

March 14, 1933.

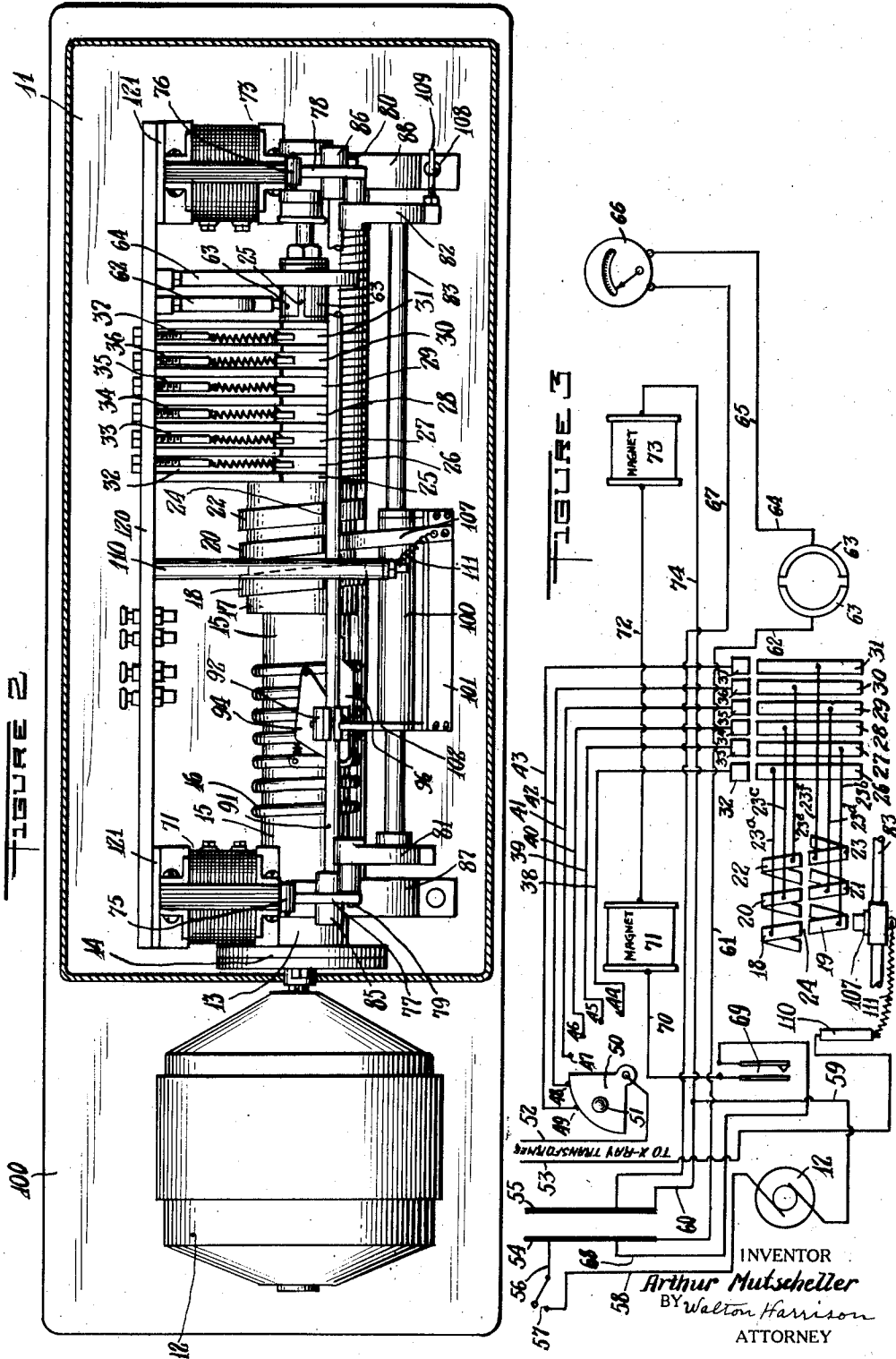
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SYNCHRONOUSLY OPERATED TIMING DEVICE

