April 22, 1941. H. G. SPEAR 2,238,918

ELECTRIC ARC APPARATUS

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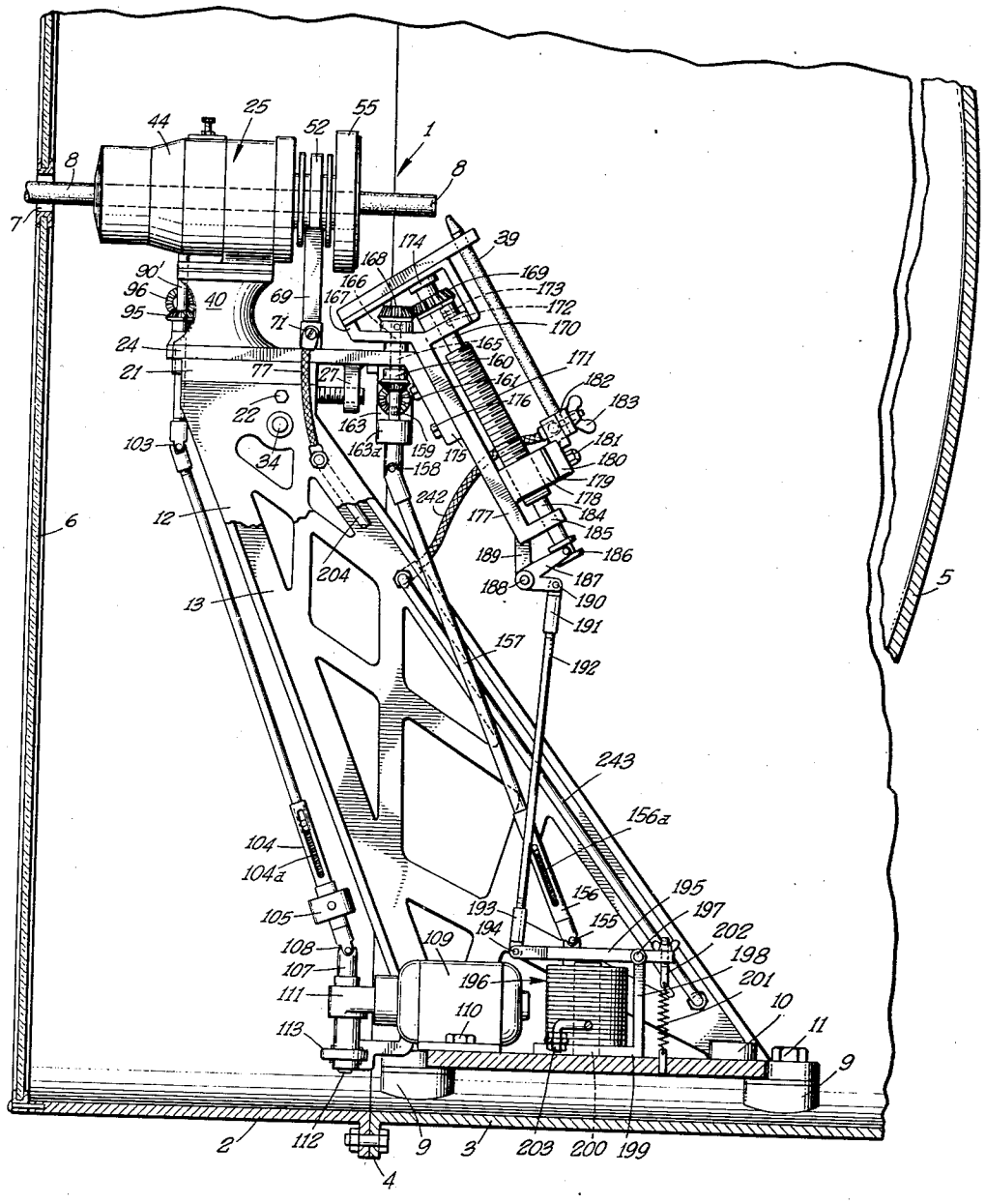


Fig. 1.

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ELECTRIC ARC APPARATUS

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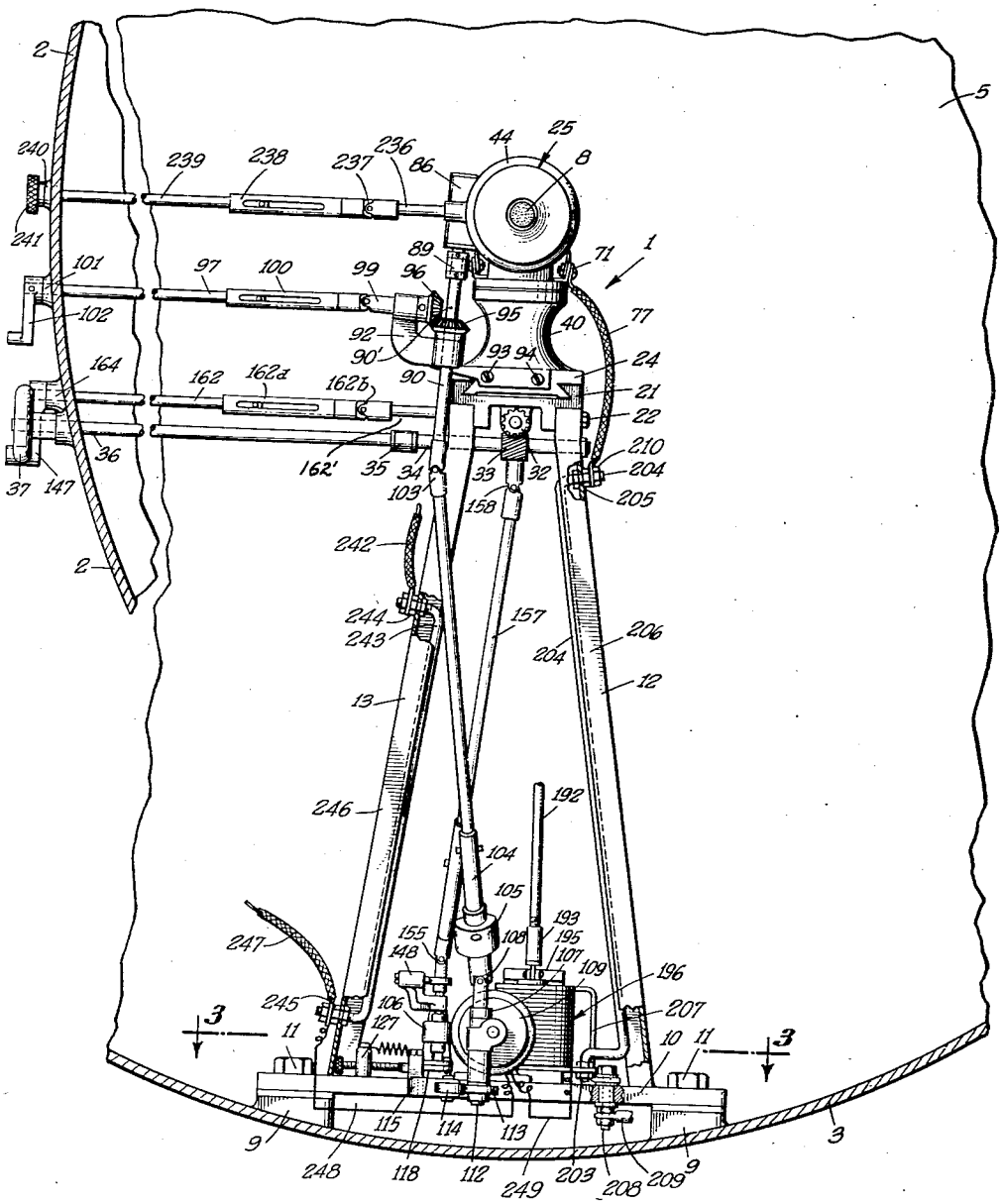


