Dec. 29, 1942. R. BOWN 2,306,862

TELEVISION REMOTE CONTROL

Filed July 8, 1941 2 Sheets-Sheet 1

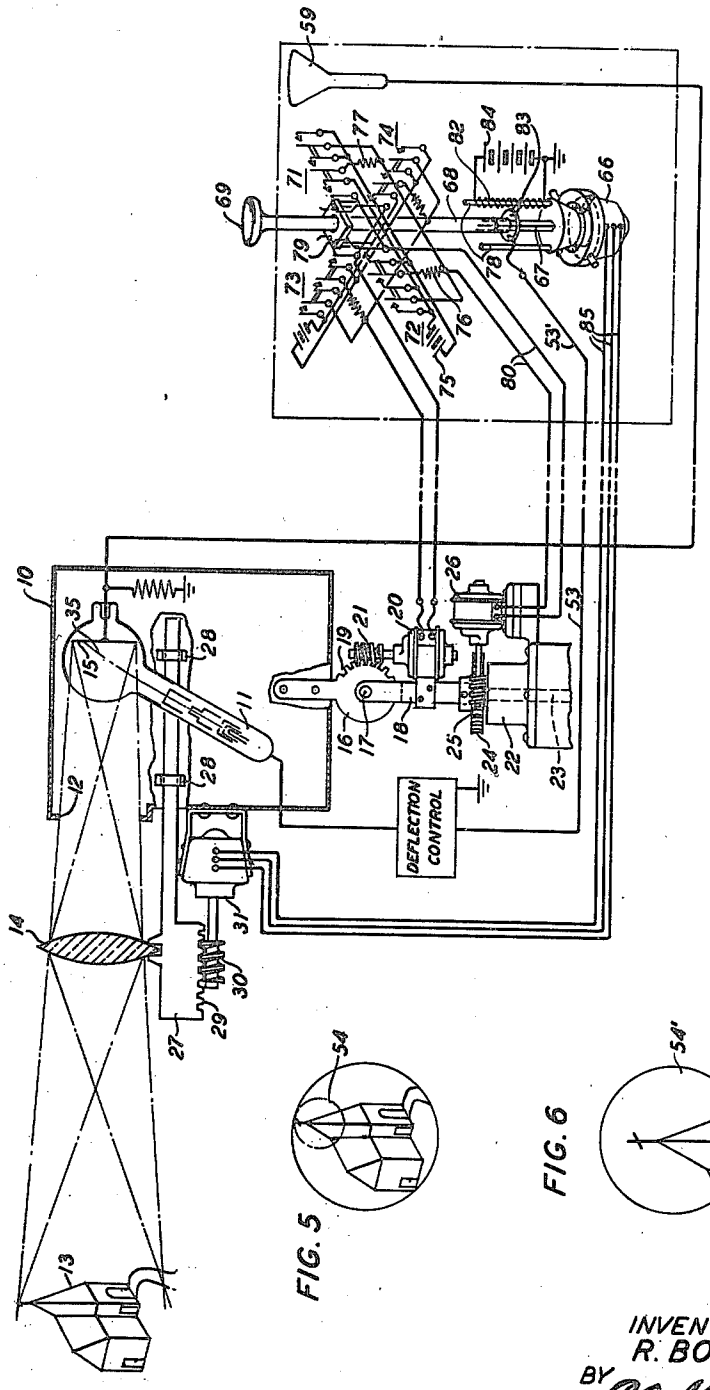

FIG. 1

FIG. 5

FIG. 6

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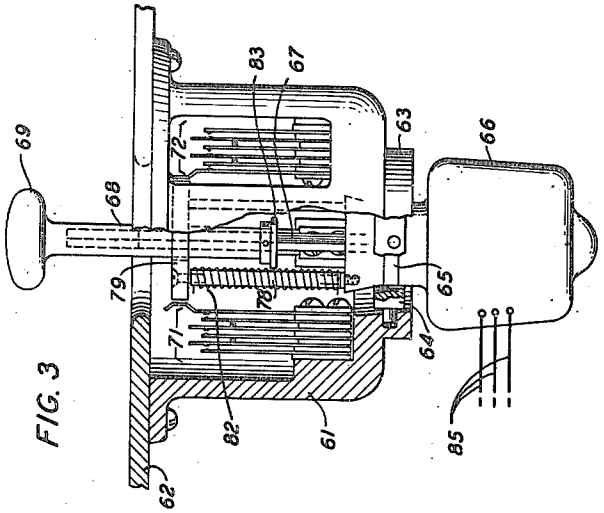

