United States Patent

Woodbridge et al.

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[45] **June 20, 1972**

[54] IRRADIATOR APPARATUS WITH A FLUID FLOWPATH DETERMINED BY COMMUNICATING CORE AND CASTING BAFFLES

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[52] **U.S. Cl.** .....**250/44,** 250/48, 250/106 R

[51] **Int. Cl.** **G01n 21/26**

[58] **Field of Search** .....250/44, 48, 106 R, 106 S, 52

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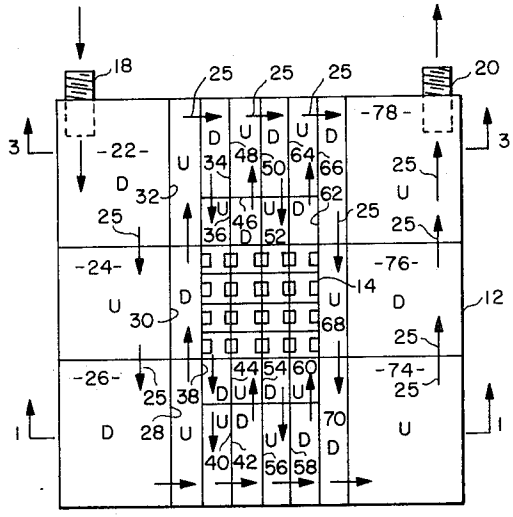
[57] **ABSTRACT**

An irradiator apparatus designed to perform a sterilization treatment or like process on waste material especially in the liquid state such as sewage or general industrial waste wherein a radiation source in the form of radioactive material is utilized to eliminate various types of micro-organisms or other undesirable elements which are carried by the liquid waste material. The apparatus includes a structure comprising a plurality of parallel baffles arranged about a substantially centrally located core mounted within the casing and structurally designed to support a plurality of radioactive material elements serving as the radiation source. The core also includes a plurality of parallel baffles which communicate with the baffles of the casing to define a somewhat serpentine flowpath along which the liquid travels as it passes through the irradiator.

8 Claims, 8 Drawing Figures



Patented June 20, 1972 3,671,741

2 Sheets-Sheet 1

FIG 4

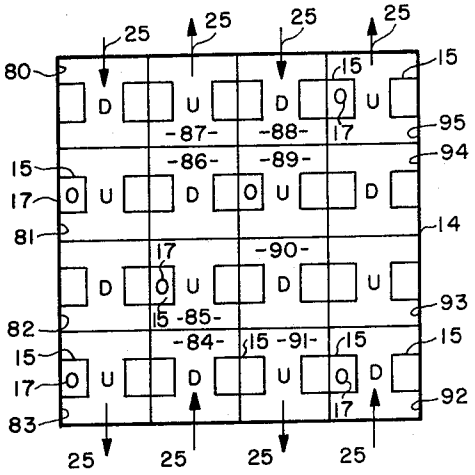
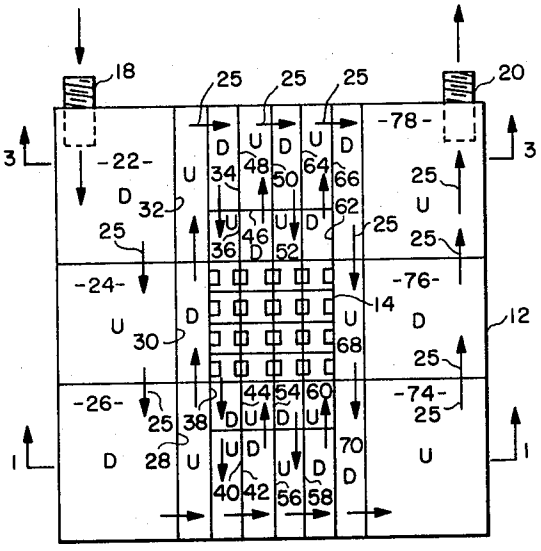


