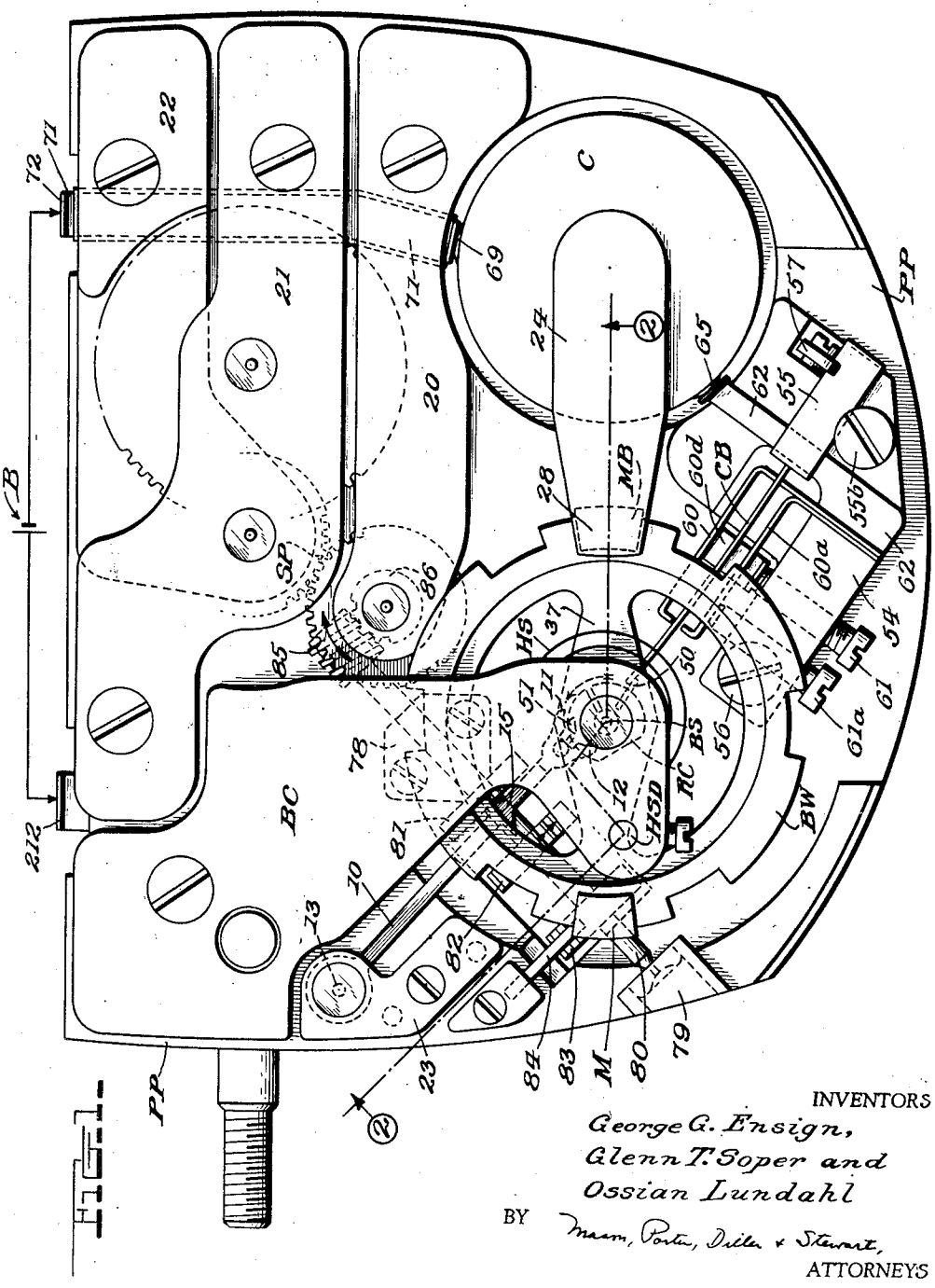
July 30, 1957 G. G. ENSIGN ET AL 2,800,763

POWER TAKE-OFF DEVICE WITH STAGGERED RATCHETS

Filed Aug. 4, 1953 3 Sheets-Sheet 1



INVENTORS
George G. Ensign,
Glenn T. Soper and
Ossian Lundahl
BY Mann, Porter, Dilla & Stewart,
ATTORNEYS