FIG. 3

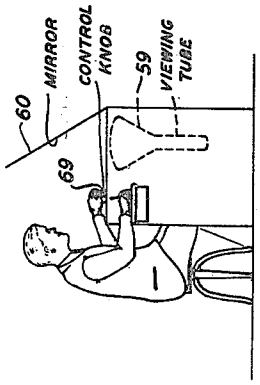

FIG. 4

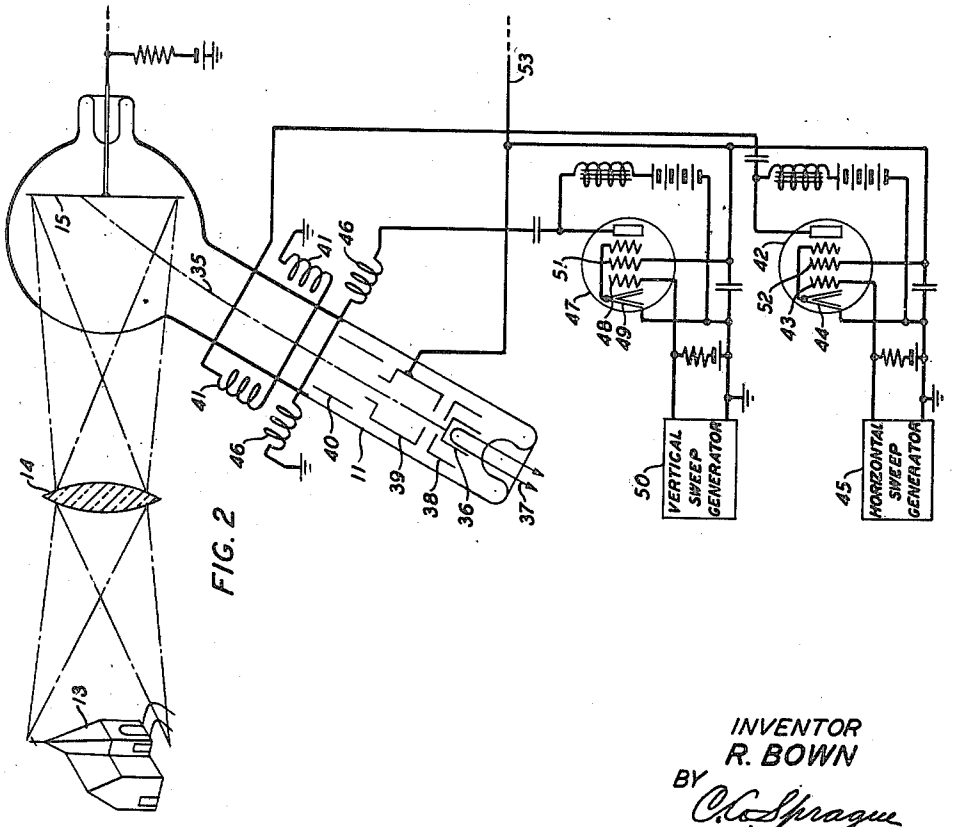

FIG. 2

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UNITED STATES PATENT OFFICE

2,306,862

TELEVISION REMOTE CONTROL

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Application July 8, 1941, Serial No. 401,441

12 Claims. (Cl. 178—7.2)

This invention relates to television and particularly to the control of the mode of operation and performance of a television pick-up device or camera by a person in position to observe a television image synthesized on the screen of a receiver device which may be located at a point remote from the camera and who may observe in the synthesized image the results of his control of the camera.

An object of the invention is to provide means for controlling the operation of the camera in a number of different ways; for example, its direction of view, the distance at which it is sharply focused, the angle of view and the magnification. Another object is to provide for independence of each of these controls. Another object is to provide simple and convenient means for operating the controls by different independent movements of a single control element which may be grasped in one hand, thus leaving the observer's other hand free for different employment.

