Sept. 13, 1966 A. KOHN ETAL 3,272,987

ARRANGEMENT FOR IRRADIATING AN OBJECT WITH RADIOACTIVE RADIATION

Filed Oct. 24, 1962 4 Sheets-Sheet 1

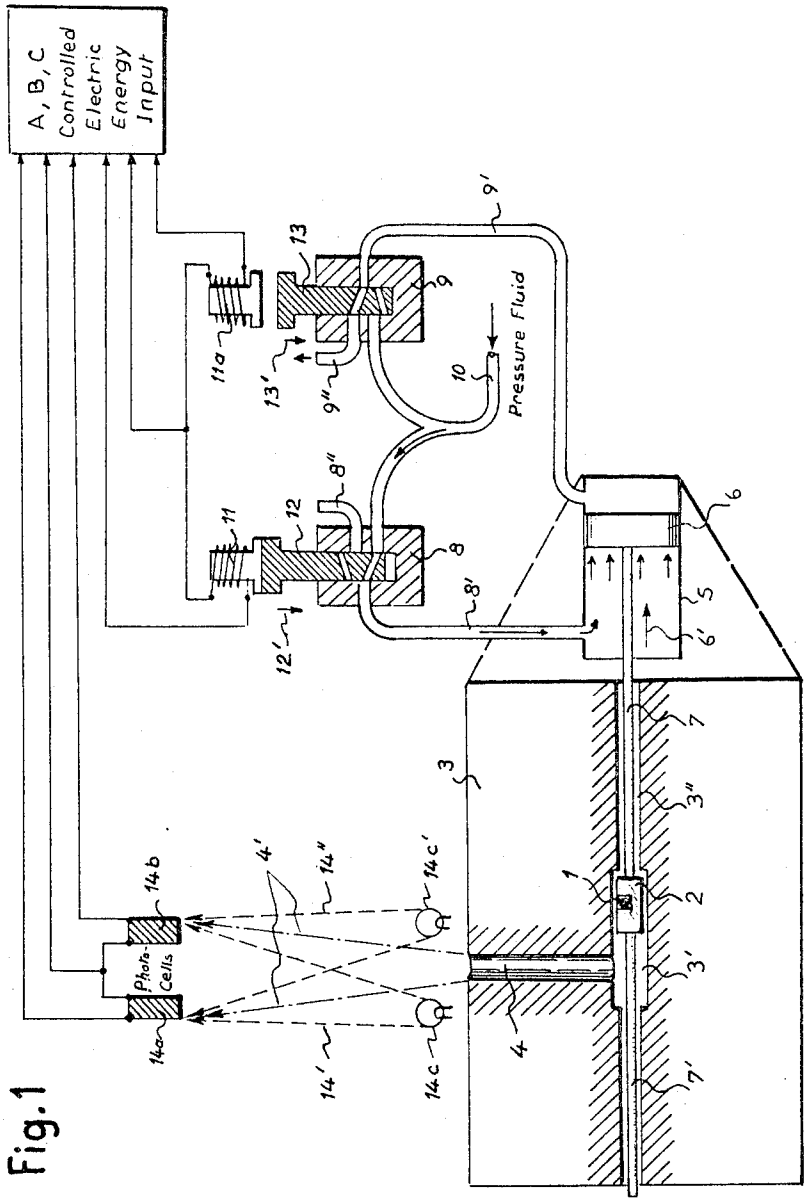

Fig. 1

Inventors
André Kohn
Jean Aupée
by Michael S. Striker
Atty

Sept. 13, 1966 A. KOHN ETAL 3,272,987

ARRANGEMENT FOR IRRADIATING AN OBJECT WITH RADIOACTIVE RADIATION

Filed Oct. 24, 1962 4 Sheets-Sheet 2

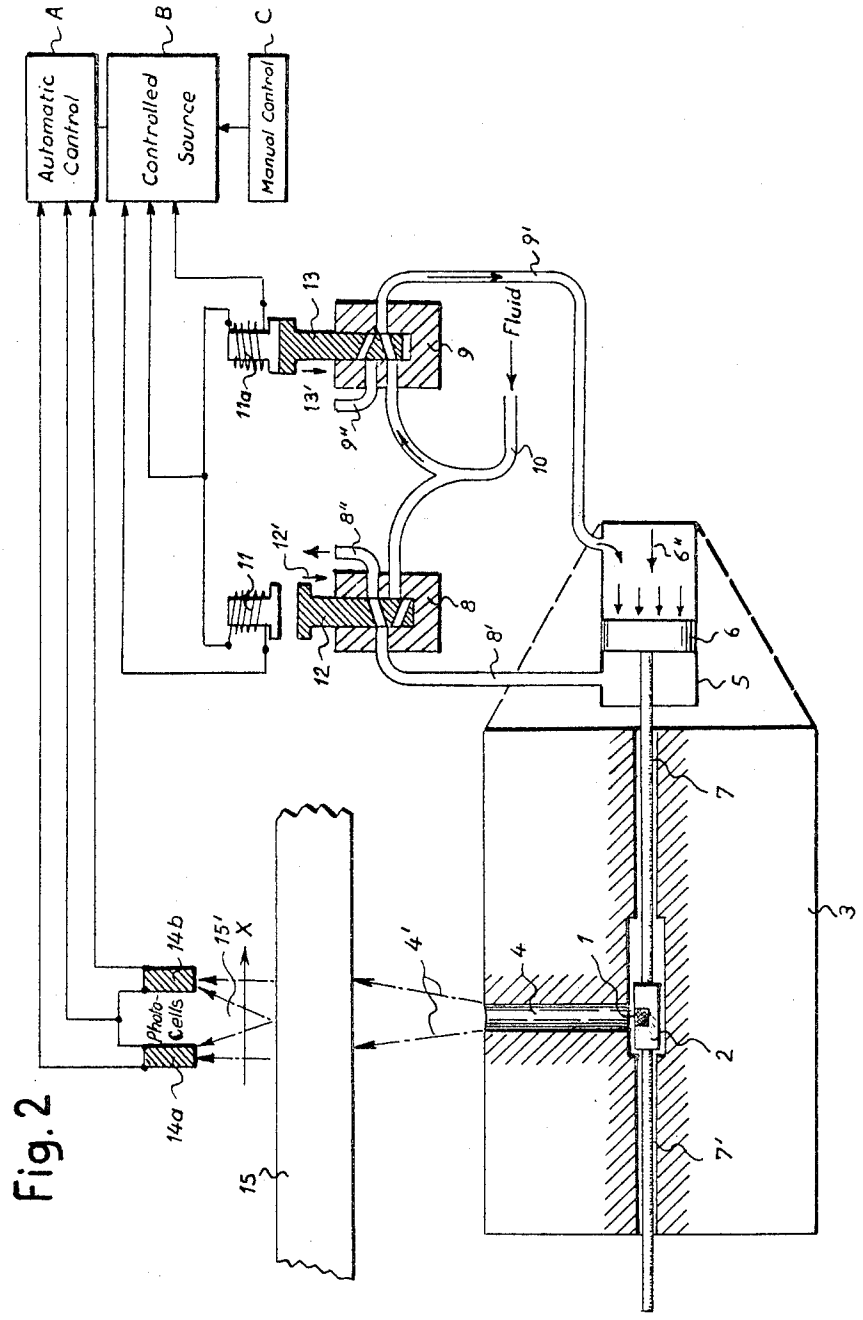

Fig. 2

Inventors
André Kohn
Jean Aupée
by
Michael S. Striker
R. Hoffman

Sept. 13, 1966 A. KOHN ETAL 3,272,987

ARRANGEMENT FOR IRRADIATING AN OBJECT WITH RADIOACTIVE RADIATION

Filed Oct. 24, 1962 4 Sheets-Sheet 3

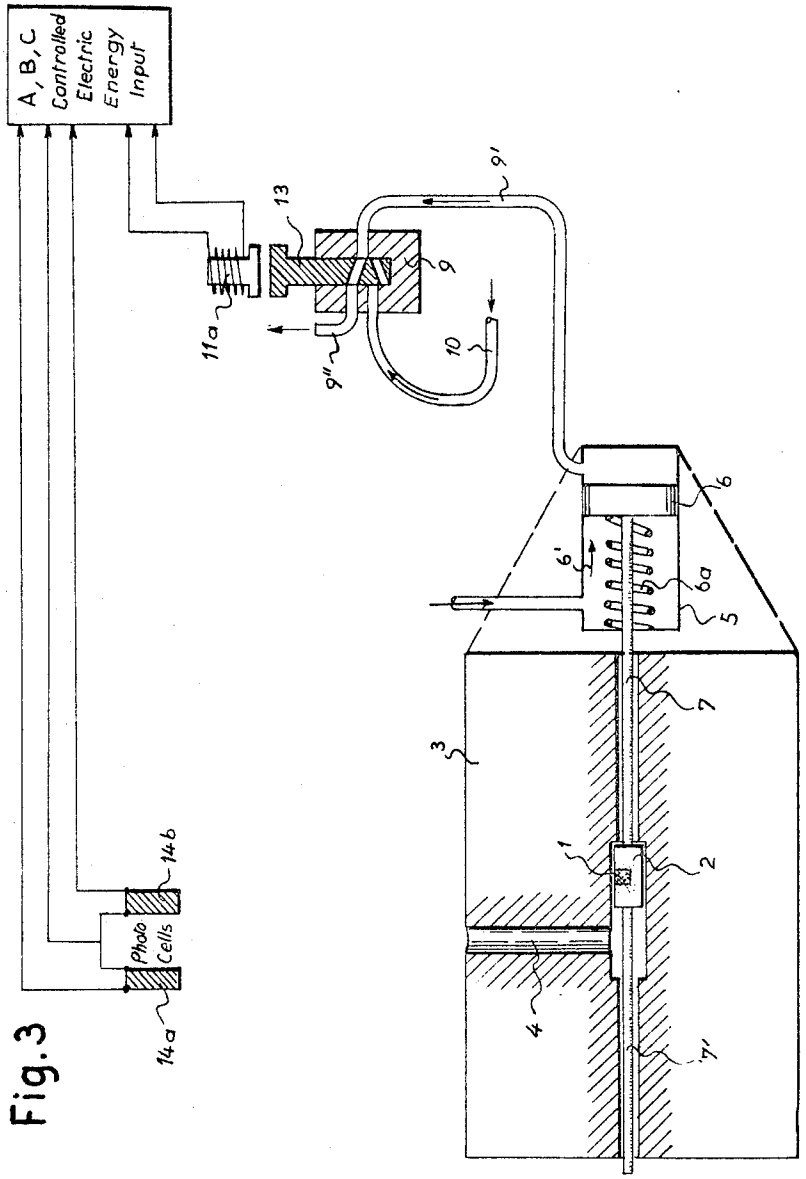

Fig. 3

Inventors
André Kohn
Jean Aupée
by Michael S. Striker
Atty

Sept. 13, 1966 A. KOHN ETAL 3,272,987

ARRANGEMENT FOR IRRADIATING AN OBJECT WITH RADIOACTIVE RADIATION

Filed Oct. 24, 1962 4 Sheets-Sheet 4

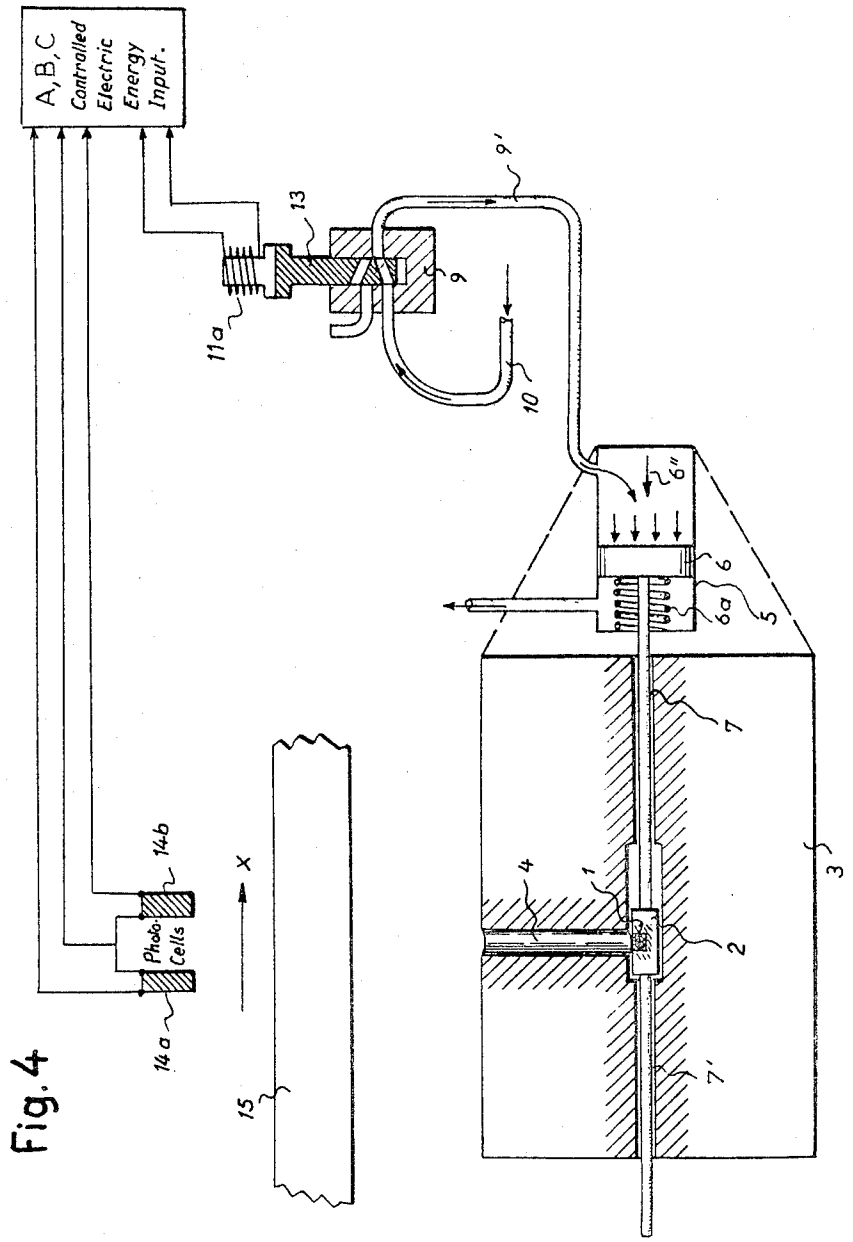

Fig. 4

Inventors
André Kohn
Jean Aupée
by
Michael S. Striker
Kirker

United States Patent Office 3,272,987 Patented Sept. 13, 1966

3,272,987

ARRANGEMENT FOR IRRADIATING AN OBJECT WITH RADIOACTIVE RADIATION

André Kohn, Saint-Germain-en-Laye, and Jean Aupée, Le Pecq, France, assignors to Institut de Recherches de la Siderurgie Francaise, Saint-Germain-en-Laye, France

Filed Oct. 24, 1962, Ser. No. 232,827
