

Aug. 30, 1949.

R. W. DANIELS

2,480,122

ELECTRON DISCHARGE APPARATUS

Filed Sept. 10, 1947

2 Sheets-Sheet 1

Fig. 1

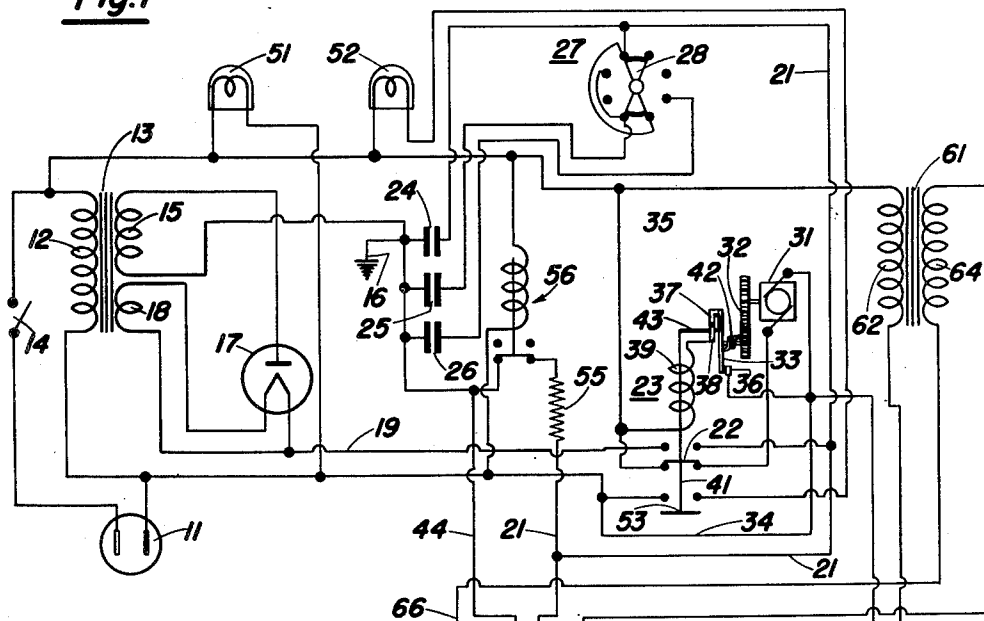


Fig. 2

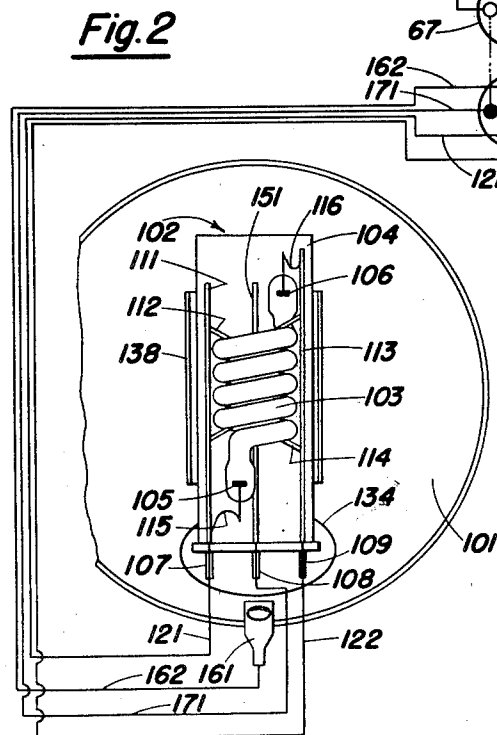
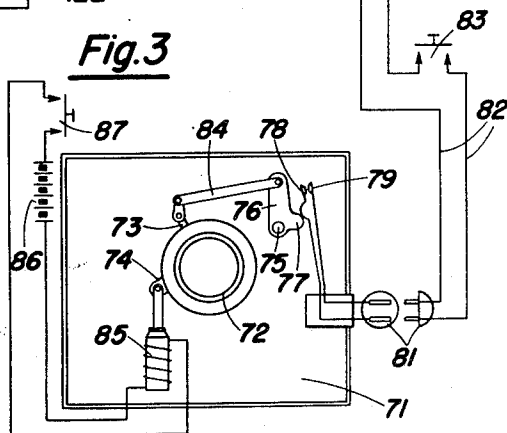