Filed Aug. 5, 1930

3 Sheets-Sheet 2



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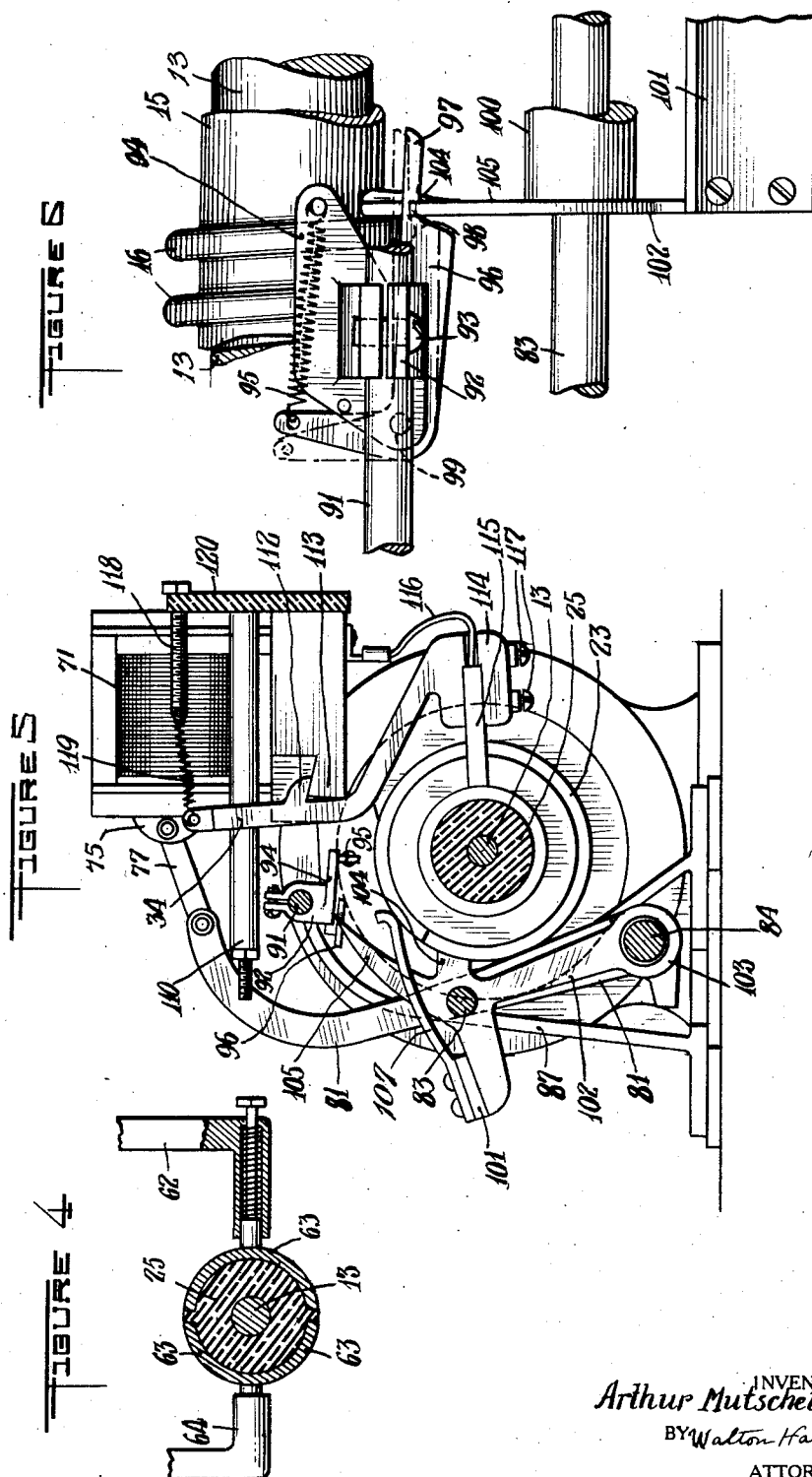
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UNITED STATES PATENT OFFICE

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SYNCHRONOUSLY OPERATED TIMING DEVICE

Application filed August 5, 1930. Serial No. 473,221.

My invention relates to synchronously operated timing devices of the type in which an electric circuit is to be closed and opened for a very short period of time, usually a predetermined small but aliquot fraction of a second, and used for controlling an X-ray tube or the like.

More particularly stated, my invention contemplates an improved timer adapted for use in closing and opening a circuit energized by alternating current, and in which the principal movements of certain parts controlling the timing elements are first set by hand and then driven in synchronism by means of a synchronous motor.

Heretofore in this art synchronously driven timing devices for controlling X-ray exposures have been used to some extent, but most of them have been open to serious objection.

In some instances the circuit to be timed was energized by alternating currents, but was closed and opened more or less haphazard as regards the precise condition of the current at the moment the circuit was closed or opened. Even when efforts were made to close and open the circuit to be timed during a predetermined interval during a cycle, great difficulty was experienced in causing the contact mechanism to function at precisely the right instant. This has caused undue arcing to take place, and has brought about much uncertainty as to the precise condition of the current at the exact instant when the circuit is closed or opened. Moreover, in the timing devices of the prior art the contacts used for controlling the timing circuits have necessarily been of large size because of the uncertainty of the action, as just mentioned. It has been impracticable to close and open the circuit at the instant when the potential of the alternating current was at or near zero. Hence, there has been spoiling of the contacts and undue loss of electrical energy, as well as uncertainty in the duration of the time interval as sought to be measured.

By my invention I seek to accomplish a number of distinct purposes, among which are the following:—

1. To facilitate the making of shorter ex-

posures than have heretofore been found practicable, and particularly to enable the operator to successfully make exposures ranging from 1/120th of a second up to any desired multiple of this period, or from one-half of a single cycle to a considerable number of cycles of the alternating current; and also to reckon the time of the exposure in terms of aliquot parts of a second.

2. To insure absolute accuracy of the exposure in the sense that, during the exposure, only integral impulses are used for energizing the circuit used for timing.

3. To prevent the virtual loss of impulses in the action of the contacts, and thus to avoid uncertainty and confusion in the actual time of exposure.

4. To render it practicable for the timing device to interrupt much heavier currents than have heretofore been used for contacts of a given size, and also to avoid the necessity for using special means for cooling the contacts and parts immediately adjacent thereto.

Broadly speaking, what I seek to do is; to provide a timing device which is so completely under control of the operator that he can accurately time an exposure of very small duration, say 1/120th of a second, and can so handle the timing mechanism that the exposure will synchronize accurately with a precise predetermined part of the current phase; or in other words, will be accurately selected from the best part of the voltage curve suitable for the purpose, and so that the closing and opening of the timing circuit takes place when the voltage is at or very near zero.

Reference is made to the accompanying drawings forming a part of the specification and in which like reference characters indicate like parts throughout the several figures.

Figure 1 is a side elevation of my improved timing device;

Figure 2 is a plan view of the same, and shows in section a protective casing for the working parts.

Figure 3 is a diagram of the wiring;

Figure 4 is a section on the line 4—4 of Figure 1, looking in the direction indicated by arrows;

Figure 5 is a section on the line 5—5 of Figure 1, looking in the direction indicated by arrows;

Figure 6 is a fragmentary plan, corresponding to a portion of Figure 2, but upon a larger scale.

Mounted upon supporting legs 10 is a platform 11, preferably a table top. Resting upon this table top is a synchronous motor 12. I find that a motor making 3600 revolutions per minute is suitable in this connection, and particularly if the alternating currents to be used are of sixty cycles per second.

