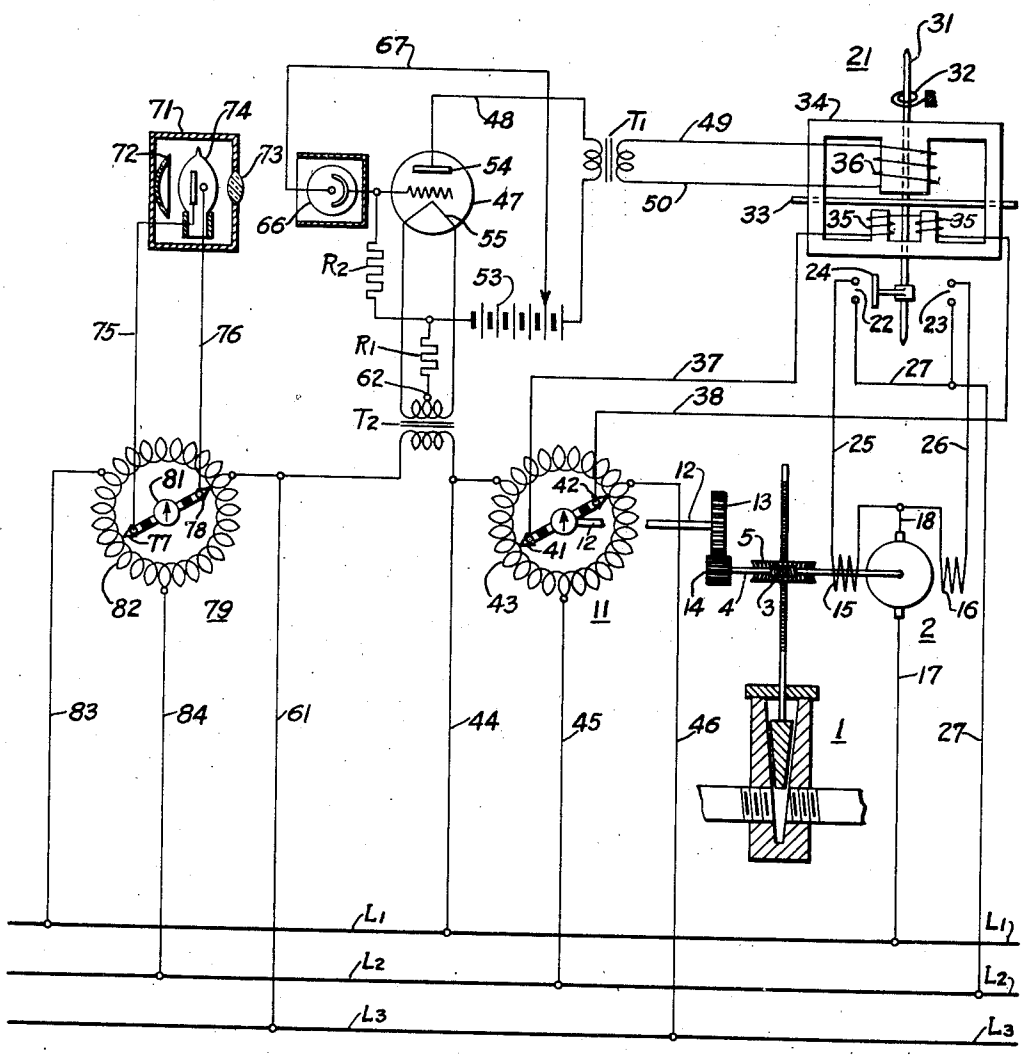
June 16, 1936. H. L. BERNARDE 2,044,146

CONTROL SYSTEM

Filed Jan. 25, 1933



WITNESSES:

Leon J. Taya

F. F. Hicks

INVENTOR

Henry L. Bernarde.

BY H. L. Bernarde

ATTORNEY

Patented June 16, 1936

2,044,146

UNITED STATES PATENT OFFICE

2,044,146

CONTROL SYSTEM

Henry L. Bernarde, Kearny, N. J., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application January 25, 1933, Serial No. 653,495

7 Claims. (Cl. 250—41.5)

My invention pertains to control systems and more particularly to systems for remotely controlling valves, doors, switches, rheostats or other devices.

