May 7, 1935. F. LOEFFLER 2,000,600

ELECTRIC CLOCK

Original Filed Sept. 25, 1930 6 Sheets-Sheet 1

Fig. 1.

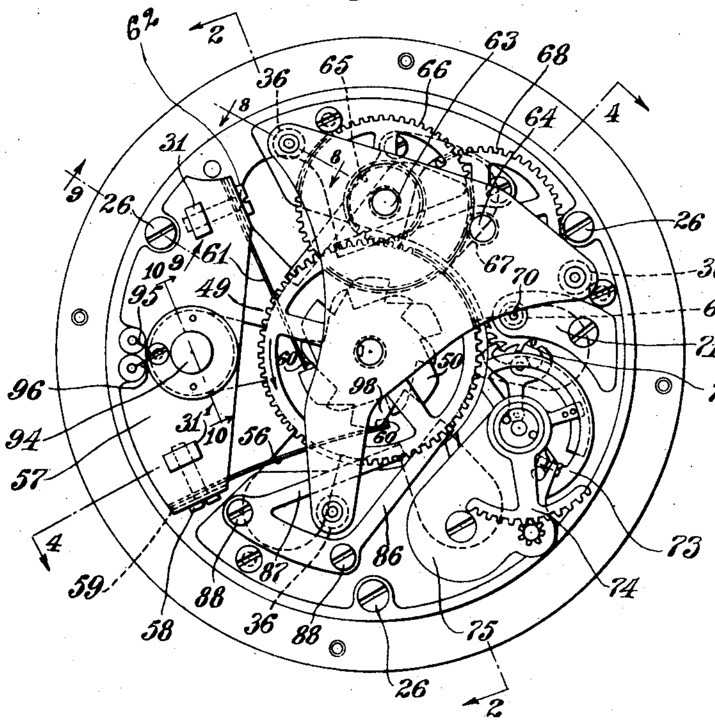
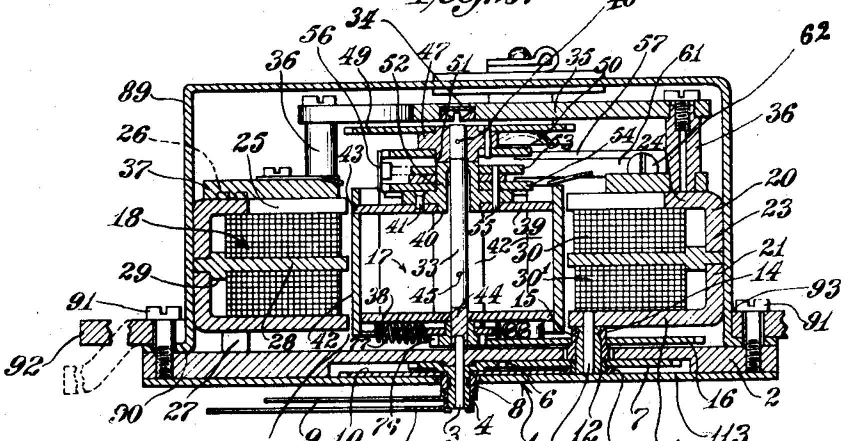


Fig. 2.



FRITZ LOEFFLER
INVENTOR

BY [signature]

ATTORNEY

May 7, 1935. F. LOEFFLER 2,000,600

ELECTRIC CLOCK

Original Filed Sept. 25, 1930 6 Sheets-Sheet 2

Fig. 3.

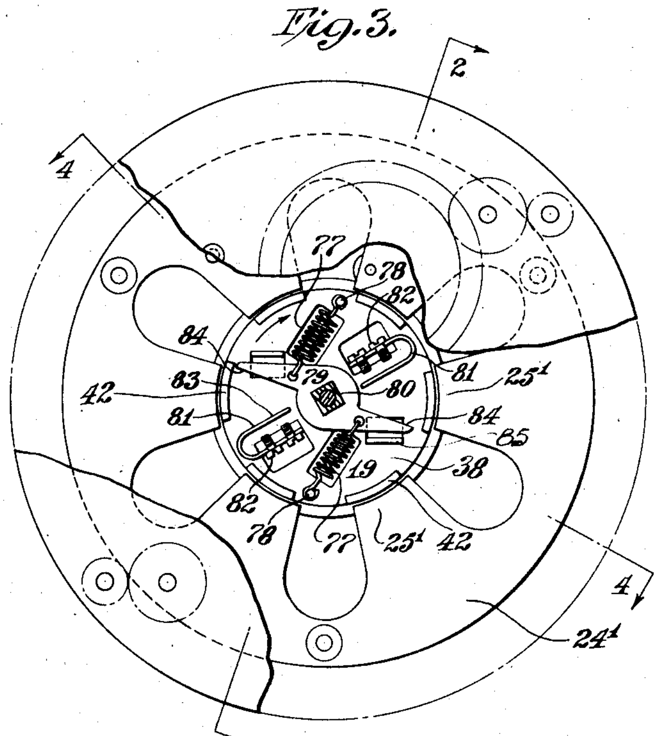
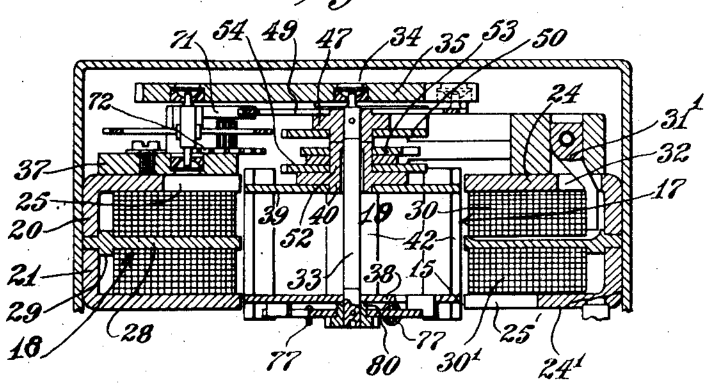


Fig. 4.



FRITZ LOEFFLER
INVENTOR

BY

ATTORNEY

May 7, 1935. F. LOEFFLER 2,000,600

ELECTRIC CLOCK

Original Filed Sept. 25, 1930 6 Sheets-Sheet 3

Fig. 5.

