

Aug. 25, 1959

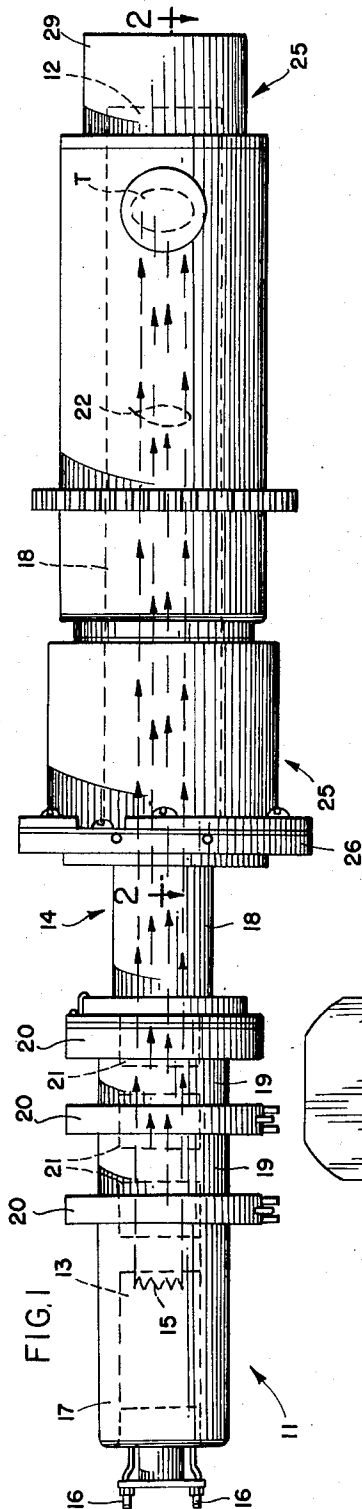
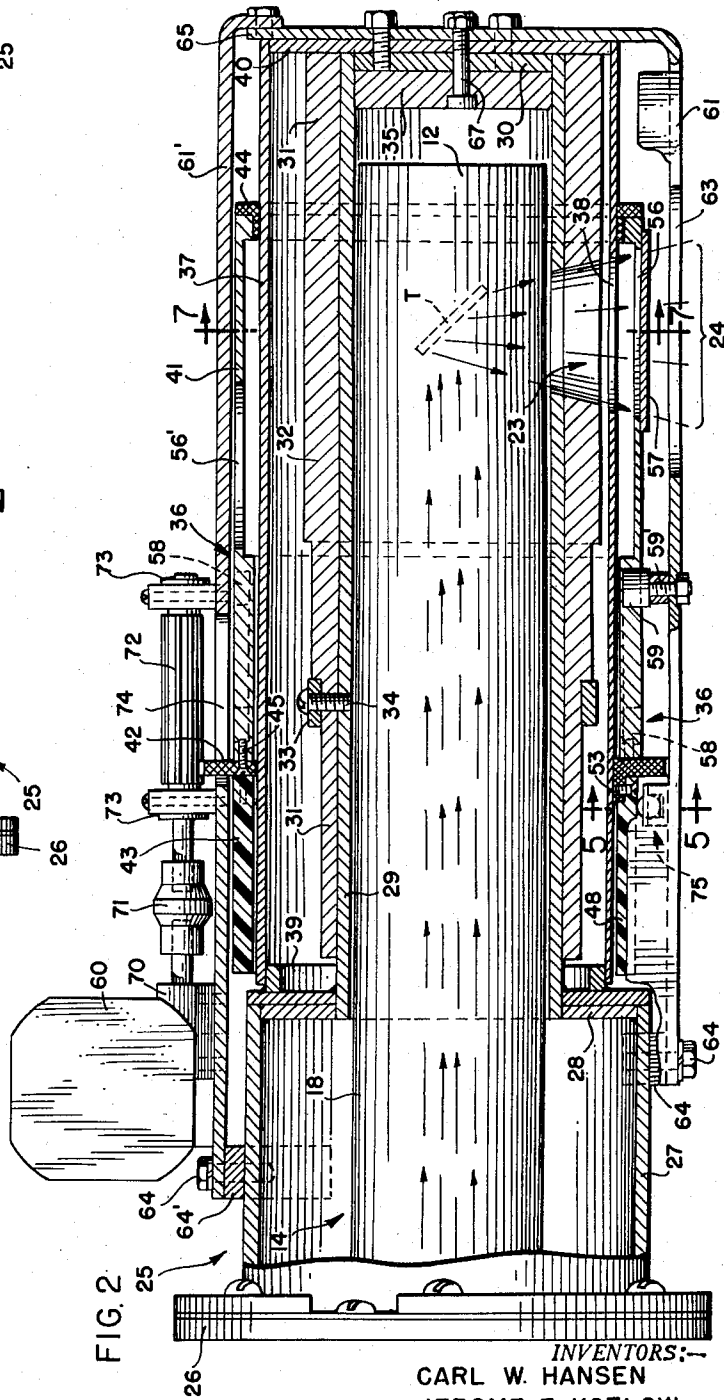
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2,901,631

