

Dec. 18, 1956

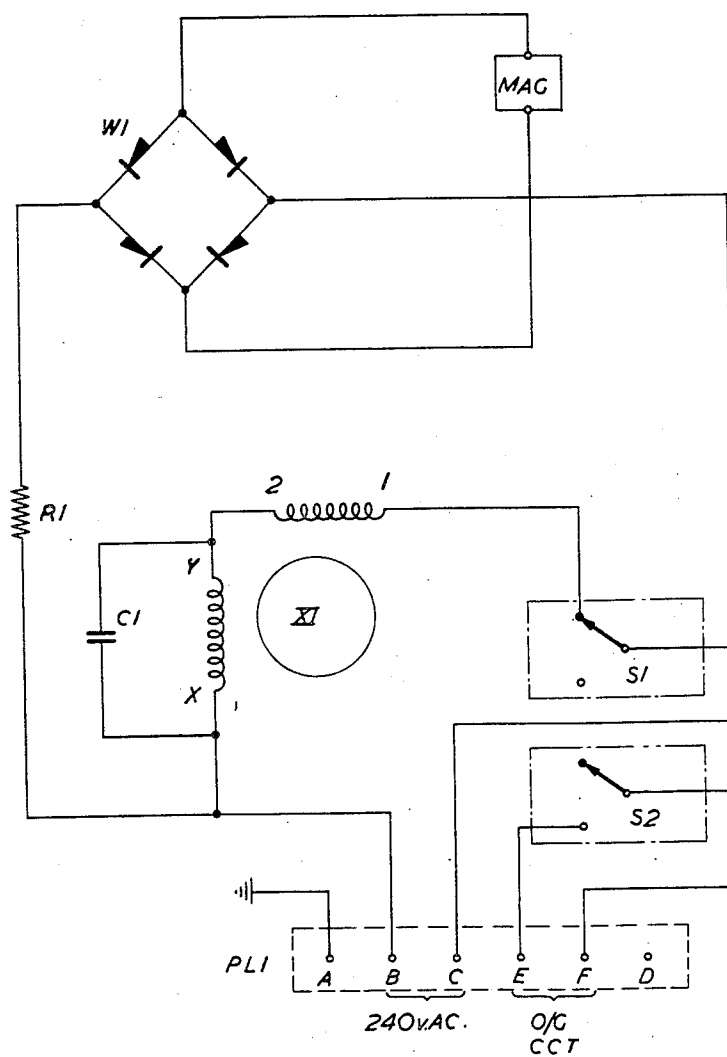
E. C. FIELDING
TIME DELAY MECHANISM

2,774,422

Filed Sept. 14, 1953

2 Sheets-Sheet 1

FIG. 1.