Fig. 2.

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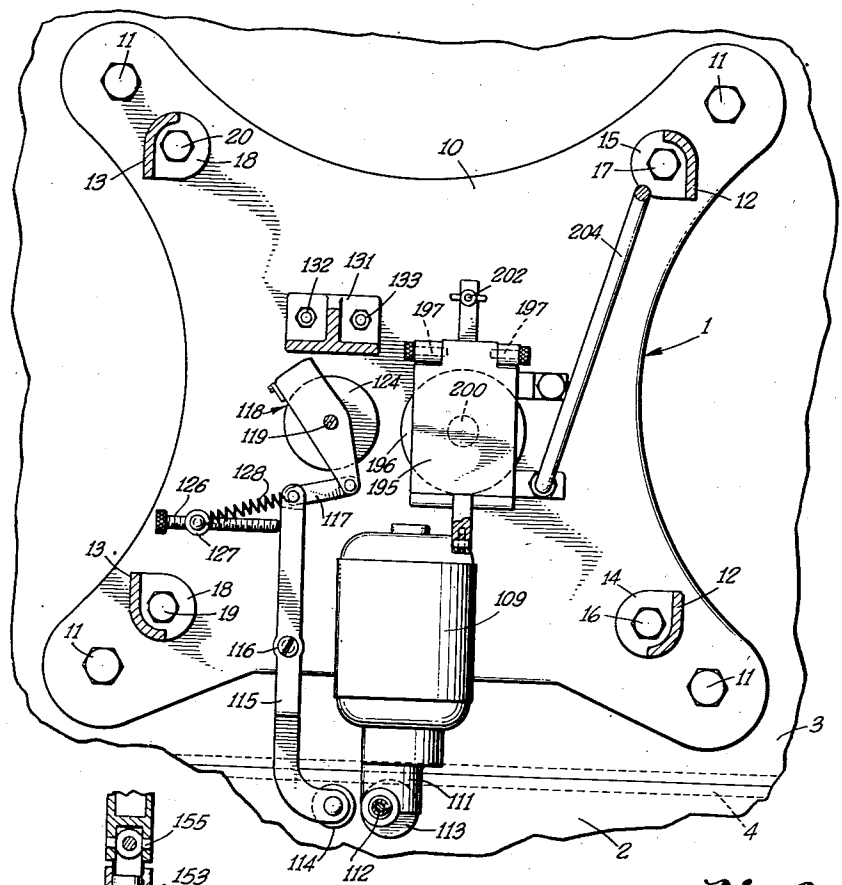


Fig. 3.

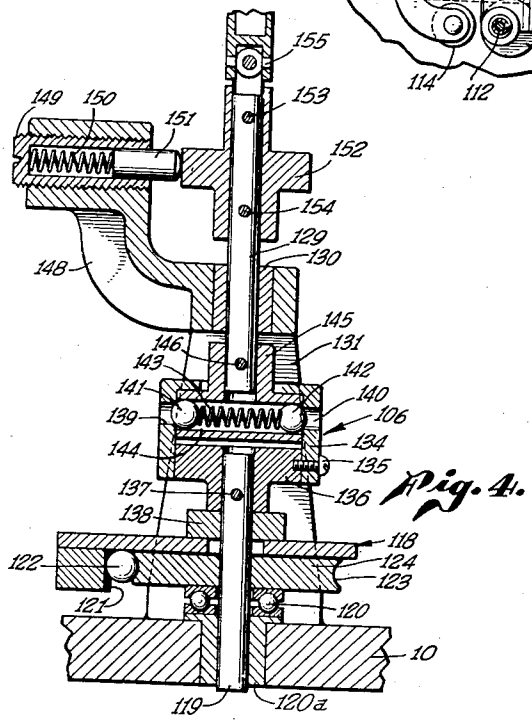


Fig. 4.

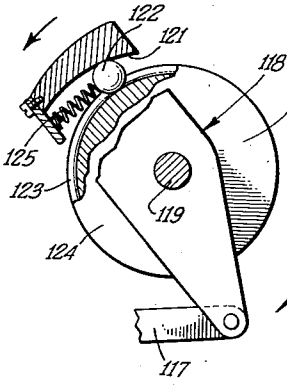


Fig. 5.

