March 6, 1945. T. R. FREITAG ET AL 2,370,621

AUTOMATIC CONTROL FOR ELECTROPLATING SERVICE

Filed Sept. 25, 1942 2 Sheets-Sheet 1

FIG. 1.

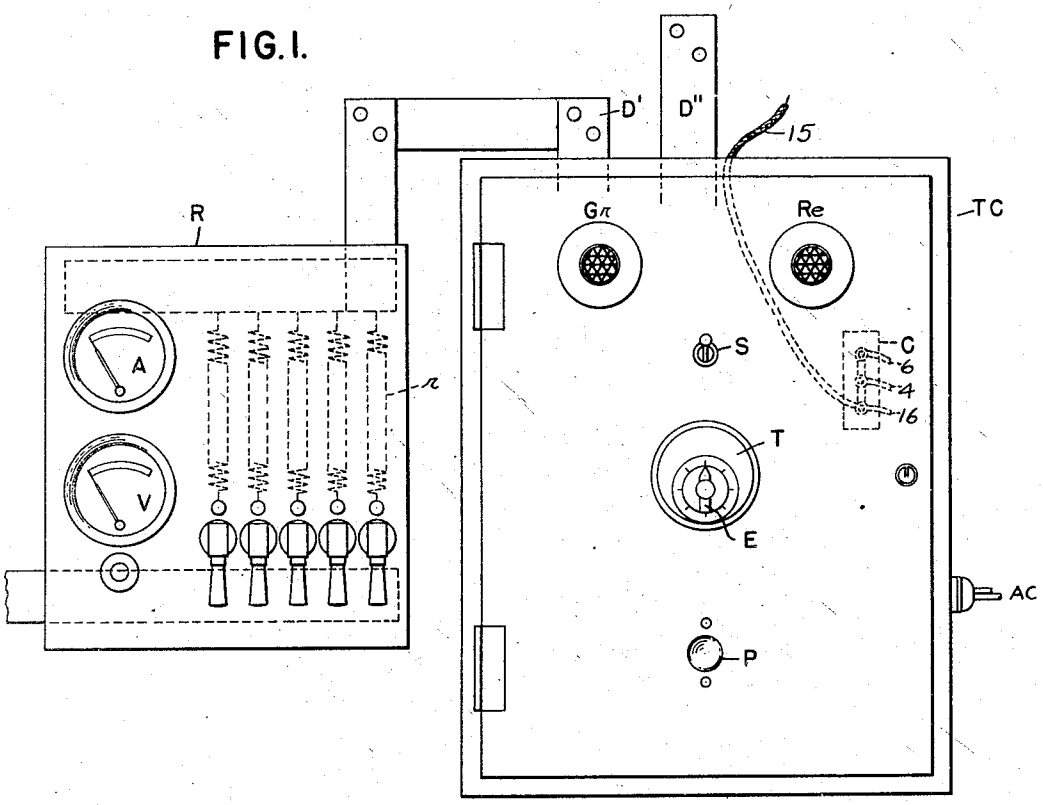
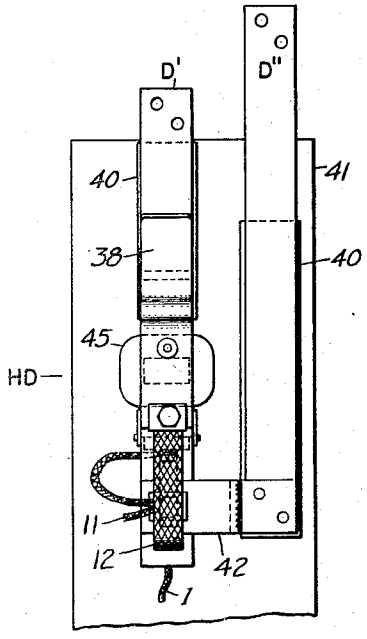


FIG. 2.