To this end there is provided in accordance with the invention a controller unit of novel design and construction, characterized by a manually operable control element or lever arranged to be independently movable in several different ways, while independent circuit control elements are arranged to be actuated by each of the independent movements. In a preferred embodiment an intermediate element is universally mounted on a fixed base for rocking about two mutually perpendicular axes, which rocking movements control two corresponding movements of the camera, while at the same time it may be axially rotated and axially translated to control two other independent camera operations. For example, side-to-side rocking movements may control the training of the camera by rotation in the horizontal plane and fore-and-aft rocking movements may control the camera elevation by rotation in the vertical plane, while the axial rotation may control the movement of the camera lens to bring into sharp focus objects which are located at greater or less distances and the axial translation movement may control the camera magnification. Thus any one or more or all of these controls may be operated by the observer by appropriate movements of one hand, the other hand remaining free for other employment.

The invention will be fully understood from the following description of an illustrative embodiment thereof, taken in connection with the accompanying drawings, in which:

Fig. 1 is a schematic illustration of a system according to the invention, showing a controlled camera and a remotely located controller unit capable of four independent movements;

Fig. 2 is a circuit diagram of apparatus which may be employed for remote control of the magnification of the camera of Fig. 1;

Fig. 3 shows the construction of a four-way controller unit in accordance with the invention;

Fig. 4 shows an observer of a synthesized television image operating the controller unit of the invention;

Fig. 5 shows how an object field may be projected on a television camera screen; and

Fig. 6 shows how an enlarged image of a restricted portion of the object field may appear as synthesized on the receiver screen.

Referring now to Fig. 1, the television camera may comprise a housing 10 containing a television pick-up device 11 of any suitable type, the latter being so mounted with respect to an aperture 12 in the housing that a field of view 13 may be imaged by an objective lens 14 on the image receiving member 15 of the pick-up device 11. The housing 10 is fixed to a bracket 16, pivoted to rotate about a horizontal axis 17 on a pedestal 18. The bracket 16 may be provided with gear teeth 19. A reversible motor 20 may be mounted on the pedestal 18 and arranged to drive a worm 21 which engages with the gear teeth 19. Thus, operation of the motor will cause the housing 10 to rotate in the vertical plane in one direction, while reversal of the direction of rotation of the motor will reverse the movement of the housing.

The pedestal 18 is in turn pivotally mounted on a fixed member 22 for rotation about a vertical axis 23. The drive for the pedestal 18 may be similar to that above described, the pedestal being provided with a worm gear 24 with which meshes a worm 25 driven by a reversible motor 26 so that operation of the motor 26 in one sense or the other causes the pedestal 18, and with it the camera housing 10, to rotate in a corresponding sense in the horizontal plane.

The objective lens 14 is arranged to be movable toward or away from the camera 11. To this end it may be fixed in a lens mount 27 arranged to move axially in guides 28 fixed to the housing 10. The movement may be imparted to it through a rack 29 with which meshes a worm 30 driven by a reversible motor 31 fixed to the housing 10.

With this arrangement, by operation of the motors 20, 26, 31 in the proper sense or in any desired order, the camera may be aimed in any direction and objects at any distance from it,

within the limits imposed by the focal length of the objective lens 14 may be brought into sharp focus on the screen 15 of the camera 11.

The three motors 20, 26, 31 may be of any desired type. Reversibility, though not essential for these motors, is highly advantageous. For this reason direct current shunt wound motors or self-synchronous motors are preferred. By way of illustration, the direction-controlling motors 20, 26 are shown as direct current motors of which the armature currents may be remotely controlled. Field windings and direct current sources, which, of course, must be provided, may be of any suitable type and are omitted from the drawings. The motor 31 which moves the lens 14 may likewise be a direct current motor though a self-synchronous motor is preferred for reasons which will be apparent hereinafter. Accordingly, three-phase conductors are shown terminating in this motor. As in the case of the other motors, the necessary field windings, whose excitation and arrangement are well known in the art, are omitted from the drawings in the interests of simplicity.

