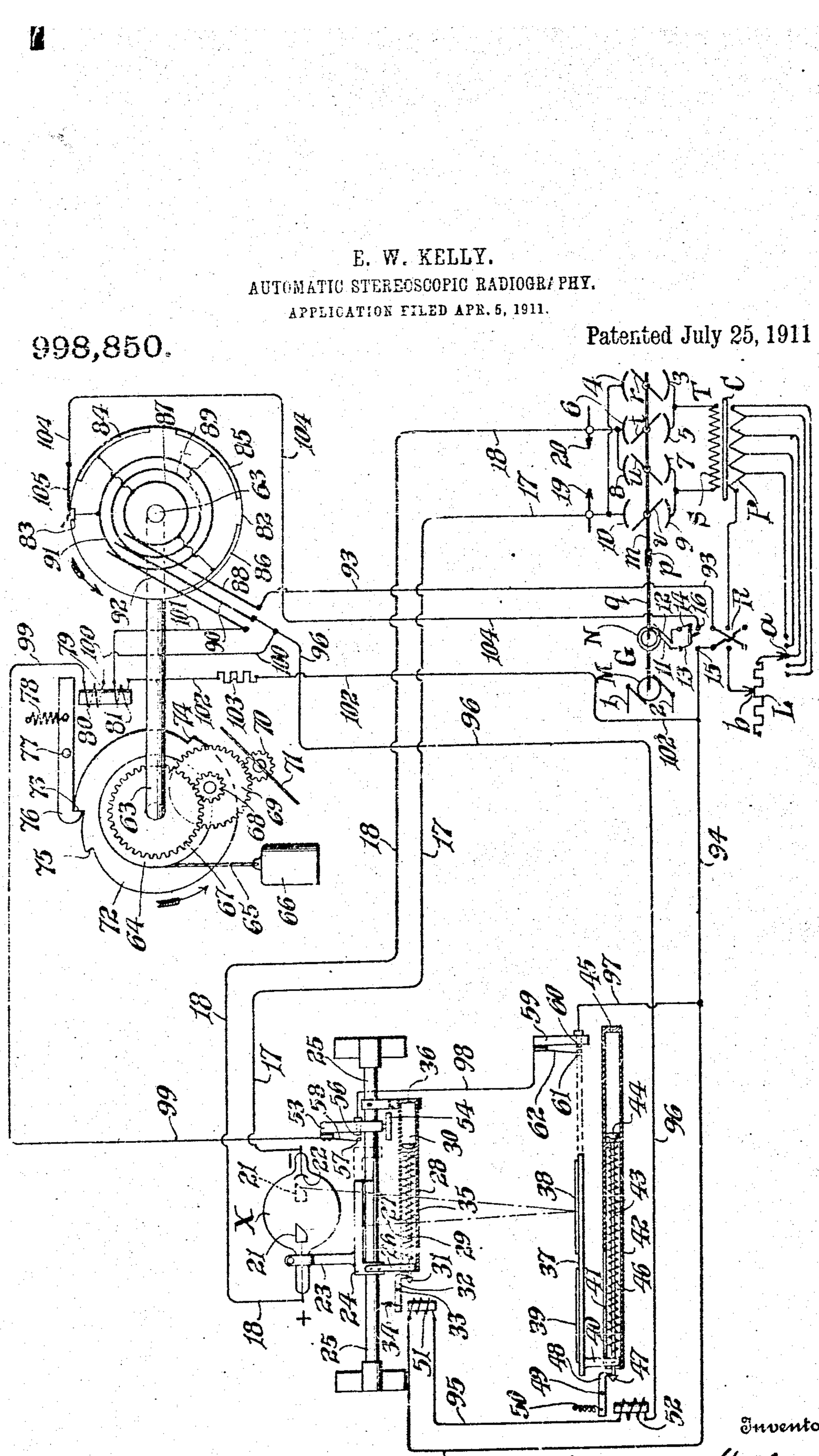
E. W. KELLY.

AUTOMATIC STEREOSCOPIC RADIOGRAPHY.

APPLICATION FILED APR. 5, 1911.

998,850.

Patented July 25, 1911



Witnesses

Daniel Webster, Jr

Anna E. Steinbeck

Inventor

Edwin W. Kelly

By Cornelius L. Chase

his Attorney

UNITED STATES PATENT OFFICE.

EDWIN W. KELLY, OF PHILADELPHIA, PENNSYLVANIA.

AUTOMATIC STEREOSCOPIC RADIOGRAPHY.

