United States Patent [19]

Woodbridge

[11] **3,865,734**

[45] **Feb. 11, 1975**

[54] **IRRADIATOR APPARATUS**

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[73] Assignee: **McMillin Investments, Inc.,** Vero Beach, Fla.

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[21] Appl. No.: **300,202**

[52] **U.S. Cl.** **250/432,** 250/435

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

[58] **Field of Search** 250/44, 46, 48, 432, 435, 250/438

[56] **References Cited**

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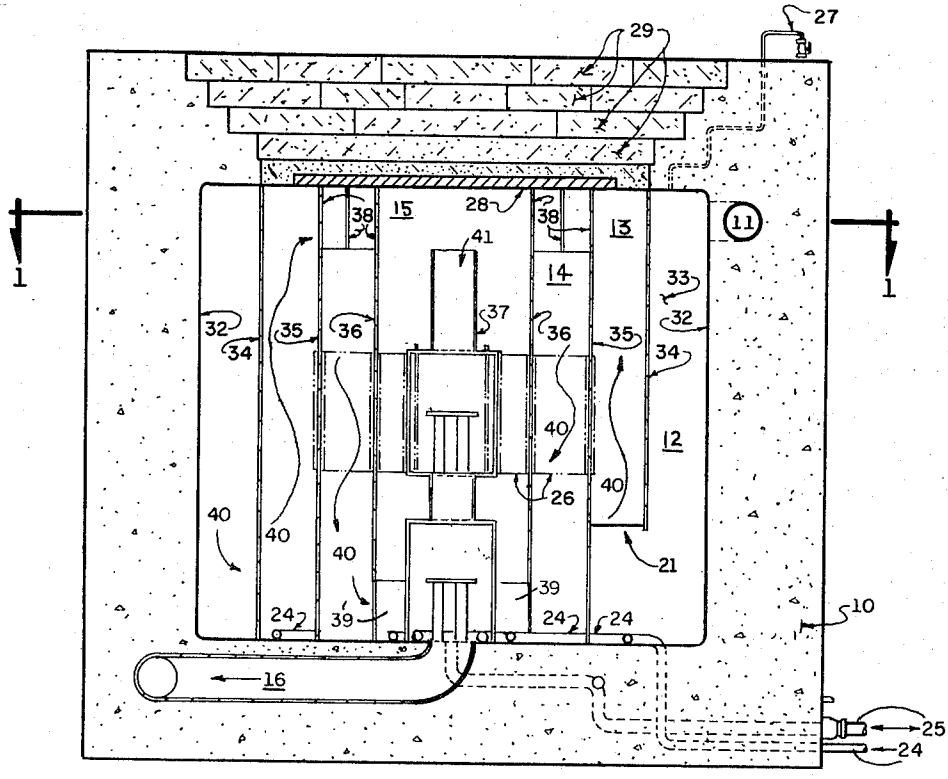
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Primary Examiner—Archie R. Borchelt
Assistant Examiner—Harold A. Dixon
Attorney, Agent, or Firm—Duckworth, Hobby & Allen

[57] **ABSTRACT**

An irradiator of the type using radioactive material as a source of radiation having a casing for holding an irradiator core and inputs and outputs passing through the casing to the core. The core includes a plurality of concentric walls forming chambers with the flow of fluid passing from one chamber to the next and then out of the irradiator. A plurality of radiation sources are located in the core and a system for feeding predetermined gases through a liquid being treated in the core and for bleeding excess gases out of the core is provided. The gas inputs are located to provide a turbulence in the liquid along the walls for keeping the irradiator clean as well as for increasing the effectiveness of the irradiator and the use of pre-selected gases improves the treatment by the combined action of the gases and irradiation of the fluid.

