

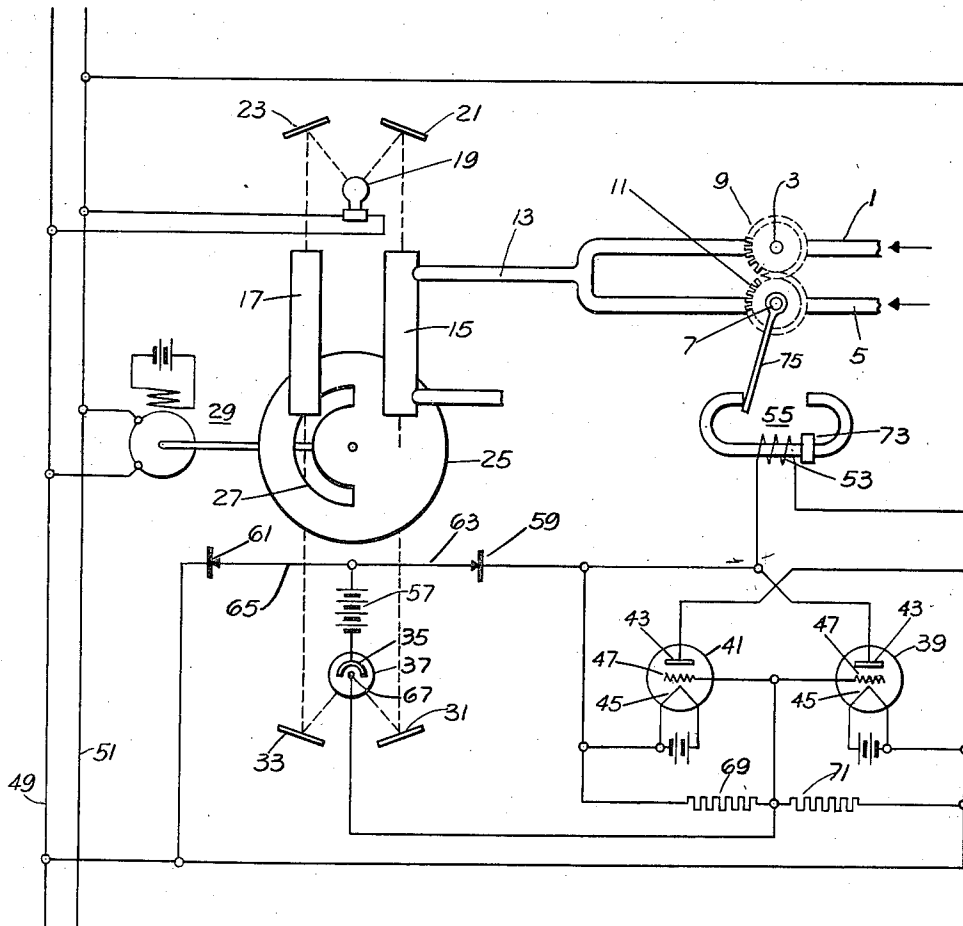
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ELECTRIC DISCHARGE APPARATUS

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ELECTRIC DISCHARGE APPARATUS

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My invention relates to electric discharge apparatus and has particular relation to photometric apparatus.

It is an object of my invention to provide photometric apparatus that shall incorporate a minimum of mechanical moving parts.

Another object of my invention is to provide photometric apparatus that shall not be subjected to the complications involving commutators that is characteristic of similar apparatus of the prior art of which I am aware.

More concisely stated, it is an object of my invention to provide simple and tractible, but precisely operative, photometric apparatus for comparing the radiant energy emitted by a working substance with that emitted by a standard and for so changing the working substance that it corresponds with the standard.

According to my invention, I provide a photometric system in which the radiations emitted by the sources of radiant energy that are to be compared impinge on a photo-sensitive device. The photo-sensitive device is connected in the control circuits of a plurality of electric discharge devices. Preferably, a source of alternating current is provided for supplying potentials to the discharge devices. The potentials are so supplied that one of the discharge devices is energized while the other is deenergized and vice versa.

