placed in close proximity to the outer surface of the tubular path in such a manner that heat can be radiated to the tubular path.

15 Brief Description of the Drawings

Fig. 1 is a sectional view of an ultraviolet liquid treatment apparatus in accordance with an embodiment of the invention, which is of the type that passes liquid to be treated through a tubular path;

Fig. 2 is a sectional perspective view showing another embodiment
20 of the present invention;

Fig. 3 is a sectional perspective view showing still another embodiment of the present invention;

Fig. 4 is a view explanatory of an example of the ultraviolet liquid treatment apparatus where an adhesive is interposed between a ballast and
25 the outer surface of the tubular path;

Fig. 5 is a view explanatory of another example of the ultraviolet liquid treatment apparatus where a cushioning member is interposed

between the ballast and the outer surface of the tubular path;

Fig. 6 is a view explanatory of another example of the ultraviolet liquid treatment apparatus where the ballast is attached to the outer surface of the tubular path with metal fittings;

5 Fig. 7 is a schematic perspective view of still another embodiment of the present invention; and

Fig. 8 is a sectional view showing, in an enlarged scale, a cooling liquid tank and ballast box of Fig. 7.

10 Best Mode for Carrying out the Invention

Detailed description will be made hereinbelow about embodiments of the present invention, with reference to the accompanying drawings.

Fig. 1 is a sectional schematic view of an ultraviolet liquid treatment apparatus in accordance with an embodiment of the invention, which is of
15 the type that treats liquid P with ultraviolet rays by passing the to-be-treated liquid P through a sealed tubular path 1. The sealed tubular path (hereinafter referred to as a "sealed tube", for convenience of description) 1 are sealed, in a liquid-tight manner, at its opposite ends with sealing members 2 and 3. The liquid P to be treated, which is introduced
20 via an inlet 1a, is passed through the interior of the sealed tube 1 and then discharged through an outlet 1b. Ultraviolet lamp 5 is accommodated in a hard, light-transmissive lamp protecting pipe 4, made of quartz glass, in a liquid-tight manner, and the lamp protecting pipe 4 with the ultraviolet lamp 5 accommodated therein is placed in the sealed tube 1. End covers 6
25 and 7 mounted at opposite ends of the sealed tube 1 are shut off, via the respective sealing members 2 and 3, from the interior of the sealed tube 1 in a liquid-tight manner but kept in communication with an interior space of

the lamp protecting pipe 4. Namely, opposite end portions of the lamp protecting pipe 4 extend through the sealing members 2 and 3 into interior spaces defined by the end covers 6 and 7, respectively. Thus, when the ultraviolet lamp 5 is to be replaced with another or new one, the ultraviolet lamp 5 can be removed from the lamp protecting pipe 4 through either one of the ends of the protecting pipe 4, and the new ultraviolet lamp can be inserted into the protecting pipe 4 through either one of the ends. The end covers 6 and 7 can be opened and closed as desired by means of a conventionally-known mechanism (not shown); of course, these end covers 6 and 7 are opened when the ultraviolet lamp 5 is to be removed and the new one is to be inserted. Ballast 8 for illuminating the ultraviolet lamp 5 is provided at an appropriate position of the outer peripheral surface of the sealed tube 1 in close contact with the outer peripheral surface. Normally, the sealed tube 1 is made of, for example, metal having good thermal conductivity, such as stainless steel.

The function of the lamp-illuminating ballast 8 itself is similar to that of the conventionally-known counterparts; that is, the ballast 8 converts a commercial A.C. signal into a D.C. signal and then converts the D.C. signal into a predetermined high-frequency signal for illumination of the ultraviolet lamp 5. Although the ballast 8 in the example of Fig. 1 does not directly contact the to-be-treated liquid P within the sealed tube 1, it contact the to-be-treated liquid P indirectly via the sealed tube 1 by being mounted in close contact with the outer peripheral surface of the sealed tube 1. Because the sealed tube 1 is cooled by the to-be-treated liquid P, a considerable cooling effect can be achieved without provision of a particular heat radiating fan or plate. Although it has heretofore been necessary to provide a heat radiating fin or plate for the conventionally-known

lamp-illuminating ballast, the instant embodiment of the present invention can eliminate the need for providing such a heat radiating fin or plate for the ballast 8, and accordingly it can reduce the size of the ballast 8, which thereby facilitates mounting of the lamp-illuminating ballast 8 on the sealed tube 1. Of course, there may be provided a cooling fan 9 at an appropriate position on the outside (outer peripheral surface) of the sealed tube 1, to supplement the cooling effect. In such a case, it is only necessary for the cooling fan 9 to provide the supplementary cooling effect, and thus the cooling fan 9 may be of a small size.