Fig. 3



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Fig. 5

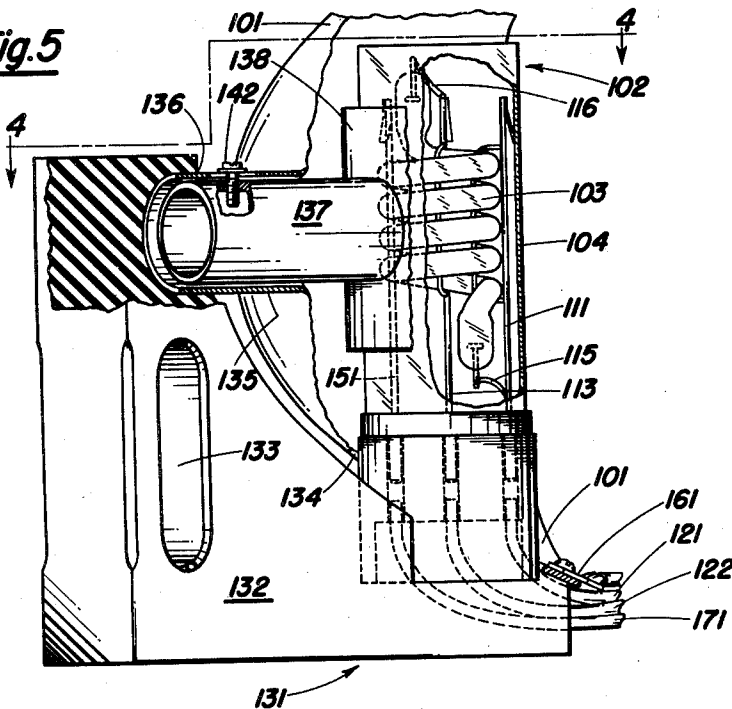


Fig. 4

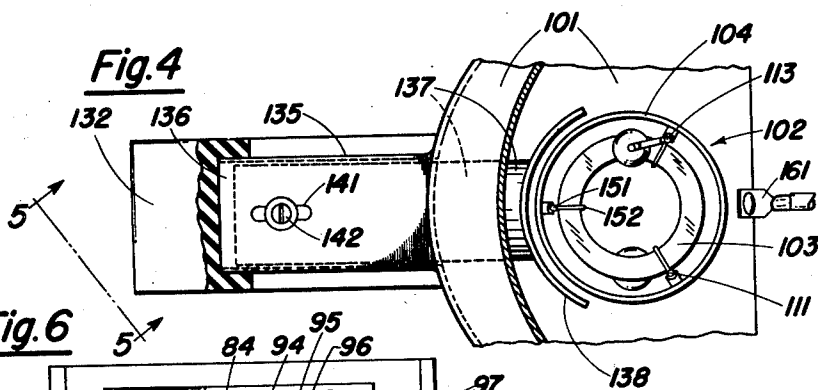
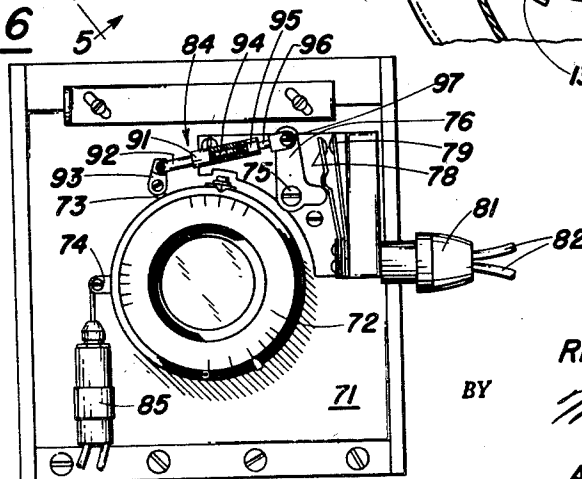


