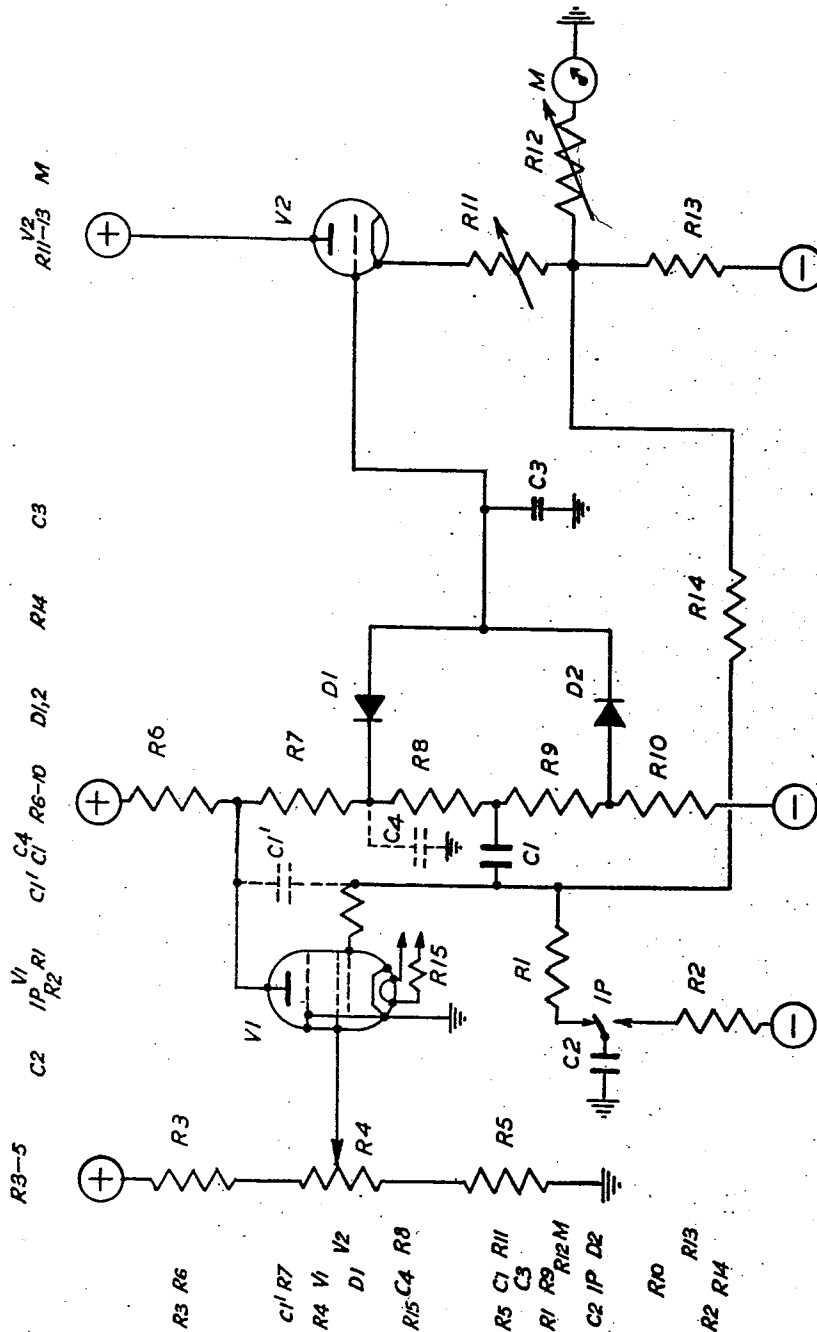


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ELECTRIC TIME CONSTANT CIRCUIT

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ELECTRIC TIME CONSTANT CIRCUIT

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This invention relates to electric signalling or control systems.

In many of such systems it is necessary to insert at an appropriate place in the circuits, a time constant circuit comprising for example a resistance in series and a condenser in shunt to smooth out voltage fluctuations. This involves a time lag in the system and involves a compromise between satisfactory smoothing of voltage fluctuations and reasonable response to changes in mean voltage.

It is the object of the invention to overcome this difficulty and to provide a circuit arrangement which enables a circuit having a long time constant to be used to smooth out slow voltage fluctuations whilst at the same time ensuring a rapid response to a change of mean voltage that is required to be effective.

According to one of its features the invention consists of a variable electric time constant circuit having a reactive element, a resistive element consisting of one or more non-linear resistances and a means of varying the resistance of the said non-linear resistance or resistances so as to vary the time constant of the circuit.

