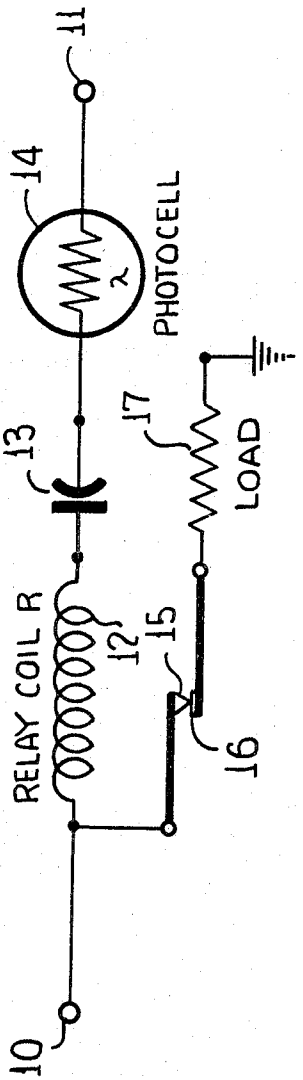
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DUAL VOLTAGE PHOTOELECTRIC CONTROL

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DUAL VOLTAGE PHOTOELECTRIC CONTROL

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The present invention relates generally to relay circuits and more particularly to series resonant photo-sensitive relay circuits including photo-sensitive resistances in series with a relay coil and a tuning capacitor, operative over a range of supply voltages extending from about 100 v. to about 300 v. without modification or adjustment of the circuitry, in response to nearly the same levels of illumination.

As electrical loads increase, utilities supplying the loads show a tendency to modify their supply networks, from the presently usual 120 v. to 240 v. and higher, and the changeover is proceeding ever more rapidly. During the changeover period, which will of necessity be a long one, both 120 v. and 240 v. (nominally) lighting controls for street lighting systems will be required. To simplify stocking requirements both for the utilities and for manufacturers of lighting controls it is desirable to provide controls which are capable of operating indifferently over the range from about 100 v., with no appreciable alteration in operating characteristics, i.e. pull-in point versus illumination.

Various solutions to the above recited problem have been advanced. For example, a voltage dropping resistance may be included in the control. This technique necessitates using large resistors capable of considerable heat dissipation. Since photo-resistive cells are sensitive to high temperatures, provision must be made for heat isolating the cells, adding to the costs and increasing the sizes of such units. Further, provisions must be made for including or excluding the resistances, at will, involving circuit complications and possible maintenance difficulties.

It is an object of the present invention to provide a light responsive relay system which, without producing heat or requiring adjustment operates equally well over a three to one voltage range, i.e. or any voltage in the range 100 v. to 300 v., i.e. pulls in and releases at about the same illumination levels regardless of voltage.

Briefly describing the invention, the relay coil is included in series with a tuning capacitor, individual reactances being large, say 30K. The coil and capacitor reactances are selected to resonate at the supply frequency, for all supply voltages. A photo-resistor is connected in series with the resonant circuit, and is selected to have far higher impedance than the coil impedance when unilluminated, say 1 meghohm, but far smaller when fully illuminated, say 200 ohms. The total series impedance is thus the resistance of the coil and the photocell resistance, coil resistance being the larger.

Total current through the relay coil is thus negligible when the photo-resistor is unilluminated or is insufficiently illuminated. When illuminated, circuit resistance falls radically and the relay coil operates. For precisely a given pull-in illumination the photo-resistor has a specified resistance and thus a specified current flows, for a given applied voltage, say 100 v. For a far different voltage, say 300 v., however, the voltage across the coil triples, for precisely that illumination. But, the photo-cell is selected to have a very steep slope of resistance versus illumination, so that pull in of the coil occurs at nearly the same illumination for the higher voltage, increase in supply voltage being compensated by increase in photo-cell resistance, but the latter being variable over a large range for a very narrow range of illumination intensity, at least near the values for which operation is desired.

For example, assume a coil resistance of 1000 ohms and a photo-cell resistanace which has values of 200–300 ohms over a narrow range of illumination for which it is desired that the relay pull in. Relay current is determined entirely by resistance values and line current, since reactance balances out in the resonant relay circuit. Hence pull in occurs at

$$\frac{100 \text{ v.}}{1200 \text{ ohms}}$$

or

$$\frac{300 \text{ v.}}{3200 \text{ ohms}}$$

equally well, because coil current is the same, essentially for both conditions. But both conditions occur in response to essentially or very nearly the same external illumination.