Variation in the camera magnification and angle of view may be secured in various ways. For example, they may be secured by the provision of a variable magnification lens system of a type well known in the motion picture art, the necessary movement of the component elements of the optical lens system being effected by a remotely controlled motor as in the cases of the other movements. It is preferred, however, to exert the magnification and angle of view control through electrical means. To this end, a pick-up device and associated control circuits shown in Fig. 2 may be employed. Referring to Fig. 2, the pick-up device 11 may comprise an evacuated envelope containing in one end thereof a photosensitive mosaic screen 15 backed by a conductive plate from which, when the field 13 is imaged on the screen 15 and the latter is scanned by an electron beam 35, image currents may be drawn. The beam electrons may be derived from a suitably shaped and treated cathode element 36 rendered thermionically active by a heater 37. The electrons may be accelerated toward the beam-receiving end of the vessel and focused to a sharp spot on the screen by suitably shaped and disposed electrodes 38, 39, 40 which may be supplied with suitable operating potentials in well-known manner.

Deflection of the beam 35 in the course of the scanning operation may be accomplished either electrostatically or electromagnetically, electromagnetic deflection means being shown by way of example. Thus horizontal sweeping current may be supplied to horizontal deflecting coils 41, from the plate circuit of an amplifier tube 42 to whose control grid 43 and cathode 44 is fed the voltage output of a saw-tooth scanning generator 45; and vertical sweeping current may be supplied to vertical deflecting coils 46 from the plate circuit of a tube 47 to whose control grid 48 and cathode 49 is fed the voltage output of a saw-tooth scanning generator 50.

In practicing the invention it is contemplated that the whole of the image on the photosensitive screen may be scanned, in which case an image thereof may be reconstituted at the receiver in a manner to occupy the full receiver screen area; or a part only of the image may be scanned, in which case the vision currents are representative of a restricted portion of the whole field and a correspondingly restricted image will be reproduced at the receiver. If, as is contemplated will be the case, this restricted image portion is synthesized in a manner to occupy the whole receiver screen area, magnification of the received image as well as restriction of the angle of view will be the result.

In accordance with the invention means are provided for controlling the angle of view and magnification of the system from the receiver station simply by changing the amplitudes of the horizontal and vertical sweep currents. To this end additional grids 51, 52 are provided in the tubes 42, 47, which grids are connected together while potentials may be supplied to them over the control channel 53 from the receiver. Depression of the grid voltage reduces the amplitudes of the scanning currents in the same ratio and thus serves to reduce the horizontal and vertical excursions of the scanning spot while maintaining the aspect ratio of the scanned area unchanged, thus preventing distortion in the synthesized image.

In order that successive scanning lines shall always be contiguous and not overlap, it is desirable to reduce the size of the scanning spot in proportion to the reduction in size of the image portion scanned. To this end the remote potential control conductor 53 is also connected to one of the anodes 39 which determines the cross section of the beam 35. To a first approximation this type of control leaves the number of electrons in the beam cross section unchanged so that the scanning spot becomes more highly concentrated as its size is decreased. This constitutes an advantage in itself, since the resulting vision currents are increased in amplitude and result in increased contrasts in the image reconstituted at the receiver when it is a magnified image of a narrow angle of view. Fig. 5 shows the portion of the object field projected onto the receiver screen 15, the small circle 54 representing the portion scanned, and Fig. 6 shows the corresponding image at the receiver in which only the portion 54 is synthesized as an enlarged image 54'.

The image synthesizing apparatus may be of any desired type. It may comprise, for example, an evacuated vessel containing a cathode, a heater, accelerating and focusing electrodes and a fluorescent beam-receiving screen and means for causing the cathode beam to scan the screen. The scanning means may be electrostatic or electromagnetic as preferred. These means may comprise deflecting coils, saw-tooth wave generators and amplifiers, just as in the case of the pick-up device. Such apparatus is well known in the art and is indicated in the figures merely by the outline of a cathode ray tube 59 of conventional form.

