

[54] **IRRADIATION APPARATUS FOR PROVIDING A HIGH INITIAL IRRADIATION OF THE PRODUCT**

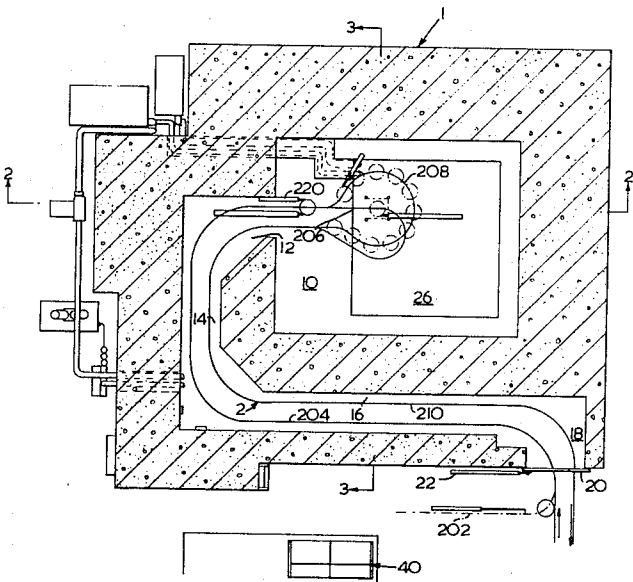
[72] Inventor: **William R. Green**, Ottawa, Ontario, Canada
[73] Assignee: **Atomic Energy of Canada Limited**, Ottawa, Ontario, Canada
[22] Filed: **March 27, 1970**
[21] Appl. No.: **23,273**

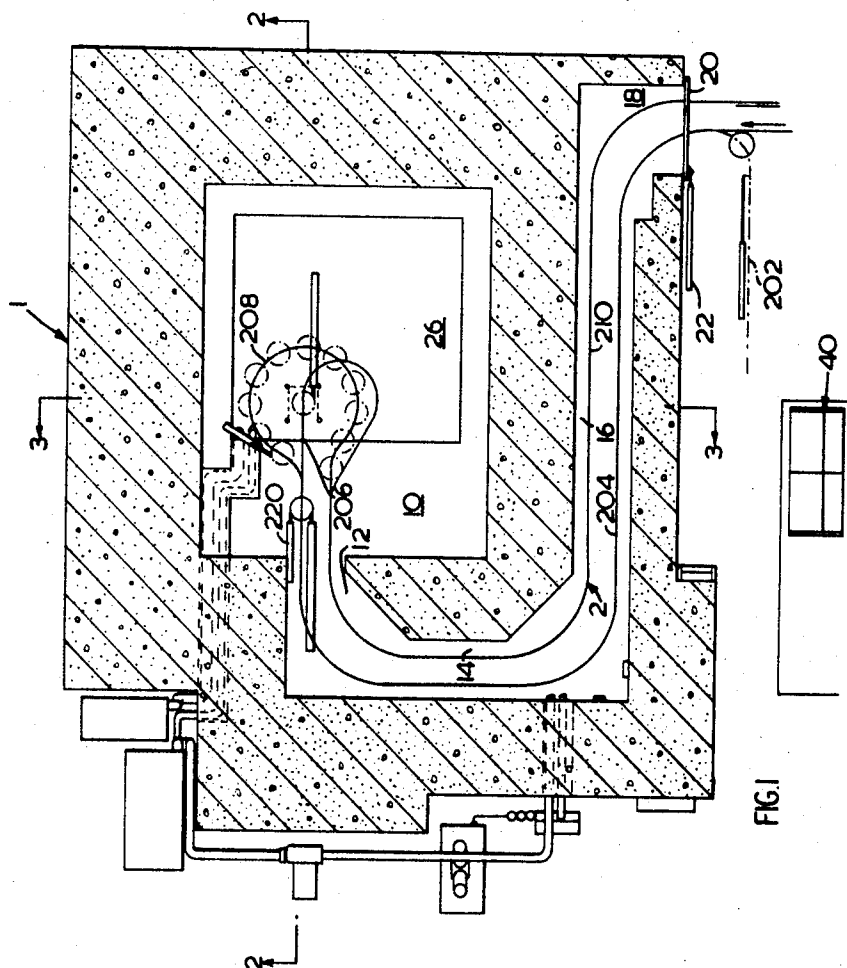
[30] **Foreign Application Priority Data**
Feb. 6, 1970 Canada.....074167
[52] U.S. Cl.**250/106 R, 250/52**
[51] Int. Cl.**G21h 5/00**
[58] Field of Search.....**258/106 R, 52**