Claims priority, application France, Nov. 7, 1961, 878,165, Patent 1,313,153
13 Claims. (Cl. 250—106)

The present invention concerns an arrangement for irradiating an object with radioactive radiation, a method becoming more and more popular in various industries e.g. in rolling mills for examining sheet material in the course of its manufacture so as to detect flaws, to determine its thickness or the like.

However, it is well known that such radioactive radiation e.g. gamma radiation constitutes a considerable hazard for the personnel. Therefore, a body of radioactive material intended to be used for irradiating an object is ordinarily shielded by being enclosed in a heavy container composed predominantly of material absorbing radioactive radiation. Of course, the container must have at least one opening through which the desired radioactove radiation can be released in direction toward the object to be irradiated. For the sake of safety against unintentional irradiation of objects or personnel this opening would have to be normally covered and be uncovered only when irradiation of an object is desired. A cover establishing safety would have to be very heavy and as thick as the walls of the protective container, and therefore it would require considerable forces to move the cover between a position in which the opening of the container is covered and a position in which it is uncovered. In addition, alone on account of the considerable inertia of such a heavy cover its movement between the above mentioned positions could hardly be carried out with the high speed which is desirable.

Particularly in the case of the application of an arrangement for irradiating an object with radioactive radiation in a steel or other metal rolling mill, rapid or even instantaneous changes between irradiating condition and protected condition of the irradiating arrangement is of great importance.

It is therefore one of the objects of this invention to provide for an arrangement for irradiating an object with radioactive radiation which provides for the above mentioned changes to take place with great rapidity and by applications of a comparatively moderate force.

It is another object of this invention to provide for an arrangement as set forth which is comparatively simple in its structure and entirely reliable in operation.

With above objects in view the invention includes an arrangement for irradiating an object with radioactive radiation, comprising, in combination, container means composed predominantly of material absorbing radioactive radiation and including an inner chamber of predetermined dimensions, said container means further including a channel leading in a predetermined direction from a selected portion of said inner chamber to the outside of said container means; a body of radioactive material arranged within said inner chamber and having dimensions smaller than those of said inner chamber so as to be movable therein between a first position in which said body of radioactive material is located opposite the inner end of said channel whereby its radiation is released to the outside in said direction of said channel toward an object that may be present opposite the outer end of said channel, and a second position in which said body of radioactive material is located within said inner chamber at a distance from said inner end of said channel whereby said radiation is blocked from reaching the outside; and moving means alternatively moving said body of radioactive material from said first position to said second position, and vice versa.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a schematic diagram illustrating one embodiment of the invention with a body of radioactive material in shielded position;

FIG. 2 is a similar illustration of the same embodiment showing the body of radioactive material in operative position for irradiating an object;

FIG. 3 is a schematic diagram illustrating a simplified embodiment of the invention, with the body of radioactive material in shielded position; and

FIG. 4 illustrates the same arrangement as FIG. 3, with the body of radioactive material in operative position for irradiating an object.

