

July 2, 1946.

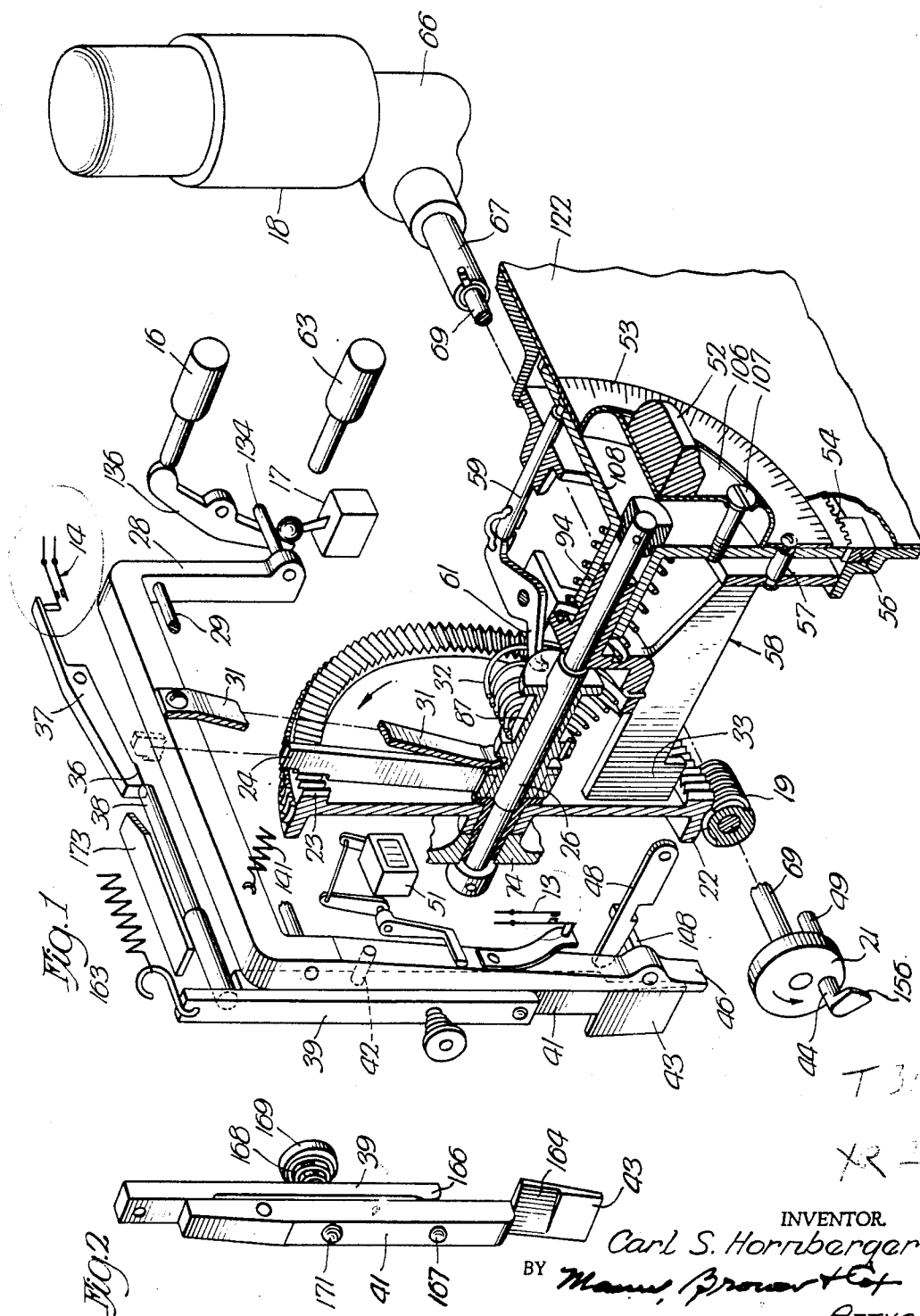
C. S. HORNBERGER

2,402,965

TIMING DEVICE

Filed Sept. 19, 1941

10 Sheets-Sheet 1



July 2, 1946.

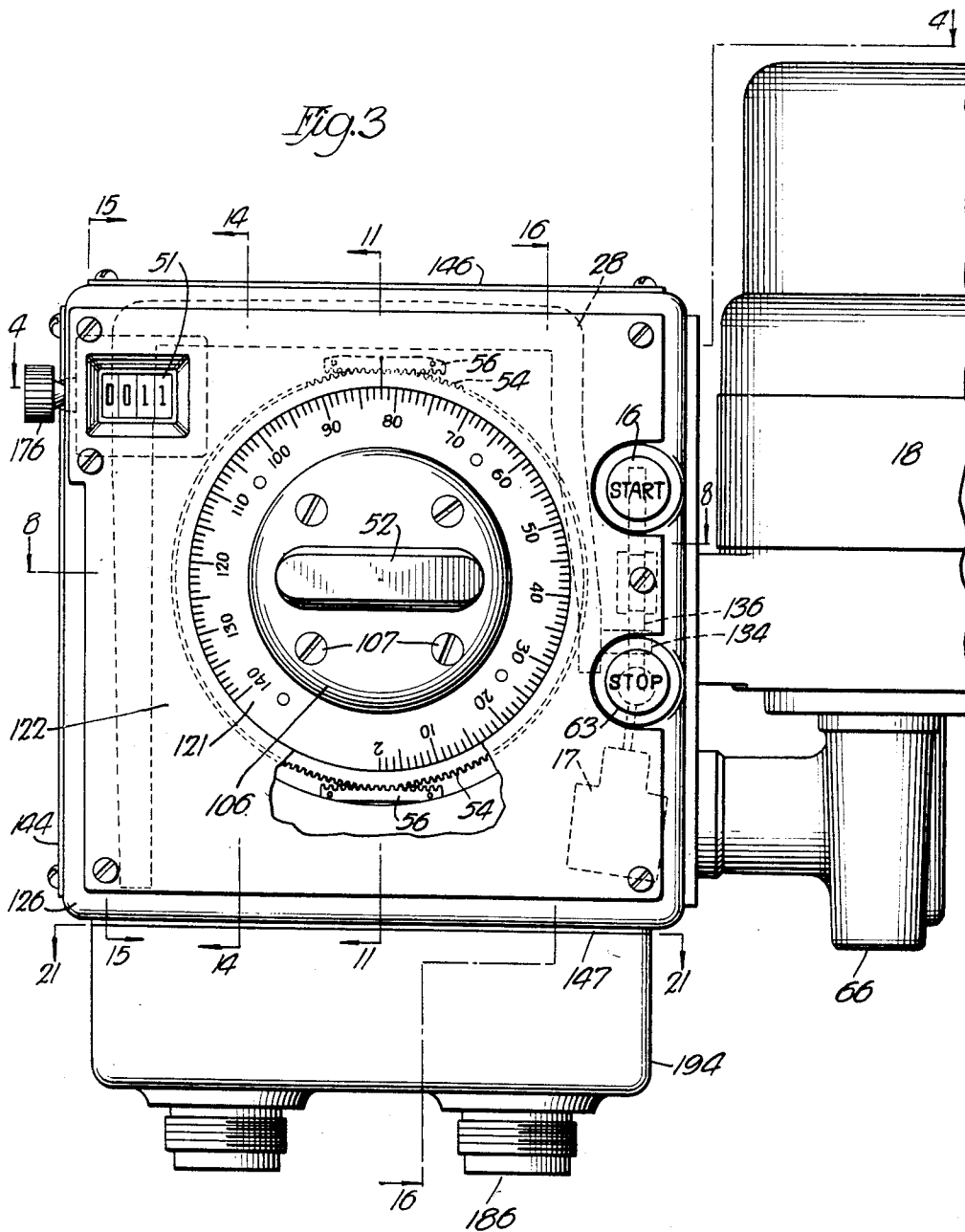
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TIMING DEVICE

Filed Sept. 19, 1941

10 Sheets-Sheet 2



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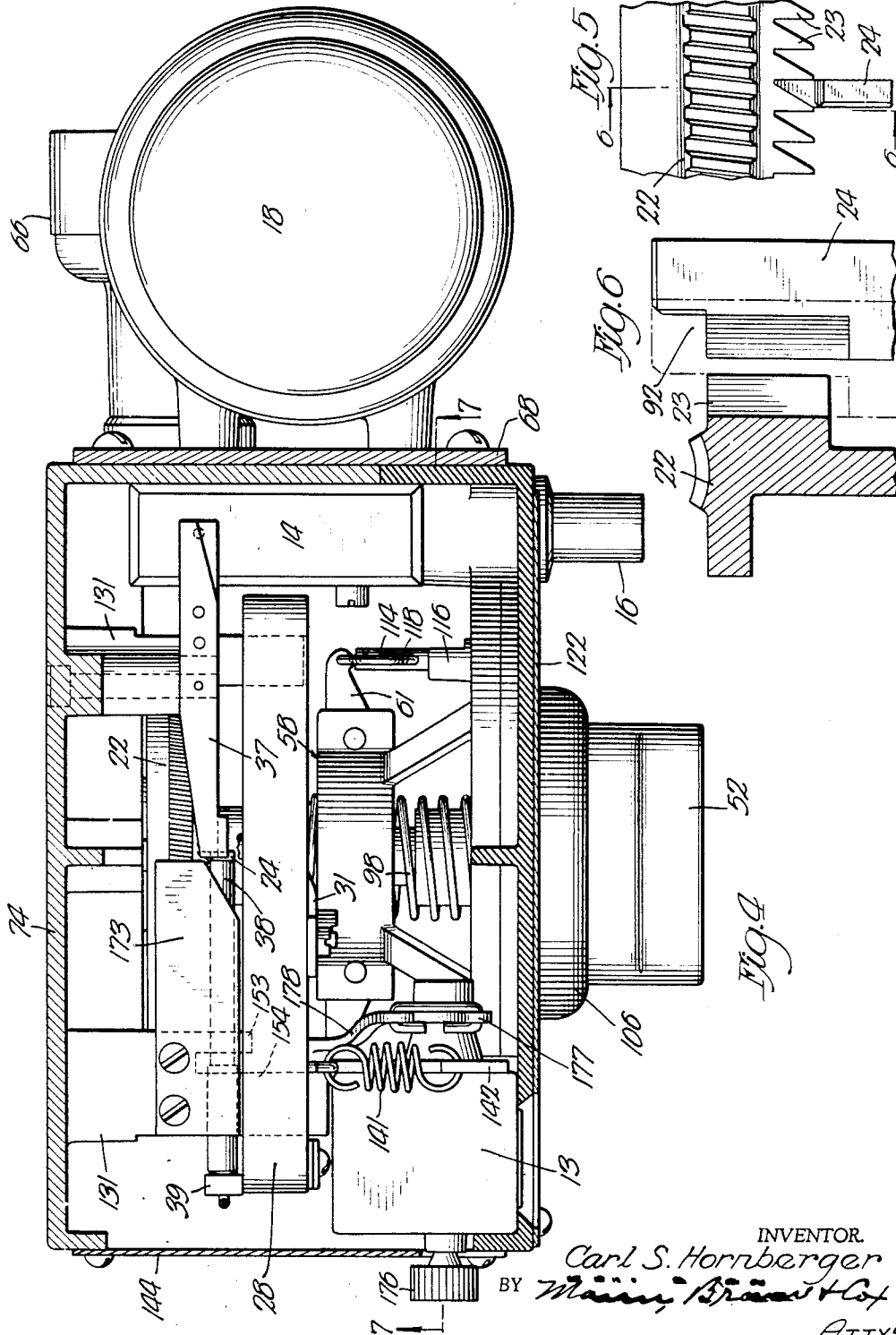
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TIMING DEVICE

