Feb. 3, 1959 S. STEIN 2,872,587

RADIOACTIVE SOURCE APPARATUS

Filed Oct. 17, 1956 6 Sheets-Sheet 1

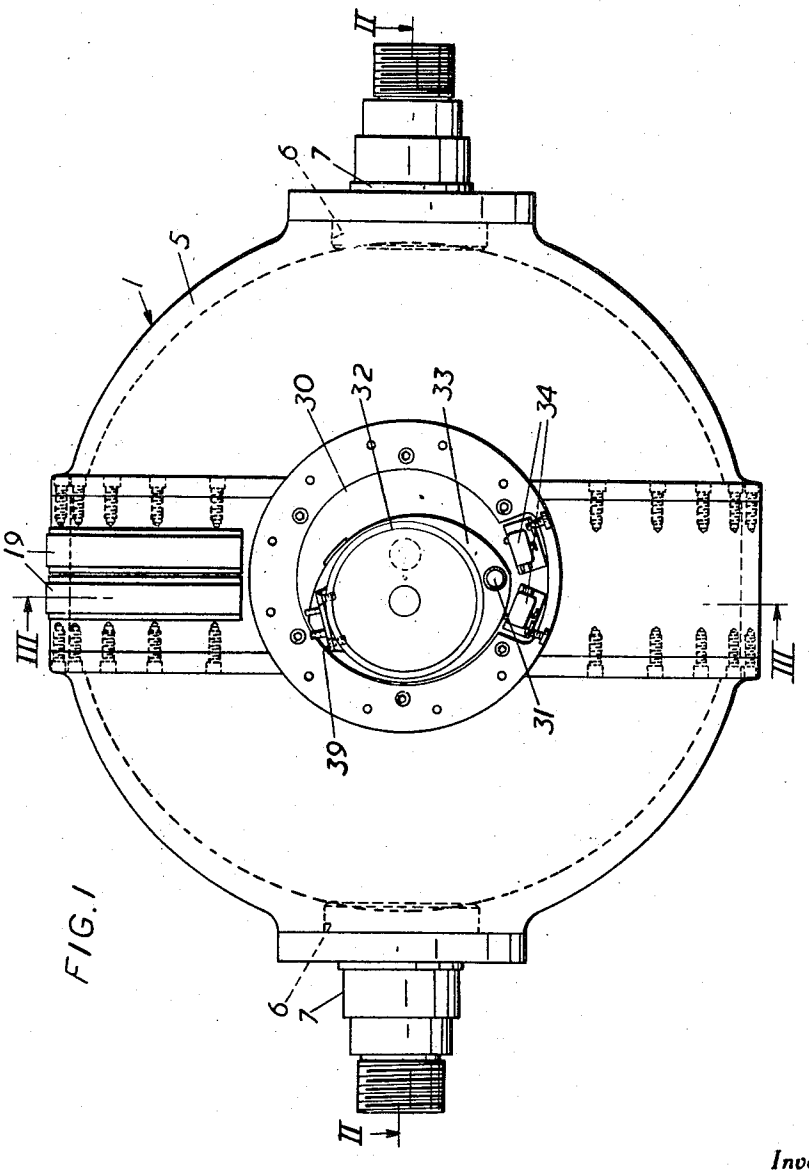



FIG. 1

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