

[72] Inventors Shunsuke Matsuo;
Shunichi Agatahama, both of Kyoto-fu,
Japan
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[73] Assignee Omron Tateisi Electronics Co.
Ukyo-ku, Kyoto, Japan
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[33] Japan
[31] 43/87765 and 44/105703

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Primary Examiner—Harold Broome			
Attorney—Craig, Antonelli and Hill			

[54] **TIMING DEVICE**
19 Claims, 11 Drawing Figs.
[52] U.S. Cl. 335/68
[51] Int. Cl. H01h 3/54
[50] Field of Search 335/68, 69,
70, 71, 72, 73, 74, 75, 76, 77, 59, 63, 64, 65;
200/38, 35-37; 74/436

ABSTRACT: A timing device in which a motor drives a driven gear by way of a drive gear; the driven gear is provided along its periphery with a toothless portion into which the drive gear can detachably engage; an electromagnet causes the drive gear to engage with or to disengage from the driven gear while a time-limit switching mechanism controlling an electric circuit is operated at a predetermined time in accordance with the rotation of the driven gear, thereafter the drive gear rotates with a lost motion in the toothless notched portion of the driven gear for the purpose of cutting off the power transmission from the drive gear to the driven gear.

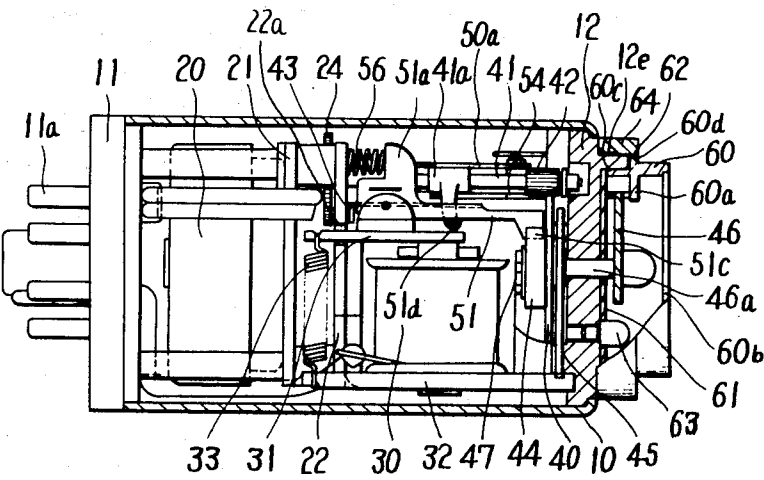


FIG. 1

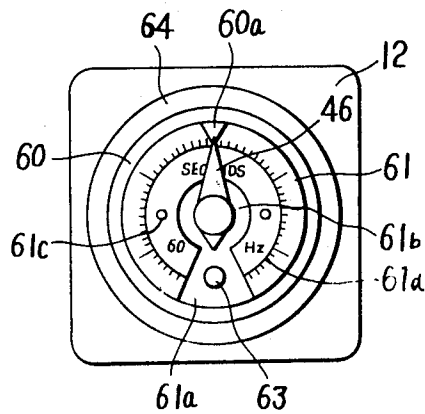


FIG. 2

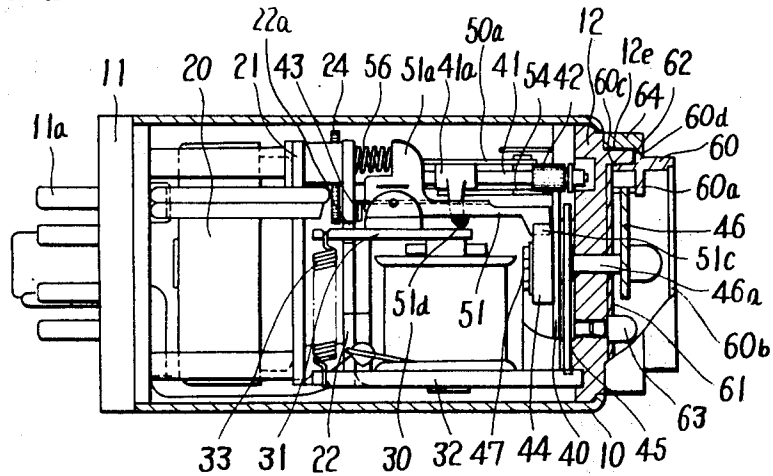
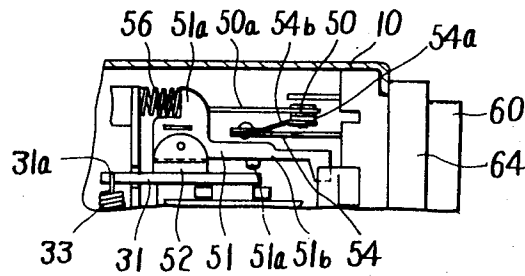