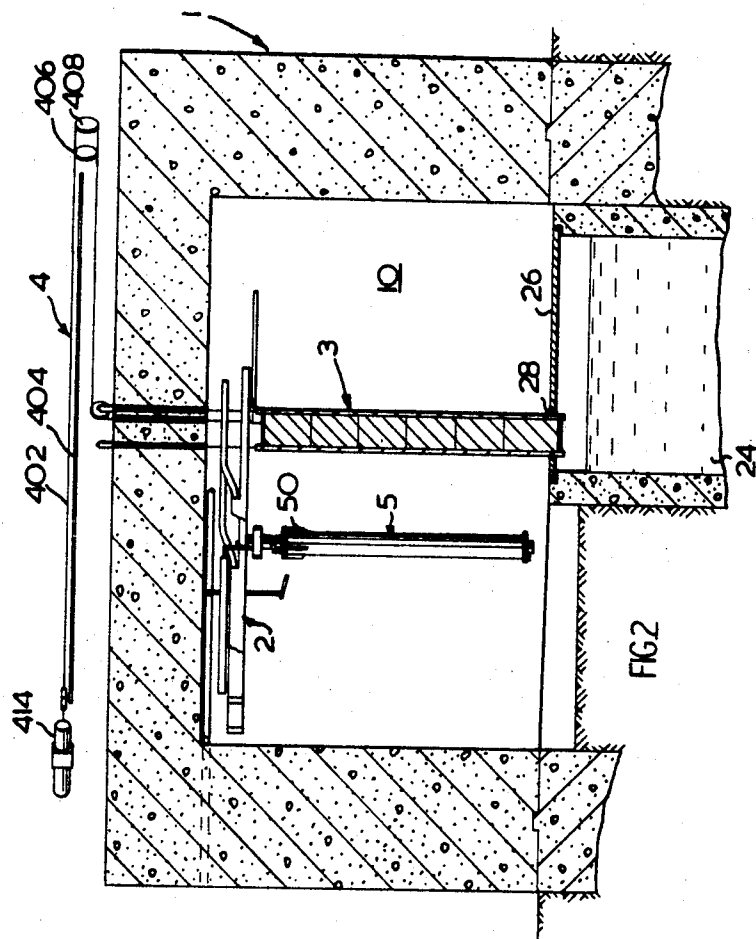
[56] **References Cited**
UNITED STATES PATENTS
3,142,759 7/1964 Jefferson et al.....250/106 R
Primary Examiner—Walter Stolwein
Assistant Examiner—Morton J. Frome
Attorney—Stevens, Davis, Miller & Mosher