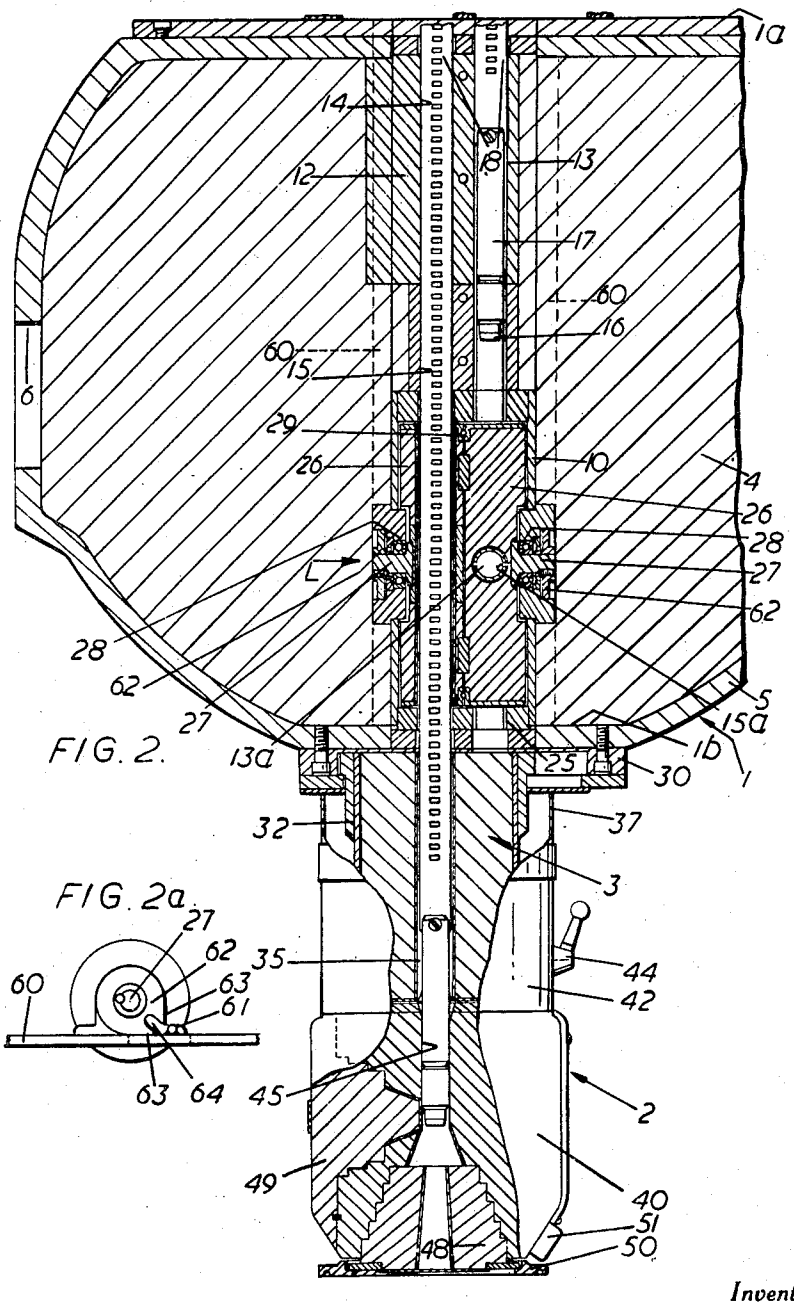



FIG. 2.




FIG. 2a.

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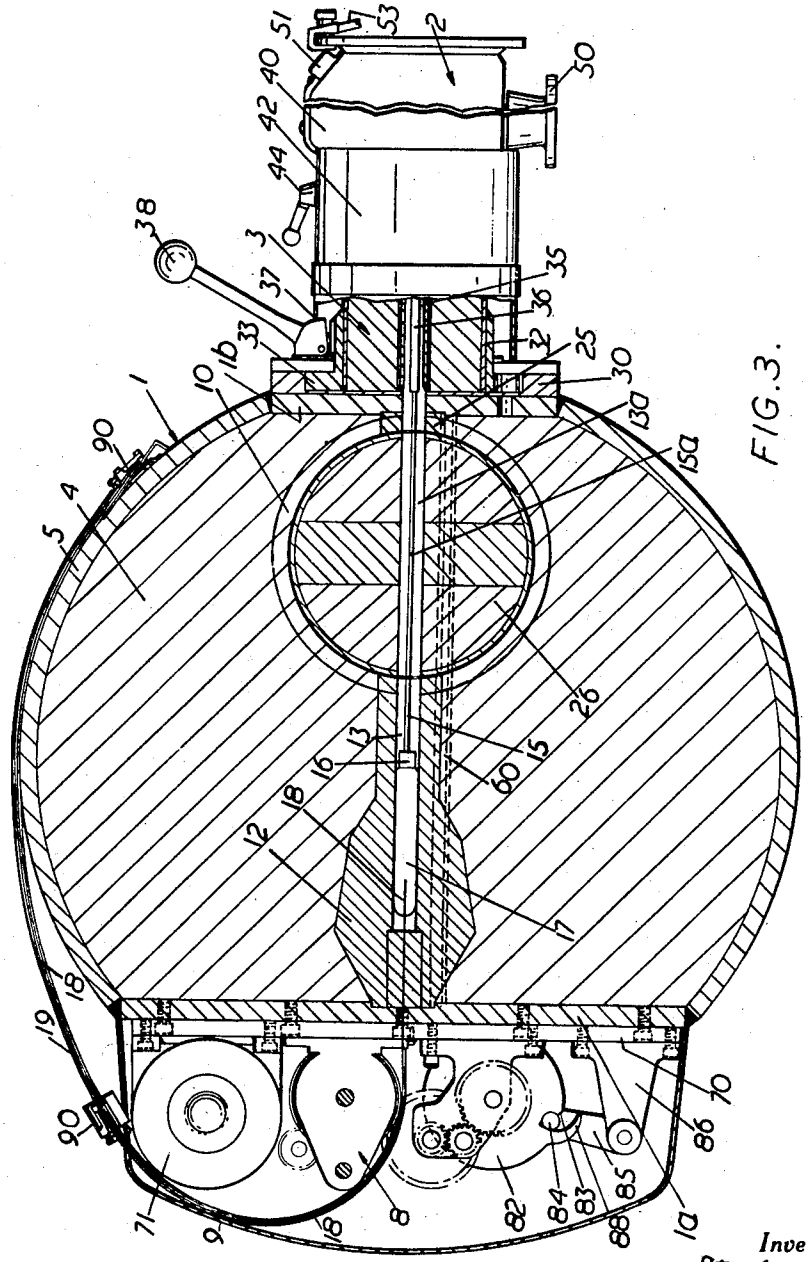



FIG. 3.