6 Claims, 8 Drawing Figures



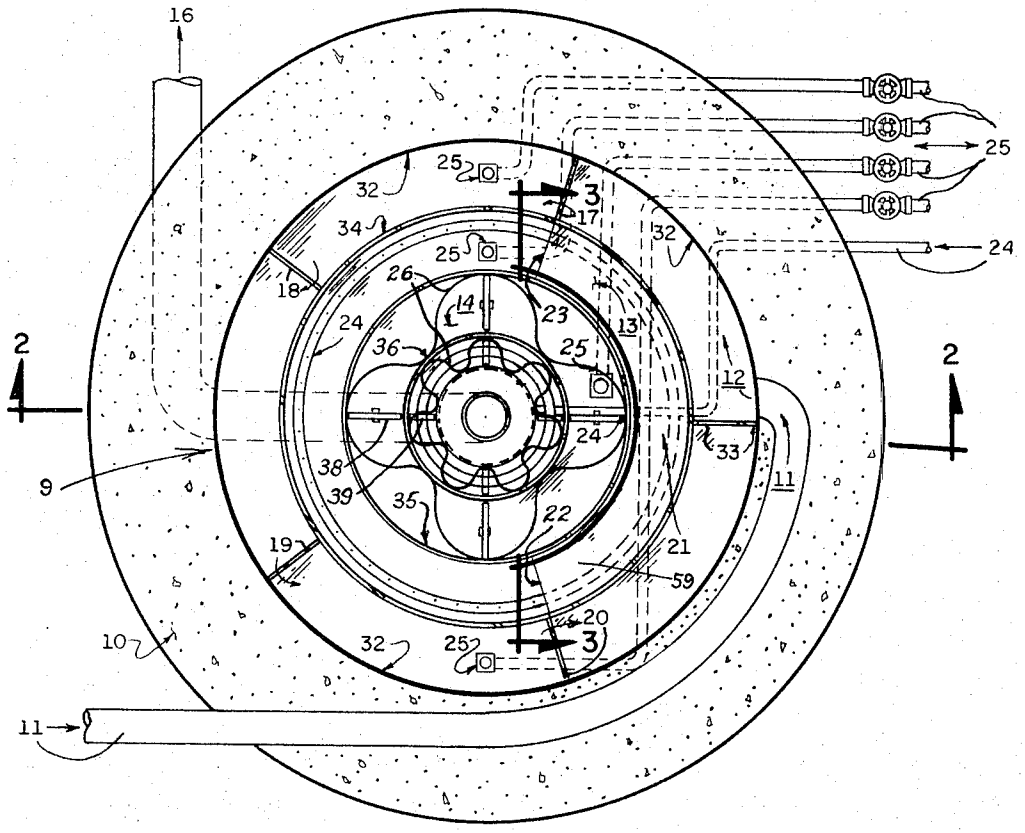


FIGURE 1

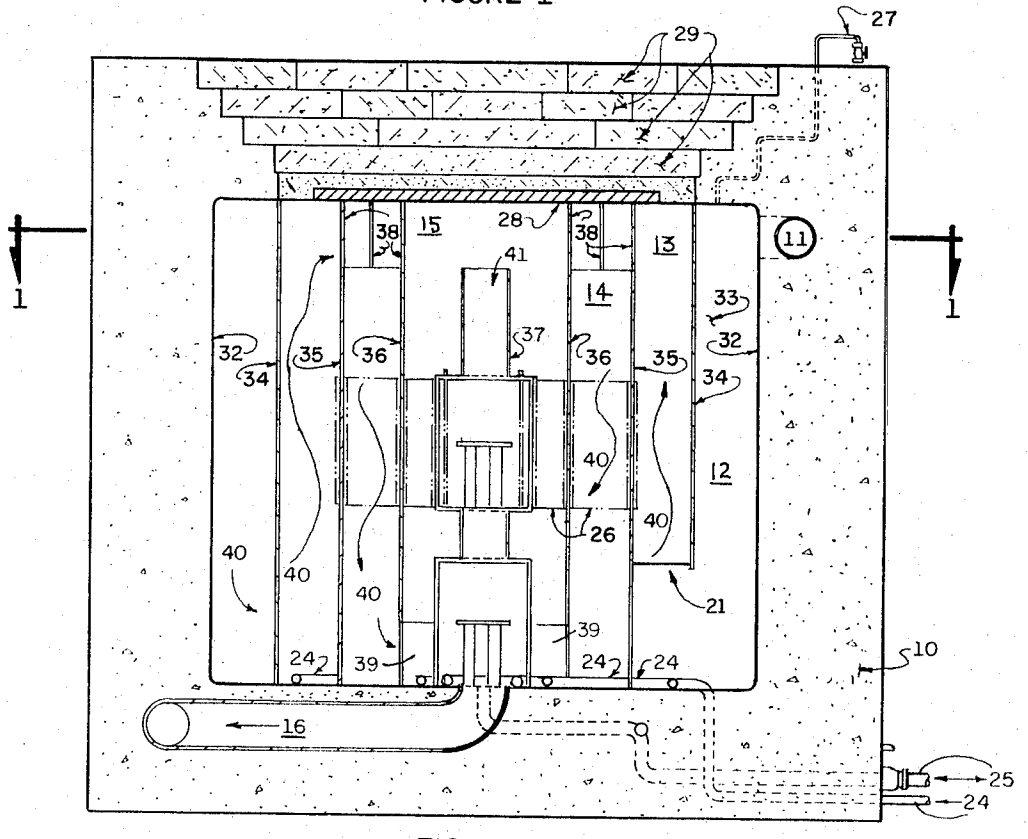


FIGURE 2

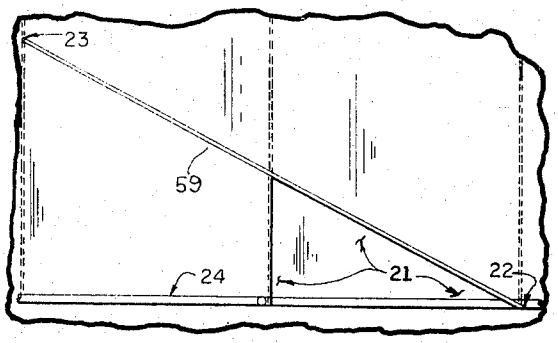


FIGURE 3

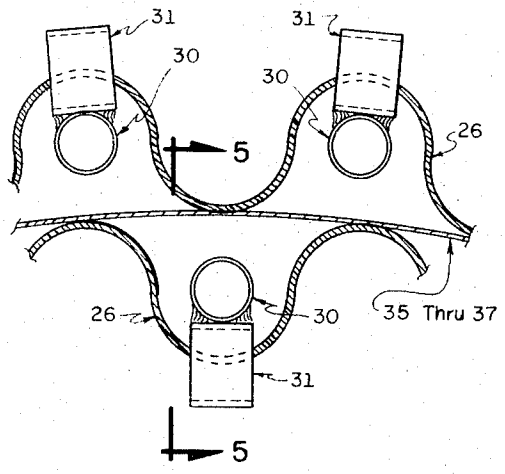


