Oct. 2, 1962 A. C. ALBEE 3,056,864

PROGRAM TIMER

Filed Sept. 3, 1959 3 Sheets-Sheet 1

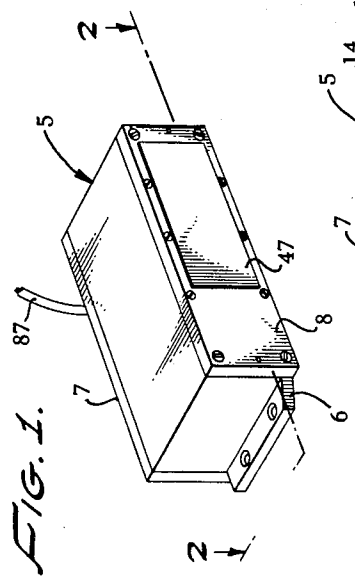


FIG. 1.

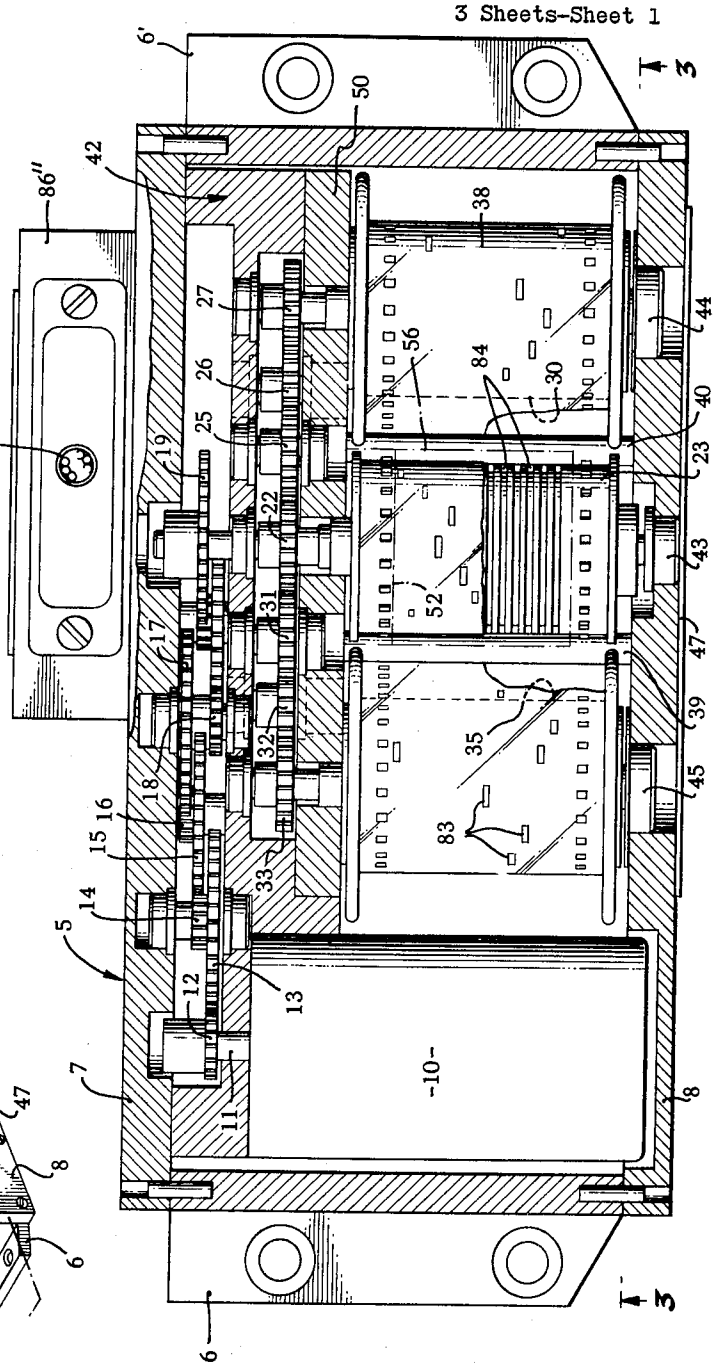


FIG. 2.

