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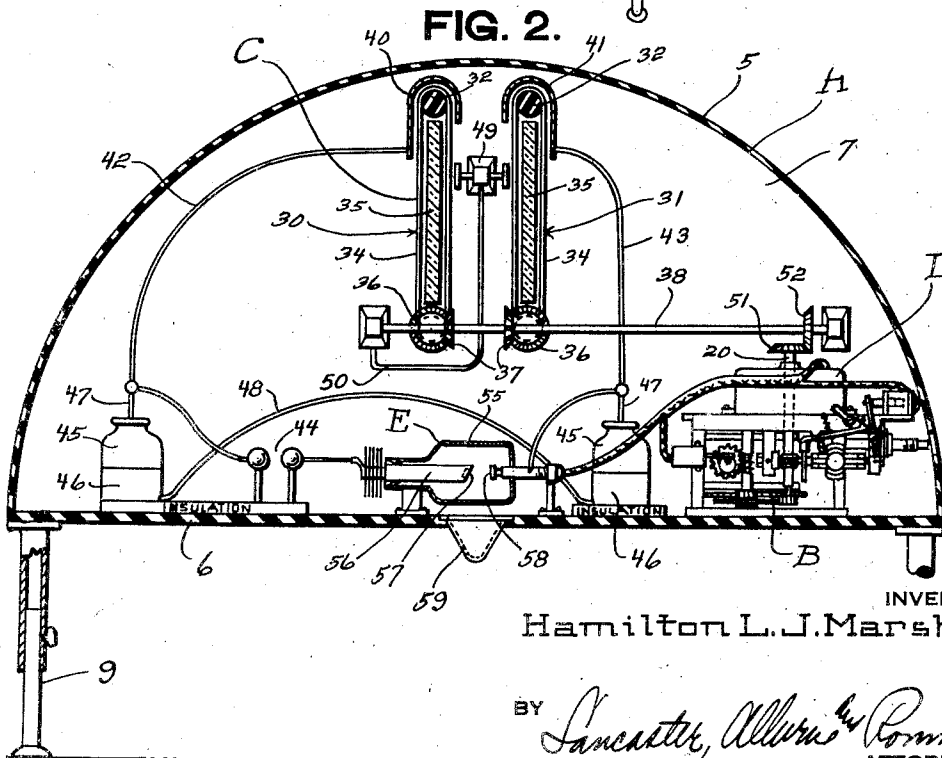
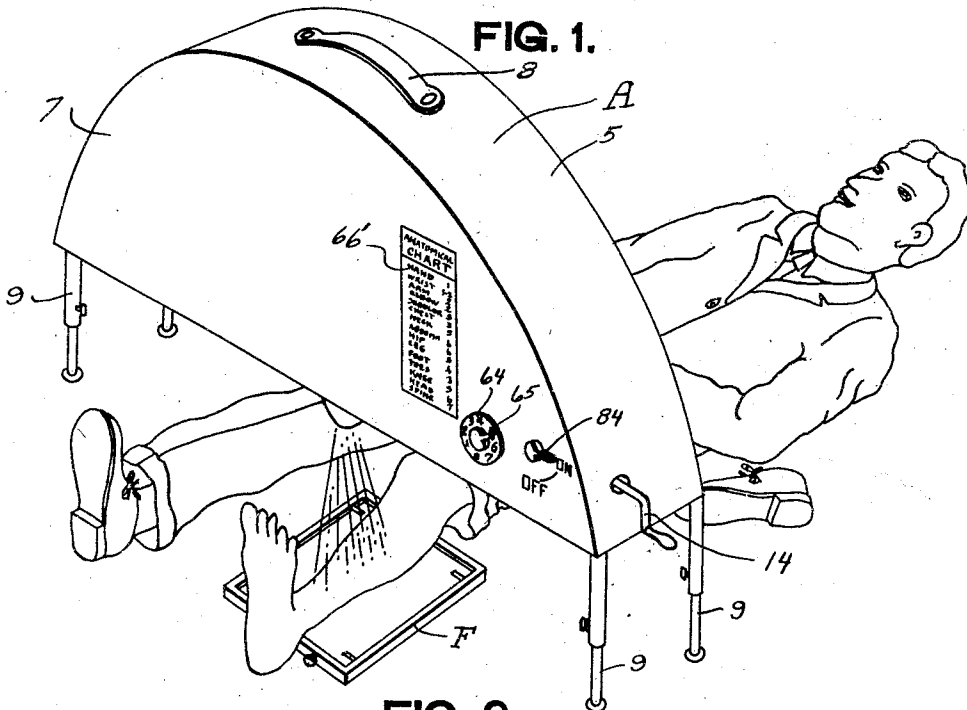
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2,106,873