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ELECTRIC ARC APPARATUS

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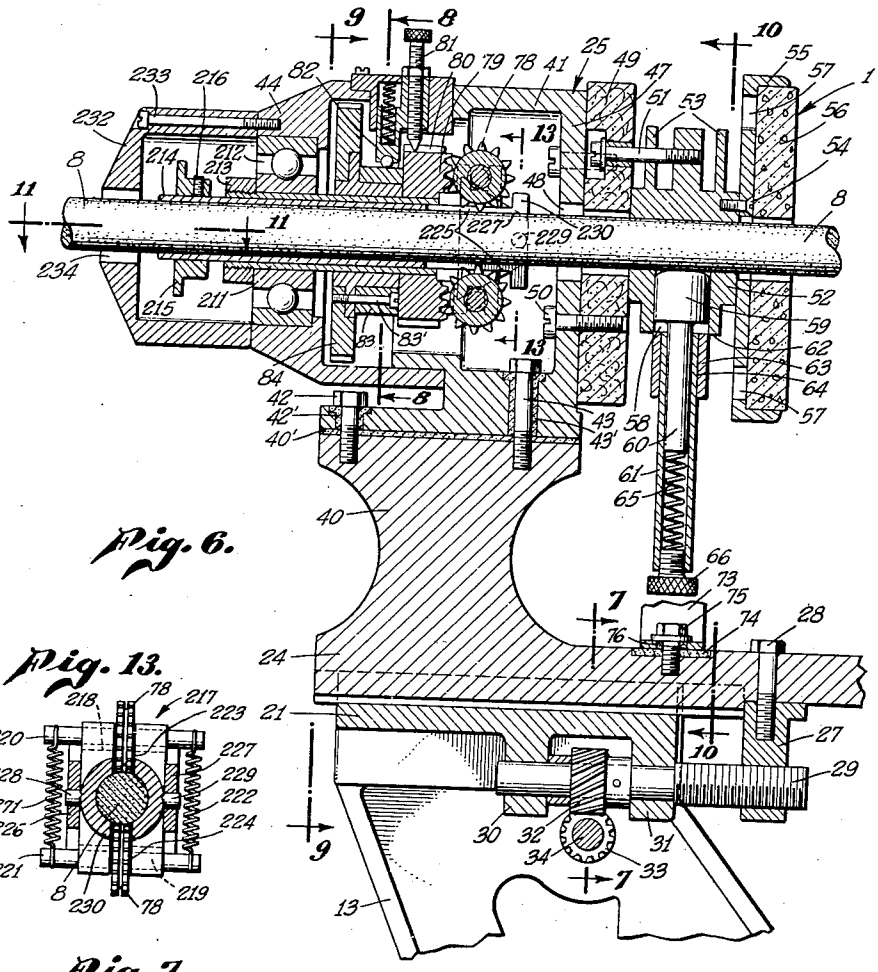


Fig. 6.

Fig. 13.

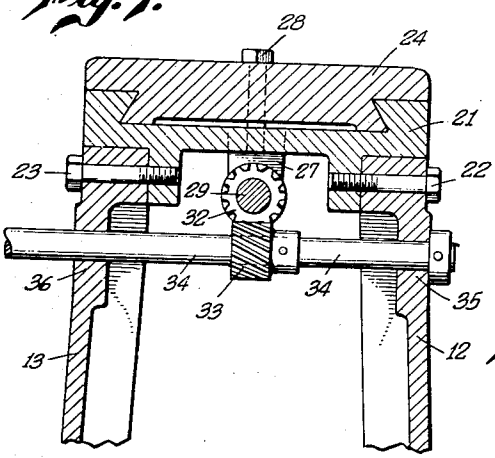


Fig. 7.

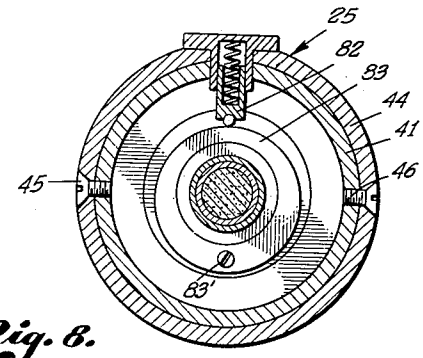


Fig. 8.

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Fig. 9.

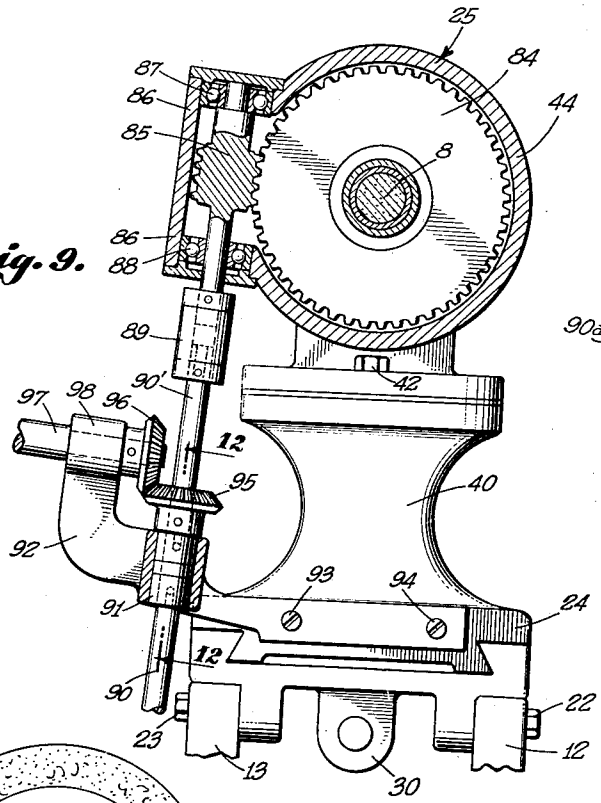
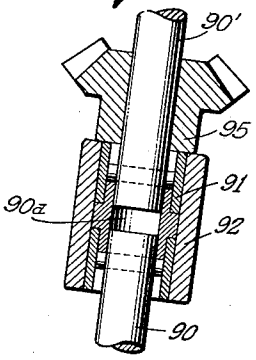


Fig. 12.



