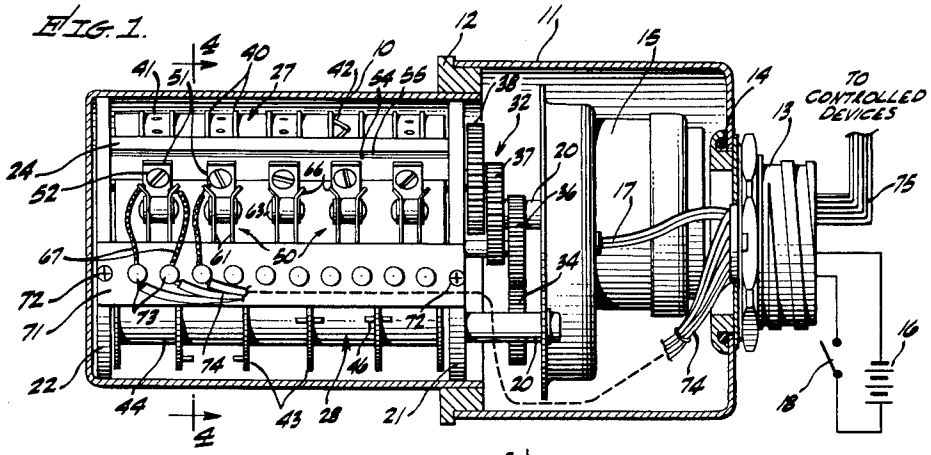
July 11, 1961 C. J. SAUNDERS 2,992,299

INTERVAL TIMER

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FIG. 1.



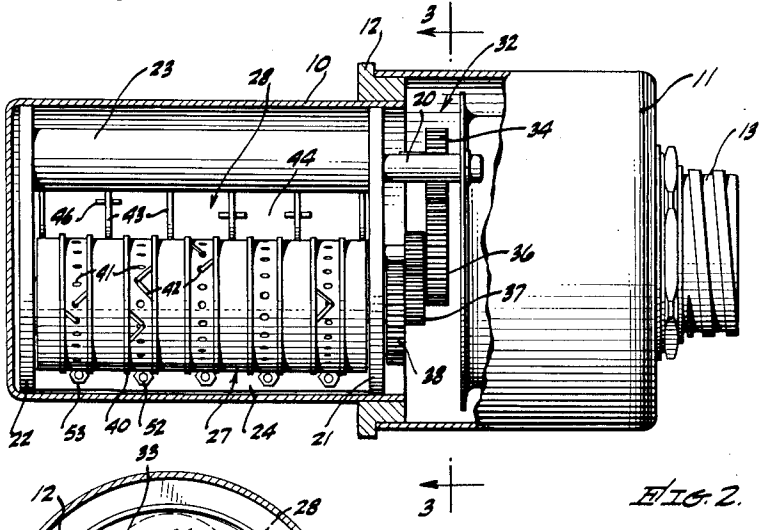


FIG. 2.

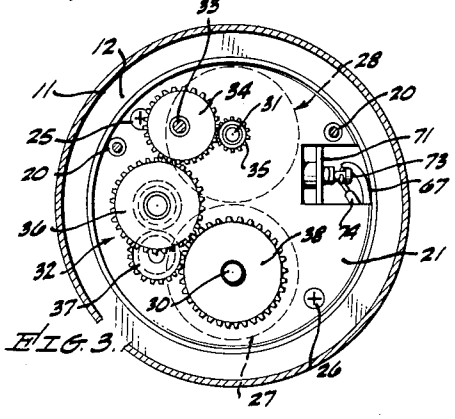


FIG. 3.

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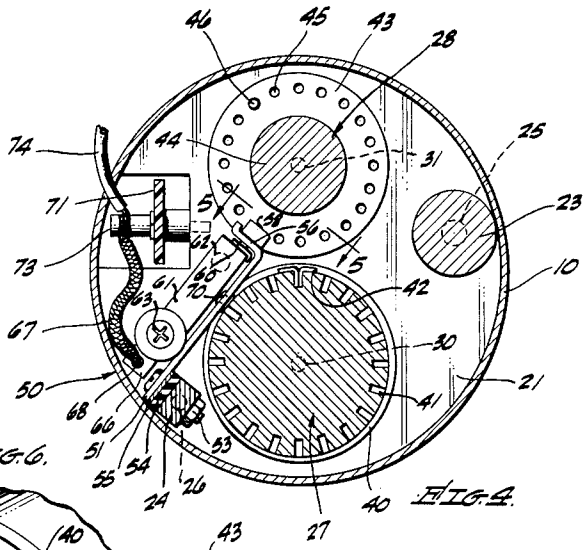


FIG. 4.