PORTABLE SELF CONTAINED X-RAY APPARATUS

Filed Sept. 16, 1935

3 Sheets-Sheet 1



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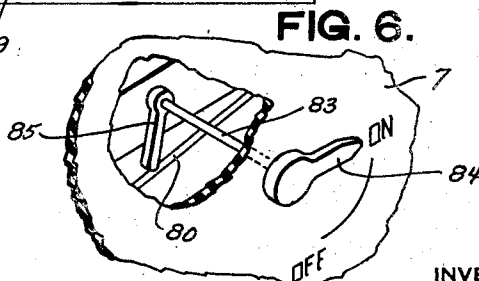
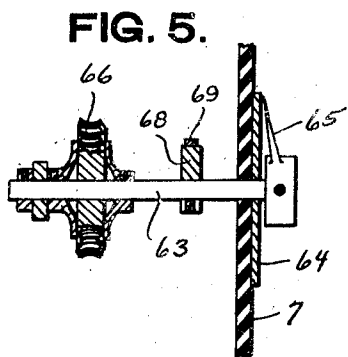
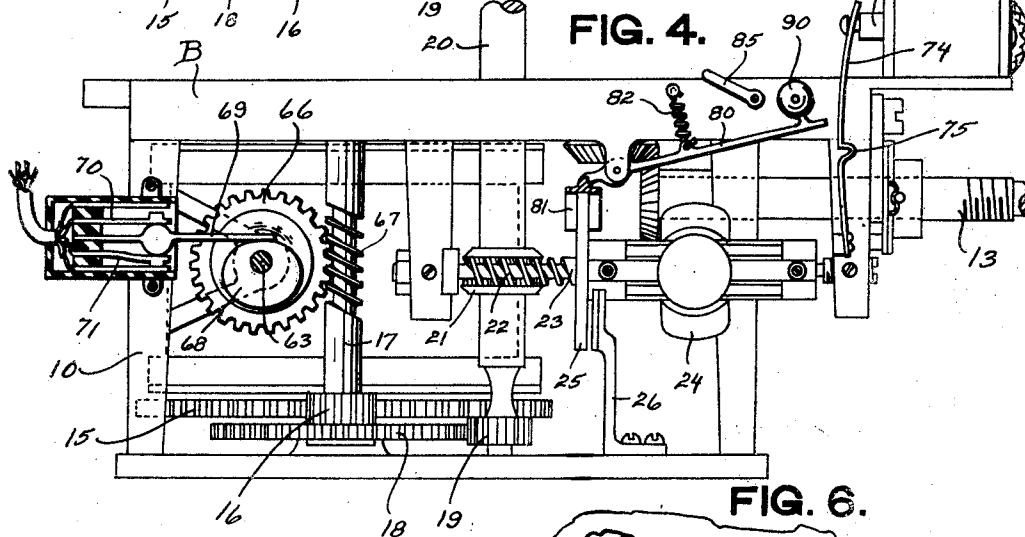
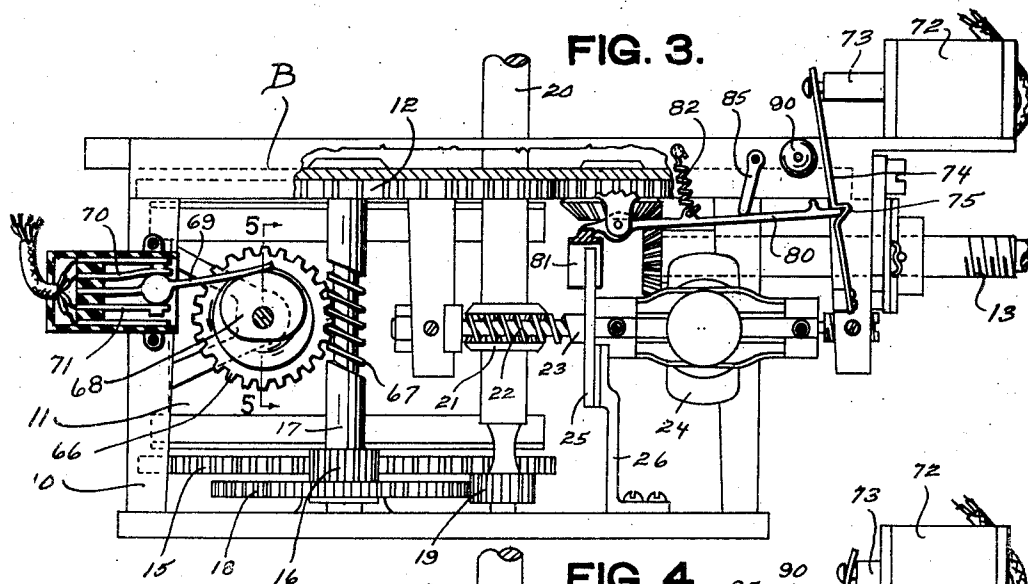
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PORTABLE SELF CONTAINED X-RAY APPARATUS