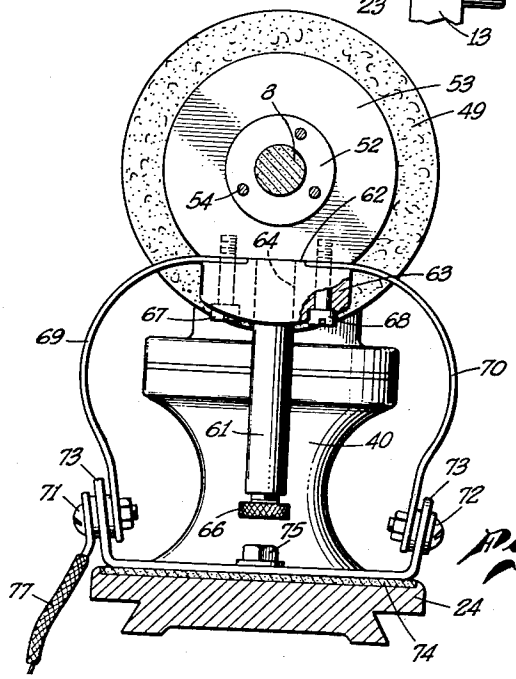
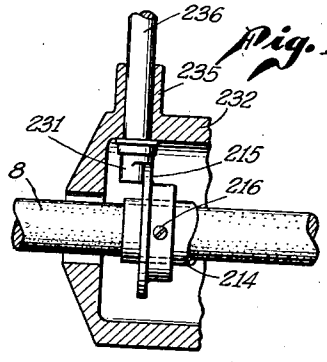


Fig. 10.

Fig. 11.



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Patented Apr. 22, 1941 2,238,918

UNITED STATES PATENT OFFICE

2,238,918

ELECTRIC ARC APPARATUS

Howard G. Spear, North Hollywood, Calif., assignor, by direct and mesne assignments, to William E. Beatty, Los Angeles, Calif.

Application April 8, 1940, Serial No. 328,463

21 Claims. (Cl. 176—55)

My invention relates to electric arc apparatus wherein two carbon electrodes are fed to the arc by means of negative and positive heads and has particular reference to searchlights wherein such heads are mounted in a casing having a reflector at the back thereof. Heretofore, where the reflector casing is quite large, say 60 inches in diameter, it has been proposed to mount the heads on a support provided by the bottom of the reflector casing and to provide a motor to drive both heads.

One object of my invention is to simplify the power drive from the motor for operating the heads. Another object is to reduce the shadow or projected area thereof on the mirror so as to increase the light reflected from the mirror, in case the heads, the support therefor, the motor and its driving connections are all arranged in front of the mirror.

Heretofore, it has been proposed to close the front of the reflector casing with a pane of plane glass having an aperture in the center thereof through which the positive electrode is adapted to pass. In order to provide access to the working parts, a manhole has heretofore been provided in the side of the reflector casing.

A further object of the invention is to provide an improved arrangement for feeding the positive and negative electrodes by hand, from a position exterior of the reflector casing.

The positive head is provided with feed wheels for feeding the positive electrode. Another object of the invention is to release these feed wheels from a point outside of the reflector casing.

Heretofore, a slide has been provided for both the positive and negative heads so that they can be reciprocated as a unit along the axis of the mirror in order to bring the arc to the focal point of the mirror. A further object of the invention is to provide an improved mount for the negative head on the slide so as to increase the intensity of the light projected from the crater of the positive electrode to the mirror.

A further object of the invention is to simplify the mechanism for moving the negative electrode longitudinally to strike the arc.

Heretofore, the positive electrode has been fed forward by means of feed wheels controlled by a scroll gear held stationary at certain times by a cam. A further object of the invention is to improve the shape of the cam to increase the latitude of the feed.

A further object of the invention is to strike the arc quickly and without prolonged hunting of the negative electrode in seeking its operating position.

For further details of the invention reference may be made to the drawings wherein:

Fig. 1 is a side elevation with certain parts broken away and other parts in cross section of electric arc apparatus according to the present invention.

Fig. 2 is a front elevation of the apparatus of Fig. 1.

Fig. 3 is a sectional view on lines 3—3 of Fig. 2, looking in the direction of the arrows.

Fig. 4 is an enlarged vertical sectional view of part of the power drive for the negative electrode drive shaft.

Fig. 5 is a plan view partly in section of the clutch mechanism in Fig. 4.

Fig. 6 is an enlarged vertical cross sectional view of the positive head.

Figs. 7, 8, 9, 10, and 11 are sectional views on lines 7—7, 8—8, 9—9, 10—10, and 11—11 respectively of Fig. 6, looking in the direction of the arrows.

Fig. 12 is a sectional view on line 12—12 of Fig. 9, looking in the direction of the arrows.

Fig. 13 is a sectional view on line 13—13 of Fig. 6, looking in the direction of the arrows.

Referring in detail to the drawings, the arc apparatus generally represented at 1 is shown as being mounted inside of a reflector casing which is known in the art. This casing comprises two cylindrical sections 2 and 3 bolted together at 4 and having a concave mirror not shown in the concave back 5 and of the same diameter as casing 2 and 3. The casing 2 and 3 has a plate glass front 6, provided with a central aperture 7 through which the positive electrode 8 passes. The casing section 3 has four apertured bosses 9 which support the arc apparatus including motor 109 and strike coil 196, as a unit. Base plate 10 is secured to the bosses 9 by bolts 11. Plate 10 is flat and has sides which are cut away, as shown in Fig. 3. On plate 10 are mounted two spaced columns 12 and 13, each of which comprises an open grid as shown in Fig. 1, to reduce weight. The columns 12 and 13 are arranged edgewise toward the end of the casing 5, so as to cast a minimum of shadow on the mirror not shown, and are spaced crosswise of the axis of the positive head 25. Columns 12 and 13 incline toward and project over the casing section 2, as shown in Fig. 1. Column 12 at the bottom thereof has apertured feet 14 and 15 which rest on plate 10 and which are secured thereto by bolts 16 and 17. Similarly column 13