FIG 2



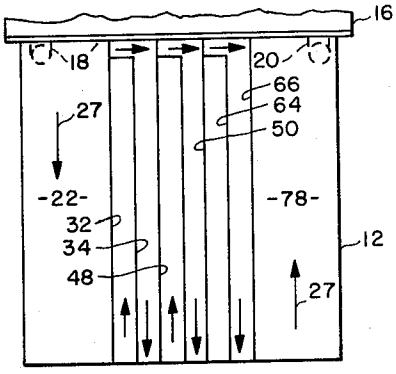


FIG 3

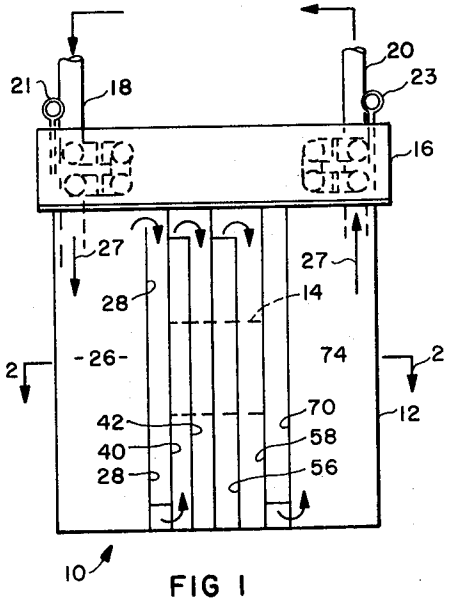


FIG 1

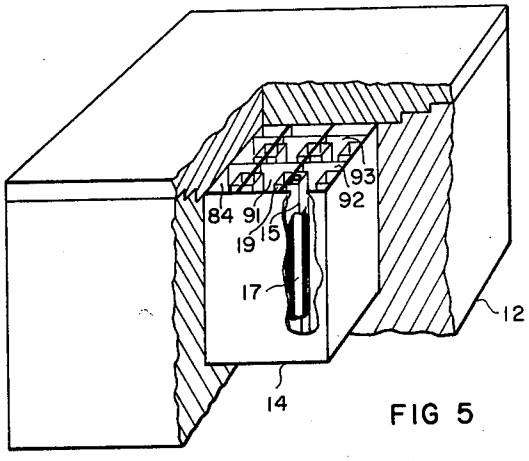


FIG 5

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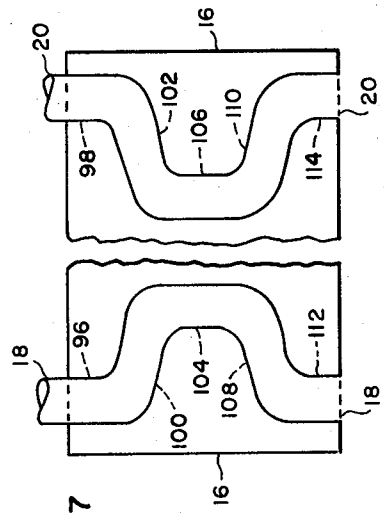