998,850. Specification of Letters Patent. Patented July 25, 1911.

Application filed April 5, 1911. Serial No. 619,101.

To all whom it may concern:

Be it known that I, EDWIN W. KELLY, a citizen of the United States, residing in the city of Philadelphia, county of Philadelphia, and State of Pennsylvania, have invented certain new and useful Improvements in Automatic Stereoscopic Radiography, of which the following is a specification.

My invention relates to automatic stereoscopic radiography whereby the exposure of sensitive plates or the like in succession with successive positions of the source of X-rays is accomplished.

My invention resides in apparatus for accomplishing the aforementioned purpose, preferably automatically, and resides also in the process.

My invention resides in the matters hereinafter described and claimed.

For an illustration of one of the forms the apparatus may take for carrying out my invention, reference is to be had to the accompanying drawing, which is a diagrammatic view of the circuits and diagrammatic or fragmentary views of the associated apparatus.

In the drawing, G represents a motor generator or rotary converter, of which M is the electric motor element and N the generator element driven by the motor M. The motor M is supplied by either direct or alternating current from the supply conductors 1 and 2, and the brushes 11 and 12 collect the alternating current from the slip rings and communicate with the switch blades 13 and 14 respectively, which are adapted to engage the contacts 15 and 16 respectively. A reversing switch R has the pairs of cross connected supply contacts and the middle pair of contacts communicating with the consumption circuit. This consumption circuit includes the primary P of a transformer, such as a closed magnetic circuit transformer of the type described in prior U. S. Patent No. 954,056, C representing the core of such transformer. This consumption circuit includes also the adjustable resistance L adjustable by the switch *b*. And the switch *a* is adapted to include in the consumption circuit a greater or less number of turns of the primary P.

S represents the high potential secondary of the transformer T whose primary is P, one terminal of the secondary being connected to the conducting arcs 3 and 5, while the other terminal is connected to the conducting arcs 7 and 9. Opposed to these arcs are the conducting arcs 4, 6, 8 and 10, of which 4 and 10 are electrically connected together and the arcs 8 and 6 electrically connected together. The cross connectors *r*, *t*, *u* and *v* are rotated by the shaft *m* connected by insulating coupling *p* with the shaft *q* of the source of alternating current N. These arcs and cross connectors constitute a rectifying switch, as explained in said aforementioned Letters Patent, which then delivers uni-directional current at high potential to the conductors 17 and 18, 17 being connected to the arcs 4 and 10, while the conductor 18 is connected to the arcs 6 and 8.

19 and 20 are spark gap terminals forming a spark gap which may be employed if desired to determine the maximum potential which shall be impressed upon the X-ray tube X.

The conductor 18 connects with the positive terminal or anode 21, while the conductor 17 connects with the negative terminal or cathode 22 of the X-ray tube X, the conductor 18 being positive with respect to the conductor 17. When the alternating current generator N is rotating at full speed, the rotating cross connectors *r*, *t*, *u* and *v* of the rectifying switch are driven in synchronism therewith so that there is delivered to the conductors 17 and 18 high potential uni-directional current as above mentioned. If for any reason the conductor 18 should be negative with respect to conductor 17, the reversing switch R may be thrown over to opposite position, whereupon the conductor 18 will become positive and conductor 17 negative, so that the current will pass through the tube in the right direction.

The tube X is supported in the bracket 23 carried upon the movable carriage 24, slidable or movable upon the stationary frame 25. Connected to the carriage 24 is a member 26 extending through a slot 27 into the tube 28 held in fixed relation with respect to the frame 25. Within the tube 28 is a rod 29 carrying a plunger 30 and at its outer end the head 31 adapted to be held by the latch 32 pivoted at 33 and controlled by the spring 34, the spring holding the right hand end of the latch 32 depressed in position to restrain the head 31 on the rod 29. Within the tube 28 is a spring 35 whose one end is connected to the tube 28 and whose other end is connected to the rod 29.

The right hand end of the tube 28 is closed, except for the small air passage 36.