FILTER MEANS FOR PENETRATING RAYS

Filed March 4, 1955

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 3

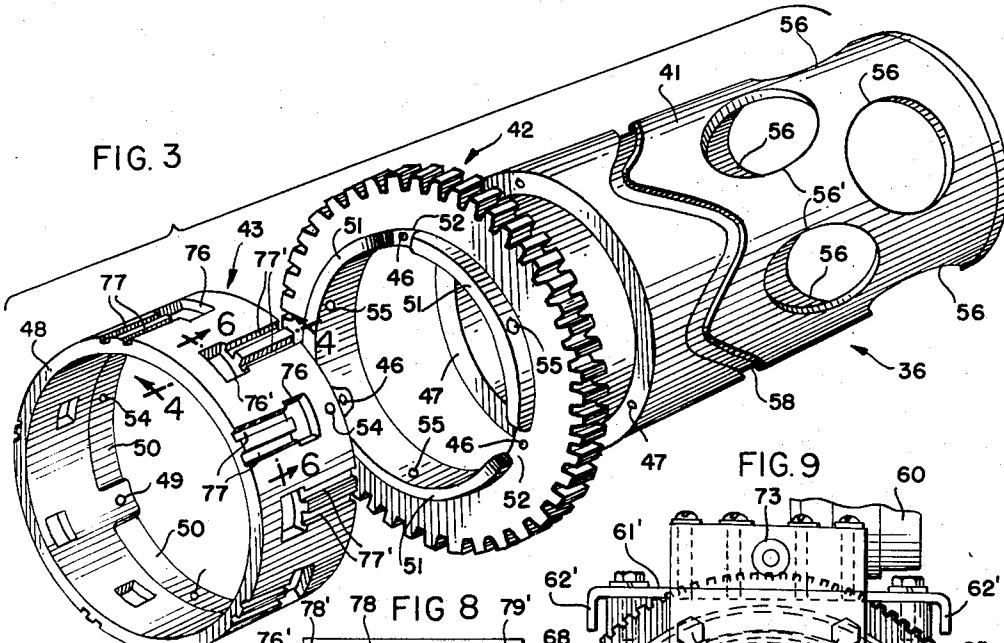


FIG. 9

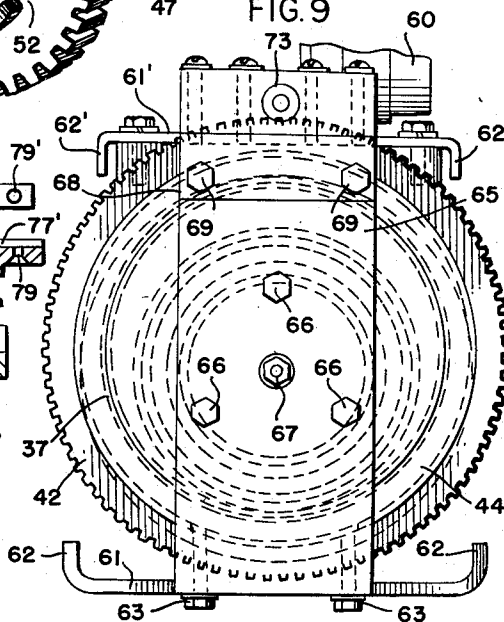


FIG. 4



FIG. 5

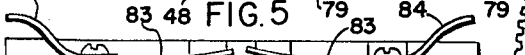


FIG. 6

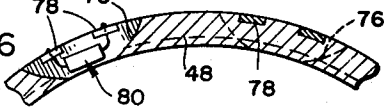


FIG. 7

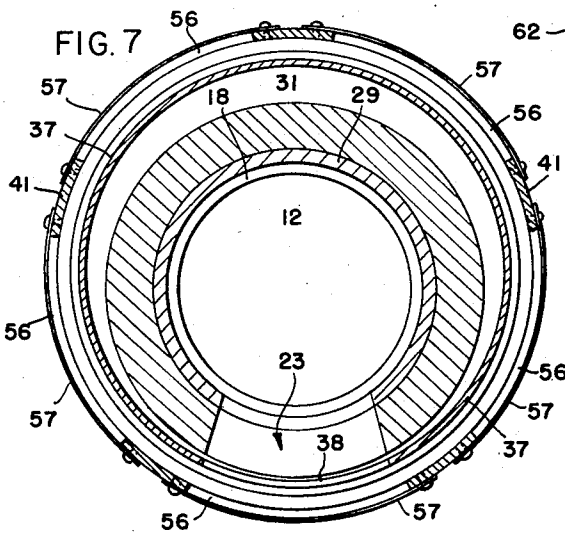
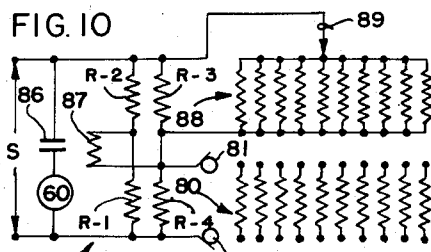