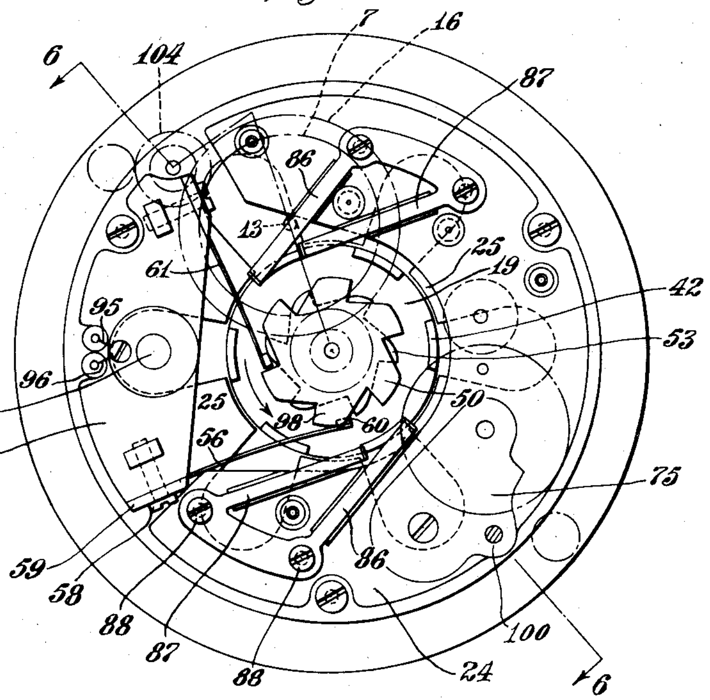
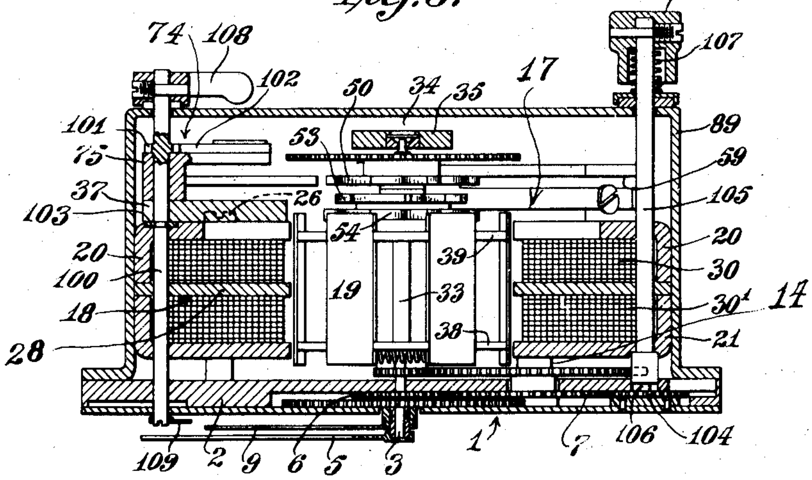


Fig. 6.



FRITZ LOEFFLER
INVENTOR

BY [signature]

ATTORNEY

May 7, 1935. F. LOEFFLER 2,000,600

ELECTRIC CLOCK

Original Filed Sept. 25, 1930 6 Sheets-Sheet 4

Fig. 7.

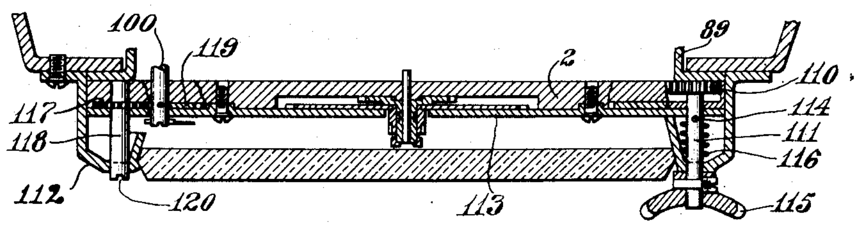


Fig. 8.

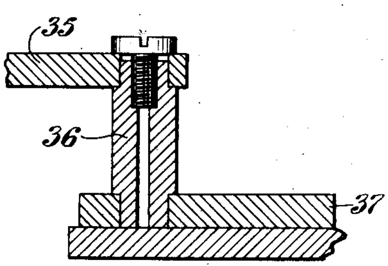


Fig. 9.

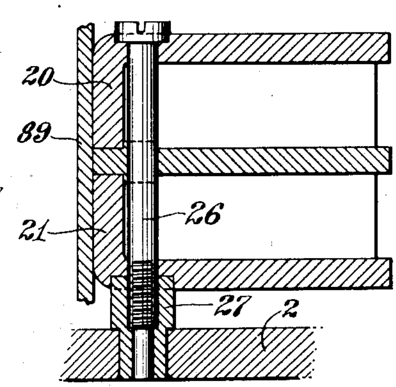
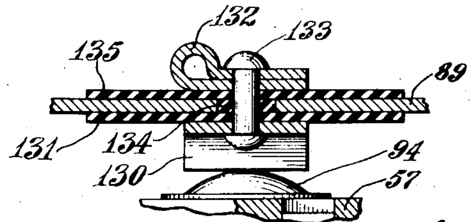


Fig. 10.



FRITZ LOEFFLER
INVENTOR

BY [signature]

ATTORNEY

May 7, 1935. F. LOEFFLER 2,000,600

ELECTRIC CLOCK

Original Filed Sept. 25, 1930 6 Sheets-Sheet 5

Fig. 12.

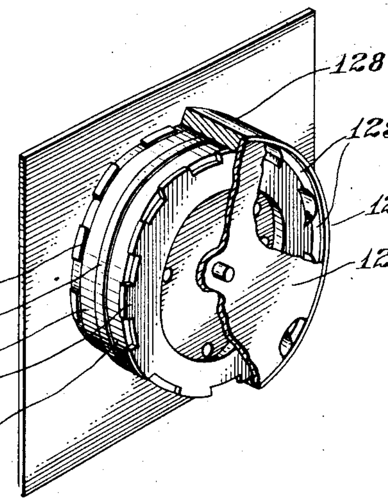


Fig. 13.

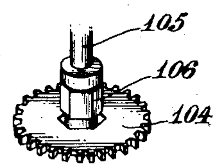
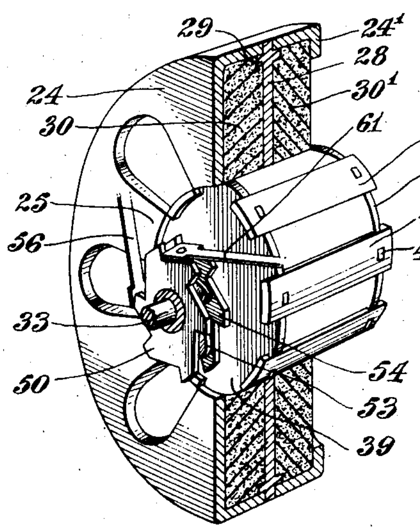


Fig. 11.