FIG. 3



INVENTORS

SHUNSUKE MATSUO and SHUNICHI AGATAHAMA
BY

Craig, Antonelli, Stewart & Hill

ATTORNEYS

FIG. 4

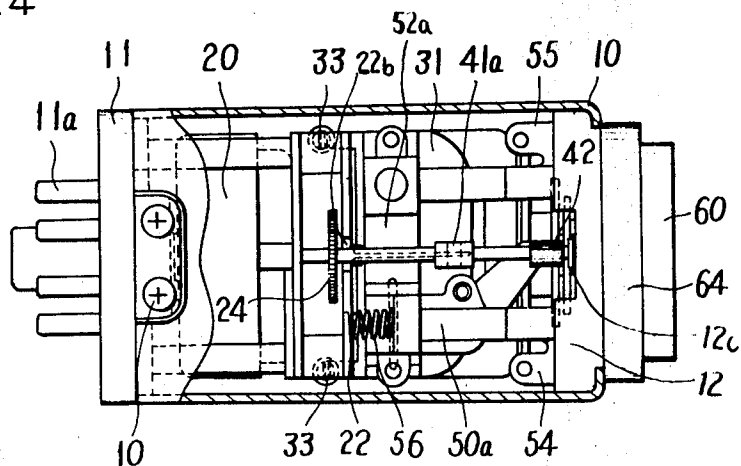


FIG. 5

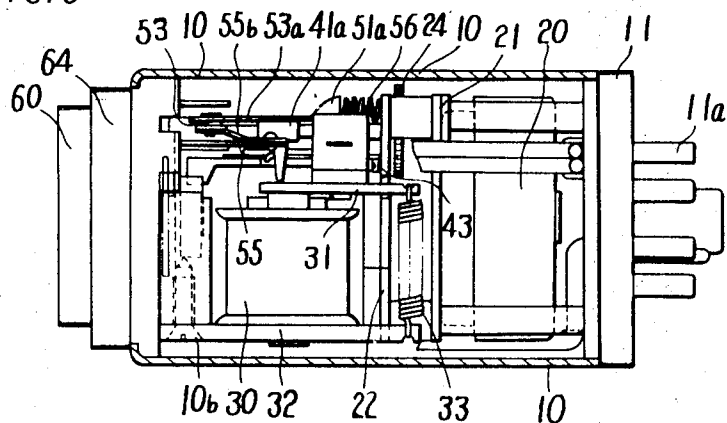
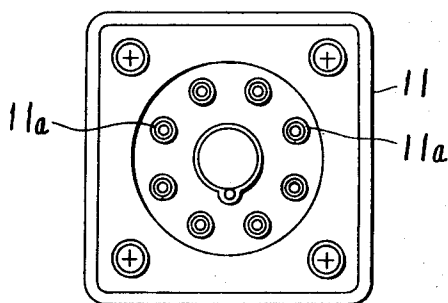
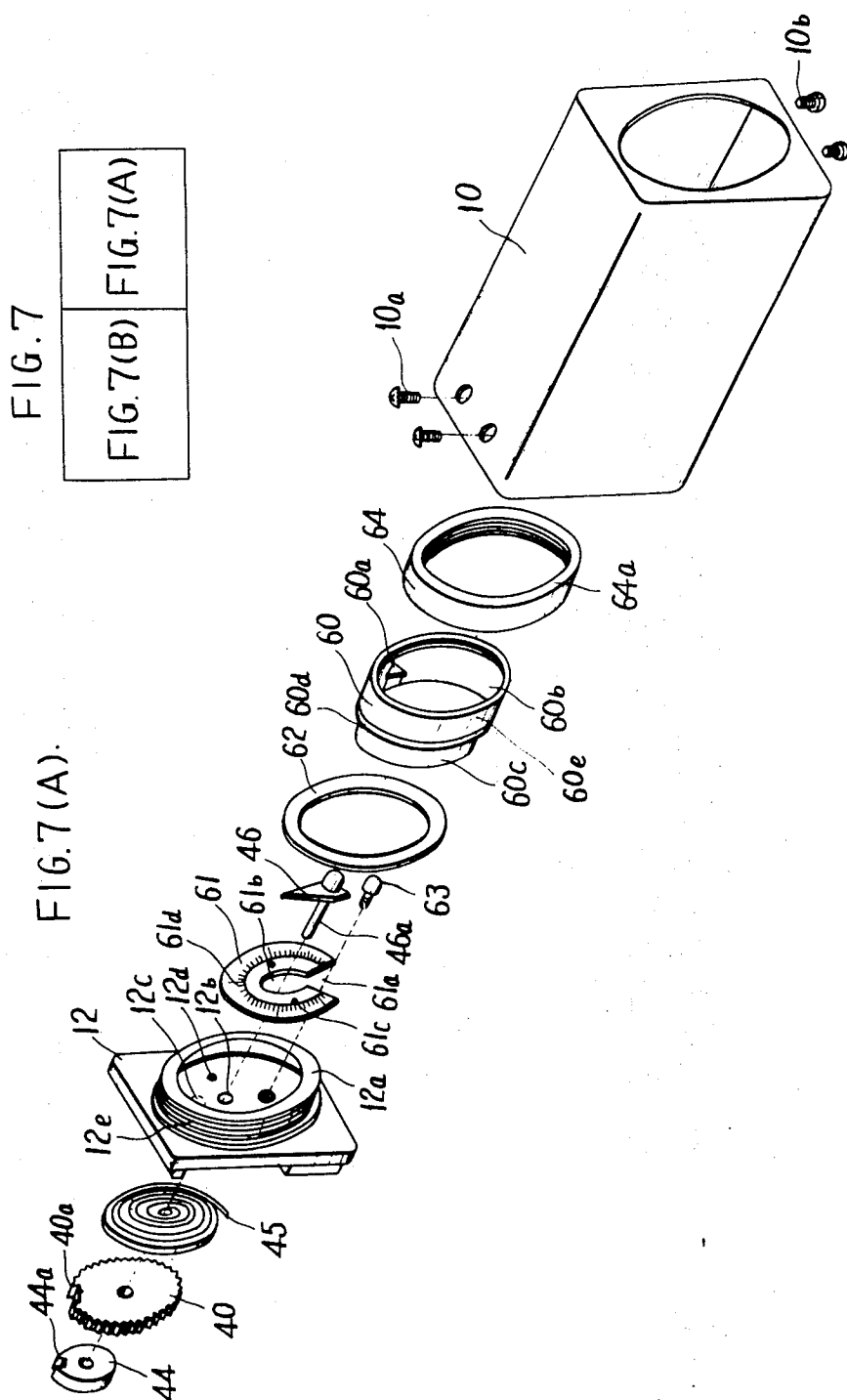


FIG. 6



INVENTORS
SHUNSUKE MATSUDA and SHUNZCHI AGATAHAMA
BY
Craig, Antonelli, Stewart & Hill
ATTORNEYS



INVENTORS
SHUNSUKE MATSUO and SHUNICHI AGATAHAMA
BY
Craig, Antonelli, Stewart & Hill
ATTORNEYS

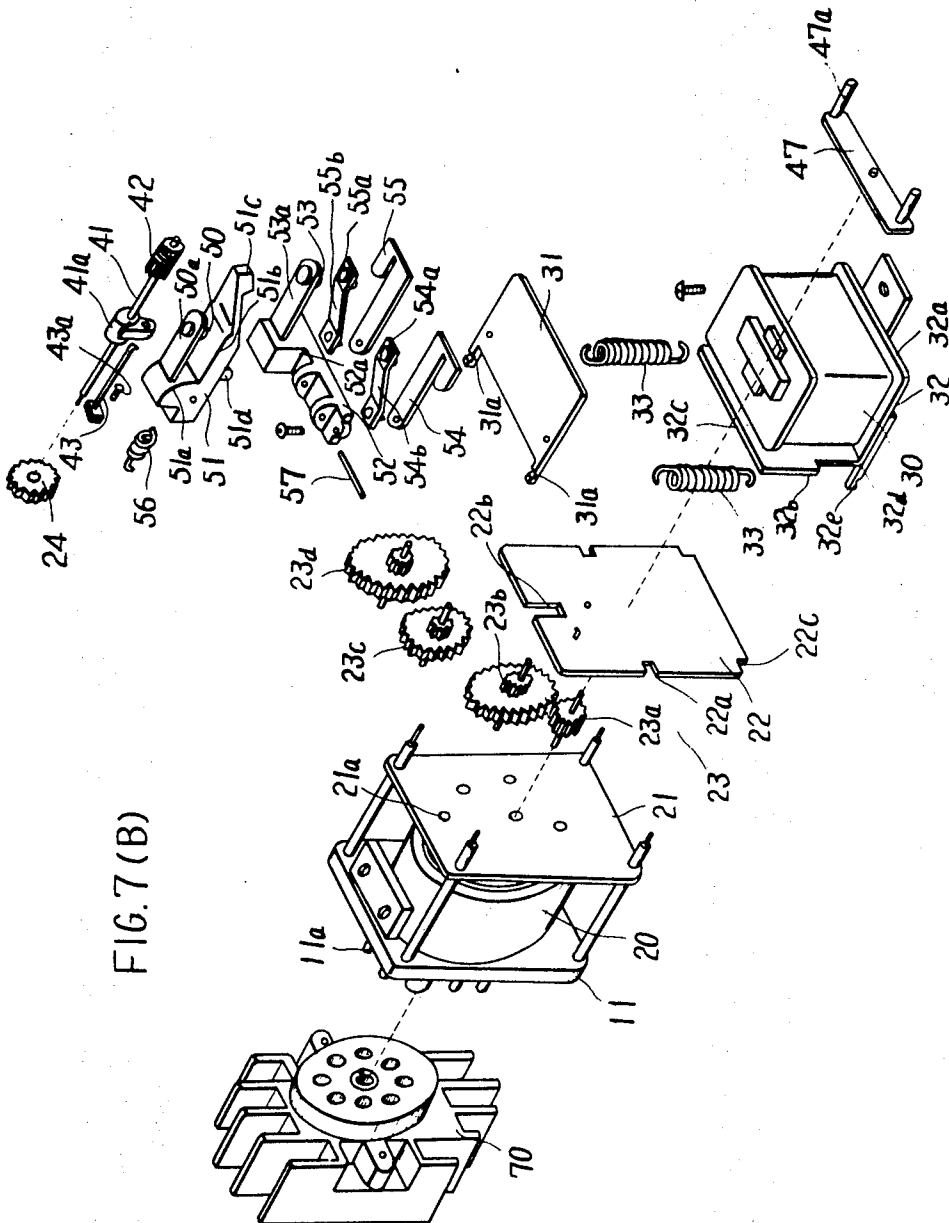


FIG. 7(B)