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3 Sheets-Sheet 2



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PORTABLE SELF CONTAINED X-RAY APPARATUS

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3 Sheets-Sheet 3

FIG. 7.

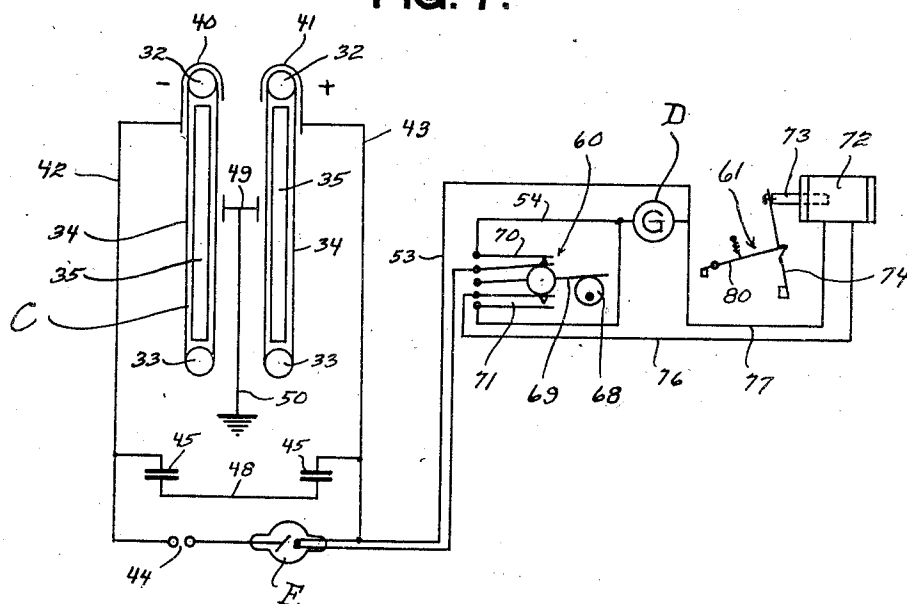
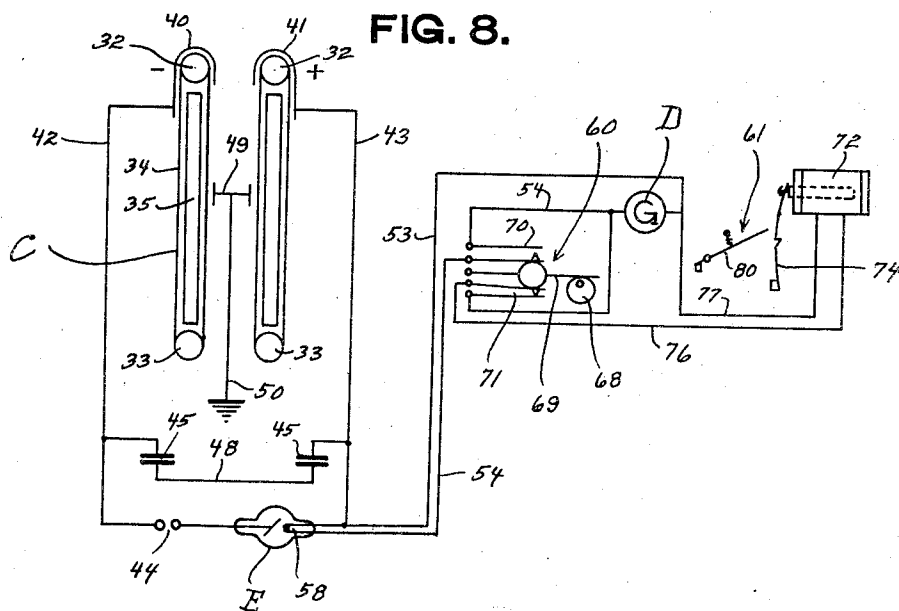


