Aug. 18, 1942. B. C. HASKIN ET AL 2,293,207

APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 1

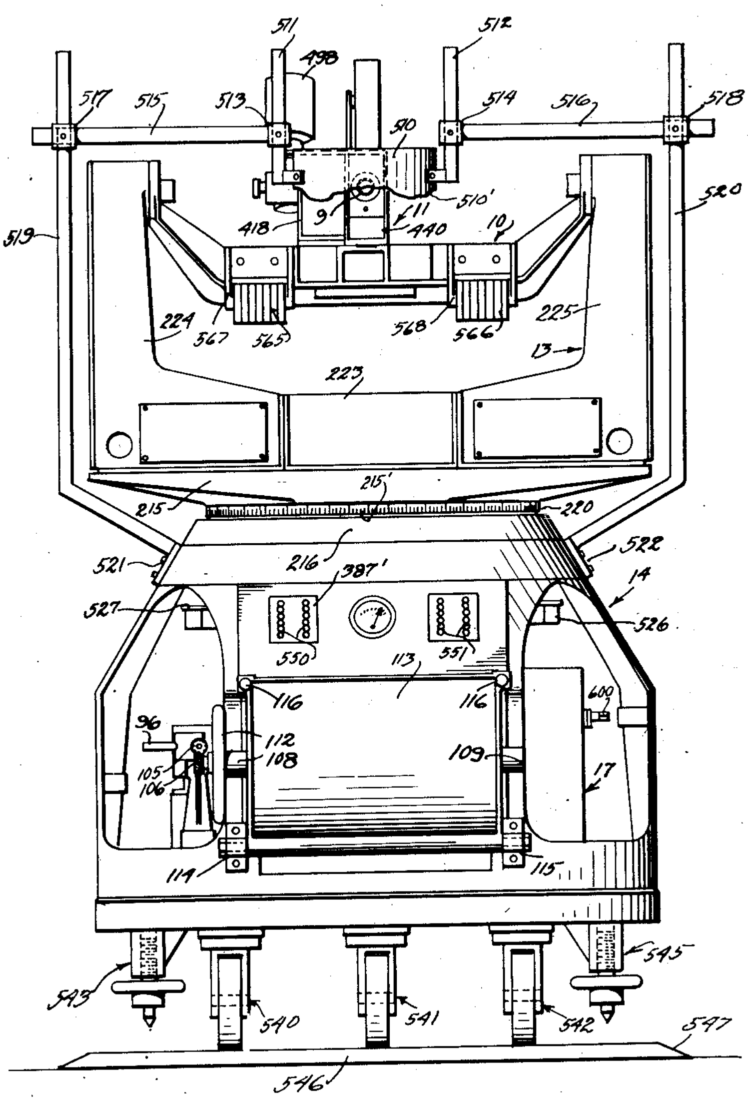

FIG.1.

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HERMAN C. MUHLBACH
WILLIAM F. ARNDT

BY W E Beatty
ATTORNEY.

APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 2

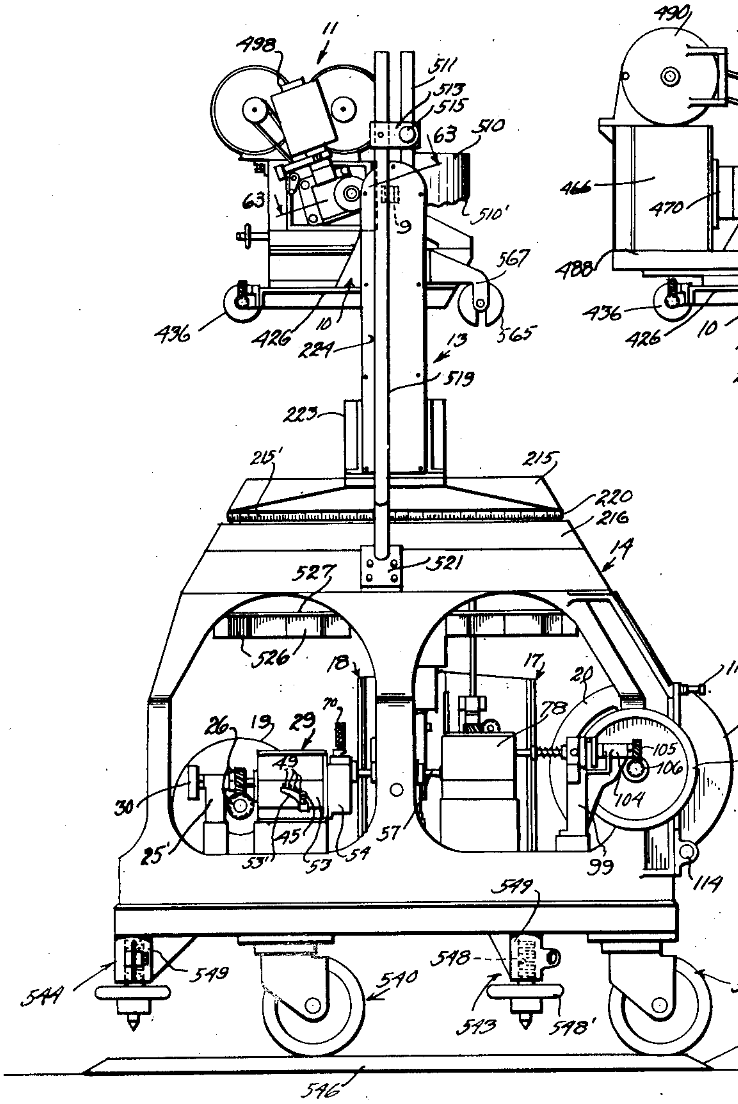

FIG. 2.

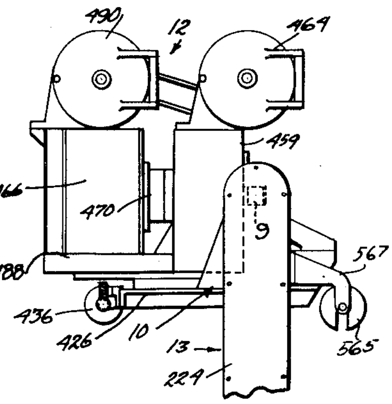

FIG. 3.

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 3

FIG.4.

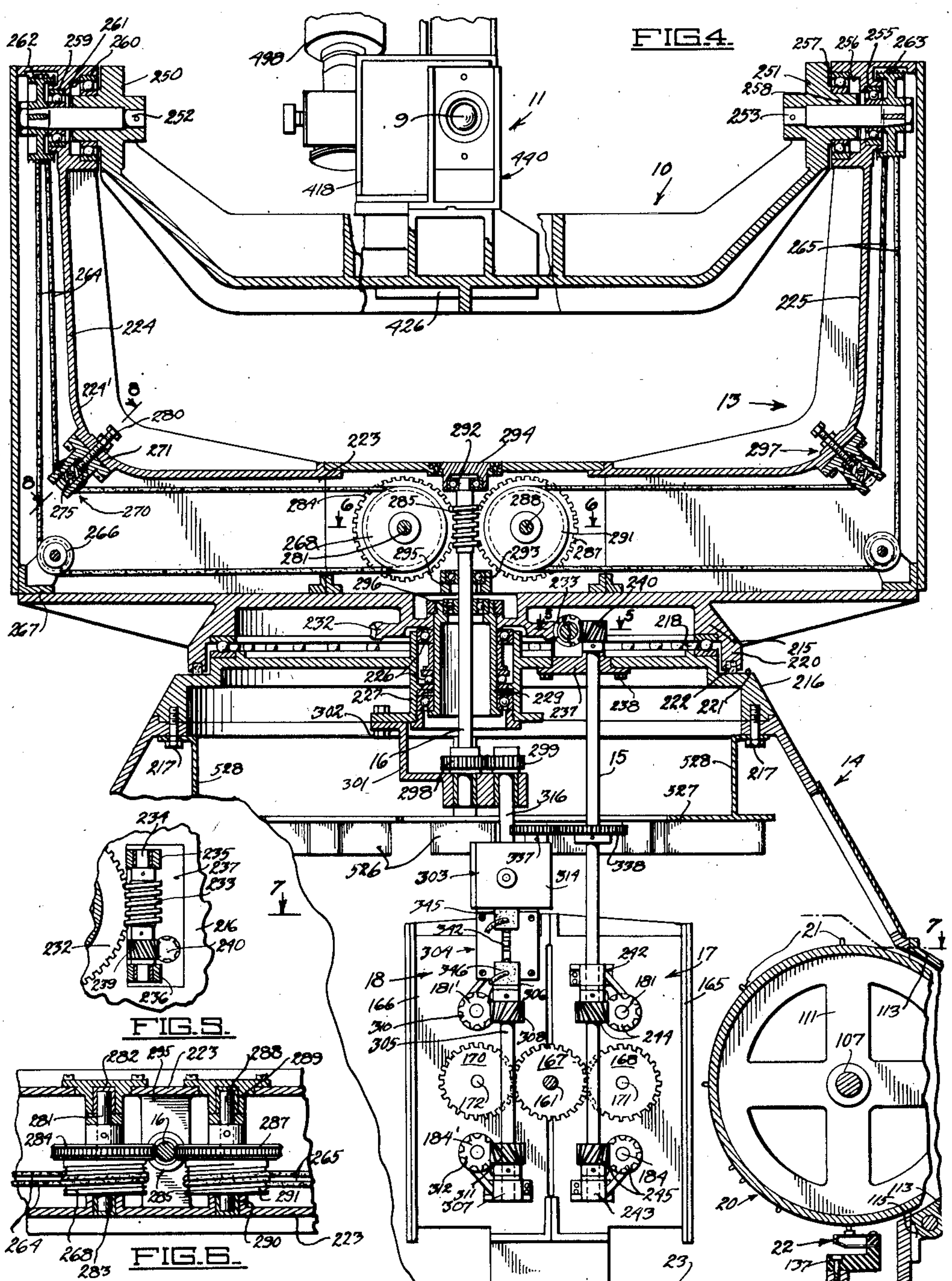

FIG.5.

FIG.6.

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 4

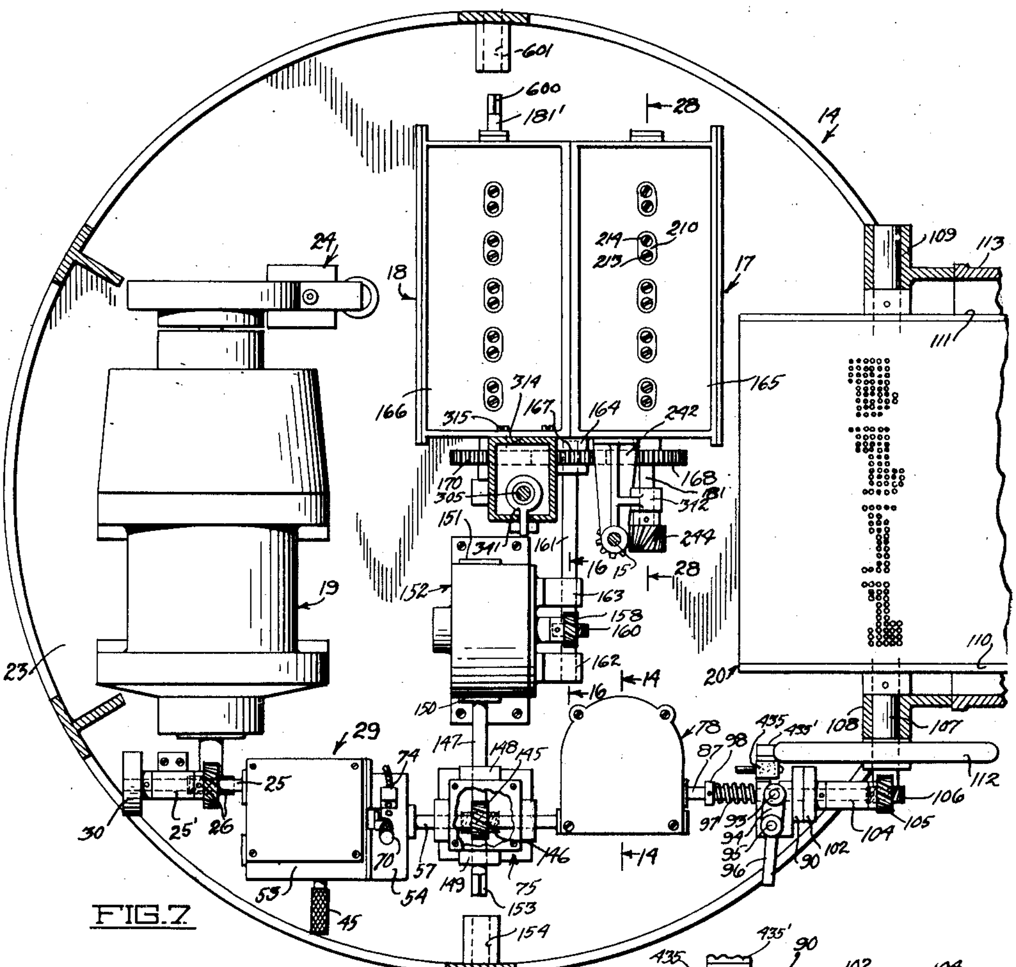

FIG. 7

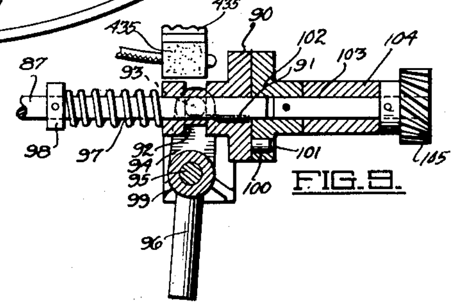

FIG. 9.

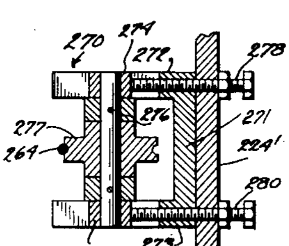

FIG. 8.

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 5

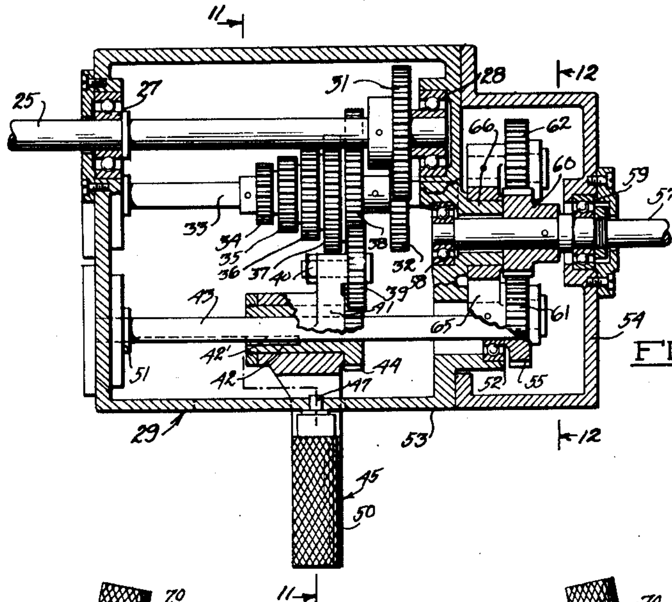

FIG.10.

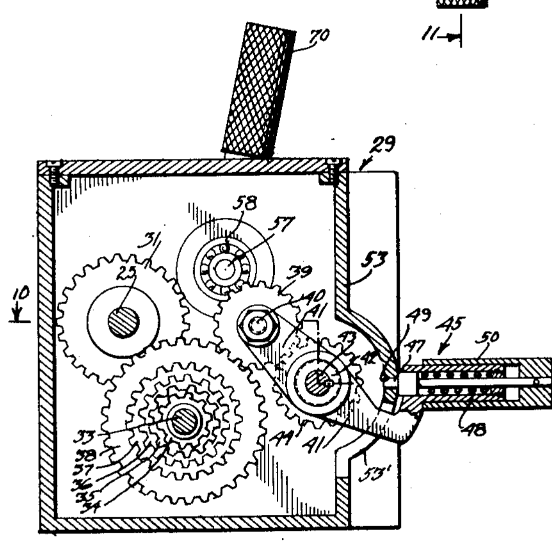

FIG.11.

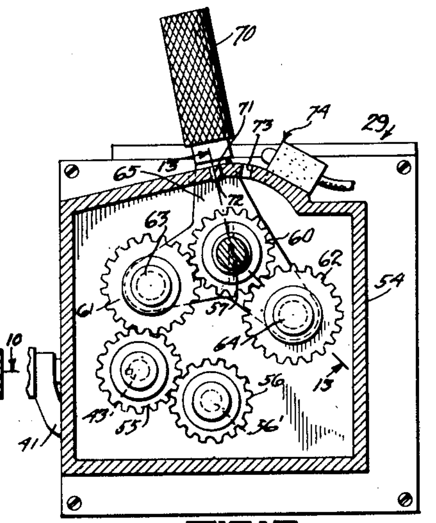

FIG.12.

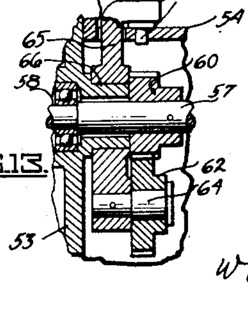

FIG.13.

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 6

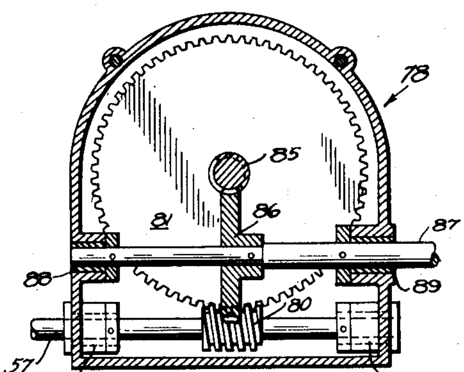

FIG.15.

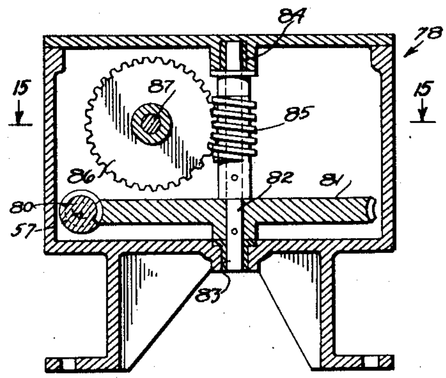

FIG.14.

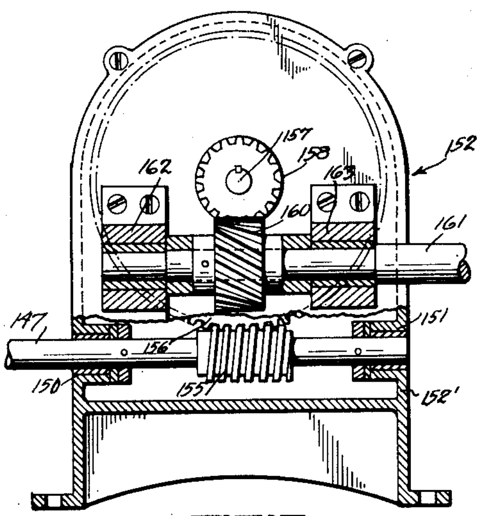

FIG.16.

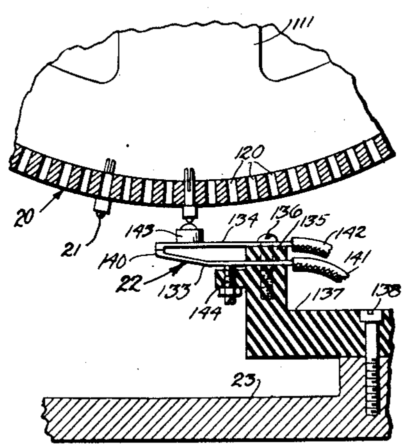

FIG.17.

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 7

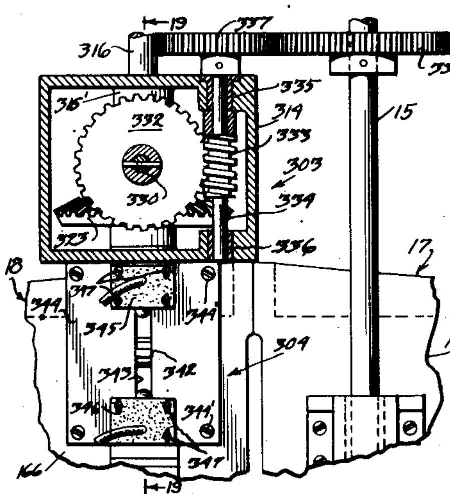

FIG.18.

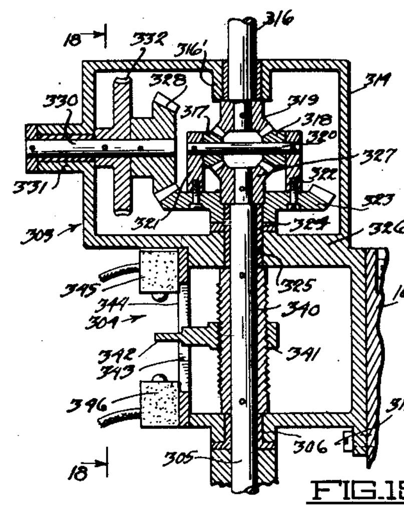

FIG.19.

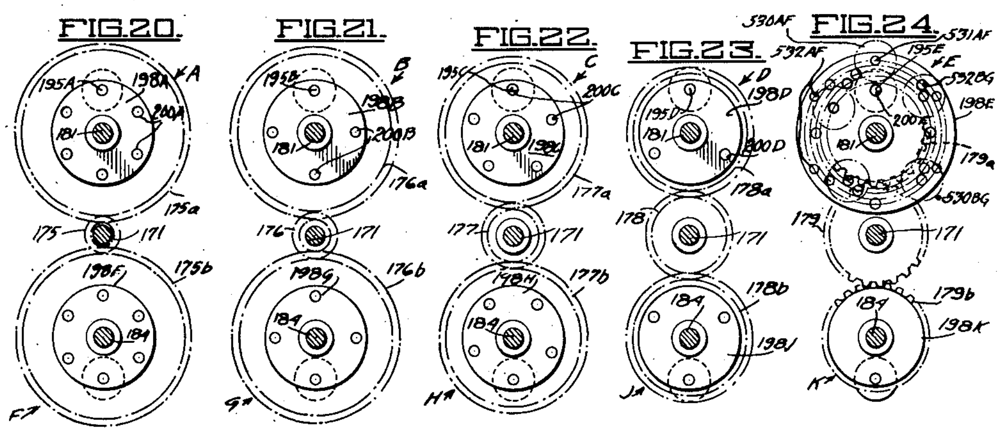

FIG.20. FIG.21. FIG.22. FIG.23. FIG.24.

