July 21, 1964 J. S. MACINTYRE 3,141,976

RADIOACTIVE SOURCE HOUSING WITH REMOTELY OPERATED SHUTTER

Filed April 18, 1961 2 Sheets-Sheet 1

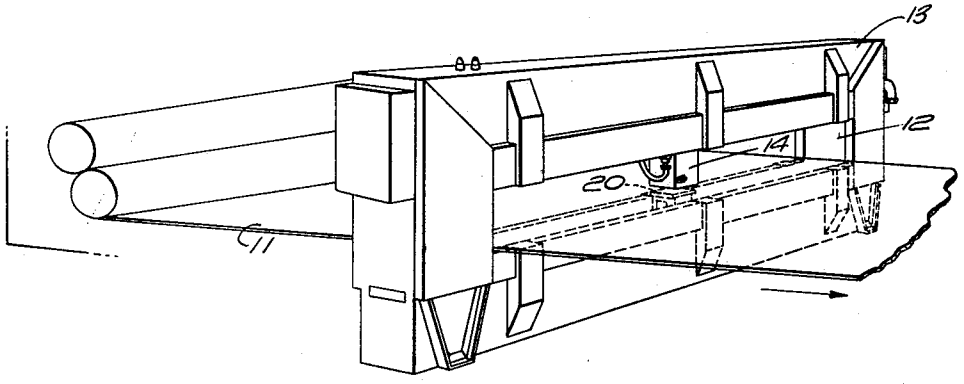


FIG. 1

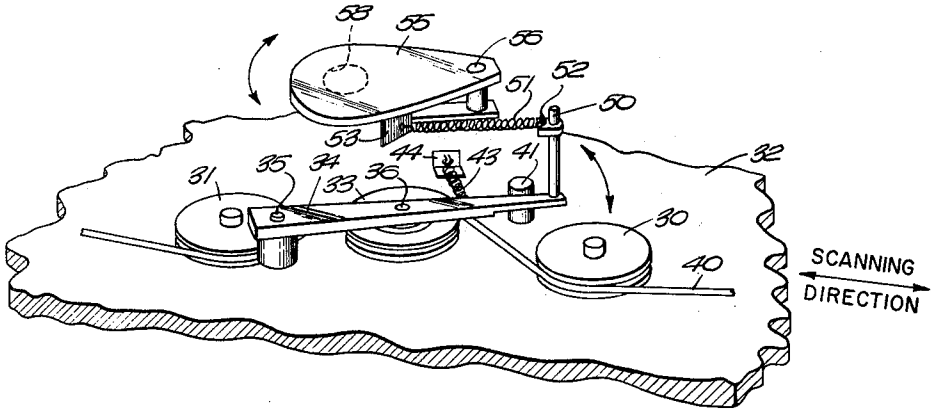


FIG. 2

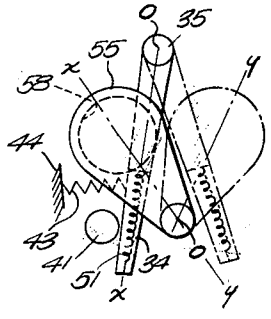


FIG. 3

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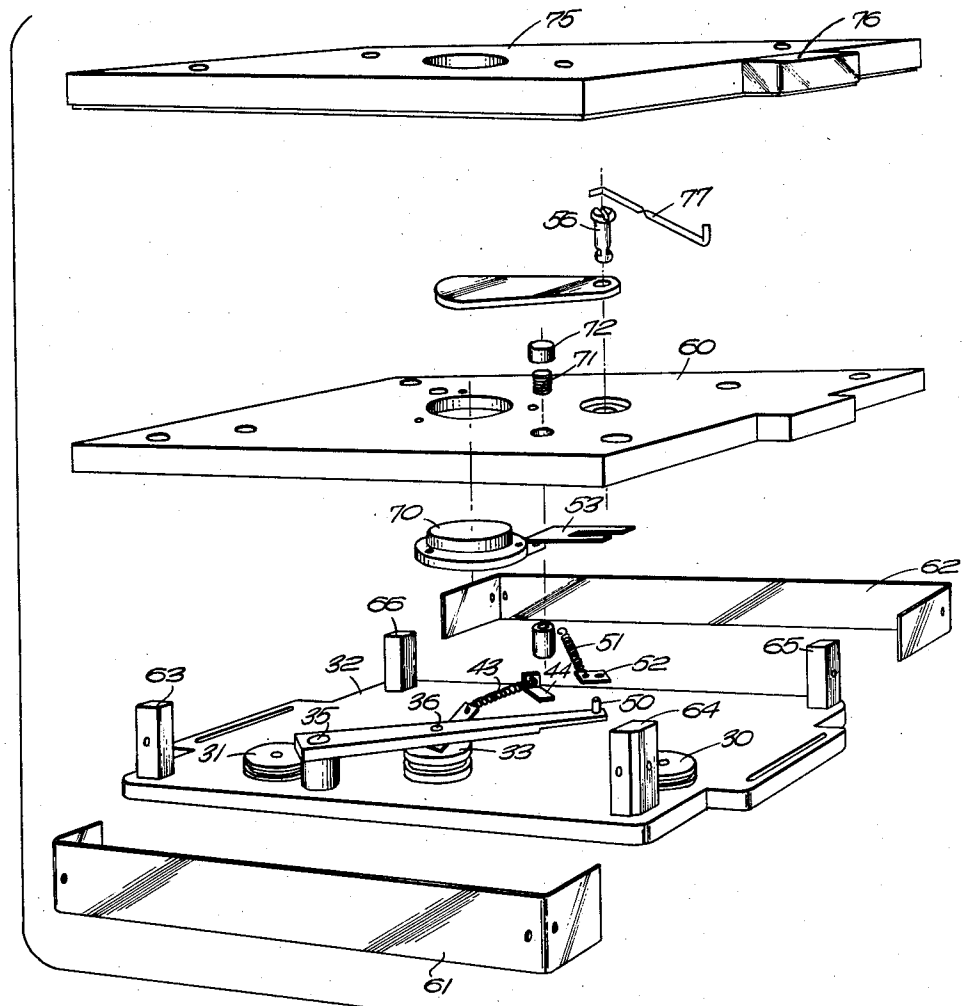


FIG. 4

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RADIOACTIVE SOURCE HOUSING WITH REMOTELY OPERATED SHUTTER

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This invention relates in general to radioactive source housings and, more particularly, to a radioactive source housing having a remotely operated shutter and adapted to be scanned along a path of travel.

The increased use of radioactive sources in medical and industrial applications has led to increasingly complex problems associated with the housings for such sources. Thus, any housing construction must take into account factors of motion of the radioactive source in a predetermined scan, radiation safety factors, industrial atmosphere factors, such as, explosion proofing and the like. In any use of radioactive sources, a prime consideration is always the radiation safety aspect. In an industrial application, the radioactive source may be required to provide a relatively high intensity beam of nuclear radiation when the particular equipment utilizing the radioactive source is in operation and, yet, when the equipment is not in operation, the radiation external to the source housing should be maintained at a minimum in order to minimize radiation hazard to personnel. Further, where the operation may involve only intermittent generation of the high intensity radiation beam, it is usual to shut off the radiation beam during those portions of the operation where it is not required, again in order to minimize radiation hazard. Since the nature of a radioactive source