FIGURE 4

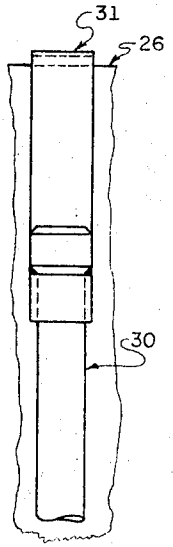


FIGURE 6

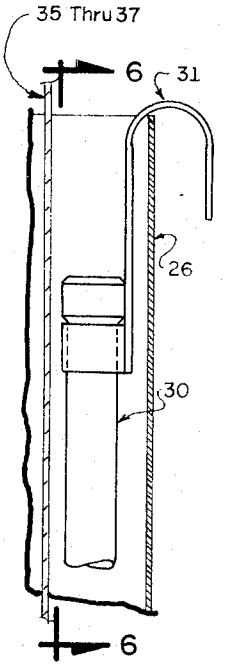


FIGURE 5

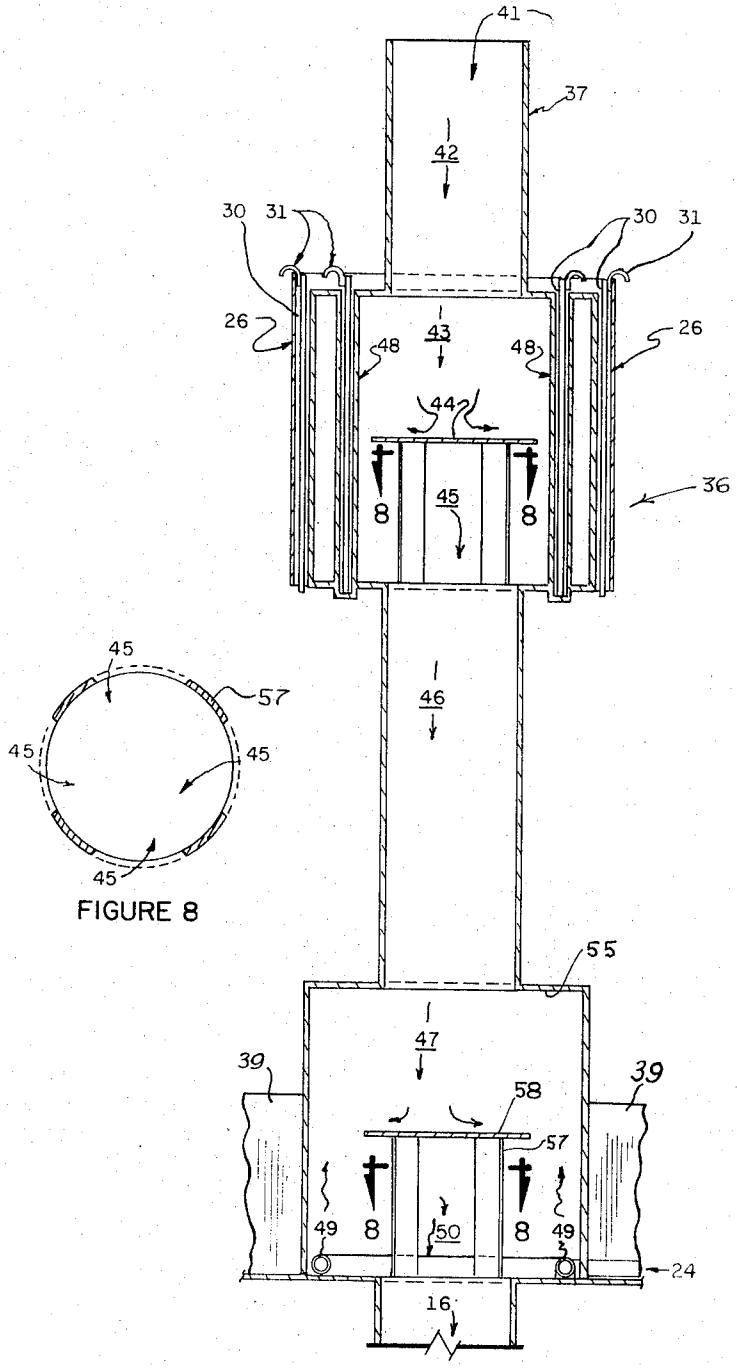


FIGURE 7

FIGURE 8

IRRADIATOR APPARATUS

BACKGROUND OF THE INVENTION

The present invention is directed towards a fluid treating apparatus for treating polluted fluids, by irradiation of the fluid while simultaneously directing predetermined gases through the fluid adjacent the irradiation sources.