According to another of its features the invention consists of a variable electric time constant circuit having a reactive element, a resistive element consisting of one or more non-linear resistances, a source of potential and a means for varying that potential, the said potential being applied to the non-linear resistance or resistances so as to vary the resistance thereof whereby the time constant of the circuit is varied.

The resistive element of the time constant circuit comprises two resistances and two miniature rectifiers so arranged that the junction point between the resistances and that between the rectifiers are at the same potential under balanced conditions. The reverse resistance of the rectifiers is connected in circuit so that the time constant is large. When the balance is disturbed the voltage drop across the resistances alters and the forward resistance of one of the rectifiers comes into circuit, thereby reducing the time constant.

According to another of its features the invention consists of a variable electric time constant circuit having a reactive element and a resistive element, the latter consisting of two rectifiers, opposite poles of which, are connected together and to the reactive element, whilst the other ends of the said rectifiers are connected respectively to the positive and negative termi-

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nals of a source of potential, means for varying the potential difference between the junction of the two rectifiers and the reactive element on the one hand, and the terminals of the said source of potential on the other hand, the potential between the terminals of the said source remaining substantially constant whereby two alternative conditions only of the two rectifiers may be brought about namely, on the one hand both rectifiers are biased in the non-conducting direction giving a long time constant to the circuit and on the other hand one of the rectifiers is biased into the conducting condition and the other is biased into the non-conducting direction giving a short time constant to the circuit.

According to another of its features the invention consists of an electric signalling or control system adapted to convert a rate into a quantity having a first condenser which receives periodic increments of charge from a second condenser at the rate to be converted, a means of discharging the first condenser periodically between the times of adding such increments of charge, a time constant circuit the output of which is a quantity varying with the rate to be converted, such time constant circuit consisting of two rectifiers and a reactive element, the rectifiers being connected at one end of each to different tappings on an electric potential divider the ends of which potential divider are connected to a source of potential and joined at the other end of each to a reactive element, the first condenser being also connected to a point on the said potential divider, the said rectifiers being connected so as to be capable of being rendered non-conducting by virtue of the potential difference between the said two tappings on the potential divider in relation to the potential at the point of junction of the two rectifiers and the reactive element but one rectifier becoming conducting when the rate to be converted varies at a speed greater than a predetermined speed due to a change in the potential of that point of the potential divider to which the first condenser is connected, in relation to the potential of the point of junction of the two rectifiers and the reactive element, the time constant of the circuit constituted by the two rectifiers and the reactive element being reduced when one of the rectifiers is in the conducting condition.

The invention will be more readily understood from the description of an embodiment thereof in relation to the attached drawing which is a circuit diagram of a device for use in a system

such as that described in the U. S. application Serial No. 719,772 filed June 2, 1947.

That system comprises a condenser arranged to receive equal charges each time relay contacts are operated. This condenser is connected in parallel with a high gain amplifier so that the condenser constitutes a negative feedback path for the amplifier so that the charge on the condenser increases linearly with increasing increments instead of logarithmically, so long as the amplifier is working below full load.

In one form of the system the condenser terminal connected to the output of the amplifier is connected over a potential divider to a point of negative potential to provide a leakage circuit, and a point on the potential divider is connected over a resistance capacity time delay circuit to the grid of a cathode follower tube in the output circuit of which is a meter. The leakage circuit stabilises itself for a given rate of adding increments to the condenser and each charge on the condenser just leaks away before the next arrives when the increments are being added at the given rate. The time delay circuit has time constant of the order of 20 seconds and smooths out the voltage variations to a straight line value which is transferred to the meter which is calibrated to read the rate of adding the increments of charge to the condenser. By this means the operation of contacts by a kilowatt-hour meter can be made to cause a meter to register kilowatts.

In the drawing a large condenser C1 receives increments of charge via resistance R1 from a smaller condenser C2 which is itself periodically fully charged negatively over contacts IP in their unoperated position, via a resistance R2.

Condenser C1 is connected across the control grid and anode of an amplifier pentode valve V1, the screen grid of which is maintained at the required potential by a potentiometer consisting of resistances R3, R4, and R5, connected between positive H. T. and earth.

The source of voltage from which C2 is charged, is negative with respect to earth with a voltage which may be approximately equal to the said positive H. T. voltage.

The anode of V1 and the opposite terminal of C1 from that connected to R1, are both connected to a potential divider consisting of resistances R6, R7, R8, R9, and R10, of which R6 is virtually the anode load of V1.

Hitherto, in circuits of this type, C1 has been connected via a resistance capacity time constant circuit to the control grid of a valve arranged either as an amplifier or a cathode follower and the output from this valve has been applied to a meter.

It has further been the practice to arrange that the time constant circuit has a time constant sufficiently long to even out fluctuations on the state of charge of C1 so that the meter maintains a steady reading. This has the disadvantage that with slow rates of adding increments of charge to C1, it takes some time for the device to respond to charges of this rate.