is such that the primary material which is emanating the radiation always emits the radiation and this process is not itself controllable, then some type of shutter mechanism must be employed in order to provide a high intensity radiation beam at appropriate times and at other times to maintain the radiation external to the housing at a minimum. Such shutter mechanism must usually be operated remotely and, hence, must have some form of connection between a control point and the actuated shutter. In many instances, as for example in thickness gauging of materials which are formed in a continuous strip in industrial plants, the radioactive source and a detector aligned with it, must be moved in a scanning path across the width of the strip which may be a few yards. In these instances, the housing problem is then complicated by the fact that the housing itself must be capable of the scanning motion and that the shutter actuation must also be adapted to operate on a housing in any one of several different positions. Source housings for use in this type of application have been devised in attempts to meet satisfactorily the above requirements. One method of solving the actuation problem has been to employ electrically operated solenoids within the housing to move the shutter from the open to the closed position and provide flexible electrical coupling from the remote control operating point to the housing itself. This system is subject, however, to the problems associated with operating electrical equipment in an atmosphere requiring explosion proofing and, in addition, requires a relatively unwieldy mechanism for reeling in and out the electrical cables connecting the housing to the remote control position. Another solution has involved the use of hydraulic actuating devices, but here again the requirements of reeling in and out the hydraulic lines on the scanning housing have led to unnecessarily cumbersome equipment.