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10 Sheets-Sheet 3



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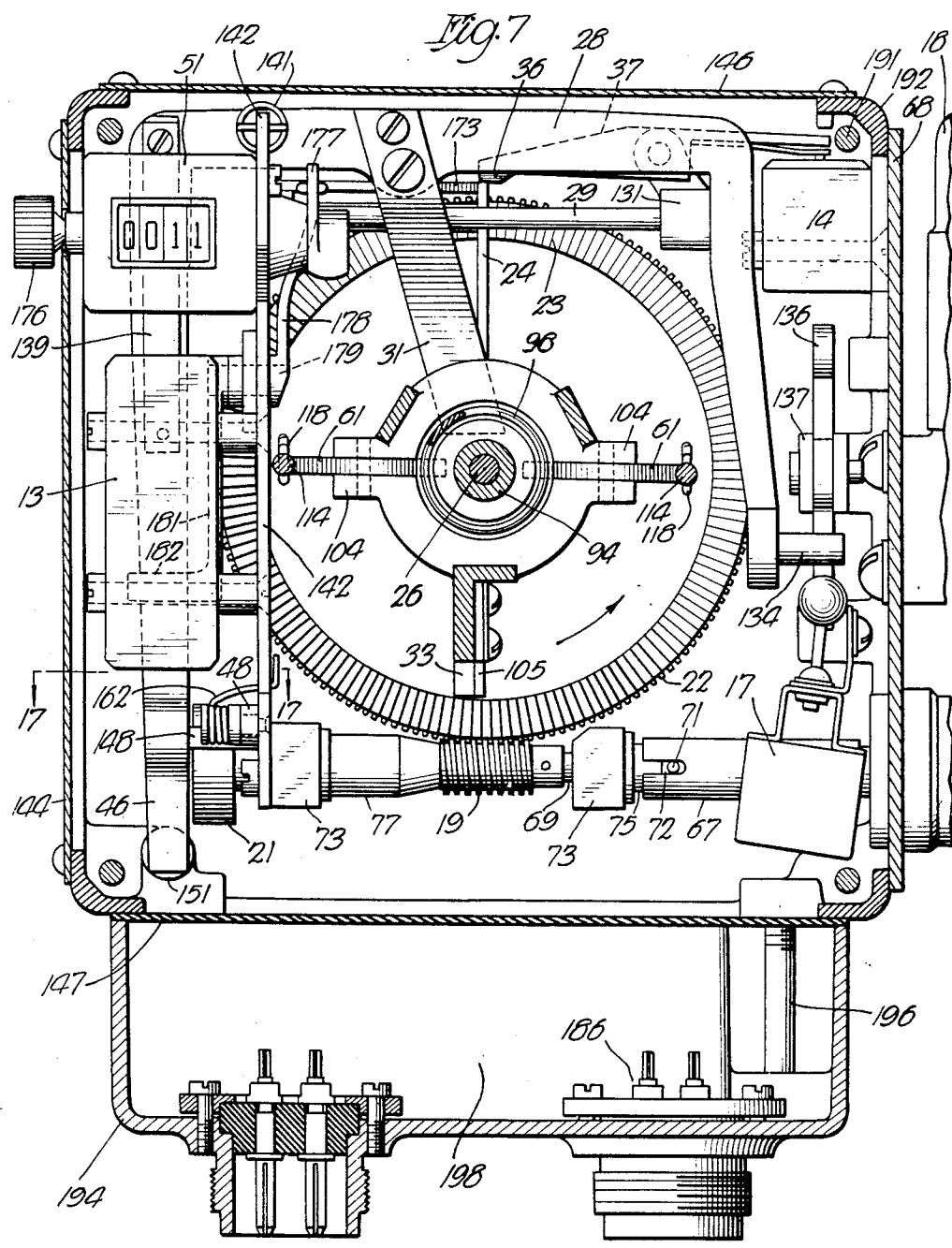
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10 Sheets-Sheet 4