DESCRIPTION OF THE PRIOR ART

In the past various types of irradiators and sterilizers have been suggested for liquids and especially for disinfecting water. Prior art sterilizers frequently involve the use of heat to elevate the temperature and sometimes the pressure for a predetermined length of time to obtain a substantial kill, as desired, of the microbiological agents in the liquid. It has been suggested to use various types of radiation for the sterilization of liquids as well as for the sterilization of food, drugs, and the like. This prior radiation treatment has included ultraviolet light for use in sterilizing the liquid. It has also been suggested to use radioactive isotope sources for the sterilization of liquids as well as for gases and solids. This type of sterilization has proved advantageous over heat sterilizers because of the time saved in the rapid sterilization by radiation by avoiding the time loss during the thermodiffusion period. Typical of prior art irradiators using gamma radiation sources may be seen in U.S. Pat. 3,602,712 for a Fluid Irradiating Apparatus using Gamma Rays in Helical Passageways and in U.S. Pat. No. 3,671,741 for an Irradiator Apparatus with a Fluid Flowpath determined by communicating core and casting baffles. Another irradiator design can be seen in U.S. Pat. No. 3,603,788 for a Gamma Radiation Source and Method for the Treatment of Sewage, all of which are directed to devices for the treating of Polluted Fluids in large quantities.

It has also been suggested in prior art literature to utilize ozone in treated polluted materials and that gamma radiation generates its own ozone which would be responsible for all or part of the sterilization action of the radiation. It is of course also known that gamma radiation will destroy certain viruses and will act to break down certain large molecular structures when large enough sources are provided.

Finally, in U.S. Pat. application No. 271,800 for Sewage Treatment System Rendering Useful Soil Additives by the present inventor, the combination of chlorine for reducing the amount of microbiological organisms is followed by irradiation in which the gamma radiation source reduces the chlorine so that the output is safe from an excessive chlorine level in the liquid.

SUMMARY OF THE INVENTION

The present invention is directed towards a liquid treatment apparatus utilizing gamma radiation sources and a gaseous feeding system for feeding predetermined gases in a predetermined pattern through liquids passing through the irradiation system for the purpose of increasing the effectiveness of the irradiation and of the gases, and also for cleaning the irradiator by the turbulence produced by the gas bubbles. The gases can produce oxidation of organic materials in the liquid along with sterilization, decomposition and recombination of materials in the liquid being treated depending upon the gases used. The irradiator and gas feeding apparatus provides a shielding casing having a plurality of inputs and outputs passing therethrough to shield gamma radiation sources located in an irradiator core inside the casing. The core defines a flowpath of liquids therethrough from one of the inputs to one of the outputs through the casing and has a plurality of concentric chambers in which the liquids pass from one chamber to the next in sequence and out the output. Radiation sources are located in the core for the liquids to pass through and a plurality of gas feeds are provided at predetermined locations for feeding predetermined gases such as chlorine, ozone and oxygen through the liquid as it passes through the irradiator. The irradiator also has a bleed for allowing the gases being fed thereinto to escape therefrom and baffles are located to direct the gases in a predetermined manner past the irradiation sources. A plurality of gases can be utilized to gain the advantage of each gas such as oxygen or air in outer chambers for oxidizing organic materials followed by sterilization by the chlorine in the most central chamber during the irradiation of the liquids.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 is a top sectional view of the irradiator core and shielding;

FIG. 2 is a sectional view taken along lines 2—2 of FIG. 1;

FIG. 3 is a sectional view taken along lines 3—3 of FIG. 1;

FIG. 4 is a sectional view of a portion of irradiator showing the cobalt pencils and hangers;

FIG. 5 is a sectional view taken along the line 5—5 of FIG. 4;

FIG. 6 is a sectional view taken along the line 6—6 of FIG. 5;