FIG. 8.



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PORTABLE SELF-CONTAINED X-RAY
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6 Claims. (Cl. 250—34)

The present invention relates to X-ray apparatus and the primary object of the invention is to provide a portable, self-contained X-ray machine or apparatus which is entirely independent of any external source of power.

A further and important object of the invention is to provide a portable X-ray machine which may be constructed at comparatively low cost and one wherein extreme economy of operation will be had since no batteries are required for its operation.

A further object resides in the provision of apparatus of this character embodying a spring motor driven electrostatic machine or generator of improved construction, with timing means for automatically controlling the motor to permit the apparatus to run for various periods of time in accordance with the desired time exposure.

A further object is to provide apparatus of this character employing a hot cathode X-ray tube (such as the Coolidge tube), with an electrostatic generator and a low tension generator driven by a spring motor for operating the tube.

Other objects and advantages of the invention will be apparent from the following detailed description, taken in connection with the accompanying drawings forming a part of this specification and in which drawings:—

Figure 1 is a perspective view of the X-ray apparatus shown in use.

Figure 2 is a vertical longitudinal section thru the apparatus.

Figure 3 is an enlarged detail side view of the spring motor and associated mechanism shown in an operating position.

Figure 4 is a view similar to Figure 3 but showing the brake mechanism having been released for stopping operation of the apparatus.

Figure 5 is a fragmentary section on the line 5—5 of Figure 3.

Figure 6 is a fragmentary perspective view showing the starter means for releasing the brake mechanism and setting the apparatus for operation.

Figure 7 is a wiring diagram showing the position of switches, etc., during operation of the apparatus such as shown in Figure 3.

Figure 8 is a wiring diagram showing the position of switches, etc., when the brake mechanism has been released as shown in Figure 4.

Referring to the drawings in detail and wherein like reference characters designate corresponding parts thruout the several views, the apparatus comprises an elongated closed case A of a suitable insulating material and preferably semi-circular shape providing an arched upper wall 5, a flat bottom wall 6 and parallel semi-circular side walls 7. A suitable carrying handle 8 may be attached to the case for easily transporting the apparatus. Provided at each lower

corner of the case is an adjustable supporting leg 9 whereby the case may be vertically adjusted with respect to its supporting surface.

Arranged within the case A is a suitable spring motor B providing driving means for the improved electrostatic generator C and a low tension generator D. The letter E designates a hot cathode vacuum X-ray tube operating on the principle of the "Coolidge tube" but possessing improved features as will be subsequently described.