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TIMING DEVICE

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10 Sheets-Sheet 5

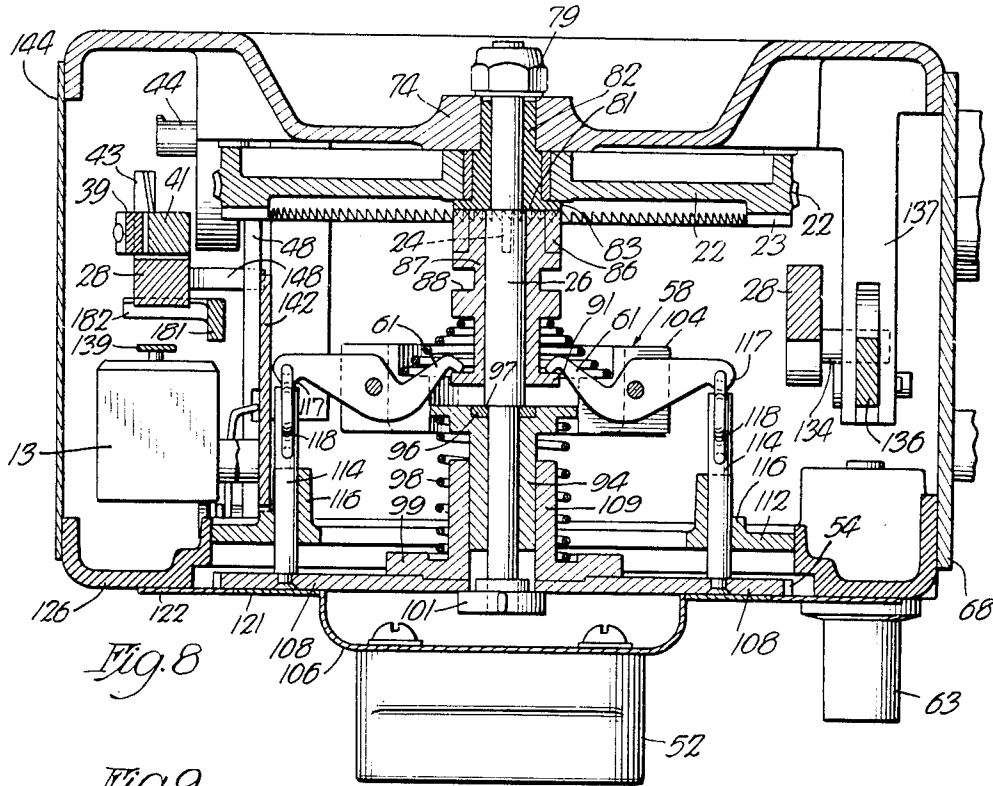


Fig. 8

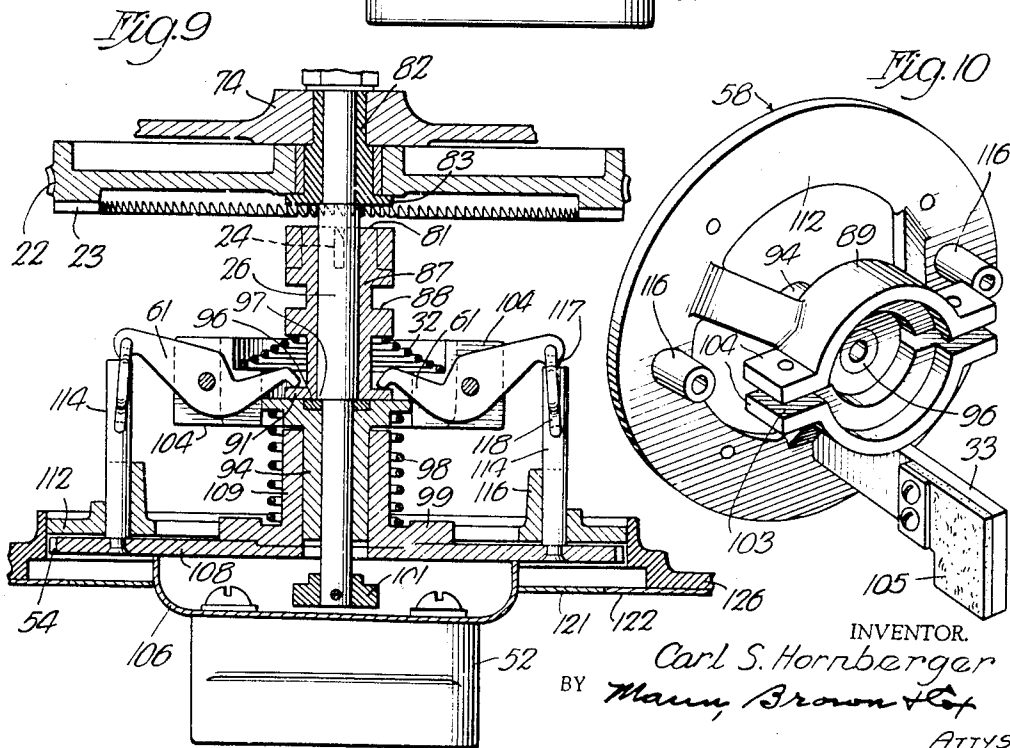


Fig. 9

Fig. 10

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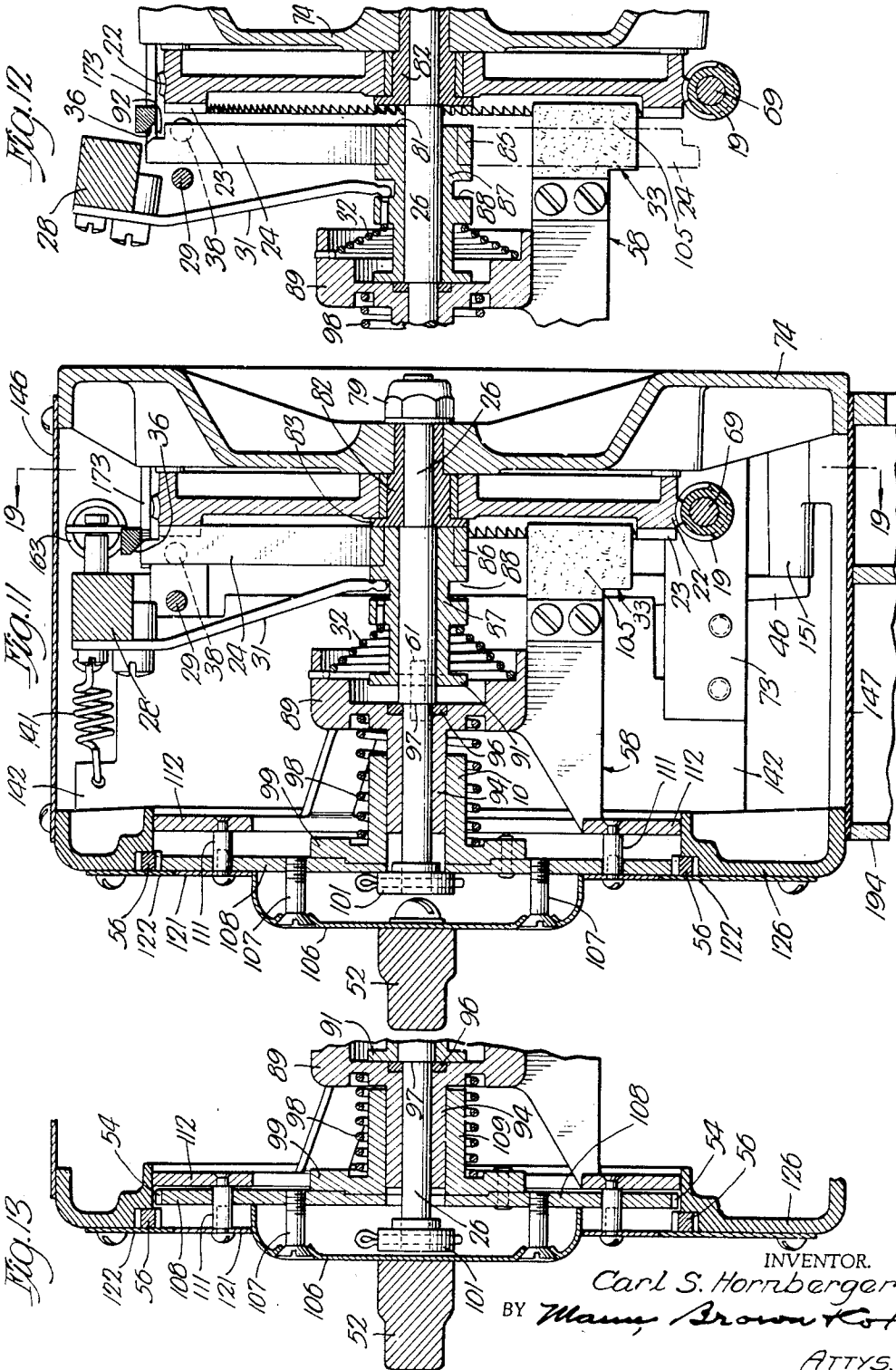
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10 Sheets-Sheet 6



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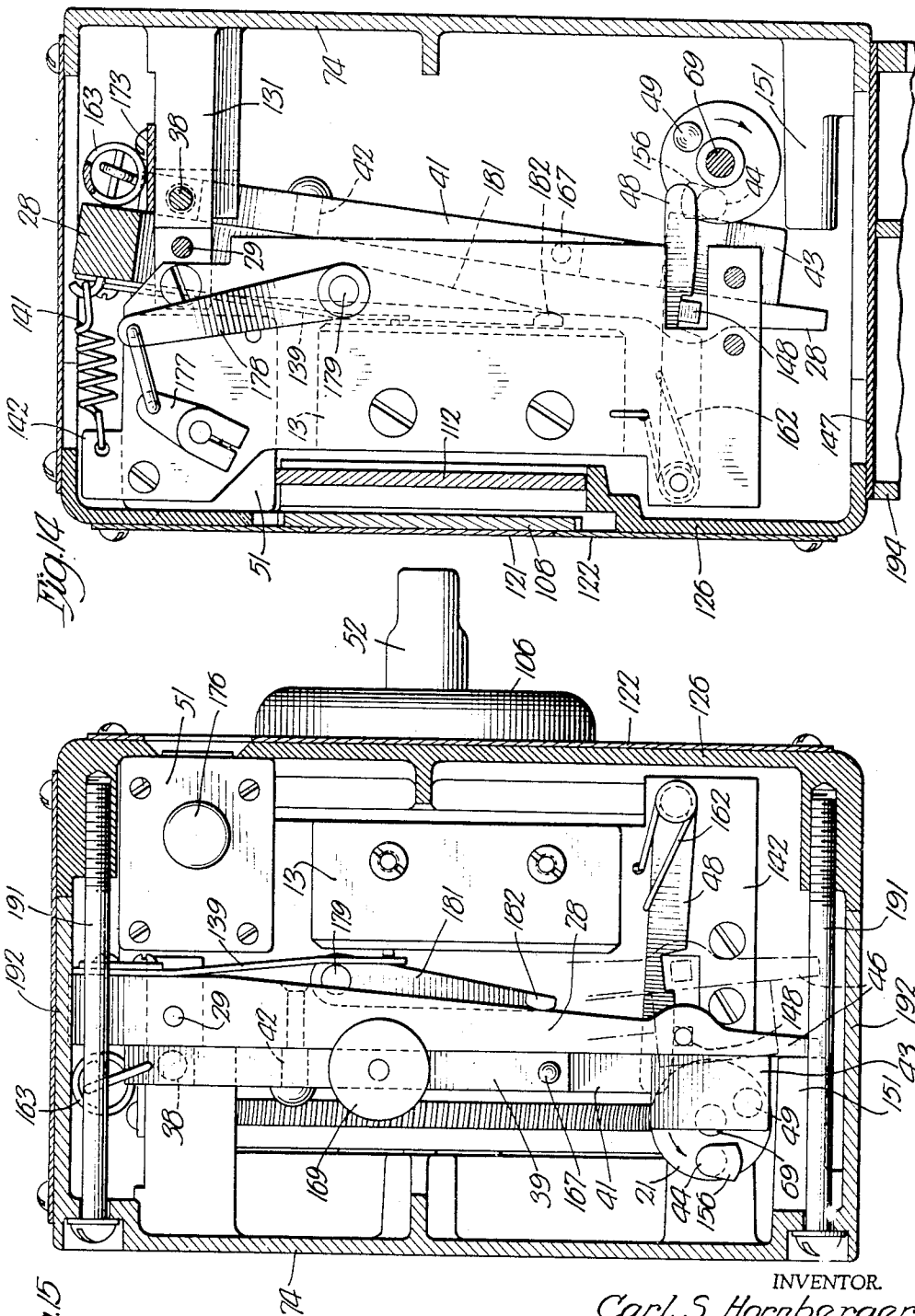
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TIMING DEVICE