In a preferred form and as shown in Fig. 3, the controller unit of the invention may comprise a housing 61 which may be mounted by attachment of its upper surfaces to the underside of a panel 62 conveniently located with respect to the screen on which the image is synthesized. For example, it may be mounted adjacent the viewing screen of the receiver tube 59, a mirror 60 being arranged at 45 degrees to enable the observer to view the image while facing in a horizontal direction. Pivoted to the lower portion 63 of the housing is a universal joint or gimbal of two concentric rings 64, 65, of which the inner one 65 may rock in any direction with respect to the housing 61. The stator member of a circuit control element, for example, the stator member of

a self-synchronous motor 66 which is paired through conductors 65 with the self-synchronous motor 31 at the camera, may be fixed to this inner gimbal member. The rotor member, which may be mounted to rotate axially within the stator member, may have fixed to it a shaft 67 along which another member may be arranged to slide axially. For example, the rotor shaft 67 may be splined or squared and a sleeve 68 may fit snugly about it so as to be freely slidable along it but yet impart to it motions of all other types. The sleeve 68 may be provided at its upper end with a knob 69 shiftably formed and located for convenience in manipulation.

Within the housing 61 and fixed to a convenient surface thereof are mounted four like multiple contact switches 71, 72, 73, 74, all contacts of which are normally open in the absence of further constraint. They are preferably mounted 90 degrees apart, opposite members 71, 72 constituting one pair and the other members 73, 74 constituting the other pair. Two members 71, 72 of one pair of switches may be interconnected with a battery 75 or other suitable current source and with resistors 76, 77 as shown in Fig. 1. The inner member 65 of the gimbal may have fixedly mounted on it a rod 78 which extends upward a short distance within the housing 61 and bears an insulating member 79, preferably square in form, in position to press against any one of the multiple contact switches 71, 72, 73, 74 and close the contacts thereof in succession, as the control knob 69 is rocked on the gimbals to one side or the other.

Considering the operation in connection with one of the switches, for example the switch lying to the observer's left hand, as the first contact is closed, the battery 75 is connected through the resistor 76 and the second contact to the line 80 leading to the azimuth control motor 26 located at the camera station. The connection is made with a polarity such that when the second contact is closed by a further rocking movement of the knob 69 in the same direction, current, limited in amount by the resistor 76, will flow over the line 80 and through the armature of the motor 26 in such a direction as to cause the camera to rotate to the left. Further rocking in the same direction short-circuits the resistor 76 and increases the current and, therefore, the speed of rotation of the camera. If the pressure on the knob 69 be relieved the resistor 76 is once more placed in circuit to slow the motor down, and if the pressure is further relieved the circuit of the motor 26 is opened and the motor stops.

If now the knob 69 be pushed in the opposite direction or to the right, closure of the first contact connects the battery 75 to the line 80 with the opposite polarity. Closure of the second and third contacts by further rocking movement of the knob 69 results in the same cycle as above described except that, due to the change in battery connections, the movement of the camera is to the right.

The forward and backward switches 73, 74 may be identical with the right and left switches both in construction and in manner of operation, so that pushing the knob forward results in rotating the motor 20 in a sense to depress the camera and drawing it backward rotates the motor 20 in the opposite direction to elevate the camera.

Each of these rocking movements of the control knob 69 is of the type which would most naturally be produced by an observer wishing to direct the camera toward a desired part of the field of view. Furthermore, the movements may evidently be combined in any desired manner; and when so combined they produce a corresponding combination of movement of the camera 11. That is to say, the motors drive the camera toward that part of the field of view which corresponds to the image part toward which the control element is inclined.

To bring the apparatus into focus at various distances the operator has only to twist the control knob 69 in one direction or the other. For example, the connections of the self-synchronous motors 31, 66 may appropriately be such that a twist in a clockwise direction draws the lens 14 back toward the camera to focus it on more distant objects while a counter-clockwise twist advances the lens to bring nearer objects into focus. These twisting movements are entirely independent of the rocking movements above described. Any desired amount of twist may be given the knob 69 while it occupies any angular rocked position, and the resulting lens movements are likewise wholly independent of the directional movements.

In the control unit of the invention yet another control element is provided. In a preferred embodiment a rheostat resistor 82 may be fixedly mounted on the inner gimbal ring 65 extending upward therefrom alongside the knob-topped sleeve 68. A movable contact ring 83 may be fixed to the lower part of the sleeve 68 and arranged to slide along this resistor 82 when axial movement is imparted to the knob 69. These axial sleeve movements, and therefore the resulting circuit variations, are wholly independent of the degree of rotation or angular position of the sleeve 68.

If preferred, the rheostat 81 may be mounted directly on the self-synchronous motor shaft and the movable tap mounted directly on the manual control element, in which case the rheostat and the tap would rotate together as the focusing control is manipulated. This would normally require slip ring connections and for this reason the arrangement shown is preferred.

