United States Patent

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[54] PORTABLE, NONELECTRICAL RADIOGRAPHIC DEVICE

10 Claims, 4 Drawing Figs.

[52] U.S. Cl. 250/106, 250/105
[51] Int. Cl. G21h 5/00
[50] Field of Search ..... 250/105, 106 (S)

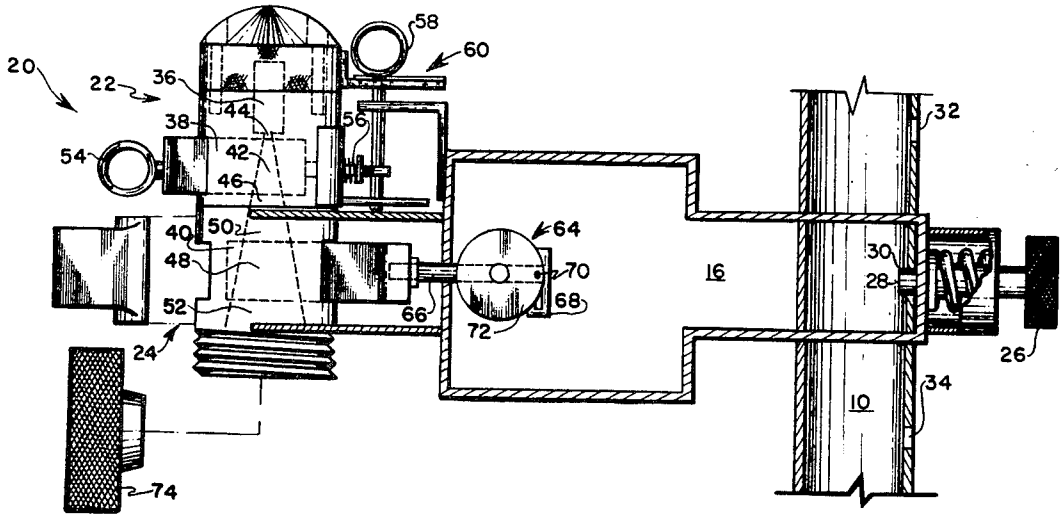
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ABSTRACT: A readily conveniently portable nonelectrical radiographic device for exposing X-ray sensitive film by utilizing a radiation source which emits electromagnetic radiation at or near the X-ray region (such as pure thulium 170 as the preferred source) as a gamma ray emission source and which incorporates multiple safety features integrally interrelated in such a manner as to enable a relatively untrained operator to utilize the machine or exchange power sources.