The projection of radiant energy from the sources to be compared on the photo-sensitive device is so regulated that it corresponds to the supply of potential to the discharge devices. When one of the discharge devices is energized, it is also subjected to the control of the radiation emitted by one of the sources. The same condition exists as to the other source of radiant energy when the second discharge device is energized. The currents transmitted by the discharge devices during the intervals during which they are energized actuate a translating device, the moving parts of which are provided with sufficient inertia to render them dynamically responsive to the average rather than to the instantaneous current transmitted. The discharge devices replace the commutators which would otherwise be necessary for comparison of the sources of radiation.

While the discharge devices utilized are preferably of the high-vacuum hot-cathode type, gas-filled hot-cathode discharge devices or cold-cathode discharge devices of the Grid-Glow tube type may also be utilized. In situations where considerable current is required to operate the

translating apparatus, the discharge devices may be of the Ignitron tube type. Such discharge devices comprise a mercury pool cathode and a starting electrode which dips into the mercury pool. When current is transmitted between the starting electrode and the mercury pool a discharge is initiated between the mercury pool and a cooperative electrode.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, 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 connection with the accompanying drawing, in which the single figure is a diagrammatic view illustrating an embodiment of my invention.

In the drawing, my invention is shown as utilized to control one or more of the properties of a fluid. For example, it may be applied to control the alkalinity of the fluid. In such a case, a component of the fluid tending to increase the alkalinity is projected through a tube 1 provided with a valve 3 while a second component tending to decrease alkalinity is projected through a second tube 5 also provided with a valve 7. The valves 3 and 7 are coupled together by gears 9 and 11 in such manner that the flow through one tube is increased at the same time that the flow through the other tube is decreased. The arrangement makes possible rapid changes in the condition of the fluid.

The components of the fluid are combined in a single tube 13 and transmitted through a comparison cylinder 15. It is assumed that variations in alkalinity are to be detected by optical means, that is, by the variations in the color or the opacity of the compound fluid. For example, phenol-thalein may be added to the fluid and the variations in alkalinity may be detected by comparing the redness of the fluid in the cylinder with a standard. In such a case, the standard of comparison is disposed in a second cylinder 17, similar to that through which the fluid to be compared is projected.

Radiant energy from a suitable source 19 is projected through the cylinders 15 and 17 after being reflected from mirrors 21 and 23. Preferably the radiation is projected longitudinally through the cylinders and for this reason the ends of the cylinders are transparent to the radiant energy emitted by the source 19. In the simplest embodiment of my invention the source 19 is an

incandescent lamp. It may happen however, that a monochromatic source of visible light or a source of ultra-violet or infra-red radiations are utilized.

8 The radiations emitted by the cylinders 15 and 17 are intercepted by a rotating disk 25 provided with a semi-circular opening 27. The disk is rotated in the path of the radiant energy emitted by the cylinders by a synchronous motor 29 energized from an alternating current supply (not shown). 10 The dimensions of the semi-circular opening 27 and the speed of the disk 25 are so related to the frequency of the electrical supply that during half cycles of the supply potential that are of one polarity the radiation from one of the cylinders is transmitted through the opening while during the half cycles of the opposite polarity the radiation from the other cylinder is transmitted through the opening. The radiation transmitted through the opening 27 is projected on mirrors 31 and 33 and reflected thereby to the cathode 35 of a photo-sensitive device 37. The photo-sensitive device thus receives light impulses first from one cylinder (15, say) and then from the other cylinder (17) at intervals corresponding to half periods of the power supply.

In accordance with my invention, I provide a plurality of electric discharge devices 39 and 41 to respond to the excitation of the photo-sensitive device 37. Each electric discharge device is provided with an anode 43, a cathode 45 and a control electrode 47.