In operative relation with respect to the target or anode 21 of the tube X is disposed the plate carrier 37 which is movable substantially parallel to the frame 25 upon which the tube X is movable. Upon the carrier 37 are disposed sensitized plates or the like, 38 and 39, inclosed in plate holders or any other suitable means, for excluding ordinary light. Secured to the carrier 37 is the member 40 extending through the slot 41 in the fixed tube 42 within which is movable the rod 43 having a plunger head 44. The tube 42 is closed at its right hand end except for the air escape passage 45. Within the tube 42 is a spring 46 whose one end is secured to the rod 43 which carries at its left end a head 47 restrained by the latch 48 pivoted at 49 and urged to the position shown by the spring 50. Associated with the latch 32 is the electro-magnet 51 and with the latch 48 is associated the electro-magnet 52. These windings are here shown connected in series with each other, it being the object that they shall be simultaneously energized. When these electro-magnets are traversed by alternating current, as in the case here illustrated, the cores and their armatures are, of course, preferably laminated.

The member 53 is secured by set screw 54 to the frame 55 and carries the stationary contact 56 with which is adapted to engage the contact 57 carried by the leaf spring 58 supported on but insulated from the member 53. And, similarly, a fixed member 59 carries a stationary contact 60 adapted to be engaged by the movable contact 61 carried by the spring 62 supported on but insulated from the member 59. These switches 56, 57 and 60, 61 are connected in series with each other so that the circuit controlled by them is not closed until both are closed.

Upon the shaft 63 is secured a drum or grooved wheel 64 to which is secured one end of a rope or the like 65, carrying the weight 66. The weight 66 tends to rotate the drum 64 and also the commutator or switch mechanism, later referred to, in the direction indicated by the arrows. Secured upon the shaft 63 or to the drum 64 is a gear wheel 67 meshing with the pinion 68 secured to the gear 69 which drives the pinion 70 carrying the air or other fan 71. This step-up gearing rotates the fan 71 at high speed so that the rotation of the drum 64 and the attached parts is suitably retarded. The amount of retardation may be adjusted by using different sizes of fan, or by any other suitable means.

Secured to the shaft 63 is the locking wheel 72 having the shoulders or notches 73, 74 and 75. The latch 76 is adapted to engage these shoulders or notches in succession, the latch being pivoted at 77 and urged toward the position shown by the spring 78. Adapted to attract the right hand end of the latch 76 in opposition to the spring 78 is a core 79 having the two windings 80 and 81. When these windings are traversed by alternating current, as in the present case, the core 79 and the part which it attracts, may be suitably laminated. On the shaft 63 is secured the switch mechanism or commutator 82 comprising peripheral contacts 83, 84, 85 and 86. Contacts 83 and 85 are insulated from each other and from the contacts 84 and 86. Contacts 84 and 86 are electrically connected together and to the slip ring 87 upon which bears the brush 88. Contact 85 is electrically connected to the slip ring 89 upon which bears the brush 90. The contact 83 is electrically connected to the slip ring 91 upon which bears the brush 92. From the brush 88 a conductor 93 extends to one supply terminal of the reversing switch R. From the other supply terminal of the reversing switch R and from contact 15 extends a conductor 94 to one terminal of the electro-magnet 51 whose other terminal connects by conductor 95 to one terminal of the electro-magnet 52, whose other terminal connects by conductor 96 to the brush 90. From the conductor 94 there is a connection through conductor 97 to the contact 60, and from the movable contact 61 extends a conductor 98 to the switch contact 56, and from the switch contact 57 extends a conductor 99 to one terminal of the electro-magnet 80 whose other terminal connects by conductor 100 to the brush 90. The brush 92 connects by conductor 101 to one terminal of the electro-magnet 81 whose other terminal connects through conductor 102 to the conductor 94, a suitable resistance 103 being included when desired. From contact 16 extends a conductor 104 to brush 105.

The operation is as follows: The motor generator or rotary converter, or alternator N, is brought up to speed by any suitable means and, as before stated, the cross connectors *r*, *t*, *u* and *v* of the rectifying switch rotate in synchronism therewith. Normally the other mechanism is in the position shown. Upon closing the operator's switch 13, 14, brush 11 is brought into communication with contact 15 and brush 12 into communication with contact 16. Current then flows, for example, from contact 16, through conductor 104 to brush 105, thence through contact 83, through slip ring 91, through brush 92, conductor 101, electro-magnet winding 81, conductor 102, back to contact 15 and to the other terminal 12 of the generator N. In consequence, the core 79 is magnetized and the latch 76 is lifted free of the shoulder or notch 73 and the weight 66 is free to descend and rotate the shaft and attached parts in the direction of the