10 The ballast 8 has an electric wire connected thereto to introduce a commercial A.C. signal from the outside. Because the electric wire is designed for introduction and delivery of the commercial A.C. signal, there will occur no significant inconveniences such as high-frequency noise. Lamp-illuminating high-frequency signal generated by the ballast 8 is fed, via a suitable electric wire, socket connector and the like, to the corresponding ultraviolet lamp 5 accommodated in the lamp protecting pipe 4. In this case, because the ballast 8 and the ultraviolet lamp 5 are located close to each other, the problem of high-frequency noise can be minimized.

Whereas only one ultraviolet lamp 5 is shown in Fig. 1, a plurality of such ultraviolet lamps 5, accommodated in the respective lamp protecting pipes 4, may be provided in the sealed tube 1, as necessary, as illustratively shown in Fig. 2 (in the illustrated example of Fig. 2, three ultraviolet lamps 5 are provided). In such a case, a plurality of the ballasts 8 are mounted on the outside of the sealed tube 1 in corresponding relation to the ultraviolet lamps 5. Each of the ballasts 8 is a single-lamp operating ballast designed to illuminate only a single ultraviolet lamp, and the lamp-illuminating high-frequency signal generated by each of the ballasts 8

is fed, via a suitable electric wire, socket connector and the like, to a corresponding one of the ultraviolet lamps 5 accommodated in the respective lamp protecting pipes 4. Although the illuminating ballasts 8 illustrated in Fig. 2 do not directly contact the to-be-treated liquid P within the sealed tube 1, they contact the to-be-treated liquid P indirectly via the sealed tube 1 so that the heat of the ballast 8 can be efficiently radiated to the sealed tube 1, by being mounted in close contact with the outer peripheral surface of the sealed tube 1. Because the sealed tube 1 is cooled by the to-be-treated liquid P, a considerable cooling effect can be achieved without a particular heat radiating fan or plate. Of course, there may be provided a cooling fan (not shown) at an appropriate position on the outer portion of the sealed tube 1. In such a case, it is only necessary for the cooling fan to attain the supplementary cooling, and thus the cooling fan can be of a small size.

Whereas each of the ballasts 8 is shown in Fig. 2 as illuminating only a single ultraviolet lamp, the ballast 8 may be constructed and used, in some case, as a multi-lamp-operating ballast for illuminating two or more ultraviolet lamps 5. As an example, the ballast 8 may be constructed and used as a multi-lamp-operating ballast for illuminating three ultraviolet lamps 5, as illustrated in Fig. 3. In such a case too, the ballast 8 is mounted at an appropriate position on the outer peripheral surface of the sealed tube 1 in close contact with the outer peripheral surface, and the lamp-illuminating high-frequency signal generated by the ballast 8 is fed, via a suitable electric wire, socket connector and the like, to the corresponding ultraviolet lamps 5 accommodated in the respective lamp protecting pipes 4. Although the ballast 8 illustrated in Fig. 3 does not directly contact the to-be-treated liquid P within the sealed tube 1, it

contacts the to-be-treated liquid P indirectly via the sealed tube 1 by being mounted in close contact with the outer peripheral surface of the sealed tube 1. Because the sealed tube 1 is cooled by the to-be-treated liquid P, a considerable cooling effect can be achieved without a particular heat
5 radiating fan or plate. Of course, there may be provided a cooling fan (not shown) at an appropriate position on the outer portion of the sealed tube 1. In such a case, it is only necessary for the cooling fan to attain the supplementary cooling, and thus the cooling fan can be of a small size.

Fig. 4 shows another example of the ultraviolet liquid treatment
10 apparatus, where an adhesive 10 having good thermal conductivity is interposed between the ballast 8 and the sealed tube 1. As an example, the adhesive 10 may be an adhesive that contains, as its primary component, silicon or other material of good thermal conductivity. In this case, if the ballast 8 has a flat bottom surface and the sealed tube 1 has a curved outer
15 peripheral surface, the flat bottom surface of the ballast 8 can be appropriately attached via such a thermally conductive adhesive 10 to the curved outer peripheral surface of the sealed tube 1 in close contact therewith with no gap formed between the bottom surface and the curved outer peripheral surface. The close contact between the entire flat bottom
20 surface of the ballast 8 and the curved outer peripheral surface of the sealed tube 1 can keep good thermal conductivity. In this way, the heat of the ballast 8 can be radiated through the adhesive 10 to the outer surface of the sealed tube 1, and thus the cooling of the ballast 8 through the indirect contact with the to-be-treated liquid within the sealed tube 1 can have a
25 sufficient effect.