FIG. 10



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1

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FILTER MEANS FOR PENETRATING RAYS

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Application March 4, 1955, Serial No. 492,144

8 Claims. (Cl. 250—86)

The present invention relates in general to the production and control of penetrating rays, such as X-rays, and has more particular reference to the modification of penetrating rays by filtration thereof, the invention pertaining more especially to improved ray filtering means well adapted for use in conjunction with a penetrating ray generator, such as an X-ray tube. In its broader aspects, however, the present invention is not necessarily limited to filter means for use in conjunction with X-ray generating tubes, but may have utility for the filtration of rays other than X-rays, including rays emitted from a source other than a ray generating tube.

X-ray generating tubes commonly comprise an electron emitting cathode and a cooperating anode enclosed in a sealed and evacuated envelope, X-rays being produced at the anode and projected thence outwardly of the envelope as the result of impingement of electrons on the anode, at speeds in excess of a critical ray generating electron velocity, the electrons being liberated by and at the cathode, when electrically excited for electron emission. Electrons thus emitted at the cathode may be driven thence toward the anode under the influence of a driving force comprising electrical potential applied between the anode and cathode.

The intensity and quality of X-rays thus generated and emitted at the anode is a function of electron driving potential maintained between anode and cathode, which is a factor determining the speed of electron impingement on the anode. Electrons which strike the anode at relatively slow speeds in excess of the critical ray generating electron velocity are commonly referred to as "soft" rays, to distinguish the same from rays of more highly penetrating quality, commonly called "hard" rays, which are produced as the result of high velocity electron impingement upon the anode.

The quality of generated X-rays is also a function of the rate of electron impingement upon the anode, such rate of impingement being a function of the rate of electron emission from the cathode, such emission rate, in turn, being proportional to cathode excitation. As a consequence, the intensity and quality of X-rays produced by operation of a generating tube may be expressed in terms of anode-cathode potential and of cathode excitation; and it is usual to prescribe desired X-ray therapy in terms of the anode-cathode voltage and cathode exciting current required to produce X-rays of desired quality.

It is also common practice to utilize ray filters, especially when applying X-rays for therapy purposes, in order to modify the intensity and quality or character of the rays in desired fashion. X-ray filters may comprise thin sheets of copper, tin, aluminum or other materials, which sheets may be used singly or in various combinations in order to accomplish desired filtration. Such filters, to a greater or less degree, reduce the intensity of the X-ray beam as applied to the patient and function to filter the "soft" ray component from the beam. X-ray filters may be mounted in individual holders and applied in the path of the beam to be filtered, as at the beam emitting window

2

of the X-ray generating tube, the filter being preferably supported as closely as possible to the X-ray source. Heretofore it has been the practice to manually apply the selected filter in filtering position as a part of the adjustment of an X-ray generating tube for the application of a desired therapy in the treatment of a patient. Several different filters, each having desired filtering characteristics within a filtering range, may be provided in order to afford an adequate filtration range; and, in that connection, it is common to supply as many as nine filters having different filter values.

An important object of the present invention is to provide a filter mounting for use in conjunction with means forming a ray emission source, the mounting being adapted to support a plurality of filters and operable to dispose any selected one of the so supported filters in filtering position with respect to a ray beam emitted from said source; a further object being to form the mounting as a movable member carrying the several filters in adjacent relatively staggered positions thereon, whereby to support a plurality of filters in compact juxtaposition in the mounting.

Another important object is to provide a ray filter mounting comprising a turnably supported member carrying a plurality of ray filter elements thereon in relatively offset or staggered relationship, whereby the several filters may be presented successively in filtering position with respect to a ray emitting source; a further object being to employ a tubular filter mounting sized to snugly embrace a penetrating ray source, said mounting being turnable about the axis thereof and axially movable to present filters carried thereon in staggered relationship successively in filtering position with respect to said ray source; a still further object being to provide a serpentine cam circumferentially in a tubular filter mounting sleeve in position to cooperate with a cam element, whereby to axially reciprocate the sleeve in response to turning movement thereof, and thereby cause filter elements mounted circumferentially in axially staggered relationship on said sleeve to be successively positioned at a filtering station as the mounting sleeve is rotated.