Referring particularly to Figures 3 and 4, the spring motor B may be of any approved type and in the example shown is substantially of the type such as shown in U. S. Patent #1,421,404, granted July 4, 1922. The motor B is mounted in one end portion of the case A and embodies a frame 10 having mounted therein a spring barrel 11 revolving about a vertical axis. Operatively connected with the upper portion of the spring barrel 11 is a gear 12 connected by suitable gearing with a winding shaft 13 which extends toward one end of the case for attachment of a winding crank 14 adapted for winding the motor. Operatively associated with the lower end of the spring barrel 11 is a gear 15 meshing with a pinion 16 on a shaft 17. Mounted on the shaft 17 is a large gear 18 meshing with a pinion 19 on the lower end of a vertical drive shaft 20 which extends upwardly above the motor frame 10. Secured on the drive shaft 20 is a worm gear 21 meshing with a worm 22 on a horizontally disposed governor shaft 23 having a fly ball governor 24 mounted thereon embodying a flat disc 25 for cooperating with a speed regulator 26 which is preferably adjustable for regulating the speed of the drive shaft 20.

Referring now to the electrostatic machine or generator C, the same is adapted to generate static electricity by electrostatic induction and embodies a pair of substantially identical static units 30 and 31 arranged vertically in the case A midway between the ends thereof. The units 30 and 31 are of the endless belt type and each embodies an upper supporting roller 32 and a lower drive roller 33, each formed of a suitable insulating material such as hard rubber, mica, etc. Trained over each pair of rollers 32 and 33 is an endless, non-conducting belt 34 which is preferably formed of silk. Arranged between the parallel vertical runs of each belt 34 is a glass plate 35 having its faces in slightly spaced relation to the runs of the belt and with the upper and lower edges of the plate terminating in spaced relation to the rollers 32 and 33. The units 30 and 31 are suitably mounted in close proximity to one another and in parallel spaced apart relation with the spacing between the units being approximately two inches.

Secured to one end of each of the lower drive

rollers 33 is a bevel gear 36, and these gears each mesh with bevel gears 37 mounted upon a shaft 38 journaled longitudinally in the case A with one end extending above the spring motor B. As will be observed in Figure 2, the bevel gears 37 are oppositely arranged on the shaft 38 so that the endless belts 34 will be caused to run in opposite directions to one another, thus causing one of the static units to receive a negative charge and the other unit a positive charge.

Associated with the upper ends of the units 30 and 31 are collecting combs 40 and 41, to which are respectively connected high tension conductors 42 and 43 for delivering high tension current to the tube E. Provided in the conductor 42 is a spark gap 44 for intensifying the current delivered to the tube. Connected in series across the conductors 42 and 43 is a bank of condensers or accumulators 45 which in the example shown are in the form of Leyden jars, each provided with the usual outer coatings 46 and with rods 47 which connect the inner coatings of the jars with the conductors 42 and 43. These outer and inner coatings may be a thin, highly conductive metal foil such as tinfoil, aluminum, copper, silver, etc. The outer coatings 46 are connected by a conductor 48 whereby the accumulators 45 are connected in parallel with the tube E.

Arranged between the adjacent runs of the belts 34 is an equalizer 49 which may be in the form of a metallic arm spaced slightly from the belts and serving to ground any overflow of current thru the conductor 50 which may be connected to one of the bearings for the shaft 38 whereby the equalizer is grounded upon the metal framework of the apparatus.

The low tension generator D provides current for heating the cathode of the X-ray tube E and this generator is preferably mounted directly upon the upper side of the spring motor frame 10 with the vertical drive shaft 20 forming the generator shaft. The shaft 20 projects above the generator and has mounted thereon a bevel gear 51 which meshes with a bevel gear 52 on the shaft 38. Thus the spring motor B serves to operate both the electrostatic generator C and also the low tension generator D. Connected with the generator D are the low tension conductors 53 and 54 which connect with the heater element of the tube E.

The hot cathode X-ray tube E may be of the radiator type Coolidge tube and embodies the usual tube or envelope 55 in which is sealed an anode 56 provided with the usual target 57, and a cathode adapted to be heated and to which the low tension conductors 53 and 54 are connected. With the usual type of hot cathode X-ray tube, the cathode usually consists of a resistance wire filament. These filaments after repeated heating will warp and otherwise deviate from the proper alignment thus causing a change of the focal spot. To overcome this difficulty, I substitute for the usual resistance wire filament, a solid block of carborundum 58 so that all possibilities of warping are eliminated and a true focal spot can be maintained indefinitely. In operation, the carborundum cathode 58 is heated to a degree suitable for the emission of electrons. The carborundum cathode is heated to a temperature of 1500 degrees centigrade, this being the temperature at which carborundum begins emitting electrons in vacuum, and being the point at which this material reaches incandescence. This heater block also eliminates burning out of the heater thru overloads or becoming otherwise injured.