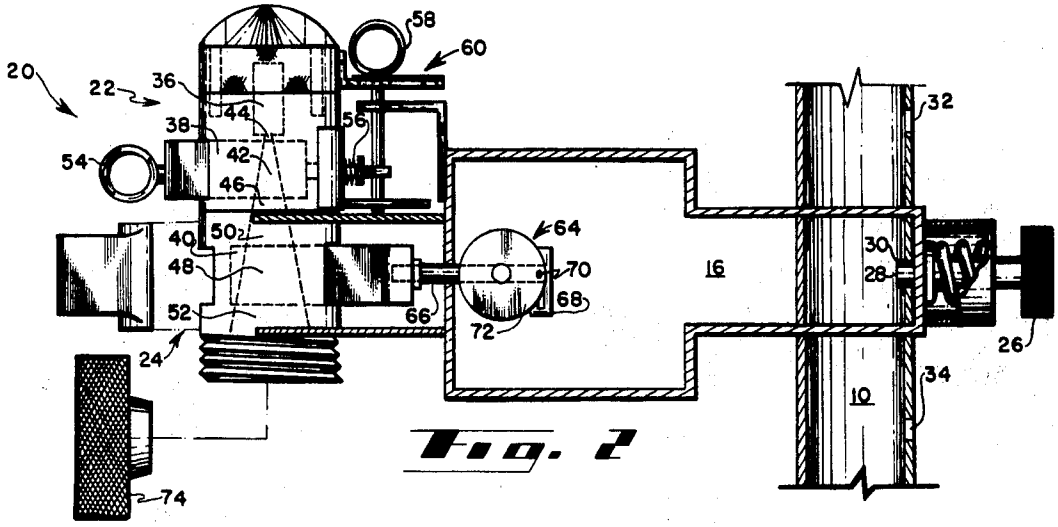


Fig. 2

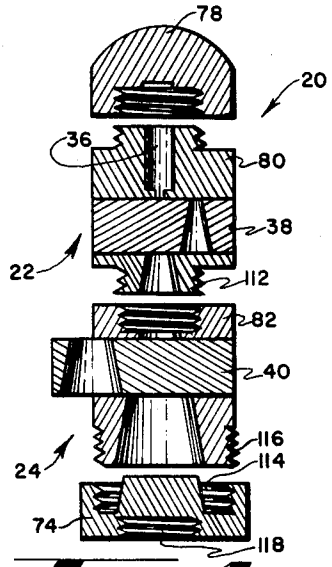


Fig. 4

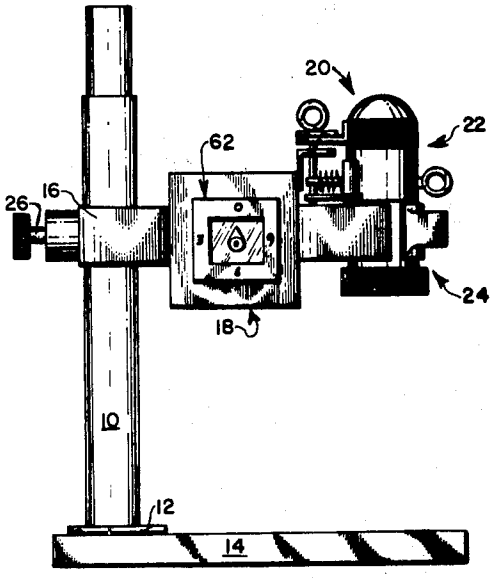


Fig. 1

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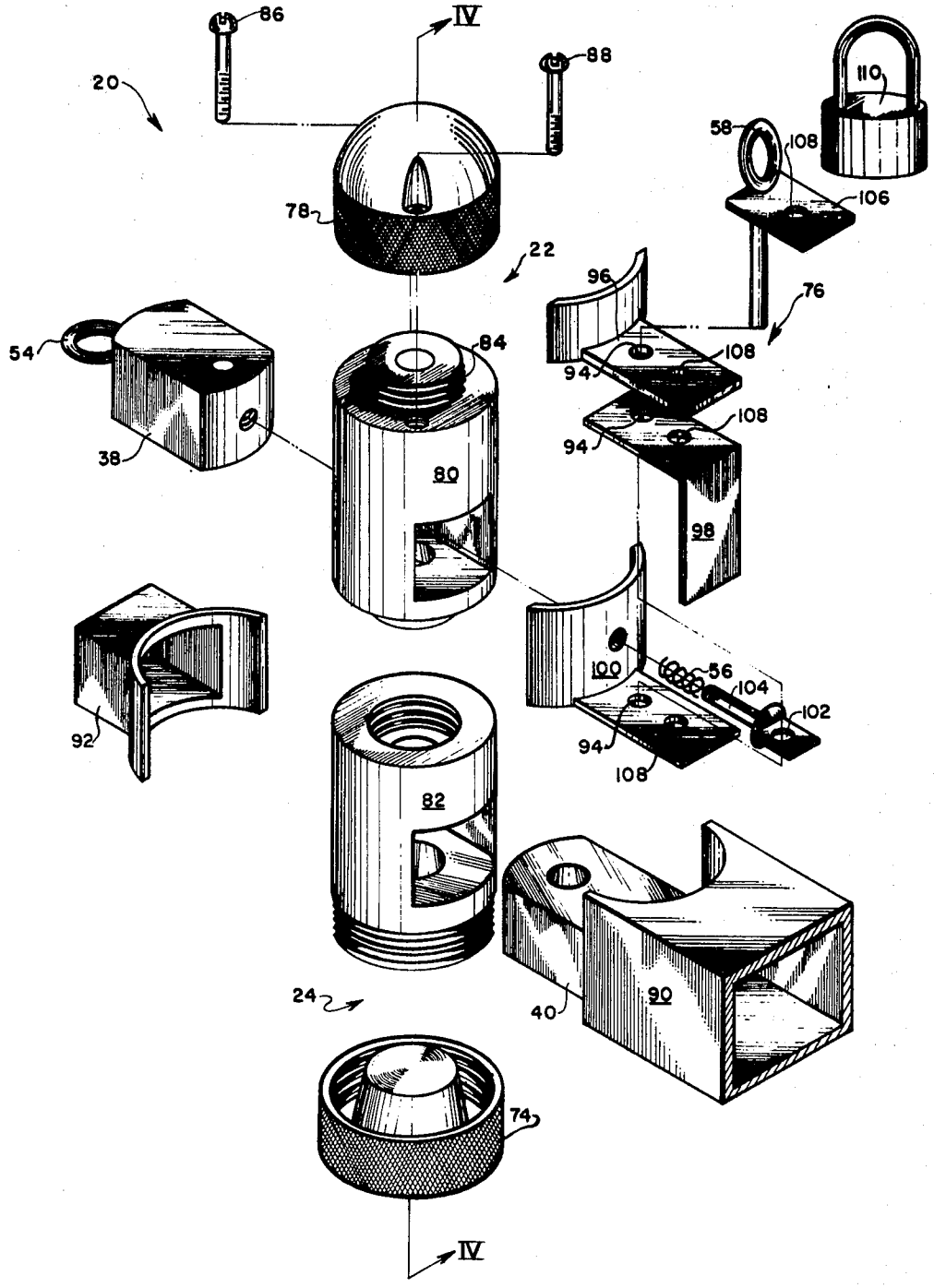