arrows. Contact 83 immediately leaves brush 105, but contact 84 approaches and passes under brush 105 whereupon current then passes from contact 16 through brush 105, contact 84, slip ring 87, brush 88, conductor 93, to one supply terminal of the reversing switch R, thence through a consumption circuit contact of the switch R, through the primary P of the transformer T, switch *a*, resistance L, switch *b*, back to the other terminal of the reversing switch R, thence to the supply terminal in communication with contact 15 to the other side of the generator N. This energizes the transformer and as a result uni-directional current is passed through the X-ray tube X exciting the same to produce X-rays, the rays passing through the patient or other object and impinging upon the plate 38 where they make their impression. This energization of the X-ray tube X lasts only so long as the contact 84 is in engagement with brush 105. After the contact 84 has passed from under brush 105, contact 85 engages the brush 105, whereupon current will flow from one side of the generator N through contact 16, conductor 104, brush 105, contact 85, slip ring 89, to brush 90, thence through conductor 96, electro-magnets 52 and 51, conductor 94 back to the other side of the generator. Electromagnets 51 and 52 are, therefore, simultaneously energized, and, consequently, their respective latches 32 and 48 are actuated by them to release the rods 29 and 43 respectively, whereupon the springs 35 and 46 move these rods toward the right, the movements being retarded in the first case by the plunger 30 expelling air through passage 36 from the tube 28, and in the latter case by the plunger 44 expelling air from the tube 44 through the passage 45. In consequence, the X-ray tube X and the plates 38 and 39 are moved toward the right. The tube X is moved to the right a distance substantially 2½ inches, being the average distance between the human eyes, so that the anode or target 21 then assumes the dotted line position indicated. The plates 38 and 39 move a greater distance, however, so that the plate 39 comes to the position previously occupied by the plate 38. The carriage 24 carrying the X-ray tube moves to and beyond the position indicated in dotted lines and at the end of its movement actuates the spring 58 to bring contact 57 into engagement with contact 56. And, similarly, the plate carrier 37 at the end of its movement actuates the contact 61 to bring it into engagement with the contact 60. During these movements of the tube X and the carrier 37 toward the right, the notch 74 has come into engagement with the latch 76 thereby stopping the shaft 63 and the attached parts. In such position the contact 85 is still in engagement with brush 105. When both the tube X and the carrier 37 have reached the ends of their travels both switches 56, 57 and 60, 61 are closed and thereupon current flows from one side of the generator N through contact 16, brush 105, contact 85, slip ring 89, brush 90, through conductor 100, electromagnet winding 80, conductor 99, through switch 56, 57, conductor 98, switch 60, 61, conductor 97 to conductor 94 back to the other side of the generator N. The core 79 is, therefore, again energized, this time by the winding 80, whereupon the latch 76 is again raised and the weight 66 again descends continuing the rotation of the shaft 63 and attached parts. Contact 85 passes out from under brush 105, and later the contact 86 comes into engagement with brush 105, whereupon current will flow from one side of the generator N through contact 16, brush 105, slip ring 87, brush 88, thence through the primary circuit of the transformer T back to the other side of the generator N, thereby again exciting the tube X, producing X-rays making the second exposure whose duration is determined by the time required for the passage of the contact 86 under the brush 105. As contact 86 passes from under brush 105 the shoulder or notch 75 has come around into engagement with the latch 76 and the parts are again stopped, and the operator then opens the switch 13, 14. This completes the operation of the mechanism, and the result has been the successive exposure of sensitized plates with successive positions of the source of X-rays, the images on these plates, when developed, then being in stereoscopic relation, and they may be viewed in suitable stereoscopic apparatus as understood in the art. If 56, 57 and 60, 61 are closed before 76 engages 74, the shaft 63 continues to rotate without interruption. When it is desired to make another series of exposures the operator simply lifts the latch 76 and allows the shoulder 75 to escape and the parts rotate until the latch 76 again engages the shoulder or notch 73. And the tube X and plate carrier 37 are returned to their original latched positions. Then, upon a second closure of the switch 13, 14, the cycle of operations will be automatically repeated.

While I have shown a source of alternating current with a step-up transformer and rectifying switch as means for energizing the X-ray tube and the alternating current as means for energizing the tripping magnets, it is to be understood that a direct current may be used for energizing these magnets, or that an ordinary induction coil with Wehnelt or other interrupter in its primary may be used as a source of current for the X-ray tube, direct current being used in most cases in the induction coil primary circuit.

From the arrangement of the switches 56,

57 and 60, 61, in series with each other in the relation described, it follows that both the X-ray tube and the plates must have reached their new positions before the X-ray tube can again be excited. If the tube should be excited before either the tube or the plates had reached the second position, a premature explosure would result, and a plate would be spoiled because either the plate or the tube would still be moving at the time of exposure.