A shaft 13 is connected with the armature shaft of the motor by means of a coupling 14, and for practical purposes may be considered as a continuation of the motor shaft.

The coupling 14 is adjustable by hand, for enabling the operator to advance or retard the motor shaft relatively to the motor armature.

Mounted rigidly upon the motor shaft 13 and surrounding the same is a worm 15 in the form of a collar, the function of which is purely mechanical, this worm being essentially a screw with coarse, rounded threads 16, as may be understood from Figure 6.

The shaft 13 also carries a drum 17 made of insulating material and abutting against the adjacent ends of the worm 15.

The drum 17 carries a number of contact members 18, 19, 20, 21, 22, 23, each made of metal and having the form of a spiral sector. These contact members are insulated from each other by small insulating sectors 24, or equivalent air gaps, as required.

These contact members are grouped in the proximate form of threads, which have the same pitch as the worm threads 16.

The shaft 13 also carries a drum 25 made of insulating material, and mounted upon this drum are a number of metallic contact rings 26, 27, 28, 29, 30, 31 and a number of connecting wires 23a, 23b, 23c, 23d, 23e and 23f, extending from these contact rings to the respective sectors 18, 19, 20, 21, 22 and 23.

Engaging the contact rings just mentioned are an equal number of contact brushes 32, 33, 34, 35, 36, 37. These brushes are all alike, and of the representative form indicated for the brush 34, as shown in Figure 5 and herein-after more completely described.

Connected with the contact brushes just mentioned are wires 38, 39, 40, 41, 42, 43, leading therefrom to contact buttons 44, 45, 46, 47, 48, 49, which are so positioned as to be engaged by a movable sector 50, provided with a handle 51. These parts together constitute a selective switch.

Two wires 52 and 53 are a part of the alternating circuit to be timed. This circuit being old and well-known, I do not deem it necessary to illustrate or to describe it further. It may lead directly to the X-ray transformer as indicated by the legend To X-ray transformer, or it may be a part of any circuit

appropriate for controlling the X-ray tube.

A pair of alternating current leads are shown at 54 and 55, at the left of Figure 3. From the lead 54 a wire 56 extends to a snap switch 57, and from thence a wire 58 leads to the motor 12. Connected with this motor is a wire 59, from which a wire 60 extends to the lead 55. Thus the motor 12 is bridged across the leads 54 and 55, and is in series with the snap switch 57 and controllable thereby.

A wire 61 is connected with the lead 54, and extends therefrom to a brush 62 of a commutator 63. The other brush 64 of this commutator is connected by a wire 65 with a polarity indicator 66 and from the latter a wire 67 extends to the lead 55.

As may readily be understood from Figure 3 the polarity indicator 66 is in series with and controllable by the brushes 62 and 64 of the commutator 63 and is bridged across the leads 54 and 55.

The polarity indicator and the commutator used in connection therewith are merely shown conventionally. They being old and well-known I will not describe them.

Connected with the lead 54 is a wire 68, extending to a hand grip switch 69. From it a wire 70 leads to a magnet 71 and from the latter a wire 72 leads to another magnet 73. In the diagram shown in Figure 3 these magnets are each indicated by the legend Magnet.

A wire 74 from the magnet 73 is joined to the wire 60.

The two magnets 71 and 73 together with the hand grip switch 69 are in series with each other, and are bridged across the leads 54 and 55. Hence, they are adapted to be energized and de-energized under control of the hand grip switch 69.

The magnets 71 and 73 are shown more particularly in Figures 1, 2 and 5. They are respectively provided with armatures 75 and 76. Connected with these armatures are links 77 and 78, which are also connected to pins 79 and 80 carried by rocker arms 81, 82, the form of which may be understood from Figure 5.

The rocker arms 81, 82 carry a shaft 83, fixed in position relatively thereto. Hence, the shaft rocks bodily forward and backward in a direction lateral to its length as the rocker arms are actuated, but has no turning movement.

A shaft 84 of large size is mounted rigidly in the bearings 85, 86, shown more particularly in Figure 1, these bearings being mounted upon frame pieces 87 and 88.

The frame pieces 87 and 88 are provided with bearings 89 and 90. Supported within these bearings and extending across the frame piece 87 to the frame piece 88 is a stationary shaft 91.

Mounted upon the shaft 91 is a clamp 92, provided with a clamp bolt 93. The clamp is adjustable relatively to the shaft 91. That

is, the operator loosens the bolt 93 and slides the clamp 92 a short distance in either direction along the shaft 91, and then by tightening the bolt 93 secures the clamp in the new position into which it is thus adjusted.

The clamp 92 carries a supporting plate 94, the form of which may be understood from Figure 6. A tensile spring 95 is connected with the supporting plate 94, and with a bell crank lever 96. This bell crank lever has a narrow end portion 97, and a shoulder 98 disposed adjacent this narrow end portion, as indicated in Figure 6. The bell crank lever 96 is mounted upon the under side of the supporting plate 94 by means of a pivot 99. The spring 95 is always under tension, and has a tendency to swing or rock the bell crank lever 96 in a clockwise direction, upon the pivot pin 99 as a center, according to Figure 6. The parts 92 to 98 are used as hereinafter described, in connection with movements of the carriage.

Slidably mounted upon the shaft 83 is a tubular slide 100, supporting a carriage 101 and forming a part thereof.

This carriage is provided with an end plate 102, having a bottom portion 103 formed into an eye, the end plate being provided with holes through which extend the two shafts 83 and 84. By this arrangement the carriage is slidable back and forth lengthwise of the shafts 83 and 84.

The form of the end plate 102 is indicated in Figure 5.