As shown in Fig. 1, the rheostat 82 is supplied from a suitable source of current such as a battery 84, one side of which is grounded, and a conductor 53' leads from the contact ring 83 to the magnification control apparatus shown in Fig. 1 and described above.

Various modifications of the system as above described may be made without in any way departing from the spirit of the invention which is defined in the appended claims. For example, the magnification and focusing controls, or, for that matter, any two or more controls, may be interchanged. Solenoids or the like may be employed in place of motors, variable impedances in place of variable resistors, continuously operating control elements may replace the multiple contact switches, and, generally, individual elements of one type may be employed in place of those of another, since the invention resides in an organized combination.

The control signals may be carried from the receiver to the pick-up device in any desired manner, by radio, or by line or cable. They may be transmitted either directly or by carrier modulation in accordance with well-known principles.

What is claimed is:

1. In apparatus for remotely controlling the operation of means coupled to a television camera

for altering the aim of said camera in elevation and in azimuth, a controller unit arranged and conveniently disposed for manipulation by an observer of a synthesized image of an object field toward which said camera is aimed, said controller unit comprising an element which is freely inclinable in all directions with respect to a support, circuit control means actuated by fore-and-aft inclinations of said element for delivering control energy to said camera elevation altering means, and circuit control means for delivering control energy to said camera azimuth altering means, said control energy being in each case of a characteristic such as to produce camera movements having a psychologically natural relation to the inclinations of said element.

2. Apparatus for remotely controlling the operation of a television camera which comprises a controller unit at a receiving station and adapted to be manually operated by an observer of a television image at that station, said controller unit comprising an element capable of three or more different, independent movements with respect to a fixed support, an independent circuit element arranged to be actuated by each of said independent movements, and means for supplying control energy from said independent circuit elements to modify the operation of said camera in three or more corresponding independent respects.

3. In combination with a television camera provided with means for modifying its operation in four different respects, a controller unit placed under the manual control of an observer of a television image at a receiver station, said controller unit comprising an element capable of four different, independent movements with respect to a fixed support, an independent circuit control element arranged to be actuated by each of said independent movements, and means for supplying control energy from each of said independent circuit control elements to a corresponding one of said camera operation modifying means.

4. Apparatus for remotely controlling the operations of a television camera having variable speed aim-altering means and means for modifying its operation in at least one other respect, which comprises a fixed element, a second element arranged for limited inclinations in all directions with respect to said fixed element, a third element movable with respect to said second element, and mutually independent circuit control means arranged to be actuated by inclinations of said second element and movements of said third element for delivering speed control energy to said aim-altering means and position control energy to said other camera operation modifying means, respectively.

5. In combination, a television camera, means for mechanically rotating said camera about two mutually perpendicular axes to change the direction of its aim, means for altering the focus of said camera, a controller unit located conveniently to the hand of an observer viewing a television image at a receiver station, said controller unit comprising a fixed element, a movable element mounted to be inclinable about two mutually perpendicular axes fixed with respect to said fixed element and for axial rotation, circuit control means responsive to inclinations of said movable element about one of its axes for governing the speed of one of said camera rotating means, circuit control means responsive to inclinations of said movable element about the other of its axes for governing the speed of the other of said camera rotating means, and circuit control means responsive to said axial rotation for governing the position of said focusing means.

6. In combination, a television camera, means for mechanically rotating said camera about two mutually perpendicular axes to change the direction of its aim, means for altering the focus of said camera, means for altering the magnification of said camera, a controller unit comprising a fixed element, a movable element mounted for rocking about two mutually perpendicular axes fixed with respect to said fixed element and for axial rotation and axial displacement, circuit control means responsive to rocking movements of said movable element about one of its axes for actuating one of said camera rotating means, circuit control means responsive to rocking movements of said movable element about the other of its axes for actuating the other of said camera rotating means, and mutually independent circuit control means responsive to said axial rotation and said axial displacement for actuating said focusing means and said magnification control means.