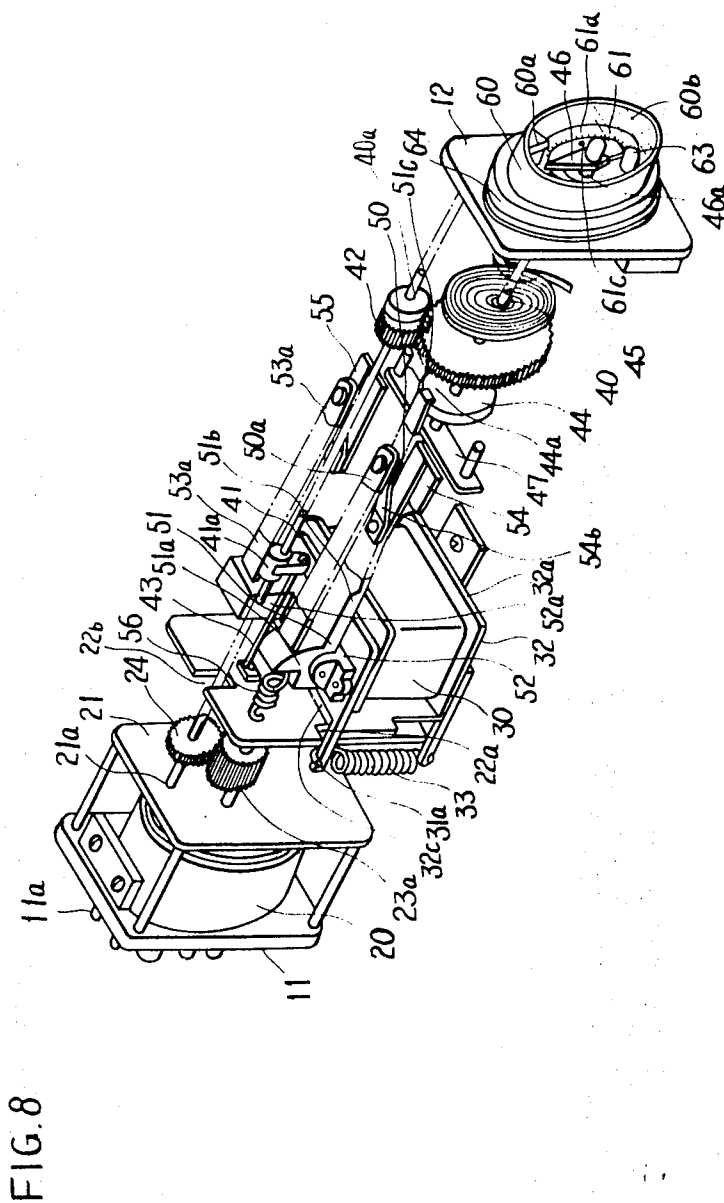
INVENTORS

SHUNSUKE MATSUO and SHUNICHI AGATAHAMA

BY

Craig, Antonelli, Stewart & Hill

ATTORNEYS



INVENTORS
 SHUNSUKE MATSUO and SHUNICHI AGATAHAMA
 BY
 Craig, Antonelli, Stewart & Hill
 ATTORNEYS

FIG. 9

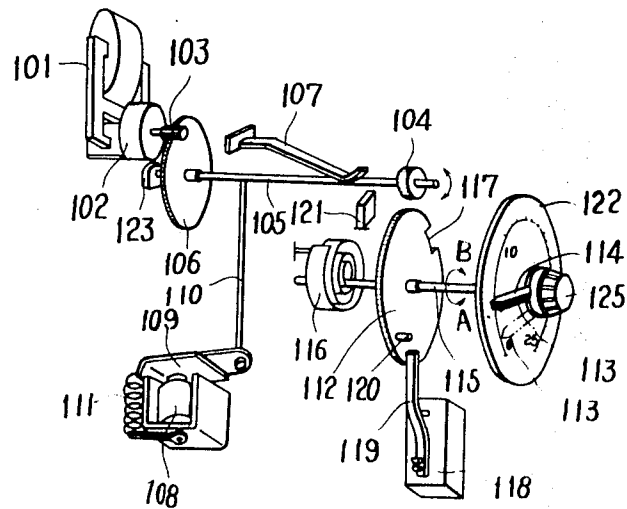
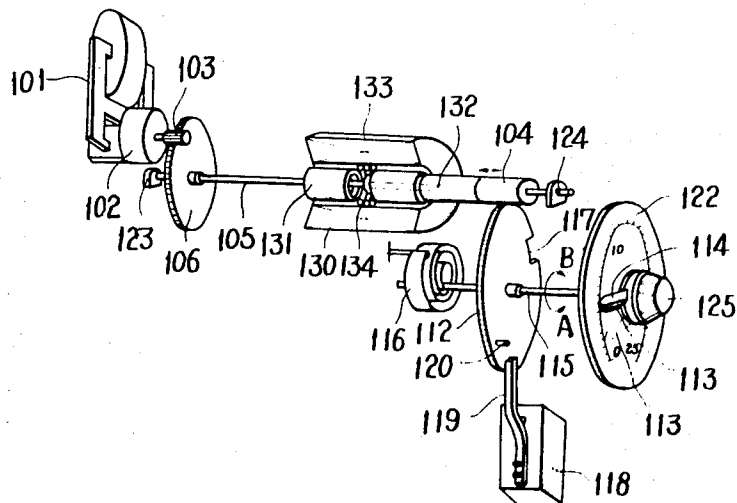


FIG. 10



INVENTORS
SHUNSUKE MATSUO and SHUNICHI AGATAHAMA
BY
Craig, Antonelli, Stewart & Hill
ATTORNEYS

TIMING DEVICE

The present invention relates to an electrical timing device and, more particularly, to an electrical timing device of improved performance and simplified type wherein the time limit switching mechanism is operated at the lapse of the desired time in such a manner that the motor driven drive gear is engaged with the driven gear by the action of the electromagnet means

Heretofore, there has been proposed various types of the timing device. Of these types, one exemplary type has been designed so as to be operated in such a manner that, while the drive gear is constantly driven by the motor, the rotational power of the drive gear is transmitted to the driven gear by the clutching action in cooperation with the electromagnet and, immediately after the driven gear is rotated through a certain angle of rotation, that is, at the lapse of the preset time, the time-limit switching mechanism for controlling an external circuit is operated.

In the timing device of such type, it is necessary to cut off the power transmission from the motor to the driven gear after the time-up moment in which the time-limit switching mechanism is operated. If this power transmission cut off operation is neglected or fails, the motor will be subjected to an unbearable load which may result in breakage of the timing device, otherwise the malfunction of either the drive gear or the driven gear.

There has also been proposed two conventional types of a timing device provided with means for preventing the motor from being subjected to such an unbearable load, one type of which is so designed that the electric power supply to the motor may be cut off immediately after the time-up moment while the other type is so designed that the electric power supply to the electromagnet may be cut off immediately thereafter for the purpose of forcibly disengaging the drive gear from the driven gear.

The timing device of the first-mentioned conventional type is largely accepted because of its technical reliability and less frequent occurrence of the malfunction. However, there has been a drawback in that the timing device is bulky in size due to the provision of an additional switching mechanism for cutting off the power supply to the motor and a large-size electromagnet necessary to operate said additional switching mechanism, resulting in an increasing of the manufacturing cost.

On the other hand, even in the timing device of the second-mentioned conventional type, for the purpose of forcibly disengaging the drive gear from the driven gear, it has been necessary to provide therein an auxiliary lever which will not only result in a complicated construction, but also will increase the size of the electromagnet as well as the timing device of the first-mentioned type.

No matter what it may be, what has been required in connection with the timing device heretofore generally available is an additional switching mechanism for cutting off the electric power supply to the motor or the electromagnet, and this additional switching mechanism has been either built in the timing device or arranged in an external load control circuit to be operated by the time-limit switching mechanism of the timing device for controlling said load control circuit. In the former case, it has been necessary to provide in the timing device not only the time-limit switching mechanism, but also said additional switching mechanism, and therefore increase of the size of said device has been inevitable, otherwise reduction of the size thereof accompanies the reduced switching capacity of both switching mechanisms. In the latter case, for the purpose of controlling the timing device by said additional switching mechanism provided in the external load control circuit, it has been necessary to connect the timing device with the external load control circuit, and thereby to complicate the constructions of the timing device and the external load control circuit.

One of the objects of the present invention is to provide a timing device wherein the above-mentioned additional

switching mechanism for cutting off the power supply to the motor or the electromagnet at the time-up moment is substantially eliminated.

In the timing device constructed in accordance with the present invention, there is provided a toothless notched portion along a part of the periphery of the driven gear to be engaged with the drive gear whereby at the time-up moment the drive gear is to be sunken into said notched portion running idle and thereby to prevent the motor from being subjected to an overload.

Specifically according to the present invention, the timing device comprises a drive means including the motor, the drive gear to be driven by said drive means, the driven gear having on its periphery the toothless notched portion into which the drive gear is detachably engaged, the electromagnet for causing the drive gear to engage with or to disengage from the driven gear through the clutch action, and the time limit switching mechanism for controlling the external load control circuit, said time-limit switching mechanism being operated at the time-up moment in association with the rotational movement of the driven gear rotated in engagement with the drive gear through the clutch action and thereafter said drive gear being imparted with a lost motion in the notched portion of the driven gear.