Integral with the end plate 102 and extending endwise therefrom is a thread finger 104, for detachable engagement with the thread 16 of the worm 15.

The parts are so formed and arranged that whenever the thread finger 104 engages the worm 16 and the latter is turning, the carriage 101 is moved to the right according to Figure 1.

The end plate 102 is further provided with a guide finger 105, integral with and extending obliquely upward from it, above the thread finger 104, as indicated in Figure 5.

For the purpose of retracting the carriage, after each sliding movement to the right according to Figure 1, I provide a compression spring 106, loosely but snugly encircling the shaft 84. This spring engages the rocker arm 82 and the lower portion 103 of the end plate 102. Thus the tendency of the spring is to shift the carriage to the left according to Figure 1 after the carriage completes its stroke to the right and the thread finger 104 is disengaged from the worm 15 as elsewhere described.

Mounted upon the carriage 101 is a contact brush 107, adapted for engagement with the spiral contact members 18 to 23 above described.

These spiral contact members each in succession pass under and into engagement with

the contact brush as the drum 17 turns with the motor shaft and the carriage 101 moves to the right according to Figure 2.

As the carriage reaches the end of its travel, the brush 107 is disengaged from the last contact sector 31, and remains inactive.

The rocker arms 81 and 82, together with the shaft 83 constitute a rocker frame, adapted to swing back and forth upon the shaft 84.

Whenever the magnets 75 and 76 are energized, the rocker frame swings inwardly or toward the motor shaft; and whenever the magnets are de-energized the rocker frame swings outwardly or away from the motor shaft.

To retract the rocker frame or cause it to thus swing outwardly I provide a tensile spring 108, extending from the base of the frame piece 88 to a pin 109 carried by the rocker arm 82. Under action of this spring, the retraction of the rocker frame is automatic.

For convenience in connecting the brush 107, I provide a rather lengthy binding post 110, located above the drum 17. From this binding post a flexible connection 111 extends to the brush 107.

The purpose of the flexible connection is to enable current to be supplied to the brush while the carriage is traveling.

The brush 34, which is shown in Figure 5 and is typical of the brushes above numbered 32 to 37 inclusive, is provided with a hook 112, which rests upon a ledge 113, and upon which the weight of the brush is thus supported. This mounting enables the brush to be easily and quickly removed and replaced.

The lower end of the brush is provided with a clamping head 114, in which is fitted a block 115 of conducting material, preferably copper or carbon. Current is supplied through this block by means of a strip 116 of copper.

Clamping screws 117 are provided for holding the block 115. By means of these clamping screws the block can be held in slightly different positions relatively to the clamping head 114, and thus adjusted.

The brush 34 is adjustable by means of an adjusting screw 118, from which a spiral spring 119 extends to the top end of the brush.

There are as many of the clamping screws 117 as there are brushes 32 to 37 inclusive. These clamping screws and the binding post 110 are mounted upon a back board 120 of insulating material, and upon this back board the magnets 71, 73 are mounted by aid of supports 121, as indicated in Figure 2.

In instances where the current used is of sixty cycles per second and the synchronous motor 12 has a speed of 3600 revolutions per minute, the spiral contact members 18 to 23 above described can each be readily made of such proportions as to provide for time ex-

posures of aliquot fractions of a second and multiples of such aliquot fractions, thus practically dispensing with computations, and to lessen the liability of making mistakes in the length of time of the exposures.

In other words, the operator can blindly operate the machine according to rule, and yet obtain exposures which are very exact.

I find in practice that $1/120$ th of a second coinciding as it does with exactly one-half of a complete cycle, makes an ideal unit for purposes of X-ray exposure for a machine of this type.

In the particular apparatus here shown and described, each contact sector 18 to 23 inclusive is so proportioned as to provide for closing a circuit during exactly $1/120$ th of a second. Hence, if a particular exposure desired is to be $1/120$ th of a second, only one of the contact sectors is brought into active use, namely, the one designated as 23. If the exposure required is $1/60$ th of a second, two sectors are employed, namely, 22 and 23. If the exposure is to be $1/40$ th of a second, three sectors are employed, namely, 21, 22 and 23. For $1/30$ th of a second, four sectors are used, namely, 20, 21, 22 and 23. If the exposure is to be $1/24$ th of a second, the sectors 19 to 23 are all used. And finally for an exposure of $1/20$ th of a second, all of the contact sectors 18 to 23 inclusive are brought into active use.

Referring now to Figure 3, it will be noted that the movable section 50 is adapted for closing circuits through the contact sectors 18 to 23 inclusive, in the order of succession just mentioned.

Suppose, first, that the movable section 50 be shifted into its normal position, so that it engages none of the contact buttons, 44 to 49 inclusive.

Suppose, next, that the operator wishes to make an exposure of $1/120$ th of a second. This means that he must energize a circuit including the wires 52 and 53 during the time required for the sector 23 to come once into contact with the brush 107.

For this purpose the operator proceeds as follows:

He first moves the sector 50 into engagement with the contact button 49 alone.

Next he closes the hand switch 57. This energizes the motor circuit, which may be traced as follows: Lead 54, hand switch 57, wire 58, motor 12, wire 59, wire 60, lead 55 to source of alternating current, not shown, and thence back to lead 54.

This starts the motor 12 into action, causing the shaft 13 and parts carried thereby to turn as above described.

The operator next glances at the polarity indicator 66, and ascertains if the polarity of the synchronous circuit to the X-ray tube is correct as regards the safety of the tube. If it is not, he takes appropriate steps to correct the polarity. One convenient way to do this

is to simply open the hand switch 57 and then close it almost immediately. This will slacken the speed of the motor for a moment, by cutting off its supply of current; and when the current again picks up the motor, the phase of the current will be most likely reversed. If not, this step is repeated until the polarity indicator makes an indication showing that the polarity is correct.