The tube E is mounted upon the lower wall 6 of the case A midway between the ends of the case, directly above a tube cone 59 which projects below the case as clearly shown in Figure 2. This tube cone 59 is formed of thin aluminum and aside from serving to filter some of the undesirable gamma rays, also serves to indicate the center of the focal spot of the tube so as to enable the operator to correctly approximate his work.

Timing means is provided to permit the apparatus to run for a predetermined length of time necessary to make the proper penetration of the part to be X-rayed so as to make the proper exposure, and comprises a timing control device 60 which operates to control a manually released stop means 61 for the spring motor B.

The timing device 60 comprises a control shaft 63 journaled in the spring motor frame 10 beside the shaft 17 with one end of the control shaft extending thru a graduated exposure dial 64 mounted upon one of the casing side walls 7 and provided with a pointer 65. An anatomical chart 66' giving the calibration of the timer in relation to different anatomical regions of the body is printed or otherwise provided on the case adjacent the dial 64. Frictionally carried by the shaft 63 is a worm wheel 66 which meshes with a worm 67 on the shaft 17 whereby rotation will be imparted to the control shaft during running of the spring motor. Fixed upon the shaft 63 is a timer cam or eccentric 68 which co-acts with a spring switch lever 69 serving to control a pair of switches 70 and 71 in accordance with the relation of the cam to the switch lever. Each of the switches 70 and 71 in the example shown, embodies a fixed contact and a movable contact normally spring urged out of engagement with its fixed contact. By referring to Figures 7 and 8 it will be seen that the switch 70 is connected in the low tension conductor 54 and controls the filament cathode circuit of the tube E.

The stop means 61 for stopping the spring motor after the apparatus has run for the set period of time, embodies a solenoid 72 suitably mounted upon the motor frame 10 and having its armature 73 connected with a spring lever 74 provided with a notch 75. This spring lever 74 has its armature connected end normally spring urged away from the solenoid. The solenoid is energized by the low tension generator D thru the conductors 76 and 77. The switch 71 is connected in the conductor 76 so that this switch serves to control the solenoid circuit.

The spring motor B is normally held against running by a brake arrangement embodying a brake lever 80 pivoted intermediate its ends upon the spring motor frame 10 and provided at one end with a brake shoe 81 normally held in braking engagement against the peripheral edge of the speed regulator disc 25 by a suitable spring 82. The end of this brake lever 80 is arranged to be engaged in the notch 75 of the spring lever 74 when the apparatus is set for operation as shown in Figure 3. A means is provided for releasing the brake lever from a braking position and embodies a starting shaft 83 provided with a pointer handle 84 for rotating the shaft to an on position when starting the apparatus. The inner end of this shaft 83 carries a lever 85 arranged to engage the brake lever 80 and swing the lever so as to be engaged in the notch 75 thus releasing the brake shoe 81 from engagement with the disc 25.

In Figure 1, the letter F designates a film holder or cassette and while various types of film holders may be used, it is preferred to use cas-

ettes such as described in U. S. Patent 1,879,498, permitting developing of the film in the field.