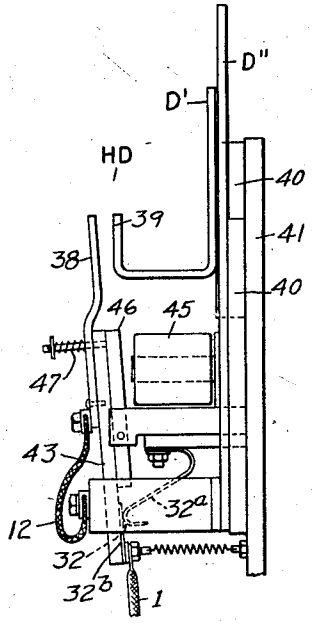


FIG. 3.

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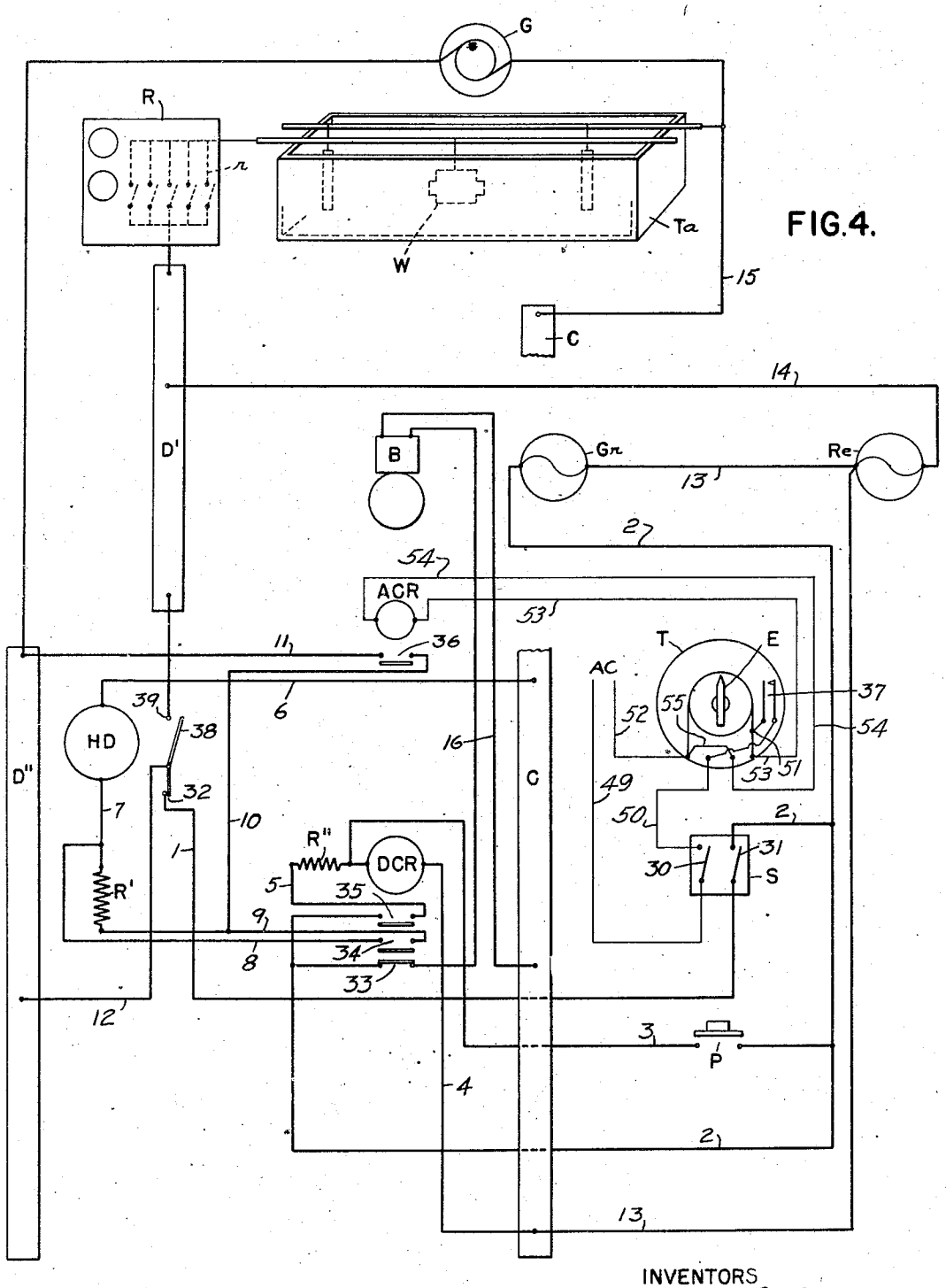


FIG.4.