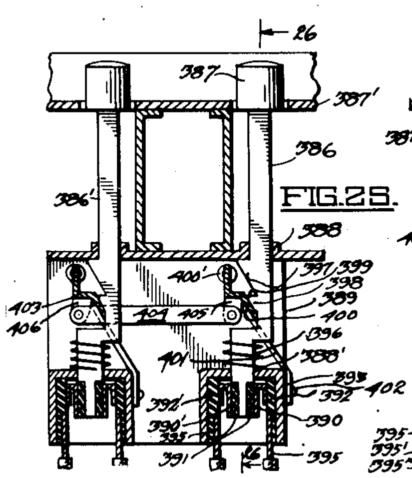

FIG.25.

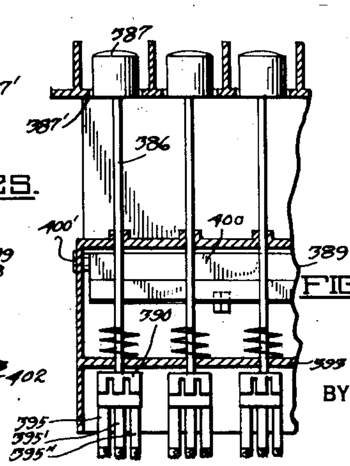

FIG.26.

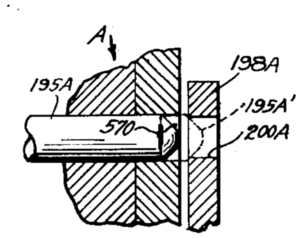

FIG.27.

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

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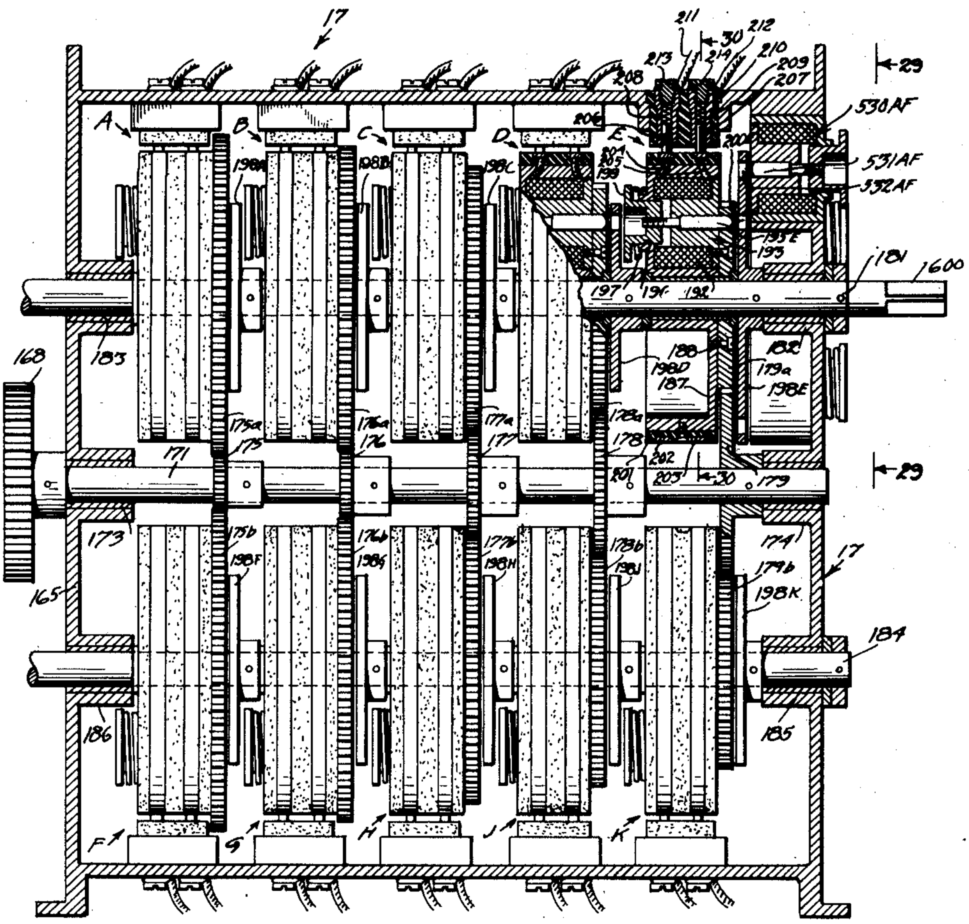

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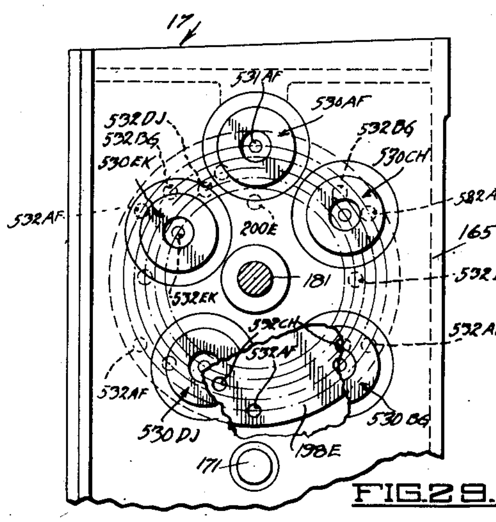

FIG. 29.

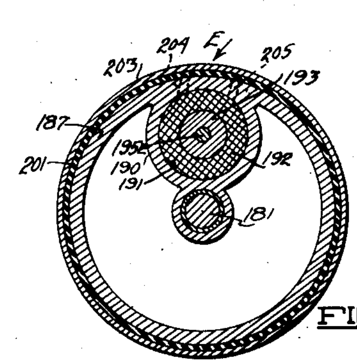

FIG. 30.

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 9

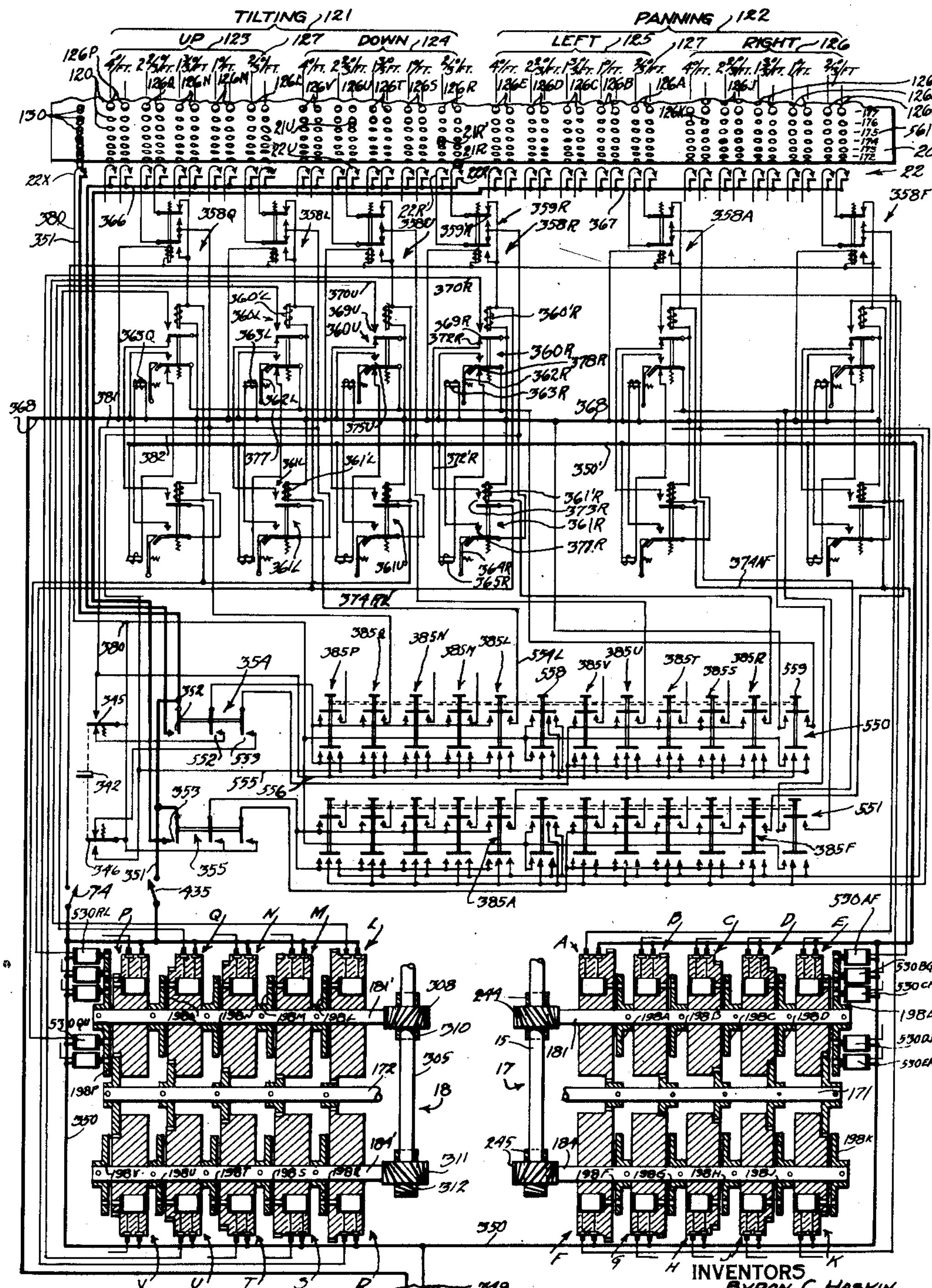

FIG. 31.

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 10

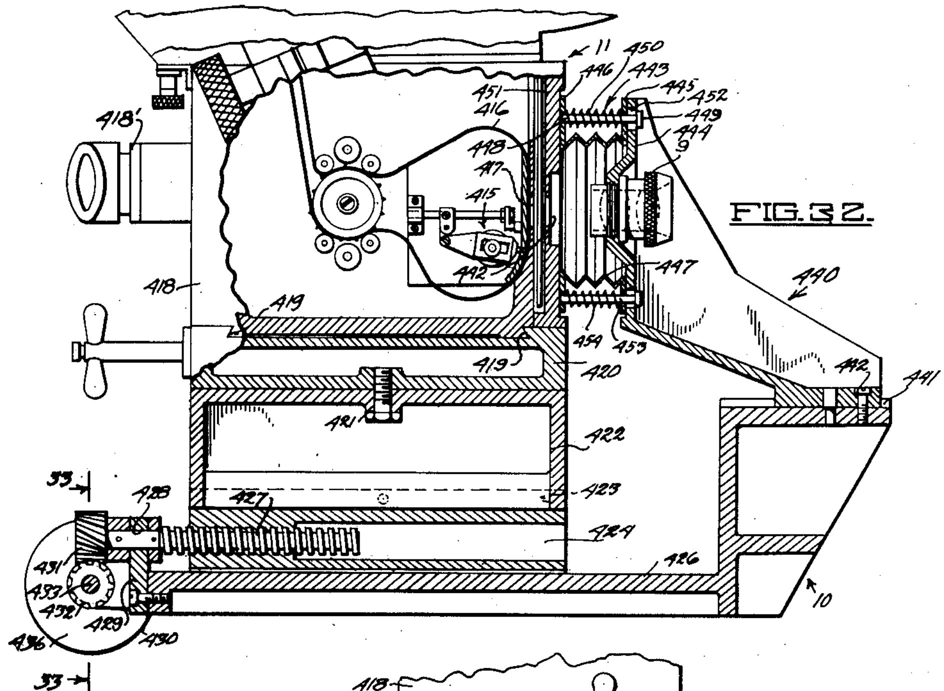

FIG. 32.

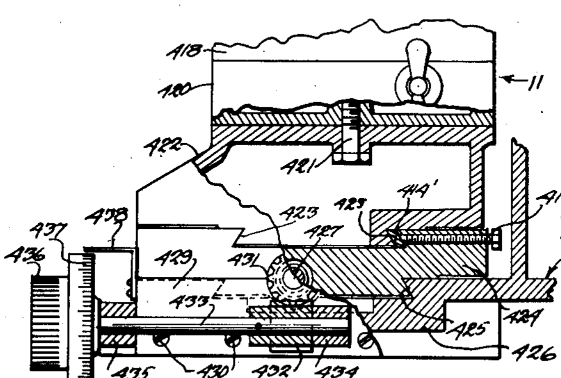

FIG. 33.

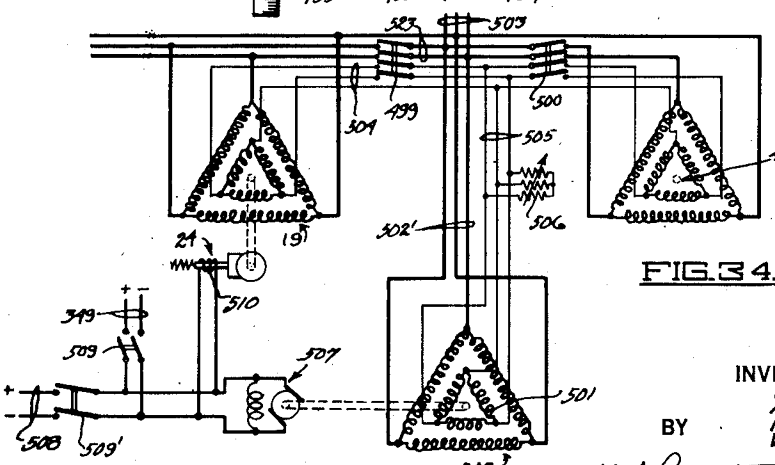

FIG. 34.

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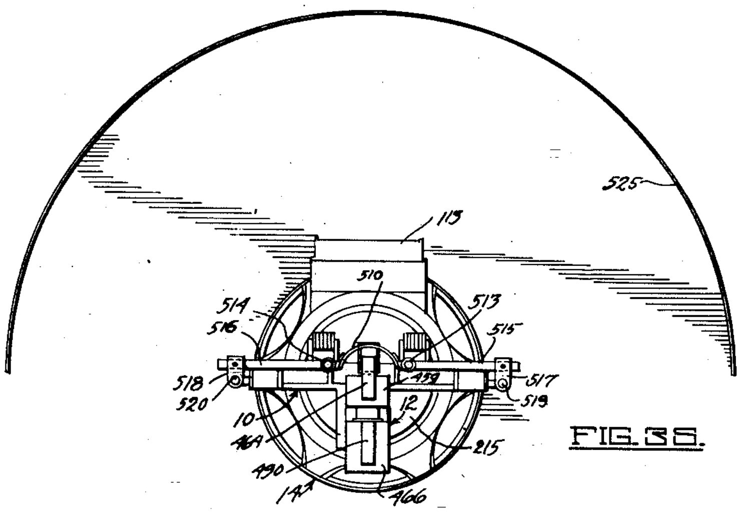
APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 11



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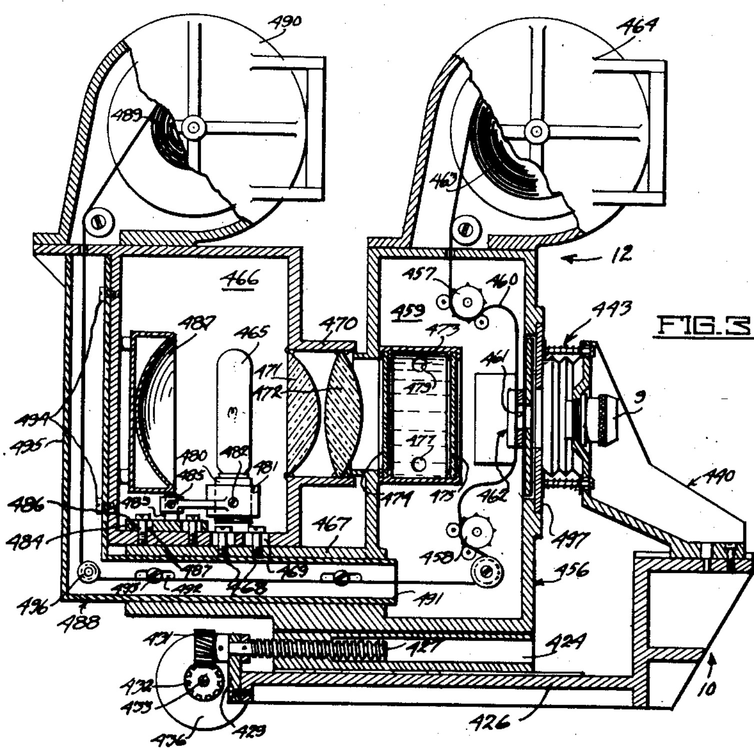

FIG. 36.

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W. L. Beatty ATTORNEY

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 12

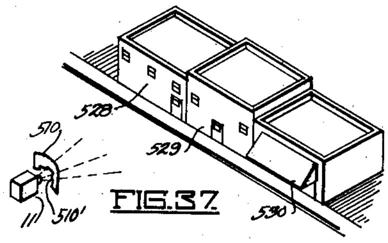


FIG. 37.

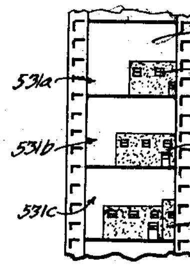
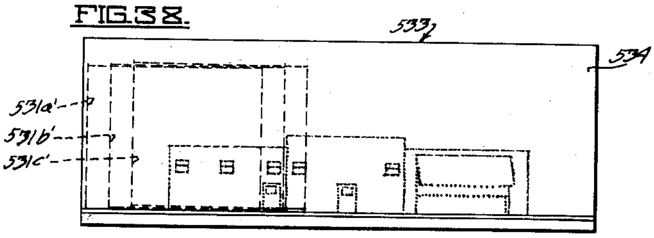


FIG. 40.

FIG. 38.



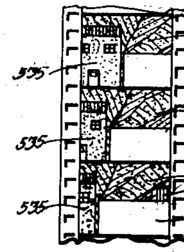


FIG. 41.

FIG. 39.

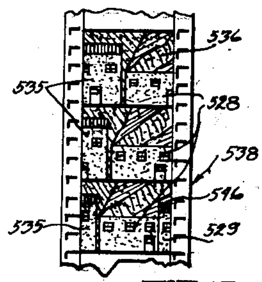


FIG. 42.

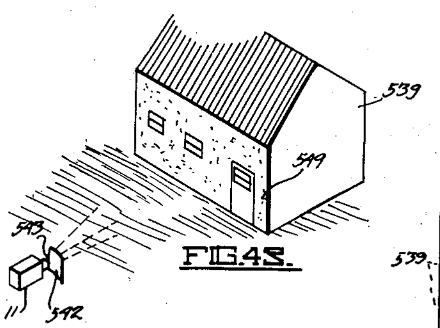


FIG. 43.

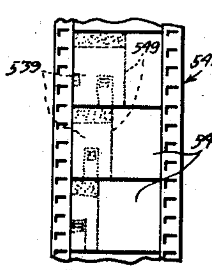


FIG. 45.

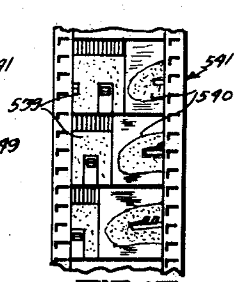


FIG. 46.

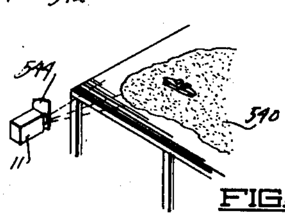


FIG. 44.

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Aug. 18, 1942. B. C. HASKIN ET AL 2,293,207

APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 13

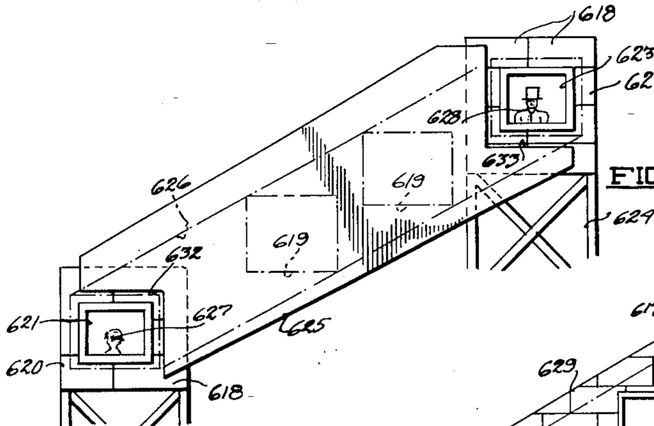

FIG. 47.

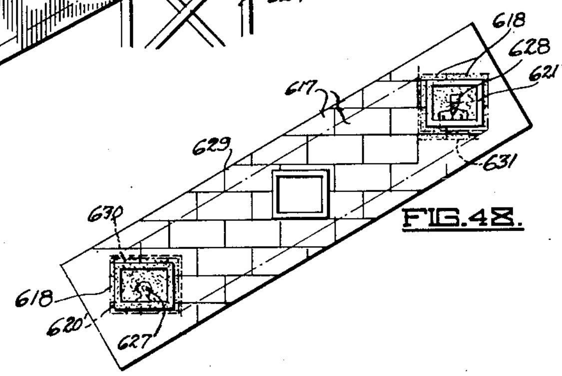

FIG. 48.

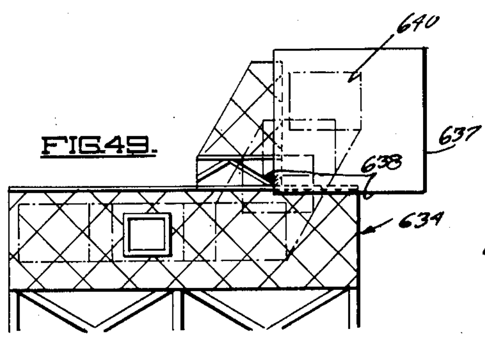

FIG. 49.

