

Feb. 17, 1970

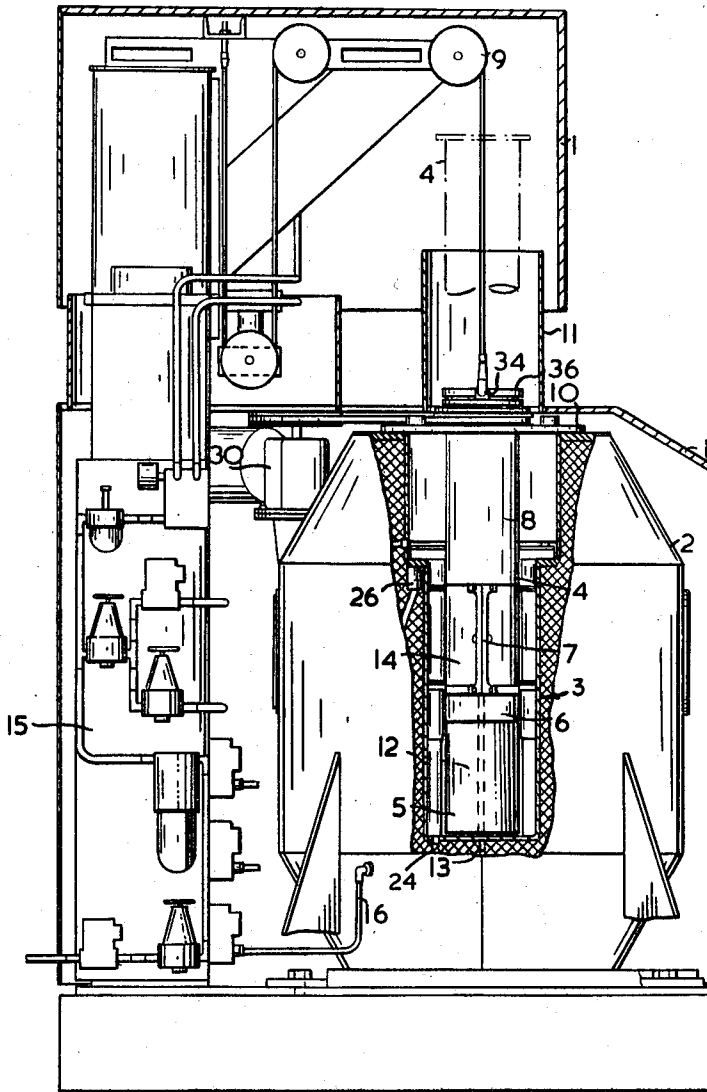
W. W. KIRKPATRICK ET AL
APPARATUS FOR IRRADIATING OBJECTS WITH SELECTED
UNIFORM DOSES OF RADIATION