Another important object is to provide motive means for turning the filter mounting member with respect to a source of rays to be filtered, including selectively operable control means for disabling the motive means when the filter mounting member reaches a position disposing a selected filter in filtering position; a further object being to provide motor controlling switch means in position to be actuated by the filter mounting member when it reaches a selected relatively turned position with respect to the ray source.

Briefly stated, the objects of the invention may be realized through the provision of a preferably cylindrical filter mounting sleeve adapted to snugly surround a penetrating ray source, such as the ray generating anode of an X-ray tube, as at a ray beam emitting window portion of the tube. The filter mounting sleeve may be formed with filter mounting seats defining a plurality of rows of circumferentially spaced apart openings in the sleeve in which filters may be mounted. The openings forming one of said rows may be relatively offset or staggered with respect to the openings of the next adjacent row so that, by turning the sleeve and moving the same axially, the openings forming a pair of adjacent rows may be successively disposed in ray filtering position at a filtering station in alinement with said emitting window. The sleeve may also carry switching means, including separate switches respectively corresponding with each of the several filter mounting seats provided in the sleeve, said switching means being operable to disable motor means, drivingly connected with the sleeve, when the sleeve

3

reaches a position presenting a desired or selected filter at the filtering station.

The foregoing and numerous other important objects, advantages, and inherent functions of the invention will become apparent as the same is more fully understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment of the invention.

Referring to the drawings:

Fig. 1 is a side view of an X-ray generating tube operable to provide an X-ray source and fitted with filter mounting means embodying the present invention;

Fig. 2 is a sectional view taken substantially along the line 2—2 in Fig. 1;

Fig. 3 is an exploded perspective view of the component parts of turnable filter mounting means embodied in the structure shown in Figs. 1 and 2;

Fig. 4 is a sectional view taken substantially along the line 4—4 in Fig. 3;

Fig. 5 is a sectional view taken substantially along the line 5—5 in Fig. 2;

Fig. 6 is a sectional view taken substantially along the line 6—6 in Fig. 3;

Fig. 7 is a sectional view taken substantially along the line 7—7 in Fig. 2;

Fig. 8 is a plan view of a contact strip of a sort forming switch contact components in the structure shown in Figs. 3, 4 and 6;

Fig. 9 is a right hand end view of the structure shown in Fig. 2; and

Fig. 10 is a diagram of electrical connections.

To illustrate the invention, the drawings show a penetrating ray source which conveniently may comprise the anode target T of an X-ray generating tube 11, although the invention is not necessarily restricted to a ray source comprising a generating tube, but is indeed applicable in connection with any suitable or convenient source of penetrating rays.

As shown, the generator tube 11 may comprise an anode 12 and a cathode 13 enclosed in a sealed and evacuated envelope 14. The cathode may embody an electron emitting element 15 which may conveniently comprise a filament suitably supported in the cathode and provided with leads extending outwardly of the envelope through suitable seals and forming terminal members 16, whereby the filament may be electrically connected with a suitable external source of power to excite the filament for electron emission. As shown, the envelope may comprise a glass portion 17 at the cathode end of the tube, the cathode 13 being mounted upon and closing an end of said glass portion 17. The envelope 14 may also comprise a tubular metal portion 18 disposed in axial alinement with respect to the glass portion 17, said tubular portion forming the anode end of the envelope and carrying the anode target T therein at the end of said tubular portion remote from the cathode.

Any suitable means may be provided for securing the tubular portion 18 to the glass portion 17. To this end, the envelope, as shown, may include a plurality of glass sections 19 and intermediate metal sections 20 sealingly secured together and to the sections 16 and 18 in end-to-end abutting relationship, said metal portions 20 serving to support metal sleeves forming electron lenses 21 in spaced apart axial alinement between the electron emitting element 15 and the anode target T.

It should be understood that the generator tube 11 may be caused to function for the production of X-rays, at the target T, by energizing the element 15 for electron emission, as by connecting the terminals 16 with a suitable source of energizing power, while simultaneously applying an electron driving potential between the cathode and the target structure, as by connecting the tube 18 and one of the terminals 16 with a suitable source of electron driving potential. The lens elements 21 may be

4

electrically biased with respect to each other and the emission element 15 for the control of electron flow between the cathode and the anode target, as by applying electrical potential between the lens mounting rings 20 and one of the terminals 16. Electrons emitted at the cathode may be guided, focused and accelerated by the lenses 21 to form a beam of electrons 22 directed toward the anode target T; and electrons will be generated at the target as the result of impingement on said target of the electrons comprising the beam 22. X-rays thus generated at the target structure may be emitted thence outwardly of the envelope, as through an X-ray transmitting window opening 23, in the form of a useful X-ray beam 24.