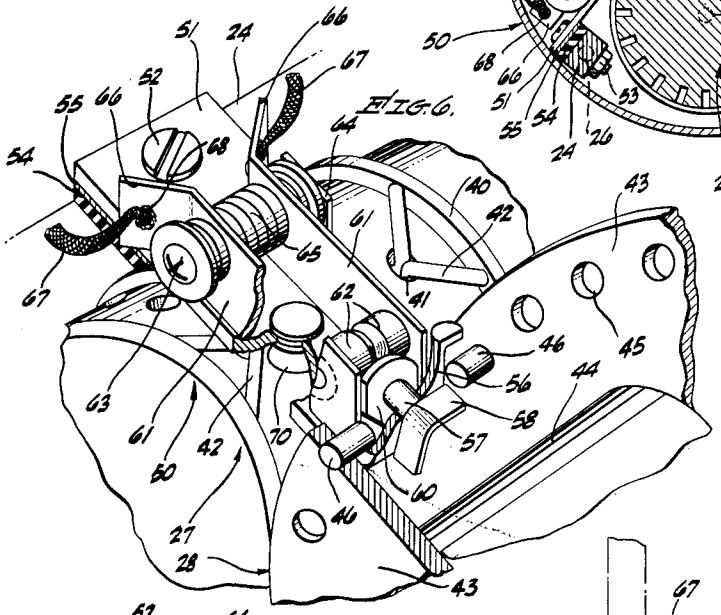


FIG. 6.

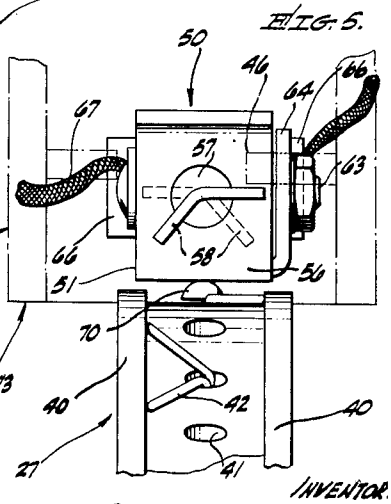


FIG. 5.

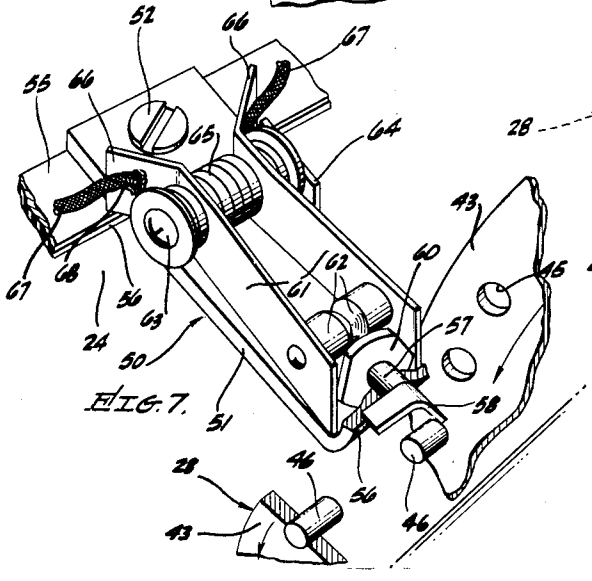


FIG. 7.

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2,992,299

INTERVAL TIMER

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Filed Jan. 29, 1959, Ser. No. 790,015
9 Claims. (Cl. 200—38)

This invention relates generally to interval timing devices and relates more specifically to programmed electrical switching structures for use in the control of multiple functions.

Many devices and electrical apparatus operate on a time interval program which requires an electrical switching apparatus accurately to establish such a program. Examples of such use are many contemporary automatic machinery such as lathes, milling machines, drill presses and combination structures; electrical testing apparatus utilized to cycle interval functions of electrical devices; aircraft and missile automatic operations; electric signs having flashing or programmed operation; and also apparatus such as automatic washing machines, clothes dryers, dish washers and the like. The various desired electrical functions must be accurately controlled in apparatus of these types and the timing structures must not only be reliable but also of a nature permitting use thereof and efficient operation over long periods of time.