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10 Sheets-Sheet 7



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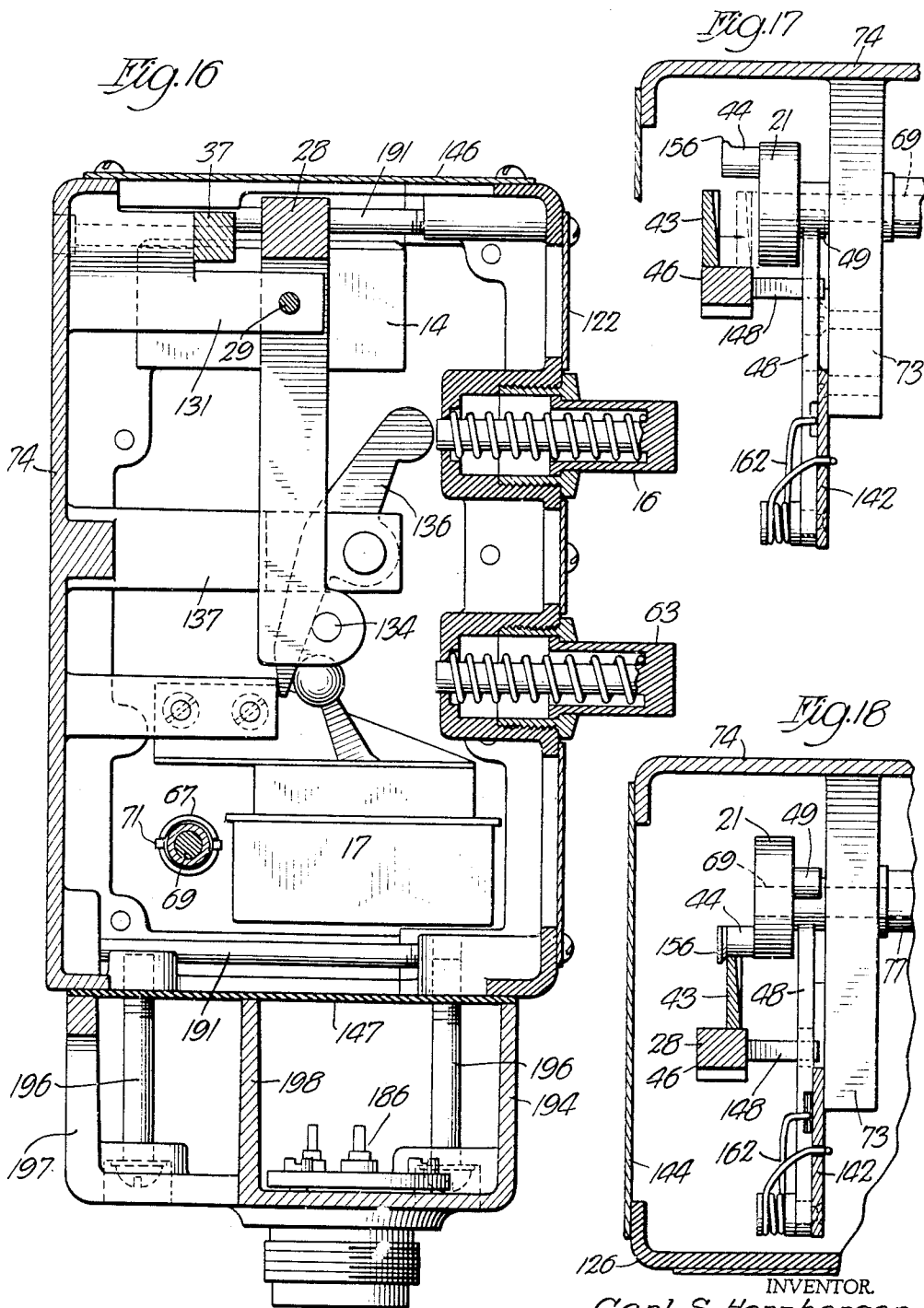
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TIMING DEVICE

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10 Sheets-Sheet 8



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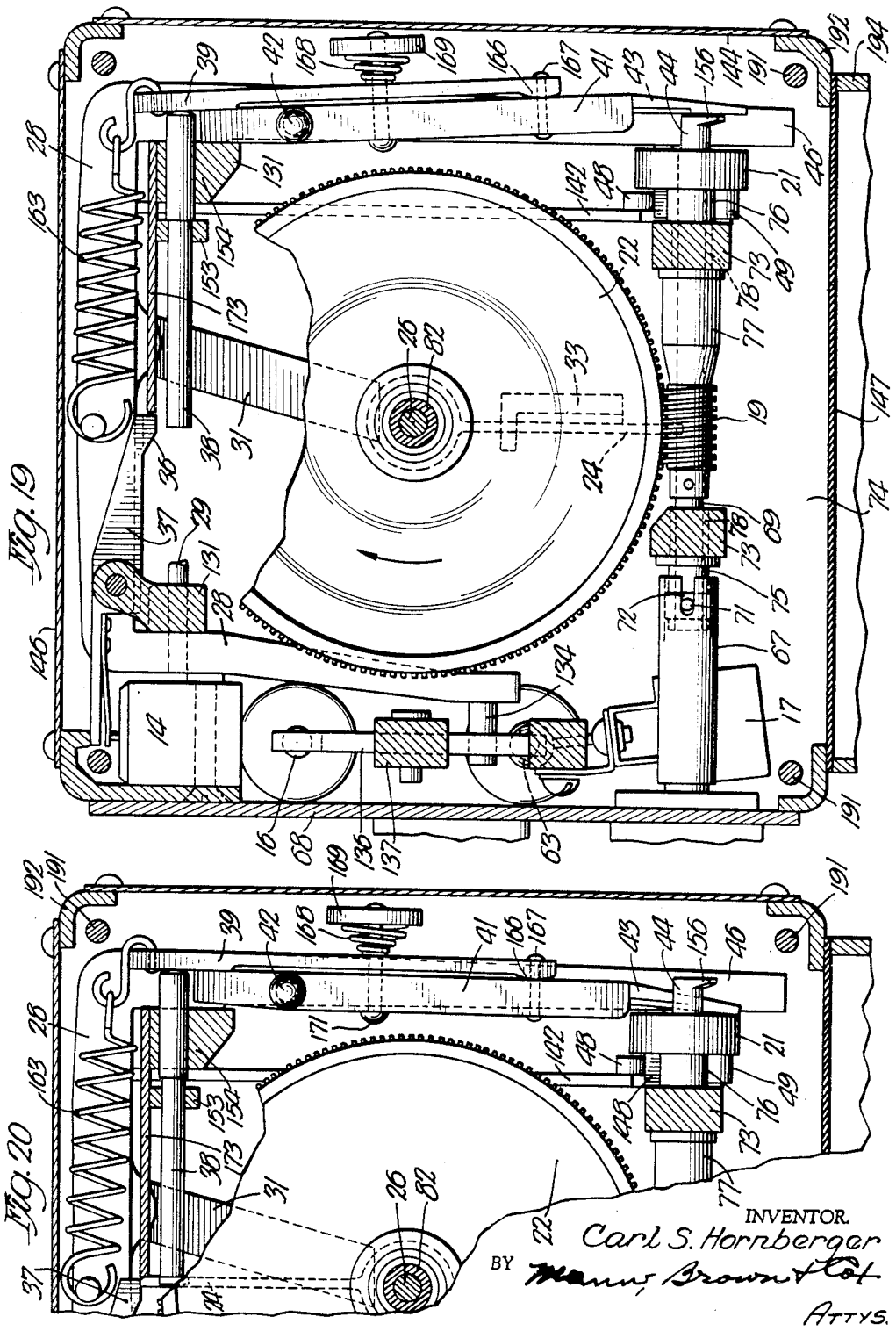
C. S. HORNBERGER

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TIMING DEVICE

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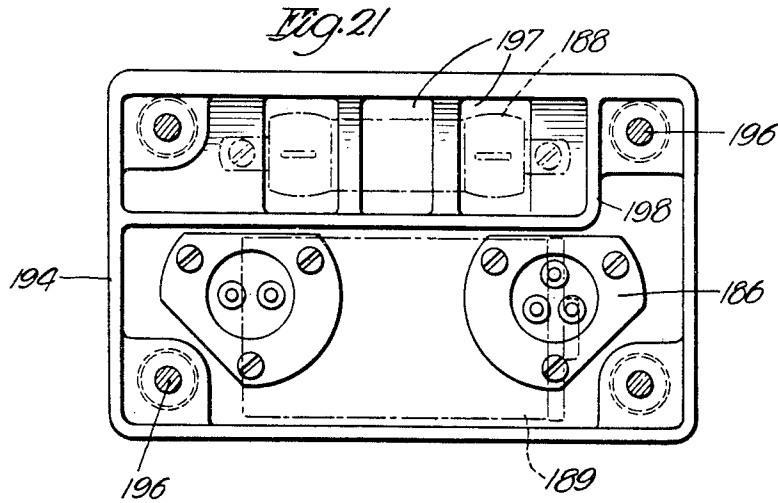
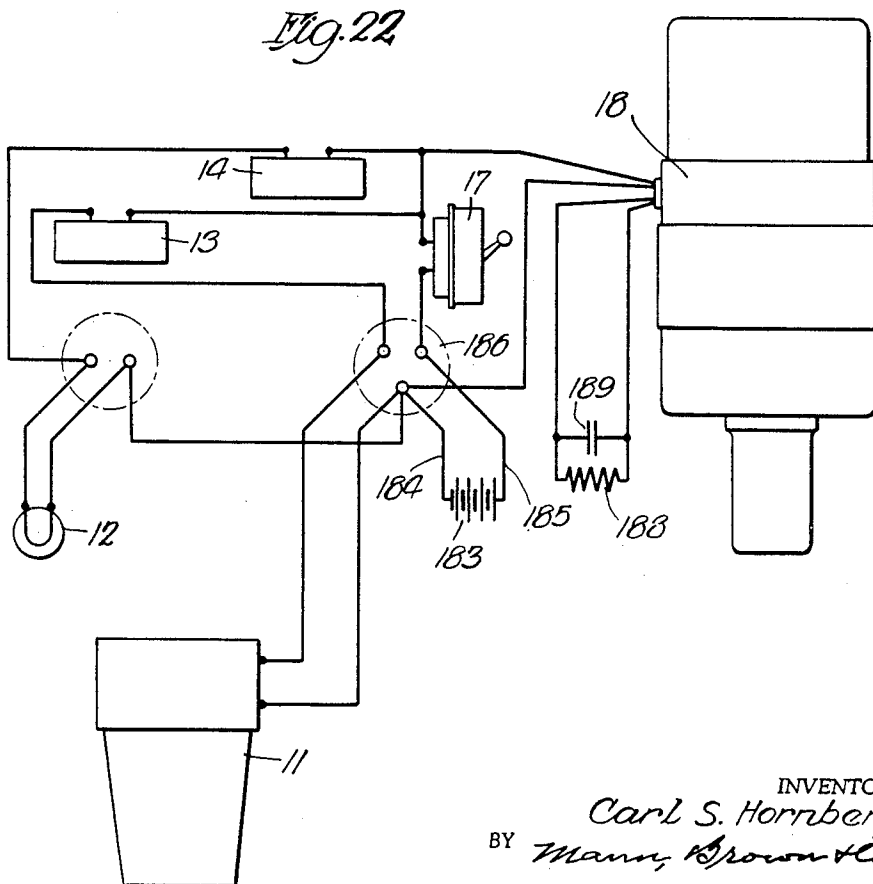
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TIMING DEVICE

Filed Sept. 19, 1941 , 10 Sheets-Sheet 10



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UNITED STATES PATENT OFFICE

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TIMING DEVICE

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Application September 19, 1941, Serial No. 411,593

15 Claims. (Cl. 161—1)

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There are many uses for a timing device that will operate an associated mechanism or circuit at regularly timed intervals, particularly when the time intervals may be adjusted over a fairly wide range. One such use is in connection with aerial photography, where it is desirable to take pictures at regular intervals to obtain photographic coverage of a particular area. Obviously the frequency at which the camera shutter must be opened to insure complete coverage of the area being photographed depends upon the elevation of the plane and its ground speed; and experience has shown that a minimum of two seconds and a maximum of one hundred and forty seconds covers the range of adjustability required for ordinary working conditions in this field.