7. In apparatus for imparting four independent mechanical movements to a television camera by remote control, a controller element placed at a point remote from said camera, which comprises a fixed element, a second element mounted to rock about two mutually perpendicular axes, a third element mounted for axial rotation with respect to said second element, a fourth element mounted for axial movement with respect to said third element, means responsive to the rocking movements of said second element for producing two independent control signals, means responsive to relative rotation of said second and third elements for producing a third control signal, means responsive to relative displacement of said third and fourth elements for producing a fourth control signal, and means for transmitting each of said control signals to corresponding camera operation modifying means.

8. In a remote control television system, a television camera mounted for mechanical rotation about a horizontal and a vertical axis to alter its direction of view and having additional operation modifying means, a variable speed motor for rotating said camera about a horizontal axis, a variable speed motor for rotating said camera about a vertical axis, means for modifying the operation of said camera in two further respects, a controller element placed at a point remote from said camera, which comprises a fixed element, a second element mounted to rock about two mutually perpendicular axes, a third element mounted for axial rotation with respect to said second element, a fourth element mounted for axial movement with respect to said third element, electrical circuit control means mounted in mutually perpendicular arrangement on said fixed element for actuation by rocking movements of said second element, connections from said perpendicularly arranged control means to said variable speed motors, respectively, means responsive to relative rotation of said second and third elements for producing a control signal, means responsive to relative displacement of said third and fourth elements for producing another control signal, and means for modifying the operation of said camera in two respects in response to said two last-named control signals, respectively.

9. In apparatus for remotely controlling the

operation of a television camera, a controller unit which comprises a fixed casing, two multiple contact switches disposed diametrically opposite to each other within said casing, and arranged to vary and reverse the current of a source, two other multiple contact switches arranged diametrically opposite each other within said casing on a line perpendicular to a line joining the first two switches and arranged to vary and reverse the current of another source, an element inclinable in all directions with respect to said casing and bearing a stator element of a rotary circuit control device, a resistor, and a switch closing element, an armature shaft and an armature mounted for rotation with respect to said stator element, a sleeve axially slidable on said armature shaft and constrained to rotate with said shaft, a conductive element mounted on said sleeve in position to make contact with said resistor at various points thereof as said sleeve is slid along said shaft, a source of current connected to said resistor, means for energizing said rotary circuit control element, and means for separately utilizing currents independently varied by said switches, said rotary circuit control element and said conductive contacting element to vary the orientation, focusing and magnification of said camera, respectively.

10. In combination, a television camera mounted for mechanical rotation about a horizontal axis and a vertical axis, a variable speed driving means arranged to rotate said camera about each of said axes in either direction at speeds dependent on the magnitude of electric signals supplied thereto, a controller unit located conveniently to the hand of an observer viewing a television image at a remotely located receiver station, said controller unit comprising a movable element mounted to be inclinable in either direction about each of two mutually perpendicular axes, circuit control means for producing an electric signal of a magnitude and sign dependent on the inclination of said movable element about each of said axes, and means for transmitting said signals to said variable speed driving means, whereby said image observer may cause said camera to rotate at a speed and in a direction dependent on the amount and direction of said inclinations.

11. In combination, a television camera mounted for rotation through a full circle in a horizontal plane, a variable speed motor arranged to rotate said camera in either direction at speeds dependent on the magnitude and direction of an electric control signal supplied thereto, a controller unit located conveniently to the at a receiver station, said controller unit comprising a fixed element, a movable element inhand of an observer viewing a television image clinably mounted on said fixed element, means for deriving an electric control signal of magnitude and direction dependent on the amount of inclination of said inclinable element, and means for transmitting said signal to said variable speed driving means, whereby said image observer may cause said camera to rotate through any angular displacement at a speed and in a direction dependent on the amount and direction of said inclinations.

12. In apparatus for remotely controlling the operation of a television camera, a controller unit which comprises a fixed casing, an element mounted for rocking movements about two mutually perpendicular axes with respect to said casing, circuit control means disposed within said casing and arranged to be actuated by said element in the course of said rocking movements, a stator member of a rotary circuit control device mounted on said element, a second element mounted for axial rotation with respect to said first element, a rotor member of said rotary circuit control device mounted on said second element, means for energizing one member of said rotary circuit control device, and means for separately utilizing currents independently varied by said circuit control means and said rotary circuit control device in response to rocking movements and axial rotations, respectively, of said second element with respect to said casing.

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