The circuit through the polarity indicator may be traced as follows: Lead 54, wire 61, commutator brush 62, polarity commutator 63, commutator brush 64, wire 65, polarity indicator 66, wire 67 to lead 55, thence to source of electrical supply and back to lead 54.

With the motor running and the polarity of the synchronous X-ray tube circuit now such as to safeguard the X-ray tube, the operator next closes the hand grip switch 69.

This closes a circuit as follows:—Lead 54, wire 68, hand grip switch 69, wire 70, magnet 71, wire 72, magnet 73, wire 74, wire 60, lead 55 to source of electricity, and thence back to lead 54.

The magnets 71 and 73 being thus energized, the rocker frame leaves its normal position and swings bodily toward the shaft 13, as above described. Hence, the carriage head 102 swings bodily toward the shaft 13. In so doing it accomplishes two distinct objects. First, it brings the guide finger 105 against the bell crank lever 96, causing the latter to rock slightly in a counter-clockwise direction according to Figure 6. Second, it causes the thread finger 104 to engage the worm 15, as may be understood from Figure 6.

The rotation of the spiral threads 16 of the worm instantly causes the thread finger 104 to find its place in between two successive threads, as indicated in Figure 6, and this brings the contact brush 107 against the nearest contact sector 18 to 23, and also causes the carriage to travel until the thread finger 104 reaches the end of the worm 15 and thus disengages the threads 16.

At the instant when the thread finger 104 disengages the threads 16 as just stated, the guide finger 105 reaches the shoulder 98 of the bell crank lever 96. Thereupon the bell crank lever under tension from the spring 95 rocks slightly in a clockwise direction according to Figure 6, as indicated by full and broken lines in that figure, and the guide finger 105 lodges against the shoulder.

With the guide finger 105 lodged against the shoulder 98, the thread finger 104 is held clear of the worm 15 and thread 16, so that the continued rotation of the worm 15 has no effect upon the thread finger 104. Not only that, but the contact brush 107 is now completely disengaged from the contact sector 23; and since the lodgement of the guide finger 105 against the shoulder 98 prevents

the carriage from being moved by the large spring 106, the contact brush 107 is prevented from touching any of the contact sectors 18 and 23 inclusive.

5 By this arrangement, therefore, provision is made to prevent any accidental or double exposure of the photographic plate, such as might otherwise occur if the carriage, under tension of the spring 106, should so move as to
10 now bring the contact brush 107 into contact with any or all of the contact sectors.

The operator next relaxes his grip upon the hand grip switch 69, and thus de-energizes the circuit through the magnets 71 and
15 73. This releases the rocker frame, which now swings outwardly to normal position. It also disengages the guide finger 105 from the shoulder 98, and this releases the carriage which, under pressure of the retracting
20 spring 106, is now quickly shifted to the left according to Figure 2, and back into normal position for use in another exposure.

It is during the movement of the carriage from left to right according to Figure 1 that
25 the exposure is actually made, and this step I will now describe.

When the carriage first swings to the right according to Figure 5 the contact brush 107 moves toward the drum 17, and thus brings
30 the contact brush 107 into engagement with some one of contact sectors 18 to 23 inclusive.

The circuit to be timed for an exposure of 1/120 of a second may be traced as follows: Wire 53, binding post 110, flexible connection 111, contact brush 107, contact sector
35 23, connecting wire 23f, contact ring 31, brush 37, wire 43, contact button 49, contact sector 50, wire 52, X-ray transformer or other mechanism to be timed (not shown),
40 back to wire 53.

If the exposure required is to be 1/60 of a second, and the sector 50 is accordingly brought into engagement with the two buttons 48 and 49, the circuit to be timed resolves itself into two distinct branches, which
45 are energized in succession, one through the sector 22 and the other through the sector 23, and which may be traced as follows: First, wire 53, binding post 110, flexible connection 111, contact brush 107, contact sector 22, connecting wire 23e, contact ring 30, brush 36,
50 wire 42, contact button 48, sector 50, wire 52 to X-ray transformer, or other member to be timed, thence back to wire 53; and, second, wire 53, binding post 110, flexible connection 111, contact brush 107, contact sector 23, connecting wire 23f, contact ring 31, brush 37, wire 43, contact button 49, sector
55 50, wire 52 to X-ray transformer, etc., and back to wire 53.

Thus the exposure of 1/60 of a second is made by virtue of the fact that the two sectors 23 and 22 are energized one at a time, the
65 work of the sector 23 beginning where the

work of the sector 22 leaves off, and each of the two sectors in succession being active for 1/120 of a second; that is, during one-half of a cycle, or while the motor shaft is making one-third of a complete revolution. 70

Similarly, if the sector 50 be shifted into engagement with the three contact buttons 47, 48, and 49, the circuit to be timed resolves itself into three branches to be energized in succession, through the respective sectors 21,
75 22 and 23, and thus making an exposure of 1/40 of a second, corresponding to a single turn of the shaft 13.

Again, if the sector 50 be brought into contact with additional contact buttons 46, 45
80 and 44, the exposure is lengthened at the rate of 1/120 of a second for each contact button.

In all instances the time of the exposure is an aliquot part of a second, simply because it is measured by an aliquot fraction of a cycle. 85 While the maximum and minimum time limits for exposure may be varied by proportioning the parts of the machine, it is convenient in practice to have each exposure exactly
90 1/120 of a second, or for some exact multiple or sub-multiple of this particular period, if the current used is of sixty cycles per second.

From the foregoing description it will be noted that the carriage 101 is under manual control to a great extent, since it is thrown
95 into and out of action by the magnets 71 and 73, and these magnets are controllable by the hand grip switch 69.