has apertured feet 18 resting on base 10 and secured thereto by bolts 19 and 20. As shown in Fig. 7 columns 12 and 13 support at the tops thereof a bed 21 to which those columns are secured by bolts 22 and 23. Bed 21 has a tongue and groove connection with slide 24 on which the positive head 25 and the negative head 26 are mounted, as shown in Fig. 1. As shown in Figs. 6 and 7, underneath slide 24 is a nut 27 secured to slide 24 by bolt 28. Nut 27 has screw threaded engagement with screw 29 which is rotatably mounted in lugs 30 and 31 underneath bed 21. On screw 29 between lugs 30 and 31 is a fixed spiral gear 32 meshing with spiral gear 33 fixed to and mounted on shaft 34 which is rotatably mounted in bearings 35 and 36 at the top of the columns 12 and 13 respectively. Shaft 34 as shown in Fig. 2 has a coupling 35 and is rotatably mounted in bearing 36 in the side of the casing 2. Shaft 34 is provided with a handle 37 so that it may be rotated from a point outside of casing 2 in order to reciprocate the slide 24 to focus the arc produced by the positive carbon 8 and the negative carbon 39.

As shown in Fig. 6, slide 24 has a raised base 40 to the top of which the section 41 of the positive head 25 is connected by bolts 42 and 43 which are insulated from section 41 by insulation 42' and 43' respectively. Section 41 is insulated from base 40 by insulation 40'. Casing 44 of the positive head 25 surrounds and is fastened to the section 41 by means of bolts 45 and 46 as shown in Fig. 8. The electrode feed apparatus of the positive head 25 as shown in Fig. 6 in several respects is like that shown and described in the United States patent to Anderson—2,173,149, patented September 19, 1939. Section 41, as shown in Fig. 6, has a flat end wall 47 which has a central aperture 48 for the electrode 8. To wall 47 is fastened a disc 49 of insulating material by means of bolts like 50. Countersunk in the insulating material 49 are bolts like 51 to secure terminal block 52 which has heat radiating flanges 53. Secured to terminal block 52 by means of screws like 54 is a flanged metal disk 55 which carries a disk 56 of carborundum or other heat insulating material. Terminal block 52 has a central bore for the electrode 8 and so has disk 56. The disk 55 is provided with a plurality of heat radiating apertures 57.

Terminal block 52 at the bottom thereof has a radial aperture 58 in which is slidingly mounted pressure shoe 59, having a reduced elongated portion 60 which slides in tubes 61. As shown in Fig. 10, the bottom of terminal block 52 is cut away on substantially a horizontal line, as shown at 62, and has secured thereto a block 63, having a cylindrical bore 64 in which the tube 61 is mounted. Tube 61 is secured to block 63 by soldering or otherwise. In the bottom of tube 61 is mounted a spring 65, tension of which can be adjusted by the screw 66 threaded into the end of tube 61 to vary the pressure of shoe 59 on the electrode 8. The elongated portion 60 serves as a spring follower to remove and protect the spring 65 from the heat of the electrode 8 and reduce the danger of such heat from causing spring 65 to loose its temper. Block 63 is secured to terminal block 52 by bolts 67 and 68 which also clamp the ends of electrical conductors 69 and 70 which may be of silver strip, between the terminal block 52 and block 63. Conductors 69 and 70 are curved to facilitate expansion due to the heat of the arc, and the lower ends thereof are secured by bolts 71 and 72 respectively, to the opposite ends of a U shaped bracket 73 insulated from slide 24 by insulation 74 and secured thereto by bolts 75 insulated from slide 24 by insulation 76. Bolt 71 secures the upper end of a flexible conductor 77 which is electrically connected to a conductor 69 and through bracket 73 to conductor 70. The upper ends of conductors 69 and 70 of course are in electrical contact with the terminal block 52.

Referring to Fig. 6, the positive electrode 8 is fed longitudinally at certain times under control of feed wheels 78, meshing with scroll gear 79 having teeth 80 engaged by screw 81 which reciprocates with a follower 82 riding on cam 83 as set forth in the above mentioned patent, However, I provide a greater latitude of feed by giving this cam the shape of an eccentric as shown in Fig. 8. As shown in the patent, the cam has three lobes, each having an extended surface concentric with the axis of the head. Still referring to the patent, no feed of the electrode takes place while cam follower is in engagement with those concentric surfaces, and even though the number of lobes were reduced to one, there would still be a substantial length of time during which no forward feed of the electrode could take place. Also, it has been found that the flattened portions 134, in Fig. 6 of the patent, are at such an angle that at times the screw will strike and skip one or two serrations before it engages a serration firmly enough to hold the scroll gear stationary. These defects are overcome by the eccentric cam 83 secured to gear 84 by bolts 83', in Fig. 8, wherein the screw 81 will not skip and wherein the electrode 8 may be fed forward for a complete revolution of the arc feed apparatus or any desired fractional part of a revolution. The surface of cam 83 is a true eccentric. Namely, it is a complete circle having a center abaxial of the center of rotation of gear 84 on which cam 83 is mounted.

Gear 84 is preferably a worm gear and, as shown in Fig. 9 it meshes with a worm 85 having an axis of rotation at right angles to the axis of rotation of worm gear 84. The casing section 44 of the positive head 25 is provided with an extension 86 which houses the worm 85 and which supports the latter at its opposite ends in bearings 87 and 88. Worm 85 is connected through a suitable removable coupling 89 to the section 90' of the positive electrode drive shaft mounted in bearing 91 carried by bracket 92 secured by screws 93 and 94 to the slide 24. Shaft section 90' is coupled through removable coupling 90a (see Fig. 12) to the shaft section 90. Shaft 90' has fixed thereto a bevel gear 95 meshing with a similar gear 96 on the hand operating shaft 97 mounted in bearing 98 in bracket 92.