Heretofore, many different types of electrical timing mechanisms have been used, the most common of which employs a rotating wheel or cam that is mechanically connected to a switch or switches for operation thereof. Where many dual functions are required, and in instances necessitating a plurality of wheels or cams and switch structures, extreme difficulty is experienced in establishing desired programs, especially in instances requiring control within tolerance limits of plus or minus .025 milliseconds. In most apparatus of this cam operated type, it is necessary that at least two switches be employed with each cam, one for an "on" position and the other for an "off" position, thereby requiring an excessive number of components, presenting associated maintenance problems and being relatively expensive. In other instances, drums or discs have been employed on which printed circuit contact areas are established. After considerable design effort, accurate programming may be accomplished with apparatus of this type; however, severe problems exist relative to the current carrying capacity of these printed elements and the useful life thereof when subjected to frictional forces between the printed circuit and a contacting brush. Additionally, printed circuit structures of this type have been subject to cracking, thereby providing a circuit interruption and changing the operational tolerances of the device.

In still other instances electrical delay devices, such as delay lines and holding relays, have been employed for interval timing. In these structures, precise accuracy in regard to programmed intervals, is extremely difficult to obtain and such apparatus is generally quite large and heavy as to prevent the use thereof in situations having space and weight limitations.

The present interval timer employs a pair of drum structures that are continuously rotated at different speeds by a synchronous electric motor connected therewith by means of a suitable gear train. One of the drums is defined as a program drum and makes one complete revolution for the entire program. The other of the drums is a switching structure for controlling operation of electrical contacts. The switching structures, including the electrical contacts, are adapted for movement into or out of position for engagement by elements of the switching drum, in accordance with the desired electrical program.

It is, accordingly, an object of the present invention to

provide an improved interval timing mechanism enabling control of electrical functions within a two percent tolerance of desired intervals.

It is another object of the invention to provide an interval timer having features enabling use thereof for control of multiple electrical functions in a programmed manner.

Still another object of the invention is to provide an improved interval timer having a minimum of components, thus to enable a relatively small size apparatus and an associated reduction in weight over prior apparatus intended for similar purposes.

A further object of the invention is to provide an interval timer that is continuously operable by means of a synchronous motor and wherein means are provided for positioning and operating switching mechanisms in accordance with the desired electrical program within tolerance limits of plus or minus .025 milliseconds.

A still further important object of the invention is to provide an interval timer having means by which a variety of different programs may be controlled thereby and which require only minor changes in the mechanism thereof.

Still another important object of the invention is to provide an interval timer that is reliable in use, efficient in operation, devoid of maintenance problems, light in weight and relatively inexpensive in manufacture.

Other and further important objects of the invention will become apparent from the disclosures in the following detailed specification, appended claims and accompanying drawings, wherein:

FIGURE 1 is a longitudinal sectional view through an enclosure for the present interval timer, mechanism of the timer being shown in one side elevational view thereof;

FIG. 2 is a sectional view similar to FIG. 1 showing another side elevational view of the timing mechanism;

FIG. 3 is a transverse sectional view showing the gear train mechanism and taken substantially as indicated by line 3—3, FIG. 2;

FIG. 4 is an enlarged transverse sectional view showing the program and switch actuating drums, together with the relationship thereof to the switching mechanism, as taken substantially as indicated by line 4—4, FIG. 1;

FIG. 5 is an enlarged fragmentary view showing the operating element of one of the switch structures and the association thereof with the program drum, as taken substantially as indicated by line 5—5, FIG. 4;

FIG. 6 is an enlarged fragmentary perspective view partially in section, and showing details of one of the switch and contact structures and the association thereof with the program and switch actuating drums, contacts being shown in a closed position; and

FIG. 7 is a fragmentary sectional view, similar to portions of FIG. 6, and showing the switch structure contacts in an open position.