35 The cathode 45 of the discharge device 39 and the anode 43 of the other device 41 are directly connected to one bus line 49 of the alternating-current source. The cathode of the last-mentioned discharge device 41 and the anode of the first-mentioned discharge device 39 are connected to the other bus line 51 of the source through the exciting coil 53 of a polarized relay 55. It is seen that the discharge devices 39 and 41 have a common output circuit in which the relay coil 53 is connected and they are so coupled to the source that they alternately transmit half wave pulses of current of opposite polarity through the coil 53.

The cathode 35 of the photo-sensitive device 37 is connected to the cathode 45 of one of the discharge devices 39 through an auxiliary potential supply 57 and a rectifier 59 which preferably is of the dry copper-copper-oxide type. It is connected to the cathode 45 of the other discharge device 41 through the auxiliary supply 57 and through another rectifier 61 similar to the first. 55 The necessity of the rectifiers 59 and 61 will be apparent from a consideration of the circuit shown. It will be noted that the conductors 63 and 65, through which the auxiliary supply 57 is connected to the cathodes 45 are both, in turn, connected across the main supply through the relay coil 53. To prevent short circuiting of the main supply by the relay coil 53 and the conductors, the rectifiers are incorporated in the conductors. The rectifiers are so connected that they permit the current from the photo-sensitive device 37 to divide and pass through the circuit but offer an open circuit to current from the main supply.

70 The control electrodes 47 of the discharge devices 39 and 41 are connected together and their common junction point is connected to the anode 67 of the photo-sensitive device 37. It will be understood, of course, that the specific connection of the control electrodes which is shown is not an essential element of my invention. The rela-

tionship between the control electrodes depends on the character of the discharge devices 39 and 41 that are utilized. It may happen that the discharge devices require different biasing potentials between their control electrodes 47 and their cathodes 45. In such a case, suitable biasing sources may be interposed between each of the control electrodes and the point to which the anode 67 of the photo-sensitive device 37 is connected.

10 To the common electrical junction point of the control electrodes 47 and the anode 67 of the photo-sensitive device 37 grid resistors 69 and 71 are connected. Each of the resistors 69 and 71 is respectively connected to the negative electrode of the rectifiers 59 and 61. It thus happens that a plurality of networks, each of which incorporates the photo-sensitive device 37 are provided. One network extends from the positive terminal of the auxiliary supply 57 through one of the rectifiers 59, the resistor 69 to the anode 67 of the photo-sensitive device 37 and through the photo-sensitive device to the negative terminal of the supply 57. The other network extends from the positive terminal of the supply 25 57 through the other rectifier 61, the other resistor 71 to the anode of the photo-sensitive device.

When the photo-sensitive device 37 is energized, a pulse of current is transmitted through the resistors 69 and 71 and a drop in potential is impressed between the control electrodes and the cathode of the discharge devices 39 and 41. Since only one of the discharge devices has positive anode-cathode potential impressed thereon during any half-cycle interval, only the pulse of current transmitted through its corresponding resistor is effective in producing a response in the relay coil 53. A pulse of current corresponding to the magnitude of the radiant energy impinging on the photo-sensitive device at the time is transmitted through the relay coil. The magnitude of the radiant energy in question on the other hand depends on the optical properties of one or the other of the cylinders by reason of the synchronizing influence of the disk 25. Consequently, the excitation of each of the discharge devices 39 and 41 in its turn and the corresponding current transmitted thereby through the relay coil 53 depends on the optical properties of one or the other of the cylinders. It thus happens that first a half-wave corresponding to the fluid to be compared is transmitted through the relay coil 53 and through one of the discharge devices (39, say) and then a half-wave of current of opposite polarity corresponding to the standard is transmitted through the relay coil and through the other discharge device (41).