It is, therefore, a primary object of the present invention to provide a radioactive source housing adapted for motion along a scanning path which includes a remotely operated shutter mechanism.

It is another object of the present invention to provide a radioactive source housing having a shutter adapted to be operated from a distance while the housing is scanning over a predetermined path.

It is still another object of the present invention to provide a radioactive source housing having a remotely operated shutter mechanism particularly suited for operation in industrial atmospheres and adapted to traverse over a predetermined path.

Broadly speaking, the apparatus of the present invention comprises a radioactive source housing having a shutter which is normally maintained by spring tension in the closed position and which may be actuated to the open position from a distance by means of a mechanical linkage. The entire source housing is adapted to traverse along a predetermined scanning path and the shutter may be operated either while the housing is in motion, or at any intermittent stopping point along the path. The mechanical linkage between the remote actuating point and the source housing consist of a cable, typically a steel cable, extending along the traversing path. The cable is of fixed length and the actuation, as will be described in more detail below, is accomplished by increasing or relaxing the tension on this cable. Thus, the operation of the shutter requires no electrical components at the housing itself, which facilitates explosion proofing, nor is any pickup reel required to adjust for varying lengths of cable or hose.

Other objects and advantages will become apparent from the following detailed description when taken in conjunction with the accompanying drawing in which:

FIG. 1 is a perspective view of a typical industrial gauging application employing the novel housing of this invention;

FIG. 2 is a perspective view of a shutter mechanism in accordance with the principles of this invention;

FIG. 3 is a diagrammatic view of the operation of a shutter in accordance with the principles of this invention; and

FIG. 4 is an exploded view of a radioactive source housing embodying the principles of this invention.

With reference now specifically to FIG. 1, an industrial thickness gauge operating on a strip of material **11** is shown. The material to be measured **11** is fed through the open central section generally shown as **12** of an O frame **13**. A radioactivity detector **14** is mounted on the upper inside portion of the O frame **13** and is adapted to scan along the length of this frame. A source housing **20** containing a radioactive source is mounted on the lower inside portion of the opening of the O frame opening in conjunction with the detector **14**. In operation the detector **14** and source housing **20** are traversed back and forth within the O frame across the width of the material strip **11** to provide measurements of thickness of the material **11**. The principle of operation of a radioactive industrial thickness gauge basically is that the nuclear radiations from the radioactive source are absorbed in a manner related to the thickness of the interposed material and, hence, the quantity of radiations measured by the detector is a function of the thickness of the interposed material. The detector source housing combination may either be continuously scanned back and forth and thus provide a continuous output indication of thickness, or may be moved, in sequence, to several predetermined positions, pausing at each such position and registering the thickness at that point. In this latter type of intermittent operation, it is unnecessary to have any radiation external

to the source housing while the housing is traveling between the predetermined measuring points. It is, therefore, desirable to have a shutter mechanism permitting the beam to emanate from the source housing or not in accordance with some actuation control and, further, it is desirable to have this shutter mechanism capable of being actuated at any one of the intermittent points. In addition to the requirement of actuation at several diverse points, the shutter should be "fail safe" in that any power failure or unexpected stopping of the operation will cause the source shutter to assume the closed position thus minimizing any radiation hazard in the immediate vicinity.

With reference now to FIG. 2, a remotely operated source shutter is shown with the enclosing covers removed in order to clarify the shutter mechanism. A pair of pulleys 30 and 31 are fixed to the base plate 32 of the source housing at longitudinally spaced points in a manner such that they are free to rotate about their own axes. A lever arm 34 is attached through pivot 35 to base plate 32 at a point intermediate the two pulleys 30 and 31. The lever arm 34 has attached to it, at about the middle, a third pulley 33 and this third pulley is again free to rotate on its own axis which is parallel to the axes of the other two pulleys 30 and 31. A cable 40, typically formed of steel or the like, is threaded on one side of pulley 30, on the other side of pulley 36, and then through the side of pulley 31 corresponding to the side of pulley 30 through which it was threaded. One end of cable 40 is attached to a point on O frame 13 at one end of the scanning way of the source housing, while the opposite end of cable 40 is attached to a tensioning medium (not shown) at the opposite end of the scanning way of O frame 13. The tensioning medium would typically be a pneumatic or hydraulic piston or a solenoid arm. The cable 40, then, extends along the scanning way of the source housing and as the source is scanned along this path, the pulleys, and hence the entire housing, ride back and forth along the cable 40. Returning to the mechanism within the source housing, a stud 41 is attached to the base plate 32, and the lever arm 34 is normally held against this stud by means of a spring 43 connecting the lever to a bracket 44 fixed to the base plate 32. A vertical post 50 is attached to lever arm 34 at the end opposite to the pivot 35. A swivel plate 52 is rotatably mounted on post 50 and has attached to it one end of spring 51, the other end of which is attached to a bracket 53 which extends downwardly from and is fixed to shutter member 55.