3,496,362

Filed Oct. 21, 1965

5 Sheets-Sheet 1

FIG. 1



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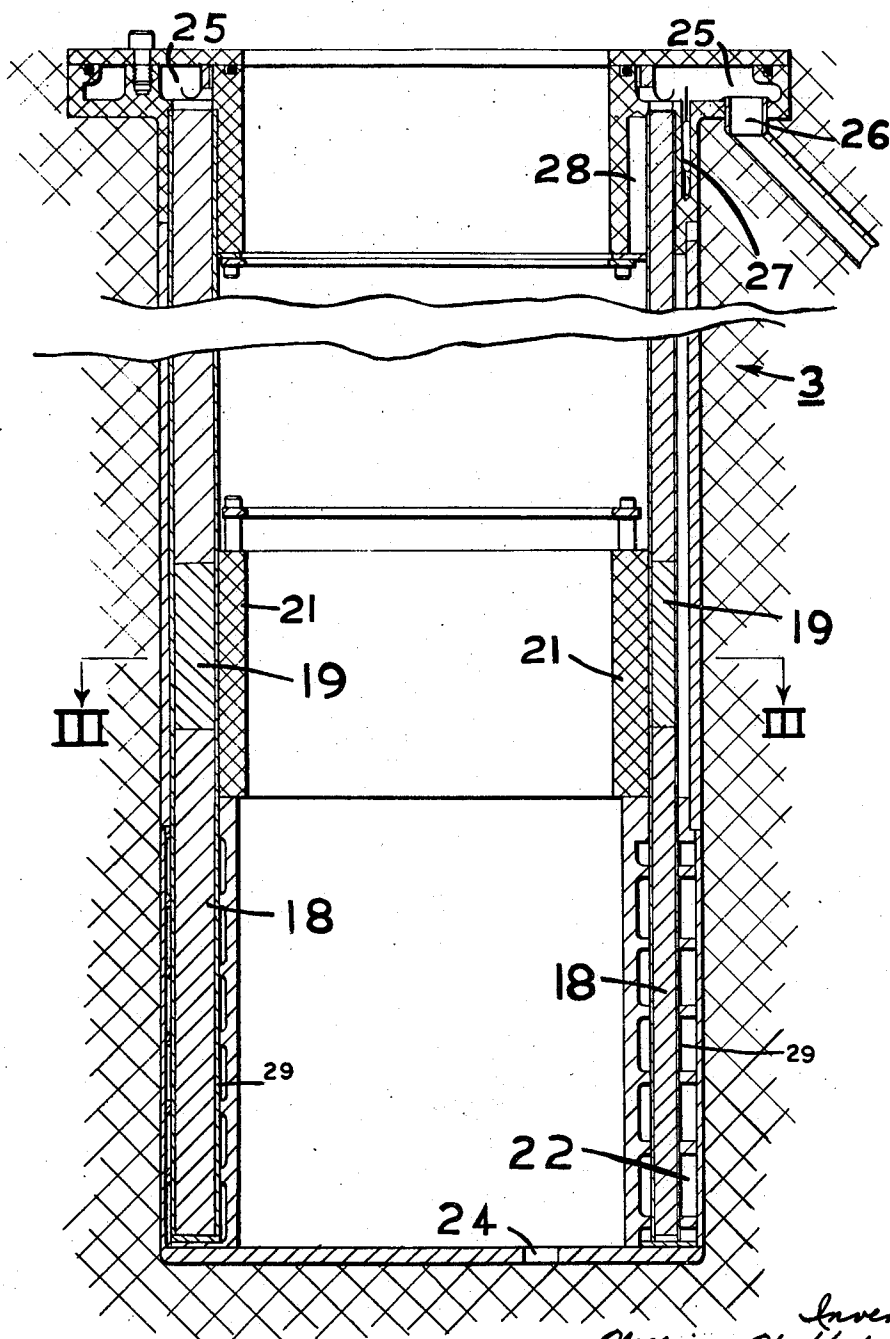
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FIG. 2



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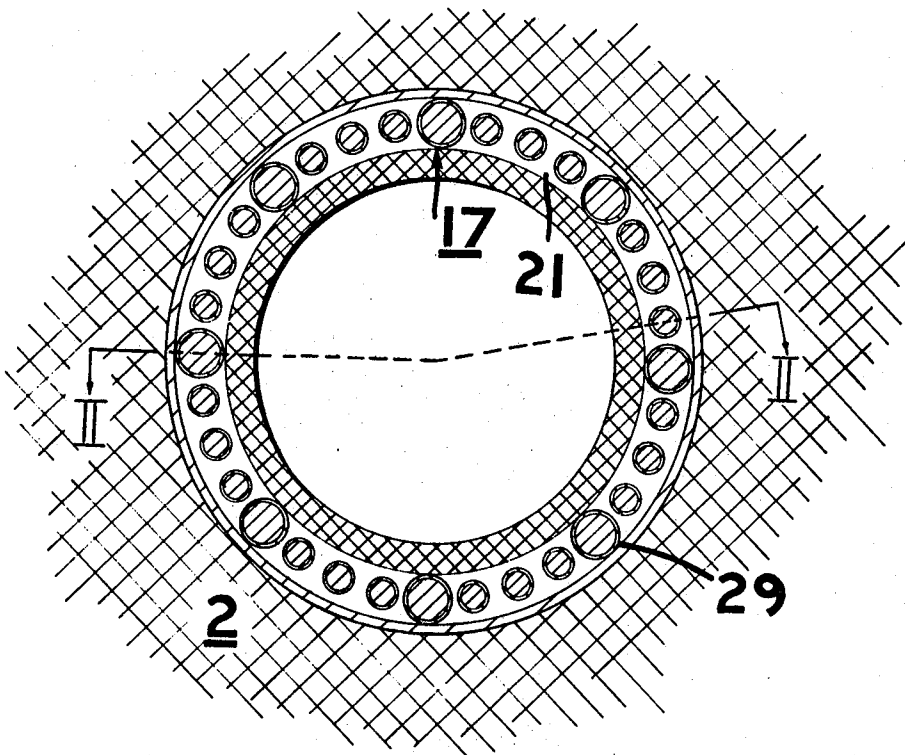
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FIG. 3