Fig. 5 shows still another example of the ultraviolet liquid treatment apparatus, where a cushioning member 11 having good thermal

conductivity is interposed between the ballast 8 and the sealed tube 1. As an example, the cushioning member 11 may be a resiliently-deformable cushioning sheet having good thermal conductivity and a predetermined thickness. In this case, if the ballast 8 has a flat bottom surface and the sealed tube 1 has a curved outer peripheral surface, the flat bottom surface of the ballast 8 can be appropriately attached via such a cushioning member 11 to the curved outer peripheral surface of the sealed tube 1 in close contact therewith with no gap formed between the bottom surface and the curved outer peripheral surface. The close contact between the entire flat bottom surface of the ballast 8 and the curved outer peripheral surface of the sealed tube 1 can keep sufficient thermal conductivity. In this way, the heat of the ballast 8 can be radiated through the cushioning member 11 to the outer surface of the sealed tube 1, and thus the cooling of the ballast 8 through the indirect contact with the to-be-treated liquid within the sealed tube 1 can have a sufficient effect. In this case, the ballast 8 may be fixed to the curved outer peripheral surface of the sealed tube 1, either by applying an adhesive of good thermal conductivity to the cushioning member 11 or by winding a fastening belt around the outer surface of the sealed tube 1 from outside the ballast 8. In an alternative, the ballast 8, having the cushioning member 11 interposed between the ballast 8 and the outer surface of the sealed tube 1, may be fixed to the outer surface of the sealed tube 1 by means of metal fittings or the like. As illustratively shown in Fig. 6, there may be provided a pair of pedestals 12a and 12b at predetermined positions on the outer surface of the sealed tube 1 such that they are opposed to the opposite side surfaces of the ballast 8. In this case, the ballast 8 is mounted, via the cushioning member 11, on the outer surface of the sealed tube 1 between the two pedestals 12a and 12b.

Further, L-shape metal fittings 13a and 13b are mounted with their respective one portions abutting against the opposite surfaces of the ballast 8 and their respective other portions secured to the pedestals 12a and 12b, respectively, by suitable means such as screwing or snap-fitting engagement (screwing in the illustrated example of Fig. 6). By thus
5 attaching the ballast 8 by means of the metal fittings, the flat bottom surface of the ballast 8 can be attached via the cushioning member 11 to the curved outer peripheral surface of the sealed tube 1 in close contact therewith with no gap formed between the bottom surface and the curved
10 outer peripheral surface. Note that the cushioning member 11 may be made of any other suitable material than a resilient material as long as the material has good thermal conductivity (i.e. as long as the material has a heat radiating effect).

Next, a description will be made about another embodiment of the
15 present invention, with reference to Figs. 7 and 8. Fig. 7 is a schematic perspective view of the other embodiment, while Fig. 8 is an enlarged fragmentary view of the other embodiment. In this embodiment, a cooling liquid tank 20 is secured, by welding or otherwise, to an appropriate position on the outer peripheral surface of the sealed tube 1 in close contact
20 with the outer peripheral surface. Predetermined cooling liquid C fills the cooling liquid tank 20 in a liquid-tight manner. Similarly to the sealed tube 1, the cooling liquid tank 20 is formed of, for example, a metal material, such as stainless steel, having good thermal conductivity. Ballast box 21 is mounted on the cooling liquid tank 20 in contact therewith, and the
25 ballast 8 is accommodated in the cooling liquid tank 20. Specifically, the ballast 8 is fixed in the ballast box 21 in close contact with the wall surface of the cooling liquid tank 20 so that the ballast 8 can be cooled by the cooling

liquid C via the thermally conductive wall surface of the cooling liquid tank 20. Although the cooling liquid C is temporarily heated by absorbing the heat of the ballast 8, the close contact, with the wall surface of the sealed tube 1, of the cooling liquid tank 20 allows the cooling liquid C to be readily cooled by the to-be-treated liquid P flowing in the sealed tube 1. The cooling medium (i.e., heat radiating medium) C filling the cooling liquid tank 20 need not necessarily be a liquid medium, and it may be a gelatinous or solid medium as long as it has a cooling effect (i.e., heat radiating effect). Specifically, water or other predetermined cooling liquid or any other suitable substance having excellent heat exchanging characteristics may be used as the cooling medium C. Of course, the ballast box 21 is constructed to be opened and closed as necessary, so as to permit replacement/repair of the ballast 8 accommodated therein. It should also be obvious that the number of the ballast 8 provided within the ballast box 21 in contact with the cooling liquid tank 20 is not limited to just one; a plurality of such ballasts 8 may be provided in corresponding relation to a desired number of the ultraviolet lamps 5 provided within the sealed tube 1. Note that an operation panel 22 including switches etc. provided thereon may be mounted at an appropriate position near the ballast box 21 (e.g., on the end cover 6 of the sealed tube 1 or on a side surface of the ballast box 21). In such a case, the operation panel 22 and the ballast box 21 are of course electrically interconnected via an electric wire (not shown).