FRITZ LOEFFLER
INVENTOR

BY [signature]
ATTORNEY

May 7, 1935. F. LOEFFLER 2,000,600

ELECTRIC CLOCK

Original Filed Sept. 25, 1930 6 Sheets-Sheet 6

Fig. 14.

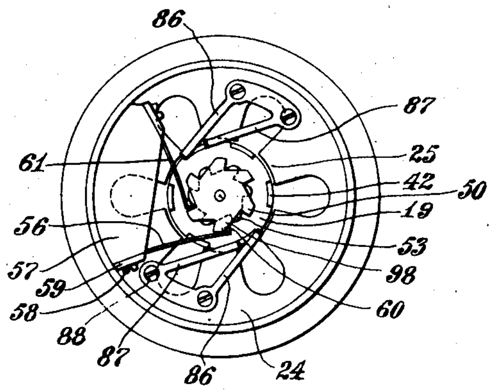


Fig. 15.

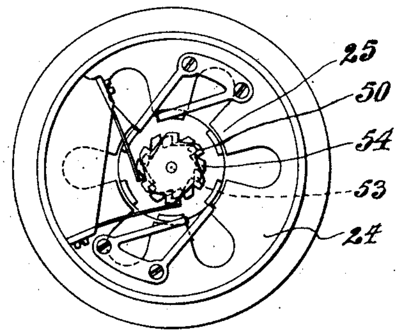


Fig. 16.

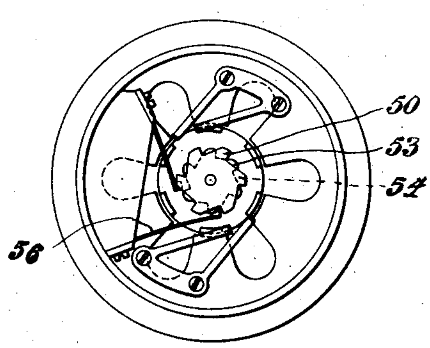
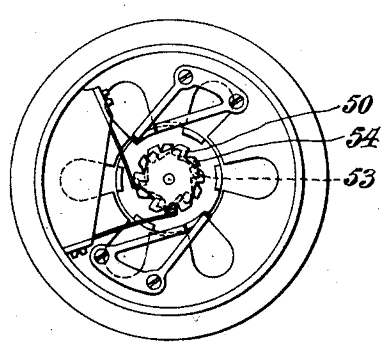


Fig. 17.



FRITZ LOEFFLER
INVENTOR

BY [signature]

ATTORNEY

UNITED STATES PATENT OFFICE

2,000,600

ELECTRIC CLOCK

Fritz Loeffler, Yonkers, N. Y.

Application September 25, 1930, Serial No. 484,330
Renewed October 6, 1934

27 Claims. (Cl. 185—40)

This invention relates to electrically driven clocks of the type wherein the driving motor operates intermittently to store up energy in a spring which serves to drive the clock escapement mechanism and hands.

It is an object of my invention to provide an improved and simple form of electric motor drive of the intermittently operating type which is arranged to apply at all times a substantially smooth and uniform driving torque to the gear trains and escapement mechanism of the clock works.

More specifically, it is an object of my invention to provide a clock driving motor which is very simple in construction and operation and to furnish between the moving element of the clock motor and the drive shaft of the clock works a driving connection of uniform resiliency, which is supplied with small amounts of energy at short intervals of time whereby a uniform driving effect upon the clock works is obtained.

A further object of my invention is the provision of an electrically driven clock wherein the escapement mechanism is placed in such a position that it is readily accessible, and to arrange the clock in a plurality of units, one comprising the escapement and associated gearing, another, the driving motor and a third, the clock plate which carries the hands or other driving mechanism and driving gear therefor.

Other objects include the association of the above mentioned units in such manner that they may readily be taken apart for repairs or replacements and the provision, for the entire mechanism, of a suitable enclosing housing or case and mounting means.

Still another object is to arrange the clock plate in such manner that the hand setting means and the escapement regulating mechanism may easily be changed from a position at the back side of the case to the front side thereof depending upon the type of mounting to which the clock is to be adapted.

In accordance with my invention I construct an electrically driven clock in the form of three units, one of which is a clock plate carrying the hands and operating gears, the second, an electrically driven motor, and the third, the escapement and gear train therefor. All three of these units are arranged to be held together by screws which are readily accessible and by means of which the different units can quickly be separated for replacement or repairs. I place the driving motor between the clock plate and escapement mechanism so that the escapement mechanism is at the back of the clock and in an exposed and readily accessible position. This insures that this portion of the mechanism, which is usually the first to require attention, may readily be adjusted and repaired.

For the driving motor I prefer to utilize a special design of mechanism wherein the rotor has no winding, and which is adapted to turn step by step through small angular distances. This driving motor may comprise a pair of annular magnetizing coils placed side by side and associated with pole pieces which are so arranged that the teeth of one of the pole pieces are offset angularly with respect to the teeth of the other pole pieces. Means is supplied for furnishing power to the coils alternately so that a series of successive power impulses are obtained. Between the clock shaft and rotor of the driving motor is placed a resilient coupling means such as a spring, which serves to store up the intermittent energy of the motor and apply it steadily to the clock drive shaft. For controlling the operation of the motor I utilize a contacting mechanism which may comprise a plurality of toothed wheels of insulating material and a concentrically mounted toothed contactor disc. One insulating disc and the contactor are mounted to turn with the rotor and the other insulating disc arranged to turn with the clock drive shaft. Spring brushes are provided to cooperate with these toothed discs and proper connections made so that when current is supplied to the motor, one of the magnetizing coils is energized and a quantity of energy stored in the resilient coupling means. As the clock escapement operates, using up a portion of this energy, the drive shaft of the clock turns carrying with it its associate toothed disc. This turning motion continues until the energy in the aforementioned resilient coupling means is nearly expended, whereupon a position is reached by the disc which causes contact to be made between the contactor and one of the brushes whereby the other coil is magnetized and an additional amount of energy stored up in the resilient coupling means. This cycle of operation is repeated continuously whereby energy is alternately stored up and then used and the clock works kept running steadily. For coupling the electric motor to the clock drive shaft, I prefer to utilize a pair of coil springs placed in balanced relationship so that the side thrust on the clock drive shaft and the motor rotor caused by one spring, is opposed and balanced by that produced by the other spring.