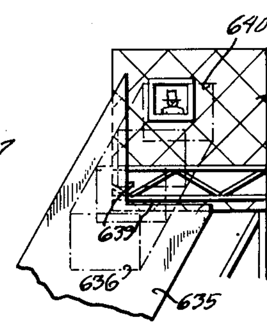

FIG. 50.

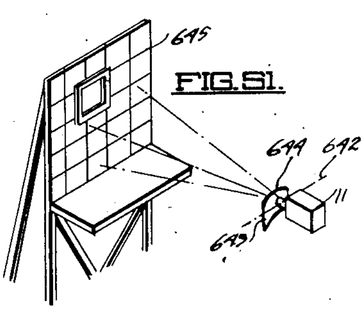

FIG. 51.

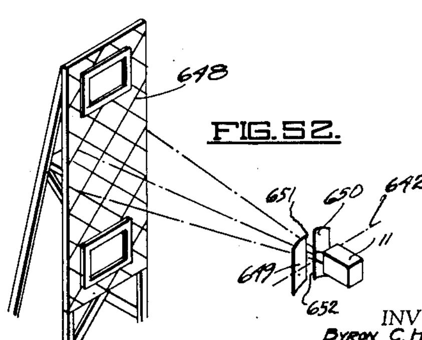

FIG. 52.

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 14

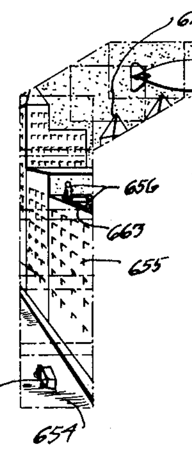
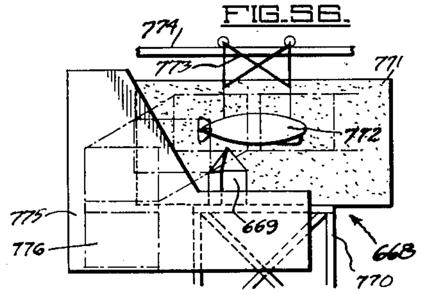


FIG. 53.

FIG. 56.



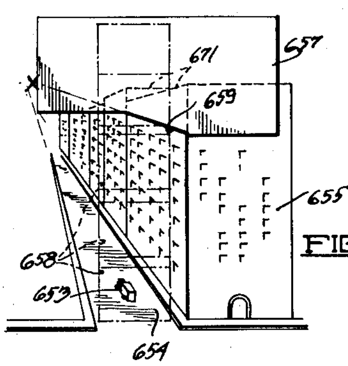


FIG. 54.

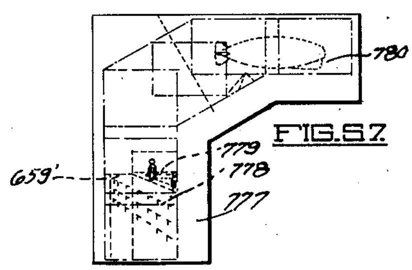


FIG. 57.

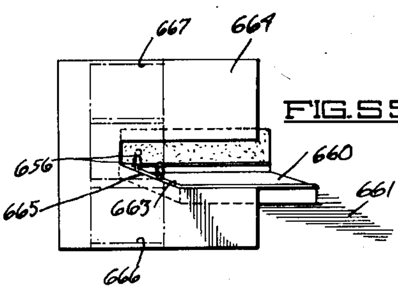


FIG. 55.

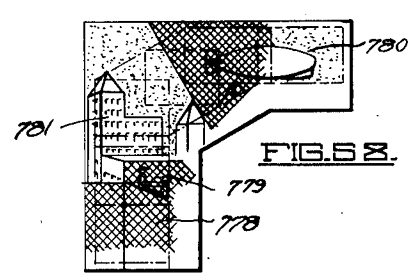


FIG. 58.

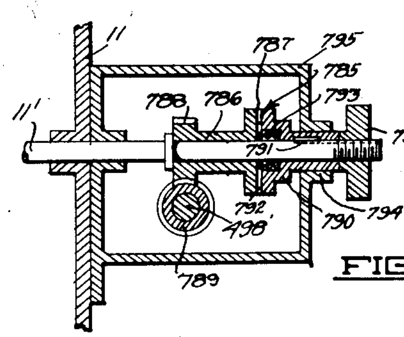


FIG. 63.

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APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Filed Aug. 25, 1939 15 Sheets-Sheet 15

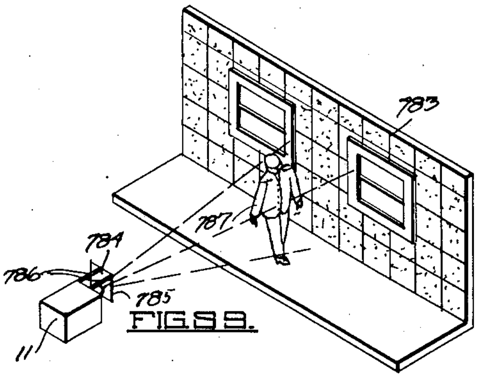

FIG. 59.

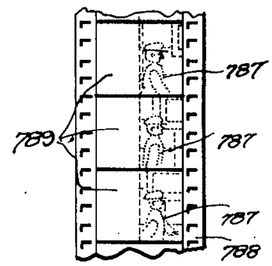

FIG. 60.

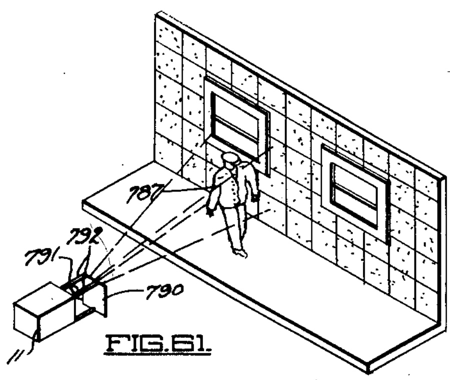

FIG. 61.

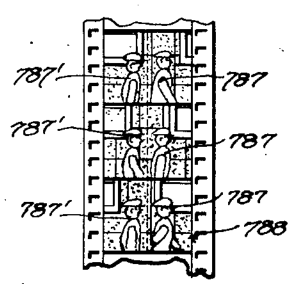

FIG. 62.

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Patented Aug. 18, 1942

2,293,207

UNITED STATES PATENT OFFICE

2,293,207

APPARATUS FOR PANNING AND/OR TILTING MOTION PICTURE APPARATUS

Byron C. Haskin and Albert W. Tondreau, Beverly Hills, and Herman C. Muhlbach and William Frederick Arndt, Los Angeles, Calif., assignors to Warner Bros. Pictures, Inc., New York, N. Y., a corporation of Delaware

Application August 25, 1939, Serial No. 291,884

37 Claims. (Cl. 88—16)

This invention relates to motion picture apparatus and has particular reference to apparatus for automatically or manually panning and/or tilting a camera, projector, or the like motion picture apparatus.

One object of the invention is to move a motion picture apparatus in a predetermined path.

A further object of the invention is to pan and/or tilt a motion picture apparatus in a predetermined path any number of times while insuring that the same field of view is presented to each successive film frame area during each traverse of the apparatus through that path.

Another object of the invention is to pan and/or tilt a motion picture apparatus at predetermined different speeds during predetermined portions of the path of movement thereof.

Another object of the invention is to selectively determine any one of a large number of paths of movement of a motion picture apparatus and thereafter automatically move the apparatus through that predetermined path.

Another object is to enable the use of a single motor for panning and/or tilting a motion picture apparatus in a predetermined manner.

Another object of the invention is to enable the same objective lens to be used for either a camera or a projector while supporting such camera or projector for movement about an axis passing through the center of the objective lens.

Another object of the invention is to remotely control a variable speed transmission device in a predetermined manner.

The invention has particular value in the production of split screen type of composite motion pictures wherein one component of a scene to be projected is first photographed while using a mask to mask off a certain area of the image of the scene on the negative film. While a different component of the scene is being photographed on the same or a different negative film in a subsequent operation, a mask complementary to the one previously used is employed to mask off the area of the image of the second component corresponding to the area already photographed. When the final composite film of the negative film or films is obtained, the two components of the scene portrayed thereon will appear to have been photographed at the same time and will appear to be photographed of a single unitary scene. This type of photographic operation enables one component of the scene to be an actual full size or miniature set while the other component is a painting or picture.

Heretofore, pictures of the above type have been obtainable only in cases where the camera has been held stationary during the photographic operation. The present invention enables split screen "shots" of the above type to be made during panning and/or tilting of the camera whereby to increase the dramatic effect of the scene being photographed.

The manner in which the above and other objects of the invention are accomplished will be readily understood on reference to the following specification read in conjunction with the accompanying drawings wherein:

Fig. 1 is a front view of the panning and tilting apparatus for panning and/or tilting a motion picture camera or projector in a predetermined path of movement and embodying the present invention, this view showing a camera being supported by the apparatus.

Fig. 2 is a side view of the apparatus illustrated in Fig. 1.

Fig. 3 is a side view of the upper part only of the apparatus, as illustrated in Fig. 2, showing a projector supported thereby.

Fig. 4 is a sectional elevational view, partly broken away, of the panning and tilting apparatus.

Fig. 5 is a fragmentary sectional plan view of part of the panning drive and is taken along the line 5—5 of Fig. 4.

Fig. 6 is a sectional plan view of part of the cable drive and is taken along the line 6—6 of Fig. 4.

Fig. 7 is a sectional plan view through the base of the panning and tilting apparatus and is taken substantially along the line 7—7 of Fig. 4.

Fig. 8 is a sectional view through one of the cable tensioning adjustments and is taken along the line 8—8 of Fig. 4.

Fig. 9 is a sectional view through the clutch for coupling the control drum to the motor drive.

Fig. 10 is a sectional view through the main speed transmission and reversing mechanism and is taken along the line 10—10 of Fig. 11.

Fig. 11 is a transverse sectional view through the speed transmission and is taken along the line 11—11 of Fig. 10.

Fig. 12 is a transverse sectional view through the reversing mechanism and is taken along the line 12—12 of Fig. 10.

Fig. 13 is a fragmentary sectional view through the reversing mechanism and is taken along the line 13—13 of Fig. 12.

Fig. 14 is a sectional view through one of the speed reduction units for driving the control drum at a reduced speed and is taken along the line 14—14 of Fig. 7.

Fig. 15 is a sectional plan view through the speed reduction unit of Fig. 14 and is taken along the line 15—15 of that figure.

Fig. 16 is an elevational view, partly in section, of another speed reduction unit for driving the panning and tilting change speed transmissions and is taken along the line of 16—16 of Fig. 7.

Fig. 17 is a fragmentary sectional view through the control drum and one of a bank of switches operated thereby.

Fig. 18 is a view, partly in section, of the differential drive and tilt limit switch mechanism and is taken along the line 18—18 of Fig. 19.

Fig. 19 is a sectional elevational view taken along the line 19—19 of Fig. 18.

Figs. 20 to 24, inclusive, are diagrammatic views of different sections of one of the remotely controlled speed change gear transmissions for controlling the panning and tilting movement of the apparatus.

Fig. 25 is a sectional view of one bank of manually operated switches for controlling the operation of one of the panning and tilting change speed transmissions.

Fig. 26 is a transverse sectional view, with parts broken away, through the bank of switches illustrated in Fig. 25 and is taken along the line 26—26 of that figure.

Fig. 27 is a fragmentary sectional view illustrating the non-positive operation of one of the driving or stopping plungers and the disc engaged thereby, incorporated in the panning and tilting change speed transmissions.

Fig. 28 is a sectional view of the panning change speed transmission and is taken along the line 28—28 of Fig. 7.

Fig. 29 is a rear view of the change speed transmission shown in Fig. 28, and is taken along the line 29—29 of that figure.

Fig. 30 is a sectional view through one of the drive units of the panning change speed transmission and is taken along the line 30—30 of Fig. 28.

Fig. 31 is a schematic circuit diagram illustrating the relays and circuit connections therefor for the manual and automatic remote control of the panning and tilting change speed transmissions.

Fig. 32 is a transverse, sectional view through the cradle and a motion picture camera supported thereby.

Fig. 33 is a sectional view through part of the focusing adjustment for a motion picture camera or projector and is taken along the line 33—33 of Fig. 32.

Fig. 34 is a schematic circuit diagram of the motor system and controls therefor.

Fig. 35 is a plan view of the panning and tilting apparatus with a projector thereon for projecting a picture on a sensitized surface.

Fig. 36 is a sectional elevational view of a projector supported on the cradle.

Figs. 37 to 42, inclusive, illustrate a method involving the use of the apparatus of this invention for obtaining a pan shot from a physical set to a painting. Fig. 37 is a perspective view of the physical set and camera arranged in front thereof. Fig. 38 is a front view of a sensitized sheet of paper having a latent image of the set shown in Fig. 37 impressed thereon. Fig. 39 is a front view of the sheet of Fig. 38 after being developed and with a supplementary painting or drawing formed thereon. Figs. 40, 41 and 42 are fragmentary portions of motion picture films obtained during different steps in the process of forming the composite picture.

Figs. 43 to 46, inclusive, illustrate a method of using the apparatus of this invention to obtain a composite picture involving panning from a full sized set to a miniature set. Fig. 43 illustrates a full sized set and camera arranged in front thereof for panning movement thereacross. Fig. 44 illustrates a miniature set and camera arranged in front thereof for panning movement thereacross. Figs. 45 and 46 are fragmentary portions of a motion picture film showing photographic images produced thereon in the course of this method.

Figs. 47 and 48 illustrate a method of using the apparatus of this invention for panning and tilting from one full sized set to another while supplying in a separate step a painting, or the like, supplementary to and conjoining said full sized sets.

Figs. 49 and 50 illustrate a method involving the use of the apparatus of this invention for panning and tilting from a full sized set to a miniature set, or the like.

Figs. 51 and 52 illustrate two different methods of using the apparatus of this invention for obtaining tilt shots without panning.

Figs. 53 to 58, inclusive, illustrate a method involving the use of the apparatus of this invention for obtaining a composite shot which includes pan and tilt movement separately and in combination and wherein the composite shot involves a full sized scene involving action, a supplementary full sized set involving action, a miniature set involving action and a painting or drawing supplementing the full sized set.

Figs. 59 to 62 illustrate the use of the apparatus of this invention in combination with a matt movable with the camera for obtaining double exposure shots.

Fig. 63 is a sectional view of the camera motor adapter and clutch and is taken along the line 63—63 of Fig. 2.

General assembly

Referring to Figs. 1, 2, 3, 4 and 7 in particular, the panning and tilting apparatus comprises, in general, a cradle 10 adapted to support either a motion picture camera, generally indicated at 11 (Figs. 1 and 2) or a motion picture projector, generally indicated at 12 (Fig. 3). The cradle 10 is rotatably mounted in a yoked support 13 for movement about a horizontal axis intersecting the nodal point of emergence of the objective lens 9 for either the camera 11 or the projector 12. Support 13 is movable about a vertical pan axis on a base generally indicated at 14, the vertical pan axis also intersecting the nodal point of emergence of the lens 9. The cradle 10 and support 13 comprise a power head for movably supporting the camera 11 or projector 12.

A "pan" shaft 15 for causing a panning movement of the apparatus and a tilt shaft 16 for causing a tilting movement of the apparatus in a manner described hereinafter are driven through change speed transmissions 17 and 18, respectively, by a single motor 19.

A control drum 20, rotatably mounted in the base 14, is also driven by the motor 19 at a constant speed and has an array of holes therein into which pins are adapted to be set in a predetermined order depending on the particular path of movement and speed of movement to be imparted to the camera or projector. These various pins, as at 21 (Fig. 4), operate a bank of switches generally indicated at 22 (Fig. 17) which remotely control the operation of the change speed transmission 17 and 18 so as to cause the apparatus to pan and tilt the camera 11 or projector 12 in a manner determined by the positions of the various pins 21 on the control drum 20.

Main drive

The motor 19 is supported upon the floor 23 (Fig. 7) of the base 14 and is adapted to be stopped against rotation by a brake, generally indicated at 24, of the electro-magnetic type, well known in the art, which brakes the motor 19 when no current is passed through the energizing coil thereof. The motor 19 drives a transversely extending spindle 25 through a pair of spiral gears 26. Spindle 25 is journalled in a bearing 25' mounted on a bracket extending from the floor 23 and is also journalled in bearings 27 and 28 formed in the walls of a combined speed change and reversing mechanism, generally indicated at 29, (Figs. 10 to 13, inclusive). Mechanism 29 is mounted on the floor 23 of base 14. A hand wheel 30 (Fig. 7) is provided on the end of spindle 25 to enable manual rotation of spindle 25 when desired.

Referring to Figs. 10 and 11, a gear 31 fixed on spindle 25 meshes with a similar gear 32 secured on a counter shaft 33, journalled in bearings formed in the casing 53 of the change speed mechanism 29. Shaft 33 has secured thereon a number of drive gears 34, 35, 36, 37 and 38 of progressively increasing diameters, any of which is adapted to mesh with a tumbler gear 39 rotatably mounted on a stub shaft 40 mounted on the end of a tumbler lever 41. Lever 41 is journalled on a gear sleeve 42, slidably keyed at 42' to a shaft 43, and having formed thereon a gear 44 in constant mesh with the tumbler gear 39. A handle 45 forming part of the tumbler lever 41 extends through an opening 53' of the casing 53 of the mechanism 29 and is adapted, when moved, to position the tumbler gear 39 in mesh with any of the various drive gears 34 to 38, inclusive, whereby to drive the shaft 43 at different speeds.

The handle 45 comprises a plunger 47 (Fig. 11) pressed inwardly by a compression spring 48 into one of a series of apertures 49 formed in the outer wall of casing 53. An outer sleeve 50 is secured to the end of plunger 47 to cause the same to be retracted when the sleeve 50 is drawn outwardly. By retracting the sleeve 50 and moving the handle 45 sideways, the gear sleeve 42 may be slid longitudinally along the shaft 43 to align and mesh the tumbler gear 39 with any desired one of the drive gears 34 to 38, inclusive, to thereby drive the apparatus at a desired speed. The plunger 48 is then allowed to be pressed inwardly by the spring 48 into a corresponding one of the apertures 49 to lock the tumbler gear 39 in mesh with the corresponding drive gear.

Referring now to Figs. 10, 12 and 13, the shaft 43 is journalled in bearings 51 and 52 provided in the opposite walls of casing 53 and extends into a reversing gear housing 54 suitably secured to the transmission housing 53. A drive gear 55 secured on the end of shaft 43 within the housing 54 is in constant mesh with an idler gear 56 journalled on a stub shaft 56' secured to the wall of the housing 53.

A shaft 57 is journalled in a bearing 58 provided in the wall of housing 53 and in a second bearing 59 provided in the wall of the housing 54. A gear 60 secured on shaft 57 within the housing 54 remains in constant mesh with a pair of idler gears 61 and 62 journalled on stub shafts 63 and 64, respectively, provided on the forked ends of a reversing lever 65. Lever 65 is journalled on annular shoulder 66 (Figs. 10 and 13) extending outwardly from the wall of housing 53 to form a bearing which surrounds the shaft 57. The lever 65 extends through an aperture 68 formed in the top wall of housing 54 and has a handle 70 secured thereto, similar to that of 45, for shifting the lever 65 back and forth.

Handle 70 has a spring pressed plunger 71 therein adapted to fit into either of a pair of holes 72 and 73 (Fig. 12). When the handle 70 is moved into the position shown in Fig. 12 to engage plunger 71 with hole 72, the idler gear 61 will be brought into mesh with the drive gear 55 to transmit rotation to the shaft 57 in a "forward" direction. When the handle 70 is moved to the right to engage the plunger 71 in the hole 73, the idler gear 62 will be brought into mesh with the idler gear 56. Due to the fact that the gear train is now increased by one, the shaft 57 will be rotated in a "reverse" direction. In the "reverse" position of the lever 65, the handle 70 engages and closes the contacts of a switch 74, the operation of which will be described hereinafter.

Control drum drive

The drive shaft 57 extends through a gear box 75, also mounted on the floor 23 of the base 14, and is journalled in bearings 76 and 77 formed in the casing of a speed reduction unit generally indicated at 78 (Figs. 7, 14 and 15) for driving the control drum 20 at a reduced speed. A worm 80 fixed on the shaft 57 in the casing of unit 78 meshes with a worm wheel 81 fixed on the lower end of a vertical stub shaft 82 journalled in bearings 83 and 84 formed in the top and bottom walls, respectively, of the casing. A worm 85, also fixed to the vertical shaft 82, meshes with a worm wheel 86 fixed on a horizontal shaft 87 which is journalled in bearings 88 and 89 of the casing. The casing of the speed reduction unit 78 is supported from the floor 23.

Referring to Figs. 7 and 9, the shaft 87 extends outside of the unit 78 and is journaled in a bearing formed in a driven clutch member 102. A clutch member 90 is slidably keyed at 91 to the shaft 87 for movement longitudinally therealong and has a circumferential groove 92 formed thereon and engaged by diametrically opposed clutch dogs 93 carried in the opposite legs of a bifurcated clutch shifting lever 94. Lever 94 is pivotally mounted on a vertical shaft 95 extending from a bracket 99 (Fig. 2) projecting from the floor 23 and is provided with a handle 96 whereby the clutch plate 90 may be moved longitudinally along the shaft 87 against the action of a compression spring 97, one end of which abuts a sleeve 98 fixed to shaft 87. Clutch plate 90 has a single pin 100 extending therefrom and engageable in an aperture 101 formed in the driven clutch plate 102. Clutch plate 102 is fixed to the end of a stub shaft 103 journalled in a bearing 104 forming part of bracket 99 and has a spiral gear 105 secured to the end thereof which meshes with a similar spiral gear 106 fixed to the end of a drum shaft 107 supporting the drum 20 for rotation. Shaft 107 is journalled in bearings 108 and 109 formed in the base member 14 and has the hubs 110 and 111 of drum 20 secured thereto.

When the handle 96 is moved counter-clockwise to disengage the pin 100 from the aperture 101 in the driven clutch plate 102, the control drum 20 is free to be rotated independently of the motor drive therefor to enable the various pins 21 to be set or removed. A hand wheel 112 secured to the drum shaft 107 is provided for this purpose.