Inventor

E. C. FIELDING

By R. P. Morris

Attorney

Dec. 18, 1956

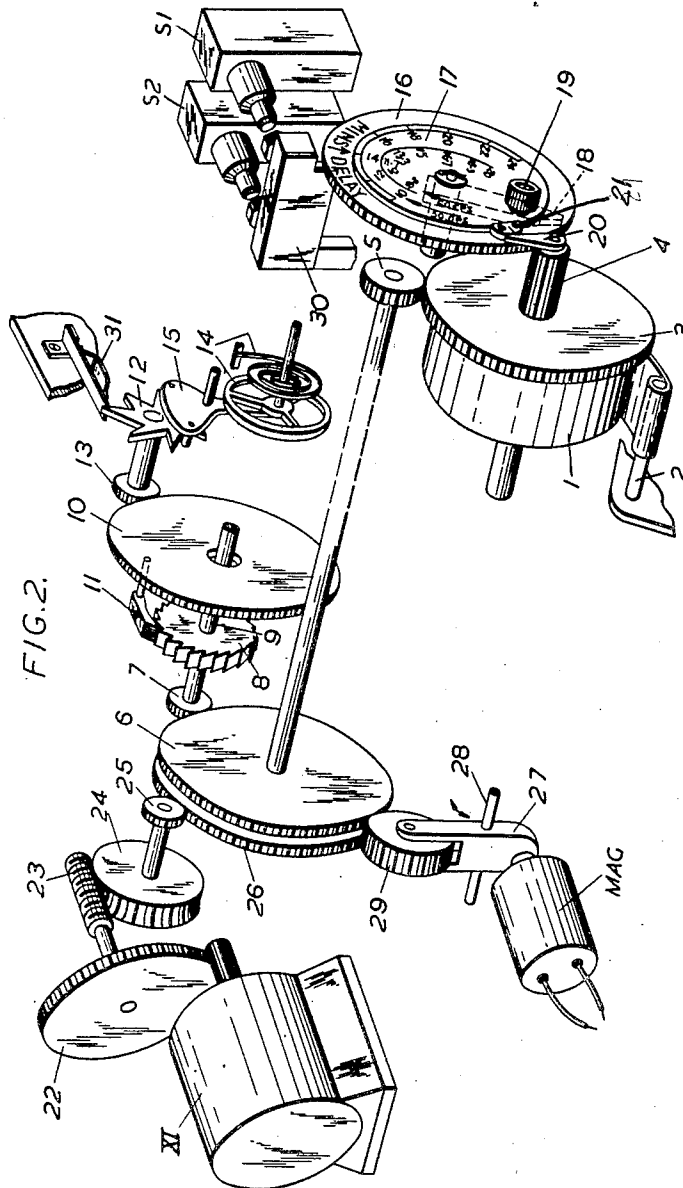
E. C. FIELDING

2,774,422

TIME DELAY MECHANISM

Filed Sept. 14, 1953

2 Sheets-Sheet 2



Inventor
E.C.FIELDING
By *R.P. Morris*
Attorney

1

2,774,422

TIME DELAY MECHANISM

Eric Clay Fielding, London, England, assignor to International Standard Electric Corporation, New York, N. Y., a corporation of Delaware

Application September 14, 1953, Serial No. 380,055

Claims priority, application Great Britain
September 16, 1952

4 Claims. (Cl. 161—1)

This invention relates to time delay switching apparatus of the type adapted to withhold the application of electric power to one part of an electric circuit for a predetermined interval of time after its application to another portion.

Such devices are well-known in the art in the form, for example, of thermal delay switches by means of which the high-tension power to thermionic valve equipment is delayed in its application until the valve heaters are fully warmed up and capable of electric emission.

The intervals of time which can be secured by this and other known means, e. g. dashpot relays, do not exceed a few minutes (less than five, and generally of the order one-half to two minutes), and they have the further disadvantage that after every interruption of current—be it only for a few seconds—the whole of the delay period must be experienced again before the equipment controlled is again in operation.

According to the present invention, there is provided a time-delay switching apparatus for delaying the initial operation of power-switching means by an interval of time T_a , characterised in this that, after interruption of power, and consequent release of said switching means, for a period of time T_b , the switching apparatus will delay re-operation of the said switching means for a period of time dependent on T_b , or for the period of time T_a , whichever is the lesser.

According to another aspect, the invention provides a time-delay switching apparatus for delaying the initial operation of power switching means by a predetermined interval of time (T_a), characterised in this that, interruption of power causes release of said switching means and also causes said time delay means to alter said time delay automatically to a delay dependent on the time for which power is interrupted, with said initial time delay as a maximum, and means controlled by the power when it is restored for automatically operating said switching means under the control of said altered time delay.

The time T_a can be made relatively long, and in an experimental model has been made as long as 24 minutes, with a minimum of 10 minutes, though these figures are purely arbitrary, being chosen to suit a particular range of equipment.

An important feature of the new delay mechanism is the fact that the "restore delay" (after a short interval power cut) is less than the initial delay (on first switching-on — T_a), and in general is equal to the time for which the power has been cut, although this is not essential. Where this interval of time exceeds T_a , then, of course, the "restore delay" is made equal to T_a , under all conditions.

The invention will now be described with reference to the accompanying drawing illustrating a preferred embodiment.