As hereinbefore described, the timing device of the present invention is constructed in such a simple manner as to provide the notched portion on the periphery of the driven gear to be engaged with the drive gear rotated by the motor, for the purpose of cutting off the power transmission from the drive gear to the driven gear. Therefore, not only the electromagnet to be built in the timing device can be reduced in size with and no excess load being imposed on the motor, but also the timing device of the present invention can be manufactured at low cost.

In other words, although the additional switching mechanism for the above-mentioned purpose in combination with the time-limit switching mechanism which is an essential component of the timing device heretofore generally available has been eliminated in the present invention, so long as the technological concept to provide a combination of two switching mechanism in any type of timing device is concerned, said two time-limit switching mechanisms may be adapted for controlling the corresponding number of an external load control circuit. Alternatively, one of the two switching mechanisms may be adapted for the same purpose only while the other may be adapted for maintaining the electromagnet in the self-energized condition throughout the lapse of the preset time. Such alternatives have been embodied in the timing device of the present invention.

Furthermore, according to a conventional timing device heretofore available, the detachable engagement of the drive gear driven by the motor and the driven gear capable of operating the time-limit switching mechanism is performed in association with the operation of the electromagnet through the connecting member such as an auxiliary lever interposed between the power transmission shaft and the moving iron member related with the electromagnet. In addition thereto, the operation of the switching mechanism is associated with the rotational movement of the driven gear. In this arrangement there have been found an unfavorable tendency that the connecting member should travel a relatively long distance and the switching mechanism should operate through many intermediaries interposed between the electromagnet and driven gear, which will result in delayed operation of the timing device beyond the expected time. Therefore, since all of the parts of such timing device are arranged in an unfavorable order, not only excessive spaces exist within the casing of the timing device, but also it is difficult to assemble the same.

Another object of the present invention is to provide the timing device of the type provided with the provision for preventing the motor from being subjected to an excessive load in such a manner as to impart a lost motion to the drive gear above the driven gear, wherein the actuator means for

operating the time-limit switching mechanism is directly connected to its supporter mounted on the moving-iron member above the electromagnet.

By achieving the above-mentioned purpose, the travel of the connecting member interposed between the electromagnet and the switching mechanism of the conventional timing device is reduced with improvement in the assemblage and performance of each component of the timing device of the present invention. In addition thereto, the size of the inventive electrical timing device is substantially reduced.

Still according to the conventional timing device comprising a central unit including the cam plate, the driven gear, and the spiral spring, all of these parts being axially aligned with the pointer spring, all of these parts being axially aligned with the pointer needle, an upper unit including the motor and the electromagnetic means capable of detachably engaging the drive gear to the driven gear, and a lower unit including the time-limit switching mechanism to be operated by engagement with the cam plate, all of these units being arranged in sequence in the vertical direction within the casing thereof, there has been found defects similar to the above-mentioned conventional timing device, especially excessive spaces which exist within the casing of the timing device.

Therefore, a further object of the present invention is to provide a timing device of the type provided with the means for preventing the motor from being subjected to an excessive load in such a manner as to impart a lost motion to the drive gear above the driven gear, the actuator means for operating the time-limit switching mechanism, said means being positioned above the moving iron member related with the electromagnet the cam plate and the driven gear being positioned about the free end of said actuator means, the drive means including the motor being positioned at one side of the electromagnet, said drive means drivingly connected with the vertically pivotable power transmission shaft to be shifted through the pivot movement of the iron member, and with the detachable engagement of the drive gear to the driven gear, said engagement being performed at the other side of the electromagnet, that is, about the free end of the actuator means.

By achieving the above-mentioned purpose, assemblage of the timing device of the above character is facilitated with reduction of the size thereof.

Furthermore, according to the conventional timing device, the calibrated scale or the like having calibrations thereon for visual representation of the preset time is generally rigidly fitted to the timing device assembly, and no replacement of the calibrated scale can be appreciated. Such inconvenience is considerable, for example, when the timing device is to be operated by the electric power of different frequency. In such device, in order to effect the replacement, the casing is to be removed away which is therefore a difficult operation for the ordinary operator. Therefore a still further object of the present invention is to provide a timing device of the type provided with the provision for preventing the motor from being subjected to an excessive load as hereinbefore mentioned, wherein only by removing the time set dial knob the calibrated scale can be easily removed or replaced for another calibrated scale or the like.

The present invention will be hereinafter fully described with reference to the attached drawings in which some embodiments of the present invention are illustrated only for the purpose of explanation thereof. In the drawings, wherein like reference numerals denote corresponding parts throughout the several views:

FIG. 1 is a front view of an electric timing device in one embodiment of the present invention,

FIG. 2 is a left-hand side view of said device with a corresponding side portion of a casing being broken away,

FIG. 3 is a side view of an essential portion of said device,

FIG. 4 is a plan view of said device with a top portion of the casing being broken away,

FIG. 5 is a right-hand side view of said device with a corresponding side portion of the casing being broken away,

FIG. 6 is a back view of said device,

FIG. 7 (A) and (B) are divided into two drawings each showing an isometric view of fragmental parts accommodated in the casing of said device,

FIG. 8 is an isometric view of fragmental parts as shown in FIG. 7, shown in the assembled state with the casing removed,

FIG. 9 is a schematic diagram of a timing mechanism within the casing incorporated with a geared clutch system in said timing mechanism in accordance with a modified embodiment of the present invention, and

FIG. 10 is a schematic diagram of a timing mechanism within the casing incorporated with a friction clutch system in said timing mechanism in accordance with another modified embodiment of the present invention.

Referring first to FIG. 1 through FIG. 8, an electric timing device as shown therein generally comprises a casing 10, a driving unit including a motor 20, an electromagnetic unit including an electromagnet 30, a clutch unit including a driven gear 40, a switch unit including a time-limit switch 50, a time setting unit including a time set dial knob 60, and a socket unit 70, the arrangement of which is such that the time setting unit is disposed about one end of the casing 10, behind which and in the interior of said casing is disposed in sequence the clutch unit, the electromagnetic unit and the driving unit, and the switch unit being positioned above the electromagnetic unit.

The operational relationship among all of these parts is such that the time-setting unit is capable of setting the clutch unit in the initial position which is then connected with the driving unit by means of the electromagnetic unit upon application of an electric input to said electromagnetic unit and thereby to operate the switch unit in connection with the clutch unit. Each component part of these units is as follows in detail.

Referring still to FIG. 1 through FIG. 8, reference numeral 10 is a hollow casing of square cross section, and 11 is a baseplate of square shape. The baseplate 11 is integrally provided at its exterior side with a plurality of pins 11a for outside connection to a suitable electric circuit to be operated by the electric timing device of the present invention and rigidly fitted at its interior side to one end of said casing 10 by means of screws 10a.

Reference numeral 12 is a baseplate of the same square shape rigidly fitted at its interior side to the opposite end of said casing 10 by means of screws 10b. This baseplate 12 is provided at its center with a through hole 12b through which a spindle 46a having at its end provided with a pointer needle 46 as will be later mentioned is rotatably inserted and also provided at its exterior side with an annular flange 12a to which a time set dial knob 60 is fitted.

In this arrangement, the pins 11a and the annular flange 12a are exposed outside from the respective exterior sides of the baseplates 11 and 12 which define the interior of the casing 10.

Reference numeral 20 is a motor rigidly secured to the interior side plane of the baseplate 11, and 23 is a gearbox defined by a pair of partition plates 21 and 22 and provided therein with reduction gears 23a-23d and a driving gear 24, which is in turn connected to a driving shaft of the motor 20.

Reference numeral 30 is an electromagnet mounted on a bottom plate 32a of a L-shaped frame 32, a vertical plate 32b of said L-shaped frame 32 being fitted to the partition plate 22. Said L-shaped frame 32 is supported within the casing 10 in such a manner that a free end of said bottom plate 32a is rigidly connected to a lower portion of the interior side of the baseplate 12.