Whenever the operator closes this switch the carriage begins its travel in one direction, and during its travel in that direction the exposure is made. 100

Whether the exposure be long or short the carriage always finishes its complete stroke to the right. When all exposures required are completed, the operator opens the hand switch 57 and thus de-energizes the motor circuit, leaving all parts of the mechanism
105 idle and in normal condition.

I do not limit myself to the particular mechanism here illustrated and described, as variations may be made therein without departing from my invention, the scope of which is commensurate with my claims. 110

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is as follows: 115

1. In a synchronously operated timing device the combination, with a synchronous motor of a revoluble shaft driven by said motor, a plurality of contact sectors carried by said revoluble shaft and insulated therefrom and from each other, said contact sectors being disposed end to end in the form of
120 a thread, a contact brush for engaging said sectors in succession as said contact sectors are turned by the rotation of said shaft, mechanism for shifting said brush and maintaining it in engagement with said contact
125 130

sectors in succession as said shaft is turned, a circuit to be timed, said circuit being normally open, and mechanism controllable by the operator for completing said circuit through said contact brush and through a predetermined number of said contact sectors as brought successfully into engagement with said contact brush.

2. In a synchronously operated timing device the combination, with a synchronous motor of a revoluble shaft driven by said motor, a plurality of contact sectors carried by said revoluble shaft and insulated therefrom and from each other, said contact sectors being disposed end to end in the form of a thread, a contact brush for engaging said sectors in succession as said contact sectors are turned by the rotation of said shaft, mechanism for shifting said brush and maintaining it in engagement with said contact sectors in succession as said shaft is turned, a circuit to be timed, said circuit being normally open, mechanism controllable by the operator for completing said circuit through said contact brush and through a predetermined number of said contact sectors as brought successfully into engagement with said contact brush, mechanism connected with said contact brush for restoring said contact brush to a predetermined normal position after each engagement between said contact brush and said contact sectors, and means for preventing the accidental engagement between said contact brush and said contact sectors as said contact brush is restored to its said predetermined normal position.

3. In a synchronously operated timing device the combination, with a synchronous motor of a revoluble shaft driven by said motor, a plurality of contact sectors carried by said revoluble shaft and insulated therefrom and from each other, said contact sectors being disposed end to end in the form of a thread, a contact brush for engaging said sectors in succession as said shaft is turned, means for moving said brush as said shaft is turned, and thus keeping said contact brush in engagement with said contact sectors, a circuit to be timed, said circuit including said contact brush and being provided with a plurality of separate branches leading to said contact sectors respectively, said circuit being normally open through all of said branches, and selective mechanism, connected with all of said branches and coacting with said contact brush for closing said circuit through some of said branches in a predetermined order of succession.

4. In a synchronously operated timing device the combination, with a synchronous motor of a revoluble shaft driven by said motor, a plurality of contact sectors carried by said revoluble shaft and insulated therefrom and from each other, said contact sectors

being disposed end to end in the form of a thread, a contact brush for engaging said sectors in succession as said shaft is turned, means for moving said brush as said shaft is turned and thus keeping said contact brush in engagement with said contact sectors, a circuit to be timed, said circuit including said contact brush and being provided with a plurality of separate branches leading to said contact sectors respectively, said circuit being normally open through all of said branches, selective mechanism, connected with all of said branches and coacting with said contact brush for closing said circuit through some of said branches in a predetermined order of succession, and mechanism connected with said contact brush for preventing said contact brush from engaging said contact sectors as said brush is moved back past said contact sectors and restored to a predetermined normal position.

5. In a synchronously operated timing device the combination, with a synchronous motor, of a revoluble shaft driven by said motor, a plurality of contact sectors carried by said revoluble shaft and insulated therefrom and from each other, said contact sectors being disposed end to end in the form of a thread, a contact brush for engaging said sectors in succession as said shaft is turned, a circuit to be timed, said circuit including said contact brush and having a plurality of separate branches leading to said contact sectors respectively, said circuit being normally open through all of said branches, and a selective switch connected with all of said branches and controllable by the operator, for enabling some but not others of said contact sectors to complete said circuit by engagement with said contact brush.

6. In a synchronously operated timing device the combination, with a synchronous motor, of a revoluble shaft driven by said motor, a plurality of contact sectors carried by said revoluble shaft and insulated therefrom and from each other, said contact sectors being disposed end to end in the form of a thread, a contact brush for engaging said sectors in succession as said shaft is turned, a circuit to be timed, said circuit including said contact brush and having a plurality of separate branches leading to said contact sectors respectively, said circuit being normally open through all of said branches, mechanism connected with said contact brush and driven by said motor for shifting said contact brush as said shaft is turned, in order to hold said contact brush in engagement with said contact sectors, mechanism for shifting said contact brush back into a predetermined normal position, means for preventing said contact brush, while thus being shifted, from again engaging said contact sectors, and a selective switch connected with all of said branches and controllable by the operator, for ena-

bling some but not others of said contact sectors to complete said circuit by engagement with said contact brush.

7. In a synchronously operated timing device the combination, with a synchronous motor, of a revoluble shaft driven by said motor, a plurality of contact sectors carried by said revoluble shaft and insulated therefrom and from each other, said contact sectors being disposed end to end in the form of a thread, a contact brush for engaging said sectors in succession as said shaft is turned, a circuit to be timed, said circuit including said contact brush and being divided into a plurality of separate branches leading to said contact sectors respectively, said circuit being normally open through all of said branches, selective mechanism connected with all of said branches and controllable by the operator, for closing said branches one at a time in a predetermined order of succession.