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UNITED STATES PATENT OFFICE

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AUTOMATIC CONTROL FOR ELECTRO-PLATING SERVICE

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Application September 25, 1942, Serial No. 459,658

5 Claims. (Cl. 177—311)

This invention relates to electroplating controls and is concerned more particularly with a control unit capable of automatically controlling the low voltage (0 to 12 v.) high amperage service (0 to 10,000 amp.) employed in electroplating and in other environments, and wherein a definite time control of the current flow is essential.

In the art of electroplating, it is well known that an article to be plated may have a metal coating deposited thereon the thickness of which will be a variable unless great care is taken to insure that, with due regard to the density or pressure of the current passing through the electrolyte bath and the temperature and specific gravity of the bath, the plating time period is carefully controlled.

The present invention has for a primary aim to render available a control unit adapted automatically to control the thickness or the amount of electrodeposition of the metal coating to be applied to the end that articles to be plated may be given uniform coatings of a specified thickness.

A further aim of the invention is to provide a time control for direct current service, having in combination visual and audible signalling means so arranged as to give indications before, during, and at the completion of an operating cycle of the apparatus to which the control is adapted so that the operator is certain to be notified of the reliability of the service before the operating cycle is started, and moveover, is given continuous notification of the functioning of the apparatus during the selected period for its operation, and again at the completion of the operating cycle. In electroplating environments, such a control relieves the attendant of the necessity of careful manual supervision, which at times may be impossible of attainment especially if one operator has several plating tanks in operation or has other duties to perform meanwhile.

Heretofore it has been customary to rely upon time clocks, stop watches, and the like, to indicate the correct time at which to open the main heavy duty switch of a given plating tank, but as such devices depend upon the alertness and promptness of the operator, there frequently occurs unnecessary or over plating of workpieces, and in a relatively short period of time they prove to be quite uneconomical to use.

The time element in electroplating is highly important not only to insure that articles to be plated will have deposited thereon a coating of at least a specified thickness for a specific use or purpose, but that the coating so applied will not be appreciably thicker than necessary. From an economic standpoint the excess thickness wastefully depreciates the electrolyte bath and the metallic electrodes therein (silver, copper, etc.), and in many instances as, for example, indium plating, a fraction of a minute longer-than-necessary plating interval means a substantial increase in the coating. If the tank operator is busy at another tank or inadvertently neglects to check the time accurately it is a simple matter for the plated coat to build up to an excess thickness in a very short time.

With the aid of the present invention, however, an operator may successively set in operation one or a battery of electroplating tanks and be assured that each tank will have its plating circuit opened at the end of a predetermined and preset time interval, and audible and visual notification given of the completion of the plating operation in respect to each tank.

Still a further aim of the invention is to render available an automatically controlled timing device for a heavy duty switch or switches having the capacity to carry 0 to 10,000 amperes or over in single or multi-pole, so as definitely to control electroplating deposits to a definite and strictly uniform thickness or amount thereby to eliminate need for close manual attention and to expedite and promote efficiency in electroplating operations of miscellaneous kinds.

In realizing the objectives of this invention it is proposed to embody an electromagnetic heavy duty switch in the circuit to a given plating tank and to control the operation thereof through the medium of a manually and automatically operated timing device. In the present embodiment, the timing device comprises an alternating current synchronous motor connected to operate an A. C. relay mechanism which in turn controls the operation of the main switch and portions of the signalling circuits controlled thereby. Other forms of interval timers may, of course, be used. An A. C. interval timer is, however, preferred owing to its reliability and accuracy in time measurement and the lack of need for manual attention. The signalling circuits include a red and a green signal lamp, a buzzer, and cut-out switch. Thus, in the present embodiment of the invention, both direct and alternating currents are interrelated to provide a compactly arranged, accurate time control for a heavy duty switch and which function first to give an audible and visual signal at the start of the operating cycle, a different visual signal during the progress thereof, and again an audible and visual signal of the

completion of the predetermined and preset period of operation for which the timer was set.