The drum 20 is normally covered for protection by means of a cover 113 hinged to the base 14 at 114 and 115 (Figs. 1 and 2) and normally secured in closed position by suitable locking screws 116. When it is desired to change the various pins 21 (Figs. 4 and 17) the cover 113 may be removed from its closed position enabling access to the surface of the control drum 20.

Control drum and switches controlled thereby

Referring in particular to the schematic Fig. 31, the control drum 20 has formed on the circumference thereof, a plurality of equi-spaced horizontally extending rows 120 of holes extending over the entire area of the drum. These various holes are also aligned in columns circumferentially around the drum 20. Each of these rows 120 of holes is divided into two main groups; one group 121 for receiving pins for the purpose of controlling the tilting movement of the apparatus and the other group 122 for receiving pins for the purpose of controlling the panning movement of the apparatus. The tilting group 121 is divided into two sub-groups of holes; one subgroup 123 for controlling the tilting movement upwardly, and the other sub-group 124 for controlling the tilting movement of the apparatus downwardly. Likewise, the panning group 122 is divided into two sub-groups, one sub-group 125 for controlling the leftward panning movement of the apparatus, and the other sub-group 126 for controlling the rightward panning movement of the apparatus.

Each of the sub-groups of holes 123, 124, 125 and 126 is divided into five sets of pairs as at 126A, 126B, 126C, etc., each of these pairs being aligned in a circumferential extending column for controlling the movement of the apparatus in a particular direction and at a particular speed which is noted (as at 127) directly above each pair. The speed notations are calibrated in degrees of turning movement of the apparatus (about the pan or tilt axis) per foot of film traversed through the camera or projector, assuming that the change speed mechanism 29 is set for a certain standard speed. Thus, the column of holes 126A enables control (when pins are provided therein) of a certain driving mechanism or unit A (to be described hereinafter) in the speed transmission unit 17 to pan the camera or projector leftwardly, at a rate of speed of ⅔° for each foot of film, about the vertical pan axis. Likewise, for example, the column of holes 126L enables control of the driving unit L to tilt the apparatus upwardly at a tilting speed of ⅔° per foot of film about the horizontal tilt axis. Similarly, for example, the column of holes 126R enables control of the driving unit R to tilt the apparatus downwardly at a tilting speed of ⅔° per foot of film.

A circumferential row of permanently positioned pins 130 are positioned around the circumference of the drum 20 and in alignment with the various horizontal rows 120 of holes therein to intermittently operate a switch 22X, in the bank of aligned switches 22, at equi-timed intervals for the purpose of manual control of the apparatus in a manner described hereinafter.

A pin, when placed in a right hand hold in one of the circumferential columns 126A, 126B, etc. of holes, causes (when this pin closes the respective one of the bank of switches 22) the respective drive unit A, B, etc., to be energized to start the apparatus in the corresponding direction and at the corresponding speed noted at 127 for this particular column.

Likewise, a pin, when placed in a left hand hole in one of the circumferential columns 126A, 126B, etc. of holes, causes (when this pin closes the respective one of the bank of switches 22) the respective drive unit A, B, etc., to be disengaged, assuming that this respective unit has been previously energized, thereby discontinuing movement of the apparatus in that particular direction and at that particular speed.

Referring to Figs. 4, 17 and 31, one of the bank of switches 22 is provided in alignment with a different one of the circumferentially extending rows of holes in drum 20. Each of these switches comprises a flexible but stationary contact spring arm 133 and a flexible movable contact spring arm 134 separated by an insulated spacer 135 and secured by a screw 136 to an insulated block 137, which is secured by a screw 138 to the floor 23. Screw 136, however, does not contact the spring arm 133. The contact points 140 of the contact arms 133 and 134 are normally apart but are moved into contact to close a circuit between conductors as at 141 and 142 connected to the contact arms 133 and 134, respectively, when one of the pins (21) engages a button 143 provided on the upper contact arm 134. Button 143 is preferably either of insulating material or is suitably insulated from the spring arm 134. A set screw 144 threaded in a projection formed on the block 137 abuts the stationary arm 133 and, when adjusted, adjusts the position of the respective one of the contact points 140. From the above, it will be readily understood that as the drum 20 is rotated, different ones of the aligned switches in the bank 22 will be momentarily closed in a predetermined order according to the positioning of the various pins (21) in the array of holes in drum 20.

The spacing of the various horizontal rows 120 of holes and the arrangement of the gear train for rotating drum 20 are such that drum 20 is rotated a distance equal to the spacing between two successive rows 120 of holes for each foot of film traversed when mechanism 29 is set for the hereinbefore described standard speed. Thus it will be seen that different ones of switches 22 may be operated at the end of each foot of travel of the film or at the end of a film travel equal to a multiple of one foot.

Panning and tilting drive

Referring in particular to Figs. 4, 7 and 16, the gear box 75 has a spiral gear 145 therein secured on the drive shaft 57 which meshes with a similar spiral gear 146 secured on a shaft 147 for driving both the panning and tilting mechanisms 17 and 18, respectively. Shaft 147 is journalled at one end thereof in bearings 148 and 149 formed in the casing of the gear box 75 and is journalled at the other end in bearings 150 and 151 formed in the casing 152′ of a gear reduction unit 152, supported from the floor 23. The end 153 of shaft 147 has a square shank formed therein whereby it may be rotated manually by a suitable crank (not shown) extending through an aperture 154 formed in the base 14 co-axial with shaft 147. Thus, it will be seen that the shaft 147, and, consequently, the entire apparatus, may be driven manually as well as by the motor 19.

A worm 155 (Fig. 16) is secured on the shaft 147 within the casing 152′ and meshes with a worm wheel 156 secured on a shaft 157 journalled in bearings provided in the casing 152′. A spiral gear 158 is secured on the end of shaft 157, extending outside of the casing 152′, and meshes with a similar gear 160 secured on a shaft 161 journalled in outboard bearings 162 and 163 secured on the face of the gear casing 152′. Shaft 161 is journalled at the other end thereof in a bearing 164 supported by the casings 165 and 166 of the change speed transmissions 17 and 18, respectively. A gear 167 secured on shaft 161 meshes with gears 168 and 170 secured on the ends of drive shafts 171 and 172, respectively, forming the driving means for the change speed mechanisms 17 and 18, respectively.

Panning and tilting change speed mechanisms

The change speed mechanisms 17 and 18 are identical with each other and, for the sake of brevity, only one (17) will be described in detail.

Referring to Figs. 28, 29 and 30, shaft 171 is journalled in bearings 173 and 174 formed in the end walls of the casing 165 and has a set of drive gears 175, 176, 177, 178, and 179 of progressively increasing pitch diameters secured in spaced relation with each other thereon. These gears mesh with driven gears 175*a*, 176*a*, 177*a*, 178*a* and 179*a*, respectively, forming part of individual upper drive members or units A, B, C, D and E, respectively. These various units are all independently journalled on an upper shaft 181, which in turn, is journalled in bearings 182 and 183 formed in the end walls of casing 165.

The various drive gears 175 to 179, inclusive, also mesh with driven gears 175*b*, 176*b*, 177*b*, 178*b*, and 179*b*, respectively, forming part of individual lower drive units F, G, H, J, and K, respectively. These last mentioned units are all independently journalled on a lower shaft 184 which, in turn, is journalled in bearings 185 and 186 provided in the end walls of casing 165.

All of the drive members or units A to K, inclusive, are identical with each other and therefore only one (the one E connected to gear 179*a*) will be described in detail.

Referring to Figs. 28 and 30, the drive unit E comprises an annular drum 187 journalled on the shaft 181 and secured by screws 188 to the respective gear 179*a*. The drum 187 has a projection 190 (Fig. 30) thereon forming a cup or socket 191 therein to receive the energizing coil 192 of a solenoid assembly. A cap member 193 threadably secured in the cup 191 holds the coil 192 in place and has a sliding bearing aperture formed centrally therein to receive and slidably guide a plunger 195E. Plunger 195E is threadably secured to a cup shaped armature 199 at one end thereof. Armature 199 is slidably fitted in a bearing 196 formed in the drum 187 and is movable against the action of a compression spring 197 interposed between armature 199 and the drum 187, on energization of the coil 192, to move the plunger 195E toward the right. A disc 198E secured to the shaft 181 directly adjacent the gear 179*a* has an aperture 200E formed therein which is adapted to be engaged by the plunger 195E when moved to the right on energization of coil 192, thereby coupling the gear 179*a* to shaft 181 to drive the same.

A ring 201 of insulating material is securely fitted on the periphery of the drum 187 and has a pair of spaced conductor slip rings 202 and 203 secured in circumferential grooves formed therein. Conductors 204 and 205 connect the slip rings 202 and 203 to the opposite ends of the energizing coil 192.

Brushes 206 and 207 are slidably supported in metallic quill bearings 208 and 209, respectively, secured in a terminal block 210 of insulating material. Terminal block 210 is fitted in a socket formed in the top wall of the casing 165. Brushes 206 and 207 are resiliently urged against the slip rings 202 and 203, respectively, by springs provided in the quill bearings 208 and 209 and are electrically connected to conductors 211 and 212 by screws 213 and 214, respectively. Preferably a flexible conductor (not shown) is connected between each of the brushes 206 and 207 and its respective one of the screws 213 and 214, to insure a good electrical connection between the brushes and their respective conductors 211 and 212. Thus, when a current is passed through the conductors 211 and 212 the solenoid assembly on drum 187 will be engaged to urge the plunger 195E against the side of disc 198E and to cause the plunger to engage the aperture 200E when this plunger is moved into alignment with that aperture.

The conductors 211 and 212 are provided in a circuit controlled by one of the bank of switches 22 in a manner described hereinafter whereby to cause the gear 179*a* (driven at a particular speed determined by the ratio between gears 179 and 179*a*) to be coupled to the disc 198E and thus drive shaft 181.

The various units A, B, C and D although identical with the above mentioned unit E, are adapted, when energized, to rotate the shaft 181 in the same direction but at different speeds due to the different ratios between the constantly rotating gears 175, 176, 177, 178, 179, and the gears 175*a*, 176*a*, 177*a*, 178*a*, 179*a*, respectively. Likewise, the lower units F, G, H, J and K are also identical with the unit E to drive the shaft 184 in the same direction (and in the same direction as shaft 181) but at different speeds, which speeds, incidentally, are the same as the individual speeds of the respective units directly above these lower units. The manner in which these various drive units are controlled by the control drum 20 will be described hereinafter.

Panning drive

Referring to Figs. 1, 2 and 4, the support 13 comprises a circular base 215 rotatably supported on a circular table 216 secured to the base 14 by bolts 217. A race of ball thrust bearings 218 concentric with table 216 rotatably supports the base 215 on top of table 216. A circular skirt 220 extending over the race of ball bearings 218 lies in juxtaposition with a flat surface 221 formed on the table member 216. A continuous band of felt 222, or the like, forming a sealing member to prevent the entrance of dirt, dust, or the like, into the ball bearings 218 is secured in a continuous channel formed in the bottom of the skirt 220 and rides in engagement with the flat surface 221.

The remainder of the support 13 comprises means forming a horizontally extending hollow body 223 also forming part of the base 215 and terminating at the ends thereof in upwardly extending hollow arms 224 and 225.

The support 13 is further rotatably supported on the table 216 by a series of radial and thrust ball bearings 226 mounted intermediate a well 227 (formed centrally in an extension of table 216 concentric with the axis of rotation of support 13) and a hollow sleeve member 229 secured in a bore formed centrally of the base 215 of support 13. A worm gear 232 depends from the base 215 concentric with the axis of rotation thereof and is shown as being integrally formed therewith to transmit a panning movement to the support 13.

A scale 215′ (Figs. 1 and 2) is formed around the skirt 220 of base 215 and is calibrated in degrees, or the like, to indicate the position of support 13 relative to base 14.

Referring to Fig. 5, worm gear 232 meshes with a worm 233 secured on a shaft 234, journalled in bearings 235 and 236 projecting upwardly from a bearing support 237. Support 237 is secured by bolts 238 to the table 216 and projects through an aperture formed in table 216. A spiral gear 239 also secured on shaft 234 meshes with a similar spiral gear 240 secured at the top of the vertical pan drive shaft 15.

As shown in Figs. 4 and 7, the pan shaft 15 is journalled at the upper end thereof in a bearing formed in the bearing member 237, and is journalled at the lower end thereof in spaced bearings formed in bearing brackets 242 and 243 extending from and secured to the front wall of the speed change mechanism casing 165. Shaft 15 is connected to and adapted to be driven by the upper drive shaft 181 through a pair of spiral gears 244. Also, shaft 15 is connected to and adapted to be driven by the lower drive shaft 184 by a pair of spiral gears 245. It will be noted that the pair of spiral gears 244 are left handed while the pair 245 are right handed.

Bearing in mind that whenever the main panning drive shaft 171 is normally rotated in a "forward" direction and any of the driving units A to K, inclusive, energized, the respective upper or lower shaft 181 or 184, thus driven, will be rotated in the same direction. That is, when one of the units A to E, inclusive, is energized, the shaft 181 will be rotated clockwise, whereas when one of the units F to K, inclusive, is energized the shaft 184 will also be rotated clockwise. Therefore, since one pair of spiral gears 244 are left handed, while the other pair 245 are right handed, it will be noted that shaft 181, when driven by one of the respective drive units A to E, will drive the pan shaft 15 in one direction whereas shaft 184, when driven by one of the respective drive units F to K, will drive the pan shaft 15 in the opposite direction.

Thus, it will be seen that when one of the upper drive units A to E (Fig. 28) is energized, the support 13 will be moved in one direction (namely, leftwardly) about the vertical pan axis intersecting the objective lens 9, whereas when one of the lower drive units F to K is energized, the support 13 will be moved in an opposite direction, (namely, rightwardly).

Tilting drive

The cradle 10 has secured in the ends 250 and 251 thereof, (Fig. 4) axles 252 and 253, respectively, co-axial with each other to form a horizontal tilt axis coincident with the nodal point of objective lens 9. Axle 253 is rotatably mounted in a ball bearing 255 supported in a counter-bore 256 formed in a housing provided at the upper end of the hollow arm 225 of support 13. A second ball bearing 257 provided in the bore 256 is fitted on a shoulder 258 of the end portion 251, concentric with axle 253. Likewise, the opposite end 250 and the respective axle 252 are rotatably mounted in ball bearings 259 and 260 provided in a counter-bore 261, formed in a housing at the upper end of the hollow arm 224 of support 13.

Cable sheaves 262 and 263 are secured on the ends of the axles 252 and 253, respectively, and have endless cables 264 and 265, respectively, wrapped therearound. Cable 264 is guided around a pulley 266 rotatably supported by a bracket 267 extending from the bottom wall of the base 223 and is wrapped around the periphery of a driving sheave 268 (Figs. 4 and 6). Cable 264, on returning from sheave 268 to sheave 262, passes under a cable tensioning adjustment generally indicated at 270 (Fig. 8).

Referring to Figs. 4 and 8, the cable adjustment 270 comprises a U-shaped base 271, the legs 272 and 273 of which have guiding channels formed therein to guide slide bearings 274 and 275, respectively, therealong. A shaft 276 extends across the legs 272 and 273 and is journalled in the bearing members 274 and 275. A cable pulley 277 is mounted on the shaft 276 intermediate the bearing members 274 and 275 to guide the cable 264. Adjusting screws 278 and 280 are threaded through the wall 224′ of the hollow upwardly extending arm 224, as well as through the base 271 at either end thereof. These screws project through the channels formed in the legs 272 and 273 and abut against the bearing members 274 and 275, respectively, to enable adjustment of the shaft 276 outwardly to increase the tension applied to the cable 264.

Referring again to Figs. 4 and 6, sheave 268 is secured on a horizontal shaft 281 journalled in bearings 282 and 283 supported in the opposite walls of the base 223 of support 13. Also fixed to the shaft 281, is a worm gear 284 which meshes with a worm 285 secured on the vertical tilt shaft 16 at the upper end thereof.

A second worm gear 287 identical with that of 284 meshes with the worm 285 diametrically opposite from gear 284 and is secured on a horizontal stub shaft 288 journalled in bearings 289 and 290 also supported in the walls of the base 223. A driving sheave 291 identical with that of 268 is also secured on the shaft 288 to drive the cable 265 over the periphery thereof. A cable tensioning adjustment 297, similar to that of 270, is provided to adjustably tension cable 265.

The cables 264 and 265 are so wrapped around the sheaves 262, 263, 268, and 291 that an equal force will be applied in the same direction to both ends of the cradle 10 to tilt the same when the shaft 16 is rotated.

Shaft 16 is journalled at the upper end thereof in bearings 292 and 293. The bearing 292 is mounted in a bearing member 294 removably secured to the top wall of the hollow base 223 of support 13. Bearing 293 is supported in a bore formed in a cross piece 295 extending between the opposite side walls of the hollow base 223. A second bearing 296 is mounted between the shaft 16 and the sleeve 229 adjacent the upper end thereof. A gear 298 is secured to the shaft 16 adjacent the lower end thereof and meshes with a gear 299 secured on the upper end of a vertical shaft 316. Shafts 16 and 316 are both journalled in bearings provided in a bearing bracket 301 secured by bolts as at 302 to the lower end of the well member 227 of the stationary table 216.

Shaft 316 is driven through a differential mechanism generally indicated at 303 by a vertical shaft 305 journalled in bearings 306 and 307, which also drives a tilt limiting device generally indicated at 304. Bearing 306 is formed in the lower wall of casing 314 (Fig. 19) while bearing 307 is provided on a bracket mounted on and extending from the casing 166 of the change speed mechanism 18. A right hand spiral gear 308 is secured on shaft 305 and meshes with a similar gear 310 mounted on the upper drive shaft 181′ of the change speed mechanism 18. Shaft 181′ is identical with shaft 181, as shown diagrammatically in Fig. 31, and when driven in the same manner, causes an upward tilting movement to be applied to the cradle 10 through the train of gears, cables, etc., described hereinbefore. That is, the field of view of the objective lens 9 on cradle 10 is tilted upwardly.

A left hand spiral gear 311 on shaft 305 meshes with a similar gear 312 mounted on a lower drive shaft 184′ of mechanism 18, which shaft is identical with shaft 184 and which is driven in the same manner. When shaft 184′ is operatively connected to the shaft 172 through the mechanism within the speed change mechanism 18, the shaft 305 will be so rotated as to cause a downward tilting movement of the cradle 10. It should be noted, however, that the shafts 181′, 184′ and 305 are constantly connected with each other through the spiral gears 308, 310, 311 and 312.

Differential mechanism

The differential mechanism 303 is provided to prevent an undesired tilting movement from being transmitted to the cradle 10 due to panning movement of the support. Consider an instant when it is desirable to maintain the camera 11 or projector 12 supported by the cradle 10 at a constant level (without tilting) while the support 13 is being panned by the pan shaft 15. If the shaft 16 were held stationary a relative rotation would result between the support 13 and the shaft 16. Thus, the relative rotation between the shaft 16 and the support 13 would cause rotation of the worm gears 284 and 287 (Fig. 4) to operate the cables 264 and 265 to tilt the cradle 10 during panning movement.

Mechanism 303 causes the tilt shaft 16 to rotate in the same direction and at the same speed as the support 13 whenever the camera or projector is panned and the drive shaft 305 is held stationary to prevent tilting movement of cradle 10. Even when shaft 305 is rotated to tilt the cradle 10 during a panning movement thereof the speed of rotation of the tilt shaft 16 is either increased or decreased by the differential mechanism 303 to compensate for any tilting movement which might be caused by a relative rotation between tilt shaft 16 and support 13.

Referring to Figs. 18 and 19, the differential mechanism 303 comprises a casing 314 suitably secured by screws 315 to the forward wall of the casing 166 of the change speed mechanism 18. The shaft 316 for causing a tilting motion of the apparatus is journalled at the lower end thereof in a bearing 316′ formed in the upper wall of casing 314 and has a bevelled gear 319 secured at the lower end thereof. Gear 319 meshes with planetary bevel gears 317 and 318 of equal pitch diameters at diametrically opposite sides thereof, which gears are journalled on a common shaft 320 mounted in brackets 321 and 322 secured to a main bevel gear 323. Bevel gear 323 is rotatable coaxially of shaft 316 and is journalled partially on a bushing 324 secured in a bore 325 formed in an intermediate wall 326 of the casing 314. The upper end of the shaft 305 is journalled within the bushing 324 and has secured at the upper end thereof a bevel gear 327 (of the same pitch diameter as gear 319) meshing with the planetary gears 317 and 318 and rotatable independently of the main gear 323.

The main gear 323 meshes with a bevel gear 328 securely mounted on a horizontal shaft 330 journalled in a bearing 331 formed in a side wall of the casing 314. A worm gear 332 also secured on shaft 330 meshes with a worm 333 (Fig. 18) mounted on a vertical shaft 334 journalled in bearings 335 and 336 provided at the top and bottom walls of casing 314. A spur gear 337 secured at the top of shaft 334 above the casing 314 meshes with and is driven by a gear 338 secured on the pan shaft 15.

During a tilting movement only of the apparatus, the pan shaft 15 and, consequently, the main gear 323 will, of course, be held stationary. Therefore, when the shaft 305 is rotated in the desired direction by the change speed mechanism 18 this rotation will be transmitted through the planetary gears 317 and 318 on the now stationary shaft 320 by the gear 327 to rotate gear 319 and shaft 316. Since, in this condition, the planetary gears 317 and 318 do not rotate about the co-extensive axes of the shafts 305 and 316, the shaft 316 will be rotated at the same rate of speed as the shaft 305 (although in an opposite direction) to transmit the tilting movement. In cases, however, where the support 13 is being panned by rotation of shaft 15, rotation of the main gear 323 will, of course, be caused by the train of gears 338, 337, 333, 332 and 328. The pitch of the worm 333 and the pitch diameters of the gears in the above mentioned gear train are so arranged that when the pan shaft 15 is rotated the main gear 323 and, consequently, the planetary gears 317 and 318 will rotate about the axis of the shaft 316 in a manner to cause this shaft to be rotated relatively to the shaft 305 by an amount equal to the rotation of the support 13 and in the same direction as the direction of rotation of support 13.