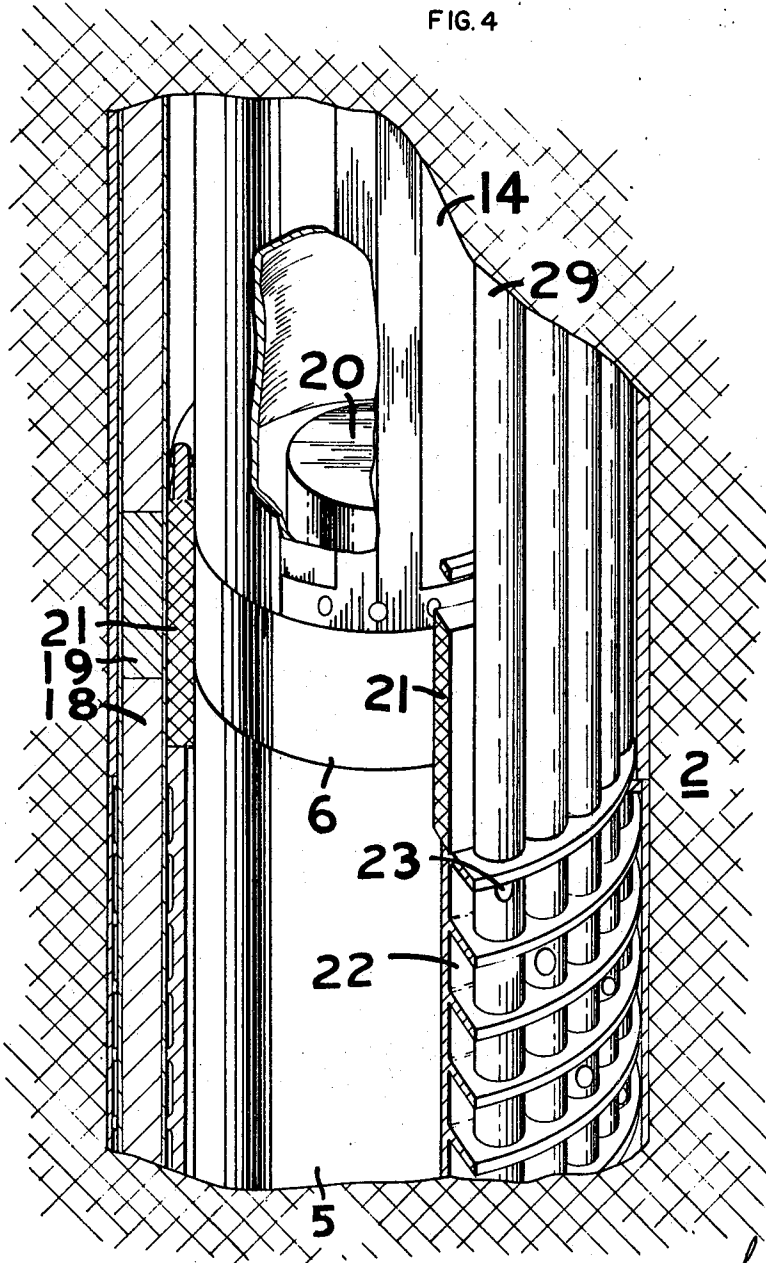
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FIG. 4



