PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements relating to Electric Clocks.

I, MAURICE PHILIPPE FAVRE-BULLE, of 15 and 17, Rue Gambetta, Boulogne-sur-Seine, France, Citizen of the French Republic, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention has for its object an electric clock of the type in which the pendulum is re-energised periodically electro-magnetically, of which the coordination of the novel devices of which it is composed permit of obtaining by a rational maintenance of the oscillations of the regulator member, a remarkable certainty of operation, and particularly the constancy of the period, this regulation being also characterised in that it is capable, under a very reduced volume, of being applied to clockwork apparatus of any dimensions.

From all time the efforts of clockmakers have tended to render the period of the pendulum of clockwork instruments independent of the amplitude, that is to say isochronous. But as has been shown by the best authors perfect isochronism of the pendulum itself should be regarded as useless in practice as it is not possible to usefully suggest obtaining isochronism of the complete system, that is to say of the pendulum in combination with the other devices.

It is in fact clear that the application to a clockwork apparatus of a regulator member responding to the conditions required of perfect isochronism cannot itself furnish a satisfactory regulation as this member is necessarily subjected to the effects of the accelerating or retarding forces derived by its connection with the mechanism.

In an electric clockwork apparatus as herein referred to, the pendulum device is essentially composed of the oscillating member which is both regulator and motor, and indispensable elements which are added thereto so as to bring it into condition for operation and adjustment and which enable it to operate, under good conditions, the ratchet wheel which transmits its movement to the hands by means of the clockwork wheels.

Amongst these various members constituting the pendulum particular mention may be made of the electric contact which is directly connected to the pendulum which controls it and which enables it to receive the electro-magnetic impulses: the constancy of the period in particular, is rigorously dependent on the conditions of operation of this device.

For the better understanding of the invention it is advisable at the start to consider briefly the perturbing causes which tend to destroy the constancy of the period and also the conditions to be fulfilled, so as to obtain certainty in operation which cannot be separated from the precision in an apparatus of good quality.

In the first instance attention may be drawn to the fact that the oscillations of the pendulum are only isochronous when the amplitudes are extremely reduced, that is to say when they do not pass beyond the zone adjacent the vertical for which the arc of a circle described by the pendulum coincides practically with a cycloid.

But this condition cannot be observed in pendulums adapted for domestic use as it implies the abandonment of the certainty of operation which should be one of the features of this type of apparatus.

It is in fact very important that the pendulum of a modern clockwork apparatus should have a large amplitude ensuring thereto the desirable inertia so that its operation is not stopped or influenced by the least change applied to its straight hanging or the least passive accidental resistance and also by vibrations which nowadays are set up in all towns.

If therefore in an electric household clock it is desired to benefit by the certainty of operation which depends strictly on the kinetic energy imparted to the pendulum by large amplitudes, it is necessary to provide this latter with a member for correcting the error of isochronism especially when the variation of current of the battery utilised as source of energy does not permit of obtaining the constancy of the amplitudes when means are resorted to which are more harmful than useful.

[Price 1/-]

It may also be mentioned that in an electric clock with direct reactions actuated by a battery the isochronism of the regulating system is not indispensable except of arcs of the zone within the range included between the greatest arcs obtained when the battery is new and the smaller ones which correspond to the extreme drop in voltage produced by wear of the battery. When this latter limit is passed, that is to say when the amplitudes become insufficient to actuate with certainty the ratchet of the wheels of clock, it is evident that isochronism no longer plays any part.

But if at the start all things are equal the constancy of the period of the regulating member will not be affected and the certainty of operation is obtained under good conditions. It is above all necessary for the clock to be provided with a contact device conceived in such a manner as to ensure the passage of current with absolute uniformity and this without opposing to the pendulum which it actuates a variable mechanical resistance. This essential condition can only be fulfilled if the contact device is constituted so as to resist wear and permit very long use without maintenance. It is also necessary that the property of the conducting surfaces is maintained automatically by the operation of the members themselves.

The present invention for the correction of isochronism comprises an oscillating fork the inner distance across which is considerably greater than the diameter of the co-acting member of the pendulum, said fork being mounted on a shaft below the hinge point of the pendulum and on the same vertical, this fork being met by a member secured to the pendulum, the length of the fork, the position of its pivotal point relatively to that of the pendulum and the distance between the pivotal point of the pendulum and the point at which contact is made with the fork being selected in such a manner that the linear speed of the point of contact on the pendulum is greater than that of the fork, the electric contact of this pendulum operated device being effected in a manner to ensure the passage of current at a favorable moment with absolute regularity and without opposing a variable mechanical resistance to the pendulum.

Various modes of construction of the invention are illustrated by way of example in the accompanying drawings, wherein

Fig. 1 is a front elevation of the device and associated parts.

Fig. 2 is a part side elevation of pendulum.

Fig. 3 is a top plan of Fig. 1. Figs. 4, 5, 6, are diagrammatic views showing the principle of the associated electric contacts.

Figs. 7, 8, 9 show, respectively, at rest and in two different positions of operation, application of this contact system.