The above mentioned and other objects and advantages of my invention and the manner of constructing the preferred embodiment and various modifications, will be made clear in the following description and accompanying drawings.

In the drawings, Fig. 1 is a top plan view of the clock mechanism with the casing removed.

Fig. 2 is a sectional view taken along line 2—2 of Fig. 1.

Fig. 3 is a bottom plan view having part of the clock plate broken away.

Fig. 4 is a sectional view with the clock plate removed taken along line 4—4 of Fig. 1.

Fig. 5 is a top plan view similar to Fig. 1 except that the gears are removed.

Fig. 6 is a sectional view taken along line 6—6 of Fig. 5 and shows a form of time unit adapted for back mounted instruments.

Fig. 7 shows one form of clock plate unit which may be used for front mounted instruments.

Figs. 8 and 9 are sectional views taken along lines 8—8 and 9—9 respectively of Fig. 1, showing the manner of supporting parts of the clock.

Fig. 10 is a view in section taken along line 10—10 of Fig. 1, showing the terminal connection and clock casing.

Fig. 11 is a sectional perspective view of the clock driving motor.

Fig. 12 shows a modified form of motor.

Fig. 13 is a perspective view showing a portion of the mechanism for setting the clock hands.

Figs. 14, 15, 16 and 17 are views showing the relation of the stator, rotor and commutator at different time intervals during the cycle of operation of the motor.

Referring more particularly to the drawings, reference numeral 1 indicates generally a time unit comprising a clock plate 2 carrying a dial 113. Plate 2 serves to support a pin 3 having journaled thereon a sleeve 4, to one end of which is fixed the minute hand 5 and to the other end of which is secured a pinion 6 which meshes with a gear 7. Rotatably mounted on the sleeve 4 is a second sleeve 8 which carries at one end an hour hand 9 and at the other end a gear 10 which in turn meshes with a pinion 11 (Fig. 2). The pinion 11 is firmly fixed to the gear 7 and both are secured to and supported by a sleeve 12 which is rotatably mounted on a pin 13. The sleeve 12 is encircled by a clutch member 14 which frictionally engages it. This clutch member may be a tube of steel or other suitable material which is forced onto sleeve 12 tightly enough to grip it frictionally. The sleeve 12 may be turned down intermediate its edges as shown in 15, in order to aid in the assembling of the parts. When this is so reduced in diameter, the clutch member 14, which has a bore slightly smaller than the diameter of the sleeve 12, may be forced into position, during which action it will be placed under slight tension sufficient to insure a smooth clutch action. The clutch member 14 has secured thereto a gear 16.

The electric driving motor

Reference numeral 17 indicates generally an electric driving unit. This motor comprises a stator unit designated generally by 18 and a rotor unit designated generally by 19. The stator unit includes a pair of frame members 20 and 21, each of which has a cylindrical portion 23. Frame member 20 has an end or pole plate 24 provided with a plurality of pole pieces 25 (see Figs. 1, 3 and 5) and member 21 has similar parts 24' and 25'. The two frame members are so arranged angularly that the pole pieces of one member are in axial alignment between the spaces between the pole pieces of the other, i. e., one member is advanced angularly with respect to the other through a distance equal the width of one pole piece. Positioned between the two end plates of the frame members is a disc or washer 28 which has no pole pieces. This washer may be held in position in any suitable manner, for example, it may be placed between the adjacent edges of the frame members 20 and 21 in which case the disc may have a rib or shoulder 29 which serves to center the frame members and disc relative to one another. The frame member 21 serves also to support the pin 13 mentioned above. Filling the space between 28 and the two frame members 20 and 21 are magnetic windings or energizing coils 30 and 30'. One terminal of each of these coils is connected to a spring contact 94 supported by an insulating block 57; the other end of coil 30 is connected to a terminal strip 31' which projects through a hole 32 in the frame member. The frame members 20 and 21 may be clamped together and to the clock plate 2 by means of screws 26 each of which passes through the frame members and engage a nut in the form of a stud or boss 27. This stud fits in a hole in the plate 2 and may be held therein by riveting or otherwise (Figs. 1, 2 and 9).

The rotor unit 19 comprises a shaft 33 which is journaled at one end on the pin 3 and at the other end in a bearing 34 held by a bearing plate 35. This bearing plate is in turn supported by bosses 36 (Figs. 2 and 8) extending upwardly from a base plate 37 secured to the frame member 20. The shaft carries rotatably mounted thereon intermediate its ends, two spiders 38, 39 which may be of non-magnetic material. The spider 38 is supported directly from the shaft whereas between the spider 39 and the shaft, a bearing sleeve 40 is interposed. This sleeve is secured to the spider by any suitable means, such as rivets 41. Connecting the two spiders is a series of magnetic bars 42 whose width may be substantially equal to or less than that of the pole pieces 25 and the spacing thereof is substantially equal to the distance between pole pieces carried by one frame member. The bars may be fastened to the spiders in any manner but I prefer to position each bar in a slot in each spider and have intermediate the edges of the bar a hole through which a portion of the spider material passes in the form of a rivet 43. The shaft 33, which has to fit its bearings closely, is made largest at end 44 forming the bearing for spider 38 and is reduced in size at the midsection 45 which provides at one end thereof a bearing for the sleeve 40. The shaft is further reduced beyond said sleeve and has secured thereto a flange plate 47 by means of a pin 48. This flange plate has fixed to one side thereof a gear 49 and to the other side thereof a ratchet plate or toothed disc 50 which is of insulating material. The inside of bearing sleeve 40 is enlarged to clear the shaft on the end adjacent to the spider 39, the outer end 51 only forming the point of support. By removing the point of contact between the sleeve and the shaft 33 as far as possible from the point of bearing of the spider 38 on the shaft, better alignment is assured. As the bearings are spaced widely apart any wear will not seriously affect the alignment of the various parts of the rotor with respect to the stator unit. The tubular portion 52 of sleeve 40 carries a small toothed disc or contactor 53, the teeth of which are the same in number and general shape to those of disc 50 and are of conducting material, preferably silver alloy. A second toothed disc 54 of insulating material similar to the first disc 50 is also carried by the hub 52. Both discs 53 and 54 are fixed on a hub by rivets 55 or other suitable means. The outside diameter of the contactor 53 is slightly less than that of the two insulating discs 50 and 54. A contact spring or brush 56 is arranged to rest on both the insulating disc 50 and contactor 53, as well as on insulating disc 54. This spring is fastened to an insulating block 57, secured to the end plate 24 of the stator, by means of a screw 58. This screw passes through a hole in the insulating block and engages a threaded aperture in the terminal strip 31' thereby making connection with the coil 30'. The spring 56 fits in a recessed seat 59 in the end of the block 57 and is thereby prevented from angular displacement (Fig. 6). The contact spring 56, which may be of any suitable material, such as phosphor-bronze, carries at its free end a contact button 60 which may be of silver or other highly conducting and spark resisting material. This button is preferably riveted to the contact spring. A similar contact spring or brush 61 is secured to the block in like manner by a screw 62 which engages a terminal strip 31 which serves as a circuit connection for the other winding 30. The brush 61 is associated with the contactor 53 and the insulating discs 50 and 54 similarly to brush 56. The outside diameter of the insulating toothed discs 50 and 54 is just enough larger than the outside diameter of the contactor 53 to lift the brushes 56 and 61 free from the contactor 53, thereby breaking the circuit between the contactor and the buttons carried by the brushes. The brushes are so positioned that with no current supplied to the device, one brush rests on the contactor 53, and the other on the insulating discs, as shown in Fig. 14.