Fig. 6



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UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE APPARATUS

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8 Claims. (Cl. 176—122)

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This invention relates to electron discharge apparatus, particularly such apparatus as is used for producing a brilliant flash of actinic light for photographic purposes. More particularly, this invention relates to a holder in which an electron discharge device capable of producing a flash of photographic light may be mounted.

It is an object of this invention to provide means for improving the timing control over a flash of actinic light.

It is another object of this invention to provide a holder for an electron discharge device having an adjustable member whereby the firing of the device may be regulated for optimum performance.

It is still another object of this invention to provide a holder for an electron discharge device having adjustable means whereby the holder may accept devices of different sizes and shapes with equal functional effectiveness.

In the following description there will be described photographic apparatus for producing a brilliant flash of actinic light. An important element of this apparatus is the electron discharge device and holder of the instant invention.

Referring to the drawing, Fig. 1 is a schematic diagram of an electric control circuit for energizing electron discharge apparatus to produce a flash of light.

Fig. 2 is a face view of the electron discharge apparatus which produces the flash of photographic light.

Fig. 3 is a face view of a camera showing a tripping means whereby the flash of actinic light may be synchronized with the opening of the camera shutter.

Fig. 4 is a fragmentary top view, partially sectioned, of the electron discharge apparatus of Fig. 2.

Fig. 5 is a partially sectioned view of the apparatus of Fig. 4, taken along the oblique line 5—5 in Fig. 4.

Fig. 6 is an enlarged face view of the camera shown in Fig. 3.

The energizing circuit

In Fig. 1, the plug 11, adapted to be connected to a source of 110 volt alternate current power, is connected to the primary winding 12 of a transformer 13 through a switch 14. A high voltage secondary winding 15 of the transformer 13 is grounded at one end as shown at 16, and is connected at the other end to the plate of a rectifier tube 17. The rectifier cathode is heated in conventional manner by energy from a low volt-

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age secondary winding 18 of the transformer 13. With the rectifier tube 17 thus connected, the cathode conductor 19 has applied thereto a relatively high uni-directional potential.

Conductor 19 is connected to a conductor 21 through a bridging contact 22 of a relay 23. Between conductor 21 and the ground 16 is connected a storage capacitor 24. Thus whenever transformer 13 and relay 23 are energized, capacitor 24 will be connected to, and charged by, a high voltage direct current source in the form of rectifier 17.

Capacitors 25 and 26 may be successively paralleled with capacitor 24 through a multi-terminal switch 27, having a rotatable bridging member 28. In the particular position shown for bridging member 28, in Fig. 1, only capacitor 25 is connected to conductor 21 so that the total capacitance charged from the high voltage direct current line is the sum of capacitors 24 and 25. It will be manifest from the drawing that all three capacitors may be paralleled by rotating the bridging member 28 one position counter-clockwise; while by rotating member 28 one position clockwise, only capacitor 24 will be connected to conductor 21.

The relay 23 is employed in the circuit of Fig. 1 to insure that the high voltage conductor 19 will not be connected to the capacitors 24—26 until the apparatus has been operating long enough to insure adequate operating temperature in the cathode of rectifier 17. The necessary time delay is provided by a small motor 31 connected, through gears 32, to a conducting disk 33. One terminal of motor 31 is connected permanently through a conductor 34 to one side of the plug 11. The other side of the motor is connected to the other side of the alternating current source through a conductor 35 and through the relay contact 22. Thus as soon as the switch 14 is closed to start heating of the cathode of rectifier 17, the motor 31 is also energized to institute rotation of the disk 33. In sliding contact with the disk 33 is a brush 36 connected to the conductor 34. Disk 33 carries a contact 37 which bears against a stationary contact 38 whenever the disk has been rotated a predetermined distance. Contact 38 is connected to one side of the coil 39 of relay 23, the other side of which is connected to the alternating current conductor 35. Thus, a predetermined time after closing of the switch 14, when the motor 31 has rotated the disk 33 so as to move the contact 37 into engagement with the contact 38, the relay coil 39 is energized, thereby lifting the armature 41 and causing contact 22 to com-