July 30, 1957 G. G. ENSIGN ET AL 2,800,763

POWER TAKE-OFF DEVICE WITH STAGGERED RATCHETS

Filed Aug. 4, 1953 3 Sheets-Sheet 2

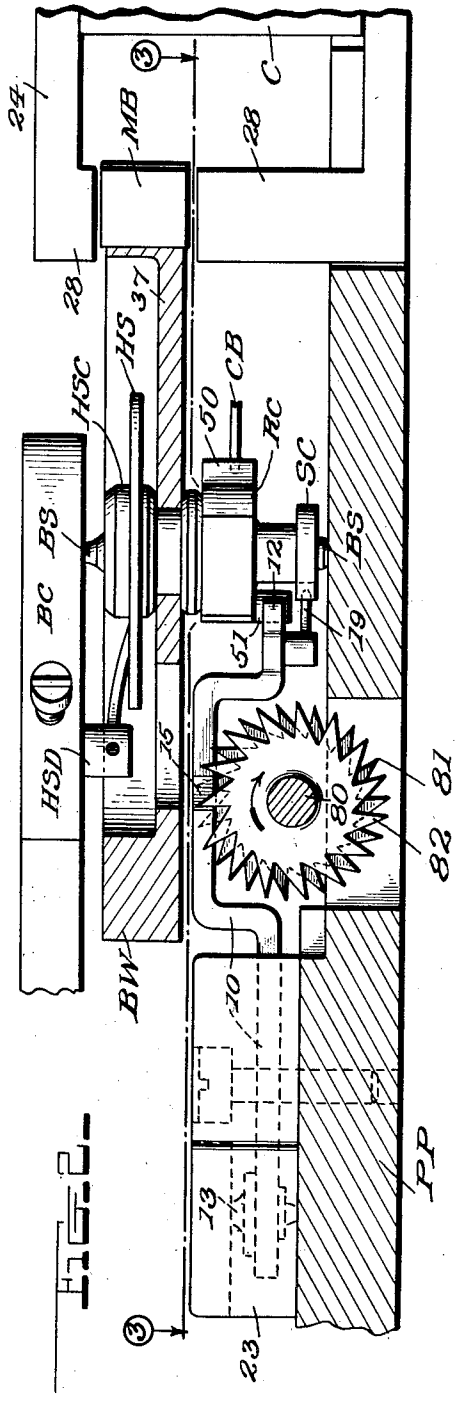


FIG. 2

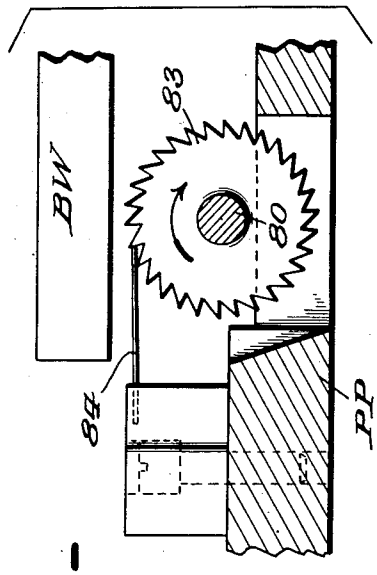


FIG. 4

INVENTORS
George G. Ensign,
Glenn T. Soper and
Ossian Lundahl

BY Mason, Porter, Dailey & Stewart,
ATTORNEYS

July 30, 1957 G. G. ENSIGN ET AL 2,800,763

POWER TAKE-OFF DEVICE WITH STAGGERED RATCHETS

Filed Aug. 4, 1953 3 Sheets-Sheet 3

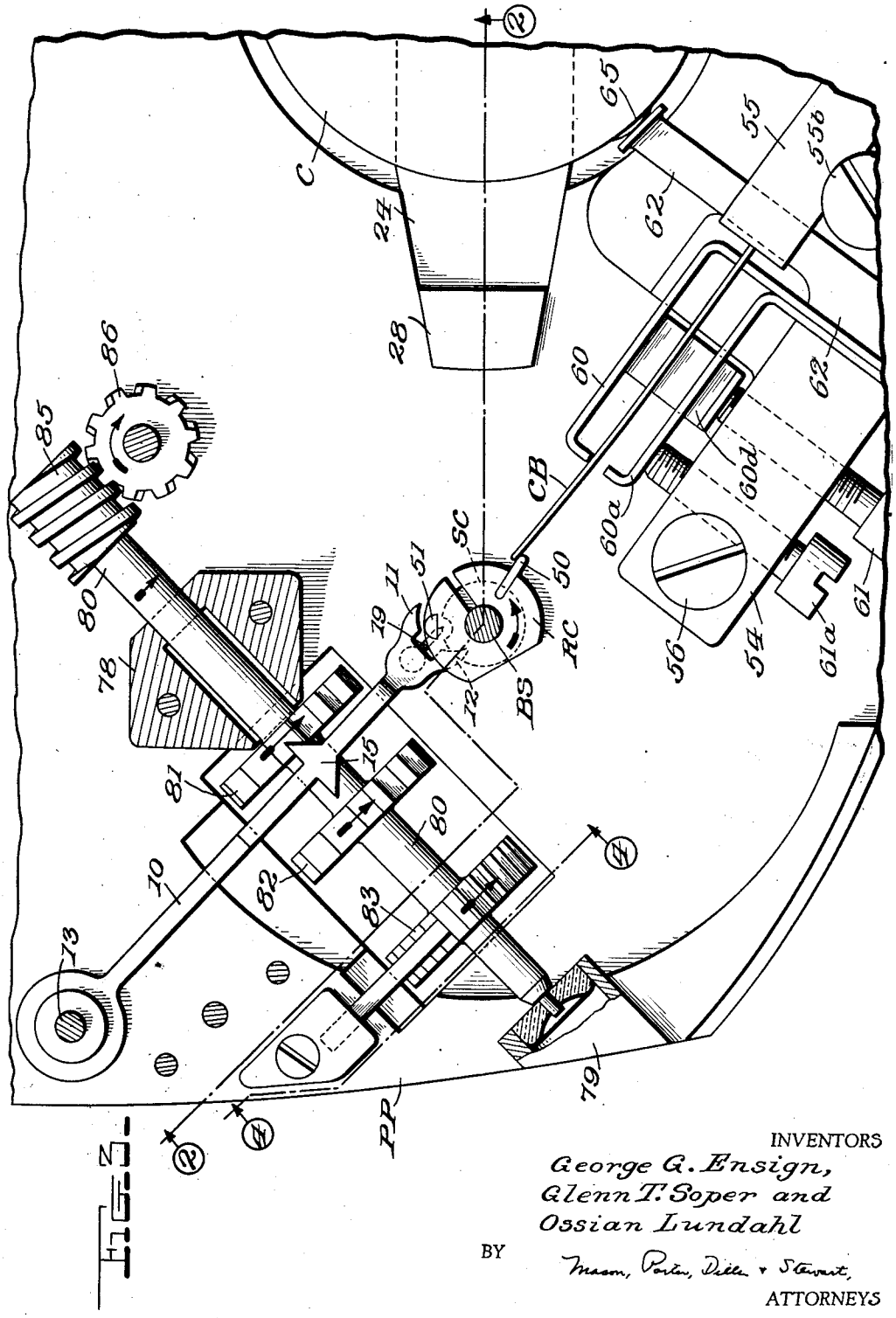


FIG. 2

INVENTORS
George G. Ensign,
Glenn T. Soper and
Ossian Lundahl

BY Mason, Porter, Dille & Stewart,
ATTORNEYS

United States Patent Office 2,800,763 Patented July 30, 1957

2,800,763

POWER TAKE-OFF DEVICE WITH STAGGERED RATCHETS

George G. Ensign and Glenn T. Soper, Elgin, Ill., and Ossian Lundahl, Orlando, Fla., assignors to Elgin National Watch Company, Elgin, Ill., a corporation of Illinois

Application August 4, 1953, Serial No. 372,218

1 Claim. (Cl. 58—28)

This invention relates to energy-transfer or power take-off devices for transferring small amounts of energy from an oscillating member to an intermittently actuated continually advanced member, for example in an electrically actuated wrist watch.

