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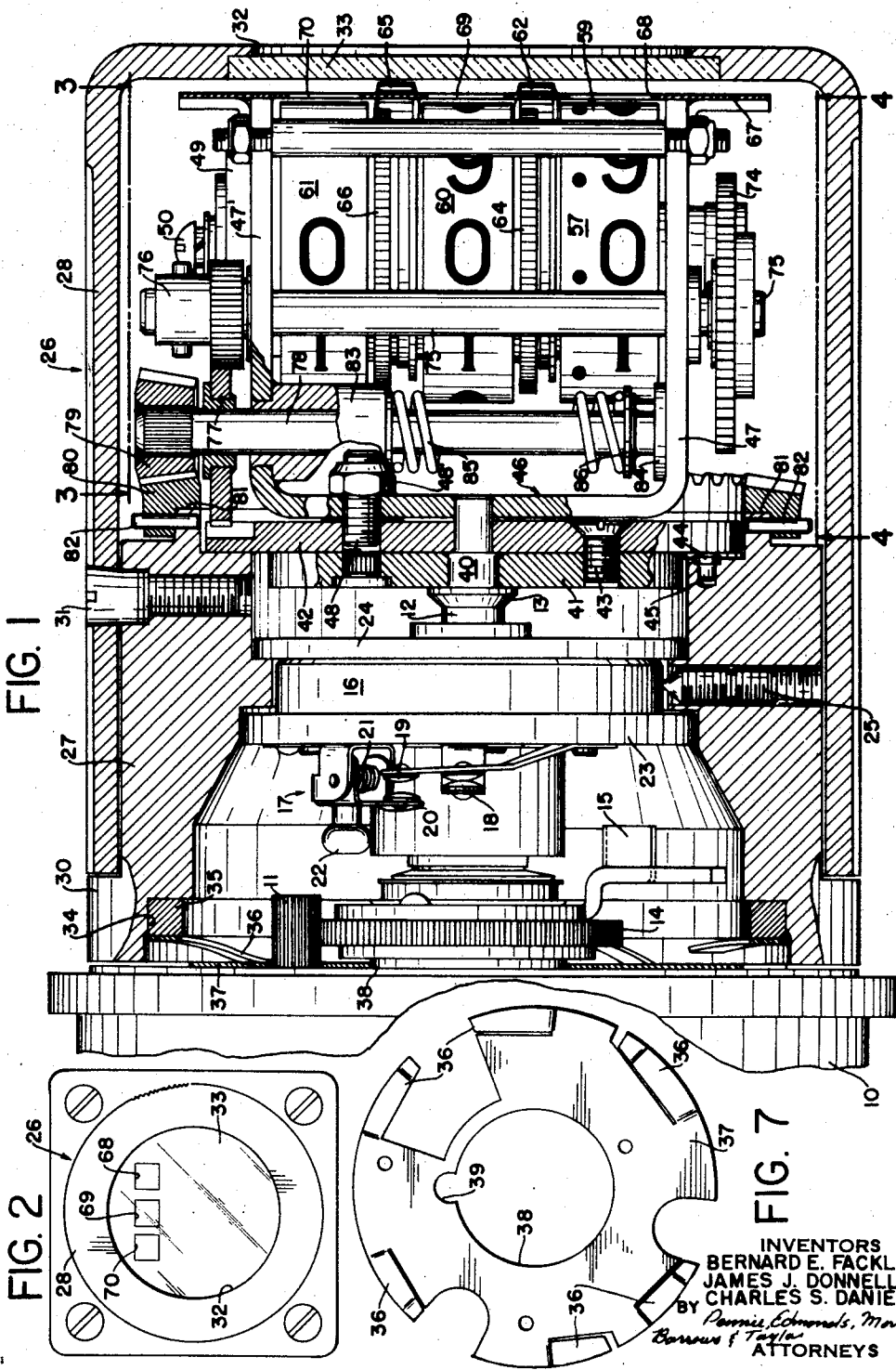
B. E. FACKLER ET AL

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DIRECT READING TIME DELAY RELAY