It is also desirable to have the camera interval control such that a picture may be made at any time, even if the normal time interval has not elapsed, should the photographer see a particular terrain that he especially wants to photograph; and preferably interruption of the regular time required for the taking of a special picture should start a new sequence of exposures at regular intervals after the special picture.

The present invention provides such a device, and one which is of reasonably light weight and small size.

Additional advantages and objects of the invention will be apparent from the following description and from the drawings, in which

Fig. 1 is a perspective view partially exploded, partially in section, somewhat diagrammatic, and with parts omitted, showing the preferred form of the invention which has been chosen for illustration;

Fig. 2 is a perspective view showing the far side of the interceptor arm shown in Fig. 1;

Fig. 3 is a front view, partly broken away, of the device illustrated in Fig. 1, showing especially the front of its case;

Fig. 4 is a horizontal sectional view taken approximately on the line 4—4 of Fig. 3;

Fig. 5 is a fragmentary detail view of the periphery of the constantly driven wheel and the intermittently driven timing finger engaged therewith;

Fig. 6 is a corresponding sectional view taken approximately on the line 6—6 of Fig. 5;

Fig. 7 is a vertical sectional view taken approximately on the line 7—7 of Fig. 4;

Fig. 8 is a horizontal sectional view taken approximately on the line 8—8 of Fig. 3;

Fig. 9 is a fragmentary view corresponding to

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a portion of Fig. 8, but showing the handle pressed in for setting the time interval.

Fig. 10 is a rear perspective view of the rotatable adjustable stop unit;

Fig. 11 is a vertical sectional view taken approximately on the line 11—11 of Fig. 3;

Fig. 12 is a fragmentary view corresponding to Fig. 11, but showing the yoke in the actuated position for causing the return of the timer finger;

Fig. 13 is a fragmentary view corresponding to Fig. 11, but showing the handle pressed in for setting the time interval;

Figs. 14, 15 and 16 are vertical sectional views taken, respectively, approximately on the lines 14—14, 15—15 and 16—16 of Fig. 3;

Fig. 17 is a fragmentary sectional view taken approximately on the line 17—17 of Fig. 7;

Fig. 18 is a fragmentary sectional view corresponding to Fig. 17, but showing the parts in actuated position;

Fig. 19 is a vertical sectional view taken approximately on the line 19—19 of Fig. 11;

Fig. 20 is a view corresponding to Fig. 19, but showing the parts in the extreme position toward which they are shifted by the timing finger;

Fig. 21 is a top (inside) view of the connecting box taken approximately on the line 21—21 of Fig. 3; and

Fig. 22 is a circuit diagram of the device, connected for use with a signal lamp and a camera which may be operated thereby.

Although only one form of the invention has been chosen for illustration, and it has been illustrated in considerable detail to comply fully with R. S. 4888, it will be understood that other forms utilizing the invention will be apparent to or devised by those skilled in the art, and the claims are to be interpreted as broadly as permitted by the prior art.

General organization and operation

One of the most important uses of the timing device of this invention is to control (electrically) the shutter and rewind mechanism of the camera 11 (Fig. 22) to take a series of pictures at accurately timed intervals, preferably illuminating a signal lamp 12 at a predetermined time before the taking of each picture. The general organization and operation of the timing device can best be described with reference to Fig. 1, where a switch 13 is diagrammatically illustrated for operating the camera, or other device, and a switch 14 is diagrammatically illustrated for connecting the signal lamp.

To start the apparatus a start button 16 is pressed which trips toggle switch 17 to connect a constant speed motor 18 through a source of power. The constant speed motor 18 constantly drives a worm 19 and an actuator or crank disc 21. The worm 19 constantly meshes with and drives a worm wheel 22. One convenient speed for the worm 19 and disc 21 is one revolution per second, in which case the slow moving worm wheel 22 will move one tooth per second.

The worm wheel 22 may be provided with teeth 23 on its face, adapted to drive a timing finger 24, both the worm wheel 22 and the finger 24 being mounted to rotate on a fixed shaft 26.

When the start button 16 is pressed, a yoke 28 is pivoted about the axis of its mounting pivots 29, and a clutch finger 31, rigidly carried by yoke 28, slides the timing finger 24 longitudinally of the shaft 26 so as to release it from teeth 23. Upon its release, spring 32 causes it to rotate in a clockwise direction, as seen in Fig. 1, until it comes to rest against an adjustably positioned stop 33. Upon releasing the starting button 16 the yoke 28 will be actuated by spring 141 unless it is momentarily delayed by latch 48, which is raised each second by crank pin 44. Upon actuation of yoke 28, clutch finger 31 presses timing finger 24 into engagement with teeth 23, and the timing movement of timing finger 24, under influence of worm wheel 22, begins.

Shortly after the timing finger 24 reaches the position shown in Fig. 1, it slides under the cam-shaped end 36 of pivoted lever 37, which operates switch 14 to illuminate the signal lamp 12 of Fig. 22. Shortly thereafter the timer finger 24 strikes interceptor pin 38 and pushes it to the left. The interceptor pin is thus pressed against a lost-motion extension 39 of interceptor arm 41. The interceptor arm 41 pivots on a pin 42 carried by the yoke 28. Ideally the interceptor arm 41 and its extension 39 operate as a unit, and they may jointly, therefore, be considered the interceptor arm.

The interceptor pin 38 rocks the interceptor arm 41 to press the interceptor block 43, at the bottom thereof, into the path of crank pin 44 on crank disc 21, and, more specifically, between the pin 44 and the lower extension 46 of yoke 28. As the crank pin rotates it presses block 43 and yoke extension 46 ahead of it, thus rocking the yoke 28 about its support member 29 as said yoke was rocked by original depression of start button 16 (Fig. 15). This again shifts timing finger 24 longitudinally of the shaft 26, so that it snaps back to the stop 33. Rocking yoke 28 also closes switch 13 so as to actuate the camera or other controlled equipment.

A latch 48 holds the yoke in the position to which it has been rocked, until the latch is released by pin 49 on a subsequent revolution of crank disc 21 (Fig. 14), thus allowing plenty of time for the timing finger 24 to come to rest against the stop 33. Upon release of the latch 48 the yoke 28 is free to return to its normal position, and spring 32 presses timing finger 24 into teeth 23 to begin another timing movement. At the same time the switch 13 is actuated a counter 51 is preferably also actuated to indicate the number of film areas that have been exposed.

The position of the return stop 33 determines the length of the path which the timing finger 24 must follow before it actuates the interceptor pin 38 to produce an actuation of the camera. The position of the return stop 33, and hence the length of time of the interval, may be adjust-

ed by a handle 52 with which dial 53 rotates. Pressing the handle inwardly on shaft 26 releases teeth 54 from a toothed lock block 56. The dial 53 may now be turned by handle 52, and through pins 57 it also turns the stop assembly 58 of which stop 33 is a portion. In order that the setting movement of stop 33 will never be blocked by timing finger 24, this timing finger is declutched from the teeth 23 upon pressing handle 52 inwardly, the declutching being accomplished by pins 59 and clutch fingers or rock levers 61.

The use of the slow moving wheel 22 permits the provision of a time interval of over two minutes, even though the equipment can be housed in a small space. When a long time interval is being used, it is sometimes desirable to take an especially important picture without waiting for the end of the normal time interval. According to the present invention this can be accomplished by the simple expedient of pressing the start button 16, and this automatically starts a new series of intervals beginning with the special picture. This follows from the fact that pressing start button 16 rocks yoke 28 and not thus only closes camera control switch 13 but also declutches timing finger 24 so that it snaps back to the stop 33.

At the end of the series of pictures it is merely necessary to press stop button 63, which turns off the toggle switch 17 and stops the motor 18.

The various details of the illustrated form of the invention may be sufficiently clear from the foregoing general description and from the drawings. It is desirable, however, to point out certain special features.

Motor

The motor 18 may be any suitable constant speed motor, and may include any suitable regulator for keeping its speed constant. For example, it may comprise a "Dumore" $\frac{1}{50}$ H. P. motor, series wound, with a governor arranged to shunt out a series resistance whenever the speed falls below a predetermined value, the constants being such that with the resistance the motor will slow down to said value. For aircraft work it will usually be a twenty-four volt D. C. motor, but it may be designed for other voltages if desired. A motor which has been found satisfactory is one having 2400 R. P. M. and provided with reduction gearing 66, having a 40 to 1 ratio, so that the drive shaft 67 rotates at the speed of one revolution per second. The drive shaft may have any convenient speed, higher speeds permitting intervals of any desired shortness. The motor is secured to and removable with end plate 68 (Fig. 4) of the housing, the drive shaft 67 having a telescoping connection with shaft 69.