In the drawing:

Fig. 1 shows the electrical details of the equipment, while

Fig. 2 shows the mechanical details in schematic form,

2

including both an electrically driven and a spring-driven clock mechanism with certain parts in common, as "first" and "second" clock mechanisms respectively. References throughout this specification to a "second clock mechanism" are to be interpreted in this sense, and not with reference to the "rate" of the clock mechanism.

Referring now to Fig. 1, this shows a preferably synchronous electric motor XI having field windings 1, 2 and X, Y, and a phase-correcting capacitor C1, and controlled by a micro-switch S1, and also a magnet MAG, adapted to be energised from an alternating current source via a rectifier bridge W1. A second micro-switch S2 controls an external circuit. S1 and S2 could be any other suitable type of switch or contact set having a very small differential between operated and de-operated conditions.

The motor, as stated, is "preferably synchronous" so as to respond to frequencies in the range 45–65 C. P. S.

Alternating current of suitable voltage and frequency—in this instance, at 240 volts and of frequency in the range 45–65 C. P. S.—is applied at terminals B and C of a multi-way plug PL1, and immediately energises the motor X1 via the normally closed switch S1, and the magnet via a dropping resistor R1 and the aforementioned rectifier W1.

The magnet operates an armature which serves to insert an idler gear wheel into a gear train between the motor and a spring-operated clock mechanism to wind up the mainspring thereof, and also to rotate a timing dial. The dial is provided with an adjustable switch operating means, or cam, by which the requisite delay can be set to a desired value between 10 and 24 minutes on a 50-cycle supply, or approximately 8 to 20 minutes on 60 C. P. S. (in this particular model) and after the predetermined interval of time the dial and cam will have rotated under the influence of the electric motor to a position in which the cam will impinge against a switch actuating lever.

Both switches S1 and S2 will then operate approximately simultaneously, S1 cutting off the power supply to the motor immediately after S2 has completed an external circuit via terminals E and F of PL1. The magnet circuit remains permanently energised while alternating current continues to be applied to the circuit, and this has the effect of preventing the spring-operated clock mechanism running backwards after the drive from the motor has ceased, and so releasing the switches. If, however, the main A. C. supply subsequently fails, or is removed, then the magnet releases, and the spring-operated clock mechanism is set in motion, timing the return of the cam to its zero position. The external circuit is broken within 2 seconds of the main supply failing. A renewal of the A. C. supply at some still later time re-energises the magnet, thus stopping the spring-operated clock mechanism, and re-energises the motor, thus reversing the unwinding process (if still in operation), and returns in due course the switch-operating cam.

The processes just described will be more readily understood by referring to Fig. 2, which shows the mechanical details of the equipment.

The spring-operated clock mechanism is driven by a mainspring 1 which is preferably wound into a barrel or drum, (not shown) the outer end 2 of the spring being fixed rigidly either to the general framework, as shown, or to the stationary drum, while the inner end is hooked to a central arbor carrying a winding wheel 3 and pinion 4. The spring is wound clock-wise from the arbor, so tending to drive the wheels 3 and 4 clock-wise when it is wound up and free to drive.

The wheel 3 drives a second pinion 5 and gear-wheel 6 (anti-clock-wise), and the wheel 6 drives a third pinion 7 rigidly attached to a ratchet wheel 8 and a central

3

arbor 9. A gear-wheel 10 coaxial with 7 and 8 is loosely mounted on arbor 9, and coupled to ratchet wheel 8 by a pawl 11, for driving in a clock-wise direction. Gear wheel 10 drives an escapement wheel 12 via a pinion 13, and 12 is coupled to a balance wheel 14 via an escape-ment lever 15, in well-known fashion.

When subject to no other restraints, therefore, the main-spring unwinds at a rate timed by the escapement and balance wheel mechanism 12, 14 and 15.

The pinion 4 drives a large gear wheel 16 which carries a timing disc 17 engraved with an equiangular scale (or scales) showing "minutes delay" (T_a), and the cam previously referred to, and shown as 18. The words "Mins. Delay" are engraved on the rim of the gear wheel, as shown, with an arrow, while the actual scale (or scales) are engraved on the movable disc. Two scales are shown in this model, to enable the device to be used with 50 C. P. S. or 60 C. P. S. A. C. supplies (q. v.). The engraved disc and cam are locked to the gear wheel 16 by means of a clamping nut 19, and in the figure, the disc is shown as set for 14 minutes delay.