As shown, the anode portion 18 of the envelope may be enclosed in a support structure 25, as of metal such as steel, comprising collar means 26 secured on the tubular anode portion 18 at a point spaced from the target T, a tubular metal structure carried by the collar means and comprising a sleeve portion 27 adjacent and secured to the collar means, a plate portion 28 sealed to and supported on the end of the sleeve 27 remote from the collar means, and an elongated tubular portion 29 snugly enclosing the tubular portion 18 of the ray generator, including the target carrying end thereof, said tubular portion 29 being sealingly secured to and supported by the plate portion 28. The outer end of the tubular portion 29 remote from the collar means 26 preferably projects beyond the target carrying end of the anode of the ray generating tube, said end being closed, as by means of a preferably steel plate 30 sealingly secured in the end of the tubular portion 29, as by welding.

The tubular portion 29 forms a support sleeve which carries a sleeve-like shield 31 of material, such as lead, which is highly resistant to the passage of penetrating rays. The shield may be sized to snugly surround and fit upon the support sleeve 29, and may have a stepped configuration presenting a relatively thick shield portion 32 in position surrounding the anode target T, the ray window being formed through said relatively thick portion 32 of the sleeve in position opposite the target, whereby to define the sectional shape of the ray beam 24. The sleeve-like shield 31 may be secured upon the tubular support 29 in any suitable or preferred fashion, as by means of a fastening ring 33, snugly embracing the sleeve-like shield and secured on the support sleeve 29, as by means of fastening screws 34 penetrating the fastening ring and the sleeve-like shield and having threaded connection in threaded sockets formed in the support sleeve. A shielding plate 35 of metal, such as lead, substantially impervious to penetrating rays, may be applied within the end of the support sleeve 29 and outwardly of the tubular anode portion 18 of the ray generator, said shielding member 35 being secured to the cover plate 30 in any suitable or preferred fashion.

The support structure 25 also provides a mounting for ray filtering means embodying the present invention, and comprising a turnable filter mounting and changing structure 36 operable selectively to present any desired one of a number of ray filters in position opposite the window 23 in the path of the ray beam 24. To this end, the support structure 25 carries an outer, preferably cylindrical, bearing sleeve 37, as of steel, formed with an opening 38 opposite the window 23, said sleeve 37 being secured at its inner end on the plate portion 28 of the support structure 25, said end of the bearing sleeve 37 being preferably supported on a ring 39 secured to said plate portion 28 in position forming a peripheral shoulder for the reception of the sleeve 37. The opposite end of the sleeve may peripherally surround and thus supportingly engage the marginal edge of a plate 40 secured to the outer end of the support sleeve 29. The filter mounting structure 36, as shown, preferably comprises a sleeve-like filter mounting portion 41, a portion 42 forming a driving gear connected as at an end

of the filter mounting portion, and a switching portion 43 comprising a sleeve drivably connected with the gear and operable to selectively operate control switches as the structure 36 is turned to present selected filters carried thereby in registration with the ray beam 24.

The filter mounting portion may comprise a preferably cylindrical sleeve of metal, such as steel, sized to snugly encircle the bearing sleeve 37, said mounting portion 41 being provided at one end with a ring 44 of suitable bearing material, such as brass, sized to encircle and bearingly engage the sleeve 37. At its opposite end, the filter mounting sleeve 41 may be formed for detachable engagement with the gear forming portion 42, as by screw threaded fastening members 45 which may extend in openings 46 formed in the gear member and in threaded sockets 47 formed in the sleeve 41. The gear forming member 42 may snugly encircle and bearingly engage the sleeve 37 in order to support the structure 36 for rotational and axial sliding movement on the bearing sleeve 37.

The switching portion 43 preferably comprises a sleeve 48 of suitable insulating material, such as Bakelite, sized to loosely encircle the sleeve 37 and formed with tongues 49 and pockets 50 at one end thereof, to interfittably receive and engage corresponding flanges 51 and openings 52 formed in the gear means 42, preferably on the side thereof remote from the filter carrying sleeve 41, screw threaded fastening elements 53 extending in openings 54 formed in the sleeve 48 at the pockets 50 and having threaded connection in sockets 55, formed in the gear means, as in the flanges 51, being provided for fastening the sleeve 48 in the structure 36.

The filter carrying sleeve 41 is preferably provided with a plurality of filter mounting seats forming filter mounting stations, the same defining a plurality of rows of circumferentially spaced openings 56 and 56', the openings 56 comprising one row of openings being circumferentially staggered or offset with respect to the openings 56' comprising another row. Ray filters 57, comprising a thin sheet or sheets of copper, tin, aluminum or other material, may be applied each in position covering a corresponding opening 56 and 56', such filters preferably each having its desired corresponding individual ray filtering characteristics. The filter forming sheets may be secured in any suitable, preferred or convenient fashion, as by riveting the same to the sleeve 41 in position extending at the openings forming the filter mounting stations in the member 41. Filter means preferably is entirely omitted at one of the openings, such as the opening 56' in Fig. 2.