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PROGRAM TIMER

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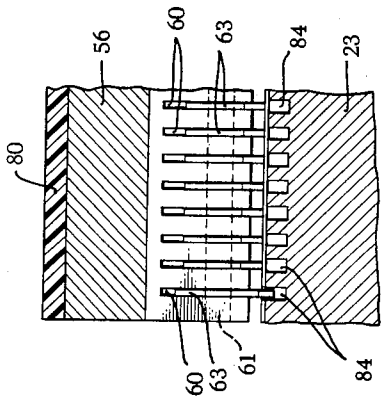


FIG. 5.

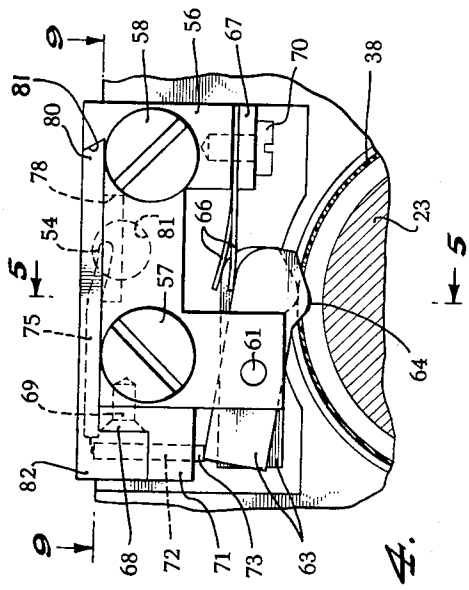


FIG. 4.

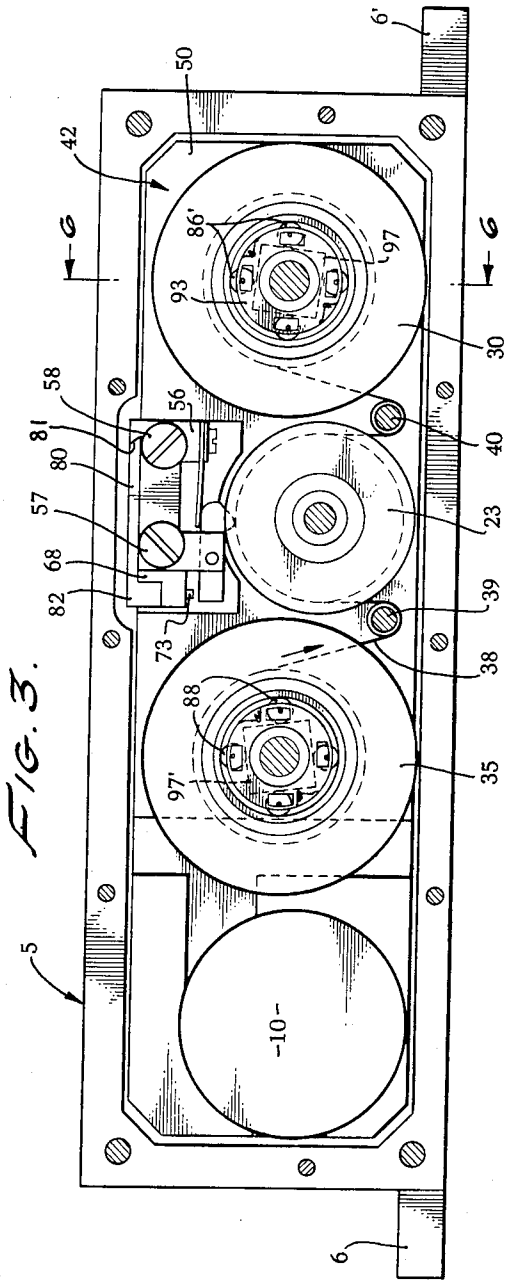


FIG. 3.