Once the coil has pulled in its contacts, any further increase in illumination is not important, so long as the coil can sustain the voltage and current without breakdown. The coil itself sees a larger voltage than line voltage, due to circuit Q, and therefore resistance values can be sufficiently large to provide relatively low Q even for negligible values of photo-resistive resistance, if the coil is to operate on low voltage. A suitable coil Q value for this purpose might be 2 or 3, with correspondingly higher values of photo-cell resistances than those specified. The crucial feature of the circuit is to provide a sufficiently steep slope of photo-cell resistance versus illumination to afford pull in and pull out of the relay for nearly the same illumination over the required wide range of operating voltages, and it is crucial to this end that the relay coil reactance be balanced out since it is a very large value.

It is, accordingly, an object of the invention to provide a street lighting relay including in series, a relay coil, a tuning capacitor and a photo-cell, the photo-cell having a sufficiently high slope of resistance versus illumination to effect pull in of the relay for essentially the same level of illumination over a wide range of voltages.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of one specific embodiment thereof, especially when taken in conjunction with the accompanying drawings, wherein:

The single figure of the drawings is a schematic circuit diagram of a system according to the invention.

Referring now to the drawings, **10**, **11** are terminals of supply line. Connected across the line terminals **10**, **11**, in a series circuit, is a relay coil, **12**, a capacitor **13** and a photo-cell **14** of the photo-resistive type. The relay coil may have a reactance of about 30K and the capacitor a capacitance of about .11 mfd., so that these elements resonate at supply line frequency. The relay coil and its associated reluctances and magnetics circuitry are such that its reactance remains constant, for all operating conditions. Current in the series circuit, and thus coil current, is thus determined entirely by R_c+R_{pc}, i.e. the resistance of the relay coil **12** plus the resistance of the photocell **14**.

Associated with coil **12** are normally open contacts **15**, **16**. These are pulled and open an energizing circuit to a load **17** when illumination reaches a predetermined value, dropping the value of R_{pc} to a value arranged to provide sufficient coil current to pull the contacts **15**, **16**.

By arranging that the slope of photocell resistance versus illumination be sufficiently high, the relay R, comprising coil **12**, will pull in (or out) for approximately the same illumination for a wide range of line voltages across terminals **10**, **11**, say 100 v. to 300 v. This result assumes that coil resistance is sufficiently low that a fairly narrow range of photocell resistances will provide the

same coil current for the desired range of voltages, and that this range of photocell resistances is attained for nearly equal values of illumination. Thereby pull in illumination level (or pull out) is the same regardless of line voltage, within a narrow range of limits adequate for practical system.

It will be evident that the load and the relay may be connected across the same lines, or different lines. Essentially, the contacts and the relay coil can be independent of one another, although this is not normally the case in street lighting circuits. In such applications of the relay of the present invention it is desired to open contacts **15, 16** when illumination increases to a desired level, in the morning, and to close them when illumination decreases to a desired level, in the evening. As illustrated contacts **15, 16** are normally closed, to accomplish the stated function.

While I have described and illustrated one specific embodiment of my invention, it will be clear that variation of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claim.

What I claim is:

A street lighting relay system operative across a pair of terminals supplied with alternating current voltage

in the range 100 volts to 300 volts, comprising a relay having a relay operating coil and normally closed contacts operative to open in response to at least predetermined current in said operating coil, a capacitor connected in series with said coil, said capacitor being selected to resonate with the reactance of said coil at the frequency of said alternating current voltage, a photocell of the photoconductive type connected in series with said coil and said capacitor across said terminals, said coil having a resistance R_c, said photocell having a sufficiently low resistance R_{pc} when illuminated to a predetermined level and sufficiently steep slope of resistance R_{pc} versus illumination that the sum of R_c+R_{pc} permits actuating current to flow to said coil in magnitude sufficient to operate said contacts to open condition at substantially said predetermined level of illumination over the entirety of said range of values of alternating current voltage.

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