The escapement mechanism

Rotatably supported in bearings carried by base plate 37 and bearing plate 35 are two gear-carrying spindles 63 and 64. The spindle 63 has fixed thereto a pinion 65 and gear 66. The pinion meshes with the gear 49 carried by the rotor shaft 33 and the gear 66 meshes with a pinion 67 carried on the shaft 64. The shaft 64 also has fixed thereto a gear 68 which meshes with a pinion 69 fixed to a spindle 70, which is rotatably supported by a bracket 71 fixed on the base plate 37. The spindle 70 also carries toothed escapement wheel 72 which cooperates with the usual fork and that in turn oscillates the balance wheel 73. The balance wheel with its well known adjusting mechanism 74 is supported as a unit by a bearing block 75 carried by the base plate 37. Because of the separable structure of the escapement mechanism, these units may readily be removed for repairs whenever necessary without dismantling either the driving motor or gear units.

General assembly

The rotor shaft 33 has fixed to the end thereof which is journalled on the pin 3, a pinion 76 which meshes with the gear 16 of the clock train or time unit. As the spiders 38 and 39 are mounted for free rotation on the shaft 33, a driving connection between the spiders and the shaft is necessary. This connection must be resilient in order that the spaced impulses of the driving motor will be smoothed out into a uniform torque which is applied through the gear 49 at one end of the shaft to the train of gears leading to the escapement and through the pinion 76 at the other end of the shaft, to the time unit which drives the clock hands. This connection between the rotatably mounted spider and the drive shaft 33 is obtained by means of a pair of springs 77, each of which is fastened at one end to the spider 38, as shown at 78 and at the other end is connected to a double lever arm 79. This arm 79 has a square hole intermediate the ends thereof which fits onto a square shoulder 80 of the pinion 76. By means of the springs, which are connected to points of the arms 79 spaced equal distances from the axis of rotation thereof, a driving connection is made between the spiders, which are rotated by the magnetic attraction between the energized pole pieces and the bars 42, and the shaft 33. The shaft 33 is, however, not free to rotate, being held back by the gear train leading to the escapement mechanism and therefore upon each driving impulse of the motor, the springs 77 are tensioned. As the two springs are arranged symmetrically on each side of the shaft 33, wear on the bearing surfaces between the spiders and shaft 33 is reduced. The side thrust induced by one spring is balanced by that of the other. In order to prevent shock to the driving mechanism in case the movement of the rotor under the influence of the energizing current is very great, a pair of bumpers 81 are furnished. Each of these bumpers comprises an angle clip 82 which is fixed to spider 38 or made integral therewith, and supports a U-shaped leaf spring 83 with its open side pointed towards the axis of rotation of the spider. These springs are so arranged as to be engaged by faces 84 of the arm 79. The shaping of the springs and the cooperating faces 84 is such that the free end of the spring is engaged first, this engagement necessarily being made near to the axis of rotation of the arms 79. For this reason, the initial retarding action of the bumper springs 83 is relatively small but as the springs deflect, the contact is made at points successively greater in distance from the axis of rotation whereby the retarding action is increased. In order to prevent the arms 79 from turning too far in the opposite direction, two stops 85 are secured to the spider 38. Like the clips 82 these stops may be made integral with the spider, by cutting and bending up a portion of the metal, for example. These parts appear most clearly in Figs. 2 and 3.

In order to maintain the bars 42 slightly offset from their adjacent pole faces when the motor is deenergized and to prevent reverse rotation of the rotor, pawl springs 86 and 87 are provided. These springs are fastened to the base plate 37 by means of screws 88 and have their free ends arranged to engage with some suitable ratchet means. As shown in the drawings, the ends of the magnetic bars 42, which project slightly beyond the spider 39, serve as a ratchet. The spacing between the ends of the springs 86 and 87 along the arc of the circle traversed by the magnetic bars **42** is such that spring **87** falls into place back of the projecting end of one of the bars **42** while the spring **86** is left free. Upon advancement of the rotor so that the magnetic bars move ahead one pole piece, pawl spring **86** drops back of the bar just mentioned and the spring **87** is left free. From this it will be seen that the springs serve alternately to hold the rotor against reverse rotation. Two sets of pawl springs may be used as shown, in which case the side thrust caused by one will be counteracted by that produced by the other, with the result that wear on the bearings will be reduced.

The entire motor and gearing is enclosed by a cover or case **89** which fits snugly around the outside of the stator frame members **20** and has a flange **90** bearing against the clock plate **2**. It is held in position by means of a plurality of screws **91** which may serve also as a means of mounting the clock. One manner of mounting is shown, for example, in Fig. 2 wherein the screws **91** pass through holes in a panel **92**, the clock plate **2** being on the front side of the panel and the enclosed works passing through an opening **93** in the panel.