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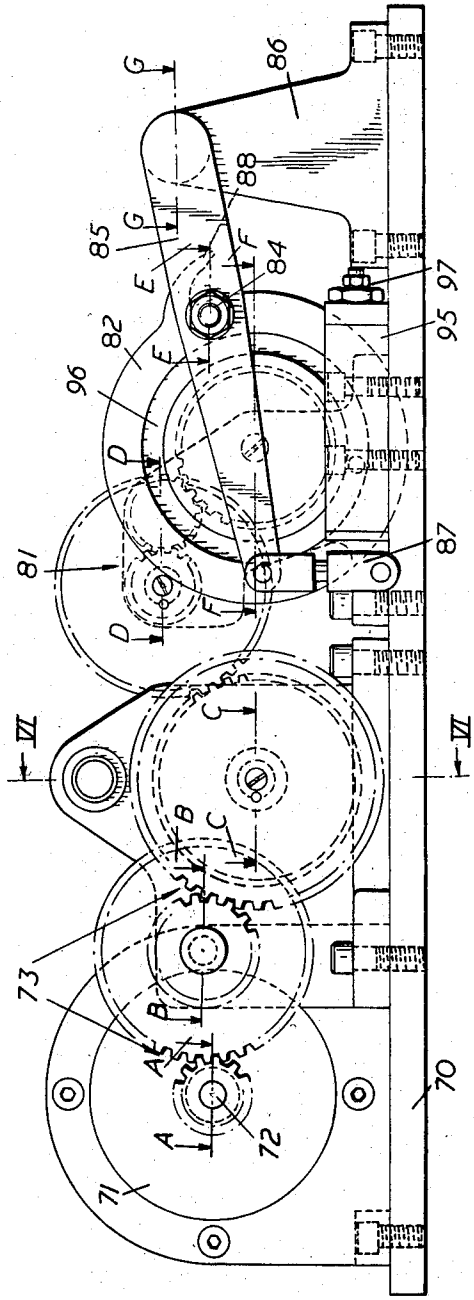



FIG. 4.

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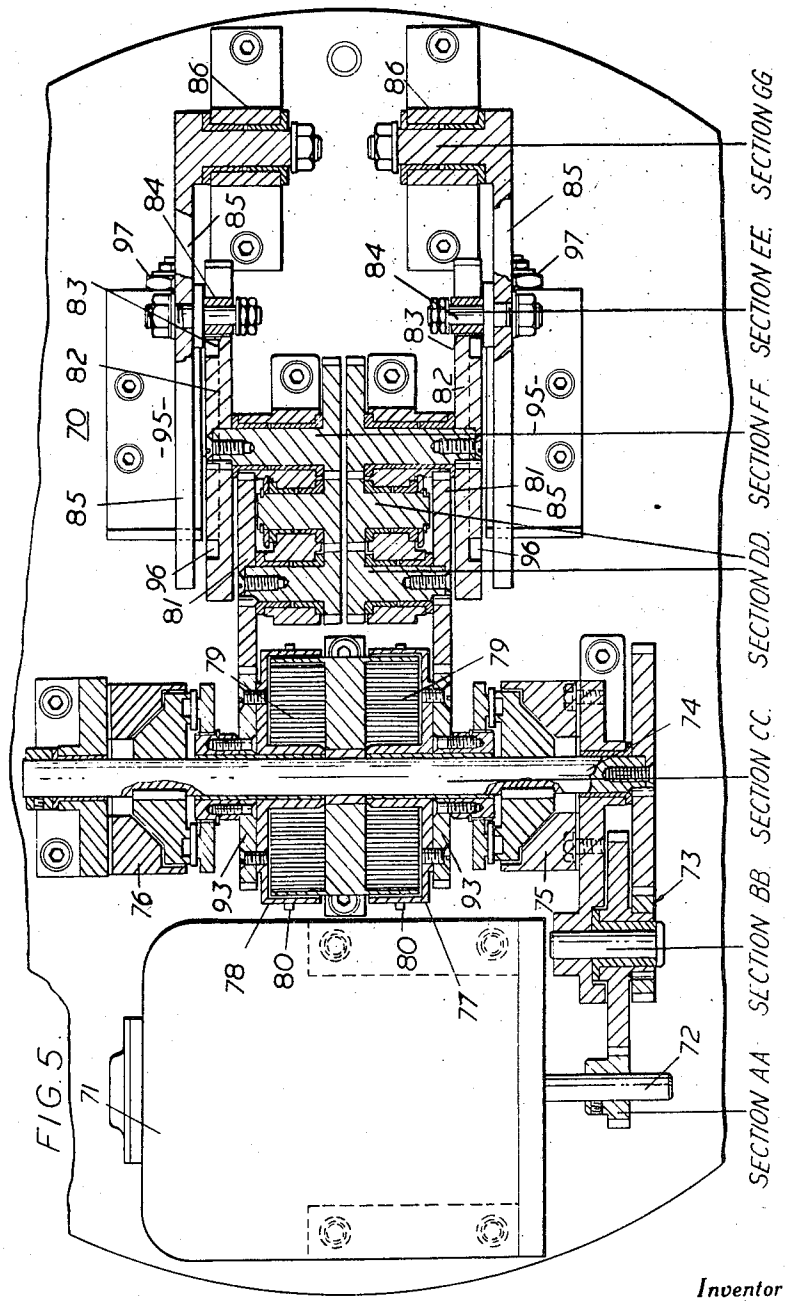