Mechanism for limiting tilting movement

A sleeve 340 is secured to the shaft 305 within the lower half of the casing 314 and has a helical screw thread formed thereon. A travelling nut member 341 threaded over the sleeve 340, has an extension 342 formed thereon. Extension 342 extends through and is guided along an elongated vertical slot 343 provided on a cover member 344 mounted on the front of the lower half of casing 314 as by screws 344′. Slot 343 guides the nut 341 vertically on rotation of the shaft 305. A pair of upper and lower double throw limit switches 345 and 346 (Figs. 18, 19 and 31) are secured to the cover 344 adjacent the top and bottom, respectively, of the slot 343 and in the path of movement of the projection 342 on nut 341. Thus, as the shaft 305 is rotated to tilt the cradle 10, the nut 341 will travel along the sleeve 340 and the projection 342 thereof will engage at either end of the travel thereof, one of the switches 345 and 346 to operate the same and cause the apparatus to automatically stop in a manner described hereinafter. These switches **345** and **346** are adjustably secured by screws, as at **347**, to the cover **344** of casing **314** to enable the same to be adjusted in position a certain amount vertically to change the limit of travel of cradle **10** about its horizontal tilting axis.

Control system

Referring to the diagrammatic Figs. 20 to 24, inclusive, illustrating the relationship between the various elements of the panning mechanism, and particularly to Fig. 20, it will be noted that the disc **198A**, similar in purpose to that of **198E**, (described hereinbefore) is adapted to be coupled to the driving unit A on energization of the driving solenoid assembly of that unit. Disc **198A** has a series of six equi-spaced holes **200A** formed therein, all located on a circle concentric with the shaft **181**. Each of holes **200A** is, therefore, adapted to be engaged by the driving plunger **195A** of unit A to enable disc **198A** and, consequently, shaft **181** to be driven at a rate of speed determined by the ratio of the gears **175** and **175***a*.

Likewise, the disc **198B**, associated with unit B, has a series of four equi-spaced holes **200B**, all located on a circle concentric with the shaft **181** and each adapted to be engaged by the driving plunger **195B** of driving unit B. Similarly, the disc **198C** has a series of five equi-spaced holes **200C** located on a circle concentric with shaft **181**, each of which is adapted to be engaged by the driving plunger **195C** of driving unit C. Disc **198D** has three equi-spaced holes **200D** located therein on a circle concentric with shaft **181** and engageable by the driving plunger **195D** of unit D. As before stated, disc **198E** has a single hole **200E** therein having the path of movement thereof in alignment with and adapted to be engaged by the driving plunger **195E** of unit E.

Bearing in mind that the ratio of speed between the panning and/or tilting movement of the apparatus (consequently, the drive shaft **171**) and the speed of the film traversed through either the camera **11** or the projector **12**, when supported on cradle **10**, is always the same for a certain standard setting of the speed change mechanism **29**, and assuming that the mechanism **29** is so set in a standard setting or position that the drive shaft **171** will rotate one revolution for each foot of film (sixteen picture frames) traversed through the camera or projector, it will be noted that, due to the ratio (1 to 6) between the pitch diameters of gears **175** and **175A**, the disc **198A** will be rotated a distance equal to the spacing between two successive holes **200A** as each foot of film is traversed.

Likewise, the ratio between the gears **176** and **176***a* is such that disc **198B** will be rotated the distance between two successive holes **200B** during the traverse of one foot of film. Similarly, disc **198C** will rotate the distance between every other one of the holes **200C** (⅖ revolution per foot of film travel); the disc **198D** will rotate the distance between every other one of its holes **200D** (⅔ revolution per foot of film travel); and the disc **198E** will rotate one complete revolution, on the traverse of one foot of film. Therefore, for example, if it is desired to pan the camera leftwardly at a rate of ⅔° per foot of film travel (which rate is controlled by the unit A) for a period corresponding to the passage of one foot of film, and remembering that control drum **20** is usually rotated a distance equal to the spacing between two of the horizontal rows **120** of holes for each foot of film traversed, a start and a stop pin (to be described hereinafter) will be placed in successive horizontal rows **120** of holes and aligned in right and left hand circumferential rows, respectively, of the circumferential column **126A** of the control drum **20** (Fig. 31). Thus, during the period of energization of the solenoid assembly of the unit A (equal to the passage of one foot of film), the disc **198A** and consequently the shaft **181**, will be rotated only ⅙ of a revolution. Likewise, for example, if it is desired to pan the camera leftwardly at a speed of 2⅔° per foot (as controlled by unit D) for a period corresponding to the traverse of one foot of film, start and stop pins would be positioned in successive horizontal rows **120** and in right and left hand circumferential rows, respectively, of the circumferentially aligned column of holes **126D**. During the period of energization of the solenoid assembly of unit D, (between the time the start pin closed its respective switch and the time the stop pin closed its respective switch) the disc **198D** will rotate the shaft **181** two-thirds of one revolution.

Therefore, it will be seen that changes in direction as well as in speed of either panning or tilting movement may be caused to occur at intervals equal to the traverse of one foot of film or any multiple thereof. However, by changing the setting of the speed change mechanism **29**, the length of time during these intervals may be increased or decreased.

In order to stop and lock the disc **198A** after it has rotated one-sixth of a revolution, or any multiple thereof, a solenoid assembly **530AF**, hereinafter termed "stop solenoid," is fixedly mounted on the rear wall of the casing **165** (Figs. 24, 28, 29 and 31). This stop solenoid assembly is identical with that provided on each of the various drive units A to V, inclusive, and is shown in detail in Fig. 28. The plunger **531AF** of stop solenoid **530AF** is adapted, on energization of this solenoid, to engage any one of a series of six equi-spaced holes **532AF** (Figs. 24 and 29) provided in the disc **198E** and all located on a circle concentric with the shaft **181**. Therefore, the plunger **531AF** may be moved to engage any of the holes **532AF** to lock the shaft **181** against further rotation when one foot of film or any multiple thereof has traversed through the camera or projector. The energization of plunger **531AF** is controlled by a stop pin located in any left hand hole of either of the columns **126A** or **126F** (Fig. 31) as described hereinafter, and will cause plunger **531AF** to engage one of the holes **532AF** at practically the same time that the driving plunger in either the unit A or the unit F is allowed to be retracted (under control of this stop pin) from engagement with a hole in the respective adjacent disc **198A** or **198F**. Other stop solenoid assemblies as at **530BG**, **530CH**, **530DJ** and **530EK** are also mounted on the rear wall of casing **165**, and are provided at different distances away from the shaft **181**. Each of these various stop solenoid assemblies is adapted to move its respective stop plunger into engagement with one of a certain circular row of equi-spaced holes provided in disc **198E** concentric with shaft **181**. The number of holes in each row corresponds with the number of holes in a certain pair of upper and lower drive units. For example, the plunger of stop solenoid **530BG** is aligned with the path of movement of a circle of four holes **532BG**. Likewise, the plunger of stop solenoid 530CH is aligned with the path of movement of a circle of five holes 532CH. The plunger of the stop solenoid 530DJ is aligned with the path of movement of three holes 532DJ and the plunger of the stop solenoid 530EK is aligned with the path of movement of a single hole 532EK.

Thus, it will be seen that rotation of the pan shaft 15 may be stopped by a certain one of the stop solenoids on deenergization of the above mentioned corresponding driving unit, at the end of one foot of film travel or any multiple thereof when the apparatus has been driven by that particular corresponding drive unit. Since the holes in the lower driving discs 198F to 198K, inclusive, are of the same number and are provided in the same relative positions as the holes in the respective upper discs 198A to 198E, inclusive, the stopping solenoids 530AF to 530EK, inclusive, will suffice for stopping the shafts 181, 15, and 184 when any of previously energized lower driving units F to K, inclusive, are deenergized.

Referring to Fig. 27, a large fragmentary view of the driving plunger 195A and one of the coacting holes 200A in disc 198A is illustrated. It will be noted that the plunger 195A is somewhat larger in diameter than the hole 200A and that it is rounded at 570 at the end thereof. Thus, when the plunger is moved into engagement with the hole, that is, in the position indicated by the dotted lines 195A', a non-positive locking or coupling action is obtained since the current supplied to the solenoid is maintained at such a level that the solenoid will cause a driving engagement of the plunger 195A but will not be effective to hold the plunger against an undue force tending to move the plunger into its retracted position. Therefore, since the plunger is more or less resiliently pressed against the hole by its respective solenoid through electromagnetic force, it will be seen that when the torque between the disc 198A and the drive unit A exceeds a certain amount, the plunger 195A will be driven outward enabling the unit A to rotate relatively to the disc 198A even though the driving solenoid assembly thereof is energized.

The above arrangement is embodied in each of the various driving and stop solenoid assemblies for the units A to V, inclusive. This arrangement forms a safety feature in preventing breakage of different parts of the apparatus in the event that two or more driving units become accidentally energized at the same time or in the event that a stop and a driving solenoid of any driving unit or different driving units become energized at the same time.

Relay system

Referring to Fig. 31, the various driving units of the panning and tilting mechanisms 17 and 18, respectively, are controlled either automatically by the control drum 20 or manually on operation of two banks of switches generally indicated at 550 and 551, the former bank controlling the tilting movement and the latter bank controlling the panning movement. Power is supplied to these various driving units and relay systems connected thereto by a main direct current supply circuit 349.

A ground line 350, forming part of the minus (—) side of circuit 349, is connected to the right hand one of the slip rings on each of the panning units A to K, inclusive, and each of the tilting units P to R, inclusive. Ground line 350 is also directly connected to a common ground bus 350'. A continuation 351 of ground line 350 is connected thereto through a normally closed switch 435.

Referring to Figs. 7 and 9, the normally closed switch 435 is supported on a suitable bracket 435' extending upwardly from the floor 23 of base 14 and remains in closed position when the shafts 87 and 103 are coupled together. However, when the handle 96 is moved counterclockwise to disengage the pin 100 from the aperture 101 in the driven clutch plate 102, the clutch plate 90, slidable along the shaft 87, engages and opens switch 435. Switch 435, when open, renders the control drum 20 and pins thereon ineffective to control the operation of the panning and tilting mechanisms 17 and 18, respectively. Thus, when switch 435 is open the control drum 20 may be rotated by hand for the purpose of setting the various pins 21.

The continuation line 351 normally supplies (when switch 435 is closed) ground to the stationary contact of a switch 22X aligned with the bank of switches 22. Switch 22X, similar in construction to the rest of the bank switches 22, is intermittently closed by successive ones of the pins 130 arranged circumferentially around the drum 20. The line 351 also normally supplies ground to the contacts 352 of a master tilt switch 354 and to contacts 353 of a master pan switch 355, respectively. Master switch 354, when moved to the left, serves to prepare the various tilting relay systems for automatic tilting operation under control of the drum 20 by connecting a tilt ground bus 366 to the ground line 351 and, when moved to the right, serves to prepare the various relay systems for operation under the control of the bank of tilt switches 550. Likewise, the master pan switch 355, when moved to the left, serves to prepare the various panning control relay systems for automatical operation by connecting a pan ground bus 367 to the ground line 351 and, when moved to the right, serves to prepare these relay systems for manual operation under control of the bank of pan switches 551.

It should be noted at this time that one of the switches 354 and 355 may be set for automatic control while, at the same time, the other may be set for manual control, thus enabling independent automatic or manual control of both the panning and tilting movements.

A separate control circuit is provided for each of the panning drive units A to K, inclusive, and each of the tilting drive units P to V, inclusive. Certain of these control circuits are shown, as indicated generally at 358A, 358F, 358R, 358S, etc. However, for the sake of brevity, only a few of these control circuits are shown, since all these various relay units operate substantially the same as each other, either under control of the drum 20 or the bank of switches 550 or 551, depending on the settings of the master switches 354 and 355.

Hereafter, for the purpose of clarity, all reference indications ending in a certain letter indicate a particular element in the control system for the correspondingly lettered driving unit. For example, the control circuit 358A controls the driving unit A.

Each of the control circuits is controlled (when the apparatus is set for automatic operation) by pins provided in a respective set of holes in the control drum 20, as described hereinbefore. For example, pins provided in the pair of circumferentially extending columns of holes 126A control the circuit 358A and, consequently, control the panning drive unit A. Likewise, pins in the pair of circumferentially extending columns of holes 126L control the circuit 358L and, consequently, control the tilting drive unit L. Likewise, (when the apparatus is set for manual operation) the various control circuits are controlled by respective ones of the switches as at 385A, 385F, 385R, 385U, etc., provided in the switch banks 550 and 551.

Since the various separate control circuits are identical, one (385R) only will be described in detail. Control circuit 385R comprises a double pole-double throw reversing relay 359R normally spring pressed into the position shown, a self-locking, double pole, double throw operating relay 360R and a self-locking, double pole, single throw release relay 361R.

Relays 360R and 361R are of a type well known in the art, such as are produced by the Leach Relay Company of Los Angeles, California, and known as type #2417. Relay 359R is also of a type well known in the art, such as are produced by the above company and known as type #1027.

Relay 360R is shown in its normal unlocked position but is adapted, when moved by its energizing coil 360'R, to be locked in an alternate upper position by a spring pressed latch 362R. Latch 362R is retractable out of locking engagement with the relay 360R by a release coil 363R to allow this relay to be spring pressed into its normal position.

Relay 361R is also shown in its normal position but is adapted, when moved by its respective energizing coil 361'R, to be locked in an alternate upper position by a spring pressed latch 364R. An energizing coil 365R is provided to release latch 364R when this coil is energized. When latch 364R is moved out of locking engagement, the relay 361R is spring pressed into its normal position shown providing, of course, no current is simultaneously passed through its energizing coil 361'R.

The upper contacts 359'R of reversing relay 359R are connected to the movable contact of a start switch 22R aligned with the path of movement of "start" pins as 21R provided in the right hand one of the circumferentially extending columns 126R of holes. The stationary contact of switch 22R is connected to the tilt ground bus 366, common to all of the stationary contacts of the portion of the bank of switches 22 on the tilting side 121 of the drum 20. Ground bus 366 is connected to the main ground line 350 when the master tilt switch 354 is moved to the left into "automatic" position (assuming the switch 435 is closed).

Likewise, the pan ground bus 367 is connected to the stationary contacts of the portion of the bank of switches 22 on the panning side 122 of drum 20 and is connected to the ground line 350 when the master pan switch 355 is moved to the left in the "automatic" position.

When, due to rotation of drum 20, a start pin as at 21R closes its respective start switch 22R, a circuit is completed through the normally closed contacts 359'R of the reverse relay 359R and through the energizing coils 360'R and 361'R across the tilt ground bus 366 and a battery bus 368 forming part of the positive (+) side of circuit 349. The two relays 360R and 361R will, therefore, be moved and locked with their respective contact arms in an upper position. As the contacts 369R of relay 360R close, current is passed therethrough from the battery bus 368, down through line 370R and through the left hand one of the slip rings on unit R. The unit R will, therefore, be energized to cause the respective plunger to engage one of the six equi-spaced holes in the adjacent disc 198R on the lower shaft 184' and, thereby, cause the cradle 10 to be tilted downwardly at the rate of ⅔° per foot of film traversed through the camera or projector supported on cradle 10. Since relay 360R is self-locking, the unit R will remain energized after the momentary closing of the switch 22R by pin 21R and will remain energized until the release coil 363R is energized to cause the relay 360R to assume its original illustrated position.

When a stop pin as at 21R' in the left hand one of the circumferentially aligned columns of holes 126R later momentarily closes the respective stop switch 22R', a circuit will be completed through the now closed contacts 371R of relay 361R and through release coil 363R across the battery bus 368 and tilt ground bus 366. Thus, the relay 360R will drop and the contacts 369R will be opened to allow the unit R to be de-energized. Therefore, the unit R will be disengaged from the shaft 184' to discontinue downward tilting movement of the cradle 10 at the aforementioned speed.

Bearing in mind that release relay 361R is still locked in its upper position, a circuit will now be completed from the battery bus 368 through the newly closed contacts 372R, line 372'R, the now closed contacts 373R of release relay 361R and thence through a line 374RL to the stop solenoid 530RL to energize the same. When solenoid 530RL is energized, the plunger thereof will be engaged in one of a series of six equi-spaced holes provided in the disc 198P to stop and lock the shaft 181', and, consequently, the shafts 305 and 184'.

It should be noted that after the stop switch 22R' has been momentarily closed, the release relay 361R will still be maintained in a locked position and, therefore, the solenoid 530RL will remain energized to hold and lock the disc 198P, and consequently, shaft 305 from rotation.

When another start pin in the tilt side 121 of the drum 20, as for example, the pin 21U closes its respective start switch 22U to energize the respective control circuit 358U, the operating and release relays 360U and 361U, respectively, will, of course, be actuated and locked to cause current to pass through the contacts 369U of relay 360U, through line 370U to and through the solenoid assembly of driving unit U to cause this unit to be coupled to the adjacent disc 198U to drive shaft 184' and, consequently, shaft 305 at a new speed of 2⅔° per foot of film traversed and in a downward direction.

As operating relay 360U closes the contacts 375U, current will be transmitted from the battery bus 368, and through these contacts to a tilt release bus 377. Bus 377 will then supply this current through the now closed contacts 378R of relay 360R and through the release coil 365R, the other end of which is connected to the ground bus 350'. Therefore, as the new control circuit 358U is energized to cause its respective driving unit U to be coupled to the shaft 184', the relay 361R will be substantially simultaneously unlocked by coil 365R to de-energize its respective stop solenoid 530RL to free the disc 198P and allow the shafts 184' and 305 to be rotated by the newly energized drive unit U.

Note that the upper contact arms of the reverse relays of the up and down tilt control circuits for each tilting speed are connected to the same stop solenoid line. For example, the upper contact arms of the reverse relays 361R and 361L, controlling the apparatus at ⅔° per foot of film downwardly and ⅔° per foot upwardly, respectively, are connected to the same stop solenoid 530RL via the line 374RL, thereby enabling the same stop solenoid to arrest and lock the shaft 305 from rotation when either of the previously energized drive units L and R is de-energized. Likewise, the upper contact arms of the reverse relays of the right and left pan control circuits for like panning speeds are connected to the same stop solenoid line. Note line 374AF connected to stop solenoid 530AF.

The contact arms of the upper and lower limit switches 345 and 346, respectively, are connected together and to the movable contact of the intermittently closed switch 22X by a line 380, permitting ground to be intermittently supplied at equi-timed intervals to these contact arms. Since the various pins 130 intermittently closing the switch 22X are spaced apart a distance equal to the distance between two successive horizontally extending rows 120 of holes, the grounded impulses will be supplied to the line 380 at intervals, the period between which is equal to the passage of one foot of film through the camera or projector supported by the apparatus when the main transmission is in a standard position.

The upper and normally open contact of the upper limit switch 345 is connected to a common uptilt stop bus 381 which is connected to the lower contact arm of the release relay in each of the control circuits as at 358L and 358Q, etc., for controlling the tilting movement of the cradle 10 upwardly.

Likewise, the lower and normally open contact of the lower limit switch 346 is connected to a common down-tilt stop bus 382 which is connected to the lower contact arm of the release relay of each of the control circuits as at 358R and 358U for controlling the tilting movement of the cradle 10 downwardly.

When, for example, the cradle is being tilted upwardly, and when, because of misplacement of one of the various pins 21 in the tilting side 121 of the drum 20, or for any other reason, the cradle 10 moves towards its extreme limit of upward tilting movement, the projection 342 of the traveling nut 341 engages and moves the contact arm of the upper limit switch 345 upwardly to engage the upper contact of that switch, thereby supplying the intermittent ground impulses from the line 380 to the up-tilt stop bus 381 to energize the release coil (as at 363L and 363Q) of the operating relay of the up-tilt control circuit which is in locked position, thereby to release this operating relay and enable the driving unit therefor to become de-energized and uncoupled from the lower shaft 184'.

To facilitate positioning of the various holes on the control drum 20, the successive horizontal rows 120 of holes in the drum are consecutively numbered as indicated in the right hand column 561. These numbers represent film footage, assuming the main speed transmission unit 29 is set at the hereinbefore mentioned standard setting.

Thus, for example, if the various pins have been positioned on the drum to cause the apparatus to tilt upwardly at a rate of ⅔° per foot just prior to the passage of the one hundred seventy-sixth foot of film in the camera or projector and it is desired to start a change in speed and direction of movement of the apparatus to tilt downwardly at 1° per foot, and at the same time to pan to the right at 1⅗° per foot exactly at the one hundred seventy-sixth foot mark, a pin is placed in the left hand hole (stop row) in the circumferential column 126L and in the horizontal row numbered one hundred seventy-five (column 561). A second pin is positioned in the right hand hole (start row) in the column 126S and also in the horizontal row numbered one hundred and seventy-five to initiate downward tilting movement at 1° per foot. Also, a third pin is placed in the right hand hole (start row) in the circumferential column 126H and also in the horizontal row numbered 175 to simultaneously initiate a rightward panning movement of the apparatus at 1⅗° per foot of film. Obviously, the control drum is either first positioned with the first or zero marked (column 561) horizontal row of holes in alignment with the bank of switches 22 before the apparatus is started, or, preferably, the drum is first positioned with a row of holes, which is somewhat in advance of the zero marked row, in alignment with the bank of switches 22 to enable the driving motors and train of elements driven thereby to be brought up to normal operating speed before the zero marked row of holes passes the switches 22.

Referring to Fig. 4 in particular the various relays illustrated in Fig. 31 are mounted in housings as at 526 suitably secured to the under surface of a ring 527. Ring 527 is formed of several separate segmental sections each suspended by brackets 528 from the top of base 14. Brackets 528 are secured in place by the bolts 217.

Manual control

As stated hereinbefore, when the apparatus is operated under manual control, use is made of the two banks of switches 550 and 551. As these two banks 550 and 551 are identical with each other, the physical embodiment of only one will be described in detail.

Referring to Figs. 25 and 26, a section of part of one bank of switches (550) is shown. Each switch comprises a plunger rod 386 having a push button 387 formed at the top thereof and extending through a panel 387', forming part of the exterior wall of the base 14, thereby to enable manual operation. Plunger rod 386 is slidably guided in bearings 388 and 388' formed in a switch housing 389 common to the entire bank of switches. A pair of contacts 390 and 390' are secured to the plunger rod 386 at the bottom thereof and on opposite sides of the rod 386. These contacts 390 and 390', forming part of one particular switch, are insulated from the rod and from each other by insulating material 391. As the rod 386 is moved downwardly the contacts 390 and 390' slide on strips 392 and 392', respectively, of insulating material, secured to the inner walls of an inverted channel 393 forming part of the switch housing 389. At the end of the downward stroke of plunger 386, the contacts 390 and 390', each engage and short or connect a series of three stationary contact strips 395, 395' and 395'', inlaid in each insulating strip 392 and 392' and connected to individual conductors leading to various parts of the relay systems, as will be described hereinafter.