As a consequence, by turning and axially shifting the structure 36 upon the bearing sleeve 37, the openings 56 and 56' may successively be presented in alignment with the openings 23 and 38, whereby the filter means carried by the mounting sleeve 41, including the opening at which no filter means is mounted, may be presented selectively in the path of the ray beam 24. In order to provide for thus turning and axially shifting the filter carrying structure 36, the sleeve member 41 may be provided with a circumferentially extending serpentine cam groove 58 adapted to ridingly receive a preferably stationary roller 59 carried on the structure 25, motor means 60, suitably supported as on the structure 25, being provided for driving the structure 36 through the gear means 42. Accordingly, by actuating the motor 60 to turn the structure 36, the interaction of the cam groove 58 with the roller 59 will cause the structure 36 to move axially as it turns, to thereby successively present the filter mounting stations defined by the openings 56 and 56' successively in the path of the ray beam 24 in alignment with the windows 23 and 38.

The roller 59 and the motor 60 may be supported on a framework comprising bracket means carried on the support structure 25, said bracket means, as shown, conveniently comprising a pair of elongated formed sheet metal

plates 61 and 61', respectively having marginal rigidifying flanges 62 and 62'. The plates 61 and 61' may be disposed at and along diametrically opposite sides of the tubular portion 18 of the ray generator, with the plate 61, if desired, extending across the path of the ray beam 24 and being provided with an opening 63 in alignment with the openings 23 and 38 to permit unimpeded passage of the ray beam. Both of the plates may be secured at one end thereof on the sleeve portion 27 of the support structure, as by means of threaded studs 64 mounted in bosses 64' on the sleeve portion 27.

The ends of the plates 61 and 61' remote from the sleeve portion 27 may be secured to the outer end of the support structure remote from said sleeve portion 27. Accordingly, the end of the plate 61 remote from the boss mounted end thereof may be bent to form a tongue 65 adapted to extend diametrically across the end closure plate 30 of the support structure 25 and the support plate 40, threaded studs 66 being provided for securing the tongue 65 and the plate 40 to the closure member 30. A bolt 67, extending in aligned openings formed in the plates 30, 35 and 40 and the tongue 65, may be provided for clamping said parts together. The end of the plate 61', remote from its boss mounted end, may also be bent to form a flange 68 in position to overlie the terminal end of the tongue 65, threaded studs 69 or other suitable fastening means being provided for securing the flange 68 on the tongue.

The motor 60 may be firmly mounted upon the plate 61', as at the end thereof which is supported on the sleeve portion 27 of the support structure 25. The motor may be drivably connected, as through a suitable reduction gear train 70 and a coupling 71, with an elongated gear driving pinion 72 journaled in spaced bearings 73 carried on the plate 61', the pinion 72 being thus carried in position opposite and drivably engaged with the gear 42 of the turnable filter mounting structure 36, said gear 42 extending through a slot 74 formed in the plate 61'.

The cam following roller 59 is carried on a stud 59' which forms an axle for the roller 59, the stud 59' being secured on the plate 61 as by means of clamping nuts threaded on the stud. The bracket plate 61 also carries stationary switch contact means 75 in position to cooperate with contact means mounted on the switching sleeve 48. To this end, the sleeve 48 may be provided with a plurality of rows of circumferentially spaced openings 76 and 76', corresponding with the rows of correspondingly spaced filter mounting stations 56 and 56', the openings 76 comprising one row of openings being circumferentially staggered or offset with respect to the openings 76' comprising another row. The switching sleeve 48 is also provided with parallel, longitudinally extending, superficial grooves 77 and 77', said grooves being arranged in pairs and sized to snugly receive each a metal contact strip 78; whereby the contact strips may be seated in the grooves 77 and 77' with the outwardly facing surfaces of the strips extending flush with the outer cylindrical surface of the sleeve 48. Rivets or other suitable fastening elements, disposed in holes 79 formed in the sleeve 48 and extending in openings 79' in the strips 78, may be employed to secure the strips 78 in place in the grooves 77 and 77'. Each pair of grooves 77 extends between one end of the sleeve 48 and a corresponding one of the openings 76. Each pair of grooves 77' extends between the opposite end of the sleeve 48 and a corresponding one of the openings 76'. The contact strips 78 have ends 78' extending in the openings 76 and 76', the opposite ends of the strips terminating in the carrying grooves 77 and 77' inwardly of the ends of the sleeve 48.

The openings 76 and 76' form resistor mounting stations, each opening being adapted to receive a corresponding one of a plurality of resistor elements 80, each of said elements 80 having a resistance value different from that of the other elements. Each of the resistance elements 80 is supported in its corresponding opening 76

or 76' by being mechanically and electrically connected at its opposite ends with the ends 78' of the pair of contact elements 78 at the opening in which the element is disposed.