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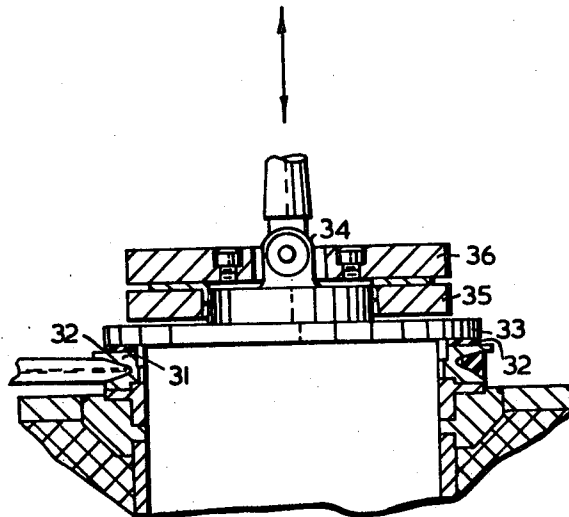


FIG. 5

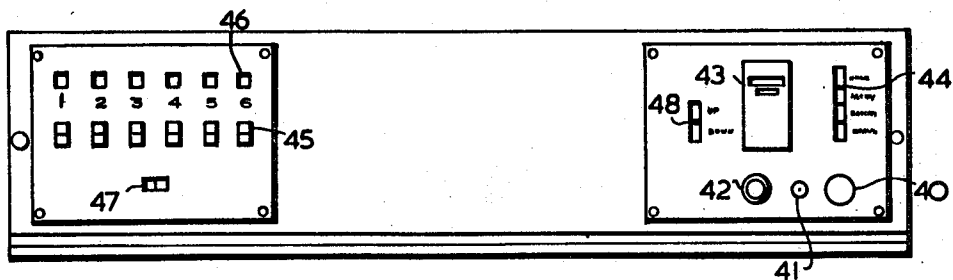


FIG. 6

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APPARATUS FOR IRRADIATING OBJECTS WITH SELECTED UNIFORM DOSES OF RADIATION

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U.S. Cl. 250—106

4 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for selecting and applying varying dose rates of radiation to an object is described. The apparatus includes means for shielding radioactive sources while a sample is being moved into and out of a radiation zone within the apparatus, and means are provided for selecting and moving varying numbers of the radioactive sources into radiating positions around the sample. Fluid pressure is used for moving the radioactive sources into radiating positions, and a plurality of the radioactive sources may be moved at one time by a single source of fluid pressure.

This invention relates to an apparatus for subjecting a sample to a field of influence and particularly, but not exclusively, to an apparatus for irradiating a sample with radioactive energy from a radioactive source.

Previously-known techniques of irradiation required that a sample be placed in a large room in the vicinity of a radioactive source. This was a disadvantage as the samples had to be taken into the room by the operator and because of this, special clothing had to be worn by the operator when entering the irradiating room. Furthermore, the construction of a special shielded room for irradiating samples was comparatively expensive and space-consuming.

To change the dose rate of radioactive energy, i.e. to change the intensity of the field of influence, when a special room was provided it was normally necessary for the operator to re-enter the room and change or modify the radioactive source, i.e. the source of the field of influence. This is, of course, a disadvantage.

It is also known in the prior art to provide for apparatus wherein a sample can be placed within a radiation zone within the apparatus, and various arrangements have been attempted and provided for moving a source of radiation into position for irradiating whatever sample is to be treated. However, such prior art devices have not provided for complete versatility in selecting and varying precise radiation dose rates while, at the same time, providing for a uniform irradiation of the sample or object being treated.