Other objects and advantages will be in part indicated in the following description and in part rendered apparent therefrom in connection with the annexed drawings.

To enable others skilled in the art so fully to apprehend the underlying features hereof that they may embody the same in the various ways contemplated by this invention, drawings depicting a preferred typical construction have been annexed as a part of this disclosure and, in such drawings, like characters of reference denote corresponding parts throughout all the views, of which—

Figure 1 is a front view of a time control unit embodying this invention.

Fig. 2 is a front view of the time controlled heavy duty switch.

Fig. 3 is a side view of the switch illustrated in Fig. 2.

Fig. 4 is a line diagram of the control circuits in which the various elements are shown diagrammatically.

With reference to Figures 1 and 4, the apparatus therein illustrated comprises a generator G which furnishes direct current to the electroplating tank T*a* through and under control of a resistance panel R and timer panel TC.

In all electroplating operations the various factors incident to securing perfection in the deposited coating are, with the exception of the time element, fixed or reasonably ascertainable beforehand. The current density is controlled by rheostats *r* and indicated on a voltmeter V and ammeter A, the specific gravity and temperature of the bath by hydrometers and thermometers, and having assured oneself that the article W to be plated is thoroughly clean it is then necessary only to immerse it in the bath and connect it to the negative or cathode side of the generator and effect closing of the line switch. From that point forward, the article will receive a deposit of metal on its surface that will continue to increase in thickness until the current to the tank is again interrupted.

Figs. 2 and 3 illustrate one form of construction of the heavy duty time controlled switch HD, which comprises essentially a heavy copper tank feed bar D', and an equally heavy generator feed bus D'', and a heavy pivotally mounted switch lever **38**. The feed bars D', and D'' are securely mounted upon insulation blocks **40** and **41**, and form a unitary assembly capable of convenient mounting within the panel box TC in such manner that the bus bar ends project through the top thereof.

The generator bus bar D'' carries an angular plate **42** at its lower end, which extends forward from the base **41** and overlays the insulated tail end **43** of the switch lever **38**, and a flexible connection **12** establishes a permanent connection between the stationary bus bar D''—**42** and the movable switch lever **38**.

The tank feed bus bar D' is somewhat J-shaped and mounted to the base **41** so that the upturned end thereof underlies the switch lever **38** and forms a large contact area **39**. Between the contact **39** and the pivot of the rocking lever **38**, an electromagnet **45** is located and adapted when energized to actuate the switch armature **46** clockwise (in Fig. 3) thereby closing the circuit across bus bars D' and D'' through members **38** and **39**.

To insure that a firm electrical contact is made each time the switch is closed, the contact arm **38** of the switch is arranged to have a slight amount of movement relative to the armature **45** but is held, and moves normally as a unit therewith, by the action of a spring **47**.

To the opposite side of the pivot of the switch lever, an auxiliary switch **32** is mounted and so arranged that the resilient contact finger **32a** maintains contact with its cooperating terminal plate **32b** through the major portion of the movement of the main switch lever **38**. The construction is such that current will flow through **32a** and **32b** whenever the main contacts **38**, **39** are open, and continues to flow therethrough until just immediately before members **38**, **39** make contact. The switch **32**, in accordance with this invention, controls a holding circuit for a relay DCR (Fig. 4) which in turn controls a portion of the circuit to the coil **45** of the main switch. Hence it is important to continue the circuit to the direct current relay effective until after the heavy switch armature and parts carried thereby are in motion and about to close on contact **39**. When the auxiliary switch **32** opens, the starting circuit for the controlling relay is broken and the current that was flowing unresisted through the coil **45** of the main switch is now flowing through the fixed resistance R', in an amount amply sufficient to hold the switch lever **38** firmly in engagement with the tank feed bar D'.

The elements making up the time control for the heavy duty switch HD, including control relays, switches, signals, and timer, are of standard, well known, construction and in the interests of clarity are illustrated symbolically in Fig. 4, to which reference will now be made.