Filed Oct. 10, 1956

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FIG. 5

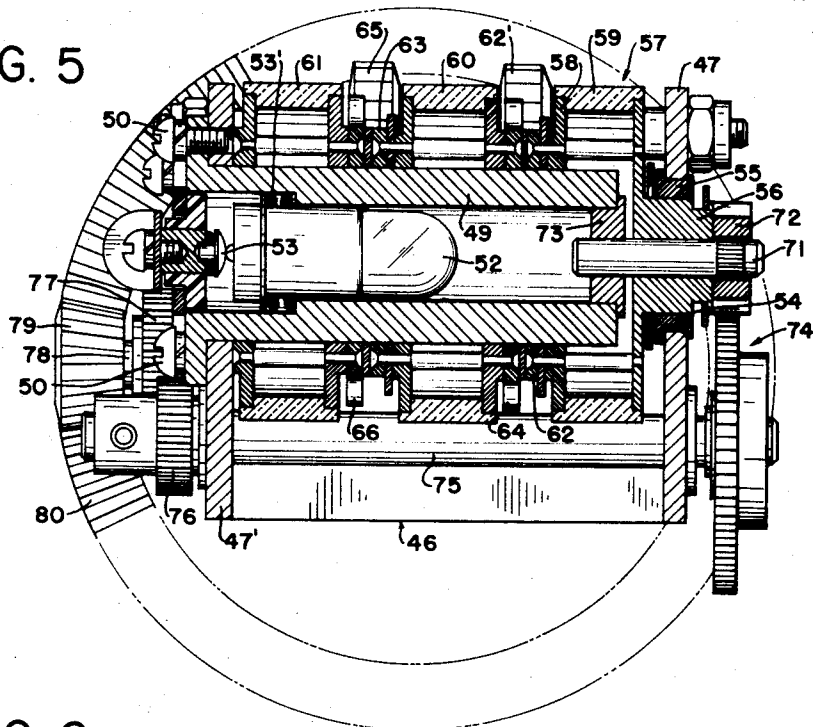
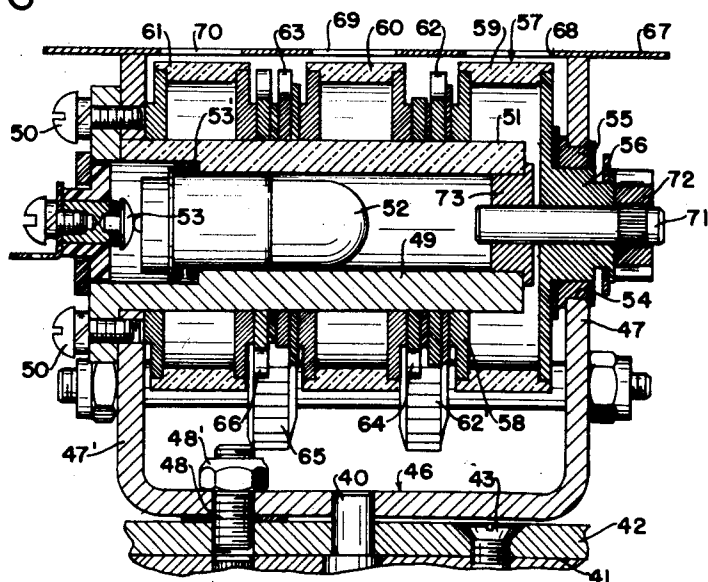


FIG. 6



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DIRECT READING TIME DELAY RELAY

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8 Claims. (Cl. 200—33)

The present invention relates generally to electrical control apparatus, and more particularly to a novel and improved adjustable time delay device incorporating means providing a direct reading of the adjusted setting of the device.

For certain applications it is desirable to employ time delay switches of a type having a pair of relatively movable switch contacts and a constant speed motor drive for moving the contact elements together at a predetermined rate of speed. A control operation may thus be effected after a predetermined delay period between the energizing of the drive and the closing (or opening, as the case may be) of the switch contacts. Since the speed of the drive is known, and is constant, the delay period may be regulated by adjusting the initial spacing of the relatively movable contact elements. That is, the greater the initial spacing, the greater the time required for the elements to be moved into operative relation at a constant speed. An apparatus of this type is described and claimed in the copending application of Bernard E. Fackler, et al., for "Time Delay Relay," Serial No. 504,254, filed April 27, 1955 and assigned to the same assignee as is this application.