The present invention provides for apparatus which can be easily operated to select and apply varying, but uniform, irradiation to a sample or object. The apparatus includes a housing having a shielded irradiating chamber, and means are provided for carrying and transferring an object between a position exterior to the irradiating chamber and a working position within the radiating chamber. A plurality of guide tubes are positioned within the housing and around the irradiating chamber, and a radioactive source is carried in each guide tube so as to be movable from an isolated position to an irradiating position which is adjacent to an object placed in the irradiating chamber. Each of the radioactive sources is individually operable in its respective guide tube by fluid-pressure-operated means associated with the apparatus. The fluid-pressure-operated means may include a series of plenum channels through which fluid pressure is applied to one

or more of the guide tubes for moving one or more of the radioactive sources within the guide tubes. In accordance with the invention, a specific number of radioactive sources may be selected and moved to irradiating positions to apply a known dose rate to the sample or object. Means are provided for selecting and moving one, all, or combinations of the radioactive sources for adjusting dose rates, and whatever number is selected may be evenly spaced around the sample so that the selected dose rate will be uniformly applied to the sample. Also, means may be provided for rotating the sample or object relative to the radioactive sources.

One embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a side view, partly in section, of apparatus for irradiating a sample from a radioactive source;

FIGURE 2 is a view, partly in section, of the source cage assembly utilized in the apparatus of FIGURE 1;

FIGURE 3 is a cross-sectional view of the apparatus shown in FIGURE 2 taken along the line III—III to show the arrangement of the pencils;

FIGURE 4 is a perspective view of part of the apparatus shown in FIGURE 1;

FIGURE 5 is a side view, partly in section, of the drawer top assembly utilized in the apparatus of FIGURE 1, and

FIGURE 6 is a front view of the control panel used for controlling the apparatus of FIGURE 1.

In the different figures the same reference numeral has been applied to like parts throughout.

In FIGURE 1, apparatus for irradiating a sample from a radioactive source is illustrated together with its associated equipment mounted within a protective shroud assembly 1. A body of shielding material 2, contained therein, houses a source cage assembly 3 and an elongated cylindrical drawer assembly 4, disposed along the longitudinal axis of the body of shielding material and within the source cage assembly. The drawer assembly 4 is made up of four basic sections; a lower extension 5, a depleted uranium base 6, a sample chamber 7 and an upper extension 8. The drawer assembly is capable of being raised and lowered by a crane arrangement 9 which is used to raise the drawer assembly 4 to a "loading" position, as indicated by the dotted lines in FIGURE 1, or to lower "irradiating" position within the source cage assembly 3 as shown. When the drawer assembly is in the upper "loading" position access to the sample chamber is effected by raising a Plexiglas protector 11 and removing doors 14 which are provided on the sample chamber. As a safety precaution, when the drawer assembly is in its upper "loading" position and the sample chamber doors 14 are removed, spring loaded plunger (not shown) hold the drawer up. Replacing the sample chamber doors allows the drawer assembly to be lowered to the irradiating position. The sample chamber 7 is provided with a drain tube 12 which extends from the bottom of the sample chamber 7 to the outside of the body of shielding material via a drain pipe 13 protruding from the bottom of the source cage assembly. A head plug 10, having a cavity therein to provide the movement of the drawer assembly, seals the top of the body of shielding material and can be removed when access to the source cage assembly 3 is required.

Referring now to FIGURES 2, 3 and 4 illustrating the source cage assembly 3, it will be seen that a pencil guide tube assembly 17 is provided comprising pencil guide tubes 29 disposed in a circle and located within a cavity provided by the body of shielding material 2 (FIGURE 1). The inner diameter of the pencil guide tube assembly 17 is made greater than the outer diameter of the drawer

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assembly 4 to permit the latter to be slidably located within the pencil guide tube assembly.