FIG. 7 is a sectional view of the central core of the irradiator; and

FIG. 8 is a sectional view taken along line 8—8 of FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1 through 8, and especially to FIGS. 1 and 2, a core 9 is surrounded by shielding 10, which may be concrete, earth or other shielding material as desired. An inlet pipe 11 receives fluids, such as sewage effluent in an industrial or municipal sewage waste treatment plant and kills bacteria and viruses, degrades odors and degradation detergents, as well as reduces organic solids and algae growth in the effluent passing therethrough. The irradiator in this type of system must be designed to handle large quantities of continuously flowing liquids in an efficient manner to take advantage of the radiation materials, and similarly should be simple and easily produced as a commercial item. The core is generally made of stainless steel but could be made of other materials and has a first cylindrical chamber 12, second cylindrical chamber 13, third cylindrical chamber 14 and fourth cylindrical chamber 15, with the input 11 feeding into the first cylindrical chamber 12. The input effluent passes through chambers 12, 13, 14 and 15 and out an output or exit pipe 16. Chamber 12 has a first baffle 17, a second baffle 18, third baffle 19 and fourth baffle 20

therein. The flow of fluid is under the first baffle **17** over the second baffle **18,** under the third baffle **19** and over the fourth baffle **20** to produce the flow of liquids around the concentric chamber **12.** A fluid opening **21** is located in the bottom of the second cylindrical chamber **13** so that the liquid can flow from chamber **12** into chamber **13.** Chamber **13** has a ramp **22** (see FIGS. **1** and **3**) which produces a circular flow of the liquid passing into this chamber from the bottom to the top portion of the ramp **23** and produces a circular turbulent flow of the liquid passing therethrough. A gas injection or input pipe **24** is used for fluid diffusion within the core **9** of the irradiator and injects a gas or liquid into cylindrical chambers **13, 15** and center chamber **41,** as more clearly illustrated in FIG. **2.** Line **24** feeds a plurality of outputs in the bottom of the core **9** at predetermined points along the bottom of the core which may be opening or nozzles in the circular portion of the pipes **24.** A plurality of input pipes **25** passes through the shielding **10** into the core **9** and are used for obtaining samples from different section of the core, as well as for the injection of materials or gases into the core. Chambers **12, 13** and **14** of the core **9** can be sampled for a degree of treatment as the liquids pass therethrough and the same pipes can be utilized to feed gas or liquids into the core **9.** Liquids being fed into the core on the bottom of the core produce a turbulence and mixing action which stirs up any settled solids and also cleans the walls of the chambers as the gas is fed through the core **9** and out output **16.** This allows the core irradiator to be self-cleaning in addition to the benefits obtained by the feeding of chlorine or other gases into the core **9,** past the irradiation sources. The bubbles of gas may be baffled with baffles in a predetermined manner to increase the turbulence and for directing the gases near the sources of radiation. The radiation holding structures **26** are utilized for holding cobalt **60** or Cesium **137** or any other pencil-shaped gamma radiation sources. A gas bleeder line **27** is connected from the top of the core **9** through the shielding material **10** and has a valve thereon to bleed off the gases being fed into the core through the pipes **24** and **25** out of the top of the irradiator core **9.**