A feature of the invention is the provision of an oscillating member having a projecting part, a rocker member moved by said part and having an actuator, and a continually advancing member having ratchets with staggered or offset teeth which are successively actuated from the rocker.

Another feature is the provision of an oscillating member having a projecting part, a rocker member moved by said part and having an actuator, and a driven member having ratchets with staggered or offset teeth which are successively and alternately engaged and moved by the actuator during the forward and return strokes of the oscillating member.

A further feature is the provision of a horological assembly including an oscillating member, means for impulsing the same, and a projecting jewel pin moved with the member; a pallet piece having a fork for receiving the pin and being moved thereby, and also having an actuator; and a counting train including a pair of ratchets having their teeth staggered or offset and presented in the path of said actuator for successive and alternate actuation thereby during the forward and return strokes of the member: and in which the pallet piece acts to prevent excessive oscillatory movement.

A further feature is the provision of a power take-off for an electrically actuated timepiece comprising a balance and train parts mounted with parallel axes, together with a shaft extending in a radial plane relative to the axes and having parts intermittently advanced from said balance and having a worm in driving relation to a train part, whereby a speed reduction is obtained.

With these and other features in view, as will appear in the course of the following description and claim, an illustrative form of practice is shown in the accompanying drawings, in which:

Fig. 1 is a plan view of parts of an electrically actuated watch, including a staggered-ratchet train drive or power take-off;

Fig. 2 is an upright section on a larger scale, substantially on broken lines 2—2 of Figs. 1 and 3;

Fig. 3 is a horizontal section of the same, substantially on line 3—3 of Fig. 2, that is, with the balance cock and parts of the balance removed;

Fig. 4 is a fragmentary upright section, substantially on line 4—4 of Fig. 2.

In the drawings, the watch has a support or frame structure comprising a pillar plate PP, a balance cock BC and bridges and plates **20**, **21**, **22**, **23**, on which are mounted the train and the actuator lever, and the magnetizable

yoke **24** having pole pieces **28** and the electrical winding or coil C. A balance staff BS is journalled in bearings of the plate PP and the balance cock BC and has a diametrical arm **37** connected to the balance wheel rim BW which carries the diametrically opposed masses MA and MB. The wheel rim and mass MA are of non-magnetizable material; and the mass MB is magnetizable for cooperation with the pole pieces **28** between which it passes as the balance oscillates (Fig. 2). A hairspring collet HSC is connected to one end of the hairspring HS, which at its other end is fixed to a stud HSD on the balance cock BC.

A roller collet RC on the balance staff BS supports a contact fin **50** which during each stroke encounters the contact blade CB near the neutral axis, i. e. at the time of maximum velocity, and causes the blade CB selectively to engage the side contacts **60**, **60***a* whereby to close a current path from the blade CB through the contact **60** to the coil C, during the forward stroke of an oscillation cycle, or through the contact **60***a* to the coil C, during the return stroke thereof. A block **54** of insulating material is fixed on the pillar plate PP by screw **56** and slidingly carries a block **55** on which is mounted the contact blade CB. The block **55** can be moved toward and from the balance axis by the screw **57** which has a flange engaged in a kerf of the block **55**: the binder screw **55***b* holds the block **55** in adjusted position, at the desired depth of engagement of the free end of contact blade CB with the contact fin **50**. The side contacts **60**, **60***a*, are also mounted in the block **54** at their bent ends; and a conductor **62** is electrically associated at one end with the side contact pieces and at the other end with a terminal **65** of the coil C. The other terminal **69** of the coil C is connected by conductor **71** insulatedly carried on the plate PP to the connection clip **72**. A second connection clip **212** is connected to the plate PP which thus serves as a return conductor. The conventionally illustrated battery B is connected at one terminal to the clip **212** and at the other terminal to the clip **72**: so that when the contact blade CB engages either side contact **60** or **60***a*, current flows from the battery to clip **212**, the plate PP, screw **55***b*, block **55**, contact blade CB, the contact **60** or **60***a*, conductor **62**, through the coil C, and by conductor **71** and clip **72** back to the battery B. The positions and tensions in the contacts **60**, **60***a* may be regulated by the screws **61**, **61***a*, the contact **60** having a bight piece **60***d* extending beneath the contact blade and contact **60***a*. Each time the fin **50** causes the blade CB to engage a contact **60**, **60***a*, the pole pieces **28** are magnetized and deliver an impulse to the mass MB, and thereby the balance system is maintained in oscillation.