plete the circuit for the capacitors 24—26. De-energization of the motor 31, by the lifting of contact 22, would normally cause the disk 33 to snap back under the impulse of a torque biasing spring 42; but this is prevented by an interlock member 43, attached to the armature 41 which physically engages the contact 37 and holds it against the contact 38. The energizing circuit for coil 39 through contacts 37—38 is thus held closed by virtue of the raised position of armature 41. Under this condition the capacitors 24—26 will be charged from rectifier 17, the voltage of this charge appearing between conductor 44 connected to ground 16, and the high voltage direct current conductor 21. The quantity of the charge depends on the number of capacitors 24—26 across the line, which in turn depends on the position of the switch 27.

An indicator light 51, connected across the primary winding 12, shows when the apparatus has been energized by the closing of switch 14. A high voltage indicator light 52 is also placed across the primary winding 12 through an auxiliary contact 53 carried by the armature 41 of relay 23. Light 52 indicates that the delay time has passed, and that the high voltage from rectifier 17 has been applied to the conductor 21, and to the capacitors 24—26.

In order that a high voltage will not remain on the conductor 21 when the apparatus is not in use, means must be provided for discharging the capacitors 24—26. To this end the conductor 21 is grounded through a resistor 55 and a relay 56, the coil of which is energized whenever the switch 14 is closed, thereby opening the grounding circuit.

The apparatus of this invention also employs a high voltage alternating current, which is derived through a transformer 61, the primary winding 62 of which is connected in parallel with the primary winding 12 through a plug 63, which is in turn connected to a switch on the camera of Fig. 3 (to be described later). One side of the secondary winding 64 of the transformer 61 is grounded through a conductor 65, and the other side is connected to a conductor 66. A plug 67 is provided to which the ground conductor 44 and the high voltage direct current conductor 21 are connected, and also to which the ground conductor 65 and the high voltage alternating current conductor 66 are connected.

The circuit of Fig. 1 thus makes available for the electron discharge apparatus of Fig. 2, a direct current potential between conductors 44 and 21, as stored on the capacitors 24—26. It also makes available a high voltage alternating current between the conductors 65 and 66. This latter voltage, however, does not appear until the conductors of the plug 63 have been bridged by operation of the switch on the camera shown in Fig. 3.

The camera

In Fig. 3 there is shown the face of a camera 71 having a conventional lens assembly 72, which includes a shutter setting lever 73 and a shutter release lever 74. Pivoted on the face of the camera 71 by a pin 75 is a cam arm 76 having a knob 77 which bears against a protuberant portion of a spring contact 78. Spring contact 78 cooperates with an opposed spring contact 79 to comprise a normally open switch, which is closed momentarily as the cam arm 76 rotates counter-clockwise. The contacts 78 and 79 are connected through a plug 81 to conductors 82 which may be

connected to the plug 63. In series with one of the conductors 82 is a normally open foot switch 83, which must be held down during operation of the camera in order to complete the circuit for energizing the primary winding 62 of the transformer 61.

Tripping of the camera, which causes counter-clockwise motion of the lever 73 in the conventional manner, also effectuates, through a link 84, the afore-mentioned counter-clockwise rotation of the cam arm 76 and thereby energizes momentarily the primary winding 62. The camera tripping lever 74 is actuated through a solenoid 85 energized by a small battery 86 through a manually carried push button 87.