As shown in Fig. 2, shaft 97 has a universal coupling 99 and a slidable coupling 100 and is mounted at its outer end in a bearing 101 in the wall of casing 2. Shaft 97 outside of casing 2 is provided with a handle 102 to feed the positive electrode 8 by hand. Shaft 90 has a universal coupling 103, a slidable coupling 104 housing a compression spring 104a and a frictional coupling 105 like the frictional coupling 106 later described in connection with Fig. 4. Coupling 105 is connected to the top end of slow speed driven shaft 107, through the universal coupling 108.

Motor 109 which drives both the positive head 25 and the negative head 26 is mounted on base 10 between the columns 12 and 13 by means of bolts like 110. To reduce masking the light re-

flected from the mirror not shown, motor 109 is arranged endwise towards the mirror, in other words, its shaft and axis are parallel to the axis of casing 2. Also such interference is reduced by reason of the fact that motor 109, in being mounted on plate 10 which rests practically on the bottom of casing 2, is removed practically as far as possible from the axis of casing 2. Such reduction of interference is also increased due to the use of a compact reduction gearing 111, having a ratio of about 60 to 1, and mounted on and carried by the end of motor 109, and by the further fact that this reduction gearing 111 in being arranged at the end of the motor is in effect behind the motor so far as light reflected from the mirror is concerned. Slow speed shaft 107 which is driven by the reduction gearing 111 extends on opposite sides of the axis of motor 109, the lower extension 112 having mounted thereon an eccentric 113 which cooperates with the follower 114 (see Fig. 3). The follower 114 oscillates lever 115 which is pivotally mounted intermediate its ends to the base 10 at 116. Lever 115 at its other end is connected through link 117 to lever arm 118 rotatably mounted on shaft 119 (see Fig. 4). Shaft 119 is rotatably mounted in bearing 120*a* in the base 10. Ball bearing 120 rests on bearing 120*a* and takes up the thrust of disk 124 and the elements resting on it including the universal coupling 155 which is pushed downwardly by compression spring 156*a* in coupling 156. Lever arm 118 has an eccentric groove 121 in which rides the ball 122 which also rides in groove 123 in the clutch disk 124 fixed to shaft 119. Ball 122 is urged to the right, as shown in Fig. 3 by spring 125. When clutch arm 118 is moved counterclockwise, ball 122 is wedged between clutch arm 118 and disk 124 to rotate the disk 124 with clutch arm 118. When clutch arm 118 rotates in a clockwise direction, ball 122 is moved slightly towards the wide portion of groove 121 by the cam action of that groove and it does not couple lever arm 118 to disk 124. Shaft 119 is thus rotated step-by-step as lever 115 oscillates. The amount of the step-by-step movement and therefore the speed of shaft 119 is regulated by the adjusting screw 126 in threaded engagement with post 127 mounted on base 10. The top of post 127 has secured thereto one end of a tension spring 128, the other end of which is connected to lever 115 as shown in Fig. 3, in order to return lever 115 to a normal position against the screw 126.

As shown in Fig. 4, shaft 119 is coupled by the frictional coupling 106 to shaft 129 rotatably mounted in bearing 130 at the top of support 131 which is secured to the base 10 by bolts 132 and 133, as shown in Fig. 3. The coupling 106 comprises a cup shaped member 134, which is secured by screw 135 to an inner member 136 fixed at 137 to shaft 119. Between the bottom of member 136 and the top of ratchet arm 118 is a washer 138. The member 134, at diametrically opposite points, has apertures 139 and 140 which are slightly smaller than the balls 141 and 142 which are urged outwardly by spring 143. The balls 141 and 142 and spring 143 are housed in a bore 144 at right angles to the axis of the coupling member 145, which is fixed to shaft 129 at 146.

Frictional coupling 106 permits shaft 119 to remain stationary, and shaft 129 to be rotated by the handle 147 in Fig. 2 to feed the negative electrode by hand. The support 131 carries an extension 148 which houses a hollow adjusting screw 149, which in turn, houses a spring 150 bearing on plunger 151 which bears against disk 152, fixed to shaft 129 at 153 and 154. The spring pressed plunger 151 serves as a frictional brake to prevent overthrow of the ratchet 118. Shaft 129 has a universal joint 155, as shown in Figs. 1 and 2, connected through a slidable coupling 156 (Fig. 1) to shaft 157 which has a universal coupling 158 with shaft 159 rotatably mounted in the horizontol portion of slide 24, and in the bearing 163*a* and bracket 163. Below slide 24, shaft 159 has fixed thereon a gear 160 meshing with gear 161 mounted on shaft 162 (Fig. 2), the inner end of shaft 162' being mounted in a bracket 163 which depends from the underside of slide 24, as shown in Fig. 1. Shaft 162' has slidable coupling 162*a*, shaft 162 and universal coupling 162*b* and the outer end thereof rotatably mounted in a bearing 164 in the side of casing 2. Shaft 159 is rotatably mounted in slide 24, as indicated at 165, and it extends through slide 24 and is also rotatably mounted as indicated at 166, in the bracket portion 167 of the negative head 26. Shaft 159 at its top has fixed thereto a gear 168 which meshes with gear 169 mounted on the smooth shaft end 170 of screw 171. The shaft 170 is provided with a slot 172 in which extends a pin 173 fixed to gear 169 also mounted on the end of shaft 170 which is rotatably supported by a bearing 174 which bears at one end against the bracket 167 and at its other end against gear 169 to keep gear 169 from sliding longitudinally on shaft 170 while permitting shaft 170 to slide in it. The collar of gear 169 rests against bracket 167. The horizontal portion of slide 24 terminates at its rear in a depending portion 175 to which the bed 177 of negative head 26 is secured by bolts like 176. The axis of the negative head 26 is arranged at approximately 50° to the axis of the positive head 25, as I find this gives improved illumination from the arc.