For setting the clock hands a gear **104** (Figs. 5 and 6) is furnished, which rests in an opening in the plate **2**, and meshes with gear **7** of the clock or hand driving gear train. By turning the gear **104** the gear **7** is rotated moving the clock hour hand **5**, through the agency of gear **6**. During the hand setting operation the clutch member **14** slips thereby permitting the setting operation to take place independently of the driving motor. For rotating gear **104** a shaft **105** is provided. This shaft which passes through suitable openings in the frame members **20**, **21**, has at one end a clutch member **106**, shown most clearly in Fig. 13, which is adapted to engage a non-circular shaped opening in the gear. The shaft has fixed to its other end a knob or button **106'** and between the knob and the case is interposed a compression spring **107** which serves to keep the clutch member **106** normally out of engagement with the gear **104**. When the knob is pushed in, the clutch **106** engages with the opening in the gear so that as the knob **106'** is rotated the shaft **105**, gear **104**, and gear **7** are rotated as well, with the result that the clock hands are moved to a new position.

The adjusting mechanism **74**, which is for regulating the escapement to cause the clock works to run faster or slower, may be operated by a shaft **100** (Figs. 5 and 6) carrying a gear **101** meshing with a sector **102** which serves, in the well known manner, to tension the hair spring of the escapement balance wheel. Endwise movement of this shaft is prevented by a split washer **103** which engages a groove in the shaft, the washer being inserted in a pocket provided between the base plate **37** and frame member **20**. The shaft **100** has at one end an operating handle **108** secured thereto and at the other end a pointer **109**. The entire clock may be adapted either for mounting substantially flush with a surface, under a common glass panel with other instruments, or for individual mounting with a separate crystal. In the former case the adjusting shafts **100** and **105** may project through the back of the case as shown, and in the latter case the clock plate may be arranged as shown in Fig. 7.

In Fig. 7 an extra gear **110** is carried by a shaft **111** which passes outwardly through the plate **2**, dial **113** and retaining ring **112**. A pin **114** passes through the shaft and a knob **115** is secured to the end of it. Between the pin **114** and the retaining ring a compression spring **116** is arranged, which thrusts the shaft **111** endwise and keeps the gear **110** normally out of mesh. In setting the hands the knob is first pulled outward to engage gears **110** and **104**, then rotated to move the clock hands. A gear **117** mounted on shaft **118** is meshed with a gear **119** fixed to shaft **100**. The shaft **118** passes outwardly through plate **2**, dial **113**, and retaining ring **112** and is furnished with a slot **120** by means of which it may be rotated to adjust the escapement mechanism **74**.

The manner of operation of the device

One connection is made to the frame of the clock, which is metallic, and serves to conduct current to the contactor **53**, and the other connection is made to the spring contact or circuit maker **94** carried by the block **57**, which is connected through wires **95**, **96** with one end of each of the coils **30**, **30'**. Assuming the rotor **19** and drive shaft **33** to be in the position shown in Figs. 1, 3, 5 and 14, brush **56** will be out of engagement with the contactor **53** but brush **61** will be in engagement with the contactor so that current will flow from one side of the line to the frame of the machine through the bearings of shaft **33** and the shaft to the contactor **53**, brush **61**, and to the terminal strip **31**, whence it will pass through the coil **30**, conductor **95**, circuit maker **94**, to the other side of the line, and cause a magnetic field to be set up thereby. This magnetic field causes flux to flow between the disc **28** and the pole pieces **25** of pole plates **24**, which, it will be recalled, are angularly displaced with respect to those appearing in Fig. 3 by the width of a bar **42**, whereupon the bars **42** will be attracted thereto. This attraction results in movement of the bars **42**, which are of magnetic material, from the position shown in Figs. 2, 3 and 5, in the direction of the arrow, the width of one bar, causing them to occupy a position opposite the pole pieces **25** of the pole plates **24** as shown in Fig. 15. This movement, because of the fact that the shaft **33** is unable freely to turn, results in tensioning of the springs **77**. Upon completion of the movement pawl spring **86** falls into position back of the adjacent bar **42** thereby holding the rotor against reverse movement and maintaining the springs **77** tensioned. Just prior to the time when the pawl spring **86** was about to drop into position one of the teeth **97** of insulating toothed disc **54** lifted the brush **61** slightly so that the button **60** severed connection with the contactor **53**, thereby breaking the circuit of the winding **30** and deenergizing the pole pieces **25**, the kinetic energy of the rotor being sufficient to continue the forward movement thereof until the pawl spring **86** acted.

As the escapement wheel **72**, through it associated gearing, permits the shaft **33** slowly to revolve and turn the clock hands, the contactor **53** and disc **54** remain stationary, being secured to the rotor which is held in a fixed position by pawl spring **86**, carrying with it the toothed disc **50**. At the start of the cycle in the conditions we first assumed, this disc was in alignment with the disc **54**, serving to hold the brush **56** free from the contactor **53** as shown most clearly in Fig. 5. Upon sufficient movement of the disc

50 as a result of turning of shaft 33 in driving the escapement mechanism, the tooth 98 thereof which has been holding up the brush, moves in the direction shown by the arrow in Fig. 1, out from under the brush 56 permitting it to snap down and force the button 60 against the contactor 53. Fig. 16 shows the relative position of the parts just at the instant this action takes place. The disc 54 has already been disengaged from the brush 56 by the previous movement of the rotor under the control of brush 61 and therefore does not prevent the brush 56 from snapping down. This movement of disc 54 has been completed by the time the springs 77 have become nearly untensioned so that they are in substantially the position which we initially assumed, the remaining tension being sufficient to keep the clock escapement in proper motion. Because of the cam-like shaping of the teeth of contactor 53 a wiping action is made by the brushes 56 and 61, on the making of contact. This insures a perfect circuit closure and a minimum of sparking. As soon as this contact is made between the brush 56 and the contactor 53, an energizing current is passed through the winding 30′ in the same manner as was described in connection with winding 30. Energization of the coil 30′ causes a magnetic flux to be passed between the disc 28 and the pole pieces 25′ of pole plate 24′. These pole pieces, being placed opposite the opening of the pole face 25, attract the bars 42 and advance the rotor to a position where the bars are situated to their original position between the pole faces 25. The connection is thereby broken and pawl spring 87 falls in behind the adjacent bar 42. The parts are now in the position shown in Fig. 17. The springs 77 are tensioned and the clock works will continue to run until the shaft 33 has turned sufficiently, by permission of the escapement, to cause coil 30 again to be energized whereupon the cycle above described will be repeated.