The relay 55 is provided with a lag loop 73 and does not respond to the instantaneous values of the current transmitted thereto. It responds, however, to the net value of the current in such manner that if the current transmitted through one discharge device 39 or 41 predominates over that transmitted through the other, one pole of the relay is more highly magnetized than the other.

The relay 55 is provided with a movable arm 75 which, in turn, is rigidly mounted on the pin controlling the closing and opening of the valve 7. As the excitation of the coil 53 varies, the arm 75 is pivoted about the axis of the pin and varies the opening of the valve. The valve 7 is opened and closed in accordance with the movement of the arm and the other valve 3 is corre-

spondingly closed and opened. The variations detected by the photo-sensitive device 37 are thus neutralized.

One of the outstanding advantages of my invention resides in the oppositely connected discharge devices 39 and 41. This feature of the invention makes possible the elimination from the system of commutators and their complications. Another outstanding advantage resides in the arrangement of the circuit which makes possible the use of a single photo-sensitive device 37. If more than one photo-sensitive device were necessary for comparison purposes the problems arising from the differences between the devices would be involved. The arrangement making possible the use of a single source also involves the same advantage.

It is to be noted that in the practice of my invention essentially the current transmitted by the discharge device operating in correspondence with the radiations emitted by the standard is compared with the current controlled by the fluid that is under observation. Accordingly, an optical standard of comparison while advantageous is not altogether essential. The current transmitted by the comparison discharge device may be varied by other means. For example, in lieu of a discharge device provided with a control electrode, a comparison discharge device comprising simply a rectifier provided with suitable adjustments to vary the anode cathode current to correspond to the requirements of the standard may be utilized.

My invention has herein moreover been shown as photo-sensitively controlled. Photo-sensitive control has, of course, numerous advantages. However, it is conceivable that contact control or control by variations in conductivity may be applied without deviating from the essential principles of my invention.

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 insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. Apparatus for comparing a first source of radiant energy with a second source of radiant energy comprising periodic potential supply means, a radiant-energy responsive device, means for subjecting said responsive device to the radiations from said first source during certain periods of the periodic potential, means for subjecting said responsive device to the radiations from said second source during certain other periods of said periodic potential, current-responsive means, a first valve means controlled by said radiant-energy-responsive means, means for connecting said first valve means in such manner that current is supplied therethrough to said current-responsive means during said first-mentioned periods, a second valve means controlled by said radiant-energy-responsive means and means for connecting said second valve means in such manner that current is supplied therethrough to said current-responsive means during said last-mentioned periods.

2. In combination, a first current path, a second current path, valve means in each said path for controlling the current in said path, radiant-energy-responsive means for controlling said valve means, periodic power supply means, a first means for supplying radiant energy to said radiant-energy responsive means during certain

periods of said supply means, a second means for supplying radiant energy to said radiant-energy responsive means during certain other periods of said supply means and means for so connecting said supply means to said valve means that the current in said first current path is increased during said first-named periods and decreased during said last-named periods and the current in said second current path is increased during said last-named periods and decreased during said first-named periods.

3. Apparatus according to claim 2 characterized by that the radiant-energy-responsive means is a single photo-sensitive device common to the valve means in both the current paths.

4. Apparatus according to claim 2 characterized by a single current-responsive load controlled by the algebraic sum of the currents in both the current paths.

5. Apparatus according to claim 2 characterized by translating means of the type responsive to the polarity of the current transmitted therethrough during an interval of time which is appreciably longer than the periods during which the radiant-energy-responsive means is energized and which is so connected to the current paths that the current supplied therethrough by the first path is of opposite polarity to the current supplied therethrough by the second path.