The shutter member 55 is a generally paddled shaped plate formed of a suitable material and thickness to absorb virtually all of the radiation from the radioactive source. The shutter 55 is mounted on a pivot 56 to the top plate (shown as plate 60 in FIG. 4) of the source housing. In its normal or closed position, the shutter covers a radioactive source indicated generally by the dotted lines 58 and prevents radiations from it from emanating outside of the source housing. The closed position of shutter 55 is maintained when the cable 40 has low enough tension so that the spring 43 can hold the lever arm 34 against the stop 41 thus enabling spring 51 to hold the shutter 55 in the closed position. This condition of cable 40 will hereafter be referred to as the "slack" condition.

Referring now to FIG. 3, the closed position is indicated as that position where lever 34 is in the position OX. When the cable 40 is tensioned bringing pulley 33 into line with pulleys 30 and 31, the lever 34 is forced into the position OY and the action of spring 51 now pulls shutter 55 into the open position exposing the source (indicated generally as source 70 in FIG. 4), which has remained in the position 58, as indicated by the dotted line.

Considering the operation of this source housing and shutter, it is seen that when the cable 40 is in its slack condition, the shutter member 55 is closed covering the radioactive source and movement of the source housing along its scanning path does not affect the operation of the shutter. Rather the housing slides along cable 40 freely. If at any particular moment, while the housing is either at rest or in motion, the cable 40 is tensioned then the shutter member 55 is opened exposing the source and this does not affect the motion of the housing along its scanning path. Hence, the position of the source housing on its path of travel does not affect the operation of the shutter, nor does the shutter affect the operation of the scanning. In the event that there should be a power failure or other interruption to operation or even a breaking of cable 40, the mechanism is fail safe in that the shutter automatically returns to its closed position. Since the source housing rides along the length of the cable, there is no need to reel up or unreel the cable corresponding to different positions along the path of travel of the housing. Also, by holding cable 40 with its longitudinal axis parallel to the direction of source travel, no external side thrust is applied to the source housing.

With reference now to FIG. 4, an exploded view of the entire source housing including the shutter mechanism is shown. In this figure, like numbers refer to like parts of FIG. 2. The basic enclosure frame for the source housing is formed by the base plate 32 and the top plate 60 together with side panels 61 and 62. As indicated in FIG. 4, the radioactive source 70 would typically be formed as a circular piece and this piece is attached to upper plate 60 such that the upper surface of the source which is permeable to the radiation enclosed within the source is approximately flush with the upper surface of plate 60. The upper plate 60 is attached to corner posts 63, 64, 65 and 66, which are fixed to the four corners of the rectangular base plate 32. Side panels 61 and 62 are formed with flanges at either end extending inwardly from the side panel itself and these side panels attach to the counterposts 63, 64, 65 and 66 with the flanges enclosing both ends of the housing, except for a small opening near the center of each end allowing for passage of the cable 40. A combination of a threaded screw 71 and a collar 72 fitting over it, the whole being attached to top plate 60, form a stud which limits the travel of the shutter member 55 when it moves from the closed to the open position. A top cover 75 fits over the upper plate 60 and serves to protect the shutter mechanism from dust and the like. The cover member 75 is formed with a radiation transparent window 78 such that with the shutter in the open position, radiation from the source 70 passes readily through the cover 75. A projecting rectangular window 76 in the top cover provides for visual observation of the position of the shutter by means of the indicator arm 77 which is fixed to the pivot 56 and, hence, rotates with the rotation of the shutter member 55.

The radioactive source element 70, described briefly above, will be formed in various ways depending upon the exact nature of the radioisotope employed. Thus, if the radioisotope is a beta emitting isotope, the source is typically formed as a metal cup shaped element having a hermetically sealed upper cover which is sufficiently thin to be transparent to beta radiation. On the other hand, if the source is a gamma emitting source, then the entire source mount 70 may be formed of relatively heavy metal and again would usually be hermetically sealed.