Referring to Fig. 5 it will be noted that the pawl spring 87 is so arranged as to hold the rotor slightly offset angularly in the direction of rotation thereof. This is to insure that the attraction of the magnetized pole pieces will be stronger for the rotor bars in the direction in which rotation is desired, so that when current is applied to the coils the rotor will be attracted in the proper direction. The pawl spring 86, when in holding position, maintains the rotor in the same relative position also. The brushes 56 and 61 are so related with respect to the contactor 53 and insulating discs 50 and 54 as to engage the contactor and close the energizing circuit while the springs 77 are still under some tension. This is necessary to insure that the clock driving energy will not be all expended just at the moment that more is supplied. If the spring energy were all used up at the instant the brush engaged the contactor, the probability is that the clock works would run periodically fast and slow. Therefore the reserve spring tension is needed.

Springs 77 and the associated mechanism may be arranged as shown, in which case if the external current supply is shut off for a longer period than that during which the spring tensioned by one tooth rotation of the rotor, will run the gear trains, the clock will stop. With this arrangement, when used in a small clock, the time interval may be two or three minutes, thereabouts, depending of course on the constructional details. The springs 77 may be arranged differently however in order to increase the time interval. This may be done by removing the bumpers 81 and replacing the springs 77 with a single spiral spring, or pair of such springs in balanced relationship. By making these springs relatively light and long and properly proportioning the size of coils 30 and 30′, the twist given to the rotor 19 by the initial application of current when the clock is first connected to the supply line, will be sufficient to turn the rotor past several teeth of contactor 53, the rotor turning through an arc corresponding to several of the bars 42, rather than only one, until the opposing tension of the springs 77 is sufficient to stop the rotor. Thereafter the rotor will maintain the springs at that relatively high tension by operation on a one tooth cycle as described heretofore. This action will insure a reserve spring tension sufficient to keep the clock works running over several idle cycles, resulting from an interruption in the power supply. This feature is particularly important where the clock is to be used on an automobile, as when the automobile engine starting motor is being used the voltage of the battery in the car may, for an appreciable interval of time, drop to a value below that necessary to operate the clock.

In place of the contactor and toothed discs of insulating material, cams might be used to operate a pair of circuit controlling contacts. In this case no contactor disc would be necessary, but merely a pair of toothed cams similar to the discs 50 and 54. Pivotally mounted breaker arms would be arranged to ride on both cams in place of the brushes shown. The stator might be made the inside unit and the rotor the outside unit. In this case the construction of Fig. 12 might be used. In this figure 121 and 122 represent the end pole pieces and 123 the intermediate washer or disc. The coils are indicated by 124 and 125. The rotor, which may be mounted in any suitable manner for rotation around the pole pieces, is indicated by 126. This rotor may comprise an end plate 127, of non-magnetic material, and a ring 128 of magnetic material. This ring is furnished on the inside with pole pieces 129.

The pole pieces might also be arranged concentrically, with their faces substantially in a common plane, in which case a flat, toothed, disc-like rotor might be used. Furthermore, while I have illustrated only two sets of pole pieces and coils therefore, it should be understood that more than two sets, or a single set, may be used if desired. I have shown six pole pieces at each side of the motor, but either a greater or a lesser number may be used, depending on the degree of smoothness of power output desired. The motor may be made of any size, depending on the space available and the amount of power necessary. Likewise it may be used for other purposes than driving clock works. It may be used for furnishing power to any mechanism, and it may act intermittently as described above, or continuously. In the latter case, it is merely necessary to remove the insulating toothed disc 50 or cause it to turn in step with disc 54. With these parts so arranged as soon as the rotor is turned, by energization of one coil, through an angle equal to one of the bars 42, the other coil is energized with the result that the rotor turns continuously. Any conventional form of commutator might be used if desired in place of that which I have illustrated.

Fig. 11 is a sectional perspective view of the motor mechanism.

As shown in Fig. 10 the spring contact 94 may be so arranged as to engage a cooperating contact member 130 supported by case 89, but insulated therefrom. The member 130 is spaced from the case by an insulating washer 131 and is fastened to a clip 132 by a rivet 133. This rivet passes through an insulating bushing 134 and a second insulating washer 135, which is placed between the clip 132 and the case 89.

The driving mechanism may be used to turn clock hands as I have shown in the drawings, or any other constant speed device which requires clock work, for example, apparatus for recording changes in conditions occurring over a period of time.

It will be obvious to those skilled in the art that the invention is capable of a wide variety of modifications and adaptations, and that the present disclosure is intended merely to illustrate its nature without limiting its scope, which is defined in the claims.

What I claim is:

1. In a clock driving mechanism, a motor having a rotor, a load shaft and a contactor or control switch, said switch comprising a first means for initially causing the rotor to revolve through a predetermined angle, and a second means, responsive to rotation of said load shaft through a definite predetermined angle but always less than 360° for controlling said first means.

2. In a clock driving mechanism, a motor having a rotor, a load shaft and a switch comprising a motor circuit closing means responsive to less than a complete revolution of a first control means turning with the rotor and also responsive to a second control means turning with said load shaft, said control means serving within a single revolution of the rotor shaft alternately to operate said circuit closing means to advance said rotor shaft through predetermined steps.

3. A device in accordance with claim 2 wherein the rotor and the load shaft are interconnected by an energy storing spring.

4. A device in accordance with claim 2 wherein the circuit closing means comprises a toothed disc of conducting material carried by the rotor, and the first control means a disc of insulating material, said two discs are positioned side by side and displaced from one another so that the teeth of the conducting disc appears between the teeth of the insulating disc and said second control means comprising a toothed disc of insulating material positioned beside the other discs.

5. In a clock driving mechanism, a motor having a rotor, separate alternately acting energizing means for advancing said rotor through a plurality of successive steps, and a load shaft, said rotor having fixed thereto a pair of toothed discs, one of said discs being of insulating material and the other of conducting material, said two discs being positioned so that the teeth of one appear between the teeth of the other and the diameter of said conducting disc being less than that of said insulating disc, a pair of contact springs connected to a terminal of said separate energizing means and engaging said pair of discs, and so positioned angularly that when one of the said contact springs is in engagement with a tooth of the conducting disc the other of said contact springs is engaged with said insulating disc.