FIG 7

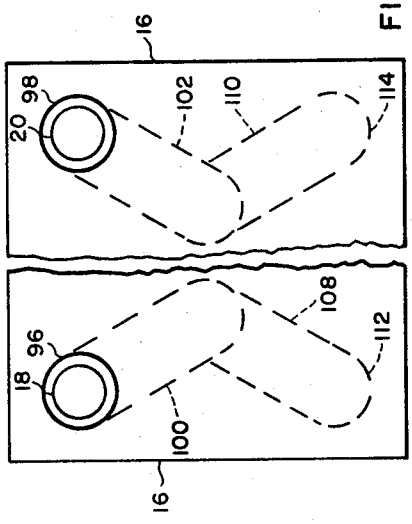

FIG 6

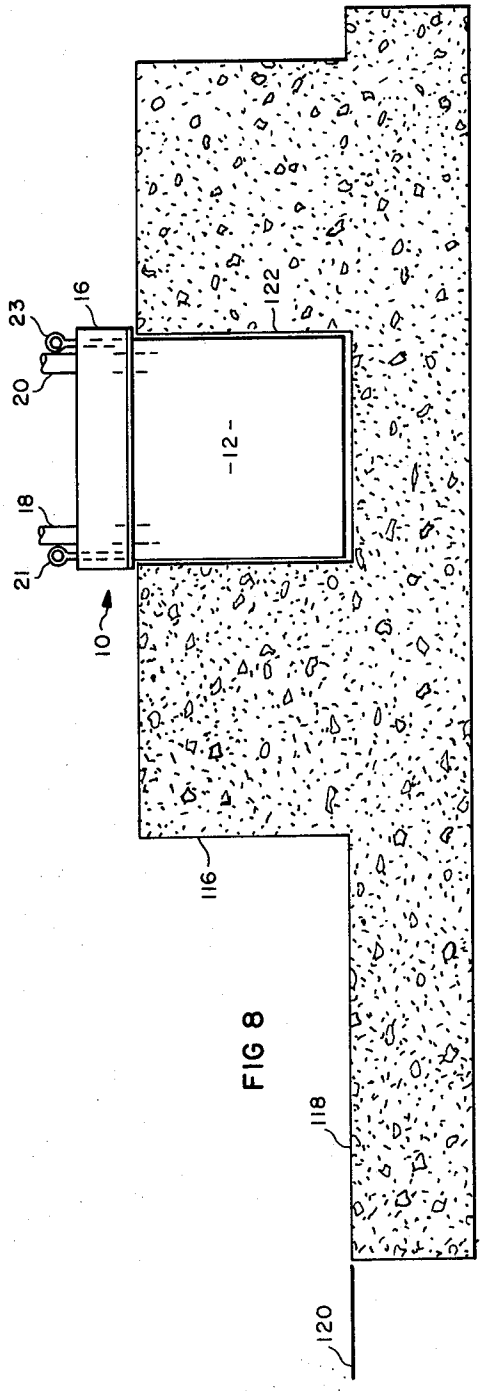

FIG 8

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IRRADIATOR APPARATUS WITH A FLUID FLOWPATH DETERMINED BY COMMUNICATING CORE AND CASTING BAFFLES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed towards an apparatus such as an irradiator, or the like, designed to sterilize or otherwise treat liquid waste, or the like, by means of radioactive material. The liquid being treated is channeled to flow throughout an area wherein it is thoroughly exposed to radiation in the form of gamma rays, or the like, for the express purpose of eliminating undesirable micro-organisms and to break down the molecular structures of the components of the waste.

2. Description of the Prior Art

Various types of prior art devices in the form of irradiators, sterilizers, and the like, have been suggested and used for the sterilization treatment or like processing of liquid material such as sewage, industrial waste or contaminated water. These prior art devices frequently involve the regulation of temperature and/or pressure for a predetermined length of time in order to accomplish the sterilization treatment. Generally these prior art devices were designed to hold the waste material under treatment at elevated temperatures and pressures for a pre-determined length of time in order to obtain a substantial kill of the micro-biological agents in the waste material. These prior art devices which utilized the regulation of temperature and pressure for the elimination of undesirable elements in the waste material are considered generally inefficient due to the expense and the relatively large amount of time needed to process relatively small amounts of liquids or waste material.

In an attempt to overcome the time and quantity limitations of temperature and pressure type sterilization devices, it was suggested that the sterilization of liquid water as well as the sterilization of foods, drugs, and the like, could be accomplished through the utilization of a radiation source in the form of ultraviolet light or the like. The processing of waste material and other liquids by exposure to this type of radiation source was frequently carried out by circulating the fluids under treatment through tubes made from a material which was transparent to the type of radiation being utilized, wherein the tubes were specifically configured so as to be arranged adjacent to the radiation source thereby allowing the radiation to pass through the tubes and onto the fluid being treated. Utilization of ultraviolet light and similar types of radiation sources for the sterilization of liquids, and the like, also contained a number of problems which rendered this type irradiator inherently inefficient. More specifically, it was found that the material being treated would become exposed to less and less radiation due either to an undesirable coating which would form on the interior walls of the tube, or to the general lack of transparency of the liquid being treated. In either case the exposure of the radiation source to the material under treatment would become minimized thereby rendering the device progressively less efficient.