For optimum photographic results it is necessary that the shutter opening of the camera be precisely synchronized with respect to the closing of the light tripping contacts 78 and 79. In order to achieve this synchronization for various makes of cameras 71, it is desirable that the length of the link 84 be adjustable. As shown in Fig. 6, this is done by making the link 84 in two parts. One of these parts consists of a female fitting 91 connected through a rod 92 to an extension arm 93 firmly affixed to the shutter setting lever 73. Into the female fitting 91 is threaded the other of these parts, a male fitting 94, having a hexagon head 95, swiveled on an arm 96, the end of which is pivoted at 97 to the upper end of the cam arm 76. By adjusting the fitting 94 in the fitting 91, the length of the link 84 may be altered to synchronize properly the shutter opening with the closing of contacts 78 and 79, and hence with the flash of light from the flash apparatus shown in Fig. 2.

The flash lamp

The flash lamp, or electron discharge apparatus, forming the claimed subject matter of this invention is illustrated in Figs. 2, 4, and 5. Referring to Fig. 2, the apparatus includes a light reflector 101, in front of which is mounted an electron discharge device 102. The discharge device 102 comprises a tubular, helical, electron discharge envelope 103 surrounded by a transparent cylindrical cover 104. The bottom termination of the envelope 103 contains an electrode 105 and the top termination likewise contains an electrode 106. The electron discharge device 102 is of the plug-in type, being provided with parallel prongs 107, 108, and 109. The prong 107 is connected to an upstanding conducting post 111, disposed parallel to the axis of the helical envelope 103 just outside the convolutions thereof. A loop 112 extending internally of the helix 103 and attached to the post 111 serves to physically support one side of the envelope 103. The other side of the envelope is similarly supported by a post 113, connected to the prong 109, and having a loop 114 similar to the loop 112. The post 111 is electrically connected by a wire 115 to the electrode 105, and the post 113 is connected by a wire 116 to the other electrode 106.

High voltage direct current is applied to the envelope 103, for discharge therethrough, by conductors 121 and 122, the former being connected to the prong 107 and the latter to the prong 109 through a suitable female plug in the electron discharge apparatus of Fig. 2. The conductor 121 is connected to the ground conductor 44 (Fig. 1), and the conductor 122 is connected to the high voltage direct current conductor 21, through the plug 67, as shown by the schematic dotted lines 123.

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It will be seen from the description of the apparatus thus far that when the electron discharge apparatus of Fig. 2 is connected to the circuit of Fig. 1 through the plug 67, the switch 14 closed, and the motor 31 rotated to close the contacts 37—38, there is applied between the electrodes 105 and 106 a high direct voltage from the charge in the capacitors 24—26. This voltage is not of sufficient magnitude to break its own path through the helical envelope 103. The capacitors 24—26 will not discharge through the envelope 103 until an ionizing field has been applied thereto from the high voltage transformer 61. The manner in which the ionizing potential is applied to the envelope 103 will now be described with particular reference to Figs. 4 and 5.

As shown in Fig. 5, the electron discharge apparatus comprises essentially a holder 131 and the electron discharge device 102. The holder 131 includes a base 132 having hand grip slots 133 therein. The reflector 101 is mounted on the base 132 and has a hole 134 (Fig. 2) near the bottom thereof, through which the electron discharge device 102 passes when installed in the holder 131. The rear portion of the reflector 101 is formed into a backward extending cylinder 135, which is flexibly mounted as shown at 136 in the base 132. The inside of the cylinder 135 forms a recess for the reception of an internally telescoped cylinder 137, which protrudes forwardly from the cylinder 135 toward the electron discharge device 102. The cylinder 137 constitutes a mounting or support member for a conducting capacitor plate 138, which is transversely secured across the forwardly extending end of the supporting cylinder 137. As best seen in Fig. 4, the capacitor plate 138 is in the form of an arcuate portion of a cylinder, so that it may fit closely to, and conform to the configuration of, the transparent cover 104 of the electron discharge device 102.