In the device of the aforementioned application, there is a contact arm which rotates about a shaft toward a fixed contact element. When the contact arm and element are engaged, a switch is opened or closed to effect a control operation. The contact arm always starts from a predetermined position, and the delay period is determined by adjusting the rotary position of the otherwise fixed contact element, so that the arc through which the contact arm must rotate to effect the contact operation is varied.

To adjust that device, a control knob is provided which is accessible from the front of the instrument, suitable calibration being provided about the periphery of the knob or surrounding panel to indicate the setting. In certain applications, however, such as for aircraft controls, where the instrument panels are crowded, and accurate observation of the calibration is difficult, an improved arrangement for indicating the setting of the control device is desirable. Accordingly, the present invention seeks to provide an improved time delay relay device having means therein providing for a direct reading of the adjusted setting. The invention contemplates the provision of a control device having observation windows at which numbers indicating the setting of the instrument are presented.

A more specific feature of the invention resides in the provision, in a timing device of the type described, of a novel and improved arrangement for accurately relating the setting of the instrument with the setting of a direct reading indicator. In this respect, the invention provides an improved drive mechanism which is compact and easily assembled.

As another specific feature, the present invention provides an improved and wholly practical arrangement for adjusting the time delay period, so that an infinite series of adjustments, within the range or capacity of the device, is possible.

The above and other objects and advantages of the invention will become apparent upon consideration of

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the following detailed description and accompanying drawings in which

Fig. 1 is an enlarged, fragmentary axial cross-section of the improved control device, with parts broken away;

Fig. 2 is a front elevation of the device of Fig. 1;

Figs. 3 and 4 are enlarged, fragmentary, sectional views taken generally along lines 3—3 and 4—4, respectively, of Fig. 1;

Fig. 5 is an enlarged, sectional view taken generally along line 5—5 of Fig. 3;

Fig. 6 is an enlarged sectional view taken generally along line 6—6 of Fig. 4; and

Fig. 7 is a plan view of a clutch element incorporated in the device of Fig. 1.

Referring initially to Fig. 1, the numeral 10 designates a housing in which are mounted a constant speed motor and clutch mechanism (not shown) which, when properly conditioned, rotate a drive pinion 11. The motor, clutch mechanism and appurtenant apparatus are fully described in the aforementioned copending application.

Mounted in fixed relation to the housing 10 is a shaft 12 having a flange 13 at its outer end. The shaft 12 rotatably mounts a contact arm assembly, including a large diameter gear 14, meshing with the drive pinion 11, and a contact arm 15 fixed to the gear and rotatable therewith.

Also supported on the fixed shaft 12, and adapted for rotation about the axis thereof, is a mounting disc or block 16 for a switch 17. In the illustrated apparatus, the switch 17 comprises normally closed contacts 18 and normally open contacts 19, and includes a movable contact member 20 urged by means of a spring 26 in a direction to open contacts 19. The contact member 20 carries a projection 22 which, upon rotation of the contact arm 15 in a clockwise direction (as viewed from the housing end), is engaged by the contact arm 15 and rocked against the force of the spring 21 to close the contacts 19 and open the contacts 18. This effects the desired control operation, and simultaneously disconnects the drive mechanism. The return of the contact arm must be effected by means of a suitable spring (not shown).

To regulate the time period from the instant at which the contact arm 15 begins to rotate until it engages and actuates the switch 17, provisions are made for adjusting the rotary position of the switch, so that the distance the arm 15 must travel may be varied. To this end, the switch mounting disc 16 is rotatable on the shaft 12, while being restrained against axial movement by means of a flange or shoulder 23.

Secured to the disc 16, by means of a retaining plate 24 and one or more set screws 25, is a control knob 26, which comprises a sleeve port 27 surrounded by a generally cylindrical cup-shaped cover 28. The sleeve port 27 has an inner shoulder, which lies between the retaining plate 24 and a flange 29 on the switch mounting disc 16, and serves to locate the sleeve 27 in proper axial relationship to the assembly. The cover 28 is received over the outer wall of the sleeve 27, and engages a flange or shoulder 30 near the inner end of the sleeve. One or more screws 31 are employed to secure the cover 28 and sleeve 27 together.

As illustrated in Figs. 1 and 2, the cover 28 is provided with a large central opening 32, in which is received a plate 33 of glass or suitable transparent plastic material, forming an observation window through which the interior of the assembly may be viewed.