With the advent of modern times the use of radioactive material in the form of various isotopes has generally become known for the treatment of liquids, gases and solids. Sterilization treatment or like processes utilizing radioactive material has proven to be highly advantageous and much more efficient than the prior art temperature and pressure sterilizers because of both the time and money saved in eliminating the thermodiffusion period required for these prior art devices. Similarly the problems connected with the exposing of various materials under treatment to radiation sources in the form of ultraviolet light have also been eliminated through the use of radioactive material in that neither the material under treatment nor the tubes in which it travels need be transparent.

While the use of radioactive material is now generally accepted as being an efficient means of sterilization or like processing of materials, numerous prior art devices now available include a number of disadvantages due to the problem of properly and efficiently exposing the radiation source to any material under treatment. More specifically, one such device provides two sets of pipes alternately wrapped around the radioactive source and encompassed within a lead shielding. The pipes and cooperating shielding are so arranged that two separate liquids may be irradiated simultaneously. However, proper and efficient placement of the radiation source has proved to be difficult. Some of these prior art devices contain a number of disadvantages rendering them not practically suitable from an efficiency standpoint for the treatment of liquid material. The disadvantages and problems present in these prior art devices include the maintaining of a desired turbulence of the liquid so that the solid contamination particles are constantly intermixed with the fluid thereby prohibiting the forming of a coating as the liquid passes through a defined path in the irradiator. This mixing of the fluid and contamination particles under treatment is necessary for proper exposure to the radiation source and consequently the required irradiation of the contaminants. Proper exposure is necessary because any "unkilled" contaminants which escape proper irradiation can rapidly grow and re-infect the entire quantity of material under treatment. Problems in prior art devices have been encountered in the efficient exposure of the radiation material to the large amount of material continuously passing through the irradiator. This inefficiency oftentimes results both from a lack of proper turbulence and from the device only being adapted to contain therein a single radiation source resulting in the problem of strategically locating the radiation source relative to the material under treatment.

SUMMARY OF THE INVENTION

The present invention is directed towards an irradiator utilizing a plurality of individual radioactive material elements or pencils used as radiation sources for the sterilization of like treatment of liquids which may include sewage and/or industrial waste. In addition the device of the present invention provides for the sterilization treatment of large volumes of liquid waste which may normally have varying amounts of solids in various forms and sizes suspended throughout the liquid. In accomplishing the sterilization or like treatment the present invention overcomes all of the above outlined problems inherent in prior art devices by the utilization of a plurality of radiation sources dispersed in a predetermined manner throughout a portion of the flowpath of the liquid passing through the irradiator.

More specifically, the irradiator or sterilization device of the present invention includes a main casing including a hollow area having a substantially cubical configuration which is positioned in the approximate center of the casing. The casing further comprises a plurality of parallel baffles arranged in a predetermined position and having various predetermined sizes in order to define the flowpath of the waste material passing into and out of the irradiator.

A radioactive material carrying core having a substantially cubical configuration corresponding to the hollow area in the casing is designed to be removably mounted or arranged within this hollow area of the casing. The core itself also comprises a plurality of parallel baffles which are arranged to cooperate in communicating relationship with certain baffles in the casing in such a manner as to define a generally serpentine flowpath relative to the parallel orientation of the baffles of both the core and the casing. Provision of the plurality of baffles in the casing and core are efficient means of increasing the turbulence in the liquid thereby accomplishing improved uniformity of radiation exposure and prevent settling of solids within the liquid. One or more elongated envelopes or sleeves are arranged within each baffle of the core and are designed to accommodate an elongated rod or "pencil" of radioactive material which may be in the form of the isotope, Cobalt 60. These sleeves are designed to be easily loaded with the pencils which are positioned directly in the flowpath thereby most ef-

ficiently exposing the radioactive material to the liquid or waste material being treated. Consequently, an important advantage of the present invention is the provision of both proper turbulence and placement of a plurality of radiation source such that no significant amount of contaminants can pass through the subject device without at least near average irradiation.