In the embodiment illustrated by FIGS. 1 and 2 a thick-wall container 3 made predominantly of material absorbing radioactive radiation is provided with an inner chamber 3′ of predetermined dimension, the left-hand portion whereof is connected by a channel 4 in a predetermined direction transverse of the longitudinal dimension of the chamber 3′ with the outside surface of the container 3. A carrier 2 supporting a body 1 of radioactive material is arranged for being movable in longitudinal direction along the chamber 3′ between a first position in which the body 1 of radioactive material is located opposite the inner end of the channel 4, as shown in FIG. 2, whereby radiation from the body 1 is released in the above mentioned direction through the channel 4 to the outside, and a second position, shown in FIG. 1, spaced a certain distance from the inner end of the channel 4 whereby radiation from the body 1 through the channel 4 is prevented. For controlling the movement of the carrier 2 with the body 1 a second channel 3″ extends in longitudinal direction of the chamber 3′ through the entire block or container 3 so that guide rods 7 and 7′ may be moved slidably along this second channel 3″.

For moving the carrier 2 with its body 1 of radioactive material a hydraulic or pneumatic device is provided which comprises a cylinder 5 and a piston 6 movable therein and connected with the guide rod 7. The two opposite ends of the cylinder 5 are connected by fluid lines 8′ and 9′, respectively, with solenoid valves 8 and 9, respectively. Both valves are constructed in the same manner. For instance, the valve 8 comprises a body and a control plunger 12 with transverse bores so that, depending upon the position of the plunger 12, the fluid line 8′ is either connected with a pressure fluid input line 10 coming from a source of compressed fluid medium (gas or liquid) or with an exhaust line 8″. In the same manner the control plunger 13 of valve 9 connects depending upon its position either the fluid line 9′ with the supply line 10 or with an exhaust line 9″. Solenoid means 11 and 11*a*, respectively, cooperate with the plungers 12 and 13, respectively, so as to move the latter, upon energization of the solenoid, from a first position as shown in FIG. 1 for the valve 9, to a second position as shown in FIG. 1 for valve 8. Spring means or the like may be provided for returning the plungers from said second position to said first position as indicated by the arrows 12′ and 13′, respectively.

When the valves 8 and 9 are in the positions as

illustrated in FIG. 1 i.e. when the solenoid **11** is energized, the pressure fluid from supply line **10** is applied through valve **8** and line **8'** to one side of the piston **6** so that the latter is moved in the direction of the arrow **6'** whereby the carrier **2** with the radioactive body **1** is placed in the position shown in FIG. 1 in which radiation from the body **1** to the outside is blocked. While the piston **6** has been moved in the direction of arrow **6'** the pressure fluid on the other side thereof has been permitted to escape through line **9'** and through valve **9** and the exhaust line **9''**.

However, when the valves **8** and **9** are in the position shown in FIG. 2 the pressure fluid from line **10** is applied through valve **9** and line **9'** to the other side of the piston **6** so that it is moved in the direction of arrow **6''** whereby the carrier **2** with the body **1** is moved to its position in which the radiation from the body **1** is released through channel **4**. During the movement of the piston **6** in the direction of the arrow **6''** the pressure fluid on the first side of the piston **6** has been permitted to escape through line **8'** and valve **8** to the exhaust line **8''**.

The solenoids **11** and **11*a*** are connected, as shown, with a controlled source of electric energy B. This source may comprise for instance relays which depending upon their energization apply electric current alternatively either to the solenoid **11** or to the solenoid **11*a***. The source B or the above mentioned relays therein may be controlled by manual control C for intentionally establishing either the position of the valves as shown in FIG. 1 or the position of the valves as illustrated by FIG. 2.

It will be understood that, although the use of hydraulic means as described above in connection with solenoid valves is preferred, the movement of the carrier **2** between its positions may quite as well be carried out by other conventional means as for instance by electromagnetic actuation of the guide rod **7** or **7'**.

It should be borne in mind that solenoid valves are available which operate with great rapidity so that by using such solenoid valves great rapidity of the movement of the carrier **2** with its body of radioactive material **1** can be accomplished.