FIG. 5.

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FIG. 6.

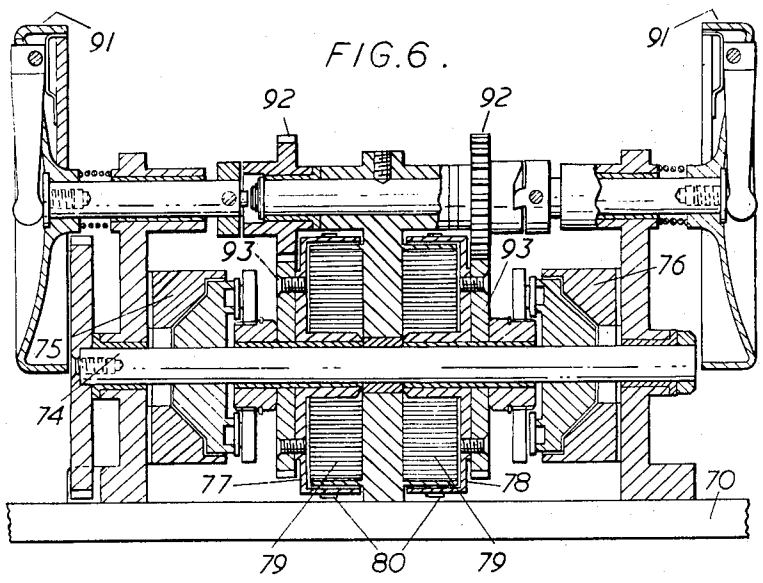
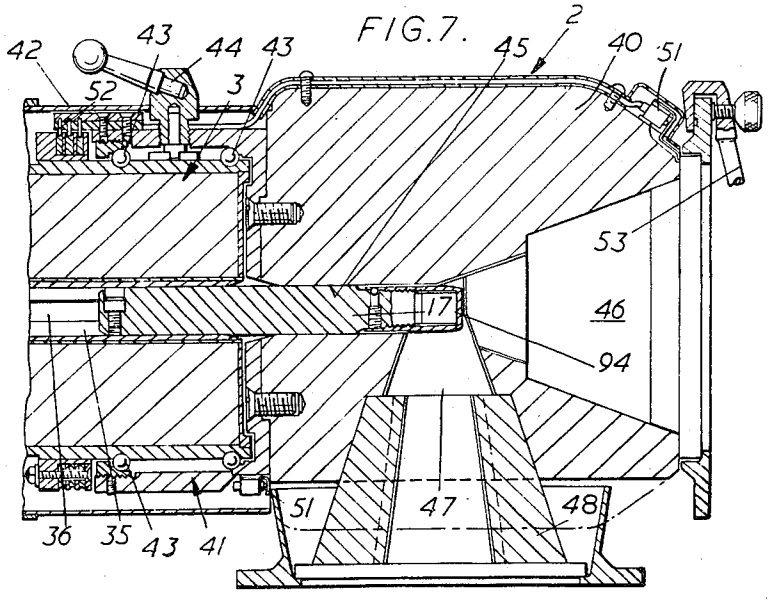



FIG. 7.




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2,872,587

Patented Feb. 3, 1959



2,872,587

# RADIOACTIVE SOURCE APPARATUS

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Application October 17, 1956, Serial No. 616,574

Claims priority, application Great Britain October 21, 1955

15 Claims. (Cl. 250—106)

This invention relates to apparatus for utilising the emanations from radio-active sources for medical therapy and other purposes and it has for its object the provision of means whereby one or more radio-active sources may be furnished with sufficient shielding to protect persons in close proximity to the apparatus from a harmful intensity of radiation and at the same time to provide for a controlled exposure of a source to be made to give a beam of radiation for, for example, thereapeutic or other purposes, the shape, size and direction of the beam being variable to suit the particular requirements of each case.

To this end according to this invention there is provided apparatus for utilising the emanations from radio-active sources for medical therapy and other purposes, said apparatus comprising a main body for containing a radio active source and shielding same in a completely safe manner when it is not being used in treatment, an applicator head carried by said main body and into which the source may be moved when it is required for use in treatment, said applicator head being adapted to shape emanations from the source into a beam and to direct same in a desired direction, a shielded conduit along which said source will pass on moving from its shielded position in the main body to the applicator head and vice versa, shutter means in said main body for closing said conduit and shutting off the source from the applicator head when the source is disposed in its shielded position in the main body, and an operating mechanism mounted on said main body and adapted to effect the opening and closing of said shutter means and to feed the source from the main body to the applicator head and vice versa.