The casing includes inlet and outlet means which are angularly arranged and mounted within a cover slab or shield positioned on top of the main casing. The shield and the angularly oriented inlet and outlet means are provided to prevent the escape of harmful radiation in the form of gamma rays from the interior of the casing. As stated above the lead shield is arranged only on top of the casing due to the fact that in actual operation the casing is designed to be mounted or positioned within a concrete or like material housing which itself may be partially or completely imbedded beneath ground level.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features, and advantages of this invention will be apparent from a study of the following written description and detailed drawings in which:

FIG. 1 is a front sectional view of a preferred embodiment of the present invention taken along line 1—1.

FIG. 2 is a top sectional view taken along line 2—2 of FIG. 1.

FIG. 3 is a sectional view of a preferred embodiment of the present invention, taken along line 3—3 of FIG. 2.

FIG. 4 is an enlarged top view of the core member of a preferred embodiment of the present invention.

FIG. 5 is a cutaway view in perspective of the core member in a preferred embodiment of the present invention.

FIG. 6 is a top view of the shield member of a preferred embodiment of the present invention.

FIG. 7 is a side view of FIG. 6.

FIG. 8 is a front view of a preferred embodiment of the present invention having a portion broken away.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1 through 3 the present invention is directed to irradiator apparatus generally indicated at **10** comprising a main casing **12** which may be made from a stainless steel or like material. Casing **12** comprises a plurality of baffles arranged in adjacent parallel relation to one another along their longitudinal axes. These baffles will be described in greater detail later with relation to the specific flowpath of the liquid material as it passes through the irradiator. A core member **14** is removably mounted or arranged in a hollow area defined in the approximate center of the casing and is generally configured to correspond to the configuration of the hollow space. The core **14**, as will be explained in greater detail later, comprises a plurality of baffles also arranged in adjacent parallel relation to one another along their longitudinal axes. As clearly shown in FIGS. **2, 4** the core **14** includes support means in the form of elongated sleeves **15** each designed to carry an individual radioactive material rod or pencil **17**. More specifically, at least one sleeve **15** is attached to a partition **19** such that it exeunts into a core baffle and consequently into the flowpath of the liquid.

A cover slab or protective shield **16** is removably but securely fastened to the top of the casing **12** in such a manner as to prevent the escape of harmful radiation, in the form of gamma rays, from the interior of the casing **12**. Inlet and outlet means **18** and **20** respectively are provided for the ingress and egress of liquid to and from the interior of the casing. FIGS. **6** and **7** which will be described in greater detail later show a specific angular arrangement of conduit piping formed within shield **16** which is necessary to prevent the escape of harmful gamma rays through either the inlet **18** or outlet **20** of the casing **12**. Hook members **21** and **23** may be imbedded within the slab **16** so as to provide means for removing the relatively heavy slab from the top of the casing **12** when desired.

With specific reference to FIGS. **1, 2** and **3**, the casing **12** comprises, as pointed out above, a plurality of casing baffles which serve as flow directing means to define the flowpath of the material being treated both to and from the core **14**. More specifically baffles **22, 24** and **26** comprise the inlet communication baffles which communicate with inlet means **18**. FIG. **2** depicts the flowpath of the liquid along the longitudinal axes of the baffles as being indicated by the letter "D" or "U" which stand for a downward or upward flow direction respectively. This downward or upward directional flow is indicated by arrows **27** in FIGS. **1** and **3** respectively. Indicating arrows **25** in FIGS. **2** and **4** refer to the direction of the flowpath adjacent, communicating baffles rather than through the baffles parallel to their longitudinal axes. More specifically waste material or liquid entering inlet **18** passes downwardly, as viewed in FIG. **2**, through baffle **22**, underneath partition **29** and up through adjacent baffle **24**. Similarly, the waste material then flows over partition **31** and down through baffle **26**. As indicated by directional arrows **25** and **27** in FIGS. **1** and **2** respectively, the waste material flows down through baffle **26** underneath partition **33** and up through baffle **28** as indicated. Similarly, the waste material continues to successively flow through baffles **28, 30** and **32** in the same up and down generally serpentine fashion as indicated in FIG. **2**.