The stationary switch contact means 75 may be mounted on the bracket plate 61 in position opposite the switching sleeve 48 to successively make contact with the contact strip pairs in the grooves 77 and 77', in order thus to successively connect the resistors 80 in a control circuit electrically connected with the contact means 75. To this end, the contact means 75 may comprise a pair of contact elements 81 spaced apart a distance equal to the spacing between pairs of contact strips 78 in the grooves 77 and 77'. As shown, the contact elements 81 may comprise a pair of metal balls adapted to rollingly engage the surface of the sleeve 48, said balls being turnably receiver in openings formed in a plate 82 of insulating material, said plate being formed for attachment on the bracket plate 61 in position presenting the elements 81 for rolling engagement with the outer surface of the sleeve 48. The plate 82 of insulating material may carry resilient blades 83 of electrical conducting material in position yieldingly pressing upon the elements 81 to hold the same against the outer surface of the switching sleeve 48, means being provided for electrically connecting the blades with conductors 84, whereby the elements 81 may be electrically connected in suitable circuit means 85 of the sort shown in Fig. 10, for controlling the operation of the motor 60.

It will be seen from the foregoing that, as the filter carrying structure 36 is rotated and axially reciprocated as a result of the interaction of the roller 59 in the groove 58 when the structure 36 is driven through the gear 42 by operation of the motor 60, the rollers 81 will make contact successively with the contact strip pairs 78 in the grooves 77 and 77', thereby connecting the resistors 80 in the motor control circuit 85, each when a corresponding filter mounting station 56 or 56' is in filtering position with respect to the ray beam 24. As a consequence, since each of the elements 80 has a resistance value different from that of every other element, the motor control circuit 85 can be made to stop the motor 60 when a selected filter station reaches filtering position in response to operation of the motor.

To this end, the motor control circuit 85 comprises an electrical bridge system which, when unbalanced, causes operation of the motor 60, motor operation being discontinued when the system reaches balanced condition. The system 85 may be energized from any suitable electrical power source S, the motor 60 being interconnected with said source in series with the switch contactors 86 of a relay switch having an operating coil or solenoid 87. The bridge system may comprise four resistance legs R-1, R-2, R-3, R-4, legs R-1 and R-2 having equal resistance value, the resistance value of the leg R-3 likewise being equal to that of the leg R-4. One side of the switch operating coil 87 is electrically connected with the connected ends of the legs R-1 and R-2, the other side of the coil being electrically connected with the interconnected ends of the legs R-3 and R-4. The interconnected ends of the legs R-1 and R-4 are connected with one side of the power source S, while the interconnected ends of the legs R-2 and R-3 are electrically connected with the other side of the power source.

The resistors 80 are adapted to be interconnected successively in parallel relationship with respect to the bridge leg R-4 and a corresponding series of resistors 88, each of which has a resistance value matching that of a corresponding one of the resistance elements 80, is provided for selective connection in parallel relationship with the leg R-3 of the bridge. To this end, the resistors 88 may be commonly connected, on one side thereof, with an end of the resistance leg R-3 of the bridge, and selectively operable means 89 may be provided for electrically connecting the remote side of any selected one of

the elements 88 with the other side of the resistance leg R-3. Accordingly, by adjusting the selectively operable means to connect a desired one of the elements 88 in parallel relation with respect to the leg R-3, the bridge system will become unbalanced, unless the element 80 corresponding with the selected element 88 be at such time connected in parallel with the resistance leg R-4 of the bridge.

When the bridge becomes unbalanced by adjustment of the selectively operable means 89, the operating coil 87 of the relay switch will become energized, thereby closing the switch 86 and energizing the motor 60 for operation. Thereafter, the motor will continue in operation and will turn the filter mounting structure 36 to successively present the filter mounting stations 56 and 56' in filtering position until the element 80 corresponding with the selected element 88 becomes connected in the circuit means 85 by operation of the switching means 75, when the corresponding filter mounting station reaches filtering position. When the bridge system thus regains a balanced condition, the coil 87 will become de-energized, thereby allowing the switch 86 to assume its normally open position to thus stop operation of the motor.

It is thought that the invention and its numerous attendant advantages will be fully understood from the foregoing description, and it is obvious that numerous changes may be made in the form, construction and arrangement of the several parts without departing from the spirit or scope of the invention, or sacrificing any of its attendant advantages, the form herein disclosed being a preferred embodiment for the purpose of illustrating the invention.

The invention is hereby claimed as follows:

1. The combination, with a penetrating ray source embodying means for emitting a directional ray beam, of a tubular sleeve forming a carrier member embracing said ray source and providing a plurality of rows of filter mounting stations, the stations of each row being circumferentially spaced apart and offset axially of the sleeve with respect to the stations of an adjacent row, means operable to turn the sleeve about said source, and a serpentine cam formed on said sleeve in position to engage a cam driving member as the sleeve is turned, to thereby axially shift the same in order to present said stations successively in aligned position with respect to said beam.