Bed 177 carries a slide 178 which has screw threaded engagement with screw 171. Insulated from slide 178 by insulation 179 is a top member 180 secured to slide 178 by insulated bolts like 181. Member 180 carries a clamp 182 operated by wing nut 183 to clamp the end of the negative electrode 39. The screw 171 at its lower end is also smooth to provide a shaft 184 which slides in the bearing 185 carried by the bed 177. Shaft 184 terminates in a collar 186 engaged by one end of a lever 187 pivotally mounted at 188 to an arm 189 extending from the bed 177. The other end of lever 187 is pivotally connected at 190 to coupling 191 which has screw threaded engagement with the strike rod 192, the lower end of which is screw threaded to coupling 193 pivotally connected at 194 to the armature 195 of the strike coil 196. Armature 195 is pivoted at 197 to a bracket 198 of magnetic material, the base 199 of this bracket supporting the coil 196 and its core 200 and being suitably secured by means not shown, to the base 10. The armature 195 is controlled by spring 201 connected at one end to base 10 and at the other end to an adjusting screw 202 mounted in the projecting end of armature 195.

As shown in Fig. 2, coil 196 has a lower terminal 203 connected to the lower end of a rigid conductor 204, and an upper terminal 207 connected to an insulated post 208 mounted in the base 10. The post 208 is connected to one side of a power line 209. The conductor 204 throughout its length is arranged behind the flange 206 on the column 12, to eliminate or reduce the shadow cast by conductor 204 on the mirror. The upper end of conductor 204 passes through an aperture in column 12 and is insulated from but

mechanically secured thereto by nuts such as 205. The upper end of conductor 204 is electrically connected to the lower end of flexible conductor 77 by nut 210.

In order that the operator from a point outside of casing may be able to release the feed wheels 78 from the positive electrode 8, the following arrangement is provided. Part of this arrangement, namely the mechanism adjacent feed wheels 78, is similar to the mechanism described in my co-pending application S. N. 313,729 filed January 13, 1940, for "Arc apparatus." As shown in Fig. 6, scroll gear 79 is frictionally mounted on sleeve 211, which is rotatably carried by a bearing 212. Sleeve 211 is secured by a set screw (not shown) to the hub of the drive gear 84. Sleeve 211 has a retaining nut 213 which bears against bearing 212. Slidably mounted inside of sleeve 211 is a tube 214 which carries a disk 215 secured thereto by set screw 216.

As shown in Fig. 13, sleeve 211 has an operating head 217 having cross slots 218 and 219 in which the shafts 220 and 221 of the feed wheels 78 are mounted. The shafts have secured thereto tension springs 271 and 222 which urge the feed wheels 78 against the electrode 8, these feed wheels extending through longitudinal slots 223 and 224 in the head 217 and also extending through similar slots 225 in the tube 214. The opposite sides of the head 217 are flat as shown in Fig. 13, and against these sides rest the wedge plates 226 and 227, the narrow ends of which are pivotally mounted on pins 228 and 229 carried on the opposite sides of the head 230 on the tube 214. Tube 214 is slidably mounted in sleeve 211. When tube 214 is moved to the right as shown in Fig. 6, the wedges 226 and 227 engage the shafts 220 and 221 to move the feed wheels 78 outwardly away from electrode 8. Tube 14 is moved to the right by means of the rotatable cam or eccentric 231 (see Fig. 11) which bears on the disk 215 which is mounted on tube 214. Disk 215 is enclosed by a housing 232 (Figs. 6 and 11) which is secured to the casing 44 by bolts like 233. Housing 232 has an aperture 234 for the electrode 8 and at the side thereof as shown in Fig. 11, it also has a bearing 235 for a shaft 236 which carries the cam 231. As shown in Fig. 2, shaft 236 is connected through a universal coupling 237 and a slidable coupling 238 to the shaft 239 which is rotatably mounted in a bearing 240 in the wall of casing 2. Outside of casing 2, shaft 239 is provided with a knob 241 so the operator can turn shaft 239 and release the feed wheels 78 from the electrode 8. Tube 214 is urged to the left as shown in Fig. 6, by the shafts 220 and 221 acting under the force of springs 271 and 222 on the inclined faces of the wedge plates 226 and 227.

As shown in Fig. 1, current is fed to the negative electrode 39 by a flexible conductor 242, which has its lower end connected to the upper end of a rigid conductor 243. As shown in Fig. 2, the ends of conductor 243 project through the column 13 and are secured thereto by insulation, not shown, and by nuts such as 244 and 245. The rigid conductor 243 throughout its length is arranged behind the flange 246 on the column 13, as described in connection with rigid conductor 204. The lower end of rigid conductor 243 is electrically connected to one side of a power line 247, the other side of this power line being 209. Motor 109 has one terminal thereof connected by conductor 248 to the line 247, and the other terminal connected by the line 249 to the terminal 203 which has a potential substantially the same as that of terminal 209, as the voltage drop in coil 196 is very low.

It will be apparent that I have provided a compact arc-light unit which may be readily installed inside of a searchlight can and wherein the following operations may be made from a remote point, i. e. outside of the can: release of feed wheels 78 by means of knob 241, feed of positive electrode 8 by means of handle 102, feed of negative electrode 39 by means of handle 147, and focusing adjustment of the arc by means of handle 37. The slide couplings 238, 100 and 162A, also the universal couplings 237, 99, 162B permit the slide 24 to be operated for focusing purposes.

I claim:

1. Arc apparatus comprising the combination of a cylindrical wall having bosses projecting from the inside of said wall, a base removably secured to said bosses, a pair of spaced columns arising from and secured to said base, positive and negative electrode heads, means at the top of said columns for supporting said heads, a motor on said base between said columns, and means coupling said motor to said heads.

2. Arc apparatus according to claim 1 comprising a strike coil on said base behind said motor.

3. Arc apparatus according to claim 1 wherein said means coupling said motor to one of said heads comprises stepping mechanism on said base.

4. Arc apparatus comprising the combination of an electrode head, a motor having a reduction gearing, shaft means coupling said gearing to said head, said shaft means comprising a frictional coupling between said gearing and said head, and manual means for operating said shaft means between said coupling and said head.