Turning now to the specific detail of the core member **14** and radiation pencil supporting sleeves **15**, FIG. **4** shows an enlarged sectional view clearly illustrating the defined flowpath. Similarly, FIG. **5** is presented for a detailed view of the core **14** and casing **12** is shown as having a removable lid member **11** seated on casing **12** along stepped joint **13** to prevent the escape of gamma rays, or the like. In addition, FIG. **5** is illustrative only in that the baffle structure of casing **12** is intentionally deleted for clarity. Upon reaching casing baffle **36** the waste material is flowing in an upward direction and at this point passes into the first baffle **80** of core member **14** (FIG. **3**). The downward and upward serpentine like flow of waste material successively continues throughout the plurality of intercommunicating, adjacent, parallel baffles arranged in core **14** in a similar fashion as described relative to baffles **22, 24, 26**, etc. of casing **12**. As indicated by arrows **25** in FIG. **4** all the baffles of core **14** are successively passed through by the waste material in a reciprocal fashion generally perpendicular to the longitudinal axes of said baffles wherein the waste material enters core baffle **80** from casing baffle **36**, travels through intermediate core baffles **81** and **82**, leaves core baffle **83** of core **14**, reenters baffle **84** of core **14** after passing through the indicated baffles **38, 40, 42** and **44** of casing **12**. The flow of liquid being treated continues to flow successively in up and down serpentine fashion through core baffles **84 - 87** and casing baffles **46, 48, 50** and **52**, whereupon it returns in the opposite direction passing through core baffles **88 - 91**. The flow continues successively in the same vertically serpentine and horizontal reciprocal fashion through casing baffles **64 – 60**, core baffles **92 - 95** and casing baffles **66, 68, 70, 74, 76** and **78** respectively, until said flow reaches outlet means **80**.

As pictured in both FIGS. **4** and **5** the radioactive material pencile **17** are supported within separate sleeves in the core baffles. These pencile **17** are readily removable and may be arranged in any desired way for efficient irradiation of the liquid being treated.

FIGS. **6** and **7** disclose detailed views of the slab having a portion broken away for clarity wherein inlet means **18** and outlet means **20** are communicating with the interior of the casing **12** and more specifically with casing baffles **22** and **78** respectively by means of angled conduits. As briefly explained above, the communicating conduit between the inlet **18** and outlet **20** and the interior of the casing must be angularly oriented to prevent the passing therethrough of gamma rays which travel in a straight line. More specifically the communicating conduits of both inlet means **18** and outlet means **20** include straight vertical sections **96** and **98** respectively which are connected to an inwardly inclined conduit section **100** and **102** as indicated. Straight conduit sections **104** and **106** are

oriented vertically downward as viewed in FIG. 7 and serve to connect outwardly oriented sections 108 and 110 to the straight portions 112 and 114 which define inlet and outlet aperturs 18 and 20 located on casing side of the shield.

FIG. 8 shows the assembled irradiator generally indicated at 10 in casing of concrete or like material housing 116 wherein the irradiator 10 is placed for operation. The concrete housing 116 has a portion 118 buried below ground level 120. The recess 122 formed in concrete housing 118 is generally configured to correspond to the shape of casing 12 so as to completely encompass all the lateral sides and bottom portion of casing 12. Consequently it can be seen that by virtue of the concrete housing 116, the protective lead slab shield 16 and the angularly arranged inlet and outlet means 18 and 20 respectively, escape of harmful radiation in the form of gamma rays is completely eliminated.

As will be clear to those skilled in the art, an irradiator or device has herein been described for irradiating liquids especially liquid wastes in the form of sewage or industrial waste and the like wherein the irradiator acts to kill mocro-organisms and further to break down contaminants such as detergents, herbicides and perticides. In the case of detergents, it has been found that they can be broken down whether they are biodegradable or not in most cases, thus simplifying the overall treatment process. It is contemplated that other embodiments are within the scope of this invention and such embodiments might for instance include a different flowpath configuration defined by the same type general parallel baffle structure within the casing and/or core. In addition the general configuration of the casing and core may be other than generally cubical as presented herein.