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PROGRAM TIMER

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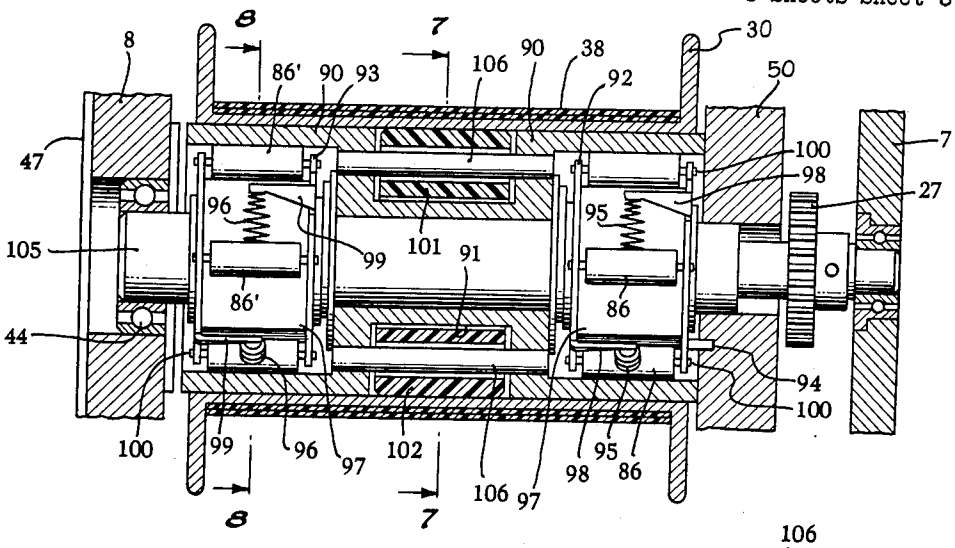


FIG. 6.

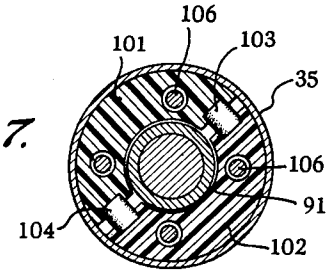


FIG. 7.

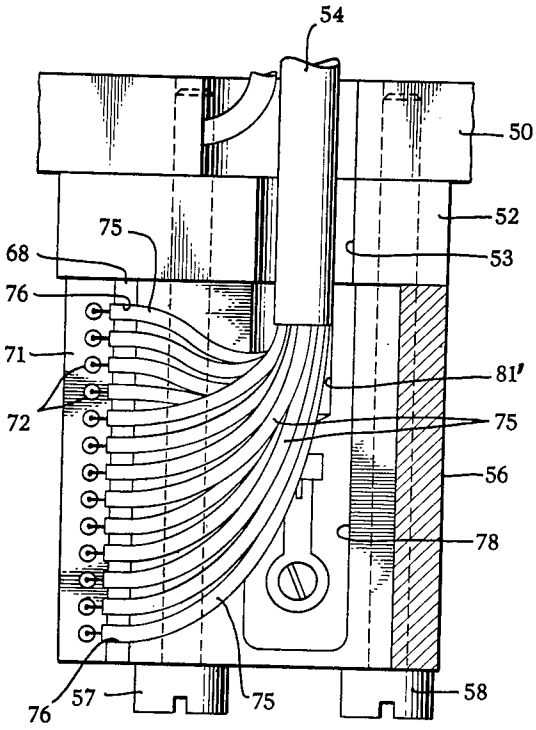


FIG. 9.

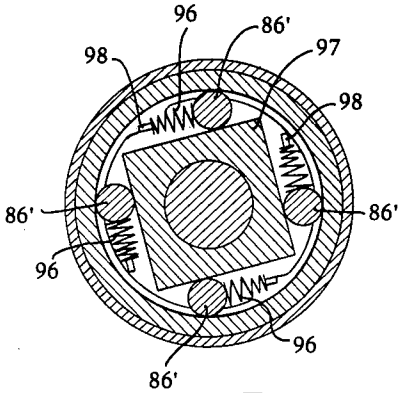


FIG. 8.

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United States Patent Office 3,056,864 Patented Oct. 2, 1962

3,056,864

PROGRAM TIMER

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Filed Sept. 3, 1959, Ser. No. 837,864
9 Claims. (Cl. 200—46)

This invention relates to program timers to provide switching facilities for a predetermined series of desired events, and is useful, for example, as a mechanism which provides switching facilities for a flight programming unit serving as an autopilot control of ballistic missiles.

Program timing mechanisms generally utilize perforated tape or film which control switches in a certain predetermined order of operation. The present invention is one wherein a perforated film is used to operate a plurality of switch blades or fingers in the order of perforation of the film. The film transport mechanism utilizes a drive sprocket, a supply reel, and a takeup reel, and is reversible in operation, since each reel is provided with its own over-running clutches to provide the proper, variable takeup drive and hold-back tension when the functions of the reels are reversed. The plurality of aligned switching blades or fingers are spring-biased and, upon encountering a perforation in the film, are moved into contact with respectively associated pins to close an electrical circuit. The sprocket is provided with grooves under the longitudinal portions of the film containing the perforations to accommodate the movement of the switch blades to enable them to make the necessary electrical contacts. The mechanism is driven by a motor through a series of reduction gears to provide the desired film speed for the sprocket and for driving the takeup reels.