Constantly driven shaft

As best seen in Fig. 19, a shaft 69 is driven by the drive shaft 67 through a pin 71, carried by shaft 69 and riding in slots in drive shaft 67. The shaft 69 fits loosely in the hollow end of drive shaft 67, so that the pin and slot connection serves as a universal joint. A sleeve of rubber or other silencing and resilient material, 72, may be carried by shaft 69 to prevent rattle. The shaft 69 is journaled in bearing arms 73, cast integrally on the rear casting 74 of the frame or housing. A collar 75 on the end of shaft 69 fitting within drive shaft 67, hub 76 of crank disc 21, and worm 19 are fast on shaft 69. A sleeve 77 may be provided on shaft 69, having a drive fit with the shaft, and forming a thrust bearing against the right-hand bearing arm 73 in Fig. 19,

the thrust on shaft 69 as a reaction to driving wheel 22 being to the right in this figure. Collared bearing bushings 78 may be provided in bearing arms 73.

Slow moving wheel

The slow moving worm wheel 22 is carried by a stationary shaft 26, which, as best seen in Fig. 8, is carried by the back casting 74, being secured thereto by nut 79 which draws a shoulder 81 on the shaft against a bearing sleeve 82, which in turn has an accurately machined shoulder bearing against the rear casting 74 and an accurately machined flange 83 spaced from the rear casting 74 to receive the bearing hub of slow moving worm wheel 22. The worm wheel 22 is not only provided with worm-shaped teeth on the periphery thereof for engaging worm 19, but it is also provided with radial teeth 23 for engagement with timing finger 24. Since these teeth only drive the timing finger in one direction it is preferred that they be ratchet-shaped to provide adequate driving strength with close spacing to facilitate the entry of the timing finger into engagement therewith. The teeth may be spaced at any desired intervals, corresponding to one or more revolutions of worm 19.

The size chosen for the worm wheel will depend upon the range desired for the timing interval. In the illustrated form the worm wheel has 160 teeth, and since the timing finger can make nearly a complete revolution with the extreme setting of the stop 33, an interval corresponding to at least 140 seconds may be provided.

Timing finger assembly

The timing finger 24 is carried by a collar 86 (Fig. 11), being secured thereto in any desired manner as by welding. The collar 86 may have a pressed fit on clutch sleeve 87, which is rotatable and slidable on shaft 26. The clutch sleeve 87 is provided with an annular groove 88, in which clutch finger 31 rides. Sleeve 87 may be urged toward slow moving wheel 22 either by spring 32 or by finger 31, or by both. Wear can be prevented by relying entirely on spring 32 and having the clutch finger out of contact with the walls of groove 88, but with slow moving parts the wear is negligible. The sleeve 87 is urged in a clockwise direction (as seen in Fig. 1) by the spring 32, one end of which engages sleeve 87 and the other end of which engages a flange formed on collar 89, by which the stop member 33 is carried. The sleeve 87 is provided with flange 91, which is engaged by the second clutch fingers or rock levers 61.

It will be observed that the timing finger assembly, including the finger 24 and the sleeve 87, has very low moment of inertia. Except for the slim timing finger 24 all of the weight is concentrated close to the axis. Accordingly, it will respond quickly to the influence of spring 32, and even if it has nearly a full revolution to move it will traverse the angle quickly and yet this will not cause the timing stop finger to strike the stop 33 with a very heavy blow. The spring 32 can be quite light and still move the timing finger 24 with a quick snap. Finger 24 and collar 86 are preferably made of steel.

When the stop 33 is set for short intervals, timing finger 24 will strike cam 36 from the side instead of from underneath. So that the warning signal will be given even under these circumstances, the meeting portions of finger 24 and cam 36 are preferably beveled at about 45° and

the timing finger 24 will push cam 36 up as it is pressed in by clutch finger 31.

The shape of the end of the timing finger 24 is preferably best seen in Figs. 11 and 12. It is notched, as at 92, so as to clear the worm 19. If preferable, the parts could be so shaped and proportioned that when the clutch sleeve 87 is slid to its extreme disengaged position the finger 24 will still be in position to actuate the lever 37. The advantage of this is that with a setting of, say, two seconds the timing finger 24 will stay under cam 36 at all times, and therefore the warning signal will remain lit. However, if it were found more desirable the parts could be positioned so that the timing finger 24 would strike the side of cam 36, with the engaging faces perpendicular to the movement, so that with the short intervals the warning lamp would never be lit. In this event the interceptor pin 38 would be in such position that it would be struck by the timing finger 24, even though the latter were resting against the side of cam 36, and furthermore, the cam 36 should not hold the timing finger 24 entirely out of engagement with the teeth 23 of the slow moving wheel.

It may be noted incidentally that the edge of the timing finger 24 engaging teeth 23 is preferably tapered, on the side which does not contact the flat face of the teeth 23, so as to correspond to the shape of the space between the teeth and to facilitate entry of the timing finger into the teeth.

Adjustable stop assembly

The stop assembly 58 is rotatably carried by shaft 26 by means of sleeve 94, clearly seen in any of Figs. 8, 9, 11 or 13. This sleeve may comprise an integral part of the stop assembly, which may desirably be cast of brass or bronze. This sleeve is preferably provided with a steel insert 96 (Fig. 11), having a pressed fit therein, or otherwise secured thereto for forming an end thrust bearing against the shoulder 97 of shaft 26. The stop assembly 58 is urged against the shoulder 97 by a spring 98, which bears at one end against the collar 89 of stop assembly 58 and at the other end against flange 99 of the handle assembly, thus thrusting the handle assembly against collar 101, secured on the end of shaft 26. The collar 101 may be secured in any convenient manner, as by a cotter pin. The clutch finger 61 or the rockers of which they form a part, are pivotally mounted in slots 103 formed between lugs 104 cast on the stop assembly 58, suitable bearing pins being secured in these lugs and passing through the rocker members.

As seen best in Figs. 10 and 11, the face of the stop 33, which is struck by timing finger 24, may be provided with a silencing and wear-preventing pad 105, which may desirably be replaceably secured by screws, as clearly seen in Fig. 10. The pad may be made of a tough rubber or other suitable material, cork at present being preferred.

Handle assembly

The handle 52 is preferably carried by a cup-shaped cover 106, which is secured by screws 107 to a gear lock disc 108, as seen best in Figs. 11 and 13. The lock disc 108 may be riveted or otherwise secured to flange 99, forming an integral part of sleeve 109, which has a sliding engagement with sleeve 94 forming a part of the stop assembly. A constant angular relationship is maintained between the stop assembly 58 and handle 52 by means of rivet pins 111, secured, by upsetting, to a ring 112 forming an integral part

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of the stop assembly 58. Lock disc 108 is provided with apertures having a smooth sliding fit with pins 111.

As seen best in Figs. 8 and 9, the lock disc 108 is provided with clutch rods 114, which are secured to the disc 108 by upsetting and which slide through bosses 116 integral with ring 112 and stop assembly 58. For declutching the timing finger 24 these rods 114 could bear directly against lugs 117 formed at the other end of the rocker levers from the clutch fingers 61. It is preferred to maintain the parts in contact by resilient links 118, each linked through a hole in rod 114 and a hole in lug 117. This will draw the links back to such a position that the clutch fingers 61 are normally out of contact with flange 91.

Dial

If the dial 121 moved inwardly when the handle 52 were pressed inwardly, it would be hard to read accurately in one position or the other. According to the present invention, the dial is secured to spacing rivets 111 which, being secured to the ring 112, rotate but do not move longitudinally of shaft 26. The pointer or other reference marking to which the calibrations of the dial 121 are related may be borne by or depressed in the front plate 122. This plate is preferably flush with dial 121 so as to make the reading of the dial setting as easy as possible.

Any suitable means may be provided for locking the handle and stop assembly in position. It should be sufficiently sturdy so that it will always be dependable and will not be shifted under repeated blows from the stop finger 24, and it should require moving the handle far enough to declutch the timing finger 24 before rotating the stop. Both objects are accomplished by providing the lock disc 108 with gear teeth on the periphery thereof, and providing one or more gear lock blocks 56, secured accurately in recesses in the front of the casting 126. The teeth of disc 108 normally mesh with the teeth of gear lock blocks 56, but upon thrusting handle 52 inwardly the disc 108 moves inwardly to a position where, as seen in Fig. 13, it is clear of the gear lock blocks 56. The angular spacing and positioning of the teeth on handle disc 108 should correspond to the teeth 23 on slow moving wheel 22, so that when latch 48 is released automatically the finger 24, resting against stop 33, will be in a position to mesh with any one of teeth 23, which will give an interval of the number of seconds indicated by the dial 121.

Yoke

As seen in Figs. 7, 14 and 16, the pivots for yoke 28 are formed by a shaft 29, which extends through brackets 131 extending forwardly from rear casting 74 and preferably cast integral therewith. The shaft may be secured in position in any desired manner, as by having a driven fit with the brackets 131 or by a setscrew either in the brackets 131 or in the yoke 28.

The general shape of the yoke is best seen in Fig. 1. It may be cast of any suitable material, brass being preferred to aluminum, however, because of better wear and warp resistance characteristics. The details of its shape are perhaps better seen from Figs. 7, 15 and 16. The declutching finger 31 may be rigidly secured thereto, as seen in Fig. 7, and is preferably made of steel. At one end a pin 134 may be secured to the yoke 28 for actuation by the starting rocker 136, which is pivotally mounted on a bracket 137

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extending forwardly from rear casting 74 and preferably integral therewith. The pin 134 and toggle lever of switch 17 are preferably spaced apart vertically so that they will not conflict with one another.