Thirty-six (or thirty-two as shown in the drawings) pencil guide tubes 29 are disposed around the cavity and are equally spaced from each other. These tubes may be of any convenient size and are arranged to form a pattern as shown in FIGURES 2 and 3. Each pencil guide tube 29 includes therein an elongate radioactive pencil 18 which is a loose fit in the respective tube. A uranium plug 19 which is a close running fit within the tube is provided on the upper end of each pencil and acts as a piston. The uranium plug 19 is encased in 400 series stainless steel sleeves to prevent conflict of bearing metals and is capable of operating indicating switches as explained below.

In operation, the drawer assembly 4 is lowered into the source cage assembly 3 so that the sample chamber 7 assumes an irradiating position. The sample 20 is still isolated from radioactive energy due to the shielding effect of the depleted base 6, the lead shield blocks 21 and the uranium plugs 19.

When irradiation is required, a selected number of pencils, corresponding to the dose rate required, are moved so as to be in their upper position adjacent the sample chamber by introducing air under pressure into the respective tubes below each associated plug. In order to facilitate removal of the source assembly and connection to the air supply, air plenums 22 are wrapped around the pencil guide tube assembly 17 in the form of a helix. Six plenums are provided so that each of six groups of pencils can be operated independently. In order to provide apparatus having maximum versatility, each pencil must be capable of being put in any of the six groups. It is arranged that each pencil guide tube goes through each plenum once and any desired pencil may be controlled by the pressure in a respective plenum by drilling an air entry hole, such as 23 in FIGURE 4, in the wall of the respective tube where it passes through the plenum. Air pressure to the six plenums is provided by a pneumatic system 15 (FIGURE 1), via pipe 16 (FIGURE 1), connected to a plenum entry hole 24 (FIGURE 2). The apparatus includes seven pipes 16, six being used for the supply of air and the seventh being used for exhaust. O-ring seals are used for the pipe connections.

On pressurizing a plenum, all the pencils contained in those tubes associated with the pressurized plenum are blown up to the "irradiate" position. Air passing around the plug 19 passes into the upper housing 25 of the source cage assembly and through an exhaust 26. When in the "irradiate" position the presence of the pencil is indicated by the release of a reed contact 27 which is normally held closed by an Alnico magnet 28 on the opposite side of the running tube. The magnet and reed contact are disposed substantially parallel to each other and each is positioned on its respective side of the tube assembly. When the pencils are in the "irradiate" position the plug sheath, which is made of 400 series stainless steel, acts as a magnetic short circuit and thereby releases the contact.

If only a small number of pencils, for example one, is used to give a low dose rate normally the distribution of the radiation around the sample would be uneven. To overcome this disadvantage, means for rotating the complete drawer assembly at approximately 30 r.p.m. is provided by the attachment shown in FIGURES 1 and 5. Rotation of the drawer assembly, and therefore the sample in the sample chamber, is accomplished after lowering the drawer assembly so that the upper part of the drawer assembly rests on a belt-driven rotating sheave 31 which is of a larger diameter than the drawer assembly as shown in FIGURE 5. The belt is driven by a motor sheave 30 (FIGURE 1). A friction disk 32 on the upper flange 33 causes the rotation of the sheave to be transmitted to the drawer assembly. The lifting ring 34, the lift plate 35, and the drawer upper-plate 36 float free when the load is removed from the lifting ring.

A control panel, as shown in FIGURE 6, is provided

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to operate the irradiating apparatus. The time-exposure controls are mounted on the control panel together with switches and indicating lamps. A key switch 40 is provided to connect the power for operating the equipment and a fuse 41 and an indicator lamp 42 are connected in the same circuit as the key switch 40. The period of irradiation can be selected by pre-setting the counter 43 and depressing the appropriate switch on selector switch 44. The selector switch 44 has four positions—manual, seconds, minutes, and hours. By depressing one of these the counter unit becomes associated with those units of time as indicated by the depressed switch. To select the proper dose rate six switches 45 are provided each associated with a separate indicator lamp 46. The switches 45 control the pneumatic system which provides the air pressure to the plenums for moving the radioactive pencils. Each switch is associated with a different plenum and any number of switches can be depressed at the same time. The drawer assembly is raised and lowered by the up-down switch 48 and may be rotated by depressing the drawer assembly rotation switch 47.