Whereas the preceding paragraphs have described the ultraviolet liquid treatment apparatus of the sealed tube type in relation to several embodiments, it should be appreciated that the basic principles of the present invention is also applicable to ultraviolet liquid treatment apparatus of the open-water-path type.

In summary, the present invention is characterized in that the ballast for operating the ultraviolet lamp is placed in close proximity to the outer surface of the tubular path that passes therethrough the to-be-treated liquid. Thus, although the ballast does not directly contact the to-be-treated liquid, a cooling effect by the ballast indirectly contacting the to-be-treated liquid can promote heat radiation from the ballast, which can thereby either eliminate a need for separate means for radiating the heat from the ballast or reduce the size of the heat radiation means if employed. As a result, the size of the ballast can be reduced. Further, such omission or size reduction of the heat radiation means can effectively avoid the necessity for the ballast to be placed within the power supply box, for the purpose of heat radiation, as was the case with the conventionally-known techniques. That is, the present invention allows the ballast to be placed in or close to the tubular path apart from the power supply box, thereby considerably downsizing the power supply box as compared to the conventional counterparts. As a result, the present invention can provide an improved ultraviolet liquid treatment apparatus and method which do not require a large installation space for the power supply box and which can be easily applied even to a small space and can achieve improved convenience of use.

CLAIMS

1. An ultraviolet ray liquid treatment apparatus comprising: a tubular path for passing therethrough liquid to be treated; a light-transmissive
5 lamp protecting pipe provided within said tubular path to contact the liquid to be treated; and an ultraviolet lamp accommodated in said lamp protecting pipe, said ultraviolet ray liquid treatment apparatus treating the liquid with ultraviolet rays irradiated by said ultraviolet lamp,
characterized in that a ballast for operating said ultraviolet lamp is
10 placed in close proximity to an outer surface of said tubular path in such a manner that heat can be radiated to said tubular path.
2. An ultraviolet ray liquid treatment apparatus as claimed in claim 1 which comprises a plurality of the ultraviolet lamps, and wherein at least
15 one single-lamp-operating ballast corresponding to at least one of said ultraviolet lamps is placed on the outer surface of said tubular path.
3. An ultraviolet ray liquid treatment apparatus as claimed in claim 1 or 2 wherein at least one multi-lamp-operating ballast corresponding to at
20 least two of said ultraviolet lamps is placed on the outer surface of said tubular path.
4. An ultraviolet ray liquid treatment apparatus as claimed in any one of claims 1 to 3 wherein said ballast is provided, with an adhesive having good
25 thermal conductivity interposed between said ballast and the outer surface of said tubular path.

5. An ultraviolet ray liquid treatment apparatus as claimed in any one of claims 1 to 4 wherein said ballast is provided, with a soft cushioning member having good thermal conductivity interposed between said ballast and the outer surface of said tubular path.

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6. An ultraviolet ray liquid treatment apparatus as claimed in any one of claims 1 to 5 wherein said ballast is provided, with a heat radiating medium interposed between said ballast and the outer surface of said tubular path.

10 7. An ultraviolet ray liquid treatment apparatus as claimed in claim 6 wherein a heat radiating medium container is provided in contact with the outer surface of said tubular path, and said ballast is placed in contact with said heat radiating medium container.

15 8. An ultraviolet ray liquid treatment apparatus as claimed in claim 7 wherein said heat radiating medium is a cooling liquid, and said heat radiating medium container is a tank filled with the cooling liquid.

9. An ultraviolet ray liquid treatment apparatus comprising:
20 a tubular path for passing therethrough liquid to be treated;
a light-transmissive lamp protecting pipe provided within said tubular path to contact the liquid to be treated;
an ultraviolet lamp accommodated in said lamp protecting pipe;
a heat radiating section containing a heat radiating medium; and
25 a ballast for operating said ultraviolet lamp, said ballast being placed in contact with said heat radiating section in such a manner that heat can be radiated via said heat radiating medium,

wherein said heat radiating section is provided in close proximity to an outer surface of said tubular path in such a manner that heat can be radiated to said tubular path.

5 10. An ultraviolet ray liquid treatment apparatus as claimed in claim 9 wherein said heat radiating medium is a cooling liquid, and said heat radiating section comprises a container filled with the cooling liquid.

11. A method for placing a ballast for operating an ultraviolet lamp in an
10 ultraviolet ray liquid treatment apparatus comprising: a tubular path for passing therethrough liquid to be treated; a light-transmissive lamp protecting pipe provided within said tubular path to contact the liquid to be treated; and an ultraviolet lamp accommodated in said lamp protecting pipe,

15 characterized in that said ballast is placed in close proximity to an outer surface of said tubular path in such a manner that heat can be radiated to said tubular path.