Reference numeral 31 is a movable iron member provided with a pair of lugs 31a extending from both side of the pivoted corner of said movable iron member 31. This iron member 31 is pivotally supported by the vertical plate 32b of the L-shaped frame 32 with root portions of said lugs 31a being respectively mounted on a top edge 32c of the vertical plate 32b so as to render the iron member 31 to position just above the electromagnet 30. The pair of lugs 31a extending from the corners of the iron member 31 are loosely inserted through corresponding notches 22a formed at the opposite side edges of the partition plate 22 so as to project beyond said partition

plate 22. In this arrangement, each return spring 33, in other words second spring, is interposed between each of the lugs 31a beyond the partition plate 22 and each of lugs 32e extending from the counter edge 32d of the L-shaped frame 32 through the notched lower corners 32c of the partition plate 22, the arrangement of one of said return springs 33 relative to the lugs being particularly shown in FIG. 8. As can be seen from FIG. 8, the return springs 33 are positioned within the gearbox 23 and adjacent to the partition plate 22.

The spindle 46a is provided at one end with the pointer needle 46 and inserted through a hole 12d disposed about the center of the baseplate 12, the other end of said spindle 46a being journaled by a bearing plate 47 having a pair of legs 47a secured to the interior side of the baseplate 12. Between the bearing plate 47 and the interior side of the baseplate 12, the spindle 46a is rigidly provided with a spiral spring 45 for rotating the spindle 46a reversely, a driven gear 40 and a cam plate 44 in sequence from the interior side of the baseplate 12, so that these parts can be rotated together with the pointer needle 46 by the spindle 46a. The spiral spring 45 is secured at its terminating end to the spindle 46a and at its leading end to the bottom plate 32a of the frame 32 so as to cause the spindle 46a to rotate in the clockwise direction. The driven gear 40 and the cam plate 44 are respectively provided with notches 40a and 44a on their peripheries at a predetermined position. However, the notch 40a on the driven gear 40 may be in the form of a toothless recess. The spiral spring 45, the driven gear 40 and the cam plate 44 are all positioned above the bottom plate 32a of the frame 32 and between the electromagnet 30 and the interior side of the baseplate 12. In other words, from the baseplate 12 to the baseplate 11 and within the casing 10, the spiral spring 45 is followed by the driven gear 40 followed by the cam plate 44 followed by the electromagnet 30 followed by the gearbox 23 followed by the motor 20.

Reference numerals 54 and 55 are a pair of electric terminal members secured to the interior side of the baseplate 12 and provided with respective stationary contacts 54a and 55a disposed on one end of each of flexible contact elements 54b and 55b extended from the respective terminal members 54 and 55.

Reference numerals 53 and 50 are an instantly switching contact and a time-limit switching contact, both of these contacts 53 and 50 being disposed on one end of each of flexible contact members 53a and 50a so that said stationary contact 55a is capable of being contacted with the instantly switching contact 53 and said stationary contact 54a is capable of being contacted with the time-limit switching contact 50. The flexible contact member 53a for the instantly switching contact 53 is secured at its other end to a fixed supporter 52 rigidly mounted on the moving area of the iron member 31 while the flexible contact member 50a for the time-limit switching contact 50 is secured at its other end to a movable supporter 51. This movable supporter 51 is in turn pivotally mounted on the fixed supporter 52 by means of a pin 57.

In other words, the fixed supporter 52 is provided about its intermediate portion with a recessed portion 52a, at one end portion with the flexible contact member 53a and at the other end portion with the movable supporter 51 pivotally fitted thereto by means of the pin 57, and rigidly mounted on an upper portion of the moving area of the iron member 31 so that the flexible contact member 53a secured to the fixed supporter 52 and the flexible contact element 50a secured to the movable supporter 51 may be forwardly projected toward the baseplate 12 in the parallel relation to the moving area of the iron member 31.

The movable supporter 51 is also provided with a stem portion 51a to which the flexible contact member 50a is secured and an elongated portion 51b of which the pointed end is formed with an engagement edge 51c to be engaged on and disengaged from the peripheral surface of the cam plate 44. This movable supporter 51 is so mounted on an upper portion of the fixed supporter 52 by means of the pin 57 as previously described that the movable supporter 51 is movable in the

same direction in connection with the pivot movement of the iron member 31.

Reference numeral 51d is a transverse stopper rod fixed to the bottom plane of the elongated portion 51b of the movable supporter 51 at right angles relative to the lengthwise direction of said elongated portion, said stopper rod being capable of contacting with the moving area of the iron member 31. Between the stem portion 51a of the movable supporter 51 and the partition plate 22, a third spring 56 is so interposed that its resilient force will cause the engagement edge 51c on the movable supporter 51 to contact with the peripheral surface of the cam plate 44 whereby the movable supporter 51 will serve as an actuator for the time-limit switching contact 50.

Since the both contact members 53a and 50a are positioned above the movable iron member 31 to be attracted by the electromagnet 30 and the moving area of the iron member 31 can be pivoted upwardly under the influence of the resilient forces of the return springs 33 with a gap left between the iron member 31 and the electromagnet 30 when the latter is not energized, the contacts 53 and 50 can respectively be separated from the stationary contacts 55a and 54a opening the respective electric circuits.

On the other hand, when the electromagnet 30 is energized, the iron member 31 is attracted by said electromagnet 30 against the composite resilient force of the return springs 33 with its moving area being downwardly moved. At this time, as the moving area of the iron member 31 is downwardly moved, the fixed supporter 52 is also swung with the movable contact 53 being engaged with the stationary contact 55a closing the electric circuit while the movable supporter 51 commences to swing around the pin 57 under the influence of the resilient force of the spring 56 resulting in the engagement edge 51c being engaged on the peripheral surface of the cam plate 44. The movable contact 50 will be engaged to the stationary contact 54a so as to close its electric circuit when the engagement portion 51c extended from the movable supporter 51 is sunken into the notch 44a provided on the cam plate 44 upon rotation of said cam plate 44 under the influence of the resilient force of the spring 56.

Reference numeral 41 is a drive shaft, in other words a power transmitting shaft, for transmitting the rotational force from the motor 20 to the driven gear 44 through the reduction gears 23a-23d, the driving gear 24 accommodated in the gearbox 23. This drive shaft 41 is extended above the iron member 31 through the recessed portion 52a on the fixed supporter 52 and a notched portion 22b provided on the upper edge of the partition plate 22 and in the parallel relation to the contact members 53a and 50a positioned along both sides of said shaft 41, while one end of said shaft 41 is rotatably and pivotally journaled at a bearing hole 21a on the partition plate 21 and the other end thereof is vertically slidably journaled at a groove 12c disposed on the interior side of the baseplate 12 so that the other end thereof may be shifted to position at any angle in the vertical direction. Nonrotatably mounted on said drive shaft 41 is a driving gear 24 adjacent to the end thereof journaled at the bearing hole 21a and positioned within the gearbox 23 and a drive gear 42 adjacent to the end thereof slidably journaled at the groove 12c and engageable with the driven gear 40.

Said drive shaft 41 is also provided at its intermediate portion with an integrally secured stopper 41a to which a free end of a piano wire 43, in other words a first spring, is secured while its other end is secured to the partition plate 22 by means of a fastener 43a. By the repellent force of the piano wire 43, a lower portion of said stopper 41a is always maintained in contact with the moving area of the iron member 31. Since the stopper 41a is in contact with the iron member by the repellent force of the piano wire 43 through its lower portion as hereinbefore described, said drive shaft 41 which is capable of being pivoted around the bearing hole 21a serving as a fulcrum can be vertically moved in dependence on the pivot movement of the iron member 31.

However, in the present instance, the driving gear 24 mounted on the drive shaft 41 at a position adjacent to the fulcrum is always engaged with one of the reduction gears 23d regardless of the vertical movement of said drive shaft 41 in dependence on the iron member 31. On the other hand, the drive gear 42 mounted on the drive shaft 41 at a position remote from the fulcrum is operable in such a manner that, when the electromagnet 30 is not energized and subsequently the iron member 31 is upwardly pivoted by the return springs 33 with a gap left between its moving area and the electromagnet 30, said drive gear 42 will be disengaged from the driven gear 40 and engaged with said driven gear 40 when the electromagnet 30 is energized and subsequently the iron member 31 is thereby attracted accompanying the downward movement of the stopper 41a together with the drive shaft 41.