It should be noted at this point that none of the input and output tubes pass straight through the shielding material **9** in order to prevent the escape of radiation from the radiation sources, inasmuch as the radiation travels in a straight line. It should also be noted that the liquid passing through the irradiator core **9** provides additional shielding since the radiation sources will generally always be covered with liquid and will be located away from the shielding **9.** The core has an entrance through the shielding **10** which is sealed with a cover **28** which can be any material desired and which is covered with shielding material **29** which shielding segments **29** can be concrete or any other shielding desired which can be removed for gaining access to the core **9** for changing the sources or for otherwise checking or removing the core **9.** A wall **32** is the interior walls of the shielding **10** and forms one of the chamber **12** walls and is not connected to the core **9** but may have baffles **17, 18, 19, 20** connected thereto. These baffles serve to align wall **34** within the shielding and allows the easy removal of wall **34.** The remainder of the core **9** also can be removed from the shielding **10.** Cobalt pencils holders **30** have cobalt pencil hangers **31** for holding the cobalt to the core **9.** Cylindrical chamber **12** has a blocking bulkhead **33** attached to the wall **32** and prevents the backflow of liquid entering chamber **12** from input **11** while concentric wall **34** divides the cylindrical chamber **12** from the cylindrical chamber **13.** Third cylindrical container wall **35** separates chamber **13** from chamber **14** with the flow of liquid being over the top of this wall. The first cobalt **60** source holder **26** is attached to the side of cylinder wall **35.** A fourth cylindrical chamber wall **36** forms one wall of the chamber **14** and divides it from chamber **15,** with the flow of fluids being under the bottom of this cylindrical wall. A cobalt **60** source holder **26** is attached to the sides of wall **36.** Wall **37** forms a part of the exit pipe **41** of the irradiator core **9** and may be used to attach Cobalt **60** sources to, but provide an overflow pipe for the flow of liquid to pass through the chamber **15** and over the top of the wall **37** to feed around baffles **56** and **58** and out of output **16.** A support structure **38** is used for the top of cylindrical wall **35** to separate and align this wall from the wall **36,** while a support structure **39** on the bottom of the cylindrical wall **36** separates and aligns the wall from overflow center portion **41.** These alignment supports can be fixedly attached to only one wall so that separate concentric wall sections can be removed if desired or can be attached to both walls to provide a unitary structure. The arrows **40** illustrate the serpentine flow through the irradiator core **9** from one chamber to the next and out the exit pipe **16.**

Angled ramp **59** has a lower end portion **22** and an upper end portion **23** and directs fluid entering chamber **13** in an arcuate path within chamber **12** and also separates chamber walls **34** and **35** and may be fixedly attached to wall **34** or **35** or both.

FIG. **3** more clearly illustrates a section through FIG. **1** showing the triangular opening **21** between chambers **12** and **13** and having the bottom **22** of the ramp **59** in the cylindrical chamber **13** for producing a circular flow in chamber **13.** The angular surface of the ramp **57** is over a portion of gas inlet pipe **24** so that gas entering chamber **13** from pipe **24** will also be directed in a circular motion for better diffusion of the gas and for cleaning the bottom of the ramp.

FIG. **5** is a sectional view showing an elevation of the radio-active pencil holders **30** having their pencil hangers **31** and the structure **26** for holding the cobalt pencils thereon along with the walls **35** and **37.**

FIGS. **5** and **6** illustrate the pencil hanger **31** having the cobalt pencil **30** hanging on the structure **26.**

FIGS. **7** and **8** more clearly illustrate the exit overflow pipe system **41** having the overflow pipe **37** connected to an enlarged section **48.** Cobalt pencils **30** and hangers **31** connected to the holder **26** are also illustrated. The flow of the fluid is illustrated through chambers **42, 43, 45, 46, 47** and **50** passing through the exit core **41.** The input from the gas inlet tube **24** has openings **49** for the gas to be fed through into the overflow system **41** and allows bubbles of gas to collide with the annular ledge **55** and then pass through the chamber **46** and collide with the baffling surface **44** prior to passing through the chamber **42.** FIG. **8** shows the baffling head **44** which has a top and a plurality of sides **57** for allowing the fluid and gas to pass between sides **57** and around the table top baffle **44.** The liquid passing through the center core **36** passes out the output tube **16.**