Preferred features of this invention will be apparent from the following particular description of an embodiment thereof and the appended claims.

An apparatus in accordance with this invention is illustrated in the accompanying drawings, in which:

Figure 1 is a front elevation of the main body of the apparatus with the neck and applicator head thereof removed;

Figure 2 is a part-section on the line II—II of Figure 1, the spigot trunnions for the main body being omitted and the neck and applicator head being included;

Figure 2*a* is a fragmentary detail view at arrow L in Figure 2;

Figure 3 is a part-section on the line III—III of Figure 1, the driving mechanism of the apparatus and part of the applicator head also being shown in side elevation;

Figure 4 shows the driving mechanism in elevation from the opposite side to that shown in Figure 3, this figure being drawn on an enlarged scale;

Figure 5 is a sectional view of the parts of the driving mechanism as shown in Figure 4 on the several section lines A—A to G—G as indicated;

Figure 6 is a section on the line VI—VI of Figure 4, but with the handwheels for the driving mechanism added, and



Figure 7 is a section, also drawn on an enlarged scale, through the applicator head, showing slightly modified treatment ports and a side applicator, and also certain details of construction.

The apparatus shown in the accompanying drawings may broadly be divided into three parts, namely a main body 1 for containing one or more radioactive sources and shielding same in a completely safe manner when not being used in treatment, an applicator head 2 into which a source may be moved from the main body when it is required for use in treatment, said applicator head being constructed so that emanations from the source may be directed or beamed to a desired area or point, and a neck 3 connecting said main body and applicator head.

The main body 1 comprises a mass 4 of heavy metal with an enclosing shell of steel 5, the mass and the shell both being formed of two identical lateral sections bolted to the opposite sides of a central section (see Figure 1). A bearing 6 is formed in each lateral section so that the body 1 as a whole has two diametrically opposed bearings for the reception of spigot trunnions 7 which form part of a supporting structure for the apparatus. This supporting structure really forms no part of the present invention and may take any suitable form. For convenience only the spigot trunnions 7 thereof have been shown in the drawings (see Figure 1).

The rear end of the main body 1 is flattened, as at 1*a*, and has mounted thereon an electrically controlled driving mechanism for the apparatus, such mechanism being indicated generally by the reference numeral 8 and contained in a removable cover 9. The driving mechanism will be described in detail hereinafter. The front end of the main body 1 is also flattened, as at 1*b*, and has mounted thereon the neck 3, as will also be described hereinafter.

Within the central section of the main body 1, near the flattened front end thereof there is formed a cylindrical chamber 10, the axis of which is parallel to the trunnion axis.

Extending rearwardly from the chamber 10 is an insert 12, the rear end of which abuts the flattened rear end 1*a* of the main body 1, this insert being formed with two parallel circular bores 13 which extend diametrically of the chamber 10. The bores 13 are restricted at their rear ends to flat slots 14 which extend centrally of the bores 13, the opposite sides of which are provided with longitudinal grooves 15 in continuation with said slots. Each bore 13 forms a chamber for the reception, when it is not required for treatment, of a radio active source 16 which is mounted on the end of a carrier rod 17. The rear end of each rod 17 is connected to the end of a flat perforated metal tape 18 by means of which the rod may be caused to move as will be explained later. The tapes 18 extend through their respective slots 14, through continuations of these slots in the flattened end 1*a* of the main body 1, through the driving mechanism 8 and into guides 19 on the outside of the central section of the main body. The opposite edges of each tape 18 slide in and are supported by the grooves 15 in its respective bore 13. This arrangement ensures that the tapes will transmit sufficient thrust to move the rods 17 without becoming buckled.

Extending forwardly from the chamber 10 is a second insert 25 which terminates centrally of the flattened front end 1*b* of the main body 1, this insert and the end 1*b* being formed with continuations of the grooved bores 13 in the insert 12.

Mounted in the chamber 10, side-by-side, are two composite shutter discs 26 of heavy metal, each disc being rigidly secured to a pin 27 rotatably mounted in a bearing 28 in the adjacent side wall of the chamber 10. Rollers or balls 29 are interposed between the two

discs, the whole arrangement ensuring that the discs can rotate freely. Actually each disc is adapted to be rotated through a right angle only between two limiting positions, in the manner hereinafter explained, each disc having therein a diametrically disposed bore 13*a* formed with opposed grooves 15*a*, the arrangement being such that in one position of the disc the bore 13*a* with its grooves 15*a* form continuations of and thus join the bore 13 and grooves 15 in the inserts 12 and 25, while in the other position of the disc the latter serves to shut off from each other the bores 13 in the inserts 12 and 25.