Rigidly attached to the top of pinion 4 is a cam 20 adapted to impinge against a stop 21 fixed to the gear wheel 16. Thus, when the clock mechanism has run for a period of time sufficient to cause the cam 20 to impinge against the stop 21, further travel is impossible and the clock stops. Note that, under these conditions, the pinion 4 is driving the gear wheel 16 anti-clock-wise. The mainspring is given an initial winding-up on assembly of some 5-6 turns, so that it will provide sufficient initial torque to operate the escapement mechanism in all circumstances. It is also of sufficient length to avoid an unduly high "rate," which would be undesirable in the fully-wound condition.

Referring now to the electrical mechanism, the electric motor X1 drives a gear wheel 22 which carries a worm-gear 23 driving a reduction-gearing 24, 25, 26. The magnet MAG, energised with the motor, attracts its armature 27, and this, pivoting about the point 28 causes the idler gear wheel 29 to mesh jointly with both gear wheels 6 and 26, whereby 6 is driven clockwise from 26. This, it will be observed, is counter to that described above for the direction of rotation of 6 when driven by the spring 1, and the motor thus tends to wind up the spring 1, at the same time driving the wheel and disc assembly 16-19 clockwise.

Now the speed of rotation of 16 imparted by the motor through the intermediate gearing is arranged to be approximately the same as that in the opposite direction due to the clock mechanism, and after the period of time T_a , indicated by the setting of the disc 17 on the gear wheel 16 (in this case, 14 minutes for 50 C. P. S. supplies, 11.7 minutes for 60 C. P. S. supplies) the cam 18 reaches a position where it impinges on the stiff vertical lever 30, deflecting it, and causing it to operate the micro-switches S2 and S1, in that order. Operation of S1 cuts the supply to the motor X1, but not to the magnet, and the slight overrun which takes place ensures that the switches are firmly operated. The continued operation of the magnet and consequent continued locking of the motor and clock gear-trains prevents the clock mechanism commencing to run, by virtue of the non-reversible effect of the worm gearing.

During the winding-up process, it will have been noticed, the ratchet and pawl gearing 10 and 11 will have prevented the balance-wheel mechanism being driven by the motor, thus reducing wear. A further precaution is the light pawl spring 31, which prevents reverse rotation of the escapement wheel, holding it in the most favourable position for reliable starting of the escapement mechanism.

Thus the full application of the main A. C. supply to the equipment controlled has been delayed by a period of time, T_a , determined jointly by the speed of the electric motor and the precise setting of the cam 18.

4

If the mains then subsequently fail, the armature 27 is released, and the spring-operated clock mechanism is freed from restraint, and allowed to run under control of the escapement mechanism, the disc 17 meanwhile rotating anti-clockwise at controlled (clock) speed. If the main supply is restored after a short period of time—less than T_a —the dial 17 will have returned only a portion of its full return distance, and the motor X1 will have to drive it a lesser distance than that represented by T_a , say T_b , before the external circuit is re-made by switch S2.

The mains are thus restored to the equipment sooner than they would be if the time switch had always to traverse the whole of its delay period after an interruption. This is particularly important for delays of the order shown—10 to 24 minutes—when an interruption of only a few cycles of the A. C. would be sufficient to bring the time switch into operation again. With the arrangement described, a re-operation delay of only a second or two would be required to restore power, and not the whole delay period, as in known devices.

It will be obvious, of course, that the timing of the spring clock is "absolute," i. e. dependent only on the balance wheel and—to a negligible extent—on the strength of the main spring, whereas the "operate time delay"—which is governed by the motor—depends on the mains frequency, and, as in the example shown, may vary from 20 to 24 minutes according to the standard frequency of the supply.

For this reason, in a device intended, as this one is, to cater for two commonly used frequencies of supply, the spring clock is adapted to indicate a mean time between the two electric clock times, i. e. 22 minutes, at a setting of 20 minutes (50 C. P. S.) or 24 minutes (60 C. P. S.).