Fig. 1

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PORTABLE, NONELECTRICAL RADIOGRAPHIC DEVICE

The present invention relates to radiant energy apparatus employing cones and shutters for controlling the emission of gamma rays from an energy source.

More particularly this invention relates to portable gamma ray devices with interrelated safety features for use in making radiographs.

This invention provides a conveniently portable, lightweight, nonelectrical, isotopic X-ray device which is complete and self contained. The preferred embodiment as shown and described in this specification and accompanying drawings is simple, yet rugged in construction, thereby enhancing its utilization in areas where the use of more conventional and more complicated X-ray devices is not feasible. The device of the invention incorporates integrated, interrelated shipping, storage, assembly and operational safety features which make handling, utilization and operation virtually foolproof for even the relatively unskilled user. Removal and replacement of the energy source once it has been depleted, as well as shipment, is facilitated while at the same time the operator, handlers and others are fully protected.

The safety features are integrated so as to preclude accidental or unauthorized operation, and while in use the arrangement prevents operation or exposure unless the source of energy is correctly positioned so as to obviate accidental or excessive exposure of the subject, the operator or others.

PRIOR ART

The art of radiography is well developed and extensive progression has occurred in this area. Early X-ray devices and machines were limited in their usage by virtue of their being bulky and immovable or by requiring an electrical power source for operation. Subsequently, nonelectrical isotopic X-ray devices were developed which naturally allowed usage without electrical power. These machines are inherently bulky and generally unsafe for both the operator and the subject.

Continued progression to date in the state of the art has achieved "portable" X-ray devices with some degree of safety in use, but the long existent problems of requiring high levels of skills in handling and operation have not, up to the present, been in any material degree solved.

Industrial uses, as well as medical and military requirements, and "back-country" needs, have made manifest the need for a more conveniently portable !X-ray device which is both safe and simple in utilization to reduce materially the necessity for "specialist" training at all levels.

This invention obviates these and other problems and meets this need by making possible a lightweight, self-contained, conveniently portable isotopic X-ray device having plural integrated safety devices incorporated therein which make operation virtually foolproof.

The device as shown and described in this specification and accompanying drawings simplifies radiographic techniques and provides safeguards against inadvertent emissions at any stage of utilization of potentially harmful radiation. This simplification and the protection afforded thereby makes utilization of the X-ray device of the present invention feasible in many diverse areas not previously susceptible to this technology.

Portability, ease of maintenance and replacement of radioactive sources and other parts make possible usage in remote areas where transportation of the larger prior art devices would formerly have been impractical. Similarly, through the invention, it is now possible to obtain immediate ascertainment of injuries in a field combat area, or in other relatively inaccessible or hitherto impracticable places. Such places include disaster areas, remote and underdeveloped areas, small ships, hospitals in the event of power failure, naval ships where space is critical, or any other location where electrical power or technological or technical skill is unavailable.

Industry, in certain instances, may make application of the invented device for radiographic inspection and quality control to ascertain faults or flaws in materials without the necessity of dismantling components or removing the part to be studied to a "special" section of the plant, thus interrupting manufacturing processes and component "flow." Veterinarians may obtain radiographs of animals more readily and economically at the site of an injury, removing the necessity for transporting the animal to a machine. A version of the invention described herein is advantageous in space environments.