The outer cylinder 136 has a longitudinal slot 141 in the upper wall thereof, through which passes a set screw 142 threaded into a tapped hole in the mounting cylinder 137. In this manner the capacitor plate 138 may be adjusted toward or away from the cover 104 by the telescoping of the cylinders 137 and 136, and held securely in an adjusted position by the screw and slot arrangement 142 and 141.

Cooperating electrically with the capacitor plate 138 is a conductor in the form of a third mounting post 151, having a loop 152 which encompasses the convolutions of the helix 103 and serves to physically support the helix within the cover 104. However, unlike the posts 111 and 113, the post 151 has no conducting relation to the envelope 103 similar to the electrodes 105 and 106. Instead, the post 151 together with its loop 152 represents a capacitor plate which, with the conducting plate 138, establishes an electrostatic field across a portion of the helical convolutions. This field is sufficient to break down the resistance within the envelope 103, thereby allowing the charge on the capacitors 24—26 to pass from the electrode 106 to the electrode 105, and produce a brilliant flash of actinic light.

Alternating current potential from the transformer 61 is placed upon the capacitor plates 151 and 138 by grounding the plate 138 through the cylinder support 137, the cylindrical recess 135, the reflector 101, a ground connector 161, a conductor 162, and up to the grounded conductor 65 in the circuit of Fig. 1; and by con-

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necting the other conductor 66 of the high voltage secondary winding 64 to the capacity post 151, through the plug 67, a conductor 171, and the prong 108. Thus when the transformer primary winding 62 is energized by the closing of the camera contacts 78 and 79, the high alternating voltage from secondary winding 64 is applied capacitively across the convolutions of the helical envelope 103, by the capacitor plate 158 and the capacitor wires 151, 152. This action lowers the internal resistance of the envelope 103 to the point where the charge on capacitors 24—26 is able to pass from the electrode 106 to the electrode 105 and produce the desired flash of photographic light.

Operation

The operation of the photographic apparatus described above is as follows: The switch 14 is closed, thereby energizing primary winding 12, indicator light 51, relay 56, motor 31, and the cathode heating circuit of rectifier 17. Energization of relay 56 opens the capacitor leakage circuit including the resistor 55, and prepares the apparatus for charging of the capacitors 24—26. Motor 31 rotates until the disk 33 has rotated far enough, against the force of spring 42, to bring contact 37 into engagement with the stationary contact 38. This energizes relay coil 38, opening the circuit of motor 31, at the contact 22, and closing the circuit between the rectifier conductor 19 and the high voltage conductor 21 which supplies the capacitors 24—26. Simultaneously the auxiliary contact 53 closes to energize the high voltage indicating light 52.

Which of the capacitors 24—26 is to be connected to the conductor 21 is determined by the position of the bridging member 28 of the switch 27. The briefest flash of light will be produced by the smallest capacitance; in this case only the capacitor 24 is left in the circuit. Conversely the longest flash of light will be produced when all three capacitors are in the circuit. In Fig. 1, switch 27 is so adjusted that only capacitors 24 and 25 are connected to the conductor 21, thereby preparing the circuit for a flash of medium length.

With the energization of relay 23, the capacitors 24 and 25 are charged, and the direct voltage is applied across the electrodes 105 and 106, through the elements 21, 122, 109, 113, 116, (106), (105), 115, 107, 121, and 44.

The camera operator, having focused the camera 71, rotates the shutter setting lever 73 clockwise to the position shown in Fig. 3, where it remains by virtue of the latch mechanism incorporated in the lens mechanism 72. This preparatory step, although momentarily closing contacts 78 and 79, does not energize transformer 61 because the foot switch 83 is open. The operator then steps on the switch 83 and presses the thumb button 87. The resulting energization of solenoid 85 trips the shutter release lever 74 and the shutter setting lever 73, thereby pulling the link 84 to rotate the cam arm 76 counter-clockwise.

The closing of the contacts 78 and 79 momentarily applies high voltage alternating current from transformer 61 through the conductors 65 and 66 to the plug 67.