A dish-shaped element 30 is bolted to the flattened front end of the main body 1, both these parts being apertured to provide continuations of the grooved bores 13. A fixed pivot pin 31 extends through the element 30 near the central lowermost point thereof and into the main body 1, and on this pivot pin is rockably supported the neck 3, the rear end of which fits into and is secured in a sleeve element 32 formed with an outwardly projecting flange 33 through the lower end of which the pivot pin 31 actually passes. Rocking movement of the neck 3 mounted in the sleeve element 32 is limited in both directions by the engagement of the flange 33 on the latter with the peripheral flange of the dish-shaped element 30. The peripheral flange of the element 30 is cut away at the lower side thereof and in the recess thus formed are mounted two micro switches 34. One or other of these switches is engaged and closed by the flange 33 when the neck has been rocked into one or other of its two positions.

The neck 3 is of cylindrical shape and also comprises a mass of heavy metal enclosed in a shell. It is formed with one central longitudinal bore 35 provided with diametrically opposed grooves 36. By rocking the neck about the pivot pin 31 the bore 35 with its grooves 36 can be brought into alignment with either one of the bores 13 with their grooves 15 in the inserts 12 and 25. The grooves 36 are, as shown in Figure 3, wider than the grooves 15 to provide continuity between the two in both positions of the neck.

At its rear end the neck 3 is enclosed in a short flanged annular member 37 which fits over the sleeve element 32, the member 37 being apertured for the pasage of the shaft of a handle 38 by means of which the neck may be rocked from one of its positions to the other. The inner end of the handle shaft is connected to a bracket 39 mounted on the sleeve element 32 (see Figure 1.)

The applicator head 2 comprises a block 40 of heavy metal which is bolted to a cup-shaped element 41 (Figure 7) secured in the forward end of a tubular sleeve 42. The cup-shaped element 41 fits over the front end of the neck 3, and is freely rotatable thereon through the intermediary of interposed ball bearings 43 (Figure 7). The rear end of the sleeve 42 fits over and is rotatable with respect to the front end of the annular member 37. Thus the applicator head as a whole may be rotated about the neck 3, a screw clamp 44 being provided in the sleeve 42 for locking the applicator head in any desired position with respect to the neck.

A bore 45 is formed in the block 40 in prolongation with the bore 35 in the neck 3, and terminates centrally of the block at the coincident inner ends of two outwardly tapering treatment ports 46 and 47, the port 46 being disposed in prolongation of the bore 45 and the port 47 being disposed at right angles thereto. The ports 46 and 47 are adapted selectively to receive either an applicator 48 or a plug 49 of heavy metal, both of which may be held in position by any suitable means such as clamping rings 50 secured to the block 40 by means of clips (not shown). In Figure 7 the port 46 is actually shown open.

In practice an applicator 48 would be mounted in one port in the block 40 and a plug 49 in the other port. The positioning of the applicator and the plug serves to close micro-switches 51 which are connected through slip rings 52 (Figure 7) on the cup-shaped element 41 and the neck 3 into the controlling electrical circuit of the driving mechanism.

A back pointer 53 or other positioning device is adjustably mounted on the applicator head to facilitate the correct alignment of applicators.

It will readily be understood from the description thus far given that when the radio-active source or sources 16 are not required for use in treatment they are retained in the chambers formed by the bores 13 in the insert 12 near the centre of the mass 4 of heavy metal which is normally lead. However since the exact distance of the source or sources 16 from the outer periphery of the mass 4 is clearly not the same to all parts thereof the insert 12 is made of, for example, tungsten alloy which has better shielding properties than lead and may be shaped somewhat on the lines shown in Figure 3.

Also in this connection the discs 26 are, as stated before, composite discs, that is to say they each include a central section of again, for example, tungsten alloy with two lateral sections of lead. The bore 13*a* passes through the central section perpendicularly thereof and when the disc is turned so that this bore is disposed at right angles to the bore 13 in the insert 12 the respective radio active source 16 will be the more effectively shielded from the front by the said central section.

The insert 25, the neck and the applicator head also preferably comprise tungsten alloy.

When it is required to use one of the radio-active sources 16 in treatment the neck 3 must first be rocked about the pivot pin 31 to align the bore 35 in the neck with the respective bore 13. The respective disc 26 must then be rotated through ninety degrees so that the rod 17 carrying the source 16 can be pushed through the bores 13, 13*a* and 35 to bring the source into position in the applicator head. The mechanism for effecting this will now be described.

Rotation of the discs 26 is effected by means of rods 60 which pass slidably through the central section of the main body 1 on the opposite sides of the cylindrical chamber 10, each rod 60 carrying a pin 61 (Figure 2*a*) adapted to engage a wheel 62 secured to the outer end of the pin 27 carrying the respective disc 26 so as to effect rotation of the disc through a right angle from one of its positions to the other. As is clearly shown in Figure 2*a* a wheel 62 has two flats 63 formed thereon at right angles to each other with a radially disposed slot 64 formed between them. Each pin 61 is secured to its carrier rod 60 at a point where the latter is cut away or recessed, and except when the wheel 62 is over such cut-away or recessed portion one or other of the flats thereon slides on the rod 60 whereby the wheel 62 is prevented from rotating. When, however, the pin 61, engages in the slot 64 the adjacent recess in the rod 60 enables the wheel 62 to be turned through ninety degrees after which a flat thereon will again engage the rod 60. This action is the same on movement of the rod 60 in either direction.