With reference to the drawings, and with reference primarily to FIGS. 1 and 2, the interval timing mechanism hereof is shown as enclosed within a housing having a pair of cup-shaped portions 10 and 11 interconnected by means of an annular fitting ring 12. The cup-shaped portion 11 has an opening in one end thereof and in which a connector 13 is secured. The connector 13 is sealed with respect to the housing portion 11 by means of an O-ring 14. The housing thereby encloses and hermetically seals the various components of the present interval timer, all electrical connections being connected through the electrical fitting 13. The housing may also be evacuated or filled with an inert gas for improved operation and long life expectancy for the components.

The interval timing mechanism hereof includes a synchronous electrical driving motor 15 that is enclosed within the housing portion 11 and adapted for operation in a continuous manner from a source of energy such as a battery 16 with a suitable converter for alternating cur-

rent. Suitable electrical leads 17 extend between the battery 16 and the motor 15, there being a suitable switch 18 for disconnecting the battery from the motor 15. The case of the motor 15 is supported by a pair of pins 20 and spacer structures that extend between the motor case and an annular transversely disposed plate 21. The plate 21 is disposed within one end of the housing portion 10 and is connected to another annular plate 22, disposed within another end of the housing portion 10 by means of an elongated cylindrical spacer 23 and a rectangular bar 24. The plates 21 and 22 are adapted for a relatively tight disposition within the housing portion 10, thereby to support other elements and the driving motor 15 in the desired positions within the housing. The spacer 23 and the bar 24 are connected to the plates 21 and 22 by means of screws 25 and 26 respectively. The housing, including the portions 10 and 11 and the ring 12, together with the plates 21 and 22, the spacer 23 and the bar 24 comprise a frame structure for this apparatus.

As shown in FIGS. 1 and 2, a program drum 27 and a switch actuating drum 28 are disposed in parallel relationship between the plates 21 and 22 and are supported on shafts 30 and 31 respectively which extend through and are rotatably journaled in the plates 21 and 22. The program drum 27 and the switch actuating drum 28 are adapted to be driven at different rotary speeds through use of a suitable gear train indicated generally at 32 and disposed between one end of the driving motor 15 and the plate 21. An output shaft 33 from the motor 15 is adapted to drive a gear 34 which, in turn, engages a gear 35 that is secured to the shaft 31 of the switch actuating drum 28. The gear 34 also engages an idler gear 36 which drives a second idler gear 37 that is, in turn, engaged with a gear 38, the gear 38 being secured to the shaft 30 of the program drum 27. The various gears of this gear train are rotatably supported by the plate 21. It may thus be seen that, for a typical program and with the motor 15 operating at 60 r.p.m., this particular gear train will provide a rotational speed for the program drum 27 of 4 r.p.m. and for the switch actuating drum 28 of 120 r.p.m. In this connection, it is to be understood that various rotational speed ratios, as between the program and switch actuating drums, may be employed through use of different gear train structures without departing from the spirit and scope of the present invention. The particular rotating speeds of the program and switch actuating drums may thus be selected to conform to the requirements of devices to be controlled by the present interval timer.

As shown in FIGS. 1, 2 and 4, the program drum 27 is provided with a plurality of longitudinally spaced, outwardly extending annular ribs 40. Intermediate alternate pairs of the ribs 40, a plurality of circumferentially spaced, radially extending openings 41 are provided in the program drum. As shown, the present embodiment hereof includes twenty such openings 41 arranged in five circumferential rows about the program drum 27. The openings 41 are adapted frictionally to support angularly disposed cam members 42 that are in the form of wire structures which have free ends disposed in contact with edge surfaces of the ribs 40. The purpose of the cam members 42 will be hereinafter more fully described.

The switch operating drum 28 is provided with a plurality of longitudinally spaced, radially disposed flanges 43 which extend outwardly from a central hub 44. The flanges 43 are positioned along the switch actuating drum 28 and intermediate a radial projection of the circumferential rows of openings 41 in the program drum 27. The flanges 43 are further provided, adjacent peripheries thereof, with circumferentially spaced, axially directed openings 45 therethrough. The openings 45 are shown as being twenty in number and are adapted frictionally to support switch actuating pins 46 which extend through the openings and project in an axial direction laterally of each of the flanges 43. The function and purpose of the pins 46 will be hereinafter more fully described.