The principal object of the invention is to provide an improved timing mechanism in which the closing of a plurality of electrical circuits in a predetermined order is facilitated.

Another object of the invention is to provide an improved program timing mechanism which is rugged and may be used in fast-moving airborne units, such as ballistic missiles.

A further object of the invention is to provide an improved mechanism for making electrical circuits in a predetermined order, which is contained in a minimum of space, and which is particularly reliable for airborne units.

A better understanding of this invention may be had from the following detailed description, when read in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view showing the over-all appearance of the casing housing the invention;

FIG. 2 is an enlarged, sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is an elevational view taken along the line 3—3 of FIG. 2;

FIG. 4 is an enlarged, detail view of the switch contact elements;

FIG. 5 is a fragmentary, sectional view taken along the line 5—5 of FIG. 4;

FIG. 6 is a cross-sectional view taken along the line 6—6 of FIG. 3;

FIG. 7 is a reduced, cross-sectional view taken along the line 7—7 of FIG. 6;

FIG. 8 is a cross-sectional view taken along the line 8—8 of FIG. 6; and

FIG. 9 is a plan view taken along the line 9—9 of FIG. 4.

Referring, now, to the drawings in which the same reference numerals indicate like elements, a film transport and switching mechanism is contained in a rectangular casing 5 having mounting extensions 6 and 6' and side closing and bearing plates 7 and 8. Within the casing

5 is a motor 10 having a shaft 11 on which is mounted a small driving gear 12. The gear 12 is meshed with a larger gear 13 which rotates with a gear 14 in mesh with a gear 15 on the shaft of a gear 16 in mesh with a gear 17 driving the gears 18 and 19. The gear 19 has a gear 22 on its shaft which also drives a sprocket 23. A series of gears 25, 26, and 27 drive the shaft of a reel 30, while gears 31, 32, and 33 drive the shaft of a reel 35. Through the gears just described, the sprocket and reels are provided with the desired rotational speed for advancing a program film 38 at the desired linear speed.

As shown in FIG. 3, the film 38 is advanced in the direction of the arrow from reel 35 around a guide roller 39 over the toothed sprocket 23, and around a guide roller 40 to reel 30. Upon reversal of the motor, the film passes from reel 30 to reel 35 over the same path but in the reverse direction. The sprocket, gears, and reels are mounted on shafts, some of which have bearings in a frame 42 and some in the side plates 7 and 8, three bearings 43, 44, and 45 being shown in side plate 8. A plate 47 covers these bearings.

Mounted on the inner portion or plate 50 of the frame 42 is a block 52 having a groove 53 therein in which is a cable 54 for the electrical conductors from the switches and to the motor. (See FIG. 9.) Fastened to the block 52 is a multiple switch which includes a metal switch block 56 attached to mounting blocks 52 by screws 57 and 58. The switch block 56 has a plurality of grooves 60 therein (see FIG. 5) through all of which passes a pivot pin 61 on which are mounted a plurality of contact fingers or blades 63 having rounded film contact portions 64 and which are under bias of a plurality of springs 66 fastened to one side of the switch block 56 by a plate 67 and screws 70. The rounded ends 64 are adapted to pass through apertures 83 in the film to drop into grooves 84 in the sprocket 23. This movement permits the other ends of the blades to make electrical contacts.

Mounted to one side of the block 56 is an L-shaped plastic contact pin support 68 which is fastened to the block 56 by screws 69. The lower portion 71 of the plastic pin support accommodates a plurality of pins 72 the lower ends 73 of which extend below the lower surface of the pin mount 71, and the upper ends of which extend to substantially the upper edge of the pin mount 68. To the upper ends of the pins 72, electrical conductors 75 are connected, the conductors being positioned along the upper surface of the block 56 and thence entering the cable 54, as shown in FIG. 9. The conductors 75 pass through notches 76 in the upper edge of the pin mount 68. The block 56 is provided with stepped grooves 78 and 81' for accommodating the cable 54.