The driving mechanism 8 is mounted on a base plate 70 to which are bolted suitable bracket members for supporting the several elements of the mechanism.

The driving mechanism has a stalling motor 71, the output shaft 72 of which engages through a reduction gear 73 with a shaft 74. On this shaft are mounted two electric clutches 75, 76 through which drive may be imparted to two drums 77, 78 respectively, it being possible to engage only one clutch at a time. A spring 79 inside each drum 77, 78 becomes wound up as the drum is rotated so that if the drive through the respective clutch is released the drum will be revolved by the spring back to its starting position.

Each drum 77, 78 is formed on the circumferential periphery thereof with sprocket teeth 80 which are adapted to engage in the apertures in one of the metal tapes 18 thus to impart the required driving force there-

to, each tape being constrained to pass around part of its respective drum in its passage between the insert **12** and the external guides **19**.

Each electric clutch **75**, **76** also serves to impart drive through a gear train **81** to a wheel **82** in which is formed a cam **83** (see especially Figure 3). This cam **83** is engaged by a stud **84** on an arm **85** pivotally connected at one end to a bracket **86**, the other end of this arm being connected by a link **87** to the end of one of the rods **60** by means of which the discs **26** are rotated. The initial rotation of the wheel **82** lifts the stud **84** and thus causes the arm **85** to be pivoted, this in turn exerting a pull on the rod **60**. After the initial rotation of the wheel **82** the stud **84** simply rides around the circular periphery of the wheel and no further pull is exerted on the rod **60**. When the wheel **82** is rotated in the opposite direction the stud **84** will re-engage the cam **83**, a finger **88** on the wheel ensuring that this occurs. The rod **60** is thereby pushed back to its initial position.

It will be appreciated that in effect the parts of the driving mechanism are duplicated to provide independent operative movements for each radio active source and its associated disc **26**.

In the rest position of the apparatus, that is when neither radio active source **16** is required for use in treatment, the two sources will, as has already been explained, have been drawn back into the bores **13** in the insert **12** and the discs **26** will be turned so that the bores **13***a* thereof lie at right angles to the bores **13**. As is clearly shown in Figures 2 and 3 a radio active source, when in this rest position, is disposed a short distance from the wall of the chamber **10** containing its associated disc **26**. Now when drive from the motor **71** is imparted to the clutch and drum appropriate to this source movement of the rod **17** carrying the source and rotation of the disc **26** start together. The rotation of the disc is, however, effected quickly in the first moment or two and it is arranged that it will have turned through the necessary ninety degrees to align the bores **13** and **13***a* before the source reaches it.

As each radio active source reaches its operative position in the applicator head a mechanical stop, not shown, prevents further movement and causes the motor to stall and hold the source in position. This stop takes the form of a pin mounted on a base-block **95** which engages in an interrupted circular slot **96** cut in the wheel **82**. The mountings for the two stops taken the form of spring plungers not shown in order to provide a smooth acting buffer. Tension in the buffer springs is adjusted by means of the nuts **97**. On the guide **19** for each tape there are provided microswitches **90** which are operated by the end of the tape to illuminate tell-tale lights to indicate when the radio active source moved by the tape has been moved into its withdrawn or operative position.

Full details of the controlling electrical circuit for the driving mechanism will not be given since in the main they are readily apparent. Only novel features thereof will be explained as follows:

The circuit to each electric clutch includes one of the micro-switches **34** and rocking the neck into either of its positions automatically ensures that drive will only be imparted to the radio active source in the bore **13** aligned with the bore in the neck.

The circuit to both electric clutches also includes the micro-switches **51** on the applicator head and unless these have both been closed by the correct positioning of an applicator in one treatment port and a closure plug in the other drive through neither clutch can be initiated.

In the event of a failure of the spring return drive **79**, the motor **71** may be reversed in order to withdraw a radio active source **16** from its position in use **94** to the centre of the main body **1**.

In the event of a fault and/or failure of the spring **79** followed by a failure in the driving mechanism concerned to withdraw a radio active source into the main body **1**, the withdrawal of the source can be effected by means of handwheels **91** (see Figure 6) each of which turns a gear **92** which is in mesh with a gear **93** mounted on the shaft **74**.

A typical mounting for the apparatus above described may consist of a yoke carrying the spigot trunnions **7** and which is carried at the lower end of a telescopic tube which latter may be mounted on the ceiling of a treatment chamber and provides for movement of the apparatus vertically. The apparatus and telescopic tube may be supported by a counterweight carried on a chain and the whole may be raised or lowered by means of a motor drive on to the chain.