With reference to FIGS. 1 and 4 through 7, the interval timer hereof is provided with a plurality of switch mechanisms indicated generally at 50. The switch mechanisms 50 are positioned in substantial alignment with the rows of openings 41 in the program drum 27 and intermediate the flanges 43 of the switch actuating drum 28. Each of the switches 50, shown as being five in number, is substantially identical with the others and includes a supporting arm 51 that is pivotally connected to the bar 24. A screw 52 extends through one end of the arm 51 and through the bar 24, there being a lock nut 53 secured to the lower end of the screw 52. As shown, with reference primarily to FIG. 4, a longitudinal strip of resilient material 54, such as rubber or the like, is positioned along one surface of the bar 24, there being a metallic strip 55 overlying the strip 54. Lower surfaces of the arms 51 are adapted for contact with a surface of the metallic strip 55, the resilient strip 54 serving to provide a constant bias between the bar 24 and the arms 51, thereby to establish a predetermined frictional resistance to pivotal movement of the arms 51 relative to the bar 24. The arms 51 are each provided with a lip 56 at an end thereof remote from the screw 52. The lip 56 serves pivotally to support a shaft 57, one end of which carries a switch actuating member 58, the other end of which supports a switching cam 60. The cam 60 is constructed from an insulating material and disposed between free ends of a pair of switch leaf members 61, these free ends also being adapted to support switch contacts 62. The leaf members 61 are carried by a pin 63 that is in turn secured to a tab 64 that is bent integrally from the arm 51. A plurality of resilient nonconductive spacers 65 are disposed about the pin 63 and intermediate the adjacent surfaces of the switch leaves 61. Ends of the leaves 61 remote from the contact 62 are formed outwardly as at 66 to provide means for attaching flexible electrical leads 67 thereto, as by a soldered joint 68.

It is to be noted that the switching structures 50 are disposed generally on a radian of the switch actuating drum 28 and are positioned substantially tangent to the surface of the program drum 27. To enable cooperation of the switching structures 50 with the program drum 27, each of the arms 50 is provided with a follower 70 which extends downwardly therefrom and into an area between the adjacent pairs of ribs 40 on the program drum 27. The switch actuating members 58 are also disposed between the flanges 43 of the switch actuating drum 28 and in longitudinal alignment with the actuating pins 46 carried thereby. It is further to be noted that the electrical leads 67 from each of the leaves 61 extend to a nonconductive terminal strip 71 that is disposed in notches and secured to the plates 21 and 22 as by screws 72. Ends of the leads 67 are connected to terminals 73 from which a loom 74 of electrical leads extends. The loom 74 extends to the fitting 13 and, from the fitting 13, suitable leads 75 may extend to devices to be controlled by the present interval timer.

In operation of the present interval timer, the desired total program is initially established through selection of a proper gear train 32 and the position of the cam members 42 in the openings 41 about the program drum 27. Additionally, the switch actuating pins 46 are disposed in appropriate openings 45 in the flanges 43 of the switch actuating drum 28. As the drums 27 and 28 rotate, the cam members 42 engage the followers 70 carried by each arm 51 of and serve to pivot the switch structures 50 about axes of the screws 52. Thus, the switch actuating members 58 are disposed adjacent one of the flanges 43 or another. As shown in FIG. 6, the switch structure 50 and the switch actuating member 58 is disposed against the most rightwardmost (as viewed in FIG. 6) flange 43. The contacts 62 are shown in a closed position. When the elements hereof are moved

from the position shown in FIG. 6 to the position shown in FIG. 7, the switch actuating member **58** will be engaged by an actuating pin **46**, thus pivotally to rotate the shaft **57** and the cam **60**. Lobes of the cam **60** are thus adapted to engage inner surfaces of the switch leaves **61** whereby to separate the contacts **62**. Upon pivotal movement of the switch mechanism **50** by another set of cam members **42**, the switch actuating member **58** will be disposed in a position for engagement by another actuating pin **46**, whereby to return the contacts **62** and other elements of the switch mechanism to the position shown in FIG. 6.

It may be seen that the location of the pins **46** is such as to enable control of the operation of the switch mechanisms **50** within tolerance limits of .025 millisecond. The program drum **27**, together with the cam members **42**, serves selectively to position the switch mechanisms at particular times for engagement by appropriate actuating pins **46**, whereby either to open or close the contacts **62**.

Accordingly, the construction of the present interval timer is such as to enable precise operation of single controlling switches for each item to be controlled thereby. A relatively few number of components are employed, thus to reduce maintenance problems and to enable changes in the total programming with only minor changes in the structure thereof.