To maintain the conductors and cable in position and to cover the upper ends of the pins 72, this portion of the block is plasticized to form the sheet 80, which is held at one end by an undercut groove 81 in the block 56, and which extends over the conductors and pins at its other end 82. The cable 54 shown in FIG. 9 passes into a terminal box 86'' to which a cable 87 may be connected for external connection of the timer.

As mentioned above, the film transport mechanism may be reversed to advance the film in either direction. To accomplish this, each film reel has included in its drive mechanism a pair of opposite-acting, over-running clutches made up of rollers 86' for one clutch of reel 30, and rollers 88 for one clutch of reel 35 (see FIG. 3). In FIG. 6, rollers 86' are shown within one end of a cylinder 90, and rollers 86 within the other end of the cylinder, the cylinder having an annular recess 91 therein. Rollers 86 are mounted on a spider 92, and rollers 86' are mounted on a spider 93. Spider 93 is fixed to the drive shaft 105, while spider 92 is pinned to inner plate 50 by a pin

94 and is free of the shaft 105. The pin ends 100 of the respective rollers 86 and 86' are mounted in elongated, over-sized slots in the spiders 92 and 93, respectively, and are biased in a linear direction by springs 95 and 96, one end of each spring being in contact with a roller 86 or 86', and the other end of each spring being mounted on a bracket 98 or 99, as the case may be, for the respective springs 95 and 96. A square cam 97 for reel 30 and a similar cam 97' for reel 35 (see FIG. 3) move the rollers radially as they move linearly to obtain a binding action between the inner surface of the cylinder and the respective cams.

Thus, for reel 30 to function as a takeup reel, the drive shaft 105 rotates the cylinder 90 through spider 93, since the springs 96 urge the rollers 86' toward one end of the respective flat surfaces of the square cam 97 to bind the inner surface of the cylinder to the cam. Since spider 92 is free of the shaft 105, it remains stationary inasmuch as it is pinned to the plate 50.

To provide the desired speed variation between the cylinder 90, which rotates at a constant speed, and the speed of the reel 30, which varies as the film roll increases in diameter when used as a takeup reel, a split fiber ring having sections 101 and 102 (see FIG. 7) is positioned in the recess 91 of the cylinder. The sections 101 and 102 are urged outwardly by resilient plugs or springs 103 and 104, the sections being held and limited in movement by pins 106 in oversized holes in the sections 101 and 102. In this manner, sufficient friction is obtained between the reel and the sections 101 and 102 to drive the reel and take up the film, but the reel can slip to accommodate its change in speed.

Now, when the reel shaft is reversed and the reel is serving as a supply reel, the cylinder 90 is locked to spider 92 by reason of the springs 95 urging the rollers 86 to the ends of the flat sides of their associated square cam 97. Since the spider 92 is held stationary, the cylinder 90 then is held stationary. However, the spider 93 can rotate freely within the cylinder, since the rollers 86' are urged toward the center of the flat surfaces of their associated square cam. With the cylinder stationary, the reel must now slip on the fiber sections 101 and 102 which now provide the desired hold-back tension in the film. Therefore, the two over-running clutches for each reel, together with the friction drive for each reel through the fiber sections, provide the desired, variable speed takeup reel action and the desired supply reel hold-back action to permit identical film advancement drives in either one of the two opposite directions.

I claim:

1. A multiple switching device comprising a sprocket adapted to advance a perforated film having perforations along different transverse areas thereof, a pair of combination takeup and supply reels for said film, reversible driving means for driving said reels, said reel driving means including a pair of opposite-acting clutch devices for each of said reels, one clutch device of each said pair being effective to transmit power from said driving means to its associated reel and the other clutch device of each said pair being effective to cause a drag to be applied to its associated reel depending upon the direction of drive of said reel driving means, means for driving said sprocket at substantially constant speed, a plurality of film actuable contact switch blades pivoted adjacent said film, one end of each of said blades being disposed for contact with a different one of said transverse areas of said film and being responsive to film perforations at the respective ones of said areas, a plurality of contact elements corresponding in number to and each associated with a different one of said switch blades, and conductors from said contact elements for connection of said switching device to devices to be actuated when contact is made between any of said blades and their respective said contact elements.