8. In a synchronously operated timing device the combination, with a synchronous motor, of a revoluble shaft driven by said motor, a plurality of contact sectors carried by said revoluble shaft and insulated therefrom and from each other, said contact sectors being disposed end to end in the form of a thread, a contact brush for engaging said sectors in succession as said shaft is turned, a circuit to be timed, said circuit including said contact brush and being divided into a plurality of separate branches leading to said contact sectors respectively, said circuit being normally open through all of said branches, selective mechanism connected with all of said branches and controllable by the operator for closing said branches one at a time in a predetermined order of succession, means for moving said contact brush backwardly in relation to said contact sectors in order to restore said contact brush to a predetermined normal position, and mechanism connected with said contact brush for preventing engagement between said contact brush and said contact sectors as said contact brush is thus restored to its said predetermined normal position.

9. In a timing device the combination of a revoluble shaft, a plurality of contact sectors carried by said shaft and revoluble therewith, said contact sectors being insulated from said shaft and from each other, a rocker frame disposed adjacent said shaft and mounted to rock toward and from the same, mechanism for actuating said rocker frame, a carriage mounted upon said rocker frame, a contact brush supported by said carriage and movable therewith so as to engage one of said contact members when said rocker frame is rocked in one direction of its travel, mechanism controllable by the rotation of said shaft for moving said carriage so as to shift said contact brush from one of said contact sectors to another in succession, a circuit connect-

ed with said contact sectors and said contact brush, said circuit being timed by the engagement of said contact brush with said sectors, mechanism controllable by the operator for varying at will the number of said contact sectors included in said circuit.

10. In a timing device the combination of a revoluble shaft, a plurality of contact sectors carried by said shaft and revoluble therewith, said contact sectors being insulated from said shaft and from each other, a rocker frame disposed adjacent said shaft and mounted to rock toward and from the same, mechanism for actuating said rocker frame, a carriage mounted upon said rocker frame, a contact brush supported by said carriage and movable therewith so as to engage one of said contact members when said rocker frame is rocked in one direction of its travel, mechanism controllable by the rotation of said shaft for moving said carriage so as to shift said contact brush from one of said contact sectors to another in succession, a circuit connected with said contact sectors and said contact brush, said circuit being timed by the engagement of said contact brush with said sectors, mechanism controllable by the operator for varying at will the number of said contact sectors included in said circuit, mechanism for restoring said carriage to a predetermined normal position, and mechanism connected with said carriage and controllable by movements thereof for preventing said contact brush from engaging said contact sectors as said carriage is being restored to its said predetermined normal position.

11. In a timing device the combination of a revoluble shaft, a worm mounted thereon and provided with threads of coarse pitch, a plurality of contact sectors carried by said shaft and insulated therefrom and from each other, said contact sectors being arranged end to end in the form of threads of the same pitch as the threads of the worm, a carriage disposed adjacent said revoluble shaft and movable in the direction of the length thereof, a thread finger mounted upon said carriage and movable into engagement with the threads of said worm, thus causing said carriage to be moved by the rotation of said shaft, a contact member mounted upon said carriage and adapted to engage said contact sectors one at a time as said carriage is moved and said shaft is rotated, and a timing circuit including said contact brush and connected with all of said contact sectors.

12. In a timing device the combination of a revoluble shaft, a worm mounted thereon and provided with threads of coarse pitch, a plurality of contact sectors carried by said shaft and insulated therefrom and from each other, said contact sectors being arranged end to end in the form of threads of the same pitch as the threads of the worm, a carriage dis-

posed adjacent said revoluble shaft and movable in the direction of the length thereof, a thread finger mounted upon said carriage and movable into engagement with the threads of said worm, thus causing said carriage to be moved in one direction of its travel by the rotation of said shaft, a contact member mounted upon said carriage and adapted to engage said contact sectors one at a time as said carriage is moved and said shaft is rotated, a timing circuit including said contact brush and connected with all of said contact sectors, and mechanism connected with said carriage and operated independently of the rotation of said shaft for restoring said carriage to a predetermined normal position.

13. In a timing device the combination of a revoluble shaft, a worm mounted thereon and provided with threads of coarse pitch, a plurality of contact sectors carried by said shaft and insulated therefrom and from each other, said contact sectors being arranged end to end in the form of threads of the same pitch as the threads of the worm, a carriage disposed adjacent said revoluble shaft and movable in the direction of the length thereof, a thread finger mounted upon said carriage and movable into engagement with the threads of said worm, thus causing said carriage to be moved in one direction of its travel by the rotation of said shaft, a contact member mounted upon said carriage and adapted to engage said contact sectors one at a time as said carriage is thus moved and said shaft is rotated, a timing circuit including said contact brush and connected with all of said contact sectors, mechanism connected with said carriage and operated independently of the rotation of said shaft for restoring said carriage to a predetermined normal position, and means for preventing said contact brush from engaging said contact sectors as said carriage is thus restored to its said predetermined normal position.

14. In a timing device the combination of a revoluble shaft, a worm mounted thereon and provided with threads of coarse pitch, a plurality of contact sectors carried by said shaft and insulated therefrom and from each other, said contact sectors being arranged end to end in the form of threads of the same pitch as the threads of the worm, a carriage disposed adjacent said revoluble shaft and movable in the direction of the length thereof, a thread finger mounted upon said carriage and movable into engagement with the threads of said worm, thus causing said carriage to be moved by the rotation of said shaft, a contact member mounted upon said carriage and adapted to engage said contact sectors one at a time as said carriage is moved and said shaft is rotated, a circuit to be timed, and a selective switch included in said circuit and coacting with said contact brush

for automatically closing said circuit through first one and then another of said contact sectors, in a predetermined order of succession.