Plunger rod 386 is urged upwardly toward an "off" position by a spring 396. Rod 386 has a pair of inclined projections 397 and 398 spaced therealong and forming a step 399 therebetween.

A horizontally extending locking and release bar 400 is pivoted at 400' at either end thereof to the walls of the housing 389 and is resiliently urged by a leaf spring 401, secured at 402 to the channel 393, against the inclined surface of the lower projection 398 (when rod 386 is in "off" postion). When the push button 387 is pressed to move the plunger 386 downwardly, the inclined surface of projection 398 tilts the bar 400 which, thereafter, snaps into engagement with the step 399 when the plunger rod 386 has reached its lowermost and "on" position. The plunger rod 386 is thereafter held in this position to complete a circuit across the conductors 395, 395' and 395'' on one side of the channel 393 and also the corresponding conductors on the opposite side of channel 393.

When a second push button, having the plunger rod thereof in engagement with the locking and release bar 400, is depressed, the inclined surface of the lower projection thereof, corresponding to that formed on projection 398, causes the bar 400 to be first tilted, thereby releasing the already depressed plunger bar 386 to open that switch. This later depressed plunger bar is then locked by the bar 400 to maintain its respective switch closed.

If it is desired, after one of the plunger bars has been depressed and locked, to cause the entire bank to be released, as when operating under automatic control, one of the released plunger bars is depressed an amount sufficient to tilt the locking and release bars 400 and 403 but not quite enough to cause this latter plunger bar to be locked. The tilting action thus applied to the bars 400 and 403 will enable any previously depressed and locked plunger bar in the respective bank to be released.

As illustrated in Fig. 25, each of the banks of switches 550 and 551 is divided into two parallel rows. One of these rows is served by the bar 400. A locking and release bar 403, similar to that of 400, is provided for the second row and is also pivoted at the ends thereof to the wall of housing 389. Bar 403 is adapted to be tilted and to lock the second bank of plunger rods as at 386'. Locking bar 403 performs the same function as does bar 400, namely, to lock one and simultaneously to release any previously locked ones of the bank of plunger rods aligned therewith.

A tie bar 404 is pivotally connected at either end thereof to arms 405 and 406 extending downwardly from the locking and release bars 400 and 403, respectively, to cause an equal tilting movement to be applied to both of the bars 400 and 403 when any one of these bars is tilted. Therefore, if any of the switches in one of the rows is locked in closed position, the act of closing another one of the switches in that row or the other row will cause the preceding switch to be opened.

When the panning or tilting operation, or both, are to be performed under manual control, the respective one or ones of the master switches 354 and 355 are moved to the right.

Considering for example, only the manual tilting control: when the master tilting switch 354 is moved to the right, the contacts 52 thereof, when closed will transmit grounded impulses from the line 380, which pass through the normally closed contacts of the upper limit switch 345, to contact points on the upper and lower indicated banks of each of the manually operated up-tilt switches 385L, 385M, 385N, 385Q and 385P controlling the upward tilting movement of the apparatus through the control units 358L, etc.

Likewise, the contacts 553 of switch 354, when closed, will transmit the grounded impulses from line 380, and passing through the normally closed contacts of the lower limit switch 346, to contact points on the upper and lower indicated banks of contacts in each of the manually operated down-tilt switches 385R, 385S, 385T, 385U, and 385V controlling the downward tilting movement of the apparatus through the control circuits 358R, etc.

Each of the various manually controlled switches, when closed, transmits the grounded impulses to the energizing coils of the operating and release relays of the respective control circuit to the battery bus 368 to thereby cause this respective control circuit to be locked in operating position to operate its respective driving unit. For example, when the switch 385L is depressed and automatically locked in a closed position as hereinbefore described, grounded impulses passing through the closed contacts 552 of switch 354 will be transmitted through line 554L and through the energizing coils 361'L and 360'L of the release and operating relays, respectively, of the control unit 358L.

The right hand contact point in the lower indicated bank of contact points of each switch in the entire bank of switches 550 is connected to a line 555 directly connected to the down-tilt stop bus 382. Likewise, the middle contact point in the lower bank of contact points of each switch in the entire bank of switches 550 is connected to a second line 556 directly connected to the up-tilt stop bus 381.

Now, consider again, for example, the switch 385L to be depressed and locked. As stated before, the operating and release coils 360'L and 361'L of the relays 360L and 361L, respectively, of the respective control circuit 358L will be energized to position this circuit in operating condition with the two relays 360L and 361L locked. As the respective contact arms of relays 360L and 361L become locked in their upper positions, grounded impulses will be transmitted through the lower middle contact of switch 385L, through line 556, through up-tilt stop bus 381, through the lower contact arm of release relay 361L, and to and through the release coil 363L of operating relay 360L. Therefore, current impulses will be simultaneously applied to and removed from energizing coil 360'L and release coil 363L, the former coil tending to move (or hold) the relay in its upper position, and the latter coil tending to release the relay from its upper position. However, each of the operating relays 360L, etc., as well as the release relays 361L, etc. is so constructed that when a current impulse is simultaneously applied to and removed from the energizing coil 360'L and the releasing coil 363L thereof, the contact arm or arms of that relay will remain in an upper closed position. That is, the latch 362L will spring back (after the current impulse is removed) much faster than the contact arms will, thereby still maintaining the contact arms of the operating relay locked in an upper position during the period between successive current impulses. However, when a second one of the tilt control switches in the bank 550, as for example, down-tilt switch 385R, is depressed, the prior locked switch 385L will be automatically released as hereinbefore described. Therefore, grounded impulses will be transmitted through the lower contact arm of switch 385R, through both lines 555 and 556 to the up-tilt stop bus 381 and down-tilt stop bus 382. Those ground impulses passing through up-tilt stop bus 381 will pass through the lower contact arm of release relay 361L and through the release coil 363L to release operating relay 360L, enabling the respective driving unit to be uncoupled from shaft 181'. As mentioned before, these grounded impulses will not be effective to unlock operating relay 360R of control circuit 358R. However, the tilt release bus 377 will now have current applied thereto, as described hereinbefore, to cause the release relay 361L to be unlocked. Thus, the entire prior energized control circuit 358L will be rendered open in its normal non-operative position.

Due to the fact that the ground impulses transmitted along the line 380 to each of the various change speed manually operated switches 385R, etc., are in isochronal relation with any periodic closing of any of the bank switches 22 operated by the pins 21 on drum 20, it will be seen that identical operation may be obtained by manual or automatic control of the apparatus. That is, when any of the manually operated switches 385R, etc., is depressed, the operation of the respective control circuit 358L, etc. will not take place until a certain point in the film passing through the camera or projector is reached, which point is spaced exactly one foot (with the standard setting of the mechanism 29) from a corresponding point on the film at which a second energization of any of the control circuits may take place.

Thus, by noting the length of film passing through the camera or projector, or the length of time (assuming the film speed to be constant) between successive changes in speed or direction of movement of the apparatus, the manual operation of the apparatus may later be identically duplicated automatically by correctly positioning the control pins on drum 20.

It should be noted at this point that the angular relationship between the control drum 20 and each of the drive units A to V, inclusive, will usually be such that (considering a short time lag for operation of the various relays and solenoids) the various driving and stop solenoid plungers will not immediately engage their respective holes but will strike the sides of the respective adjacent disc and will be held thereagainst until the respective holes are aligned therewith. When this happens, a plunger which has been driven against the adjacent disc by its respective solenoid will, of course, engage the particular hole which becomes first aligned therewith.

Included in the bank of switches 550 is a tilt stop switch 558, having supplied to certain contacts thereof the grounded impulses directly from the line 380. Both the upper and lower contact arms of switch 558 are adapted, when switch 558 is closed and locked, to supply the ground impulses to the up-tilt stop bus 381 and the down-tilt stop bus 382 to energize the release coil of any up-tilt or down-tilt control circuit which is in operative condition to thereby stop all up or down tilting movement.

Thus, switch 558 acts to arrest any tilting movement of the apparatus as previously controlled by one of the tilt switches in the bank 550. However, in this case, the respective release relay will remain locked so as to maintain the respective stop solenoid energized to hold the tilt drive mechanism including shaft 305 from rotation.

Also included in the bank of switches 550 is a tilt release switch 559. Switch 559 serves to arrest any tilting movement of the apparatus, regardless of whether the tilting side of the control system is in manual or automatic operation. Switch 559 not only renders any up or down tilt driving unit L, M, etc. uncoupled but also causes the respective stop solenoids as at 530RL to uncouple to permit the drive shaft 181' and mechanism mechanically connected thereto to be rotatable by hand.

For hand operation, the end of shaft 181' is provided with a square shank 600 (Figs. 7 and 28) to enable a hand operated crank, passed through an aperture 601 formed in the base 14 to be secured in driving relation to the shaft 181'.

When switch 559 is depressed and locked, the lower contact arm thereof transmits the timed ground impulses from the line 380 to lines 555 and 556 and thereby directly to the up-tilt bus 381 and the down-tilt bus 382. Thus, these ground impulses are transmitted through the lower contact arm of the release relay of whichever tilt control circuit is locked in operating position to energize the release coil of the operating relay of that respective control circuit. As soon as the contact arms of that operating relay drop to their unlocked lower position, current from battery bus 368, passing through the upper now closed contact arm of switch 559 and applied thereby to the tilt release bus 377, passes through the lower contact arm of the now released operating relay to energize the release coil of the respective release relay. As this release relay now becomes unlocked, its respective stop solenoid will, of course, be released.

The electrical system for automatic and manual control of the panning operation of the apparatus is substantially identical with the above described system for the control of the tilting operation, with the exception of the limit switches 345 and 346. Therefore, it is not deemed necessary to describe this latter panning control system in detail.

Reversing control

When the reversing lever 70 (Fig. 12) is moved into reversing position with the plunger 71 thereof in engagement with the hole 73, the switch 74 will be closed to complete and maintain a circuit (Fig. 31) through the energizing coils of all of the reverse relays 359R etc., across the power circuit 349. In this position of lever 70, the entire motor drive will be reversed which, of course, causes rotation of the control drum 20 to also be reversed.

As the contact arms of the various reversing relays 359R, etc., are moved to their lowermost position under the influence of their respective energizing coils, the start and stop connections of the respective control circuits are reversed. For example, the movable contact of the start switch 22R (normally in circuit with the energizing coils 360'R and 361'R forming part of the start circuit of control circuit 359R) will now be connected to the lower contact arm of the release relay 361R forming part of the stop circuit of the control circuit 359R. Likewise, the movable contact of the stop switch 22R' will now be connected to the energizing coils 360'R and 361'R to cause energization of these coils when a pin as at 21R', normally a stop pin, closes switch

22R'. Thus, in effect, the various control circuits 359R etc. will be operated in reverse order, the stop pins acting as start pins and the start pins acting as stop pins.

Thereby, the apparatus may be moved in a reverse manner through its normal path of movement, as determined by the settings of the various pins on the drum 20, to its original starting position.

Camera and support

Referring to Figs. 32 and 33, the motion picture camera 11 is illustrated as being of a motor driven type well known in the art. Camera 11 comprises a film advancing mechanism generally indicated at 415 for advancing the light sensitive film 416 intermittently past the picture aperture 417 in the camera casing 418. The film drive of camera 11 including the intermittent film advancing mechanism 415 is suitably driven by a motor 498 (Figs. 1, 2 and 4) operated in synchronism with motor 19 as described hereinafter.

The casing 418 of camera 11 is slidable transversely in dove-tail slide bearings 419 formed in a camera base 420 forming part of camera 11. Suitable shifting means (not shown) is provided to shift the casing 418 transversely on these bearings to align a focussing tube 418' with the objective lens 9 to facilitate focussing of the camera. Base 420 is secured by a clamp-screw 421 to an adapter 422 having formed thereon dovetailed guide bearings 423 (Fig. 33). Mating slide bearings are formed in a focusing slide block 424 to enable the adapter 422 to be slid therealong. A lock screw 414 threaded in block 424 abuts a jib 414' to lock the adapter 422 in any desired position along block 424. Block 424 also has dovetailed guide bearings 425 formed on the bottom thereof and extending longitudinally of the optical axis of the camera 11, which bearings are movable along mating guide bearing surfaces formed in a table 426. Table 426 forms part of the cradle 10. The slide bearings 425 enable the block 424 supporting the adapter 422, and consequently the camera 11, to be shifted in a direction parallel to the optical axis of camera 11 for focusing purposes. To effect this movement, a screw-threaded shaft 427 is threaded in the block 424 and is journalled in a bearing 428 provided in a bracket 429 which is secured to the table 426 by bolts as at 430. A spiral gear 431 secured to the end of the shaft 427 meshes with a similar gear 432 secured on an adjusting shaft 433 which is journalled in bearings 434 and 435 extending from the bracket 429, and an adjusting knob 436 is secured to the end of shaft 433 and has a scale 437 formed around the circumference thereof and calibrated in any desirable unit of length representing focal distances.

An indicator 438, suitably fixed to the bracket 429, is mounted in juxtaposition with the scale 437 on knob 436 to indicate the focal setting of the camera 11.

A lens mount 440 is supported in a groove 441 formed in a raised central portion of the cradle 10 and is removably secured thereto as by screws 442. The usual lens tube is threadably secured in an aperture formed in a vertical wall 444 forming part of the lens mount 440 in alignment with the picture aperture 417 formed in the camera body to focus the image of a scene to be photographed on the film in camera 11. The lens tube carries lens assembly 9.

A bellows unit, generally indicated at 443 is interposed between the vertical wall 444 of lens mount 440 and the front wall 451 forming part of the camera 11 and having therein an aperture 442, co-extensive with the picture aperture 417.

The bellows unit 443 comprises a pair of apertured end plates 445 and 446 having a telescoping and light sealing bellows 447 secured therebetween. An elongated pin 448 is secured at one end to the plate 446 and extends through an aperture formed in the ther plate 445. A head 449 formed on the other end of pin 448 is adapted to engage plate 445 to prevent extension of the bellows beyond a certain length. A compression spring 450 extending between the two end plates 445 and 446 presses the same against the walls 444 and 451, respectively, to form an extensible light sealing chamber intermediate the objective lens 9 and the apertured front wall of the camera 11. The wall 444 of lens mount 440 has an aperture 452 therein to allow the head 449 of pin 448 to move back and forth therein when the camera body is moved toward and away from the objective lens 9 by the knob 436 for focusing purposes. A similar pin 453 and corresponding spring 454 are interposed between the plates 445 and 446 at the bottom of the bellows unit.

Counterweights 565 and 566 are removably supported on brackets 567 and 568, respectively, extending from the front of the cradle 10 to balance the weight of the camera.

Projector and support

The projector unit 12 which may be interchanged with the camera 11 is illustrated in Figs. 3, 35, 36 and comprises a projector body 456 having suitable dovetailed bearings at the bottom thereof (not shown) extending parallel to the optical axis of projector 12, which bearings are receivable in mating bearings formed in the block 424 (Figs. 32 and 33).

The screw 414 (Fig. 33) is provided to secure the body 456 to the block 424 to enable a focusing movement to be applied to the projector body 456 by the knob 436. The projector body 456 forms a projector casing 459 having a pair of sprockets 457 and 458 therein to draw a developed motion picture film 460 downwardly past a projection aperture 461 formed in a front wall of the projector body 456. An intermittent film movement generally indicated at 462 is provided to intermittently position successive frames of the film 460 in front of the projector aperture 461. This movement 462 may be of any of the types well known in the art, and, therefore, it is not deemed necessary to describe or illustrate this movement in detail.

The film 460 is fed downwardly from a supply reel 463 rotatably supported in a magazine 464 securely mounted in a suitable manner on top of the projector casing 459.

The film positioned in the projector aperture 461 is illuminated by a projection lamp 465 provided in a lamp casing 466 which is mounted on a horizontally extending tubular extension 467 forming part of the projector bdy 456. A pair of clamping screws 468 pass through elongated slots 469 formed in the bottom of the lamp casing 466 and extending parallel to the optical axis of the projector. Screws 468 are threaded in the extension 467 to lock the casing 466 in different adjusted positions toward and away from the projector casing 459.

The lamp casing 466 has a tubular extension 470 formed therein in alignment with the projection lamp 465 and the picture projection aperture 461. A pair of condenser elements 471 and

472 are mounted in the tubular extension 470 to focus the light from lamp 465 onto the film 460.

A cooling cell 473 having glass windows 474 and 475 at the front and rear thereof is suitably attached to the rear wall of the projector casing 459 co-extensive with the condenser elements 471 and 472. A body of glycerine or the like liquid is continually fed into and out of the cell 473 through an inlet 477 and an outlet 479 to reduce the heat of the light rays projected therethrough, whereby to enable "still" projection of the film 460.

The base 480 of the lamp 465 is slidably mounted in an aperture formed in a lamp bracket 481 and is adapted to be locked in any desirable position therein by a set screw 482 to enable the filament of lamp 465 to be aligned vertically. Bracket 481 is pivotally mounted on a stud 483 extending upwardly from an adjustable plate 484 mounted on the floor of the lamp casing 466. A set screw 485 is provided to lock the bracket 481 in any desired position about the stud 483 to enable lateral alignment of the lamp 465. Clamp screws 486 pass through elongated slots 487 formed in the plate 484 and extending longitudinally of the optical axis of the projector. Screws 486 are threadably mounted in the floor of the lamp casing 466 to lock the plate 484 in different adjusted positions parallel with the optical axis of the projector to enable the lamp 465 to be adjusted toward and away from the condenser elements 471 and 472. A spherical reflector 487 is mounted on the rear wall of the casing 466 to reflect the rays of light from the lamp 465 to the condenser elements 471 and 472.

The lamp casing 466 is ventilated by a suitable suction fan (not shown) which draws air through holes in the bottom wall of the casing and past the lamp 465 to cool this lamp.

A tubular film conduit 488 is provided to guide the film 460 from the projector casing 459 to a take-up reel 489 rotatably mounted in a magazine 490 securely mounted at the top of the lamp casing 466 and rotated in a suitable manner (not shown) by the driving motor (indicated at 498 of Fig. 34) for the projector 12. The conduit 488 comprises two sections extending at right angles to each other, one section 491 being slidable within the tubular extension 467 of the projector body 456. Elongated slots 492 formed in the wall of the tubular section 491 are guided along screws 493 threaded in the tubular extension 467. The other section 495 of the film conduit 488 extends upwardly and is secured to the rear wall of the lamp casing 466 by screws 494. Section 495 terminates at the top wall of the lamp casing 466 to form a dustproof and fireproof conduit for the film 460 between the projector casing 459 and the take-up reel magazine 490. A guide roller 496 at the juncture of the two sections 491 and 495 is provided to guide the film from one section to the other. When the lamp casing 466 is moved toward or away from the projector casing 459 to correctly focus the light from the lamp 465 onto the film 460 and the aperture 461, it will be noted that the conduit 488 and the take-up reel 489 will be moved therealong as a unit, thereby forming an enclosed conduit for the film, regardless of the adjustment of the position of lamp casing 466.

The above arrangement enables the supply and take-up reels to be both mounted at the top of the projector unit while isolating the path of the film from the lamp chamber formed by the casing 466 and, at the same time providing a protection for the film against damage throughout its entire travel.

As shown in Fig. 36, the same objective lens 9 that is normally used in conjunction with the camera 11 may also be used for the projector 12. Also, the same bellows unit 443 used in conjunction with the camera 11 may be used, in which case, the rear end plate 446 abuts a forward wall 497 of the projector casing 459.

Motor synchronizing system

The motor system for driving both the motor 19 and the camera or projector motor 498 in synchronism with each other is schematically illustrated in Fig. 34. A motor 498 representing either the camera motor or the projector motor, and the driving motor 19 are illustrated as being of the three-phase interlock type, well known in the art. Each motor comprises a three-phase stator winding connected in parallel at three spaced points thereof to the corresponding points on the stator winding of the other motor through lines 523 having in circuit therewith switches 499 and 500. The stator winding of an interlock distributor 502 is connected in parallel through lines 502′ with the respective stator windings of the motors 19 and 498. Lines 502′ are connected to lines 523 intermediate switches 499 and 500. A three-phase alternating current is supplied through a circuit 503 and the lines 502′ and 523 to the various stator windings of the motors 19 and 498 and distributor to energize the same.

The three-phase rotor windings of the motors 19 and 498 and the distributor 502 are also connected in parallel with each other through lines 504 and 505, two of lines 504 also being in circuit with switches 499 and 500. A set of variable resistors 506 is connected across the rotor lines 505 to partially short circuit the various rotor windings. This action causes the various motors and distributor to act partially as induction motors and partially as interlock motors.

The rotor 501 of the distributor 502 is driven directly by a direct current motor 507 supplied with direct current from a supply circuit 508. The power supply circuit 349 for operating the various relays and driving units in the change speed mechanisms 17 and 18 is preferably connected to the main supply circuit 508 through a switch 509. A suitable governor (not shown) is preferably provided to maintain the driving motor 507 at a constant speed. Motor 507 is preferably maintained at such a speed as to cause the motor 498 to drive the film through the camera or projector at a standard rate of speed, i. e. twenty-four picture frames per second. However, the speed of the motor 507 may be varied, if desired, by adjustment of the governor or suitable rheostats (not shown, but well known in the art).

The energizing coil 510 of the electro-magnetic brake 24, connected to the rotor shaft of motor 19, is also preferably connected across the main current supply circuit 508 whereby to release brake 24 when current is applied to the driving motor 507 by closing a main switch 509′ in the circuit 508.

From the above it will be seen that both of the motors 19 and 498 will be driven in synchronism with each other, under control of the distributor 502, the speed of which will be controlled by the driving motor 507.