The above described assembly forms a housing for a radioactive source capable of being readily scanned and embodying a shutter mechanism which may be operated at any point along the path of scanning, which shutter mechanism has fail safe features. The absence of any electrical components within the source housing is an important safety feature in atmospheres requiring explosion proofing. While a specific detailed device has been described, the invention is not so limited. In view of the fact that numerous modifications may now be made by those skilled in the art, the invention herein is to be

construed as limited only by the spirit and scope of the appended claims.

What is claimed is:

1. A radioactive source housing comprising, a frame member; first and second pulley elements attached to said frame member, each of said pulley elements being adapted for free rotation about its own axis; a shutter member pivotally attached near one end thereof to said frame member; a third pulley element adapted for free rotation about its own axis and disposed intermediate said first and second pulley elements, said third pulley element being adapted for translational motion with respect to said frame member; guide means adapted to limit the translational motion of said third pulley to a predetermined path; means connecting said shutter member to said third pulley such that when said third pulley is in a first position along said predetermined path, said shutter member is in one position and when said third pulley is in a second position along said predetermined path, said shutter member is in a second position; a cable member threaded around said first, second, and third pulleys such that when said cable is taut, said third pulley is placed in said first position along said predetermined path; means constraining said third pulley to remain in said second position along said predetermined path when said cable is not taut; actuating means separate from said frame member and adapted to tauten and loosen said cable; a radioactive source emitting a beam of penetrating radiation, said source being disposed relative to said shutter member such that said shutter member absorbs substantially all of said beam of penetrating radiation only when said shutter is in said one position corresponding to said first position of said third pulley.

2. A radioactive source housing comprising, a base plate; first and second pulleys attached to said base plate in spaced apart relations, each of said pulleys being adapted for free rotation around its own axis; a lever arm pivotally attached to said base plate intermediate said first and said second pulleys; a third pulley attached to said lever arm and adapted for free rotation about its own axis; a cable threaded around a portion of each of said first, second, and third pulleys in a manner such that when said cable is taut, said lever arm is in a first predetermined position; constraining means attached to said lever arm and said base plate such that when said cable is not taut, said lever arm is constrained to be in a second predetermined position arcuately displaced from said first position; a radioactive source disposed in fixed relation to said base plate and adapted to emit a beam of penetrative radiation; a shutter element pivotally attached to said base plate and formed of a material adapted to absorb said beam of penetrative radiation; connecting means adapted to link said lever and said shutter element in such a fashion that when said lever is in said second position, said shutter intercepts said beam of penetrative radiation and when said lever is in said first position, said shutter is in a position such that it does not intercept said beam of penetrative radiation; actuating means separate from said base plate adapted to tauten and to loosen said cable.

3. A radioactive source housing adapted for motion along a predetermined path comprising a base member; first and second pulleys attached to said base member in spaced apart relation, each of said pulleys being adapted for free rotation around its own axis; a lever arm pivotally attached to said base member intermediate said first and said second pulleys; a third pulley attached to said lever arm and adapted for free rotation around its own axis; a cable threaded around a portion of each of said first, second, and third pulleys and extending along the said predetermined path, said cable being attached in a predetermined position at one end of said path; an actuating element attached to the other end of said cable and adapted to tauten and slacken said cable, said cable being threaded around said pulleys in such a fashion that when said cable is taut, said lever arm is in a first predetermined position; constraining means attached to said base member and said lever arm and adapted to retain said lever arm in a second position arcuately displaced from said first position when said cable is slack; a radioactive source disposed in fixed relationship to said base member and adapted to emit a beam of penetrative radiation in a predetermined direction; a shutter element pivotally attached to said base member, said shutter element being formed of a material adapted to absorb said beam of penetrative radiation; coupling means linking said lever arm and said shutter element such that when said lever arm is in said second predetermined position, said shutter element intercepts said beam of penetrative radiation and when said lever arm is in said first position, said shutter element is in a position such that it does not intercept said beam of penetrative radiation.

4. Apparatus in accordance with claim 3 and including cover members adapted to enclose said radioactive source housing, at least that portion of said cover members upon which said radiation beam is impingent being formed of a radiation transparent material, said cover means including means for visually observing the position of said shutter.

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