2. The combination, with a penetrating ray source embodying means for emitting a directional ray beam, of a sleeve forming a carrier member embracing said ray source and providing a plurality of filter mounting stations circumferentially spaced apart on said sleeve in position to be successively disposed in alignment with said beam as said sleeve is turned about said source, a motor and means to drivingly connect the motor with said sleeve to turn the same, a plurality of circumferentially spaced control switches supported on said sleeve and each corresponding with a said filter mounting station, and means for connecting said switches successively in controlling relationship with respect to said motor as the corresponding filter station is presented in filtering relationship with respect to said beam.

3. The combination, with a penetrating ray source embodying means for emitting a directional ray beam, of a sleeve forming a carrier member embracing said ray source and providing a plurality of filter mounting stations circumferentially spaced apart on said sleeve in position to be successively disposed in alignment with said beam as said sleeve is turned about said source, means forming a driving gear on said sleeve at an end thereof, a motor and means to drivingly connect the same with said gear to turn said sleeve, a control switch mounting ring carried by said sleeve, a plurality of circumferentially spaced control switches on said ring and each corresponding with a said filter mounting station,

and means for connecting said switches successively in controlling relationship with respect to said motor as the corresponding filter station is presented in filtering relationship with respect to said beam.

4. The combination, with a ray source embodying means for emitting a directional ray beam, of a sleeve forming a carrier member embracing said ray source and providing a plurality of filter mounting stations circumferentially spaced apart on said sleeve in position to be successively disposed in filtering alignment with said beam, as said sleeve is turned about said source, a plurality of resistors having unlike resistance values and corresponding respectively with said filter mounting stations, motor means drivingly connected with said sleeve to turn the same, a motor energizing system, an electrical bridge controllingly connected with said system, selectively operable means for connecting in said bridge any selected one of a number of resistances having values corresponding with said resistors, and switch means operable to successively connect said resistors in said bridge as the corresponding filter mounting stations are presented in filtering relationship with respect to said beam.

5. The combination, with means for emitting a ray beam, of a movable carrier providing a plurality of filter mounting stations in position to be successively disposed in filtering relation with respect to said beam, as said carrier is moved with respect to said means, a plurality of resistors mounted on said carrier and corresponding respectively with said filter mounting stations, said resistors having unlike resistance values, motor means drivingly connected with said carrier to move the same, a motor energizing system, an electrical bridge controllingly connected with said system, selectively operable means for connecting in said bridge any selected one of a number of resistances having values corresponding with said resistors, and switch means successively operable, in response to movement of said carrier, to connect said resistors in said bridge as the corresponding filter mounting stations are presented in filtering relationship with respect to said beam.

6. The combination, with means for emitting a ray beam, of a movable carrier providing a plurality of spaced filter mounting stations disposed in position to be successively presented in filtering relationship with respect to said beam, as said carrier is moved with respect to said means, a plurality of resistors having unlike resistance values and corresponding respectively with said filter mounting stations, motor means drivingly connected with said carrier to move the same, a motor energizing system, an electrical bridge controllingly connected with said system, selectively operable means for

connecting in said bridge any selected one of a number of resistances having values corresponding with said resistors, and switch means operable successively to connect said resistors in said bridge as the corresponding filter mounting stations are presented in filtering relationship with respect to said beam.

7. The combination, with a movable member and a motor for moving the same, of positioning means for disabling the motor when the movable member is in any desired one of a plurality of relatively shifted positions, comprising a plurality of resistors having unlike resistance values and corresponding respectively with said relatively shifted positions, a motor energizing system, an electrical bridge controllingly connected with said system, selectively operable means for connecting in said bridge any selected one of a number of resistances having values corresponding with said resistors, and switch means operable to successively connect said resistors in said bridge as the movable member reaches corresponding relatively shifted positions.

8. The combination, with a rotatable member and a motor for turning the same, of positioning means for disabling the motor when the rotatable member is in any desired one of a plurality of relatively turned positions, comprising a plurality of spaced resistors mounted on said rotatable member and corresponding respectively with said relatively turned positions, said resistors having unlike resistance values, pairs of spaced switching contacts on and movable with said rotatable member, each pair of said contacts being connected with a corresponding one of said resistors, a motor energizing system, an electrical bridge controllingly connected with said system, selectively operable means for connecting in said bridge any selected one of a number of resistances having values corresponding with said resistors, and a pair of spaced switching contact rollers in position to successively engage said switching contact pairs to thereby connect said resistors in said bridge as the rotatable member reaches corresponding relatively turned positions.

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