This momentary voltage is applied from the plug 67 to the conductors 162 and 171, and thence across the capacitor plate 138 and the capacitor conductors 151, 152. The brief electrostatic field thus placed across the convolutions of the helical

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envelope 103 lowers the resistance of the discharge path within the envelope sufficiently to allow the charge on the capacitors 24, 25 to pass from the electrode 106 to the electrode 105, thereby producing a brilliant flash of actinic light.

By means of apparatus constructed in accordance with the principles of this invention, it has been found possible to produce flashes of photographic light ranging from .66 microseconds to 250 microseconds, depending on the capacitance placed between ground and the high voltage direct current conductor 21.

It will be understood that this invention may be made and utilized in any suitable shape, size, or arrangement, depending upon the particular electron discharge device to be accommodated, and that various modifications and changes may be made in this invention without departing from the spirit and scope thereof, as set forth in the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. A holder for an electron discharge device, comprising a base, a capacitor plate, a mounting member secured to said plate and extending substantially normally therefrom, and means adjustably mounting said member on said base thereby to mount said plate in adjustable relation to an electron discharge device secured in said base.

2. A holder for an electron discharge device, comprising a base having recessed holding means therein, a support member movable in and out of said recess, a capacitor plate secured transversely on the end of said support member adapted to electrically affect an electron discharge device mounted in said base, and means for adjustably securing said support member in said recess thereby to support said plate in adjustable relation to the discharge device.

3. A holder adapted to receive an electron discharge device, comprising a base, a first cylinder secured to said base with the axis thereof extending out from said base, a second cylinder longitudinally slidably mounted in telescopic relation with said first cylinder, a screw and slot connection between said cylinders for adjustably securing them in predetermined relation, and a capacitor plate secured transversely on the end of said second cylinder adapted to be placed in adjustable position with respect to an electron discharge device held in the holder.

4. In combination with an electron discharge envelope having electrodes for conducting a discharge current to said envelope and a holder in which said envelope is mounted, a conductor mounted adjacent said envelope, and a conducting member disposed adjacent said envelope forming, with said conductor, a capacitor for applying an electrostatic field to said envelope, and means for adjustably securing said member to said holder, thereby holding it in adjustable relation to said envelope.

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5. In combination with an electron discharge envelope having electrodes for conducting a discharge current to said envelope and a holder in which said envelope is mounted, a conductor mounted adjacent said envelope, and a conducting plate disposed adjacent said envelope forming, with said conductor, a capacitor for applying an electrostatic field to said envelope, a mounting member secured to said plate and extending away from said envelope, and means for adjustably securing said mounting member to said holder, thereby holding said plate in adjustable relation to said envelope.

6. An electron discharge device comprising an electron discharge envelope, a cover around said envelope, a capacitor conductor in the form of a plate adjustably mounted externally of said cover immediately adjacent thereto, the shape of said plate conforming closely to the contour of the adjacent cover, the mounting for said plate permitting adjustability thereof toward and away from said cover and a complementary capacitor conductor positioned to create, in conjunction with said plate, an electric field within said envelope.

7. Electron discharge apparatus comprising a holder, an electron discharge envelope mounted in said holder, a substantially cylindrical cover mounted around said envelope, a capacitor conductor in the form of a plate formed as a portion of a cylinder having a diameter slightly larger than that of said cover, a mounting member secured to the outer surface of said plate and projecting substantially radially therefrom, means securing said member to said holder and a complementary capacitor conductor positioned to create, in conjunction with said plate, an electric field within said envelope.

8. Electron discharge apparatus comprising a holder, an electron discharge envelope mounted in said holder, a substantially cylindrical cover mounted around said envelope, a capacitor conductor in the form of a plate formed as a portion of a cylinder having a diameter slightly larger than that of said cover, a mounting member secured to the outer surface of said plate and projecting substantially radially therefrom, means adjustably securing said member to said holder to permit adjustment of said plate toward and away from said cover and a complementary capacitor conductor positioned to create, in conjunction with said plate, an electric field within said envelope.

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