According to the present invention, the roller collet RC carries a so-called jewel pin **51**, which may be of ruby, sapphire, metal, or other material. A pallet piece or rocker **10** has tines **11**, **12** with a notch between them for receiving the pin **51**, and is supported by the pivot **13** carried by the bridge **23** and the pillar plate PP. The pallet piece **10** carries projections providing an actuator **15** which has laterally extending ends having oppositely angled or beveled edges for respective engagement with the teeth of the ratchet wheels **81**, **82**. The piece **10** also carries a safety pin **19** for engaging in a passing hollow of the safety collet SC in the usual manner during the passing action.

Bearing standards **78** and **79** on the plate PP support a shaft **80** having thereon two ratchet wheels **81**, **82** with like numbers of teeth but with these teeth staggered or offset as shown in Figs. 2 and 3, so that each tooth of one ratchet lies midway of a tooth space of the other

ratchet. The lateral span and shaping of the actuator **15** (Fig. 1), and the tooth spacings of the ratchets **81, 82** are so correlated, as shown, that the actuator **15** is free of one ratchet as it completes its actuation of the other ratchet; whereby it permits movement of such other ratchet to a position at which the other ratchet receives the actuator into the next succeeding tooth gap.

A detent ratchet **83** is fixed on the shaft **80**, and has twice as many teeth as either ratchet **81, 82**. A detent spring pawl **84** is mounted on the plate PP, and cooperates with the detent ratchet **83** to prevent retrograde movements. A worm **85** fixed on the shaft **80** is in mesh with a worm wheel **86** of the counting train which leads to the indicating hand or hands (not shown) in usual fashion.

In operation, the balance assembly is maintained in oscillatory movement by the successive magnetic impulses delivered thereto. As the roller collet RC approaches neutral axis in the counterclockwise, e. g. forward, stroke, as indicated by the arrow in Fig. 3, the pin **51** passes the tine **11** of the pallet **10** which then has its actuator **15** resting in the ratchet **81**, and enters the pallet notch. The pin **51** then acts on the notch wall of tine **12** to rock the pallet clockwise about its pivot **13**; at the end of this rocking movement, the pin **51** escapes from the notch and leaves the pallet and continues in its forward stroke against the action of the hairspring HS until it reaches the end of the forward stroke. The balance assembly then moves back in the clockwise or return stroke; as the pin **51** again approaches the neutral axis, it passes the tine **12** as the pallet **10** has its actuator resting in the ratchet **82**, and again enters the pallet notch and acts on tine **11** to return the pallet **10** by a counterclockwise rocking movement until the pin **51** escapes from the notch and continues to the end of the return stroke of the balance assembly. The safety pin **19** partakes in the pallet movement, and cooperates with the safety collet SC so that the pallet can only move at the proper points in the cycle.

While the actuator rests in the ratchet **81**, it lies partly between adjacent teeth of the ratchet **81** and is clear of the ratchet **82** (Fig. 3). During the clockwise rocking of the pallet **10** during the forward balance stroke, the actuator **15** moves into engagement with a tooth of the ratchet **82**, causing this ratchet and therewith the shaft **80** to turn as shown by the arrows in Figs. 2, 3 and 4. This motion of the shaft **80** is through an angle of slightly greater than half the arcuate tooth spacing of the ratchet **81, 82** and the pawl **84** passes from one tooth to the next on the ratchet **83**. As the shaft **80** turns, the ratchet **81** also moves by a half-tooth, such movement being permitted as the actuator **15** moves from the tooth gap. During the rest of the forward stroke and essentially half of the return stroke of the balance assembly, the actuator **15** remains in a tooth space of ratchet **82** and clear of ratchet **81**. Thereafter when the pin **51** moves the pallet **10** clockwise, the actuator leaves the ratchet **82** and enters the next tooth space of ratchet **81** and produces a further half-tooth-space movement of ratchet **81** and of shaft **80**. Thus the shaft **80** is intermittently rotated by successive and alternate actuations of the ratchets **82, 81** during the forward and return strokes, so that the shaft **80** is moved by one ratchet tooth angle of either ratchet **81** or **82** for each complete cycle of the balance system. This motion is transferred by worm **85** to the wheel **86** and thus to the train. At each half-step, the detent pawl **84** acts on the detent ratchet **83** to prevent retrogression.