As best seen in Fig. 15, the yoke 28 is provided with a flat spring 139 for actuating switch 13. The yoke 28 is constantly urged by spring 141 toward the position shown in Fig. 15, in which position it leaves the timing finger 24 engaged in teeth 23. The spring 141 engages at one end with a hook carried by yoke 28, and at the other end in an aperture formed in plate 142, as seen best in Figs. 14 and 7. The plate 142 is secured to one of the brackets 131 and to one of the bearing lugs 73, as seen best in these same figures. This same plate is utilized for mounting the counter 51, switch 13, and latch 48, thus making possible the removal of side plate 144 without disturbing any of the working parts.

At the lower left hand end, as seen in Figs. 1 and 7, the yoke 28 carries a pin 148, which may desirably be square in cross-section either through its entire length or through the portion thereof engaging latch 48.

The biased movement of the yoke 28 is preferably limited by a stop pillar 151, seen best in Figs. 14 and 15. By virtue of the location of the stop pillar as far from the pivotal axis 29 as possible the stop pillars 151 may be cast accurately enough so very little machining is necessary in order to properly determine the position of rest of the yoke 28.

Interceptor pin

The mounting of the interceptor pin is probably best seen in Fig. 4. It is simply slid through apertures in arms 153 and 154 of the left-hand bracket 131. The aperture in the arm 153 is smaller than that in arm 154, and the two parts of the pin 38 are of corresponding size, as seen in Fig. 4, so that inward movement of the pin is limited, the pin being normally urged inwardly by the interceptor arm 41 or the extension 39 thereof, under influence of spring 163.

Reliably constant return interval

In order to obtain the utmost accuracy it is desirable that the time interval allowed for the return or snap back of timing finger 24 be constant and long enough to provide plenty of time for its return under the most extreme conditions. This is accomplished with the aid of latch 48 and by a novel expedient which prevents its being unlatched on the revolution of crank disc 21, during which it is latched. Crank pin 44 is provided with a flange 156. As seen best in Fig. 18, this flange projects beyond interceptor block 43 to prevent the interceptor arm from springing out of engagement with crank pin 44. The flange 156 is so designed that it assumes this retaining position before pin 44 engages block 43 to shift the block. Other wise, as soon as the block was shifted enough to disengage timing finger 24 from teeth 23 the timing finger would snap back part way, and as soon as it was snapped part way, whether all the way or not, the interceptor block 43 would be free to spring out of engagement with crank pin 44.

Flange 156 is also so designed as to hold interceptor block 43 in its active position, as seen in Fig. 14, until after the release pin 49 has passed out from under latch lever 48 as seen in Fig. 14. It follows that when the flange 156 moves off of interceptor block 43 the interceptor arm 41 will

be pivoted about the pivot 42 by its return spring 163, but the yoke 28 remains latched in its actuated position by virtue of the fact that pin 148 is still engaged in the notch of latch lever 48. Not until the end of the revolution thus started will pin 49 lift latch lever 48 to release the yoke 28. In the meantime the timing finger 24 will have had plenty of time to be snapped back to the stop 33, even if the latter is in the most remote position, and to come to rest thereagainst in spite of any possible bouncing. As a matter of fact, the momentum of the parts is so light that there probably will be no appreciable bouncing.

It may be noted that the latch lever 48 is urged toward latching position by a spring 162 surrounding the pivotal pin for latch 48, and having one end engaging the latch and the other end engaging the plate 142. The pivotal pin is secured to plate 142 by upsetting.

When the latch 48 is raised by pin 49 the yoke 28 will be returned to its normal position by return spring 141, and timing finger 24 will be shifted back into engagement with the proper tooth 23. One second of the time interval having elapsed at this time since the last actuation of switch 13, the proper tooth for the timing finger 24 to engage is a tooth which is one tooth closer to the position in which it produces actuation of the yoke than the number of seconds in the desired time interval. In other words, the dial 121 is calibrated to indicate one second more than the number of teeth between the engagement point of timing finger 24 for which stop 33 is set and the disengagement point. Hence, the dial indicates the correct interval, since the interval is the time traversed by the timing finger 24 in its timing movement plus one second. The reference to one second here is not exact, since the exact portion of the total cycle which is allowed for return of timing finger and the shifting engagement thereof will depend on the exact relationship of the pin 49, the pin 44, and other parts. Another advantage of the long retention period is that it adds one second to the maximum length of interval that can be obtained by a given worm wheel 22. It also holds switch 13 closed long enough to ensure operation of the camera.

The actuation of the camera occurs when the relatively fast moving pin 44 reaches a given point in its cycle and hence the timing is quite exact, once the motor gets up to its governed speed. This may take a few seconds, and so the start button should be pushed a few seconds before the mapping begins. It may be pushed again to start the cycle at the right time for mapping, and, if it is held depressed, only one film area will have been wasted, since holding the start button depressed holds timing finger 24 declutched.

Interceptor arm

For proper coaction between the interceptor block 43 and pin 44, pin 44 should completely miss the coating edge of interceptor block 43 on one revolution, while on the next revolution flange 156 should extend beyond or hook over the interceptor block 43. Since the movement of interceptor block 43 by interceptor pin 38 and slow moving time finger 24 will be a rather slow movement, it is preferred that pressure of the interceptor block 43 on the end of pin 44 be avoided by cutting away the adjacent face of the interceptor block 43 at 164, as seen best in Figs. 2 and 17. The outer face of interceptor block 43 also

slopes so as to provide a relatively thin lower portion of interceptor block 43, so that the flange 156 will hook around interceptor block 43 satisfactorily.

The proper timing of the movement of interceptor block 43 will depend upon the length of interceptor pin 38, which must be such as to get the lower portion of interceptor block safely beyond (inwardly of) the orbit of the flange 156, while keeping it out of the orbit of the flange 156 on the preceding turn of pin 44.

It is not essential that the timing be such that interceptor block 43 never presses its inner face against any non-yielding member, because the interceptor arm 41 is constructed in such a manner that it will yield, if necessary. The main portion of the arm 41 has an extension member 39, secured thereon by a loose rocking type of hinge 166, the two parts being held in place at this point by a loose pin 167. Normally the parts are held in fixed relationship by pressure of a spring 168, which presses bar 39 against the interceptor bar 41 at both ends. The spring 168 bears against a disk 169, which may be carried by a pin 171 secured to the main bar 41 and to the disk by upsetting. The spring 168 is in the nature of a relief spring, so that if the timing of the parts is not exactly right and interceptor block 43 is pressed inwardly too soon against the head of pin 44, the extension 39 will yield and permit the interceptor pin 38 to be moved by timing finger 24 without causing any damage. This incidentally operates to cock the interceptor arm, so that as soon as the pin 44 passes out from under it the tension of spring 168 will snap the interceptor block 43 into its active position.

If anything should go wrong, and the timing finger 24 should not be released from teeth 23 when it should be, the relief spring 168, together with a safety cam plate 173, will cooperate to prevent damage. As seen best in Figs. 4 and 11, the cam plate 173 is positioned and shaped so that it will be engaged by the timing finger 24 as soon as the timing finger has passed its normal point of disengagement. It will then ride out on the safety cam plate 173 until the latter has pressed it out of engagement with the teeth 23. In the meantime the release spring 168 will have permitted the extension 39 to move with lost motion, without injuring any parts.

Counter

The counter 51, which may be a Veeder counter, is carried by plate 142, and is preferably provided with a reset knob 176 on the outside of end plate 144. The counter may be actuated through its lever 177, which, as seen in Figs. 7 and 14, is to the right of the plate 142. The lever 177 is actuated by crank arm 178 fast on pin 179, journaled in plate 142, and bearing fast thereon crank arm 181 provided with a lug 182 adapted to engage the yoke 28 to be actuated thereby.

Circuit

The circuit of the present invention as applied to a camera is illustrated in Fig. 22. From battery 183 wires 184 and 185 lead to the terminals of plug 186, from which wire 185 is connected to toggle switch 17. When the toggle switch 17 is turned on, the wire 185 is connected to motor 18 and to switches 13 and 14. A resistance 188 is connected in the motor circuit, together with means, such as governor controlled contacts (not illustrated) for intermittently shunting out the resistance 188 with condenser 189 across the con-

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tacts. When the switch 14 is actuated, it closes a circuit, clearly seen in Fig. 22, from battery 183 through switch 17 to lamp 12. When switch 13 is closed it closes a similar circuit to the camera 11 for actuating the shutter and rewind mechanism to camera.

The switches 13 and 14 may be of any suitable form, those known as the micro switches (made by Micro Switch Corporation) being preferred because of their ability to carry and interrupt the necessary current load, although having an extremely small throw and requiring only a very slight actuating force.

Casing

As already mentioned, the casing for the device preferably includes a back casting 74 and a front casting 126. These castings are probably best seen in Fig. 15, which also shows the manner of securing the two castings together by means of screws 191. The front and back portions of the two castings are preferably spaced apart by corner pillars 192 adjacent the screws 191. The four side plates and the front plate may be secured to the castings by screws so as to be readily removable. The bottom plate 147 may be clamped to the casting by junction box 194, which in turn is secured to the casting by screws 196. The junction box preferably includes plug-in facilities for the camera and battery, and for the signal lamp, and, as seen in Fig. 21, may also include condenser 189 and governor resistance 188. The governor resistance 188 should be ventilated, and is therefore preferably in a separate compartment, which has openings 197 there-through for ventilation, a dividing wall 198 protecting the other parts from dust or other foreign matter.

The governor is located outside of the housing, under a removable cap on the motor, for ready accessibility.

The push buttons are mounted in the front casting, in a manner clearly seen in the drawings, especially Fig. 16. The front and back castings are desirably aluminum for lightness.