The operation of the apparatus in use will now be described in detail. With the drawer assembly in the "loading" position a sample to be irradiated is first inserted into the sample chamber. The sample chamber doors are then put into closed position and the drawer assembly is lowered into the body of shielding material. With the drawer assembly in the lowered position the sample is located at the irradiating position and substantially isolated from the radioactive source. The time exposure for the chosen dose rate of radioactive energy is selected by means of a counter associated with a timing unit switch and the radioactive pencils to be blown up are selected by means of switches. The selected plenums are pressurized and all the pencils associated with said pressurized plenums are thus blown upwards to the "irradiate" position. To obtain a sufficient selection of dose rate each plenum is connected to a differently numbered pencil guide tube so that a different number of pencils are forced upwards for each plenum chamber. Such an arrangement permits one, or all, or any combination of pencils to be moved to the "irradiate" position. To determine if the correct number of pencils is at the "irradiate" position corresponding to the pressing of the associated switch, a plurality of indicator lights, one for each switch, are provided to indicate that all the pencils associated with the respective plenum have moved to the "irradiate" position. When small dose rates are used, in the drawer assembly may be rotated, by depressing the drawer assembly rotation switch, to provide a uniform distribution of radioactive energy on all surfaces of the sample. When the exposure time has expired, the plenums are automatically depressurized and those radioactive pencils in the "irradiate" position drop to their storage position. The drawer assembly is raised to the "loading" position and the sample, having been subjected to the desired radiation, is removed from the sample chamber. The next sample can then be inserted in the sample chamber and the operation repeated.

It will be appreciated that the number of guide tubes and radioactive pencils used is not restricted to 36 (or 32) but may be any convenient number.

By using the embodiment described it will be seen that a sample can be irradiated with radioactive energy and the dose rate selected with little risk to the operator. Furthermore, the apparatus, as described, is self-contained and does not require a separate, specially-protected room to be provided. However, it will be appreciated that the invention is not restricted thereto.

We claim:

1. Apparatus for irradiating a sample with radiation from a radioactive source, said apparatus including a housing of shielding material defining an irradiating chamber,

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a drawer assembly for carrying a sample to be irradiated,
transfer means for moving said drawer assembly between (a) a loading position exterior to the chamber at which a sample can be safely loaded into the drawer assembly and (b) a working position within the chamber,
a plurality of guide tubes within the housing, said guide tubes being located in a cylindrical array around the chamber,
a radioactive source in each guide tube and movable by fluid under pressure from a position isolated from said working position to an operating position adjacent said working position to irradiate a sample in said drawer assembly at said working position,
and a series of individually operable fluid-pressure-operated assemblies each including a plenum channel communicating with the interior of at least one of said guide tubes, with at least one of said plenum channels communicating with a plurality of guide tubes, and each fluid-pressure-operated assembly being operable to move respective sources in respective guide tubes from isolated positions to working positions.
2. Apparatus according to claim 1 wherein the plenum channels are formed by channels extending around the guide tubes in a helical manner.

3. Apparatus according to claim 1 including means for rotating the sample relative to the radioactive sources and about an axis parallel to the longitudinal axes of the guide tubes when the sample is in the working position.
4. Apparatus according to claim 1 and including means for moving said radioactive sources from working positions to isolated positions within said housing by depressurizing individual guide tubes associated with each of said radioactive sources.

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U.S. Cl. X.R.

250—108

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,496,362 Dated February 17, 1970

Inventor(s) William W. Kirkpatrick and John Masefield

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

The claim for priority in the heading of the above patent grant has been omitted and should read as follows:

--Claims priority, application Canada filed October 28, 1964 Serial No. 915,075--.

SIGNED AND
SEALED
SEP 22 1970

(SEAL)

Attest:

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Attesting Officer

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Commissioner of Patents