As described in the Fackler et al. application, the setting of the time delay period of the switching device may be altered by manipulating the control knob 26, so that the disc 16, and hence the switch 17, is moved toward or away from the rest position of the contact arm 15.

To hold the knob 26 and switch 17 in any pre-set position, the present invention incorporates an improved and simplified arrangement to frictionally engage the knob 26 with the housing 10, or with parts affixed thereto. Thus, at its inner end, the sleeve 27 is provided with an annular recess 34 for snugly receiving an annular friction ring 35. The ring may be held in place in the sleeve 27 by virtue of the snug fit in the recess 34, or, if necessary or desirable, additional means such as pins or screws may be employed. The exposed end surface of the friction ring is recessed inwardly of the end of the sleeve 27 and is arranged to contact a plurality of spring-like projections 36. The projections 36 are integral parts of a friction disc 37, shown in Fig. 7. The body of the disc 37 is secured to the housing 10, and the projections 36 extend forwardly out of the plane of the disc into resilient engagement with the friction ring 35. The arrangement is such that the knob 26 will be frictionally held in any rotary position in which it is set. The disc 37 has a central opening 38 and a radially offset opening 39 to receive the shaft 12 and drive pinion 11, respectively.

At the outer end of the shaft 12, is a portion 40 thereof which projects beyond the flange 13. A disc 41 is received upon the projecting portion 40 of the shaft and is rigidly secured thereto by brazing, for example. The disc 41, in turn, mounts a second and larger disc 42, suitable recessed screws 43 being employed to secure the discs together. The disc assembly 41-42 is recessed in the outer end of the sleeve 27 and is supported near its outer edges by means of a plurality, preferably three, of bronze pads 44 received in recesses 45 in the sleeve.

Rigidly mounted on the disc assembly 41-42 is a U-shaped bracket 46 having outwardly extending arms 47, 47'. The base of the bracket is secured to the disc 42 by means of a plurality of studs 48 and nuts 48' and, as shown in Figs. 5 and 6, one of the arms 47' of the bracket 46 has an enlarged opening therein for the reception of a flanged sleeve 49. The sleeve 49 is secured to the arm 47' by screws 50 extending through the flange of the sleeve, and extends toward the other arm 47, terminating short of the last mentioned arm.

As shown in Fig. 6, the sleeve 49 may be formed of metal, but has an opening extending along its outer side, in which is mounted a lens 51 of glass or suitable plastic. A bulb 52 is received within the sleeve 49 and is pressed against a contact member 53 at its terminal end by means of a spring 53' engaging a flange at the base of the bulb and acting against a shoulder in the sleeve 49. The contact member has a lug to which a suitable conductor (not shown) may be connected to energize the bulb 52 for distributing light through the lens 51.

In the arm 47 of bracket 46 there is an opening 54 which is coaxial with the sleeve 49 and in which is secured a bushing 55. The bushing 55 has a central opening rotatably receiving a bearing 56 at one side of an indicia-bearing drum 57. The drum 57 is supported at its other side by a bearing disc 58 resting upon the outer surface of the sleeve 49. The center portion of the drum 57 is a sleeve 59 of glass or suitable plastic having indicia numerals about its outer surface in the form of numbers, in tenths, from zero to nine, for example.

Beside the drum 57 are similar drums 60 and 61 which are rotatably supported by the sleeve 49 and have indicia numerals in units. The center drum 60 may be numbered from zero to nine, and the outer drum 61 may be numbered in a similar manner, or with fewer numbers, if desired.

The several indicia bearing drums 57, 60, 61 form a counter mechanism. The mechanism is so arranged that after every complete revolution of the first drum 57, the second drum 60 will be caused to advance a predetermined fraction of a revolution; and after each complete revolution of the second drum 60, the third drum will be caused to advance a predetermined fraction of a revolution. This operation is obtained by providing the drums

57 and 60 with single tooth gears 62, 63, as shown in Fig. 6. Each time the drum 57, for example, completes a revolution, the single tooth of the gear 62 engages a pinion 62' and moves it through a predetermined fraction of a revolution. The pinion 62' meshes with a gear 64 carried by the second drum 60 so that the drum is moved through the desired fraction of a revolution. The other single tooth gear 63 periodically engages a pinion 65, meshing with a gear 66 carried by the third drum 61, so that the drum 61 is periodically moved by the second drum 60.