The balance staff BS, the train gear **86**, and other train parts can be mounted on the support with their axes parallel; and a large speed reduction accomplished by the stepping of the ratchets and use of the worm drive. For example, with a 300-beat balance, and 15 teeth in each ratchet, the shaft **80** turns 10 revolutions per minute, and with a single thread worm **85**, and a gear **86** of 10 teeth, the wheel **86** turns once per minute, i. e. at the proper rate for a seconds pinion, and can be coupled by a 1:1 ratio drive to a center seconds pinion SP.

The structure and conditions of operation are particularly of merit with a balance system which is impulsed during a stroke by means moved by the system, in that such a balance system is normally inherently capable of continuing excessive amplitudes of oscillation. For example, with the illustrative electrically actuated watch, it is desirable to have the balance move for about one and one-half turns, or 270 degrees at each side of the neutral axis, in each stroke. At neutral axis, the impulse is delivered. Now, if a shock occurs in the absence of a motion-limiting device, this amplitude of swing may increase to 360 degrees; whereupon a second movement of the contact blade could occur, with a further impulsing in the same direction, thereby tending to cause an additional forward movement; and during the return a first impulsing occurs as the balance regains the position of a two-turns amplitude, a further like return impulse at the neutral axis, and probably a third impulse at two-turns amplitude in the return stroke. This is avoided by the employment of the rocker member of limited motion, because as the amplitude increases toward two turns, the jewel pin **51** ultimately encounters the tine **11** or **12** of the rocker or pallet piece and thereby is brought to a standstill before the pin **51** can again engage and close the contact blade CB. Thus the maximum amplitude is limited to less than 360 degrees or two turns, and it is notable that the various frictions and resistances normally increase with amplitude, whereas the duration of contact closure, and hence the quantity of impulsing energy, decreases with increase of the balance velocity at neutral axis, so that the system tends to regain and to operate at a constant amplitude dependent upon the adjustment of the contact blade CB toward or from the balance staff.

In service, also, the system is effective to prevent disturbances and damage during setting, e. g. during movements of the hands to proper time position when the watch is placed in service. When the setting stem is actuated to cause the hands to move, rotational forces are exerted along the train toward the worm gear **86**, but can produce no rotation of the worm **85** and shaft **80** due to the low pitch of the worm teeth. Hence there is no movement of the rocker **10** from the ratchets **81, 82**; and no damaging stress exerted between parts on the rocker and parts on the balance.

It is obvious that the invention is not restricted to the illustrative form of practice, but may be employed in many ways within the scope of the appended claim.

We claim:

A power take-off device for an electrically actuated timepiece having a support and an oscillatory balance thereon, comprising a pallet piece rockably mounted on the support for movement from one end position to another about a pivot axis parallel to the balance axis and having a forked end, a first element carried in an arcuate path concurrently with the balance for entering said forked end and moving the pallet piece from one end position thereof to the other and thereafter leaving the said forked end during the continuance of the balance stroke; a shaft rotatably mounted on the support with its axis spaced from the balance axis and substantially at right angles thereto, a pair of ratchets fixed on the shaft with their teeth staggered, and actuator elements on the pallet piece and located in a plane parallel to the shaft axis and intersecting the teeth of both ratchets, each said element having an inclined surface cooperative with the teeth of the corresponding ratchet, the said surfaces being oppositely inclined relative to one another; said ratchets being spaced from one another in said plane whereby when one actuator element is engaged with and moving

one said ratchet, the other actuator element moves into the space between the ratchets so that the other ratchet can pass the other actuator element; means for preventing retrograde movement of the ratchets, and means on the pallet piece and balance for preventing movement of the pallet piece from its occupied end position so long as said first element is out of the said forked end.

References Cited in the file of this patent

FOREIGN PATENTS

46,460	France (1st addition to No. 779,105)	Mar. 24, 1936
702,282	France	Jan. 20, 1931
480,407	Great Britain	Feb. 22, 1938