It is an object of my invention to provide a convenient control system for use by an attendant who is positioned in a moving machine such as the cab of a traveling crane or who is moving about relatively to the apparatus to be controlled.

Another object of my invention is to provide a control system which will be responsive to a modulated beam of light which may be conveniently directed by an attendant from any position.

In accordance with one form of my invention, a motor for actuating the door, valve, or other device is controlled by a two phase relay. One winding of the relay is energized through a phase shifter which is connected for movement simultaneously with the device. The second winding of the relay is energized by impulses from an amplifier controlled by a photo-cell. The attendant is provided with a light source, of convenient dimensions, from which he may direct a beam of light upon the photo-cell. The light is modulated at a frequency corresponding to the energization of the first winding of the relay, but its phase relation is adjustable relative thereto. When the light impulses are adjusted out of phase, the two windings of the relay being energized in out of phase relation actuate the disk in one direction or the other accordingly as the impulses are advanced or retarded relative to the alternating current. The contacts of the relay are thus closed to actuate the motor in one direction or the other.

As the device is operated, the automatic phase shifter associated therewith is turned toward a position corresponding to the preset position of the manually adjustable phase shifter and when it reaches this position, the impulses and the alternating current will again be exactly in phase, the relay contacts will open and the motor will stop.

Hence, an attendant may, from any position within sight of the apparatus, start or stop the apparatus at any instant by merely directing a beam of light, and he may by preadjusting the phase relation of the modulated light determine the maximum extent to which the device will be operated if the light beam is held in position.

The invention both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment, when read in conjunction with the accompanying drawing, in which;

The single figure is a diagrammatic view representing a control system arranged in accordance with my invention.

Referring more specifically to the drawing, the apparatus comprises a device to be regulated, such as the valve 1 and a motor 2 for operating the same. The motor may be operatively connected to the valve in any suitable manner as by a worm 3 on an extension of the motor shaft 4 engaging a worm wheel 5 operatively associated with the valve. The motor is also operatively connected to a phase shifter 11 through a shaft 12 and suitable change speed gearing 13 and 14 in such a manner that the phase shifter will be simultaneously driven to various positions corresponding to the position of the device 1.

The motor 2 may be a universal series motor having two oppositely wound windings 15 and 16 to facilitate reversible control, although any other motor reversing scheme may be used. As shown, one side of the armature is connected through a conductor 17 to a main line conductor L1 of a commercial three-phase alternating current line. The other side of the armature is connected by a conductor 18 to the united ends of the two series field windings 15 and 16.

By selectively connecting the free end of either one of the series windings 15 or 16 to another main line conductor, such as L2, the motor 2 will be energized to run in either direction in a manner which will be readily understood. This control is accomplished through a polyphase device such as an induction disk relay 21 having stationary pairs of contacts 22 and 23 and a rotatable bridging contact 24. The free end of the motor field winding 15 is connected to one of the pair of contacts 22 through a conductor 25, and the free end of the other field winding 16 is connected to one contact of the other pair of contacts 23 by a conductor 26. The other one of each pair of contacts 22 and 23 is joined by a common conductor 27, which extends to the main line conductor L2. It will be apparent that the operation of the relay to bridge either pair of its stationary contacts 22 or 23 will selectively complete the motor circuit through either one of its series field windings to run in either direction.

The bridging contact 24 of the relay projects laterally from a shaft 31 on which it is mounted and which is normally centered by a centering spring 32 associated therewith. The rotation of the relay shaft 31 is effected by a disk 33 mount-

ed thereon and disposed in induction relation to a two-phase field structure 34 provided with two windings 35 and 36. The relay windings 35 are connected by conductors 37 and 38 to rotatable brushes 41 and 42 on the phase shifter 11, by which it may be connected across any pair of diametrically opposed points on a closed winding 43 having three equi-spaced taps which are connected by three conductors 44, 45 and 46 to the respective main line conductors L1, L2, and L3. The phase shifter brushes 41 and 42 are mechanically connected to the shaft 12, and they are thereby shifted to correspond at any instant to the adjusted position of the valve 1. It will be understood that the phase shifter may be excited from a single phase alternating current source through a suitable condenser, reactor and resistor, if desired.