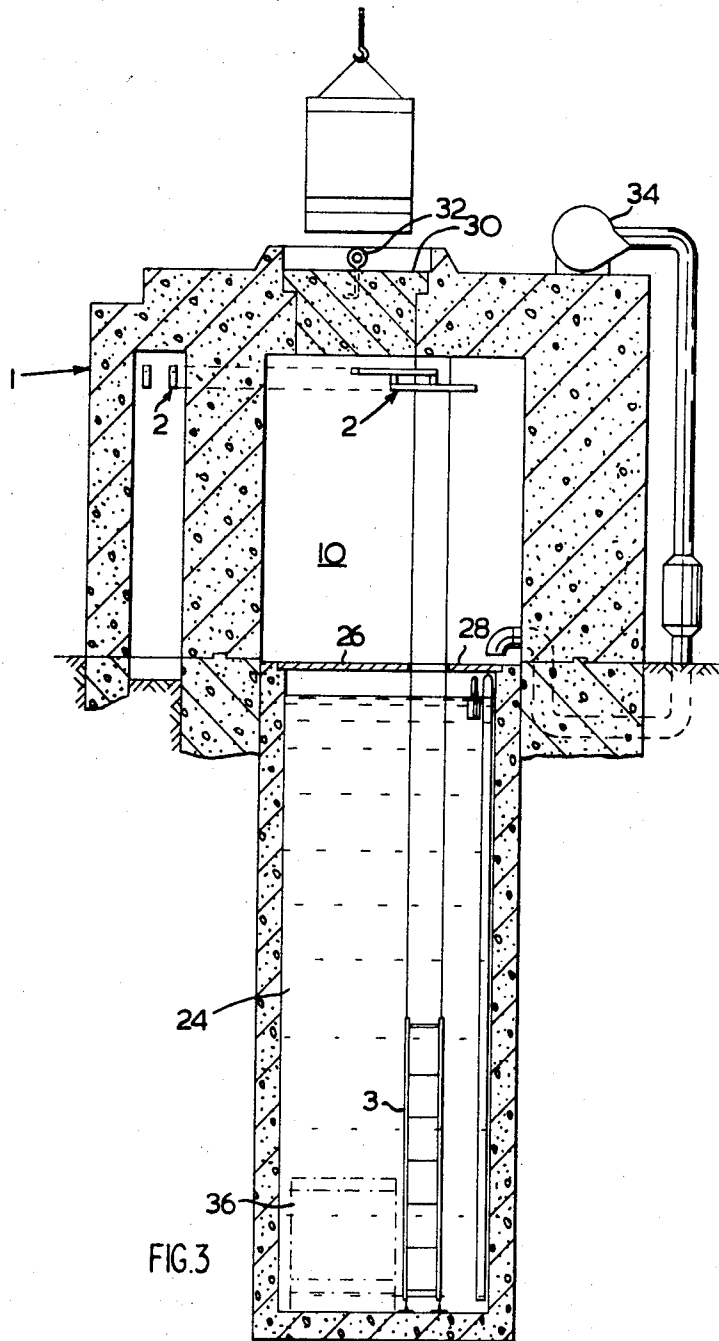
[57] **ABSTRACT**
There is disclosed apparatus for the radioactive irradiation of products whose composition requires a relatively high intensity of irradiation for a short period followed by a relatively low intensity of irradiation for a longer period. In order to efficiently utilize the source, the product is passed into the center of a rack of source material and thereafter passed around the outside of the rack. The product is cooled by water during irradiation and the same water is used to effect rotation of the product.