It will be understood that by the arrangement described above safety against unintentional release of radiation through the channel **4** can be achieved additionally by arranging in the cylinder **5** a spring or similar device as illustrated at **6*a*** in FIGS. 3 and 4, which continuously exerts force on the piston **6** in the direction of the arrow **6'**. In this case whenever either the electric power or the supply of pressure fluid should fail the piston **6** will by all means be moved to the position shown in FIG. 1 in which radiation from the body **1** to the outside is blocked.

The above described arrangement lends itself readily to automatic control and operation. For this purpose photo-responsive devices may be arranged opposite the outer end of the channel **4** and connected with the controlled source B through an automatic control device A so that depending upon energization and de-energization of the photo-responsive means the controlled source B is correspondingly controlled or actuated in a manner analogous to the above described manual control.

In a preferred embodiment as illustrated by FIGS. 1 and 2 two photo-cells **14*a*** and **14*b*** are arranged opposite the channel **4** but spaced from each other a predetermined distance so that the midpoint between the cells **14*a*** and **14*b*** is substantially in alignment with the center line of channel **4**. The photo-cells **14*a*** and **14*b*** are so connected with the automatic control A and the latter is so constructed that the controlled source B is actuated in one or the other way only when both photo-cells **14*a*** and **14*b*** are simultaneously energized or one of them is de-energized, as the case may be.

The reason for this and for the use of two photo-cells in this arrangement is the following. The purpose of the automatic photo-electric control is to automatically move the carrier **2** with the body **1** into radiation-releasing position according to FIG. 2 only when an object **15** as shown in FIG. 2 moving in the direction of the arrow X has reached a position in which it intercepts the entire beam **4'** of radioactive radiation released through channel **4**. Since this beam composed e.g. of gamma rays, has a certain tendency to diverge as illustrated, and since the object **15**, for instance a sheet or strip of metal to be irradiated, may reach the position of being irradiated not only in the direction of the arrow X but also in opposite direction, using only one photo-cell located on the center line of channel **4** might result in the release of radioactive radiation from the channel **4** before the radioactive beam **4'** is fully intercepted by the front end of the object **15**.

If the object **15** is hot so as to release infra-red radiation **15'** as shown in FIG. 2 then of course the photo-cells **14*a*** and **14*b*** should be sensitive to infra-red radiation. When energized by such radiation they will cause the automatic control A to actuate the controlled source B in such a manner that the valves **8** and **9** are placed in the condition shown in FIG. 2 and correspondingly the body **1** of radioactive material is placed opposite the inner end of the channel **4**. On the other hand, whenever the object **15** is not in a position to intercept the radioactive beam **4'**, at least one of the photo-cells **14*a*** or **14*b*** is de-energized whereby in a manner analogous to that described above the carrier **2** with the body **1** is automatically removed to the position according to FIG. 1.

If the material of the object **15** does not emit infra-red radiation but is simply opaque then a slightly different arrangement should be used. As indicated in FIG. 1 one or two light sources **14*c***, **14*c'*** should be placed in the area of the outer end of the channel **4** so as to throw light beams **14'** and **14''**, respectively, in direction toward the photo-cells **14*a*** and **14*b***. Thus both photo-cells **14*a*** and **14*b*** are normally energized simultaneously. If now an opaque object **15** is moved into a position in which it intercepts not only the radioactive beam **4'** but also the light beams **14'** and **14''** the photo-cells **14*a*** and **14*b*** are simultaneously de-energized. In this case this simultaneous de-energization of the photo-cells **14*a*** and **14*b*** will cause the automatic control A to actuate the controlled source B so as to cause movement of the carrier **2** with the body **1** into the position of FIG. 2. On the other hand, as soon as the object **15** is withdrawn so that at least one of the photo-cells **14*a*** or **14*b*** is again energized by one or the other of the light sources **14*c*** or **14*c'*** the automatic control A will cause in analogous manner as described above the automatic movement of the carrier **2** with the body **1** to the position illustrated by FIG. 1.

FIGS. 3 and 4 correspond in general to the arrangement illustrated by FIGS. 1 and 2 except that the arrangement is somewhat simplified. Instead of two valves only one valve **9** is provided which serves in the position shown by FIG. 4 to cause application of the pressure fluid through line **9'** to the cylinder **5** so as to move the piston **6** in the direction of arrow **6''** whereby the carrier **2** with the body **1** is placed in position opposite the channel **4**. A return spring **6*a*** is provided in the cylinder **5** for returning the piston **6** and with it the carrier **2** to the position as shown in FIG. 3. This return movement will take place as soon as the solenoid valve **9** is de-energized and assumes the position shown in FIG. 1. The operation of this simplified arrangement is otherwise quite analogous to that described above with reference to FIGS. 1 and 2.