15. In a timing device the combination of a revoluble shaft, a worm mounted thereon and provided with threads of coarse pitch, a plurality of contact sectors carried by said shaft and insulated therefrom and from each other, said contact sectors being arranged end to end in the form of threads of the same pitch as the threads of the worm, a carriage disposed adjacent said revoluble shaft and movable in the direction of the length thereof, a thread finger mounted upon said carriage and movable into engagement with the threads of said worm, thus causing said carriage to be moved by the rotation of said shaft, a contact member mounted upon said carriage and adapted to engage said contact sectors one at a time as said carriage is moved and said shaft is rotated, a plurality of separate conductors connected with said contact sectors respectively, a timing circuit, and means for selectively including one or more of said contact sectors in said timing circuit.

16. In a timing device the combination of a revoluble shaft, a worm mounted thereon and provided with threads of coarse pitch, a plurality of contact sectors carried by said shaft and insulated therefrom and from each other, said contact sectors being arranged end to end in the form of threads of the same pitch as the threads of the worm, a carriage disposed adjacent said revoluble shaft and movable in the direction of the length thereof, a thread finger mounted upon said carriage and movable into engagement with the threads of said worm, thus causing said carriage to be moved by the rotation of said shaft, a contact member mounted upon said carriage and adapted to engage said contact sectors one at a time as said carriage is moved and said shaft is rotated, a plurality of separate conductors connected with said contact sectors respectively, a timing circuit, a selective switch connected with all of said conductors and controllable by the operator for including one or more of said contact sectors in said timing circuit, and mechanism connected with said carriage and controllable by the operator for moving said carriage away from said revoluble shaft and thereby disconnecting said contact brush.

17. In a timing device the combination of a revoluble shaft, a worm mounted thereon and provided with threads of coarse pitch, a plurality of contact sectors carried by said shaft and insulated therefrom and from each other, said contact sectors being arranged end to end in the form of threads of the same pitch as the threads of the worm, a carriage disposed adjacent said revoluble shaft and movable in the direction of the length thereof, a thread finger mounted upon said car-

riage and movable into engagement with the threads of said worm, thus causing said carriage to be moved by the rotation of said shaft, a contact member mounted upon said carriage and adapted to engage said contact sectors one at a time as said carriage is moved and said shaft is rotated, a timing circuit including said contact member and at least one of said contact sectors, magnetic mechanism connected with said carriage for maintaining said carriage in position to enable said contact member to engage said contact sectors, means for releasing said carriage from its said position and causing it to move away from said shaft, and means for rotating said carriage to a predetermined normal position.

18. A circuit closing device comprising a revoluble shaft, a plurality of contact sectors mounted upon said shaft and insulated from said shaft and from each other, said contact sectors being disposed end to end and formed into a spiral thread, a carriage disposed alongside said shaft and movable in the direction of the length thereof, means for actuating said carriage and a contact member mounted upon said carriage and slidably engaged by said contact sectors in succession as said shaft is rotated and said carriage is moved.

19. The combination of a revoluble shaft, a worm carried by said shaft and provided with a thread of coarse pitch, a plurality of spiral contact sectors carried by said shaft and insulated from said shaft and from each other, said contact sectors being disposed end to end and formed into a spiral thread of the same pitch as the thread of said worm, a carriage disposed adjacent said revoluble shaft and mounted to travel in a path parallel therewith, a thread finger mounted upon said carriage and detachably engaging said thread of said worm, thereby enabling said worm to drive said carriage, a contact brush mounted upon said carriage and engaging the thread made up of said contact sectors, and electrical connections to said contact sectors and said contact brush.

20. A time switch comprising an electric motor, a contact drum driven by said motor provided with a conducting surface and a non-conducting surface about the periphery of said drum, a contact brush adjacent said drum movable longitudinally thereof and adapted to cooperate with the conducting and non-conducting surfaces of said drum during its movement, means connected with said contact brush and operable by rotation of said electric motor for moving said brush longitudinally of said drum, and means for rendering said last mentioned means effective to cause said contact brush to move longitudinally of said drum and to successively engage said conducting and non-conducting surfaces.

21. A time switch comprising an electric motor, a shaft driven by said motor, a con-

tact drum carried by said shaft provided with spirally disposed contact members successively positioned about the periphery of said drum, a screw thread carried by said shaft and positioned adjacent said drum, a carriage adjacent said shaft movable longitudinally of the latter, a contact brush and a thread finger carried by said carriage extending toward said shaft and spaced apart a distance corresponding to the spacing between said screw thread and said drum, means for causing the contact brush to engage the contact members of said drum and said thread finger to engage said screw thread whereby the contact brush is moved successively into engagement with the spirally disposed contact members during movement of said carriage longitudinally of said drum at a rate proportional to the speed of rotation of said drum.

22. A time switch comprising a synchronous electric motor connected to a suitable source of alternating current energy, a contact drum provided with conducting and non-conducting adjoining surfaces rotatable by said motor, said conducting and non-conducting surfaces forming a spiral about the periphery of said drum with said surfaces alternately arranged relative to each other, a contact brush adapted to engage the surface of said drum and move parallel to the axis of rotation thereof, means for causing said contact brush to engage the surface of said drum and trace the spiral path formed by said conducting and non-conducting surfaces during its movement parallel to the axis of rotation of said drum, and means for adjusting the rotative position of said drum relative to said synchronous motor to cause said contact brush to pass from one of said conducting surfaces to another at a predetermined point in the wave of the alternating current supplied to said motor.

23. A time switch comprising a synchronous motor, a contact drum connected to said motor and operable therewith, a contact brush cooperating with said contact drum upon operation of the latter by said motor for completing an electrical circuit, an alternating current source of electrical energy for said motor and for supplying a circuit through said contact drum and cooperating contact brush, means for adjusting the duration of closure of the circuit through said contact brush and said drum, and means for adjusting the time of operation of said contact drum and cooperating contact brush relative to the phase of the alternating current wave of the circuit.

Signed at Long Island City, in the county of Queens and State of New York, this 19th day of July 1930.

ARTHUR MUTSCHELLER.