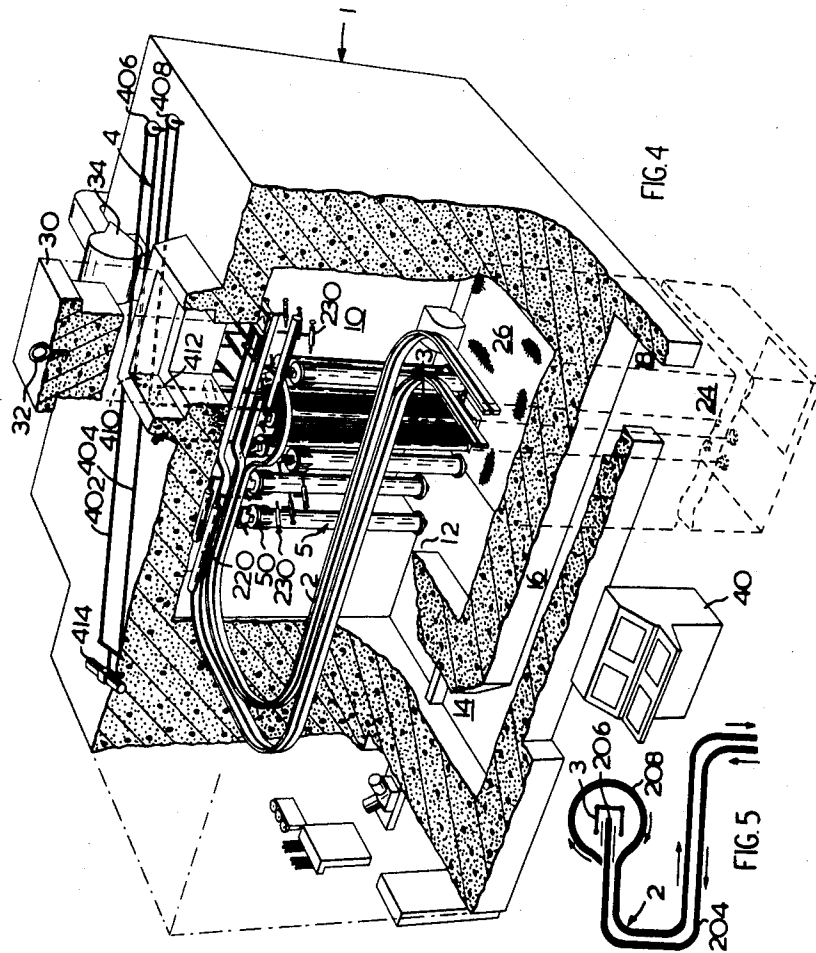
6 Claims, 5 Drawing Figures











IRRADIATION APPARATUS FOR PROVIDING A HIGH INITIAL IRRADIATION OF THE PRODUCT

This invention relates to apparatus for the radioactive irradiation of substances. More particularly the invention is related to the irradiation of substances wherein, by the nature of the substances, the dose rate, throughout the period of irradiation, must be varied in accordance with the desired properties of the irradiated substance. Yet more particularly, the invention envisages an apparatus for the irradiation of polymerizable substances such as wood polymers.

It is an object of one feature of the invention to provide apparatus for irradiating products whereby the said products are firstly irradiated at a relatively high intensity irradiation and then irradiated at a relatively low intensity irradiation.

In accordance with the foregoing object, the invention comprises a hollow elongate source rack having an opening along the length thereof, an elongate product support, means for moving said product support through said opening and into and out of said source rack, and means for moving said product support around the outside of said source rack.

A preferred embodiment of the invention will now be described with reference to the accompanying drawings, in which,

FIG. 1 is a plan view, in part section, of an irradiating plant.

FIG. 2 is a side view in section along the line 2—2 in FIG. 1.

FIG. 3 is a side view, in section along the line 3—3 in FIG. 1.

FIG. 4 is an isometric view, partly in section, of the irradiating plant.

FIG. 5 is a diagram showing the irradiation path provided by the present invention.

Referring now to FIG. 1, there is shown an irradiator building, generally indicated at 1. An irradiating chamber 10, surrounded by walls of concrete forming the building 1, is accessible through a maze comprising portions 12, 14, 16 and 18. Access to the maze is controlled by a door 20 which is movable by an actuator 22 and incorporates safety interlocks, not shown. A storage pool 24, formed in the floor of the chamber, is covered by a removable floor plate 26 having an aperture 28 therein.

A portion of the roof is formed into a removable plug 30 having a lifting eye 32 which may be hoisted upwardly by means not shown.

With reference to FIG. 2, there is shown a source rack generally indicated at 3 which may be raised into an irradiating position, as shown, or lowered into a storage, as shown in FIG. 3, by means of lifting gear, generally indicated at 4 and comprising ropes 402, 404, pulley 406, 408, 410 and 412 and a motor 414. As shown in FIGS. 1 and 5, the source rack comprises three sides of a square, e.g. having an opening on one side. The air in the chamber is circulated and/or replaced as necessary by a fan 34 mounted on the roof.