The apparatus may be provided with a motorised rotation within the yoke which would itself be rotatable about the vertical axis of the telescopic tube.

Angular scales graduated in degrees are conveniently provided between all relatively rotatable parts, both in the apparatus itself and in the mounting and also between the two, and adjustable contacts may be included to limit the overall orientation of the applicator head and any beam emanating therefrom.

The exposure of a radio active source would normally be effected from a remote control panel embodying the following features—locked power relays; indicator lamps; an exposure timer; a start button; an emergency stop button; an audible end of exposure signal; and a synchronous clock. Only in the case of an emergency would operation from the remote control panel be abandoned.

Indicator lamps may be provided on the treatment chamber door, on the above described apparatus and on the remote control panel as follows: Green indicating that the radio active source or sources is or are safely contained in the main body of the apparatus; Yellow indicating that a radio active source is actually being moved; and Red indicating that radio active source is exposed.

In use, the operating sequence is as follows: (*a*) A patient is positioned in the treatment chamber and the applicator head is set to give the prescribed beam. (*b*) The required treatment time is set on the exposure timer and the starting button is then actuated. The exposure timer automatically brings the treatment to an end.

I claim:

1. Apparatus for utilising the emanations from radio active sources for medical therapy and other purposes, said apparatus comprising a main body for containing a radio-active source and shielding same in a completely safe manner when it is not being used in treatment, a neck member mounted on said main body, an applicator head carried by said neck member and into which the source may be moved when it is required for use in treatment, said applicator head being adapted to shape emanations from the source into a beam and to direct same in a desired direction and also being rotatable about the neck member, means for clamping the applicator head with respect to the neck member in any position to which it has been rotated, a shielded conduit along which said source will pass in moving from its shielded position in the main body to the applicator head and vice versa, said conduit passing through said neck member, shutter means in said main body for closing said conduit and shutting off the source from the neck and applicator when the source is disposed in its shielded position in the main body, and an operating mechanism mounted on said main body and adapted to effect the opening and closing of said shutter means and to move the source from the main body to the applicator head and vice versa.

2. Apparatus as claimed in claim 1 wherein the shutter means comprises a disc rotatably mounted in the main body in the path of the conduit for the radio-active source, said disc being provided with a bore which may be brought into line with said conduit or turned at right angles thereto.

3. Apparatus as claimed in claim 2 wherein the radio-

active source is carried by a rod which is slidable in the conduit, said rod being adapted to be moved along the conduit by means of a flexible metal tape.

4. Apparatus as claimed in claim 3 wherein said tape is provided with perforations for engagement with teeth on a drum adapted to be rotated to impart the moving force to the tape.

5. Apparatus as claimed in claim 4 wherein said drum is adapted to be rotated and so cause movement of the rod carrying the radio-active source by means which also effects the rotation of the shutter means.

6. Apparatus as claimed in claim 5 wherein the operation of the shutter means is effected by a rod slidable in the main body and having thereon an element for engaging a member carried by the shutter means, said rod being also adapted to prevent operation of the shutter means except when said element and member are in engagement.

7. Apparatus as claimed in claim 6 wherein rotation of the drum and operation of the shutter means is effected by means of a motor through the intermediary of an electric clutch and suitable gear elements, and, in the case of the shutter means, a cam element adapted to cause sliding movement of said rod.

8. Apparatus as claimed in claim 7 wherein rotation of the drum to feed the radio-active source into the applicator head winds up a spring which on disengagement of the clutch automatically rotates the drum in the opposite direction to draw the source back into its shielded position in the main body.

9. Apparatus as claimed in claim 8 having handwheels for use in moving the radio active source back into its shielded position in the main body in the event of failure of said spring means to do so.

10. Apparatus as claimed in claim 9 wherein the tape is operatively associated with tell-tale indicators for indicating when the radio-active source is in its shielded position in the main body and in the applicator head.



11. Apparatus as claimed in claim 10 wherein the applicator head has a treatment port for the reception of any one of a set of applicators each adapted to shape emanations from the radio-active source into a beam of particular form.

12. Apparatus as claimed in claim 11 wherein the applicator head has two treatment ports, which may selectively be used in treatment, one port being disposed in prolongation with the conduit along which the source moves and one at right angles thereto, a plug being provided for closing whichever port is not actually to be used in treatment.

13. Apparatus as claimed in claim 12 wherein the applicator head includes means which until an applicator and the closure plug have been correctly positioned prevents operation of the mechanism for moving the radio-active source.

14. Apparatus as claimed in claim 13 wherein the main body is adapted to receive side-by-side two radio active sources which may selectively be moved into the applicator head, a seperate shielded conduit, shutter means and operating mechanism being provided for each source.

15. Apparatus as claimed in claim 14 wherein the neck carrying the applicator head has a single central conduit and is rockably mounted on the main body so that this conduit can be aligned with either one of the radio-active sources.

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