Having connected a clean article W to the cathode side of the plating tank, the operator closes a double pole manual switch S at the front of the panel TC. One pair of contacts **30** of the switch S is wired for alternating current A. C. and controls the synchronous motor T, through lines **49**, **50**, switch **37**, line **51**, motor T, and line **52**, and the other pair of contacts **31** is wired for direct current service, through elements D**4**, **32**, **1**, **31**, **2**, G*r*, R*e*, **13**, C, and **15**. The closing of switch **31** completes a portion of the circuit across the D. C. bus bars D'' and C, through line **12**, a normally closed contact **32** of the heavy duty switch HD, lines **1** and **2**, green light G*r*, line **13**, and parallel connected bell B, (through **2**, **33**, and **16**). Thus the closing of the switch S completes a portion of the circuit to the time device T, the green lamp G*r* lights, and the bell B rings. As the current for the signals is directed through elements of the heavy duty switch, the initial ringing and lighting thereof serves to give an advance check on the readiness of the devices to function at the critical time, namely, at the completion of the plating cycle, and also to give notice that current is at the main switch ready to flow through the tank circuit.

To stop the ringing of the bell, the operator presses the push button P which (through lines **2**, **3**, and **4**) energizes the coil of a direct current relay DCR in the circuit controlled by the manual switch **31**. The energizing of the D. C. relay operates to close two switches **34**, **35** and to open the bell switch **33**. The closing of switch **35** establishes a holding circuit around the push button P, through line **5** and resistor R'' coil DCR and line **4** so that the coil DCR continues effective to hold the bell switch **33** open.

The closing of switch **34** completes a portion

of the circuit to the coil 45 of the electromagnetic heavy duty switch HD in the circuit comprising lines 6, 7, 8, switch 34, lines 9, 10, switch 36, and line 11. This control circuit embodies an alternating current relay ACR, the switch 36 thereof being normally open, and which is closed only when the operator sets the control handle E of the timer to the time period desired. Operation of the handle E to the correct time indication, automatically closes a switch 37 connected in series with the manual switch 30, and this will start the timer T operating, and effect energization of the alternating current relay ACR, through A. C. lines 49, 50, 51, 53, 54, 55 and 52. The alternating current relay ACR operates switch 36 to complete the circuit across lines 6 and 11 to the coil of the heavy duty line switch HD. The switch arm 38 immediately moves in a direction away from contact 32 (line 1) and closes on contact 39 which is in effect a copper bus bar D' connected with the cathode side of the plating tank. With the parts in their effective positions, direct current from the generator flows to the anode of the tank, through the electrolyte to the cathode, through resistance panel R, bus bar D', contacts 39, 38 of main switch HD, line 12, negative bus bar D'' back to the generator. A connection 15 is also taken off the positive side of the generator and leads to the terminal block C in the control panel TC.

Across the tank bus D', and the positive bus C, a red lamp Re is connected (lines 13, 14) which lights up as soon as the current is flowing through the main switch HD.

The closing of the main switch arm 38 simultaneously breaks the connection at 32 across lines 1 and 12, in the circuit 12, 1, 31, 2, Gr, 13, C, and the green light Gr goes out, the holding circuit (2, 35, R'', DCR, 4) across switch 35 through resistor coil R'' to the coil of relay DCR, is broken and relay switches 34, 35 open and the bell switch 33 closes. The bell B does not ring, however, because its circuit 12, 1 is open at 32.

Meanwhile, direct current to the coil of the heavy duty switch HD is passing through lines 6, 7 resistor R', line 9, 10, A. C. relay switch 36, and line 11 in sufficient strength to hold the main switch arm 38 closed on contact 39.

When the timer T has operated the predetermined period of time, which is adjustable by moving the pointer E to the selected time indicated marking, the switch 37 therein opens and breaks the circuit to the alternating current relay ACR and the switch 36 thereof opens, direct current to the coil of the heavy duty switch HD is interrupted and the main switch arm 38 opens the tank circuit and the red light circuit at the contact 39. As the main switch opens, auxiliary switch 32 thereof closes, circuits 12, 1, 2, Gr, 13, and 12, 1, 2, 33, B, and 16 are completed, the green light Gr lights up, and the bell B gives audible notice of the completion of the plating period. The operator is thus called to the plating tank and proceeds to remove the completed work, and stops the ringing of the alarm by pressing the push button P, which, through lines 2, 3, DCR and 4, opens the switch 33. The control circuits are now preconditioned to repeat the plating cycle upon the moving of the pointer E to the desired time setting.