A product conveyor, generally indicated at 2, having an overall configuration as shown in FIG. 5, comprises a marshalling portion 202, an entry portion 204, irradiating portions 206, 208 and an exit portion 210. The irradiating portions may be mechanically separated from the conveyor, in which case a source pass mechanism, generally indicated at 220 will effect the transfer.

Referring to FIGS. 2 and 4, the product to be irradiated is packed into product containers, generally indicated at 5. The containers 5 are suspended from the conveyor rail 2 and each are free to rotate about its vertical axis. Adjacent the top of the containers are a series of blades 50 the purpose of which will be explained hereinafter. In the present embodiment the containers 5 are about 9 1/2 inches inside diameter and about 8 feet long. The walls which are about three sixteenths-inch thick and enclosing a volume of nearly 4 cubic feet, are designed to withstand a maximum internal pressure of 15 p.s.i.g. The containers 5 are moved in succession into the maze by an actuator 202. After reaching the location of the source rack 3, the containers are first moved into the center of the source rack by means of an actuator 220. After a specified irradiation within the source rack, the actuator 220 withdraws the container and sends it on a path 208 exteriorly of the

source, by a series of discrete movements between 10 different indexed locations. Since irradiation give rise to heat, there are provided a series of water jets 230. These jets of water are arranged to impinge on the blades 50 at the top of the containers in order to rotate the latter. Other suitable cooling liquids are envisaged.

When access to the chamber is required, the source rack can be lowered into the pool 24. The sources can be changed, by remote control, at the bottom of the pool. The dotted outline 36 represents a source changing or shipping facility.

A control console 40 is conveniently located near the maze entrance to provide the operator with a view of the marshalling station and entrance to the maze.

The control console 40 is in two sections — monitoring and machine operation. The monitoring section carried the monitor controls. A master key controls power to the irradiation plant which cannot be operated until the key is placed in the master control switch and the key turned on. The source may then be raised and conveyors started in motion provided all safety features are in the go position.

An adjustable timer is mounted on the face of the console in the operating section. This timer is used to control the through-put by setting the dwell time of the product containers in each irradiate position.

The following indicator lights are provided:

- Power reset
- Safety interlock
- Source up
- Source down
- High irradiation chamber temperature
- Low air pressure
- Ventillation fan

One fixed monitor is provided in the irradiation chamber designed to measure the radiation level in the irradiation chamber when the source is in the fully down "off" position in the storage pool. The meter connected to this monitor is mounted on the control panel and provides a visual indication that it is safe for personnel to enter the irradiation chamber. A portable monitor will be provided attached to the operating keys.

All interlocks in the plant control room are designed to be "fail safe." In addition to the features already described safety interlocks and devices are installed to ensure personnel protection as follows:

- a. The safety door at the entrance to the access maze is electrically interlocked with the source so that the source cannot be raised if the door is open and conversely the door cannot be opened if the source is exposed.
- b. A 90 second safety delay timer located in the irradiation chamber has to be set by the operator who then walks out of the chamber, closes the door and starts operations at the control panel, within the prescribed delay period. This ensures that personnel cannot inadvertently be shut inside.
- c. To ensure operation by authorized personnel only, the key to the master control switch can be retained in the possession of the plant operator and only issued to others with his knowledge and consent.
- d. Pilot lights on the control panel indicate the source position.
- e. In the event of compressed air failure when the source is in the irradiate position, the source will automatically lower to the "off" position in the storage pool.
- f. In the event of any malfunction of the source pass mechanism, the plant automatically shuts down and the source returns to the "off" position.
- g. Air exhausted from the irradiation chamber is filtered to permit a periodic check for the presence of radioactive contaminants.
- h. The source operating mechanism is constructed to give the source maximum physical protection with a minimum possibility of sticking or jamming.

- i. The source automatically returns to the storage position in the event of power failure so as to prevent overexposure or uneven exposure to the product.
- j. The ventilation system removes the ozone formed by the radiation inside the irradiation chamber.