Withstanding wide temperature range

For use in aerial photography the device should be capable of operating satisfactorily through a temperature range of -40° F. to 110° F. Although an accuracy of 5% is considered sufficient, the illustrated form of the invention has an accuracy of $\frac{1}{2}$ of 1% throughout this range. In obtaining this accuracy through such a wide range, care must be taken with respect to the bearings and lubrication. In general, all bearings must have generous clearance so that they will not become too tight under any temperature conditions or even under fairly rapid changes of temperature within the range in question. The motor shaft, of course, should not have excessive clearance and is preferably mounted in ball bearings which should be lubricated with a small quantity of light oil which will not become too stiff at -40° F. The bearings for the parts moving constantly, particularly for the gears, the shaft 69 and the slow moving wheel 22, may desirably be "Oilite" bushings, each having a driven fit with the part in which it is mounted. The speed reduction gears in the gear reduction box 66 are preferably made of the material known as "Synthane" (a synthetic resinous material including graphite).

Another factor which may contribute to uniform accuracy is the mounting of the return

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spring 32 in such manner that its tension is always substantially the same when the stop finger 31 rests against stop 33. There are no positional variations which might sometimes be cumulative with respect to slight temperature variations. This permits the return tension to be fairly low when the finger is against the stop and to be increased substantially as the finger moves further and further from the stop, so that the further it is away the more quickly it starts back.

From the foregoing it is seen that a timing device is provided which is thoroughly dependable and has the extreme accuracy of a precision instrument; which is easy to set; which is entirely accurate for all settings; which can be operated at any time by hand without any time lag, such as would result from indirect operation, and which, after being operated by hand, begins a new series of intervals from the hand operation. In spite of compactness the unit has a wide range of intervals, the illustrated form having a range of from two seconds to one hundred and forty seconds. As a matter of fact, it could have a cycle of one second if the structure were arranged to hold the timing finger 24 in its most advanced position and latch 48 were omitted, but this has not been found necessary for applicant's purposes.

The illustrated form of unit, because of its operating characteristics, its dependability, its compactness and its light weight (about eight pounds), is especially suitable for aerial photography, but the invention could be used for many other purposes, even in its illustrated form. For some purposes different speeds of shaft 69 might be desired, and many other changes might be desirable for special purposes, or to utilize the invention in different designs of apparatus. Among the many other uses are those in connection with timing traffic signals, or other signals, telephone circuits, welding machines, and various automatic machine tools. For some of these purposes the switch 14 would be omitted or would actuate some controlled means other than the warning lamp, and the cam 36 could be positioned to actuate the switch 14 at any portion of the interval.

I claim as my invention:

1. A timing device including a constantly driven member, a timing member adapted to be engaged therewith approximately at one end of the interval and disengaged therefrom approximately at the other end and to be driven thereby constantly between said engagement and disengagement, means rendered effective when the timing member is driven to a predetermined position by the constantly driven member for releasing the timing member therefrom and causing it to return to a starting position, controlled means operated at a predetermined position in the cycle of the timing member, characterized by the provision of a member moving faster than the constantly driven member, and means controlled thereby for timing the actuation of the controlled means and for timing the engagement between the timing member and the constantly driven member after the return of the constantly driven member to its starting position.

2. A timing device including a timing member, means for driving the timing member uniformly, pivoted means, means for causing said pivoted means to be pivoted when the timing member is driven to a predetermined position and for positively holding it in the actuated position a predetermined length of time, means disconnecting

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said timing member from the driving means in response to pivoting of the pivoted means, and controlled means actuated by the pivoted means.

3. A timing device including a constantly driven member, a timing member shiftable to be engaged with or disengaged from the constantly driven member, a separately pivoted yoke adapted to disengage the timing member when it is shifted to an actuated position, means for pivoting the yoke when the timing member reaches a predetermined position, and controlled means actuated in conjunction with movement of the yoke.

4. A timing device including a hooked actuator moving in constant cycles, interceptor means movable into the path of the hooked actuator at the end of an interval, means operated by the actuator and interceptor means for starting the timing of a new interval, the operation requiring said interceptor means to pass behind the hook of the actuator during one cycle of the actuator, and means for moving the interceptor means into said path; characterized by the provision of a relief spring in the means for moving the interceptor means, permitting the interceptor means to be yieldably pressed against the actuator so that it will snap into place during a short portion of the actuator cycle when the actuator moves out of the path of the interceptor means.

5. A timing device including a hooked actuator moving in constant cycles, interceptor means movable into the path of the hooked actuator at the end of an interval, means operated by the actuator and interceptor means for starting the timing of a new interval, the operation requiring said interceptor means to pass behind the hook of the actuator during one cycle of the actuator, and means for moving the interceptor means into said path; characterized by the shaping of the interceptor means with the point thereof closest to the actuator on the receding movement thereof closer than the thickness of the metal forming the interceptor means to the plane parallel to the movement of the actuator and passing through the point of the interceptor means which will be first telescoped by the hook whereby the hook may at least approximately clear the interceptor means on its receding stroke and still hook over the interceptor means on its engaging stroke, with only slight intervening movement of the interceptor means.

6. A timing device including a constantly rotating shaft, fast moving and slow moving members driven thereby, the slow moving member being in the form of a wheel, a timing member removably engaged with said wheel and rotatable about the axis of the wheel, control means and means rendering said fast moving member operative to operate the control means when the timing member reaches a predetermined position and to release the timing member from the wheel, means for causing the timing member to return to a starting stop, and means to set the starting stop at a variety of positions around the wheel the farthest of which will permit the timing member to travel at least three-fourths of a revolution.

7. A timing device including a constantly rotating shaft, fast moving and slow moving members driven thereby, the slow moving member being in the form of a wheel, a timing member removably engaged with said wheel and rotatable about the axis of the wheel, control means and means rendering said fast moving member op-

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erative to operate the control means when the timing member reaches a predetermined position and to release the timing member from the wheel, and means for causing the timing member to return to a starting stop; the position of the starting stop, at times at least, being angularly spaced from said predetermined position by at least three-fourths of a revolution of the wheel.

8. A timing device including a constantly rotating shaft, fast moving and slow moving members driven thereby, the slow moving member being in the form of a wheel, a timing member removably engaged with said wheel and rotatable about the axis of the wheel, control means and means rendering said fast moving member operative to operate the control means when the timing member reaches a predetermined position and to release the timing member from the wheel, and means for causing the timing member to return to a starting stop.

9. A timing device for timing a series of contiguous intervals including a member driven constantly throughout the series, a timing member adapted to be engaged therewith and disengaged therefrom, a return spring urging the timing member in the direction opposite to the movement of the constantly rotating member, stop means for limiting the return movement of the timing member and means automatically causing the timing member to be reengaged with the constantly driven member to begin another timing movement, said timing member consisting of a sleeve close to the axis of rotation and a slender finger extending therefrom whereby its moment of inertia is low.

10. A timing device including a motor, a motor control circuit, a constantly moving member driven by the motor, a timing finger adapted to be shifted to a timing position in which it is driven by the constantly moving member and to a disengaged position, a yoke adapted to shift the timing member from a driven position to a disengaged position, controlled means actuated by the yoke, a push button adapted to actuate the yoke, and a motor switch in the motor control circuit adapted to be turned on by the push button upon actuating the yoke if the motor switch is not already on, said yoke being actuable by the push button even if the motor switch is already on.

11. A timing device including a constantly driven wheel, a shaft positioned coaxially with the wheel, a timing member rotatably and slidably mounted on the shaft adapted to engage and be disengaged from the wheel, means urging the timing member in the direction opposite to the rotation of the wheel, stop means against which said timing member is urged when disengaged, said stop means being rotatably mounted on the shaft, and handle means rotatably and slidably mounted on the shaft and adapted to disengage the timing member by sliding movement and to rotate the stop means by rotative movement.

12. A timing device including a constantly driven wheel, a shaft positioned coaxially with the wheel, a timing member rotatably and slidably mounted on the shaft adapted to engage and be disengaged from the wheel, means urging the timing member in the direction opposite to the rotation of the wheel, stop means against which said timing member is urged when disengaged, said stop means being rotatably mounted on the shaft, handle means rotatably and slidably mounted on the shaft and adapted to disengage

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the timing member by sliding movement and to rotate the stop means by rotative movement, and lock means preventing rotation of said handle means and stop means except upon a sliding movement of the handle means disengaging the timing member.

13. A timing device including a constantly driven wheel, a shaft positioned coaxially with the wheel, a timing member rotatably and slidably mounted on the shaft adapted to engage and be disengaged from the wheel, means urging the timing member in the direction opposite to the rotation of the wheel, stop means against which said timing member is urged when disengaged, said stop means being rotatably mounted on the shaft, handle means rotatably and slidably mounted on the shaft and adapted to disengage the timing member by sliding movement, lock means preventing rotation of said handle means and stop means except upon a sliding movement of the handle means disengaging the timing member, and an indicator carried by the stop means and rotatable with it in a position substantially flush with a cooperating indicator, regardless of sliding movement of the handle means.

14. A precision instrument including a rotatably adjustable member, handle means carried thereby and axially shiftable with respect thereto, a casing enclosing the adjustable member, a gear

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lock ring carried by the handle means, a gear lock block carried by the casing, and an indicator shield concealing the gear ring carried by the adjustable member and positioned substantially flush with a cooperating indicator associated with the casing, regardless of the axial movement of the handle means.

15. A gauging device including a drive shaft, a gauge member driven in predetermined relation to the rotation of said shaft, a latch adapted to maintain said gauge member disengaged, an actuating pin carried by the shaft, interceptor means moved by the gauge member into the path of the pin and cooperating with it to disengage the gauge member, return means urging the interceptor means out of said path, temporary retaining means associated with said pin for retaining the interceptor means in operative position, and release means shifting said latch to a release position and allowing it to return to a latching position while the temporary retaining means is in a retaining position during each revolution of the shaft whereby the temporary retaining means retains the interceptor means in operative position during a first revolution until after the latch is returned to its latching position, and on a subsequent revolution the release means releases the latch to cause reengagement of the gauge member.

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