When modified according to the invention, the time constant circuit has a condenser element and a resistance element consisting of rectifiers connected to a source of potential with means for varying that potential so as to vary the resistance of the rectifiers and the time constant of the circuit.

In the figure two rectifiers D1 and D2 are connected to two points on the potential divider

consisting of R6, R7, R8, R9, and R10, one point being the junction between R7 and R8, the other being the junction between R9 and R10.

The junction between rectifiers D1 and D2 is connected to C3 which is the condenser element of the time constant circuit, and to the grid of valve V2, connected as a cathode follower.

The manner of operation of the device is as follows:

C2 is charged to a negative potential over impulsing contacts IP, and when these are changed over, C2 discharges into C1 which thus receives an increment of charge for each impulse of contacts IP.

C1 acts as a negative feedback path with respect to the high gain amplifier so that the charge on the condenser C1 increases linearly with increasing increments of charge from C2, instead of logarithmically as it would do in the absence of the amplifier.

A resistance R14 provides further negative feedback to valve V1 and derives its feedback voltage from the cathode circuit of V2 to the grid of which the voltage developed across C1, are delivered.

A leakage path is provided over resistances R7, 8, 9, and 10, for condenser C1, to a point of negative potential and the average state of charge of C1 stabilises itself for a given rate of adding increments from C2, that is to say, for a given rate of impulsing by contacts IP, and each added charge on C1 leaks away before the next arrives.

The resistances R8 and R9 rectifiers D1 and D2 and the condenser C3 together form the time constant circuit designed to smooth out the fluctuations in the state of charge of condenser C1 as it is periodically connected to C2 by the impulsing of contacts IP, so that a steady voltage is passed to the grid of V2, and the time constant of the circuit must be long enough to smooth out these fluctuations.

When the rate of impulsing of IP is increased or reduced, the average state of charge of the condenser C1 adopts a higher mean value for an increased impulsing rate and a lower mean value for a reduced impulsing rate and a different point of equilibrium is set up. It is required that this changed state of equilibrium shall be conveyed in the form of a changed steady voltage to the grid of valve V2 as soon as possible. For slow impulsing rates, the fixed resistance and capacity time constant circuit hitherto used, tends to delay the assumption of this new steady voltage, which imposes a serious time lag in responding to changed impulsing rates.

The potential divider consisting of R6, 7, 8, 9 and 10 carries a standing current, and the rectifiers D1 and D2, are connected across R8 and R9.

The standing voltage drop across R8 and R9 is arranged to be slightly greater than the value of each increment of voltage added to condenser C1 and it appears as a reverse voltage across rectifiers D1 and D2 which are so poled as to be in a high resistance state, a state which for brevity is referred to as "the non-conducting condition" though it is realised that the rectifiers are never (and indeed must not be) completely non-conducting.

To understand the operation of the device R8 and R9 may be considered as a single resistance.

The voltage across the rectifiers D1 and D2 is mainly governed by the voltage drop across R8, R9, but the voltage across either of the rectifiers singly, is also affected by the potential difference

between the point of its attachment to the potential divider R6, 7, 8, 9 and 10 and the point of its attachment to C3 and the grid of V2.

This potential difference is affected by a change in the potential at any point of the potential divider R6, 7, 8, 9, 10.

The changing state of charge of C1 as it is periodically charged and discharged effects such a change in the potential of the said potential divider and the potential applied from time to time across each of the said rectifiers is a fluctuating potential.

When the rate of impulsing of contacts IP is stable, the potential of the grid of V2 becomes stable at an average value between the extremes of fluctuation of the voltage applied by C1 to the rectifiers via the said potential divider and in fact tends to follow the average potential of the centre point of R8, R9. The standing potential across R8, R9 is chosen so that the fluctuations, as C1 is charged and discharged at a steady rate, do not reach the point where either of the rectifiers D1 and D2 becomes conducting.

The potential divider R6, 7, 8, 9, 10, combined with condenser C1, constitutes a source of potential for biasing the rectifiers in that the former provides a steady and the latter a fluctuating potential superimposed thereon, the fluctuations of the combined potential being within such limits that both rectifiers remain non-conducting when the rate of adding increments of charge to C1 is steady.

The system is then balanced to the particular rate of impulsing of contacts IP and under these conditions, the smoothing time constant of the circuit is governed by the high resistance of the two rectifiers together with the capacity of C3.