Referring to Fig. 63 it will be noted that the drive shaft 498′ of the camera driving motor

498 (Figs. 1, 2 and 4) is connected to the camera drive shaft 11' of the camera 11 through a clutch generally indicated at 785. Clutch 785 comprises a driving member 786 loosely mounted on the shaft 11' and having a plurality of serrated teeth 787 formed at one end thereof and arranged in a circle around the shaft 11'. A helical gear 788 is integrally formed on the driving member 786 and meshes with a mating helical gear 789 secured in a suitable manner to the camera motor drive shaft 498'. A driven clutch member 790 is slidably secured to the shaft 11' through a key 791 and has serrated teeth 792 formed thereon and adapted to engage the teeth 787 on member 786 to establish a driving connection between the motor shaft 498' and the camera shaft 11'. A compression spring 793 is interposed between the clutch members 786 and 790 to urge the driven clutch member 790 away from and out of driving engagement with the member 786. Member 790 is journalled in a bearing 794 formed in a camera adapter casing 795 which supports the motor 498 (Figs. 1, 2 and 4) from the camera 11. A nut member 796 is screw threaded on the end of the shaft 11' and engages one end of the driven clutch member 790 whereby to move this member into driving engagement with the driving clutch member 786 against the action of the spring 793. By unscrewing the nut 796 the spring 793 will urge the driven clutch member 790 out of engagement with the driving clutch member 786.

The above clutch arrangement enables the camera mechanism, including the film advancing mechanism 415 (Fig. 32) to be adjusted in position relative to the position of the camera motor shaft 498'. In other words, the phase relationship between the film driving mechanism in the camera 11 and the motor therefor may be changed as desired. Thus, the film advancing mechanism of camera 11 may be moved into any desired position before the start of a photographing or projecting operation.

Referring to Fig. 34, a phase changing device (not shown) such as is well known in the art, may be provided in any or all of the motor circuits of the distributor motor 502 and/or the interlock motors 19 and 498 whereby to vary the phase relationship between these various motors. A phase displacement indicating mechanism (not shown, but also well known in the art) may also be connected to the two motors 19 and 498 to indicate any out-of-phase relationship between these motors. Thus, in the event that one of the motors 19 and 498 becomes out-of-phase with the other, due, for example, to overload, or the like, the correct phase relationship may be established.

Mask and support therefor

Referring now to Figs. 1, 2 and 35, a semi-circular mask or matte 510 of opaque sheet material is supported in juxtaposition with the objective lens 9 and has the center of radius thereof substantially coincident with the vertical pan axis of the apparatus. A pair of vertically extending posts 511 and 512 are suitably secured to the ends of mask 510 and are slidable up and down in bearings 513 and 514, respectively, fixed to the ends of horizontal rods 515 and 516, respectively. Suitable set screws are threaded in the bearings 513 and 514 to clamp the posts 511 and 512 in any adjusted position. The rods 515 and 516 are likewise slidable horizontally in bearings 517 and 518, respectively, and are adapted to be securely locked in any desired position therein. Bearings 517 and 518 also slidably receive vertical posts 519 and 520, respectively, which are adapted to be locked in any desired position therein by suitable set screws. The posts 519 and 520 are secured at their lower ends to the upper stationary portion of the base 14 as at 521 and 522, respectively.

It will be noted that the mask 510 and supporting assembly therefor straddles the support 13 and cradle 10 whereby to enable unobstructed movement of these members to pan and/or tilt the camera 11 or projector 12 while maintaining the mask 510 in operative masking relation with respect to the lens 9.

Support for apparatus

The entire apparatus is normally supported on three spaced wheel mounts 540, 541 and 542 (Figs. 1 and 2) each of which is castered to enable the apparatus to be wheeled about as desired. However, when in operation, the apparatus is preferably supported by spaced jacks 543, 544 and 545 on an enlarged circular supporting plate 546 having the edge 547 thereof bevelled to enable the wheels of mounts 540, etc. to be rolled thereupon. Each of the jacks comprises a vertically extending screw 548 threaded in a split sleeve 549 securely mounted on the bottom of the floor 23 of base 14. Screw 548 is pointed on the lower end thereof and is movable into engagement with plate 546 by a hand wheel 548' secured thereon whereby to form a rigid support for the apparatus. By adjustment of the jacks 543, 544 and 545, the apparatus may be tilted a certain amount in any direction or may be supported in level position.

Operation of apparatus

Since the apparatus is particularly applicable to the split screen type of cinematographic operation or "shot" employed to obtain a composite picture, the general operation thereof in connection with this type of "shot" will now be described. However, it should be understood that the apparatus is not limited to the production of this type of picture, but may be employed wherever it is desired to pan and/or tilt a motion picture apparatus, particularly where the motion picture apparatus must be moved through the same path more than once for rehearsals, retakes and the like. In preparing to make a split screen type of composite picture, a sketch or artist's conception of the composite picture is generalliy made first, and from this sketch a portion of the scene which forms the component wherein any action is to occur is constructed usually in full size. This full size component may comprise only half, or even a small fraction of the entire scene to be portrayed. The panning and tilting apparatus, with the camera 11 thereon, is then placed in front of the full size set. The masking contour as at 510' (Figs. 1 and 2) of the mask 510 is then formed to enable the objective lens 9 to view, or focus on the film in camera 11, only a desired portion of the full sized set. The remainder of the field of view of the camera is thus cut off by the mask 510. The various pins 21 are thereafter positioned on the control drum 20 in such a manner as to cause the camera 11 to be panned and/or tilted through the desired path of movement thereof during the photographing of the set.

To facilitate positioning these various pins, the apparatus may first be operated under manual control, using the tilt and pan manual control switches **550** and **551**, respectively, while noting the footage of the film whenever changes in speed and/or direction occur. Thereafter, the pins may be set in accordance with such notations, bearing in mind that such changes will automatically occur in the same increments of time as did the previous manually controlled changes. To further facilitate positioning the various pins on drum **20**, the positions of the pins for causing panning movement only may first be determined as above. Thereafter, with these pins in their correct positions, the master panning switch **355** may be thrown to the left to cause automatic panning movement while the master tilting switch **354** is thrown to the left to enable the tilt switches in bank **550** to be used to tilt the apparatus under manual control while it is being automatically panned. Thus, the operator need direct his attention to one movement only at a time, i. e. panning or tilting movement.

Since as described hereinbefore, the apparatus may be reset to move the camera **11** through the same identical path any number of times, any number of rehearsals or trials may be made to insure that the camera is moved through the desired path of movement. During the panning and/or tilting movement of the camera **11**, the stationary mask **510** will mask or cut off the different portions of the field of view of the camera as predetermined.

When the negative film has been thus light exposed, it is processed and the developed negative is supplied in projector **12** which replaces the camera **11** on the cradle **10**. The same mask **510** and objective lens **9** are preferably employed during the projecting operation.

As shown in Fig. 35, a light sensitized sheet of paper, or the like, is applied to the concave surface of a suitable semicircular support **525** of sheet metal or the like, arranged concentrically about the vertical pan axis of the apparatus. With the various pins **21** remaining in their previously set positions, the lamp **465** is illuminated to project the image of the developed negative film onto the photographic paper on the support **525**, and the motor **19** is started so as to pan and/or tilt the projector **12** through the same path of movement in which the camera **11** was previously moved during the photographic operation to successively project successive kinematic aspects of the scene on the sensitized paper. Thus, a latent positive image of the unmasked portion of the original full sized set or portion thereof is impressed upon the sensitized paper on support **525**. To insure correct positioning of the successive images of the film on the sensitized paper, start marks on the film are utilized to enable the projector to be started at the same point on the film as did the camera originally.

The photographic paper is then removed from support **525** and is processed in the usual manner to render the latent image thereon visible. The photographic picture thus obtained, having a regular or irregular border determined by the contour **510'** of mask **510**, is then removed to the artist's studio where he draws or paints thereon the second component of the scene in such a manner that it will blend with the visible photographic picture already on the paper.

The photograph having the painting, forming the second component of the composite scene applied thereto is again secured on the semi-circular support **525** in the same position as previously occupied and the camera **11** is again mounted on the cradle **10**. In this case, a mask (not shown) having a masking contour complementary to that of **510'** is then mounted on the posts **511** and **512** to mask from view of the objective lens **9** the photographic picture portion of the paper on the support **525**. That is, the masking contour of this latter complementary mask occupies exactly the same position as did the original masking contour **510'** of mask **510**.

While maintaining the pins **21** in their originally set position, the apparatus is moved throughout its set path of movement while photographing the painting on the support **525**, to the exclusion of the masked photograph thereon.

The resulting film will have impressed thereon the image of the unmasked second component of the scene and may be double printed or otherwise combined in any well known manner with the original film of the first component of the scene, namely, the picture of the full sized set, to obtain a composite picture. Since the masked contours of the images of the first and second components of the scene are identical in shape and are in exact register, the resulting picture, or successive kinematic pictures, will appear to have been photographed of a single scene or set. Instead of projecting onto a sensitized sheet of paper which is secured to the support **525**, a light sensitive emulsion may be coated on the concave surface of the sheet metal support **525**, onto which coating the picture may be projected. Thereafter, suitable developing, fixing, and other suitable processing solutions may be sprayed or otherwise applied to the emulsion to render the latent image projected thereon visible and permanent.

An example of the above procedure is illustrated in Figs. 37 to 42, inclusive, wherein are shown the steps of making a composite motion picture of three full-sized buildings **528**, **529** and **530** (Fig. 37) with the addition of a building and a background of mountains and other suitable landscape. The camera **11**, mounted on the panning and tilting apparatus described hereinbefore, is positioned in front of the three buildings and the mask **510** is so formed as to exclude from the view of the camera all but the images of these three buildings. That is, the contour line **510'** is so formed as to coincide with the outlines of the buildings when viewed by the camera **11** as it is panned. The apparatus is set by means of the various pins **21** (as described hereinbefore) to pan (but not tilt) for example, to the right at a speed of $2\frac{2}{3}°$ per foot of film traversed through the camera. During the photographic operation of the camera, actors, or other animated objects may move in front of the buildings. However, care must be taken that they are not masked off from the field of view of the camera by the mask **510** during the panning traverse of the camera.

The negative motion picture film exposed during the panning traverse of the camera **11** is processed and appears as shown at **531** in Fig. 40. It will be noted that the portions **532** in each of the successive film frames **531a**, **531b**, **531c**, etc. which surround the images of the buildings **528**, etc. will be blank due to the masking effect of mask **510**.

The film **531**, after processing, is supplied to the projector **12** which is substituted for the camera **11** on the panning and tilting apparatus. The semi-circular support **525** (Fig. 35) is then positioned concentrically about the panning axis of the projector and a sheet of light sensitized paper **533** (shown in extended position in Fig.

38) is suitably secured to the concave surface of support **525**. The projector **12** and the panning and tilting apparatus are then moved to their original starting positions by throwing the handle **70** (Fig. 12) into reversing position. The projector **12** and the panning and tilting apparatus are then started to pan the projector to the right at the same speed as the camera previously traversed the field of view of the three buildings **528**, **529** and **530**, namely, at 2⅔° per foot. During this time, the projector will project the successive film frame images of the negative film **531** onto the sensitized sheet **533**. These various images will overlap each other as at **531***a'*, **531***b'* and **531***c'* (Fig. 38), corresponding to the film frames **531***a*, **531***b*, and **531***c*, respectively. On completion of the panning movement of the projector a panoramic image of the three buildings will appear on the sheet **533**.

During the above operation, the same mask **510** that was previously used in front of the camera **11** may be placed in front of the projector so as to block out the images of the outer blank portions **532** of the successive film frames of film **531**. The mask **510** may, however, be dispensed with during this latter projecting operation, in which case, the outer portion **534** on sheet **533** will be exposed throughout its areas and will appear black when the sheet is processed.

The sheet **533**, after being fully exposed in the above manner, is removed and then processed to render the various images thereon visible as at **528'**, **529'** and **530'** of Fig. 39. If the mask **510** was used during the projecting operation the portion **534** will appear substantially uniformly black due to exposure.

Thereafter, an artist paints or draws the remaining component of the composite picture on the sheet **533** in such a manner that they blend with the images already photographed thereon. For example, roofs as at **546** and **547** may be printed over the photographic pictures **529'** and **530'** of the houses **529** and **530**. Also, the picture of a house **535** and a background **536** of mountains, or the like, may painted on the blank portion **534**.

After the sheet **533** has been completely painted, it is again secured to the semi-circular support **525**, suitable locating pins (not shown) being provided to insure that the sheet is placed in the same position as it was when the images of film **531** were projected thereon. Camera **11** is then again substituted for the projector without disturbing the position of the panning and tilting mechanism and a new mask (not shown) is formed complementary to that of **510**. This latter mask is supported in front of the camera so as to mask from view thereof the photographic images **528'**, **529'** and **530'** appearing on the sheet **533**. The camera is thereafter operated to cinematograph the newly painted sheet **533** while causing the same to be panned at the above mentioned speed of 2⅔° per foot of film toward the right to produce a new negative film **537** (Fig. 41). During this latter cinematographing operation, the speed of the motor **507** (Fig. 34) may be regulated as described hereinbefore to speed up or slow down the cinematographing speed and the panning speed. This new negative, **537**, when processed, will therefore have formed thereon, the successive kinematic images of the painting on sheet **533**, such as the house **535**, the roofs as at **546**, and mountains **536** thereon while the images of the buildings **528**, **529**, **530** will be blacked out as at **548**.

The two films are then double printed in the usual well known manner onto a third film **538** (Fig. 42) which, when processed, will contain thereon both the images of the full sized houses as originally photographed as well as the images of the paintings made on the sheet **533** by the artist.

If it were desired to make a composite picture including as one component, for example, the images of the buildings **528**, **529** and **530**, without the need of registering or harmoniously blending any portion of one component of the composite picture with that of the other, the intermediate step of projecting the image of one component, as carried by the film **531**, onto the sensitized sheet **533** and thereafter painting or drawing the other component on this sheet, may be dispensed with. In this case, the film **531** may be obtained as above described by the use of the mask **510** and, before processing, the film is rewound to its starting position in the camera **11**. The panning and tilting apparatus supporting camera **11** is return to its starting position and a second scene (for example, the sky, clouds, or the like) may be photographed on the film while using a mask complementary to that of **510** to protect the successive images of the buildings **528**, **529**, **530** appearing on the film **531**.

Figs. 43 to 46, inclusive, illustrate another new method of obtaining composite moving pictures by the use of the panning and tilting apparatus of the present invention. In this case, the method of obtaining a composite picture of a full sized set **539** (Fig. 43) and a miniature set **540** (Fig. 44) is illustrated. In this case, a single film **541** may be used to photograph the complete composite picture.

The film **541** is first supplied to the moving picture camera **11** which is mounted on the panning and tilting apparatus in front of the full size set **539**, herein shown as being a house or the like. A mask **542** is formed having a vertical masking edge **543** and is stationarily supported in front of the camera **11** so that the masking edge **543** coincides with the right hand edge **549** of the house **539** when viewed by the camera **11**.

The camera **11** is then operated while the panning and tilting apparatus is caused to pan the camera to the right at a definite speed, i. e. 4° per foot. During the panning traverse of the camera **11** the field of view thereof will be progressively and gradually cut off or masked by the mask **542**.

A fragment of the film **541** having a latent image of the house **539** thereon as formed in the operation as illustrated in Fig. 43 is shown in Fig. 45. Of course the portion **549** of each film frame of film **541** which extends to the right of the image of the house **539** will be rendered blank and unexposed by the mask **542**.

With the latent image of the house **539** thereon, the light sensitive film **541** is rewound to its original starting position in the camera **11** and a mask **544**, complementary to that of **542** is stationarily positioned in front of the camera **11** as shown in Fig. 44. The minature set **540**, illustrated as comprising a minature lake having a model boat therein, is positioned in front of the camera **11**. The panning and tilting apparatus is moved to its original starting position, at which time the field of view of the camera 11 will be entirely masked off by the mask 544.

The camera and panning and tilting apparatus are then started to pan the camera at the same speed as it was originally panned during the photographing of the house 539. As the camera is panned toward the right more and more of the minature set 540 will be unmasked.

The doubly exposed negative film 541 is thereafter processed and found to contain the composite picture of both the full sized set 539 and the miniature 540 as shown in Fig. 46. The successive film frames of film 541 will show a gradual transition from the image of the house 539 to the image of the minature set 540 to simulate a panning movement from the house to the lake. Of course, the full sized set 539 and the miniature set may be cinematographed on separate films while using complementary masks as at 542 and 544 and, thereafter these two films, when processed, could be double printed onto one film to obtain the same images as appear on film 541 of Fig. 46.

Figs. 47 and 48, inclusive, illustrate another new method of producing composite motion pictures by the use of the panning and tilting apparatus of the present invention, in which case, use is made of the panning and tilting movements of the apparatus simultaneously. These figures illustrate an example of producing a composite motion picture representing simultaneous panning and tilting of a cinematographic camera from one window of a building to another window of that building without actually photographing the building. Fig. 47 represents the view at the camera station or position and taken behind a mask 625 stationarily secured in front of the camera in the same manner as the mask 510 is shown as being supported.

In this case, a lower full size set 620 is constructed, in which is formed a window 621 and a surrounding wall portion. A second full sized set 622 having a window 623 formed therein is suitably supported by means of structure 624 above and to the right of the lower set 620 so as to enable the camera to be panned and simultaneously tilted upward from one window to the other.

A mask 625 is stationarily supported in front of the camera 11 which is mounted on the panning and tilting apparatus. Mask 625 is so formed as to mask from the view of the camera the intervening space between the two sets 620 and 622. The various control pins 21 are so positioned on the control drum 20 of the panning and tilting apparatus that the camera is panned and tilted about the nodal point of the objective lens thereof to move the field of view of the camera along the path indicated by the dot and dash lines 626, the various rectangles as at 619, in dot and dash lines representing successively different positions of the field of view of the camera. During such panning movement actors as at 627 and 628 may appear in action on the sets 620 and 622, respectively.

The resulting negative film is processed and then supplied to a projector, as at 12, which is substituted for the camera on the panning and tilting apparatus.

The apparatus is thereafter positioned in front of the semi-circular support 525 (Fig. 35) in the manner hereinbefore described and a light sensitized sheet 629 is suitably secured to the concave surface of the support 525. (In lieu of the light sensitized sheet 629 a light sensitive emulsion may, of course, be applied to the concave surface of the support 525 as described hereinbefore.)

The successive film frame images of the negative film are then projected on the sensitized sheet 629 while the apparatus pans and tilts the projector at the same rate of speed and in the same direction as the camera was originally moved to form latent images of the sets 620 and 622 as shown at 620′ and 621′, respectively. Due to the fact that the space intermediate the two full sized sets was originally masked off by the mask 625, the portion of the sheet 629 intermediate the dotted lines 630 and 631 (corresponding to the matt lines 632 and 633 of the mask 625) will be unexposed.

The sheet 629 or emulsion onto which the picture was projected is then developed and fixed in the usual manner to render the images 620′ and 621′ of the two full sized sets visible. With these pictures thereon, an artist paints or draws upon a blank space intermediate the edges of the visible images 620′ and 621′ as defined by the dotted lines 630 and 631, suitable scenery, for example, a painting representing the face of the building which might exist intermediate the two depicted windows therein. Such scenery may thus be made to blend harmoniously with the images of the full sized sets. For example, the painted bricks or blocks 617 may be painted to coincide with the images of actual bricks or blocks as at 618 appearing in the photographic pictures on the sheet 629.

The photographic images 620′ and 621′ of sheet 629 are thereafter preferably painted out with suitable non-reflective black paint and the painting is cinematographed on a new negative film in the camera 11 which is again mounted on the panning and tilting apparatus. Of course, the apparatus is again automatically moved through its previously prescribed path of movement determined by the positions of the pins 21 (Fig. 4).

The resulting film after being suitably processed is then double printed with the original negative film of the two sets 620 and 622 onto a final moving picture film to obtain a composite moving picture.

Figs. 49 and 50 illustrate another new method of producing composite moving pictures by the use of the panning and tilting apparatus of the present invention wherein one component of the picture is formed by a full size set 633 (Fig. 50) and the other component of the picture is formed by a miniature set 634 (Fig. 49). These views represent views taken at the camera station or position and behind stationarily supported masks arranged to mask off certain parts of the field of view of the camera as it is being moved.

In this case, a mask 635 is stationarily positioned in front of the objective lens of the camera (not shown) in a manner similar to that of mask 510 and the camera is arranged to be moved downwardly by the panning and tilting apparatus from the full size set 633 until the field of view of the camera is entirely masked by the mask 635, the position of the field of view at that point being illustrated by the rectangle 636 of dot and dash lines.

The same film is then rewound to its original starting point in the camera and the panning and tilting apparatus is set in its original starting position. A mask 637 having edges or matt lines 638 complementary to the matt lines 639 of mask 635 is then stationarily positioned in front of the camera with the matt lines 638 thereof occupying the same positions as the matt lines 639 of mask 635 previously occupied.

The miniature set 634 is then so constructed and positioned behind the mask 637 that the images of the various parts of the structure thereof will blend harmoniously with the images of the structure of the full size set 633 on the film when subsequently processed. With the field of view of the camera occupying the same relative starting position, as indicated by the dot and dash line rectangle 640, as it did at the start of the photographing operation of set 633, the panning and tilting apparatus is started so as to pan and tilt the camera downwardly and to the right away from the mask 637 and onto the set 634. During this latter photographing operation, the main driving motor 507 (Fig. 34) may be speeded up or slowed down so as to increase or decrease the photographing speed as well as the panning and tilting speed of the apparatus.

Instead of the miniature set 634, the set may be either full sized or over-size as desired to obtain the same result. Furthermore, a painting or photograph or picture projected onto the rear of a translucent screen may be used in place of the miniature set 634 to obtain the same result.

Fig. 51 illustrates a step in a method of producing composite motion pictures by the use of panning and tilting apparatus of the present invention wherein the camera 11 is tilted about a horizontal axis, as at 642, passing through the nodal point of the objective lens thereof by the apparatus. In this case, a stationary mask 643 having a horizontally extending matt line 644 at the top thereof is positioned in front of the camera 11 to mask from view thereof a portion of a set 645, either full size, miniature or oversize, or a painting. As the camera 11 is tilted downwardly while cinematographing the set more and more of the field of view thereof is masked or cut off by the mask 643 until the entire amount thereof is completely masked off. In a subsequent cinematographing operation (not illustrated), using a mask complementary to that of 643 with the matt line thereof aligned in the same position that the matt line 644 of mask 643 previously occupied, the camera is tilted downwardly onto a second set in a manner obvious from the foregoing disclosure. In the example given above, the camera 11 need not be panned, although it could be if desired.