Having thus described the invention and the present embodiment thereof, it is desired to emphasize the fact that many modifications may be resorted to in a manner limited only by a just interpretation of the following claims.

I claim:

1. In an interval timing device: a frame structure; switch means pivotally carried by said frame structure and having electrical contacts; a switch operating member carried by said switch means and operatively connected to said contacts forming a portion of said switch means; a program drum rotatably carried by said frame structure; a switch actuator drum rotatably carried by said frame structure; engaging members carried by and disposed individually from said program and actuator drums, said engaging members of said program drum being adapted for cooperation with said switch means whereby pivotally to move said switch means from one position to another, said engaging members of said actuating drum being adapted for cooperation with said switch operating member whereby to actuate said switch operating member upon contact therewith, said movement of said switch means serving to dispose said switch operating member into or out of position for contact by said actuating drum engaging members; and means for rotating said program and actuating drums.

2. In an interval timing device: a frame structure; switch means pivotally carried by said frame structure and having electrical contacts; a switch operating member carried by said switch means and operatively connected to said contacts forming a portion of said switch means; a program drum rotatably carried by said frame structure; a switch actuator drum rotatably carried by said frame structure; engaging members carried by and disposed individually from said program and actuator drums, said engaging members of said program drum being adapted for cooperation with said switch means whereby pivotally to move said switch means from one position to another, said engaging members of said actuating drum being adapted for cooperation with said switch operating member whereby to actuate said switch operating member upon contact therewith, said movement of said switch means serving to dispose said switch operating member into or out of position for contact by said actuating drum engaging members; means for rotating said program and actuating drums; and differential driving means disposed between said rotating means and said program and actuating drums.

3. In an interval timing device: a frame structure; switch means pivotally carried by said frame structure and having electrical contacts; a switch operating member carried by said switch means and operatively connected to said contacts forming a portion of said switch means; a program drum rotatably carried by said frame structure; a switch actuator drum having an axis substantially parallel to an axis of said program drum and rotatably carried by said frame structure; engaging members carried by and disposed individually from said program and actuator drums, said engaging members of said program drum being adapted for cooperation with said switch means whereby pivotally to move said switch means from one position to another, said engaging members of said actuating drum being adapted for cooperation with said switch operating member whereby to actuate said switch operating member upon contact therewith, said movement of said switch means serving to dispose said switch operating member into or out of position for contact by said actuating drum engaging members; and motor means carried by said frame structure for rotating said program and actuating drums.

4. In an interval timing device: a frame structure; switch means pivotally carried by said frame structure and having electrical contacts; a switch operating member carried by said switch means and operatively connected to said contacts forming a portion of said switch means; a program drum rotatably carried by said frame structure; a switch actuator drum having an axis substantially parallel to an axis of said program drum and rotatably carried by said frame structure; engaging members carried by and disposed individually from said program and actuator drums, said engaging members of said program drum being adapted for cooperation with said switch means whereby pivotally to move said switch means from one position to another, said engaging members of said actuating drum being adapted for cooperation with said switch operating member whereby to actuate said switch operating member upon contact therewith, said movement of said switch means serving to dispose said switch operating member into or out of position for contact by said actuating drum engaging members; motor means carried by said frame structure for rotating said program and actuating drums; and a gear train disposed between said rotating means and said program and actuating drums whereby to provide a differential rotational speed for said program and actuating drums.

5. An interval electrical timing device comprising, in combination: a housing; a frame structure carried by said housing; a program drum and a switch actuating drum carried by said frame structure; a synchronous driving motor carried by said frame structure; a gear train mechanism connected between said motor and said program and actuating drums whereby to drive said drums; a plurality of switch mechanisms pivotally carried by said frame structure, said switch mechanisms having electrical contacts and being positioned generally in operative association with said actuating and said program drums, cam means carried by said program drum; follower means carried by said switch mechanism and positioned for cooperation with said cam means whereby to effect pivotal movement of said switch mechanisms; switch operating members carried by said switch mechanisms and adapted upon operation selectively to open and close said electrical contacts; actuating members carried by said actuating drum, said pivotal movement of said switch mechanisms serving to dispose said switch operating members alternatively into positions for engagement and operation by said actuating members; and electrical lead means interconnecting said electrical contacts and electrical devices controlled thereby.