The operation of the equipment is, furthermore, based on the tacit assumption that the electrical equipment controlled loses reserves of power, e. g. heat, at approximately the same rate (inversely) under conditions of free loss (e. g. cooling) as that at which it stores power (e. g. warms up) under the application of power. This may not necessarily be true in a particular case: thermionic valve equipment might, for example, become completely cold in 10 minutes, yet take 20 minutes to heat up adequately. Consequently, the spring clock need not necessarily run at the same rate as the electric clock (even assuming its use on one prescribed frequency), and the dial could be engraved with one scale for the spring clock and one (or more) for the electric clock.

In the application described, switch S2 is used to apply electric supply mains to an external circuit, but it will of course be understood that the switch S2 could be used for any other purpose not necessarily associated with the mains supply, and in this connection any suitable combination of contacts could be embodied in switch S2, or it could exercise, or represent, a purely mechanical function.

Furthermore, the "second clock mechanism" need not be powered by a spring—although this is extremely convenient. It might comprise a second electric clock, with an alternative source of power, e. g. a weight-driven, battery-operated clock, the battery being maintained charged by a trickle-charger under the control of the mains supply, analogously with the winding-up of the main-spring, as described.

While the principles of the invention have been described above in connection with specific embodiments, and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

What I claim is:

1. Time delay electric switching apparatus comprising a source of electrical power, switch operating means, an electric clock mechanism for driving the switch operating means in one direction at a controlled rate for a period

5

of time T_a on application of electrical power, and a spring clock mechanism arranged to drive said switch operating means in an opposite direction at a rate controlled by a rate regulating mechanism, the two said clock mechanisms coupled to a common gear train, electro-magnetic means for clutching in the said electric clock mechanism to the common gear train to drive the said switch operating means forward on application of electrical power, and means for disabling the rate regulation mechanism of said spring clock mechanism during said forward travel; means for de-energizing said electric clock mechanism at the end of said forward travel, means for preventing operation of said spring clock mechanism during the application of said electrical power to said apparatus and means for adjusting the time T_a of forward travel of said switch operating means.

2. Apparatus as claimed in claim 1 wherein the electric clock mechanism includes means for winding up the main-spring of the spring clock mechanism while the electric clock mechanism is driving the said switch operating means forward.

3. Apparatus as claimed in claim 2 wherein the rate of said electric clock mechanism when driven by alternating current of frequency of approximately 55 C. P. S., corresponds to the rate of said spring clock mechanism.

4. Time-delay electric switching apparatus comprising a source of electrical power, a gear-wheel bearing a dial for indicating intervals of time, a switch operating means coupled to said gear wheel for operating an electrical switch after an interval of time as indicated by said dial; an electric motor coupled to said power source for driv-

6

ing a gear-train, clutching means coupled to said gear train for driving said gear wheel in one direction from a starting position, to operate said switch and to wind up a spring; an electro-magnetic means for controlling said clutching means; means in said switch for disconnecting electric power from said motor upon operation of said switch; means in said gear train operable via said clutching means for preventing unwinding of said spring when said electric motor is disconnected; a balance-wheel and escapement means for controlling the rate of unwinding of said spring and driving said gear wheel in the opposite direction to said starting position, upon the failure of electric power to said electro-magnetic means; and means for preventing the operation of said escapement means during the forward driving process of said gear wheel.

References Cited in the file of this patent

UNITED STATES PATENTS

1,893,223	Burkle	Jan. 3, 1933
1,931,291	Ingraham et al.	Oct. 17, 1933
1,973,123	Stogoff	Sept. 11, 1934
2,007,769	Peterson	July 9, 1935
2,108,931	Trepanier	Feb. 22, 1938
2,120,787	Lowkrantz	June 14, 1938
2,130,405	Andrews	Sept. 20, 1938
2,147,449	Lee	Feb. 14, 1939
2,186,815	Alexanderson	Jan. 9, 1940
2,294,759	Morack	Sept. 1, 1942
2,312,077	Cowles	Feb. 23, 1943
2,396,523	Nelsen	Mar. 12, 1946