By adjusting the speed of rotation of the shaft 63, the cycle of operations may be performed in shorter or longer intervals, according as shorter or longer exposures are required.

I do not wish to be limited as to my invention to the particular arrangements or constructions herein disclosed, it being understood that the particular constructions and arrangements here disclosed are by way of example merely.

Where the amount of current for energization of the X-ray tube is so great that substantial arcing would incur at the commutator contacts 84 and 88, these contacts may be employed, instead of directly in the circuit with the X-ray tube, in the circuit of a relay or other controlling device, which will cause closure of the circuit through the X-ray tube when brush 105 is in contact with either contact 84 or 88.

While the arrangement herein disclosed is electro-mechanical in nature, it is to be understood that they may be in whole or in part replaced by mechanical, pneumatic or other suitable controls. Indeed, any mechanism, mechanical, pneumatic, hydraulic, or electrical so related as to shift the tube and the plates that the second energization of the X-ray tube is impossible until after the tube and plates have reached their final positions, may be employed.

What I claim is:

1. The process of automatically making stereoscopic X-ray exposures, which consists in automatically producing X-rays for a predetermined interval of time, thereafter shifting a source of X-rays and the sensitized medium, and thereafter automatically producing X-rays for another predetermined interval of time.

2. The process of automatically making stereoscopic X-ray exposures, which consists in automatically producing X-rays for a predetermined interval of time, thereafter automatically shifting a source of X-rays and the sensitized medium, and thereafter automatically producing X-rays for another predetermined interval of time.

3. In combination, an X-ray tube, a source of energy, means for energizing said X-ray tube from said source of energy, a plate carrier, means for automatically shifting said plate carrier and said X-ray tube, and means for thereafter again automatically energizing said X-ray tube.

4. In combination, an X-ray tube, a source of current, a commutator, means for driving said commutator, a circuit for starting said driving means, a plate carrier, means for moving said X-ray tube and said plate carrier, a circuit controlled by said commutator for energizing said X-ray tube, and a circuit controlled by said commutator after first energization of said tube for causing movement of said X-ray tube and said plate carrier, said commutator thereafter controlling further energization of said X-ray tube.

5. In combination, an X-ray tube, a source of current, a commutator, means for driving said commutator, a circuit for starting said driving means, a plate carrier, means for moving said X-ray tube and said plate carrier, a circuit controlled by said commutator for energizing said X-ray tube, a circuit controlled by said commutator after first energization of said tube for causing movement of said X-ray tube and said plate carrier, means automatically stopping said commutator after first energization of said X-ray tube, and a circuit controlled by the movement of said tube and said plate carrier for restarting said commutator, said commutator thereafter controlling a second energization of said tube.

6. In combination, an X-ray tube, a source of current, a commutator, means for driving the same, a plate carrier, means for moving said tube and plate carrier, a switch controlling the starting of said commutator, said commutator thereafter energizing said tube, causing the shifting of said tube, and said plate carrier, and thereafter causing second energization of said tube.

7. In combination, an X-ray tube, a plate carrier, means for moving said X-ray tube, means for moving said plate carrier, means for retarding the movement of said X-ray tube, means for retarding the movement of said plate carrier, and a commutator having contacts controlling respectively first energization of said tube, the movement of said tube and said plate carrier, and a second energization of said tube.

8. In combination, an X-ray tube, a plate carrier, means for moving said X-ray tube, means for moving said plate carrier, means for retarding the movement of said X-ray tube, means for retarding the movement of said plate carrier, and a commutator having contacts controlling respectively first energization of said tube, subsequent movement of said tube and plate carrier, the stopping of said commutator until said tube and plate carrier have reached their final positions, subsequent starting of said commutator, and thereafter a second energization of said tube.

9. The combination with an X-ray tube,

of a plate carrier, means for moving said tube, means for moving said plate carrier, means for locking said tube in normal position, means for locking said plate carrier in normal position, a commutator, means for locking the same in normal position, and a circuit for unlocking said commutator, a contact for said commutator controlling subsequent energization of said tube, a further contact of said commutator subsequently unlocking said tube and said plate carrier, said commutator locking means subsequently locking said commutator, a circuit energized when said tube and plate carrier have reached their final positions for again unlocking said commutator, and a further contact of said commutator controlling second energization of said tube.

In testimony whereof I have hereunto affixed my signature in the presence of the two subscribing witnesses.

EDWIN W. KELLY.

Witnesses:
ANNA E. STEINBOCK,
ELEANOR T. MCCALL.