In addition, there are certain "critical" or explosive atmospheres sensitive to "sparking" or discharge in which it is now possible to safely obtain radiographs by use of this invention since it is nonelectrical in nature and eliminates the necessity for use of a Roentgen tube or similar apparatus.

The aforementioned examples are indicative of only a few of the potential uses the present isotopic X-ray device offers because of its portability, lack of requirement for electrical power, and the multiple safety features which it incorporates.

The primary object of this invention is to provide an isotopic X-ray device which is operable under safe conditions in a diversified range of uses.

A further object of this invention is to provide a readily portable, sturdy X-ray device which will significantly enlarge the area in which use of such a device is feasible.

A still further object of this invention is to permit the utilization of X-ray techniques without the necessity for extensive periods of training for the operators.

Other objects and advantages of this invention will become readily apparent from a consideration of the following description and accompanying drawings, wherein:

FIG. 1 is an elevational view of the X-ray device in its operational position;

FIG. 2 is an elevational, partially cutaway view on an enlarged scale of the device of FIG. 1 showing the relationship between the source and timer and the method of their support;

FIG. 3 is an exploded isometric view of the energy housing composite; and

FIG. 4 is an exploded sectional elevational view of the energy housing composite taken along reference line IV–IV of FIG. 3.

Referring now to FIG. 1, wherein the operational position of the portable X-ray device is shown, a slotted positioning member **10** is removably fixed to stand holder **12**, which in turn is affixed to a table **14**, which table also serves as a holder for the X-ray sensitive film to be exposed.

Table **14** may be incorporated as part of a carrying case for the portable X-ray device, for instance as a detachable lid, thus serving a multiple purpose, that is, as an element of a protective carrying case, as a holder for the X-ray film to be exposed, and as a table base **14** to which is affixed stand holder **12**. Adjusting and carrying arm **16** to which is fixedly attached mechanical timer system **18** and energy housing and operating composite **20** which comprises source housing component **22** and operating receptacle component **24**. Composite **20** is selectively vertically and moveably attached to positioning member **10** by spring locking knob **26**.

As best seen in FIG. 2, locking knob **26** has projection **28** adapted to fit into a slot **30** in positioning member **10** to lock adjusting arm **16** to positioning member **10**. Similar slots **32**, **34** are positioned at predetermined desired intervals on member **10**. Choice of the proper slot **30**, **32** or **34**, etc. determines the source-to-film distance, and this distance can be varied by disengaging locking knob **26** and moving adjusting arm **16** up or down until the desired position is achieved. Arm **16** is then secured by releasing the spring loaded locking knob **26**, allowing projection **28** to be inserted into the proper slot **30**, **32**, **34**, etc. to thereby lock arm **16** at the desired height.

Referring still to FIG. 2, there is shown by phantom lines the apertures and their alignment in the composite unit **20** and the manner of containment of the energy source within source cavity **36**, cavity **36** being integral with source housing com-

ponent 22 of housing and operating composite 20. Dual, fail-safe protection is afforded against inadvertent emission of energy in its operative position through interdependence of plural shutter assemblies comprising upper sliding shutter 38 and lower sliding shutter 40, both of which remain closed unless positive sequential steps are taken to properly utilize the device. Emission of X-rays is achieved only when conical apertures of both the housing component 22 and operating component 24 of the housing and operating composite 20 are moved into registry with the conical apertures of the sliding shutter assemblies 38 and 40.

In performing the operational sequence required to make the device operable, it is necessary that conical aperture 42 of shutter 38 be aligned with aperture 44 and 46 of source housing component 22 and aperture 48 of shutter 40 be aligned with apertures 50 and 52 of operating component 24 so that apertures 44, 42, 46, 50, 48 and 52 of composite 20 are in exact registry, each with the others.

This registry is effected by pulling the upper shutter 38 outward by the headed end of safety pin 54 against tensioning spring 56 so that aperture 42 in upper shutter 38 and conical apertures 44 and 46 in housing component 22 coincide. Locking pin 58 is then inserted through the proper guide apertures in bracket assembly 60 (shown more clearly in FIG. 3), which results in spring 56 being held in the compressed position. This compression of spring 56 serves as an additional safety feature since, unless upper shutter 38 is held "out" by locking pin 58, it automatically returns to a closed position—i.e., the position in which the aperture 42 of shutter 38 is not in registry with apertures 44 and 46 in housing component 22 of composite 20—thereby preventing emission of gamma rays from the selected energy source contained within source cavity 36 of housing 22.