As to the mode of operation, the spring motor B is first wound by means of the crank 14 and with the pointer handle 84 in the off position allowing the brake shoe 81 to engage and hold the disc 25 against rotation as in Figure 4. The operator then determines, by consulting the anatomical chart 66', the number on the dial 64 suitable for an exposure of the part to be X-rayed and sets the pointer 65 to the proper number on the dial 64. This setting of the pointer 64 rotates the control shaft 63 and the cam 68 which causes the switch lever 69 to open the switch 71 and close the switch 70 thus opening the solenoid circuit and closing the cathode circuit as in Figures 3 and 7. The pointer handle 84 is now swung to an "on" position causing the lever 84 to swing the brake lever 80 so as to be engaged and held in the notch 75 of the spring lever 74 thus releasing the brake shoe 81 and allowing operation of the spring motor B. Running of the spring motor B operates the electrostatic generator C and the low tension generator D thus energizing the X-ray tube E. This running of the spring motor imparts rotation to the control shaft 63 thru the shaft 17, worm 67 and worm gear 66 whereby, when the pointer 65 has returned to zero position, the cam 68 allows the switch lever 69 to lower thus opening the switch 70 in the cathode circuit and closing the switch 71 in the solenoid circuit as in Figures 4 and 8. Closing of the switch 71 energizes the solenoid 72 which actuates the armature 73 and exerts a pull on the spring lever 74 and allows the brake lever 80 to be disengaged from the notch 75. The spring 82 then exerts a pull on the brake lever 80 causing the brake shoe 81 to engage the disc 25 and stop operation of the apparatus. The brake lever 80 when released, strikes a bell 90 thus giving a stop signal.

While the machine has been shown and described as being primarily designed for use as a portable, self-contained X-ray apparatus, it will readily be apparent that the apparatus is not limited for use as a portable device, and that other forms of driving means may be substituted for the specific spring motor driving means as shown.

Changes in details may be made to the form of invention herein shown and described, without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. In apparatus of the class described, an X-ray tube, a high voltage generator and a low voltage generator for energizing the tube, a spring motor, drive means between the spring motor and the generators, stop means normally holding the spring motor against operation, starting means for releasing the stop means, electrically released holding means for retaining the stop means released, and timing control means for the holding means for controlling the duration of spring motor operation.

2. In a portable, self contained X-ray apparatus, a casing having supporting means, an electrostatic generator in the case, a low tension generator in the case, an X-ray tube in the case to be energized by said generators, a single driving means in the case for operating said genera-

tors, manually releasable stop means normally holding the driving means against operation, electrically releasable holding means for retaining the stop means released, and adjustable timing control means for automatically releasing the holding means to permit stopping of the driving means by said stop means.

3. In apparatus of the class described, a case, a hot cathode X-ray tube in the case, an electrostatic generator in the case, a high tension circuit between the generator and the tube, a low tension generator in the case, a low tension circuit between the low tension generator and the tube, a spring motor in the case for operating said generators, stop means for the spring motor and manually releasable to permit operation of the motor, electrically released holding means for the stop means when released, and variable timing control means operable by the motor for opening the low tension circuit and causing release of the holding means for stopping operation of the spring motor.

4. In a portable X-ray apparatus of the class described, a hot cathode X-ray tube, an electrostatic generator for the tube, a low tension generator for the tube, a cathode circuit between the tube and low tension generator, spring motor drive means for the generators, a solenoid, a solenoid circuit energized by the low tension generator, a brake member normally holding the motor against operation, a holding lever engageable with the brake member for holding the brake member released and releasable therefrom upon energizing the solenoid, and time controlled circuit controlling means for the solenoid circuit.

5. In X-ray apparatus of the class described, a hot cathode X-ray tube, an electrostatic generator, a high tension circuit between the generator and tube, a low tension generator, a low tension circuit between the low tension generator and the cathode of the tube, a spring motor for operating both of said generators, a brake member normally holding the spring motor against operation, starting means for releasing the brake member, electrically released holding means for retaining the brake member released and adapted to be energized by the low tension generator, and circuit controlling timing means operable by the spring motor for opening the low tension circuit and energizing the holding means for releasing the brake member and stopping operation of the apparatus.

6. In X-ray apparatus of the class described, a hot cathode X-ray tube, a high tension generator and a low tension generator for energizing the tube, a low tension circuit, spring motor drive means for the generators and embodying governor means including a brake disc, a releasable brake lever having a brake shoe spring urged against the brake disc for normally holding the spring motor against operating, starting means for releasing the brake lever, solenoid controlled holding means releasably engageable with the brake lever for holding the brake shoe released, and circuit controlling means for the low tension circuit and the solenoid controlled holding means, and operable by the spring motor for controlling running time for the apparatus.

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