In the condition that the electromagnet 30 is energized and the drive gear 42 is thus in engagement with the driven gear 40, the rotational power is transmitted from the motor 20 to the driven gear 40 through the reduction gears 23a-23d, the driving gear 24 and the drive gear 42 to rotate the spindle 46a in the counterclockwise direction against the resilient force of the spiral spring 45. When the drive gear 42 is sunken into the notch 40a on the driven gear 40 by the repellent force of the piano wire 43 while the spindle 46a, i.e., the driven gear 40 is rotated, the drive gear 42 is disengaged from the driven gear 40 and a lost motion is at the same time imparted to said drive gear 42 in said notch 40a, with the result that no rotational power from the motor 20 is transmitted to said spindle 46a while the drive gear 42 runs idle within the notch 40a, the dimensions of said notch 40a being so defined that the drive gear 42 can be accommodated therein.

Referring particularly to FIG. 7 (A), provided on the exterior side of the baseplate 12 and in its area defined within the annular flange 12a having a threaded portion 12e on its outer peripheral surface is a screw-type stopper pin 63 for restricting the revolving movement of the pointer needle 46 at a predetermined position and fitting pins 12d engageable with corresponding holes 61c disposed on a calibrated scale 61.

The calibrated scale 61 is in the form of a thin disc having a central bore 61b and a split portion 61a and can be inserted within the annular flange 12a along its inner peripheral surface. The size of the central bore 61b is sufficient to permit the spindle 46a and the stopper pin 63 clear from the inner periphery of said splitted portion 61a. The calibrated scale 61 is also provided on its surface with calibrations 61d along the path of travel of the pointed end of the pointer needle 46.

In this arrangement, positioning of the calibrated scale 61 within an area defined by the inner peripheral surface of the annular flange 12a and the exterior side of the baseplate 12 can be determined by the engagement of the fitting pins 12d to the corresponding holes 61c of said calibrated scale 61 and, before and after said positioning of the calibrated scale 61, not only the stopper pin 63 can be inserted in its fitting hole, but also the spindle 46a can be inserted in a central hole 12b on the baseplate 12.

Reference numeral 60 is the time-set dial knob integrally formed with a cylindrical portion 60c, the outer diameter of said cylindrical portion 60c being slightly smaller than the inner diameter of the annular flange 12a so that the dial knob 60 is rotatably carried by said annular flange 12a through a spring washer 62 interposed therebetween while a fitting ring 64 is threaded to the threaded portion 12e on the outer peripheral surface of the annular flange 12a. In this instance, the dial knob 60 is provided with an annular collar 60d between its knob portion 60e and cylindrical portion 60c so that, when the fitting ring 64 is fastened to the annular flange 12a, said collar 60d may be engaged to and restricted by a rim portion 64a of the fitting ring 64.

The dial knob 60 is also provided with a transparent window glass 60b at its end remote from the baseplate 12 and a setting projection 60a on the inner peripheral surface of said dial knob 60. This projection 60a will be engaged with the pointed end of the pointer needle 46 by the rotation of the spiral spring

45 connected with the spindle 46a as the operator turns the dial knob 60 in the clockwise direction in such a manner that the pointed end of the pointer needle 46 follows after the projection 60a under the resilient force of said spiral spring 45.

On the other hand, when the operator intends to turn the dial knob 60 in the counterclockwise direction, upon revolution of the dial knob 60 the pointer needle 46 can be revolved in the same direction in contact with the projection 60a against the resilient force of the spiral spring 45 and thereby brought to the desired time calibrations on the calibrated scale 61.

By turning the dial knob 60 in the clockwise or counterclockwise direction as hereinbefore described, the time setting can be appreciated in the timing device of the present invention. In addition thereto, while the pointer needle 46 is revolved in the counterclockwise direction to the stopper pin 63 in accordance with the rotation of the spindle 46a during the engagement of the drive and driven gears, the dial knob 60 remains at the preset time position with its projection 60a stayed at a position corresponding to the specified time calibrations 61d until each cycle of operation of the timing device completes.

In the case where the calibrated scale 61 is desired to be replaced, the replacement thereof can be carried out by undoing the annular ring 64 and subsequently the dial knob 60 from the annular flange 12a.

Reference numeral 70 is a multipin socket to be connected disengageably to the multipin plug 11a provided outside of the baseplate 11 for outside connections of the motor 20, electromagnet 30 and switches 50, 53 to the suitable electric circuit.

The arrangement and construction of the parts of the timing device of the present invention is illustrated in FIG. 8 with its casing 10 removed away. This timing device can be connected with an electric circuit to be operated thereby, in such a manner as to insert the multipin plug 11a on the exterior side of the baseplate 11 to a corresponding multipin socket 70 included in the electric circuit to be operated by said timing device.

The operation of the timing device of the present invention will be hereinafter described.

Prior to the operation of the timing device of the present invention, an electric current must be supplied to the motor 20 to drive the reduction gears 23a-23d and subsequently to drive the driving gear 24 and the driving gear 42 through the drive shaft 41. This condition must be maintained throughout each cycle of operation of the timing device of the present invention.

Unless the electromagnet 30 is energized, the return springs 33 act to upwardly position the moving area of the iron member 31 and subsequently to upwardly position the drive shaft 42 through the stopper 41a against the repellent force of the piano wire 43 whereby an instantly switching contact and a time-limit switching contact are disengaged from the stationary contacts 54a and 55a respectively and the drive gear 42 is separated from the engagement to the driven gear 40.

At this time, the operator can turn the dial knob 60 so as to bring the pointer needle 46 to the desired time calibrations 61d on the calibrated scale 61. At the same time, accompanied by the revolution of the dial knob 60, i.e., the revolution of the spindle 46a through the pointer needle 46 associated with the projection 60a on the inner peripheral surface of the dial knob 60, positioning of the driven gear 40 and the cam plate 44 is automatically determined relative to the drive gear 42 and the engagement edge 51c of the movable supporter 51 respectively.

While the arrangement of the parts is in such a condition as hereinbefore described, upon application of an electric input to the electromagnet 30 in such a manner, for example, as to operate an external switch interposed between the electromagnet 30 and the power source, the iron member 31 is downwardly attracted by said electromagnet 30 accompanying the downward movement of the drive shaft 41 by the

repellent force of the piano wire 43 whereby the drive gear 42 is engaged to the driven gear 40 and thus the latter is rotated in the counterclockwise direction. At the same time as the driven gear 40 is rotated, the spindle 46a is also rotated in the same direction in which the spiral spring 45 accumulates its resilient force.

On the other hand, as soon as the downward movement of the iron member 31 together with the fixed supporter 52 secured thereon has been completed the instantly switching contact 53 is engaged to the stationary contact 55a and thereby to make the circuit such as to establish the self-energized condition of the electromagnet 30 until said contacts 53 and 55a are disengaged from each other.

At the same time, the movable supporter 51 is also downwardly moved by the action of the spring 56 in connection with the fixed supporter 52 to render the engagement edge 51c extended from said movable supporter 51 to contact on the peripheral surface of the cam plate 44. So long as the engagement edge 51c is in contact with the peripheral surface of the cam plate 44 without sinking into the toothless notch 44a disposed on said cam plate, the time limit switching contact 50 extended from the movable supporter 51 in parallel relation to the elongated portion 51b having said engagement edge 51c is still in the disengagement to the stationary contact 54a.

After the lapse of the desired time set on the calibrated scale, upon rotation of the driven gear 40 together with the cam plate 44 the notch 44a on the cam plate 44 is brought to a position right below the engagement edge 51c. At the same time, the engagement edge 51c falls into the notch 44a in accordance with the downward movement of the movable supporter by the action of the spring 56 resulting in that the time-limit switching contact 50 is engaged to the stationary contact 54a, whereby the electric circuit to be operated by the timing device of the present invention can be controlled either in the active condition or the dead condition.

Shortly after the engagement of the contact 50 to the contact 54a, the notch 40a on the driven gear 40 driven by the drive gear 40 is brought to a position right below the drive gear 42 and the latter thus falls into the notch 51c by the repellent force of the piano wire 43. Then, a lost motion is imparted to said drive gear 42 in the notch 51c whereby not only the motor 20 is prevented from being subjected to an over load, but also the spindle 46a mounted with the driven gear 40 ceases to rotate with the pointer needle 46 being positioned around the stopper pin 63.