Fig. 52 illustrates a step in another method of producing composite motion pictures by the use of the panning and tilting apparatus of the present invention. In this case, the camera 11, supported by the panning and tilting apparatus, is tilted about the horizontal axis 642 passing through the nodal point of the objective lens thereof while cinematographing a set 648. A pair of masks 649 and 650, illustrated as having vertically extending matt lines 651 and 652, respectively, are stationarily supported in front of the camera 11 to mask the outer vertical edges of the field of view of the camera as it is tilted about the horizontal axis 642. In a subsequent photographic operation (not illustrated) using a stationary mask with the opposite vertical edges or matt lines thereof aligned in the same positions that the matt lines 651 and 652 previously occupied, the camera is tilted downwardly along a second set or painting in a manner obvious from the foregoing disclosure to obtain the second component of the composite picture.

Figs. 53 to 58, inclusive, illustrate a method of producing a composite picture while employing a combination of several of the methods hereinbefore described. These figures illustrate, for example, the production of a composite motion picture wherein the field of view is caused to move upwardly from a street scene 654 (Fig. 53) past buildings 655, actors as at 656, and thereafter past the sky line 670 of the various buildings, depicted in the picture.

An artist's conception or drawing is first made which may appear somewhat as illustrated in Fig. 53. With this drawing in mind an actual scene is shown in Fig. 54 is located and the camera 11, mounted on the panning and tilting apparatus, is set up in front of this scene so as to tilt upwardly from the street 654 and past buildings as at 655. A mask 657 is stationarily supported in front of the camera to mask from view thereof the tops or sky line as at 671 of the various buildings 655, etc. Thereafter, the camera is tilted in the manner hereinbefore described by the panning and tilting apparatus to move the field of view thereof along the path indicated by the various dot and dash line rectangles 658 until the entire field of view thereof is masked by the mask 657. The movement of the apparatus will, of course, be controlled automatically by prearrangement of the various pins on the control drum 20. It will be noted that a portion 659 of the matt line of the mask 657 is so cut as to be aligned with one of the natural perspective lines of the scene leading to the natural vanishing point as at "X" of the scene as viewed from the camera station. It will be noted that in the above cinematographic operation, suitable action may take place in any desired portion of the scene as, for example, illustrated by the vehicle 653 travelling along the street 654.

Fig. 55 represents a full size set 660 constructed to form a second component of the composite picture. This set 660 is constructed to represent the top of the building 655 (Fig. 54) and is supported only a short distance above the studio floor 661 to enable actors as at 656 to walk safely along the ledge 663 thereof, representing the top ledge of the building 665. The camera 11 mounted on the panning and tilting apparatus is arranged in front of the set 660 to cinematograph the same in the same perspective as the scene in Fig. 54 was cinematographed. A stationary mask 664 is stationarily arranged in front of the camera and has a matt line formed therein to exclude from view all but certain desired portions of the set 660. The portion 665 of the matt line of mask 664 is aligned in the same position that the portion 659 of mask 657 originally occupied. A new negative film is supplied to the camera 11 and the apparatus is moved into such a position, under the previously set automatic control, that the field of view of the camera is completely blocked out by the mask 664, this position being indicated by the dot dash line rectangle 666. Thereafter, the camera is tilted upwardly by the apparatus while using the same pre-set automatic control as was employed in photographing the scene in Fig. 54. After the camera 11 has been tilted upwardly into such a position that the field of view thereof is again completely masked off by the mask 664, as shown by the dot dash line rectangle 667, the apparatus is stopped and the negative film thus obtained is processed in the usual manner.

Fig. 56 represents the third component of the composite picture, this being a miniature set **668**, constructed to form part of the sky line or sky portion of the composite picture. Set **668** comprises a model **669** representing the top of a sky scraper, or the like, and supported on a table **770**. A backing **771** is suitably painted to represent the sky and may have thereon pictures of the tops of other buildings, or the like, (not shown). A model dirigible **772** is suspended in front of the backing **771** by fine "invisible" wires from a carriage **773** movable along tracks **774**, which are stationarily positioned above the backing **771**.

The camera **11** having a new negative film therein is mounted on the panning and tilting apparatus which is arranged in front of the set. A stationary mask **775** is placed in front of the camera. The panning and tilting apparatus is moved into such a position as to position the camera so that the field of view thereof is entirely cut off by the mask **775** as represented by the dot and dash line rectangle **776**. Thereafter, the apparatus is started to move the camera in its prescribed path of movement across the mask **775** and onto the miniature set. During this time the model dirigible **772** may be moved to simulate action. The resulting negative film is thereafter processed.

The projector **12** is then substituted for the camera on the panning and tilting apparatus and the entire unit is arranged in front of the semicircular support **525** (Fig. 35). A sensitized sheet **777** (Fig. 57) is placed on the concave surface of the support **525** and the negative film having recorded thereon the scene shown in Fig. 54 is supplied to the projector. Using the mask **657** or one similar thereto in the same position that this mask originally occupied during the photographing of the scene in Fig. 54, the projector and panning and tilting apparatus are operated to project a latent image of this scene upon the sensitized sheet **777** as shown at **778**. In view of the fact that it is not necessary to alter or add as by painting or otherwise, any new component of the composite picture below the matt line **659'** of this scene **778**, only the upper portion of this scene need be projected on the sensitized sheet **777**.

Thereafter, the negative used in photographing the full size set of Fig. 55 is substituted for the negative of the scene of Fig. 54 in the projector and the mask **664**, or one similar thereto is stationarily positioned in front thereof in the same relative position that it previously occupied in cinematographing the full size set of Fig. 55. The panning and tilting apparatus is moved to its original starting position, or at least to such a position that the projected field of the projector is entirely below the matt line **665** of mask **664**. Then, the panning and tilting apparatus is actuated to tilt the projector upwardly while it projects upon the sensitized sheet **777** the image **779** of the full size set **660**.

The third negative film having photographed thereon the image of the miniature set of Fig. 56 is thereafter likewise projected upon the sensitized sheet **777** and appears at **780**. During this projection the mask **775**, or one similar thereto, is stationarily positioned in front of the projector mounted on the panning and tilting apparatus, and is arranged in the same relative position that it previously occupied during the cinematographing of set **668** of Fig. 56.

The sensitized sheet **777** is then suitably developed in any well known manner to render the various images **778**, **779** and **780** thereon visible, and permanent.

As shown in Fig. 58, an artist paints or draws upon a developed sheet **777** the remaining component of the composite picture which, in this case, comprises a skyscraper **781** and portions of other buildings which may or may not represent parts of buildings already appearing in the previously photographed components of the picture. The photographic images **778**, **779** and **780** are then painted out with a suitable non-reflecting black paint, or the like, and the painting representing the fourth component of the composite picture is then photographed upon a new negative film which is supplied to the camera **11** which is now mounted on the panning and tilting apparatus in front of the support **525**, the panning and tilting apparatus being regulated in its previously pre-set condition to cause the camera **11** to move in the same identical path as it originally did in photographing and projecting each and every one of the other scenes or sets shown in Figs. 54, 55 and 56.

The various negative films thus obtained or positive prints thereof are all printed, or otherwise combined in a manner well known in the art to produce a single composite film having thereon the various components of the composite picture in their correct relative positions.

When the film thus obtained or a print thereof is subsequently projected in a standard stationary projector, the composite picture projected therefrom will appear to have been cinematographed while the camera was moved across a scene as illustrated in Fig. 53.

Figs. 59 to 62, inclusive, illustrate still another new method of producing composite motion pictures by the use of the panning and tilting apparatus of the present invention, in which case, use is made of masks which are movable along with the camera. In this case, it is possible to photograph an actor in two or more operations in front of the same set or scenery and in different positions, so as to cause the actor to appear in multiple in each film frame of the picture. For example, it may be possible with this particular method to cause an actor to appear to follow himself across a room, as when portraying the role of twins.

Referring to Fig. 59 in particular, the camera **11**, mounted on the panning and tilting apparatus, (not shown) is arranged, in this case, to be panned across a set **783** representing the side of a building. The panning and tilting apparatus is, of course, pre-set in the usual hereinbefore described manner to provide automatic panning movement of the camera. A mask **784** having a vertical matt line **785** is secured to the camera or the cradle **10** (Fig. 1) in any suitable manner as by rods diagrammatically illustrated at **786**, whereby the mask **784** moves with the camera **11**. The panning and tilting apparatus is started to automatically pan the camera **11** to the right across the set **783** at a particular speed and, during this panning motion of the camera, an actor **787** moves across the set **783** while keeping in the unobstructed field of view of the camera **11**. The resulting negative film having the latent image of the actor **787** and a portion of the set **783** is illustrated at **788** of Fig. 60. Due to the masking effect of mask **784**, one-half or more or less of each of the successive film frames of the film **788** will be blank as at **789**.

In a second operation, without disturbing the relative positions of the camera 11 and set 783, the support and cradles of the panning and tilting apparatus are moved to their original starting positions and a second mask 790 having a vertical matt line 791, aligned in the same position that the matt line 785 of mask 784 originally occupied, is suitably secured to the camera 11 or the cradle 10 as by rods 792. Using the previously pre-set automatic control, the camera is again panned across the set 783 while the actor 787 again moves across the set. Care is taken during this latter operation that the actor 787 again stays in the unobstructed field of view of the camera while it is being panned.

The film 788 thus having thereon the two images of the actor 787 in spaced relation with each other is then processed and appears as illustrated in Figure 62. The latter cinematographed image of the actor 787 appears at 787′ on film 788. Due to the fact that the set 783 is immovable during the two successive photographic operations, the images of this set as obtained during these two operations, will be superimposed upon each other and will therefore appear as one.

In the above description of the production of composite pictures, while using the panning and tilting apparatus of the present invention, it has been assumed that the various masks, as at 510, are coated on their inner surfaces with black or other non-reflective paint, so as to protect the portion of the film masked thereby. However, if desired, the inner surfaces of such masks may be rendered reflective of light, and may be intensely illuminated so as to totally expose the corresponding portions of the film which are masked thereby. A different, but obvious procedure would then be followed in printing or otherwise combining the various components of the composite pictures thus obtained.

It will appear from the above that many and various methods of producing novel effects in motion pictures either by straight photography or composite photography may be obtained by the use of the panning and tilting apparatus of the present invention.

Although the invention has been described and is particularly adaptable to the use of motion picture apparatus using motion picture film, it is to be understood that the invention may also be used in connection with television apparatus, or the like, without departing from the spirit of the invention. Therefore, the term "motion picture apparatus" in the appended claims is meant to define motion picture cameras or projectors of the photographic film type, or other types, as well as television cameras or projectors, or the like.

We claim:

1. The combination comprising a mount for supporting a motion picture apparatus, means for supporting said mount for movement about an axis, means comprising a plurality of speed changing devices for moving said mount about said axis at different speeds, and means for controlling the speed of said last mentioned means in a predetermined manner comprising a movable control member having control elements adjustable to different positions for selectively controlling said speed changing devices and means for moving said control member in timed relation with said motion picture apparatus.

2. The combination comprising a mount for supporting a motion picture apparatus, means comprising a plurality of sets of speed changing devices for moving said mount about a plurality of different axes, respectively, and means for changing the speed of movement of said mount about one of said axes relative to the speed of movement thereof about another of said axes in a predetermined manner comprising a control member for all of said sets and having control elements adjustable to different positions to selectively control the speed changing devices of all of said sets.

3. The combination comprising a cradle for supporting a motion picture apparatus having an objective lens, means supporting said cradle for panning and tilting movement about axes intersecting at the nodal point of said lens, driving means, means operated by said driving means for panning said cradle, and means operated by said driving means for tilting said cradle, a record of panning movements controlling said panning means, and an independent record of tilting movements controlling said tilting means.

4. The combination according to claim 3 wherein said records comprise circuits for controlling the operation of said last two mentioned means, and a rotatable drum having pins movable to different positions thereon for controlling said circuits.

5. The combination comprising a motion picture apparatus, means for moving said apparatus about an axis, a plurality of driving members rotatable at different speeds, and means for selectively connecting said members to said first mentioned means in a predetermined order to move said apparatus at predetermined different speeds, said second means comprising a controller operable in synchronism with said apparatus, and means adjustable on said controller for varying the time when said members are selectively connected to said first mentioned means.

6. The combination comprising a motion picture camera, means for intermittently exposing successive frames of a motion picture film in said camera, means supporting said camera for movement about axes at right angles and intersecting at the nodal point of the lens of said camera, means for traversing the field of view of said camera across a scene, and an operable connection between said first and last mentioned means whereby each of said successive frames may be exposed to a predetermined image of the field of view of said camera, said operable connection comprising a record of the line of movement of said camera for traversing said field of view.

7. The combination comprising a cradle for supporting a motion picture apparatus, a yoke for supporting said cradle for tilting movement, a base rotatably supporting said yoke, a driving motor on said base, a variable speed device on said base driven by said motor for panning said yoke, a second variable speed device on said base driven by said motor for tilting said cradle, and means for independently controlling said variable speed devices in a predetermined manner.

8. The combination comprising a motion picture apparatus, means supporting said apparatus for panning and tilting movement, a driving motor, a variable speed device driven by said motor for panning said apparatus, a second variable speed device driven by said motor for tilting said apparatus, a drum, means rotatably supporting said drum, means operatively connecting said drum to said motor for rotating said drum, a plurality of speed control devices for controlling said

variable speed devices, and means movable into different positions on said drum and adapted to selectively actuate said speed control devices on rotation of said drum in a manner determined by the position of said last mentioned means.

9. The combination comprising a mount for a motion picture apparatus, means supporting said mount for movement about an axis, a plurality of drive members, means for rotating said members at different speeds, a shaft, means driven by said shaft for moving said mount about said axis, respective electro-magnetic devices for operatively connecting said drive members to said drive shaft, respective switches and circuit connections for selectively energizing said electro-magnetic devices, and means for closing said switches in any desired order.

10. The combination comprising a relatively stationary base, a yoke mounted on said base for movement about a vertical axis, aligned bearings in the arms of said yoke, a cradle for a motion picture apparatus mounted on said bearings for movement about a horizontal axis, a motor on said base, means operatively connecting said motor to said yoke for moving said yoke about said vertical axis, and means operatively connecting said motor to said cradle for moving said cradle about said horizontal axis.

11. The combination comprising a relatively stationary base, a yoke mounted on said base for movement about an axis, a cradle for a motion picture apparatus pivotally mounted on the arms of said yoke for movement about a second axis intersecting said first mentioned axis, said cradle having a base for supporting a motion picture camera with its objective lens at the intersection of said axes, a drive shaft rotatably carried by said base, means operatively connected between said drive shaft and said yoke for moving said yoke about said first mentioned axis, a second drive shaft rotatably carried by said base, and means operatively connected between said second drive shaft and said cradle for moving said cradle about said second axis.

12. The combination comprising a base, a support mounted on said base for movement about a pan axis, a cradle for a motion picture apparatus mounted on said support for movement about a tilt axis, means for moving said support about said pan axis, a tilt shaft rotatably supported by said base co-axially of said pan axis, means driven by said shaft for moving said cradle about said tilt axis, means for rotating said shaft, and means responsive to the panning movement of said support for controlling the rotation of said tilt shaft.

13. The combination comprising means for supporting a motion picture apparatus for movement about an axis, a tilt shaft for tilting said apparatus about said axis, a drive shaft, a differential means connecting said drive shaft to said tilt shaft to drive said tilt shaft, and panning means for driving said differential whereby to rotate said tilt shaft relatively to said drive shaft.

14. The combination comprising a base, a support mounted on said base for movement about a vertical pan axis, a cradle for a motion picture apparatus mounted on said support for movement about a horizontal tilt axis, means for moving said support about said pan axis, a tilt shaft, means driven by said tilt shaft for moving said cradle about said tilt axis, a drive shaft, differential means connecting said drive shaft to said tilt shaft for controlling rotation of said tilt shaft, and means operated by said first mentioned means for controlling the operation of said differential means.

15. The combination comprising a mount for a motion picture apparatus, means for supporting said mount for panning and tilting movement, means for panning said mount, means for tilting said mount, a drum, means operated by said drum for controlling the operation of said panning and tilting means, a motor, a clutch operatively connecting said motor to said drum for rotating said drum, and means responsive to the opening of said clutch for rendering said pan and tilt controlling means inoperative.

16. A combination comprising a mount for a motion picture apparatus, means for supporting said mount for movement about an axis, a drive shaft, means operatively connected to said shaft for moving said apparatus about said axis, means forming a helical screw rotatable by said shaft, a member threaded on said screw and movable therealong when said screw is rotated, and means responsive to movement of said member for controlling the operation of said drive shaft.

17. The combination comprising a base, a support mounted on said base for movement about a vertical pan axis, a cradle mounted on said support for movement about a horizontal tilt axis, a tilt shaft rotatably supported by said base co-axially of said pan axis, means on said tilt shaft forming a worm, a worm wheel meshing with said worm and rotatably supported by said support for movement about a horizontal axis, and means operatively connecting said worm wheel to said cradle for tilting said cradle.

18. The combination comprising a base, a support mounted on said base for movement about a vertical pan axis, a cradle mounted on said support for movement about a horizontal tilt axis, a tilt shaft rotatably supported by said base co-axially of said pan axis, means on said tilt shaft forming a worm, a worm wheel meshing with said worm and rotatably supported by said support for movement about a horizontal axis, and means operatively connecting said worm wheel to said cradle at one end of said cradle for tilting said cradle, a second worm wheel meshing with said worm and rotatably supported by said support for movement about a horizontal axis, and means operatively connecting said second worm wheel to the other side of said cradle for tilting said cradle.

19. The combination comprising a mount for a motion picture apparatus, means for moving said mount about an axis at different speeds, manually operable control means for controlling said first mentioned means to fix the speed of operation, and means running with the film in said apparatus for causing said control means to become effective for moving said mount at the selected speed.

20. The combination comprising a mount for supporting a motion picture apparatus, means for moving said mount about a plurality of different axes, means for changing the speed of movement of said mount about one of said axes relative to the speed of movement thereof about another of said axes, control means adapted to be actuated to control said first two mentioned means, and means for causing said control means to become effective at predetermined regular intervals only after actuation thereof.

21. The combination comprising a base, means for moving said base about an axis, means comprising a circuit and switch therefor for controlling said moving means, and means for complet-

ing said circuit at predetermined regular intervals only when said switch is closed.

22. Motion picture apparatus comprising the combination of a mount adapted to support photographic apparatus, speed change mechanism for driving said mount, means for selectively preparing said speed change mechanism for operation at different speeds, and means operative in synchronism with the photographic apparatus for completing the operation of said speed change mechanism.

23. Motion picture apparatus comprising the combination of a mount adapted to support photographic apparatus, means supporting said mount for panning and tilting movements, an array of speed change mechanisms for panning said mount, an array of speed change mechanisms for tilting said mount, means for selectively preparing each of said arrays of speed change mechanisms for operation at different speeds and means operative in synchronism with the photographic apparatus for completing the operation of the prepared speed change mechanisms.

24. The combination of a mount for motion picture apparatus, a pan drive for said mount, a tilt drive for said mount, means comprising a record of a sequence of panning movements in opposite directions controlling said pan drive, and means comprising a record of a sequence of tilting movements in opposite directions controlling said tilt drive.

25. The combination according to claim 24 wherein said records are arranged on a rotatable drum, a motion picture apparatus on said mount, and means for operating said drum in timed relation with said motion picture apparatus.

26. The combination of motion picture apparatus, a mount therefor, a drive for panning said mount, a record of panning movements at different speeds operable in timed relation with said apparatus for controlling said drive, a drive for tilting said mount, and a record of tilting movements at different speeds operable in timed relation with said apparatus for controlling said last mentioned drive.

27. A combination of a mount for motion picture apparatus, a drive comprising speed change mechanism for panning said mount, a drive comprising speed change mechanism for tilting said mount, a controller having an array of apertures arranged in groups, one of said groups controlling panning and said group being divided into two sub-groups for controlling rightward and leftward panning movement respectively, another of said groups controlling tilting, and being divided into two sub-groups for controlling tilting movement upwardly and downwardly respectively, each of said sub-groups being divided into a plurality of pairs, each pair controlling movement in a particular direction and at a particular speed, adjustable pins for certain of said apertures, contacts controlled by said pins, means in circuit with said contacts for controlling said speed change mechanisms, and means for moving said controller.

28. The combination of a mount for motion picture apparatus, means for panning said mount in opposite directions, means for tilting said mount in opposite directions, and direction controlling means running with the film in said apparatus for operating both of said first two mentioned means, for panning and tilting said mount in opposite directions.

29. The combination of a mount for motion picture apparatus, means for panning said mount at different speeds, means for tilting said mount at different speeds, and variable speed determining means running with the film in said apparatus for operating both of said first two mentioned means.

30. The combination of motion picture apparatus, a mount therefor, means supporting said mount for panning movement, a panning drive for said mount, a record of panning movements in opposite directions controlling said drive, and means for moving said record to effect panning movements in opposite directions in timed relation with the operation of said motion picture apparatus.

31. The combination of a mount for motion picture apparatus, means supporting said mount for panning movement, a panning drive for said mount, and means comprising a register of panning movements in opposite directions controlling said panning drive.

32. The combination of motion picture apparatus, a mount therefor, means supporting said mount for tilting movement, a tilting drive for said mount, a record of tilting movements in opposite directions controlling said drive and means for moving said record to effect tilting movements in opposite directions in timed relation with the operation of said motion picture apparatus.

33. The combination of a mount for motion picture apparatus, means supporting said mount for tilting movement, a tilting drive for said mount and means comprising a register of tilting movements in opposite directions controlling said tilting drive.

34. The combination of a mount for motion picture apparatus, means supporting said mount for panning and tilting movements, a panning drive and a tilting drive for said mount, and means comprising a register of panning movements in opposite directions controlling said panning drive, and means comprising a separate register of tilting movements in opposite directions controlling said tilting drive.

35. The combination of a mount for motion picture apparatus, means supporting said mount for panning movement, a panning drive for said mount, and means comprising a register of panning movements at different speeds controlling said panning drive.

36. The combination of a mount for motion picture apparatus, means supporting said mount for tilting movement, a tilting drive for said mount and means comprising a register of tilting movements at different speeds controlling said tilting drive.

37. The combination of motion picture apparatus, a mount therefor, circuit means for driving said mount in different directions and at different speeds, a controller having contact operating devices calibrated in terms of direction and speed of movement of said mount for controlling said circuit means, and means for operating said controller in timed relation with said motion picture apparatus.

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