Should there be no need to repeat, the manual switch S is opened and both A. C. and D. C. controls are rendered ineffective.

From the foregoing it will be perceived that the present invention renders available a low voltage, high amperage, make or break switch automatically controlled by an interval timer particularly suitable for controlling, by predetermination, the thickness of metal coatings to be applied by regular electroplating equipment. The entire control being compactly arranged and built into a portable cabinet that lends itself readily adaptable for quick installation in any given tank circuit. With a control unit of this character it is no longer necessary to employ complicated and delicate measuring instruments calibrated for use on only one kind of metal for a given weight or thickness of deposit, as the present unit, by its exercise of definite control of the time factor, is capable of use in controlling the thickness of any metal deposited and is, therefore, usable with any plating tank. Continuously uniform deposits of a given thickness on an unlimited number of pieces may be achieved with this type of control merely by repeatedly setting the interval timer to the same number of minutes or hours specified by the working chart. Losses in production time or in the electrolyte and anode materials have likewise been eliminated by virtue of the automatic circuit breaking features and built-in signalling instrumentalities of the unit, and there is no worry to the plater as to whether a tank load is being under or over plated.

Without further analysis, the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various utilizations by retaining one or more of the features that, from the standpoint of the prior art, fairly constitute essential characteristics of either the generic or specific aspects of this invention and, therefore, such adaptations should be, and are intended to be, comprehended within the meaning and range of equivalency of the following claims.

Having thus revealed this invention, we claim as new and desire to secure the following combinations and elements, or equivalents thereof, by Letters Patent of the United States:

1. Timing apparatus for direct current service comprising a normally open line switch; a direct current operated solenoid adapted when energized to effect closing of said line switch; a control system for the said solenoid embodying therein a direct current operated relay switch and an alternating current operated relay switch connected in series with said solenoid; a source of alternating current and a circuit from said source for operating said alternating current relay; a synchronous timed switch in said circuit and energized from said source; interconnected manually operated switches in series with the operating circuit of said direct current relay and said alternating current circuit respectively and simultaneously operable to close the circuit of the direct current relay and close said alternating current circuit at one point, said timed switch being responsive to the setting thereof for a selected time period to close the circuit to said alternating current relay at another point, maintain it closed for such time period and then to open said circuit whereby when said interconnected switches are closed and said direct current relay is energized the setting of said timed switch effects closure of said line switch for said selected time period.

2. Timing apparatus for direct current service comprising a normally open line switch; a direct current operated solenoid adapted when energized to effect closing of said line switch; a control system for the said solenoid embodying

therein a direct current operated starting relay switch and an alternating current operated relay switch connected in series with said solenoid; a source of alternating current and a circuit from said source for operating said alternating current relay; a synchronous timed switch in said circuit and energized from said source; interconnected manually operated switches in series with the operating circuit of said direct current relay and said alternating current circuit respectively and simultaneously operable to condition the circuit of the direct current relay for operation and close said alternating current circuit at one point; additional switch means in the circuit of said direct current relay adapted when actuated to closed position to energize said direct current relay; said timed switch being responsive to the setting thereof for a selected time period to close the circuit to said alternating current relay at a remaining point, maintain it closed for such time period and then to open said circuit whereby when said interconnected switches are closed and said direct current relay is energized the setting of said timed switch effects closure of said line switch for said selected time period.

3. The combination set forth in claim 1 including direct current operated signal means connected to said line switch for imparting a signal when the said switch is in open position and another signal when the said switch is in closed position.

4. The combination set forth in claim 2 including the provision of signal means rendered effective on the closure of said interconnected switches and rendered ineffective when said alternating current relay is energized.

5. The combination set forth in claim 2 including the provision of signal means connected with said direct current operated relay switch when the latter is in open position and rendered ineffective when said relay is energized, additional signal means connected to said line switch effective when said switch is in open position, and another signal means connected with said line switch and effective when said switch is in closed position.

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