It can be seen that also the arrangement according to FIGS. 3 and 4 offers added safety in the case of failure of the electric power or of the supply of pressure fluid because the spring **6*a*** tends always to return the carrier **2** with the body **1** into the blocked position.

Evidently the arrangement could be advantageously supplemented by one or more relays or similar means which respond to other general conditions applying to the area where the irradiation arrangement according to the invention is located so that by this relay or these relays either the electric supply to the control arrangement or the supply of pressure fluid, or both, are interrupted, or that by actuation of the controlled source B the arrangement is actuated to move the body 1 into blocked position, whenever the general conditions mentioned above are such that the release of radiation from the body 1 must be or should be prevented.

Practical tests with an arrangement according to the invention have shown that it operates in a very sensitive and rapid manner. The movement of the carrier 2 with the radioactive body 1 between radiation-releasing position and blocked position takes place within about .1 second after energization of the photo-cells 14*a* and 14*b* and this is achieved by applying air pressure of 85 p.s.i. to the piston 6.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of an arrangement for irradiating an object with radioactive radiation differing from the types described above.

While the invention has been illustrated and described as embodied in an arrangement for irradiating an object with radioactive radiation by means of automatic movement of a radioactive body between a radiation-releasing position and a radiation-blocking position, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. An arrangement for irradiating an object with radioactive radiation, comprising, in combination, container means composed predominantly of material absorbing radioactive radiation and including an inner chamber of predetermined dimensions, said container means further including a channel leading in a predetermined direction from a selected portion of said inner chamber to the outside of said container means; a body of radioactive material arranged within said inner chamber and having dimensions smaller than those of said inner chamber so as to be movable therein between a first position in which said body of radioactive material is located opposite the inner end of said channel whereby its radiation is released to the outside in said direction of said channel toward an object that may be present opposite the outer end of said channel, and a second position in which said body of radioactive material is located within said inner chamber at a distance from said inner end of said channel whereby said radiation is blocked from reaching the outside; moving means for alternatively moving said body of radioactive material from said first position to said second position, and vice versa; and control means in operative proximity with said body of radioactive material and in the area of said object and electrically connected to said moving means for controlling the operation of said moving means in accordance with the position of said object relative to said radiation.

2. An arrangement for irradiating an object with radioactive radiation, comprising, in combination, container means composed predominantly of material absorbing radioactive radiation and including an inner chamber of predetermined dimensions, said container means further including a first channel leading in a predetermined direction from a selected portion of said inner chamber to the outside of said container means and a second channel leading from said inner chamber in at least one direction transverse of said predetermined direction of said first channel to the outside of said container means; carrier means movable within said inner chamber and in said second channel; a body of radioactive material arranged within said inner chamber and having dimensions smaller than those of said inner chamber and supported by said carrier means, said carrier means with said body of radioactive material being movable between a first position in which said body of radioactive material is located opposite the inner end of said channel whereby its radiation is released to the outside in said direction of said channel toward an object that may be present opposite the outer end of said channel, and a second position in which said body of radioactive material is located within said inner chamber at a distance from said inner end of said channel whereby said radiation is blocked from reaching the outside; moving means for alternatively moving said carrier means with said body of radioactive material from said first position to said second position, and vice versa; and control means in operative proximity with said body of radioactive material and in the area of said object and electrically connected to said moving means for controlling the operation of said moving means in accordance with the position of said object relative to said radiation.

3. An arrangement for irradiating an object with radioactive radiation, comprising, in combination, container means composed predominantly of material absorbing radioactive radiation and including an inner chamber of predetermined dimensions, said container means further including a first channel leading in a predetermined direction from a selected portion of said inner chamber to the outside of said container means and a second channel leading from said inner chamber in at least one direction transverse of said predetermined direction of said first channel to the outside of said container means; carrier means movable within said inner chamber and in said second channel; a body of radioactive material arranged within said inner chamber and having dimensions smaller than those of said inner chamber and supported by said carrier means, said carrier means with said body of radioactive material being movable between a first position in which said body of radioactive material is located opposite the inner end of said channel whereby its radiation is released to the outside in said direction of said channel toward an object that may be present opposite of said fluid medium to said hydraulic means; and control means in operative proximity with said body of radioactive material and in the area of said object and electrically connected to said moving means for controlling the operation of said moving means in accordance with the position of said object relative to said radiation; said body of radioactive material is located within said inner chamber at a distance from said inner end of said channel whereby said radiation is blocked from reaching the outside; moving means for alternatively moving said carrier means with said body of radioactive material from said first position to said second position, and vice versa, said moving means including hydraulic means responsive to the application thereto of a fluid medium under pressure and fluid control means for controlling the application of said fluid medium to said hydraulic means and control means in operative proximity with said body of radioactive material and in the area of said object and electrically connected to said moving means for controlling the operation of said moving means in accordance with the position of said object relative to said radiation, said control means being responsive to said radiation.