The windings 35 of the relay are thus continuously energized from the main line, but the phase relation of its energizing current is varied according to the instant position of the device which is being regulated.

The other relay winding 36 is energized from the output of an amplifier tube 47 and is for this purpose coupled to the plate circuit 48 of the tube through a transformer T1 to which it is connected by suitable conductors 49 and 50. A battery 53, or other source of direct current, is provided in the plate circuit 48 for biasing the plate 54 of the tube 47 positively relative to its filament 55. The filament 55 is supplied with heating current by connection to the secondary winding of a suitable transformer T2, the primary winding of which is connected by conductors 44 and 61 across one phase of the three-phase line. A center tap 62 on the secondary winding affords a convenient connection for the plate circuit return which is connected thereto through a grid biasing resistor R1. The grid of the amplifier tube is connected to the filament through a series resistor R2, and thence through the grid biasing resistor R1 which also carries the plate space current thereby providing a suitable negative bias on the grid. Although only one amplifier tube is shown, it is to be understood that a greater number of tubes may be added to the amplifier to make a more sensitive device in the well known manner.

The system is controlled by a photo-cell 66, one electrode of which is for this purpose connected directly to the grid of the amplifier tube 47. The other electrode of the photo-cell is connected through a conductor 67 to a positive terminal of the plate battery 53. The photo-cell, according to the light impinging thereon, varies the grid bias applied to the amplifier tube 47 and thereby controls the current in the plate circuit 48. To exclude interfering light a suitable shield may partially enclose the photo-cell.

In order to enable a remotely positioned attendant to control the system at will, he is provided with a flashing lamp 71 which may be made up in some convenient form having a reflector 72 and a lens 73 for projecting a beam of light. If desired, the lamp casing may be made in the very convenient form of the common focusing flashlight. The light source 74 provided in this control lamp is a neon lamp which emits a series of light flashes, or a beam of light modulated at 60 cycles, when energized from the 60 cycle line.

The lamp 74 is connected by conductors 75 and 76 to the rotatable brushes 77 and 78 of a phase shifter 79 which may be manually adjusted by turning a dial 81. The phase shifter is provided with a continuous winding 82 having three equi-spaced taps which are connected by conductors 83, 84 and 61 to the respective main line conductors. This phase shifter may also be energized from a single phase alternating current source through condensers, reactors and resistors as above set forth with reference to the other phase shifter.

The manually adjustable phase shifter 79 is mounted adjacent the position occupied by the attendant as in a cab of a traveling crane for example. If this cannot be conveniently arranged, the phase shifter 79 may be carried about by the attendant by providing the conductors 83, 84, and 61 in a suitable cable, and it may or may not be made integral with the lamp casing 71.

In operating the regulated device 1 to a desired position, the attendant has merely to turn the dial 81 of the phase shifter 79 to the corresponding position and direct the beam of modulated light from the light source 74 upon the photo-cell 66. The modulated light beam impinging upon the photo-cell varies or modulates the grid bias on the amplifier tube 47, thereby causing a succession of current impulses in the plate circuit 48, and thereby energizing the winding 36 of the two-phase relay through the coupling transformer T1. The other relay windings 35 being continuously energized through the automatic phase-shifter 11, a torque is created which turns the disk in one direction or the other depending upon the phase relation of the excitation of the windings 35 and 36. The bridging contact 24 then bridges one pair of the stationary contacts, either 22 or 23 and drives the motor 2 in the corresponding position. It will be understood that by manually setting the phase-shifter 79, the attendant varies the phase relation of the current energizing winding 36 relative to that energizing winding 35 from the other phase shifter. Hence, the motor 2 is started in either direction depending upon the manipulation of the dial 81 by the attendant.