This invention is not to be construed as limited to these particular forms herein disclosed since these are to be regarded as illustrative rather than restrictive.

We claim:

1. An irradiator of the type utilizing radioactive material as a source of radiation for treating liquids, said irradiator comprising:

a. a casing including flow directing means to at least partially define a flowpath of said liquid as it passes through said irradiator;

b. core means mounted within said casing in communication with said flow directing means such that said flowpath of said liquid as it travels through said irradiator is partially defined by said core means;

c. said flow directing means of said casing having a plurality of baffles arranged in intercommunicating relation so as to at least partially determine a flowpath both to and from said core, said casing baffles being arranged in adjacent parallel relation to one another, each of said casing baffles intercommunicating with at least one other adjacent casing baffle, whereby said liquid is successively directed through predetermined casing baffles as it travels through said irradiator, and said core means having a plurality of baffles arranged in intercommunicating relation to one another so as to at least partially define the portion of said flowpath within said core, certain of said core baffles being positioned in intercommunicating relation with predetermined baffles of said casing, whereby a continuous flowpath from said liquid is established as it passes through said irradiator;

d. means attached to said core to support a plurality of radiation sources in exposed irradiating relation to said flowpath; and

e. inlet and outlet means cooperating with said casing to permit ingress and egress of liquid as it flows through said irradiator.

2. An irradiator as in claim 1 wherein adjacent communicating casing baffles are arranged to inter-communicate with one another such that said liquid flows parallel to the longitudinal axis of said casing baffles but in an opposite direction in each successively communicating casing baffle partially defining said flowpath; whereby said flowpath of said liquid has a generally serpentine configuration as it travels through said irradiator.

3. An irradiator as in claim 1 wherein adjacent communicating core baffles are arranged to inter-communicate with one another such that said liquid flows parallel to the longitudinal axes of said core baffles but in an opposite direction in each successively communicating core baffle partially defining said flowpath within said core; whereby said flowpath of said liquid within said core has a generally serpentine configuration as it travels through said irradiator.

4. An irradiator as in claim 1 wherein said radiation source supporting means comprises: a plurality of sleeves adapted and arranged to support a separate source of radiation, said sleeves each being mounted within one of said core baffles so as to be directly in line with said flowpath within said core.

5. An irradiator as in claim 4 wherein said sleeves have an elongated configuration designed to support a pencil of radioactive material, said sleeves each being mounted parallel to one of said core baffles.

6. An irradiator as in claim 4 wherein each if said core baffles has a plurality of sleeves mounted therein such than an individual source of radiation is removably supported within each of said sleeves.

7. An irradiator as in claim 1 further comprising a cover shield secured to said casing, said inlet and outlet means arranged on said shield in angular relation to both said shield and said casing; whereby harmful radiation is prohibited from escaping from said casing through said inlet and outlet means.

8. An irradiator of the type utilizing radioactive material as a source of radiation for treating liquids, said irradiator comprising:

a. a casing having a plurality of baffles arranged in adjacent inter-communicating relation to one another so as to define a predetermined flowpath throughout said casing, pre-determined casing baffles inter-communicating with adjacent casing baffles at points axially spaced from one another in opposite directions;

b. a core mounted within said casing in communication with said casing baffles, said core including a plurality of baffles arranged in adjacent to one another and to predetermined casing baffles so as to partially define said flowpath, said core baffles inter-communicating with adjacent baffles, along said flowpath, at points axially spaced from one another in opposite directions; whereby said flowpath has a generally serpentine configuration through said irradiator;

c. means attached to said core to individually support a plurality of radiation sources in plurality of core baffles so as to arrange said radiation sources in exposed irradiating position within said flowpath; and

d. inlet and outlet means cooperating with said casing to permit ingress and egress of liquid as it flows through said irradiator.

* * * * *