6. An interval electrical timing device comprising, in combination: a housing; a frame structure carried by and disposed within said housing; a program drum and a switch actuating drum rotatably carried by said frame structure; a synchronous electric driving motor carried by said frame structure; a gear train mechanism connected between said motor and said program and actuat-

ing drums whereby to drive said drums; a plurality of switch mechanisms pivotally carried by said frame structure, said switch mechanisms having electrical contacts and being positioned generally on a radian plane of said actuating drum and substantially tangent to said program drum; cam means carried by said program drum; follower means carried by said switch mechanism and positioned for cooperation with said cam means whereby to effect pivotal movement of said switch mechanisms; switch operating members carried by said switch mechanisms and adapted upon operation selectively to open and close said electrical contacts; actuating members carried by said actuating drum, said pivotal movement of said switch mechanisms serving to dispose said switch operating members alternatively into positions for engagement and operation by said actuating members; and electrical lead means interconnecting said electrical contacts and electrical devices controlled thereby.

7. An interval electrical timing device comprising, in combination: a housing; a frame structure carried by and disposed within said housing; a program drum and a switch actuating drum disposed in parallel relationship and rotatably carried by said frame structure; a synchronous electric driving motor carried by said frame structure; a gear train mechanism connected between said motor and said program and actuating drums whereby to drive said drums at different rotational speeds; a plurality of switch mechanisms pivotally carried by said frame structure, said switch mechanisms having electrical contacts and being positioned generally on a radian plane of said actuating drum and substantially tangent to said program drum; cam means carried by said program drum; follower means carried by said switch mechanism and positioned for cooperation with said cam means whereby to effect pivotal movement of said switch mechanisms; switch operating members carried by said switch mechanisms and adapted upon operation selectively to open and close said electrical contacts; actuating members carried by said actuating drum, said pivotal movement of said switch mechanisms serving to dispose said switch operating members alternatively into positions for engagement and operation by said actuating members; and electrical lead means interconnecting said electrical contacts and electrical devices controlled thereby.

8. An interval electrical timing device comprising, in combination: a housing; a frame structure carried by and disposed within said housing; a program drum and a switch actuating drum disposed in parallel relationship and rotatably carried by said frame structure; a synchronous electric driving motor carried by said frame structure; a gear train mechanism connected between said motor and said program and actuating drums whereby to drive said drums at different rotational speeds; a plurality of switch mechanisms pivotally carried by said

frame structure, said switch mechanisms having electrical contacts and being positioned generally on a radian plane of said actuating drum and substantially tangent to said program drum; cam means carried by said program drum; follower means carried by said switch mechanism and positioned for cooperation with said cam means whereby to effect pivotal movement of said switch mechanisms; means for frictionally biasing said switch mechanisms against inadvertent pivotal movement; switch operating members carried by said switch mechanisms and adapted upon operation selectively to open and close said electrical contacts; actuating members carried by said actuating drum, said pivotal movement of said switch mechanisms serving to dispose said switch operating members alternatively into positions for engagement and operation by said actuating members; and electrical lead means interconnecting said electrical contacts and electrical devices controlled thereby.

9. An interval electrical timing device comprising, in combination: a sealed housing; a frame structure carried by and disposed in engagement with an interior of said housing; a program drum and a switch actuating drum disposed in parallel relationship and rotatably carried by said frame structure; a synchronous electric driving motor carried by said frame structure; a gear train mechanism connected between said motor and said program and actuating drums whereby to drive said drums at speeds whereby said program drum rotates at a slower rate than said actuating drum; a plurality of switch mechanisms pivotally carried by said frame structure, said switch mechanisms having electrical contacts and being positioned generally on a radian plane of said actuating drum and substantially tangent to said program drum; adjustable cam means carried by said program drum; follower means carried by said switch mechanism and positioned for cooperation with said cam means whereby to effect pivotal movement of said switch mechanisms; means for frictionally biasing said switch mechanisms against inadvertent pivotal movement; switch operating members carried by said switch mechanisms and adapted upon operation selectively to open and close said electrical contacts; adjustable actuating members carried by said actuating drum, said pivotal movement of said switch mechanisms serving to dispose said switch operating members alternatively into positions for engagement and operation by said actuating members; and electrical leads interconnecting said electrical contacts and remote electrical devices controlled thereby.

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