The open position (apertures in alignment) or closed position (apertures not aligned) of operating receptacle component 24 is determined by mechanical timer system 18. Lower shutter 40 is connected to timer 62 through spring loaded actuation assembly 64 by shutter arm 66 and yoke 68. Yoke 68 is attached by a pin 70 to wheel assembly 72. On rotation (counterclockwise) against the actuation spring of wheel assembly 72, yoke 68 is pulled back responsive to the wheel rotation, until on 180° rotation, actuation assembly 64 is "held" back, "opening" shutter 40. In operation, timer 62 is set, actuation assembly 64 is actuated by rotating wheel 72 to the "open" position, against the actuation spring, wherein aperture 48 of shutter 40 registers with apertures 50 and 52 of operating receptacle component 24 as illustrated in FIG. 2. This starts timer 62 which runs the preset exposure time, and on completing the timer period, spring loaded actuation assembly 64 is released from the open position and forced to the "closed" or out-of-registry position by the actuation of spring rotating wheel 72 clockwise to make shutter 40 "home" as illustrated in FIG. 4.

If timer 62 or actuation assembly 64 should stick in the open or partially open position, the source is readily isolated by merely pulling locking pin 58 to close source housing component 22. Additionally, other means such as safety end plate 74 may readily be applied to either component 22 or 24 of composite 20. Other actuation systems may of course be employed, for example, such as manually loading assembly 64 while in its closed position, tripping the system from a remote position to "open," the system automatically loading itself to "close," which is then accomplished by timer 62.

FIG. 3 shows an exploded view of the housing and operating composite 20 and the locking means 76 for source housing component 22. Source housing component 22 comprises an internally tapped, dome shaped shielding cover 78 and source holder component 80, and operative receptacle component 24 comprises shutter receptacle 82 and safety end plate 74.

The internally tapped dome shaped cover 78 is secured to source holder component 80 by being received onto threaded boss 84, which boss constitutes one end of source holder component 80. Cover 78 is additionally secured to component 80 by bolts 86, 88 thus preventing inadvertent removal of the selected energy source contained within source holder component 80. Upper shutter 38 fits into source holder component 80 and lower shutter 40 (not visible in this drawing) fits into shutter receptacle 82. Shutter receptacle covers 90, 92 are affixed to shutter receptacle 82 and serve as a guard against dust and accidental radiation emission.

Upper shutter 38 is placed in the operable position when it is pulled out by the safety pin 54 to which it is attached. This aligns the aperture within upper shutter 38 with the apertures in source holder component 80 and the apertures in shutter receptacle 82 and compresses spring 56. Upper shutter 38 is held in this position by inserting the locking ring pin 58 through "open" apertures 94 in source holder pin guides 96, 98, and shutter stop 100, and through aperture 102 of shutter spring retaining rod 104.

Upper shutter 38 is placed in the nonoperating position by removing locking pin 58 from guide apertures 94. Guard positioning plate 106 is fixedly secured to locking pin 58. Removal of pin 58 permits relaxation of spring 56, automatically "closing" shutter 38, and pin 58 is then inserted through "inoperative" apertures 108 in pin guides 96, 98, shutter stop 100, and aperture 102 of spring retaining rod 104. A locking means 110 may then be utilized to retain the guard plate 106 in a fixed "inoperative"position, thus preventing any unauthorized or inadvertent emission of the source X-rays. This provision allows locking of the device in the nonoperative position when source housing component 22 is in any of the operative, storage or shipment modes and aids in preventing unauthorized use or inadvertent exposure to gamma ray emissions.

It is to be noted that when safety pin 58 is inserted through "inoperative"apertures 108, guard plate 106 is turned so as to allow placement of lock 110 through apertures 94 of guard plate 106 and pin guide 96, thus retaining bracket assembly 60 (FIG. 2) in the fixed position and maintaining upper shutter 38 in the closed position, i.e., the position in which the selected energy source is sealed off, thus preventing inadvertent emission of radiation by any one not having access to the unlocking means for lock 110.