6. In a clock driving mechanism, a motor having a rotor, separate alternately acting energizing means for advancing said rotor through a plurality of successive steps, and a load shaft, said rotor having fixed thereto a pair of toothed discs, one of said discs being of insulating material and the other of conducting material, said two discs being positioned so that the teeth of one appear between the teeth of the other and the diameter of said conducting disc being less than that of said insulating disc, a pair of contact springs connected to a terminal of said separate energizing means and engaging said pair of discs, and so positioned angularly that when one of the said contact springs is in engagement with a tooth of the conducting disc the other of said contact springs is engaged with said insulating disc, and means responsive to rotation of said load shaft between a first position and a second position for lifting free the contact spring which is in engagement with said conducting disc when said load shaft is in the first position, and permitting said contact spring which is out of engagement with said conducting disc to engage said disc when said load shaft is in the second position.

7. A device in accordance with claim 5 wherein the teeth of the conducting disc are made with a slanting contact face so that said contact spring makes a wiping engagement therewith.

8. In an electric clock driving mechanism, a step by step motor having a rotor and a plurality of energizing circuits, one for advancing said rotor through a first step and another for advancing said rotor through a second step, a load shaft and contact means for controlling the operation of said motor to drive said load shaft, said contact means serving to close one of said energizing circuits to advance said rotor through one step and responsive to rotation of said load shaft through a predetermined angle to close other of said energizing circuits and advance the rotor through another step.

9. In a clock driving mechanism, a motor and a load shaft, means for resiliently coupling said motor to said load shaft, and means for controlling energization of said motor, said means comprising a contact means for causing said motor to advance through a predetermined angle less than 360° to store energy in said coupling means and means responsive to rotation of said load shaft through a predetermined angle less than 360° to cause said motor to rotate through another predetermined angle.

10. A rotor assembly for an electric motor comprising a shaft, a first toothed disc of insulating material keyed to said shaft, a rotor rotatably supported on said shaft, a pair of toothed discs keyed to said rotor and positioned adjacent to said first disc, one of said pair of discs being of insulating material and the other of conducting material, the disc of conducting material being of smaller diameter than said one of said pair and having its teeth arranged between the teeth of the other disc of said pair.

11. In an electric motor, a field frame comprising a pair of end plates with pole faces thereon, and a plain middle plate or washer positioned between said end plates, said end plates being so positioned relatively angularly with respect to one another that the pole faces on one plate come between the pole faces on the other plate, a magnetizing winding positioned between each of said end plates and said middle plate, a rotor positioned axially within

said field frame and comprising a plurality of bars of magnetic material equal in number to said pole faces and adapted to cooperate therewith, contacting means for causing energy to be supplied first to one of said windings and then the other to cause the magnetic bars to be attracted to said pole faces and said rotor to be advanced first one step and then another.

12. A device in accordance with claim 11 wherein the rotor is connected to a load through a spring and pawl and ratchet means is provided for preventing reversed rotation of said rotor under the influence of said spring.

13. A device in accordance with claim 11 wherein the rotor is connected to a load through a spring and pawl and ratchet means is provided for preventing reversed rotation of said rotor under the influence of said spring, said pawl and ratchet means being arranged to maintain said magnetic bars slightly off-center with respect to said pole faces in the direction of rotation of said rotor.

14. A device in accordance with claim 11 wherein pawl springs are provided for engaging said bars of magnetic material and preventing reversed rotation of said rotor.

15. In an electric motor, a plurality of series of field poles arranged side by side, and displaced angularly with respect to one another, a rotor comprising a plurality of bars of magnetic material and means comprising an energizing winding separating by its full width one series of field poles from the other series for separately and successively energizing said series of field poles to cause said rotor to be advanced step by step.

16. A device in accordance with claim 15 wherein the means for energizing said field poles comprises a plurality of windings coaxial with said series of field poles said windings separating by their full width two series of field poles.

17. A device in accordance with claim 15 wherein said energizing winding magnetizes all of the field poles in one series to the same polarity.

18. In an electric motor, a stator comprising a pair of frame members, each in the form of a cylinder with a plate partly closing one end, said plate having pole faces thereon and said frame members being positioned in axial alignment with the open side of the cylinders facing each other.

19. An electric motor according to claim 18 wherein the plate is formed integrally with the cylinder.

20. An electric motor in accordance with claim 18 wherein a centrally apertured disc is positioned between the plates of the end members.

21. An electric motor, according to claim 18 wherein the pole faces of one of said plates are aligned with the openings between the pole faces of the other plate.

22. An electric motor according to claim 18 wherein the pole faces of one of said plates are aligned with the openings between the pole faces of the other plate, a centrally apertured disc is positioned between said plates, magnetizing coils are positioned in the spaces between said plates and said disc, and a rotor is associated with said pole faces.

23. In an electric motor, a stator and a rotor, said stator having a plurality of series of spaced pole pieces, the pole pieces of one series being out of alignment with the pole pieces of another series, and means for alternately energizing said series to move said rotor from a position opposite one set of pole pieces to a position opposite another set of pole pieces.

24. An electric motor according to claim 23 wherein means is provided for holding said rotor magnetically off center with respect to said pole pieces when no energizing current is supplied.

25. A rotor assembly for an electric motor, comprising a shaft, a first toothed disc of insulating material keyed to said shaft, a rotor rotatably supported on said shaft and a pair of toothed discs keyed to said rotor and positioned adjacent to said first discs, one of said pair of discs being of insulating material and the other of conducting material.

26. In an electrical machine, an angular magnetizing coil, a plurality of pole faces at one end of said coil, a rotor positioned co-axially with said coil, said rotor comprising a plurality of bars of magnetic material in cooperating magnetic relationship with said pole faces, and contacting means for intermittently energizing said coil to cause rotation of said rotor.

27. In an electric motor, an energizing winding, a rotor comprising a plurality of members of magnetic material, a series of field poles adjacent said windings and arranged to expose substantially the full width of said winding to the rotor members, and means for repeatedly energizing and deenergizing said windings to move said rotor by means of said poles step by step.

FRITZ LOEFFLER.

CERTIFICATE OF CORRECTION.

Patent No. 2,000,600. May 7, 1935.

FRITZ LOEFFLER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 7, second column, line 38, claim 26, for the word "angular" read annular; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of April, A.D. 1939.

Henry Van Arsdale
Acting Commissioner of Patents.

(Seal)

CERTIFICATE OF CORRECTION.

Patent No. 2,000,600. May 7, 1935.

FRITZ LOEFFLER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 7, second column, line 38, claim 26, for the word "angular" read annular; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of April, A.D. 1939.

Henry Van Arsdale
Acting Commissioner of Patents.

(Seal)