The embodiment of the invention thus far described is intended for the irradiation of wood plastics composites. Such composites are formed of wood as a matrix into which the cellular structure is filled by impregnation with various thermoplastics. The plastics are usually in a monomeric liquid or vapor state and are subsequently polymerized by irradiation. Lucite (trademark) and Perspex (trademark) are typical of the many possible plastics suitable for impregnation.

The apparatus described is adequate to process at least six containers per hour. The wood to be treated, usually in the form of small strips, is first packed into the containers which are evacuated to remove oxygen and then soaked in a monomer. The excess monomer is drained off and the container pressurized up to 15 p.s.i.g. Generally, nine containers are impregnated in a batch. The irradiating building will contain up to eleven containers at a time (containing about 1,463 lb. of wood plastics composites) so that 20 containers will be in use at any one time.

The source rack would require, for a throughput of about 700 lb./hr. of wood plastic, a nominal capacity of 200,000 curies and Co60 has been used and divided into ninety source-pencils distributed through the three sides of the source rack.

When processing oak fingers packed in the containers at 67 percent packing density, the throughput is estimated to be 10 million square feet per year at 1,950 lb. wood plastic composite per hour and for 8,000 hours operation per year.

It is estimated that the radiation utilization efficiency is 21.3 ± 20 percent.

FIG. 4 shows, in isometric projection, partly in section, the irradiation plant as a whole.

Referring to FIG. 5, there is shown diagrammatically, the route taken by the product containers 5 in relation to the source rack 3. This routing forms an important aspect of the invention. As previously stated, in the irradiation of the polymerizable wood product, it has been found that a significantly improved product results from varying the irradiation intensity during irradiation. A great improvement is experienced if the product is subject firstly to a relatively high intensity irradiation, followed by irradiation at a relatively lower intensity. Thus, as shown in FIG. 5 the product containers move, firstly, into the interior of the three-sided source rack 3 where the radioactive intensity is relatively high. The containers are simultaneously rotated about the vertical axes thereof and cooled by the jets 230. Thereafter, the containers

are withdrawn and passed around the outside of the source rack 3, and as before rotated and cooled. All movements are effected by the actuators 220. It will be appreciated that the total irradiation received while the containers are entering, at rest, or withdrawing from the rack may be established by the size of the source rack, the number of pencils of radioactive material in the rack and the time taken in each stage of movement. Similarly, the total irradiation received by the containers while moving around the outside of the rack may be varied by the time taken for the outside movement and the average distance by which the route is separated from the rack. The various timing sequences may be automatically programmed at the control console 40.

Other variations falling within the terms of the appended claims will occur to those skilled in the art.

I claim:

1. Apparatus for the irradiation of products requiring at least a high initial irradiation intensity followed by irradiation at a relatively lower intensity, comprising: a radioactive source,
 - a chamber surrounded by shielding,
 - a bent passageway through said shielding into said chamber,
 - a hollow elongate rack for holding said source in said chamber having an opening along the length thereof,
 - an elongate product support,
 - means for moving said product support through said passageway, into said opening and into and out of said source rack to give a high initial irradiation of said product, and
 - means for moving said product support around the outside of said source rack to give a lower intensity irradiation of said product, said product support being suspended for movement with its longitudinal axis at all times substantially vertical.
2. Apparatus as defined in claim 1 wherein said product support is during irradiation continuously rotatable about said vertical axis, and wherein means are provided to effect rotation of the supports.
3. Apparatus as defined in claim 2 wherein said product support is cooled by jets of cooling liquid during irradiation.
4. Apparatus as defined in claim 3 wherein the means to rotate said supports comprises vanes on the supports against which said jets impinge.
5. Apparatus as defined in claim 4 further including a plurality of actuators for effecting movements of said supports into, out of and around said rack.
6. Apparatus as defined in claim 5 further including program control means for scheduling the movement of said containers and timing thereof.

* * * * *

55

60

65

70

75