Referring now to FIG. 4, it will be apparent that housing and operating composite 20 is so designed that internally tapped dome shaped shield cover 78, source holder component 80, upper shutter 38, bolts 86, 88 (not shown), and safety end plate 74 can be removed as a unit. This is accomplished by removing locking pin 58 (shown in FIG. 2) thus enabling spring 56 (shown in FIG. 2) to expand and upper shutter 38 to close automatically, thereby completely isolating the selected energy source which is contained within energy source cavity 36. Source housing component 22 comprising shielding cover 78 and source holder component 80 (which are screwed together and further secured by bolts 86, 88, except for replacement of the source), may then be removed as a unit from operating receptacle component 24 by unscrewing threaded boss 112 of source holder component 80 from operating receptacle component 24. Safety end plate 74 is then inverted and screwed onto threaded boss 112, thereby forming a radiation and dusttight container suitable for shipping as a unit for replacement, replenishment, or storage.

Safety end plate 74 is internally tapped at 114 on one side to accept threads 116 on the bottom of shutter receptacle 82 and is also internally tapped at 118 on the other side to accept threaded boss 112 on the bottom of source holder component 80.

This invention as shown and described in the preceding specification and drawings provides a readily and conveniently portable, lightweight, nonelectrical isotopic radiographic device which integrally incorporates multiple safety features permitting utilization by operators without extensive periods of training.

The device prevents accidental or unauthorized operation or inadvertent emission of radiation while changing energy sources. The combination of compactness, simplicity and

safety features permits use in situations and places which have been heretofore inconvenient or inaccessible.

We claim:

1. A non-electrical radiographic device for use with an isotopic energy source, comprising in combination:

a. housing means including:

1. a first component defining a shaped energy source cavity adjacent and contiguous therewith to one extremity thereof, said first component having means integral therewith for lockably securing a second component to one extremity thereof, said first component also defining a shaped aperture extending from the lower inner face of said source cavity to the opposite extremity thereof and adapted to laterally receive a plurality of shutter means;

2. a second component forming a cover shield member for said first component and having a first locking means integral therewith for locking engagement with said lockably securing means of said first component and a second locking means fixedly attached thereto for locking engagement between said first component and a shutter means;

b. shutter means defining a plurality of shaped apertures, said shutter means operable to cause said shaped apertures to come into registry with the shaped aperture defined by said housing component, at least one shutter having means fixedly attached thereto for locking engagement between said second locking means of said cover component and said shutter means; and

c. means operable to cause the apertures defined by each of said shutters to selectively register with apertures defined by said housing components or alternately be withdrawn from such registry.

2. The device defined in claim 1 wherein said first component of said housing means is selectively separable into two portions, at least one of said portions adapted to receive shutter means and at least one of said position having means for effecting locking engagement with said second component each of said positions having means operable to selectively receive a second cover shield member on the extremity thereof furthest removed from said first cover.

3. The device defined in claim 1 wherein said housing means slideably receives said plural spaced shutter means.

4. The device defined in claim 2 wherein said housing means has a longitudinal axis established by a centerline drawn vertically through the aperture defined by said housing component and, said spaced shutter means are slideably unilaterally movable in a direction normal to said vertical axis.

5. The device defined in claim 1 wherein at least one of said shutter means is selectively actuated by a timer mechanism.

6. The device defined in claim 2 wherein at least one of said shutter means is selectively actuated by a timer mechanism.

7. The device defined in claim 1 wherein said means operable to selectively cause apertures defined by said shutters to register with apertures defined by said housing apparatus is a yoke and slotted wheel assembly operably attached to a timer mechanism.

8. A nonelectrical radiographic device constructed from material which is resistant to penetration by gamma and X-rays for use with an isotopic energy source comprising in combination:

a. a source holder component having a concentric threaded boss on the upper extremity thereof and defining a cylindrically shaped energy source cavity adjacent and contiguous to one extremity thereof, said source holder component being adapted to slidably laterally receive shutter means and further defining a conical aperture shaped so as to diverge to the lower extremity, said conical aperture extending from the lower end of said cylindrically shaped energy source cavity and connecting therewith to the lower extremity thereof which has integral thereto a second concentric threaded boss;

b. an operative receptacle component internally tapped so as to be received onto the threaded boss on the lower extremity of said source holder component, and adapted so as to slidably and laterally receive shutter means, and further defining a conical shaped aperture with continuous downward divergence which when the operative receptacle component is affixed to the source holder component is aligned in registry with the conical aperture defined by the source holder component and extends to the bottom extremity of said operating receptacle component which is externally threaded;

c. a first safety end plate internally tapped on one side to accept the threaded lower end of said operative receptacle component and is also internally tapped on its reverse side to accept the threaded boss on the bottom of said source holder component;

d. a second shield cover capable of being bolted to said source holder component which is internally tapped to be threadedly received onto the upper threaded boss of said source holder component;

e. locking means comprised of:

1. a headed ring pin fixedly attached to a guard plate which plate defines an aperture for reception of said ring pin therein;

2. a first pin guide fixedly attached to a first cover and defining two apertures for reception for said pin therein;

3. a second pin guide fixedly attached to an adjusting arm and defining two apertures for reception of said pin therein;

4. a shutter stop fixedly attached to a source holder component and defining two apertures for reception of said pin therein; and

5. a spring retaining rod defining an aperture on one end thereof and fixedly attached to a shutter element, the apertures defined by the various components of the locking means being capable of alignment in two positions which in turn position the shutter attached to the spring retaining rod so as to place the conical aperture defined by said shutter in or out of registry with the conical aperture defined by the source holder component and capable of being further secured by insertion of a padlock or the like through said apertures;

f. a first shutter element defining a conically shaped downwardly diverging aperture, said element being shaped so as to be laterally and slidably received into the cavity defined by said source holder component and adapted so as to have fixedly attached thereto a spring retaining rod on one lateral extremity thereof and a headed safety pin on the extremity opposite thereto;

g. a second shutter element defining a conically shaped downwardly diverging aperture said shutter element being shaped so as to be laterally and slidably received into cavity defined by said operative receptacle component and adapted so as to have operably attached thereto an actuating means;

h. a cover member shaped so as to receive said second shutter element and configured so as to be capable of being fittedly affixed to said operative receptacle component;

i. a base supporting member defining a means for placement of film to be exposed;

j. a vertical member extending upwardly from and secured to said base supporting member;

k. a carrying arm adapted on one extremity so as to be capable of fixedly attaching to said source holder component and so configured as to be capable of containing said actuating means, said carrying arm being adapted on the other extremity so as to be selectably positionable upon said vertical member.

9. The device defined in claim 8 wherein the actuating means is a mechanical timer system operably and fixedly attached to said second shutter element through a spring loaded

actuation assembly by a shutter arm and yoke, said yoke being attached by a pin to a wheel assembly which when rotated against said actuation spring of said wheel assembly causes the desired positioning of the aperture defined by said operative receptacle component.

10. A device constructed from material which is resistant to penetration of gamma and X-rays for protectively isolating an isotopic energy source comprising in combination:

a. a source holder component having an externally threaded boss on one extremity thereof and defining cylindrically-shaped energy source cavity adjacent and contiguous to one extremity thereof, said source holder component being adapted to slidably laterally receive shutter means and further defining a downwardly diverging conical aperture, said aperture extending to the other extremity thereof which has integral thereto a second externally threaded boss;

b. a first shield cover internally tapped on one side to accept the threaded boss on the bottom extremity of said source holder component;

c. a second shield cover adapted so as to allow fixed attachment by bolting means to said source holder component and further being internally tapped so as to allow reception onto a threaded boss on one extremity of said source holder component;

d. a shutter element defining a conically-shaped downwardly diverging aperture said shutter element being shaped so as to be laterally and slidably received into the cavity defined by said source holder component and adapted so as to have fixedly attached thereto a spring retaining rod on one lateral extremity thereof and a headed safety pin on the extremity opposite thereto;

e. locking means comprised of:

1. a headed ring pin fixedly attached to a guard plate which defines an aperture therein:

2. a pin guide fixedly attached to said second cover and defining two apertures therein;

3. a shutter stop fixedly attached to said source holder component and defining two apertures therein;

4. a spring retaining rod defining an aperture on one end thereof and fixedly attached to said shutter element, the apertures defined by the various components of the locking means being capable of alignment in two positions which in turn position the shutter attached to the spring retaining rod so as to place the conical aperture defined by said shutter element in or out of registry with the conical aperture defined by said source holder component and capable of being further secured by insertion of a padlock or the like through said apertures.