2. A multiple switching device comprising a sprocket adapted to advance a perforated film having perforations along different transverse areas thereof, a pair of combination takeup and supply reels for said film, reversible driving means for driving said reels, said reel driving means including a pair of opposite-acting clutch devices for each of said reels, each of said clutch devices comprising an over-running clutch, one for driving its reel as a takeup reel and the other for placing a drag on its said reel during the time it functions as a supply reel, means for driving said sprocket at substantially constant speed, a plurality of film actuable contact switch blades pivoted adjacent said film, one end of each of said blades being disposed for contact with a different one of said transverse areas of said film and being responsive to film perforations at the respective ones of said areas, a plurality of contact elements corresponding in number to and each associated with a different one of said switch blades, and conductors from said contact elements for connection of said switching device to devices to be actuated when contact is made between any of said blades and their respective said contact elements.

3. A multiple switching device in accordance with claim 2 in which means are positioned within each said reel for providing a predetermined driving friction to its reel and providing a predetermined drag thereto when its said reel functions as a supply reel.

4. A program timing device comprising an enclosing casing and within said casing a film sprocket adapted to advance a perforated film having perforations along different transverse areas thereof, reversible motor means for driving said sprocket at a substantially constant speed in one or the other of two opposite directions to correspondingly advance said film, a pair of film reels adapted to alternately function as takeup and supply reels depending upon the direction of rotation of said sprocket, a plurality of gears between said motor means and said sprocket and said film reels for driving said sprocket and reels in correspondence with each other, a shaft for each of said reels driven by said gears, means including a pair of opposite-acting clutch devices on each of said shafts coupling each of said reels to their respective said shafts, one clutch device of each said pair being effective to transmit power from its associated one of said shafts to its associated reel, and the other clutch device of each said pair being effective to cause a drag to be applied to its associated reel, in each case depending upon the direction of drive of said motor, a plurality of switch blades pivoted adjacent said sprocket, one end of each of said blades being disposed for contact with said film along a different one of said transverse areas thereof, said sprocket having grooves therein over which the perforations in said film pass, a plurality of contact elements corresponding in number to and each associated with a different one of said switch blades and adapted to be contacted by the other ends of said switch blades when said first-mentioned ends pass through said perforations and into said grooves, a plurality of conductors attached to said contact elements and extending externally of said casing, and means for hermetically enclosing said contact elements and said conductors.

5. A program timing device comprising an enclosing casing and within said casing a film sprocket adapted to advance a perforated film having perforations along different transverse areas thereof, reversible motor means for driving said sprocket at a substantially constant speed in one or the other of two opposite directions to correspondingly advance said film, a pair of film reels adapted to alternately function as takeup and supply reels depending upon the direction of rotation of said sprocket, a plurality of gears between said motor means and said sprocket and said film reels for driving said sprocket and reels, a shaft for each of said reels driven by said gears, means including a pair of opposite-acting clutch devices on each of said shafts coupling each of said reels to their respective said shafts, said clutch devices comprising over-running clutches, one of said clutches connecting its as-

sociated reel to its shaft when functioning as a takeup reel, and the other of said clutches holding said last-named reel shaft stationary when said associated reel functions as a supply reel, a plurality of switch blades pivoted adjacent said sprocket, one end of each of said blades being disposed for contact with said film along a different one of said transverse areas thereof, said sprocket having grooves therein over which the perforations in said film pass, a plurality of contact elements corresponding in number to and each associated with a different one of said switch blades and adapted to be contacted by the other ends of said switch blades when said first-mentioned ends pass through said perforations and into said grooves, a plurality of conductors attached to said contact elements and extending externally of said casing, and means for hermetically enclosing said contact elements and said conductors.

6. A program timing device comprising an enclosing casing and within said casing a film sprocket adapted to advance a perforated film having perforations along different transverse areas thereof, reversible motor means for driving said sprocket at a substantially constant speed in one or the other of two opposite directions to correspondingly advance said film, a pair of film reels adapted to alternately function as takeup and supply reels depending upon the direction of rotation of said sprocket, a plurality of gears between said motor means and said sprocket and said film reels for driving said sprocket and reels, a shaft for each of said reels driven by said gears, means including a pair of opposite-acting clutch devices on each of said shafts coupling each of said reels to their respective said shafts, means positioned on each of said reel shafts for frictionally driving said reels when functioning as takeup reels and for exerting a predetermined amount of drag on said reels when functioning as supply reels, a plurality of switch blades pivoted adjacent said sprocket, one end of each of said blades being disposed for contact with said film along a different one of said transverse areas thereof, said sprocket having grooves therein over which the perforations in said film pass, a plurality of contact elements corresponding in number to and each associated with a different one of said switch blades and adapted to be contacted by the other ends of said switch blades when said first-mentioned ends pass through said perforations and into said grooves, a plurality of conductors attached to said contact elements and extending externally of said casing, and means for hermetically enclosing said contact elements and said conductors.