Referring to all of the figures, it should be clear that gas can be fed through pipes **24** and **25** into the bottom of any of the concentric chambers **12, 13, 14** and **15.** This gas is allowed to bubble up through these chambers and pass the irradiation sources **30** where they treat the polluted fluid in the chamber which is simultaneously being irradiated for combined sterilization, oxidation and chemical reduction, as desired. However, in the case of chlorine, sterilization or the substantial reduction of micro-organisms can be accomplished while the irradiation then reduces the chlorine. Oxygen or air can be utilized to further oxidize organic materials passing through the irradiator. In addition to chlorine, ozone can be utilized and each of the gases can be bled out of the bleed **27** so as to prevent the buildup of pressure in the top of core **9.** The irradiator is designed to specifically allow the feeding of more than one type of gas to gain a combination of treatments in different chambers as the liquids pass from one chamber to the next and some of the pipes allow for samples to be removed at predetermined points in the chambers. The gas bubbling into the bottom of the chamber produce the turbulence for maintaining a clean irradiator and allow for the easy cleaning by removing accumulated materials on the bottom of the core **9** through the pipes **25** and for the ease in backwashing from pipe **16** out of pipe **11.** Baffles **44** and **58** allow gas entering the central core **36** to be baffled and baffle **44** directs it more towards the irradiation sources while providing a more turbulent action for better mixing with the liquids.

It should of course be realized that sewage effluent in which the present invention will be utilized will first have had primary and even secondary treatment, and the present system will be utilized in a tertiary or advanced treatment system in which one irradiator provides a combination of treatments in which the combined effect of the treatments would exceed the individual treatments because of the advantages gained by the irradiation, and reduction of the chlorine in the fluid prior to the exit of fluid from the system. Advantageously, the core can be built in sections and removed and inserted in sections if desired by having concentrate walls spaced from each other and free standing on the floor of the irradiator.

It should also be noted that the pattern of flow through the irradiator core **9** is such to gain advantage by the efficient utilization of the gamma rays in order to uniformly irradiate fluid passing through the core.

Accordingly, this invention should not be construed as limited to the particular forms disclosed herein since these are to be regarded as illustrative rather than restrictive.

I claim:

1. Apparatus for treating polluted fluids comprising in combination:

a. a casing including a plurality of inputs and outputs therefrom;

b. core means located in said casing defined a flowpath for liquid therethrough from at least one input to at least one output;

c. said core means having a central overflow pipe and a plurality of chambers each chamber being operatively connected to at least one other chamber for the feeding of liquid from one to the other and out the overflow pipe;

d. radiation sources located in said core means for irradiating liquids passing therethrough;

e. gas feed means operatively connected to said core means for feeding a gas into said core means through liquid passing through said core means;

f. bleed means located to allow accumulated gases in said core means to escape therefrom; and

g. baffle means located in spaced relationship to at least one gas feed means through said liquid in said core means, whereby liquid passing through said apparatus is irradiated during chemical treatment.

2. The apparatus in accordance with claim **1** in which said chambers have concentric walls with openings for said liquid to flow over at least one wall and under at least one wall.

3. The apparatus in accordance with claim **1** including sampling means for sampling the liquid passing through said core at a plurality of points in said core.

4. The apparatus in accordance with claim **1** in which said gas feed means are located in said core for said gas fed therefrom to agitate said liquid for cleaning said core means.

5. The apparatus in accordance with claim **1** in which said casing has a plurality of cylindrical walls and has an entrance for removing at least one cylindrical wall from said core and said casing forms the outside wall of the outermost chamber in said core, said entrance being smaller than said entire core and larger than said core without the outer wall of the outermost chamber.

6. Apparatus for treating polluted fluids comprising in combination:

a. a casing having a plurality of inputs and outputs therefrom;

b. core means located in said casing defining a flowpath for liquid therethrough from at least one input to at least one output;

c. radiation sources located in said core means for irradiating liquids passing therethrough;

d. gas feed means operatively connected to said core means for feeding a gas into said core means through liquid passing through said core means, said gas feed means having a plurality of pipes connected to said core means for feeding gas to a plurality of chambers in said core means and means for feeding different gases to different chambers;

e. bleed means located to allow accumulated gases in said core means to escape therefrom; and

f. baffle means located in spaced relationship to at least one gas feed means to partially direct the flow of gas from said gas feed means through said liquid in said core means, whereby liquid passing through said apparatus is irradiated during chemical treatment.

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