When the impulsing rate of contacts IP changes, however, and the rate of adding increments of charge to C1 alters, the fluctuation in the voltage delivered to the said potential divider by C1 will occur about a raised or lowered mean value according to whether the impulsing rate is raised or lowered, and the potential of the various points on the said potential divider will be changed relative to the potential of the junction of D1, D2, C3 and the grid of V2, unless the rate is changing so slowly that the potential at this junction has time to adjust itself to the new level despite the long time constant of the circuit.

On the peaks of the fluctuations, therefore, the potential across one of the rectifiers between its point of attachment to the said potential divider and to the grid of V2, will overcome the standing potential across R8, R9 and cause this rectifier to become conducting.

This rectifier will therefore be in a low resistance state (which, for brevity is herein referred to as the "conducting condition") and the time constant of the circuit including this rectifier and C3 will be shortened considerably.

The circuit arrangements which bring about a change in the general level of charge of C1 in response to a change of the impulsing rate of contacts IP, when the change is sufficiently rapid, as explained above, constitute a means of varying the potential applied to the rectifiers D1 and D2 by the potential divider R6, 7, 8, 9, 10, in combination with C1.

At the time therefore, when the fluctuation of the potential from C1 makes one of the rectifiers conducting, there will be a rapid change of the voltage on the grid of V2 in the direction corresponding to the change in the impulsing rate of IP.

When the fluctuation of the potential of C1 passes its peak, the rectifier which was conducting will pass to the non-conducting condition again till the next similar peak, and if the potential of the grid of V2 has not completely adjusted itself to the changed impulsing rate, the rectifier will again become conducting and the potential on the grid of V2 will again change.

This will take place repeatedly until the potential of the grid of V2 has adjusted itself to the new impulsing rate, whereafter the fluctuation in the potential of C1 will no longer produce a potential difference between the connection of the rectifier to the said potential divider and to the grid of V2, sufficient to overcome the standing bias potential across R8, R9, and both rectifiers will remain non-conducting, giving a slow time constant to hold the potential of the grid of V2 steady.

The arrangement therefore gives a high time constant at a steady rate of impulsing of IP, and thus effectively smooths out fluctuations in the voltage delivered to the grid of V2 but allows of a rapid response to a change in the rate of impulsing.

In the drawing, C1 is shown as connected to the junction of R8 and R9 but it will be clear that C1 can be connected to various points of the said potential divider according to the convenience of circuit design, so long as fluctuations in its state of charge are arranged to cause fluctuations of the potential of various points on the said potential divider and particularly the points of connection thereto of the rectifiers D1 and D2. The connection of C1 to the junction of R6 and R7 has been found to be successful and such a connection is shown in dotted lines in the drawing, the condenser C1 being re-designated C1¹.

In the drawing, a meter M is shown connected via a variable resistance R12 to a potentiometer consisting of R11 and R13 in series, constituting the cathode load of V2. R11 is variable to adjust the zero setting of the meter.

This meter records the rate of impulsing of contacts IP by measuring the output of the cathode circuit of V2 which "follows" the voltage on the grid V2.

R12 enables the response of the meter to be calibrated.

The charging time constant of C1 may be adjusted to suit different impulsing rates and different values for C1 and if this time constant is shortened beyond certain limits it may be advisable to add a further condenser element to the smoothing time constant circuit constituted by rectifiers D1 and D2 and condenser C3.

This may be effected by connecting a condenser C4, where shown in dotted lines in the drawing, from the junction of R7, R8, and rectifier D1 to earth.

It is sometimes of advantage to reduce the heater current of V1 to reduce grid current at times when the grid of the valve is driven positive.

In the drawing, a resistance R15 is shown in series with the cathode heater supply leads, for this purpose.

We claim:

1. A variable electric time constant circuit having a long time constant in its normal condition of operation for smoothing out slow fluctuations in an input signal and a short time constant for ensuring rapid response to change in said input signal comprising a reactive element and a resistive element connected together, said resistive

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element including two rectifiers, opposite poles of said rectifiers being connected together and to said reactive element, a source of direct potential, a potentiometer connected across said source, the other ends of said rectifiers being connected respectively to a positive and a negative point on said potentiometer to bias said rectifiers to the non-conducting condition, and means for applying said input signal to a point on said potentiometer whereby rapid changes in the input signal cause unbalance of the voltages about the bridge formed by said potentiometer and said rectifiers and a biasing of one of the rectifiers into a conducting condition, thereby reducing the time constant of the reactive and resistance elements.

2. A circuit according to claim 1 in which said reactive element comprises a condenser.

3. A circuit according to claim 1 in which said input-signal-applying means is connected to a point on said potentiometer intermediate said positive and negative points.

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4. A circuit according to claim 1 in which said rectifiers are connected to positive and negative points designed to bias said rectifiers so that they remain in the non-conducting condition except when the frequency of the fluctuations of the input signal exceeds a predetermined value.

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