7. A multiple switching device comprising a sprocket adapted to advance a perforated film having perforations along different transverse areas thereof, a pair of combination takeup and supply reels for said film, reversible driving means for driving said reels concurrently in one or the other of two opposite directions, first and second opposite-acting clutches interposed between said driving means and one of said reels, third and fourth opposite-acting clutches interposed between said driving means and the other of said reels, means for applying drag to the respective said reels, said first clutch being effective to transmit power from said driving means to said one reel and said fourth clutch being effective to cause said drag applying means to apply drag to said other reel in response to operation of said driving means to drive said reels concurrently in said one direction, said second and third clutches then being inactive, and said third clutch being effective to transmit power from said driving means to said other reel and said second clutch being effective to cause said drag applying means to apply drag to said one reel in response to operation of said driving means to drive said reels concurrently in said other direction, said first and fourth clutches then being inactive, means for driving said sprocket at substantially constant speed, a plurality of film actuable contact switch blades pivoted adjacent said film, one end of each of said blades being disposed for contact with a different one of said transverse areas of said film and being responsive to film perforations at the respective ones of said areas, a plurality of contact elements corresponding in number to and each associated with a different one of said switch blades, and conductors from said contact elements for connection of said switching device to devices to be actuated when contact is made between any of said blades and their respective said contact elements.

8. A program timing device comprising an enclosing casing and within said casing a film sprocket adapted to advance a perforated film having perforations along different transverse areas thereof, reversible motor means for driving said sprocket at a substantially constant speed in one or the other of two opposite directions to correspondingly advance said film, a pair of film reels adapted to alternately function as takeup and supply reels depending upon the direction of rotation of said sprocket, a plurality of gears between said motor means and said sprocket and said film reels for driving said sprocket and said reels in correspondence with each other, a shaft for each of said reels driven by said gears, a first friction coupling member and first and second opposite-acting clutches on one of said shafts for coupling said one shaft to one of said reels, a second friction coupling member and third and fourth opposite-acting clutches on the other of said shafts for coupling said other shaft to the other of said reels, said first clutch being effective to transmit power from said one shaft to said first friction coupling member to thereby drive said one reel and said fourth clutch being effective to cause said second friction coupling member to apply drag to said other reel all in response to operation of said motor means in one direction, said second and third clutches then being inactive, and said third clutch being effective to transmit power from said other shaft to said second friction member to thereby drive said other reel and said second clutch being effective to cause said second friction coupling member to apply drag to said first reel in response to operation of said motor means in the reverse direction, said first and fourth clutches then being inactive, a plurality of switch blades pivoted adjacent said sprocket, one end of each of said blades being disposed for contact with said film along a different one of said transverse areas thereof, said sprocket having grooves therein over which the perforations in said film pass, a plurality of contact elements corresponding in number to and each associated with a different one of said switch blades and adapted to be contacted by the other ends of said switch blades when said first-mentioned ends pass through said perforations and into said grooves, a plurality of conductors attached to said contact elements and extending externally of said casing, and means for hermetically enclosing said contact elements and said conductors.

9. In combination, a sprocket adapted to advance a film, a pair of combination takeup and supply reels for said film, reversible driving means for driving said sprocket and said reels concurrently in one or the other of two opposite directions, first and second opposite-acting clutches interposed between said driving means and one of said reels, third and fourth opposite-acting clutches interposed between said driving means and the other of said reels, means for applying drag to the respective said reels, said first clutch being effective to transmit power from said driving means to said one reel and said fourth clutch being effective to cause said drag applying means to apply drag to said other reel in response to operation of said driving means to drive said reels concurrently in said one direction, said second and third clutch then being inactive, and said third clutch being effective to transmit power from said driving means to said other reel and said second clutch being effective to cause said drag applying means to apply drag to said one reel in response

to operation of said driving means to drive said reels concurrently in said other direction, said first and fourth clutches then being inactive.

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