5. Arc apparatus comprising the combination of a positive head having a casing, a slide supporting said casing, feed mechanism in said casing comprising a worm wheel having an aperture through which the electrode is adapted to pass, a worm meshing with one side of said worm wheel and arranged with its axis at right angles to the axis of said worm, means on said casing for supporting said worm at opposite ends thereof, a motor driven shaft connected to said worm, a bearing for said shaft, a gear fixed to said shaft, a hand operating shaft having a gear meshing with said last mentioned gear, a bearing for said hand operating shaft, and a bracket on said slide for supporting said bearings.

6. Arc apparatus comprising the combination of a reflector casing, a base mounted in the bottom of said casing, a support arising from said base, a slide at the top of said support, a positive electrode head on said slide, feed wheels in said head, means operable to release said feed wheels, remote control means operable from the exterior of said casing for operating said means, and a motor on said base having a power drive for operating said feed wheels.

7. Arc apparatus comprising the combination of a base, a column arising from said base, an electrode head supported by said column, a casing having a reflector, means for supporting said base in said casing with said column edgewise towards said reflector, a flange at the edge of said column, a rigid conductor for said head behind said flange, and a flexible conductor connecting said rigid conductor to said head.

8. Arc apparatus comprising the combination of a slide, negative and positive electrode heads

on said slide, feed wheels in said positive head, a reflector casing surrounding said slide and said heads, means for operating said slide, separate means for hand feeding the electrodes in each of said heads and means for releasing said feed wheels, said last three mentioned means being positioned adjacent each other at the same side of said reflector casing.

9. Arc apparatus comprising the combination of a motor having a shaft, a reduction gearing carried by said motor and having a slow speed shaft extending at right angles to and on opposite sides of said motor shaft, positive and negative electrode heads, means coupling said slow speed shaft at one side of said motor shaft to one of said heads, and means coupling said slow speed shaft at the other side of said motor shaft to the other of said heads.

10. Arc apparatus for a reflector casing comprising the combination of a base plate, means for securing said plate in said reflector casing, a pair of spaced supports on said base, positive and negative heads at the top of said supports, a motor on said base between said supports, a reduction gearing for said motor and having a slow speed shaft, a positive electrode drive shaft extending between said positive head and said slow speed shaft, a bearing on said base, a negative electrode drive shaft extending between said negative head and said bearing, and stepping means operatively connecting said reduction gearing and said negative electrode drive shaft.

11. Arc apparatus comprising the combination of a base, an electrode head, an electrode drive shaft having a plurality of aligned sections arising from said base, a bearing on said base for each of said sections, a stepping device for that one of said sections which is adjacent said base, a connection between the other of said sections and said electrode head, a frictional coupling between said sections, a motor for operating said stepping device, and hand operating means for said section which is connected to said electrode head.

12. Arc apparatus comprising the combination of feed wheels, a scroll gear therefor and having a peripheral serrations, an adjustable screw engageable with said serrations, a cam follower for operating said screw and a cam for operating said cam follower, said cam being substantially a circle and arranged about a center abaxial with respect to said scroll gear, and a driving gear fixed to said cam and frictionally coupled to said scroll gear.

13. Arc apparatus comprising the combination of a support, a bed at the top of said support, a slide on said bed, a post on said slide, a positive head on said post, a depending flange on said slide, a negative head on said flange and having its axis arranged substantially at 50° from the axis of said positive head, a screw on said negative head for advancing the negative electrode, a gear on said screw, a negative electrode drive shaft having a gear meshing with said first mentioned gear and means rotatably supporting said gears behind said post.

14. Arc apparatus according to claim 13, comprising bearings on said negative head for both of said gears.

15. Arc apparatus comprising the combination of a slide, a post on said slide, a positive head on said post, a negative electrode drive shaft rotatably mounted in said slide, a depending flange on said slide, a negative head on said flange, a gear for said negative head, and a gear on said drive shaft above said slide and meshing with said first mentioned gear.

16. Arc apparatus comprising the combination of a slide having a horizontal portion and a depending portion, a positive head on said horizontal portion, and a negative head on said depending portion, a screw slidably mounted in said negative head, a negative electrode holder movable with said screw, a lever pivotally mounted on said negative head for reciprocating said screw, a base having a support for said slide, a strike coil on said base and having an armature, and a rod connecting said armature to said lever.

17. An arc apparatus unit movable for assembly purposes as a unit through the open end of a casing having a cylindrical wall, said unit comprising the combination of a slide, positive and negative electrode heads on said slide, a pair of upright columns spaced crosswise of the axis of said heads and terminating at their upper ends in a bed for supporting said slide, a base between the lower ends of said columns and secured thereto, a motor on said base, operative connections between said motor and said heads; and means for securing said unit inside of said casing.

18. An arc apparatus unit according to claim 17 comprising bosses inside of said wall, said means comprising means for securing said base on said bosses.

19. An arc apparatus unit movable for assembly purposes as a unit through the open end of a casing having a cylindrical wall, said unit comprising the combination of a slide, positive and negative electrode heads on said slide, a pair of upright columns spaced crosswise of the axis of said heads and terminating at their upper ends in a bed for supporting said slide, a base, means for securing the lower ends of said columns on said base, a motor on top of said base, operative connections between said motor and said heads; and means for securing said base adjacent to the inside of said wall.

20. Arc apparatus comprising the combination of a motor having a shaft, a reduction gearing coupled to said motor and having a slow speed shaft extending vertically at right angles to and on opposite sides of said motor shaft, positive and negative electrode heads, means coupling the upper end of said slow speed shaft at the upper side of said motor shaft to said positive head, stepping mechanism for driving said negative head; and means coupling the lower end of said slow speed shaft below said motor shaft to said stepping mechanism.

21. Arc apparatus comprising the combination of a support, a bed at the top of said support, a slide on said bed, a positive head on said slide and having an axis parallel thereto, a flange depending from said slide and integral therewith and extending substantially at 50° from said slide; and means on said depending flange for supporting a negative electrode for movement parallel to said depending flange.

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