On the other hand, when the self-energized condition of the electromagnet 30 is released by operating the external switch, the iron member 31 is upwardly moved under the influence of the resilient force of the return springs 33 as the attracted relation of said iron member 31 to the electromagnet 30 diminishes, accompanying the upward movement of the drive shaft 41 through the stopper 41a against the repellent force of the piano wire 43 whereby the drive gear 42 escapes from the notch 40a on the driven gear 40 without any contact with the peripheral surface of the driven gear 40 to return to the initial condition. At the same time, the both fixed and movable supporters 52 and 51 are also upwardly moved together with the iron member 31 thereby to permit the engagement edge 51c to escape from the notch 44a on the cam plate 44, resulting in the instantly switching contact 53 and the time-limit switching contact 50 being respectively disengaged from the stationary contacts 55a and 54a. At this time, as soon as the drive gear 42 is clear away from the driven gear 40, the pointer needle 46 accordingly returned to the initial position by means of the resilient force of the spiral spring 45, until it abuts against the projection 60a on the inner peripheral surface of the dial knob 60.

In such a manner as hereinbefore described, one cycle of operation of the timing device of the present invention has been completed.

In the foregoing description, the timing device provided with the instantly switching mechanism and the time-limit

switching mechanism therein has been fully described in conjunction with one embodiment thereof with reference to the attached drawings, particularly FIG. 1 through FIG. 8, it should be noted that various modifications of the timing device of the present invention can be contemplated by those skilled in the art without departing from the true spirit and scope of the present invention. For example, instead of a combination of the instantly switching mechanism and the time-limit switching mechanism, a plurality of time-limit switching mechanisms may be provided with a slight modification on the timing device of the above-mentioned type. In addition, although the cam plate has been provided in the timing device of the above-mentioned type, it may be integrally formed with the driven gear without any reduction in the reliability and the performance of the timing device of the present invention.

In the following description with reference to the drawing shown in FIG. 9, the second embodiment of the timing device in accordance with the present invention will be fully disclosed.

Referring now to FIG. 9, reference numeral 101 is a motor and 102 is a rotator of said motor of which the driving shaft is connected with a pinion 103. Reference numeral 105 is a drive shaft nonrotatably provided about one end thereof with a driving gear 106 in constant mesh with said pinion 103 and about the other end thereof with a drive gear 104. The pointed end of said drive shaft 105 adjacent to the driving gear 106 is pivoted to a bearing 123 disposed on a casing (not shown) so that said drive shaft 105 can be vertically shifted around the engaged point of the pinion 103 and the driving gear 106 as its fulcrum.

Said drive shaft 105 is elastically supported by a plate spring 107 and an operating lever 110 connected from a movable iron plate 109 disposed right above an electromagnet 108. While the engagement of the pinion 103 and the driving gear 106 is always maintained throughout each cycle of operation of the timing device, only the drive gear 104 can be engaged to and disengaged from a driven gear 112 in accordance with the shifting of the drive shaft 105 by the means of the operating lever 110 the electromagnet 108 and the plate spring 107.

Reference numeral 111 is a return spring disposed at one side of the electromagnet 108 and between a rear end of the movable iron plate 109 and a bottom plate of the electromagnet 108 in the same or substantially similar manner as disclosed in the first embodiment of the present invention. This return spring 111 acts to upwardly move a front end of the movable iron plate 109 connected with the operating lever 110 which in turn upwardly pushes the drive shaft 105 against the repellent force of the plate spring 107 upon deenergization of the electromagnet, and thereby to disengage the drive gear 104 from the driven gear 112. This condition of the parts of the timing device is illustrated in FIG. 9.

Reference numeral 115 is a spindle nonrotatably provided with a movable needle 113 and the driven gear 112 with a notched portion 117 on its periphery, the size of said notched portion 117 being sufficient to impart a lost motion to the drive gear 104 when the latter is sunken into said notched portion.

Reference numeral 114 is a time setting needle provided with a time setting dial knob 125 for operating the spindle 115, and 116 is a spiral spring for reversely rotating the spindle 115 in the direction of the arrow (B) under the resilient force thereof when said spindle 115 is rotated in the direction of the arrow (A) against the resilient force thereof.

Reference numeral 118 is a circuit switching means, preferably a microswitch having an actuator lever 119 to be operated by a pin 120 disposed on the driven gear 112 at a position opposite to the notched portion 117 across the center through which the spindle 115 is passed.

Reference numeral 121 is a stopper for restricting the downward movement of the drive shaft 105 when the engagement of the drive gear 104 and the driven gear 112 takes place, and 122 is a calibrated scale fixed at a position in relation with the movable needle 113 and time setting needle 114.

The operation of the timing device according to the second embodiment of the present invention is as follows. Prior to the operation thereof, an electric current must be supplied to the motor 101 from the power source to drive the pinion 103, the rotational power of said pinion 103 being then transmitted to the drive gear 104 through the driving gear 106 by means of the drive shaft 105. This condition must be maintained throughout each cycle of the operation.

After the operator turns the dial knob 125 so as to bring the time setting needle 114 to the desired time calibrations on the calibrated scale 122 together with the movable needle 113 and thereby to determine the positioning of the driven gear 112 relative to the drive gear 104, and subsequently an electromotive force is applied to the electromagnet 108, the movable iron plate 109 is downwardly attracted by said electromagnet 108 against the return spring 111 accompanying the downward movement of the operating lever 110. At this time, since the upwardly pushing force of said operating lever 110 is released, the drive gear 104 is downwardly moved through the drive shaft 105 downwardly pressed by the plate spring 107, resulting in that the drive gear 104 is engaged on the periphery of the driven gear 112 to rotate the latter in the direction of the arrow (A).

As soon as the driven gear 112 rotates, the pin 120 abuts against the actuator lever 119 thereby to operate the circuit switching means 118. When the notched portion 117 is brought to a position right below the drive gear 104, i.e., after the lapse of the desired time preset on the calibrated scale, the drive gear 104 commences to sink into the notched portion 117 and subsequently runs idle therein. At this time, the driven gear 112 ceases to rotate.

On the other hand, when the operator operates the circuit switching means 118 so as to break the circuit between the electromagnet 108 and the power source, the movable iron plate 109 is upwardly moved under the resilient force of the return spring 111 to cause the operating lever 110 to upwardly push the drive shaft 105 against the repellent force of the plate spring 107. Subsequently, the drive gear 104 escapes from the notched portion 117 without engaging to the driven gear 112 and the spindle 115 is also rotated in the direction of the arrow (B) by means of the resilient force of the spiral spring 116 with the movable needle 113 being returned to the original position indicated by the time setting needle 114.

In such a manner as hereinbefore described, one cycle of operation of the timing device in the second embodiment of the present invention has been completed.

A further modification of the timing device of the present invention will be disclosed in the following description.

However, it should be noted that the like parts bearing the like numerals in the drawing of the third embodiment as shown in FIG. 10 are substantially the same as disclosed in connection with the second embodiment as shown in FIG. 9 and the description of the details of said parts is, therefore, omitted for the purpose of simplification of the present specification.

Referring to FIG. 10, the drive shaft 105 is rotatably supported at both ends by bearings 123 and 124 and provided at its intermediate portion with a friction clutch 130 having an electromagnet 133 in which a spindle 131 is secured on the drive shaft 105 in one side of the bearing 123 and another spindle 132 is slidably mounted thereon in the other side of the bearing 124. The spindle 132 is rigidly secured with a drive gear 104 in constant mesh with the driven gear 112 and remains unrotated unless the spindle 132 is engaged with the spindle 131.

The operation of the timing device according to the third embodiment of the present invention is as follows: While the arrangement of the parts of the timing device is in the condition as shown in FIG. 10, and when an electric current is supplied to the motor 101 to drive the latter, the drive shaft 105 is rotated in the same or substantially similar manner as disclosed in connection with the second embodiment. At this time, although the rigidly secured spindle 131 on said shaft

105 is also rotated, the spindle 132 remains unrotated unless the both spindles are engaged with each other. Therefore, the driven gear 112 also remains unrotated.

Upon application of an electromotive force to the electromagnet 133 included in the friction clutch 130 from the power source through an external switch operated, the spindle 132 is attracted to move toward the spindle 131 along the drive shaft 105 and finally engaged with said spindle 131, resulting in the rotation of the spindle 132. At the same time as the spindle 132 is rotated in driving connection with the spindle 131, the driven gear 112 is also rotated in the direction of the arrow (A) until it sinks into the notched portion 117. However, as soon as a lost motion is imparted to the driven gear 104 which has dropped into the notched portion 117, the actuator lever 119 of the circuit switching means 118 is kicked by the pin 120 to break the power supply to the electromagnet 133, resulting in that the engagement of the both spindles 131 and 132 is released by means of the resilient force of a spring 134 included in the friction clutch 130. Thus, no further rotational power is transmitted from the motor to the driven gear 112 so that the driven gear 112 is only rotated in the reverse direction under the resilient force of the spiral spring 116 accompanying the idle rotation of the drive gear 104 on the drive shaft 105.