Attached to the forward ends of the arms 47, 47' of the U-shaped bracket 46 is a face plate 67 having a plurality of rectangular windows 68-70 therein positioned directly in front of the indicia bearing drums 57, 60, 61. The face plate 67 and windows are visible through the glass front 33 of the knob 26, as shown in Fig. 2, and limited portions of the indicia-bearing drums 57, 60, 61 are visible through the windows. To facilitate observation of the exposed portion of the indicia drums, the bulb 52 will be energized so that light is distributed through the lens 51 to illuminate the drums from the inside, making opaque numerals thereon readily distinguishable.

In accordance with the invention, the indicia-bearing drums 57, 60, 61 are keyed to the control knob 26, so that when the latter is rotated, to adjust the time delay setting, the drums will be correspondingly moved. The arrangement is such that the numerals presented at the windows 68-70 will indicate directly the time duration of the delay period, in seconds and tenths of seconds. To this end the "tenths" drum 57 mounts a drive shaft 71 which has a pinion 72 at its outer end and is supported at its inner end in a bearing 73 received in the sleeve 49. The pinion 72 meshes with a relatively large diameter gear 74 supported upon the end of a shaft 75, which is journaled in the spaced arms 47, 47' of the U-shaped bracket 46. At the end of the shaft 75 opposite from the gear 74 there is a small diameter pinion 76 which meshes with a larger gear 77 carried by a shaft 78.

As shown in Fig. 1, the outer end of the shaft 78 carries a bevel pinion 79 which is arranged to mesh with a large diameter annular bevel gear 80. The annular bevel gear 80 has an internal annular recess which is received over an annular boss 81 on the rotatable sleeve 27. The gear 80 is secured in its assembled position by means of a plurality of radial pins 82.

To avoid backlash between the bevel pinion 79 and gear 80, the shaft 78 mounting the bevel pinion 79 is received in inboard and outboard bearings 83, 84 in the arms of the U-shaped bracket 46 and is adapted for axial as well as rotary movement. A spring 85 acts upon the end of the inboard bearing 83 and upon a washer 86 fixed to the shaft 78 to urge the shaft and bevel pinion 79 radially inward of the annular ring gear 80. By virtue of the beveled relationship of the pinion 79 and gear 80, the two gears are drawn into tight engagement, so that all backlash is avoided.

In some cases, it may be desirable to employ a face gear and pinion in place of the bevel gear and pinion 80, 79, in which case the spring 85 might be eliminated.

It will thus be apparent that all manipulations of the knob 26 are accurately reflected in movements of the counter drums, and by proper adjustment of the drums and through the use of proper driving ratios, the counter will indicate directly, in seconds and tenths of seconds, the delay period of the device corresponding to any rotary position of the knob 26.

Through the use of the friction ring 35 and disc 37, rapid and precise adjustment of the timer, in infinitesimal increments, is possible, and the apparatus is self-holding in any adjusted position.

The counter mechanism, which affords a direct reading of the time setting, is fixed with respect to the main housing 10, and the control knob 26 surrounds and

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rotates about the counter. The observation glass 33 is therefore of such size as to expose the window openings 68-70 in any rotary position of the knob, affording a direct observation of the control setting at any time.

One of the important novel features of the invention resides in the provision of an improved counter-indicator mechanism which is constructed about a hollow sleeve. The arrangement is such that an illuminating bulb and light distributing lens may be built into the mechanism to facilitate observation of the instrument under adverse operating conditions.

The improved control device is employed to great advantage in aircraft, for example, where a control setting must be made quickly and accurately, and where lighting conditions may be less than ideal.

We claim:

1. In an adjustable time delay mechanism of the type having a constant speed drive system, a first control member movable by the drive system, a second control member engaged by the first control member to effect a control operation, and means to adjust the initial spacing of the first and second control members, the improvement comprising a fixed shaft rotatably mounting said first and second control members, a control knob mounted for rotation on said shaft and having a hollow portion outwardly of the end of the shaft, a U-shaped bracket secured in fixed relation to the shaft and having spaced arms extending outwardly thereof, a plurality of indicia-bearing counter drums journaled on a common axis between said arms, and means to drive the counter drums comprising a shaft journaled in said arms and having a bevel pinion at one end and an annular bevel gear secured to the knob in concentric relation to said shaft, said knob having an opening in its outer end permitting viewing of the counter drum in any rotary position of the knob.