4. An arrangement as defined in claim 3 wherein said hydraulic means comprises cylinder and piston means, and

wherein said fluid medium causes movement of said piston means in response to control by said fluid control means.

5. An arrangement as defined in claim 3 wherein said hydraulic means comprises double-acting cylinder and piston means, and wherein said fluid medium causes alternatively movement of said piston means in one and the opposite direction, respectively in response to control by said fluid control means.

6. An arrangement as defined in claim 2 wherein said moving means includes cylinder and piston means causing movement of said piston and carrier means to said first position in response to the application thereto of a fluid medium under pressure, resilient means for causing return movement of said piston and carrier means when pressure application is discontinued and fluid control means for controlling the application of said fluid medium to said cylinder means for causing movement of said piston means toward said first position.

7. An arrangement as defined in claim 6 wherein said fluid control means includes a source of compressed fluid medium and fluid line means to said cylinder means, and further comprising solenoid valve means arranged in said fluid line means and changeable between opened and closed condition depending upon electrical energization, and electric means for energizing said solenoid valves.

8. An arrangement as defined in claim 7 wherein said cylinder and piston means are double-acting cylinder and piston means, wherein said fluid control means causes alternative movement of said piston means in one and the opposite direction, respectively, and said fluid line means includes first and second fluid line means to the opposite ends, respectively, of said cylinder means, said solenoid valve means being arranged in said first and second fluid line means, respectively and each being changeable between opened and closed condition, and further comprising electric means for alternatively energizing one of said solenoid valve means to assume open condition while causing the other one to assume closed condition, and vice versa.

9. An arrangement as claimed in claim 7, wherein said control means include infra-red light responsive means located substantially opposite the outer end of said first channel in said predetermined direction thereof for causing energization of said solenoid valve means when an object to be irradiated and emitting itself infra-red light radiation is placed between said outer end of said first channel and said infra-red light responsive means.

10. An arrangement as claimed in claim 8, wherein said control means include infra-red light responsive means located substantially opposite the outer end of said first channel in said predetermined direction thereof for causing, when an object to be irradiated and emitting itself infra-red light radiation is placed between said outer end of said first channel and said infra-red light responsive means energization of said first solenoid valve means, for causing opening of the latter and correspondingly movement of said carrier means to said first position thereof.

11. An arrangement as claimed in claim 8, wherein said control means include light source means located in the area of the outer end of said first channel and light responsive means located substantially opposite the outer end of said first channel in said predetermined direction thereof for causing, when an opaque object to be irradiated is placed between said outer end of said first channel and said light responsive means, energization of said first solenoid valve means for causing opening of the latter and correspondingly movement of said carrier means to said first position thereof.

12. An arrangement as claimed in claim 5, wherein said control means include infra-red light responsive means located substantially opposite the outer end of said first channel in said predetermined direction thereof for causing, when an object to be irradiated and emitting itself infra-red light radiation is placed between said outer end of said first channel and said infra-red light responsive means, energization of said solenoid valve means for causing opening of the latter and correspondingly movement of said carrier means to said first position thereof.

13. An arrangement as claimed in claim 5, wherein said control means include light source means located in the area of the outer end of said first channel and light responsive means located substantially opposite the outer end of said first channel in said predetermined direction thereof for causing, when an opaque object to be irradiated is placed between said outer end of said first channel and said light responsive means, energization of said solenoid valve means for causing opening of the latter and correspondingly movement of said carrier means to said first position thereof.

References Cited by the Examiner

UNITED STATES PATENTS

2,732,083	1/1956	Smith	214—658
2,822,776	2/1958	Morganstern	250—106
2,965,761	12/1960	Harvath	250—106
2,999,591	9/1961	Crump	250—83.3
3,032,661	5/1962	Wolf	250—106

RALPH G. NILSON, *Primary Examiner.*

JAMES W. LAWRENCE, *Examiner.*

S. ELBAUM, *Assistant Examiner.*