The present invention has been heretofore fully disclosed with reference to the attached drawings in conjunction with the preferred embodiments thereof. As fully disclosed, the timing device of the present invention is provided with the simplified construction, for example, the notched portion of the driven gear to be engaged with the drive gear, and therefore, not only it can be manufactured at low cost with a provision of the reduced size of the electromagnet, but also with the notched portion the motor is prevented from being subjected to an over load. The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A timing device, comprising driving means including a motor, a drive gear being driven by said driving means, a driven gear having a toothless portion, electromagnetic means for engaging or disengaging said drive gear to said driven gear in response to respective first and second states of operation thereof, and a pair of time-limit switching contacts being operated at the moment of a certain time lapse in response to preselected rotation of said driven gear, said drive gear being run idle in said toothless portion of the driven gear immediately after the time lapse.
2. (Amended) A timing device, comprising driving means including a motor, a drive gear being driven by said driving means, a driven gear having a toothless portion, electromagnetic means for engaging or disengaging said drive gear to said driven gear in response to actuation or nonactuation thereof, respectively, an actuator being operated in accordance with the rotation of said driven gear, and a pair of time-limit switching contacts capable of controlling an output device and being operated at the moment of a certain time lapse in response to preselected rotation of said driven gear, said drive gear being run idle in said toothless portion of the driven gear immediately after the time lapse.
3. A timing device according to claim 1, wherein said toothless portion of the driven gear includes a recess into which the drive gear may be sunken.
4. A timing device according to claim 1, wherein said switching contacts include a plurality of a pair of time-limit switching contacts.
5. A timing device, comprising driving means including a motor, a drive gear being driven by said driving means, a driven gear having a toothless portion,

electromagnetic means for engaging or disengaging said drive gear to said driven gear in response to the operating condition thereof,

a pair of time-limit switching contacts being operated at the moment of a certain time lapse in response to preselected rotation of said driven gear, and

a pair of instantly switching contacts capable of controlling an output device and being operated at the moment of engaging of said drive and driven gears,

said drive gear being run idle in said toothless portion of the driven gear immediately after the time lapse.

6. (Amended) A timing device, comprising driving means including a motor, a drive shaft being driven by said driving means, a drive gear provided on the shiftable end of said shaft, a driven gear having a toothless portion, electromagnetic means for shifting said shaft to engage or disengage said drive gear with said driven gear in response to the operating condition thereof,

a first spring for shifting said shaft to engage said drive gear with said driven gear by means of its resilient force, and

a pair of time-limiting switching contacts being operated at the moment of a certain time lapse in accordance with the rotation of said driven gear,

said drive gear being run idle in said toothless portion of the driven gear immediately after the time lapse.

7. A timing device according to claim 6, wherein said electromagnetic means is provided with a movable member operatively associated with the shiftable end of said shaft, and a second spring for shifting said movable member and shaft to disengage said drive gear from said driven gear against the resilient force of said first spring.

8. A timing device, comprising driving means including a motor, a drive gear being driven by said driving means, a driven gear having a toothless portion, electromagnetic means for engaging or disengaging said drive gear to said driven gear in response to the operating condition thereof,

a cam plate being driven with the rotation of said driven gear,

an actuator for switching being operated with the rotation of said cam plate, and

a pair of time-limit switching contacts capable of operating an output device and being operated at the moment of a certain time lapse in accordance with the rotation of said driven gear,

said drive gear being run idle in said toothless portion of the driven gear immediately after the time lapse.

9. A timing device according to claim 8, wherein said driving means is positioned at one side of said electromagnetic means and said cam plate is positioned at other side of said electromagnetic means, while said time-limit switching contacts are above said electromagnetic means.

10. A timing device, comprising driving means including a motor, a drive gear being driven by said driving means, a driven gear having a toothless portion, electromagnetic means having a moving-iron member for engaging or disengaging said drive gear to said driven gear,

a cam plate being driven with the rotation of said driven gear,

an actuator for switching being operated with the rotation of said cam plate,

a pair of time-limit switching contacts capable of operating an output device and being operated at the moment of a certain time lapse in accordance with the rotation of said driven gear, and

a pair of instantly switching contacts being operated at the moment of engaging of said drive and driven gears for sustaining the operation of said electromagnetic means, said drive gear being run idle in said toothless portion of the driven gear immediately after the time lapse.

11. A timing device according to claim 10, wherein said actuator is mounted on a movable supporter interlocking with said moving-iron member.

12. A timing device according to claim 10, wherein the moving contact of said instantly switching contacts is operatively associated with a fixed supporter mounted on said moving-iron member.

13. A timing device according to claim 12, wherein the moving contact of said instantly switching contacts is provided on one end of the fixed supporter mounted on said moving-iron member, and said movable supporter fixed with the actuator to be engaged with the cam plate by the resilient force of a third spring is provided on other end of the fixed supporter, while the drive shaft of said drive gear passes through a recess provided at the intermediate portion of the fixed supporter.

14. A timing device according to claim 12, wherein said driving means is positioned at one side of said electromagnetic means and said cam plate is positioned at other side of said electromagnetic means while said time-limit switching and instantly switching contacts are positioned above said electromagnetic means.

15. A timing device, comprising a driving means including a motor, a drive shaft being driven by said driving means, a drive gear provided on the shiftable end of said drive shaft, a driven gear having a toothless portion, a first spring for shifting said drive shaft to engage said drive gear with said driven gear,

electromagnetic means having a moving-iron plate operatively associated with the shiftable end of said shaft for shifting said drive shaft to disengage said drive gear from said driven gear and a second spring for shifting said moving-iron member and shaft to disengage said drive gear from said driven gear against the resilient force of said first spring,

a cam plate being driven with rotation of said driven gear, an actuator being operated with the rotation of said cam plate,

a pair of instantly switching contacts being operated by a fixed supporter mounted on said moving-iron member at the moment of engagement of the drive and driven gears, and

a pair of time-limit switching contacts being operated at the moment of a certain time lapse in accordance with the rotation of said driven gear,

said drive gear being run idle in said toothless portion of the driven gear immediately after the time lapse, the moving contact of said instantly switching contacts being provided on one end of the fixed supporter mounted on said moving-iron member and said movable supporter fixed with the actuator to be engaged with the cam plate by the resilient force of a third spring being provided on the other end of the fixed supporter while the drive shaft of said drive gear being passed through a recess provided at the intermediate portion of the fixed supporter.

16. A timing device according to claim 15, wherein said driving means includes reduction gears positioned at one side of said electromagnetic means and said second spring is positioned at the side of said reduction gears.

17. A timing device, comprising driving means having reduction gears driven by a motor, a drive shaft being driven by said driving means, a drive gear provided on the shiftable end of said drive shaft, a driven gear having a toothless portion, a driven shaft having said driven gear, a cam plate, a spiral spring and a pointer needle,

a calibrated scale associated with said pointer needle, a first spring for shifting said drive shaft to engage said drive gear with said driven gear,

electromagnetic means having a moving-iron plate operatively associated with the shiftable end of said drive shaft for shifting said drive shaft to disengage said drive gear from said driven gear and a second spring for shifting said

15

moving-iron member and shaft to disengage said drive gear from said driven gear against the resilient force of said first spring,
a cam plate being driven with rotation of said driven gear,
an actuator being operated with the rotation of said cam plate,
a pair of instantly switching contacts being operated by a fixed supporter mounted on said moving-iron member at the moment of engagement of the drive and driven gears, and
a pair of time-limit switching contacts being operated at the moment of a certain time lapse in accordance with the rotation of said driven gear,

16

said reduction gears being positioned at one side of said electromagnetic means together with said second spring, said cam plate and driven gear being positioned at the other side of said electromagnetic means, said drive gear being run idle in said toothless portion of the driven gear immediately after the time lapse.

18. A timing device according to claim 17, wherein said pointer needle is rotated with a time-set dial knob having a setting projection in contact with said pointer.

19. A timing device according to claim 18, wherein said calibrated scale is removable by removing said dial knob.

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