2. Apparatus according to claim 1, including means to urge the bevel pinion radially inward of the annular bevel gear to prevent backlash between the bevel pinion and gear.

3. Apparatus according to claim 2, characterized by the means to urge the bevel pinion comprising a spring acting on the shaft supporting the bevel pinion tending to move the shaft in a longitudinal direction.

4. Apparatus according to claim 1, characterized by the knob comprising a sleeve part mounted for rotation on the shaft, and a cup-like member having side walls received over the sleeve and having an outer end spaced from the outer end of the sleeve and defining therewith the said hollow portion.

5. In an adjustable control device having a control member adapted for adjustment upon rotation, the combination of a fixed shaft for rotatably supporting the control member, a control knob rotatably supported on said shaft and having a hollow portion outwardly of the outer end of the shaft, a counter mechanism fixedly mounted at the outer end of the shaft and having a plurality of indicia-bearing drums, and a drive system for the counter including said knob, said knob having a viewing window in its outer end exposing the drums in all rotary positions of the knob, and said counter mechanism including a sleeve rotatably mounting said indicia-bearing drums and having an opening therein facing outwardly, an illuminating bulb mounted within the sleeve, and a face plate mounted forwardly of the counter and having windows therein exposing limited portions of the drum.

6. In an adjustable control device having a control member adapted for adjustment upon rotation, the combination of a knob attached to the control member and supported for rotation for effecting adjustment of the control member, said knob having a hollow portion in its outer end, a counter mechanism mounted in fixed position in said hollow portion, said counter mechanism including a plurality of indicia-bearing drums and means rotatably supporting the drums, a face plate mounted in

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fixed position outwardly of the drums and within said hollow portion, said face plate having openings therein exposing limited portions of said drums, said knob having an opening in its outer end for viewing the face plate openings in any rotary position of the knob, and drive means for the counter mechanism including said knob, said knob comprising a sleeve part attached to said control member and a cup-like member secured to said sleeve part and defining therewith said hollow portion, and said means rotatably supporting said drums comprising a hollow sleeve, an illuminating bulb in said sleeve, and a lens mounted in said sleeve and adapted to direct light from said bulb toward limited portions of said drums, said drums being formed of a material adapted to transmit light.

7. In an adjustable control device having a control member adapted for adjustment upon rotation, the combination of a fixed shaft for rotatably supporting the control member, a control knob rotatably supported on said shaft and having a hollow portion outwardly of the outer end of the shaft, a counter mechanism fixedly mounted at the outer end of the shaft and having a plurality of indicia-bearing drums, a drive system for the counter including said knob, said knob having a viewing window in its outer end exposing the drums in all rotary positions of the knob, a first friction member mounted in fixed relation with respect to said shaft, and a second friction member carried by said knob and having resilient engagement with the first friction member to frictionally retain the knob in an infinite number of adjusted positions, said first friction member comprising a disc-like element of resilient material having a plurality of peripheral contact portions deformed out of the plane of the element and projecting outwardly thereof, and said second friction member comprising a ring adapted to engage the projecting peripheral portions of the first friction member, said ring having an effective diameter not substantially less than that of the knob, and said contact portions being so spaced and arranged as to provide frictional contact with said ring at a plurality of spaced areas located radially outward of the axis of the shaft a substantial distance in relation to the diameter of the knob.

8. In an adjustable time delay mechanism of the type having a constant speed drive system, a first control member movable by the drive system, a second control member engaged by the first control member to effect a control operation, and means to adjust the initial spacing of the first and second control members, the improvement comprising a fixed shaft rotatably mounting said first and second control members, a control knob mounted for rotation on said shaft and having a hollow portion outwardly of the end of the shaft, a bracket secured in fixed relation to the shaft, a plurality of indicia-bearing counter drums journaled on a common axis on said bracket, and means to drive the counter drums comprising a shaft journaled on said bracket and having a driven member at one end and a driving member secured to the knob in concentric relation to said shaft, said knob having an opening in its outer end permitting viewing of the counter drum in any rotary position of the knob.

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