As the controlled device 1 is operated, the automatic phase-shifter 11 is turned through corresponding positions, and when its position coincides with the position of the manually adjustable phase-shifter 79, the windings 35 of the two-phase relay are energized in phase with the other winding 36, there is no torque acting upon the disk 33, and contact 24 is opened by the centering spring 32, thereby stopping the motor.

If the controlled valve or device is small enough, it is possible to dispense with motor 2, and the relay itself may be used as the motor which actuates the valve and phase shifter. There is a distinct advantage in this arrangement in that the system will not hunt, or overshoot the correct position, because as the correct position is approached, the power applied to the induction disk motor is gradually diminished and it comes to a gradual stop.

It is apparent that in the operation of my system the attendant not only has precise control over the exact position to which the regulated device will turn, but he may also very conveniently stop or start the system at any instant by merely directing the beam of light toward or away from the photo-cell.

It will be seen that I have provided a simple convenient control system by which an attendant may reversably control and actuate a remotely positioned apparatus to any desired position.

Although I have shown and described a certain

specific embodiment of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except as necessitated by the prior art and the scope of the appended claims.

I claim as my invention:

1. In apparatus for controlling the position of a movable element, an alternating-current source, means for producing a periodically pulsating light flux of frequency dependent upon that of said source, a primary element operable to vary the phase position of said light flux through a graduated angular range as compared to said source, means including a photoelectric device subject to said light flux for producing current pulsations having a phase position dependent upon said phase position of said light flux, an alternating current device for controlling said movable element, said device including a pair of cooperating windings, means for energizing one of said windings from said alternating-current source, and means for energizing the other of said windings in accordance with said pulsations.

2. In combination a polyphase device to be operated, a source of alternating current for energizing one phase of said device, light sensitive means for controlling the energization of another phase of said device, remote control means therefor comprising a modulated light source and means for controlling the phase of said modulated light relative to said alternating current source.

3. In combination a polyphase device to be operated, a source of alternating current for energizing one phase of said device, light sensitive means for controlling the energization of another phase of said polyphase device, and remote control means therefor comprising a modulated light source, manually adjustable means for controlling the phase of said modulated light relative to said alternating current source and manually adjustable means for controlling the direction of a beam of light from said light source to impinge upon said light sensitive means.

4. In combination a polyphase device to be operated, a source of alternating current for energization one phase of said device, light sensitve means for controlling the energization of another phase of said device, remote control means therefor comprising a modulated light source and means for controlling the phase of said modulated light relative to said alternating current source, and means associated with said device for automatically varying the phase relation of said alternating current relative to said modulated light in accordance with the operation of the device.

5. In combination a device to be operated, means for controlling the operation of said device comprising a two-phase relay having two windings, a source of alternating current for continuously energizing one of said windings, a photo-cell for controlling the energization of said second winding, a source of flashing light, and an adjustable phase shifter for energizing said light source from said alternating current source whereby the energization of said second winding may be regulated to any desired phase relation relative to the energization of said first winding at the instant when said photo-cell is exposed to said light.

6. In combination a device to be operated, means for controlling the operation of said device comprising a two-phase relay having two windings, a source of alternating current for continuously energizing one of said windings, a photo-cell for controlling the energization of said second winding, a source of flashing light, an adjustable phase shifter for energizing said light source from said alternating current source whereby the energization of said second winding may be regulated to any desired phase relation relative to the energization of said first winding at the instant when said photo-cell is exposed to said light, and means responsive to the operation of said device to control the energization of said first winding to be in phase with said second winding when said device is moved to a predetermined position.

7. In combination a device to be operated, means for controlling the operation of said device comprising a winding continuously energized from an alternating current source, a second winding, means responsive to radiant energy impulses for energizing said second winding, means for transmitting radiant energy impulses having the same frequency as said alternating current source, adjustable means for varying the phase relation of said impulses relative to said alternating current source, and controlling means responsive to simultaneous dephased energization of said windings.

HENRY L. BERNARDE.