6. In combination a first electric discharge device having a control electrode and a plurality of principal electrodes, a second electric discharge device having a control electrode and a plurality of principal electrodes, photo-sensitive means comprising a plurality of electrodes, means for coupling the electrodes of said photo-sensitive means between the control electrode and a principal electrode of each said discharge device, a source of periodic potential, means for coupling said discharge devices to said source in such manner that during certain periods of said source the current between the principal electrodes of said first discharge device is increased while the current between the principal electrodes of said second discharge device is decreased while during certain other periods of said source the current between the principal electrodes of said first discharge device is decreased while the current between the principal electrodes of said second discharge device is increased, a first means for exciting said photo-sensitive means during said first-mentioned periods and a second means for exciting said photo-sensitive means during said second periods.

7. Apparatus according to claim 6 characterized by unitary translating means to be energized from said discharge devices.

8. Apparatus according to claim 2 characterized by translating means to be energized by the current transmitted through said current paths and means responsive to said translating means to vary the radiant energy emitted by said first radiant-energy source.

9. In combination a first electric discharge device having a control electrode and a plurality of principal electrodes, a second electric discharge device having a control electrode and a plurality of principal electrodes, the conductivity of the paths between the principal electrodes of said discharge devices being asymmetric, photo-sensitive means comprising a plurality of electrodes, means for coupling the electrodes of said photo-sensitive means between the control electrode and a principal electrode of each said discharge device, a source of alternating potential, means for

coupling said discharge devices to said source in such manner that said first and second discharge devices are alternately conductive, a first means for exciting said photo-sensitive device during the
5 half cycles of said source that are of one polarity and a second means for exciting said photo-sensitive device during the half cycles of said source that are of the opposite polarity.

10 10. Apparatus according to claim 9 characterized by that the principal electrodes of each of the discharge devices is an anode and a cathode, one electrode of the photo-sensitive device being connected to the control electrodes of the discharge devices and another electrode of the
15 photo-sensitive device being connected to the cathodes of the discharge devices.

11. Apparatus according to claim 9 characterized by translating means which has one response when energized for an interval of time appreciably longer than the periodicity of the source by current of one polarity and another response when energized for a similar interval by current
20 of the opposite polarity and means for coupling said translating means to the discharge devices in such manner that currents of opposite polarity are supplied thereto by the discharge devices.

12. In combination a first electric discharge device having a plurality of principal electrodes, a second electric discharge device having a plurality of principal electrodes, a source of periodic potential, means for coupling said first discharge
30 device to said source in such manner that during certain of the periods of said source the current transmitted between the principal electrodes of said discharge device increases while during certain other periods said current decreases, means for controlling the magnitude of the current transmitted by said first discharge device and means for coupling the second discharge device to
35 said source in such manner that during said other periods a predetermined current is transmitted between the principal electrodes of said second discharge device.

13. In combination a first electric discharge
40 device having an anode and a cathode, a second

electric discharge device having an anode and a cathode, a source of alternating potential, means for coupling said first discharge device to said source in such manner that during certain of the
5 periods of said source the current transmitted between the principal electrodes of said discharge device increases while during certain other periods said current decreases, means for controlling the magnitude of the current transmitted by said first discharge device and means
10 for coupling the second discharge device to said source in such manner that during said other periods a predetermined current is transmitted between the principal electrodes of said second discharge device.

14. In combination, a first electric discharge device having a plurality of principal electrodes, a second electric discharge device having a plurality of principal electrodes, a source of periodic potential, means for coupling said discharge
15 devices to said source in such manner that said discharge devices are alternately conductive, means for controlling the magnitude of the current transmitted by said first discharge device and means providing for the transmission of current of a predetermined magnitude through said
20 second discharge device.

15. Apparatus according to claim 13 characterized by translating means to be energized by the current transmitted through both said discharge
25 devices.

16. Apparatus according to claim 9 characterized by that the principal electrodes of each of the discharge devices is an anode and a cathode, one electrode of the photo-sensitive device being
30 connected to the control electrodes of the discharge devices and another electrode of the photo-sensitive device being connected to the cathodes of the discharge devices, the connection to each cathode incorporating a rectifier so arranged in the circuit that the connection between one
35 cathode and the other cathode through the rectifiers is non-conductive.

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