Figs. 10 and 11 illustrate respectively a front elevation and side view of an alternative form of construction.

Figs. 12 and 13 show two forms of constructional details for enabling friction at the point of the pendulum to be reduced.

Fig. 14 is a detail front view of various members of the apparatus.

Figs. 15, 16 and 17 show side and end elevations of a form of construction of the operating pawl actuating the ratchet wheel.

Finally Fig. 18 is a diagrammatic view of an application of the ratchet system to a clock of large dimensions. And Figs. 19 and 20 are detail views of a modification of the ratchet and pawl device.

On the plate 1 is pivoted, on the shaft 2, the pendulum 3 terminated at its lower end by an induction coil 4 moving along a permanent magnet in the form of an arc of a circle 5. The shaft 2 is held between the plate 1 and the small plate 1^1.

The electric contacts for closing the circuit of coil 4 at each complete swing of the pendulum are adapted to ensure the operation of the apparatus and are shown diagrammatically in Figs. 4, 5 and 6, according to which two parallel reglets 6 and 7, separated by a slight interval, are respectively hinged about the shafts 8 and 9 placed above one another in the same vertical. If one of the reglets, 6 for example, is actuated by the pendulum 3 in such a manner as to oscillate therewith, it will be seen that when the oscillations of this reglet are dampened in one direction or the other, one of its ends comes into contact with the reglet 7 and drives it whilst sliding thereon, (Figs. 5 and 6). Under these conditions if the reglets 6 and 7 are of conducting metal, one of the ends of 7 being alone provided with a layer of insulation 10, and that they are suitably interposed in a circuit, the first being connected to one of the poles of the circuit and the other to the other pole, it will be seen that this circuit is closed when the pendulum causes the reglet 6 to oscillate towards the position shown in Fig. 5 and that it is opened when oscillation is produced in the other direction (Fig. 6).

In practice the reglets are advantageously replaced by anchors 6 and 7 of which the first is keyed to the axis of the pendulum. Each of the arms of the anchor 6

(Figs. 7, 8, 9) is provided with a pin, one of these, 11, being conducting whilst the other 12 is insulated. The pins come alternatively into contact with the arms of the anchor 7 and the opening and closing of the circuit is effected in the manner above described. It may be mentioned that the duration of contact between the conducting pin 11 and the arm of the anchor 7 is strictly limited by the width of this arm and that the anchor 7 ceases to be moved by the pin 11 immediately this reaches the inner heel of this arm. The electric contact is then interrupted and the pin 11, continuing its path, penetrates into the opening of the anchor of which the stop on the arm is insulated.

The form of construction shown in Figs. 1, 3, 10 and 11 is identical with that described except that the shafts of the two anchors are side by side instead of being superposed. The anchor 6 is formed by a split block in which are fitted the contacts of silver 11 and 12 held by screws 29, 29^1 and of which one is a conductor and the other insulated. The anchor 7 is constituted by a member of general rectangular shape with two symmetrical notches. This arrangement has the advantage of permitting of easily obtaining a perfectly balanced member of which the two sides may be used indifferently. If one of the sides of this piece 7 has been worn by reason of long wear it is sufficient to turn it over so as to obtain the same result as with a new piece. The stability of the system is ensured by means of a small flat spring 13 secured at 14 to the plate 1 and bearing against the shaft of the anchor 7, preferably into a circular groove provided in this shaft, this small spring forming at the same time a brush for the passage of current.

It will be seen that with the contact device described it is easy to regulate with precision, not only the duration of contact but also the points of opening and closing of the circuit which, from a chronometric point of view, is of considerable importance. It will also be seen that the sliding of the conducting pin on the arm of the opposite anchor, also a conductor, ensures in a permanent manner the effective action of the surfaces in contact, which enables the resistance to the passage of current to be reduced to a minimum and rendered constant.

It may also be mentioned that this device is constituted in such a manner, that the duration of contact is independent of the value of the amplitude of the oscillating member which drives it (starting from at least a minimum amplitude). It will also be seen that, by reason of its method of operation, the contact cannot remain closed when by reason of accidental stopping, the pendulum remains vertical. This feature is important as, if it did not exist, the stoppage of the clock would produce exhaustion of the battery.

The above advantage is influenced by the fact that the contact commences to operate when the oscillations are slightly dampened, which enables the apparatus to restart itself, even if it is almost completely stopped for an accidental reason.

The transmission of the movement of the pendulum to the wheels of the clockwork apparatus may be effected by any suitable mechanism. In the form of construction shown in Figs. 7, 8 and 9 the anchor 7 is in the form of an X and the extended ends of its lower arms carry pins 15 and 16 which drive the first wheel 17 of the train which is provided with ratchet wheel teeth for the driving anchor.

In the form of construction of Fig. 1 the shaft 2 of the clock carries an arm 18 on which is hinged the operating pawl 19 of which the end 20, bent so as to form an obtuse angle, acts on the wheel 17 subjected also to the action of a retaining pawl 21, oscillating about the shaft 22.

It is particularly advantageous in this type of ratchet device to obtain that the action of the operating pawl with the ratchet wheel does not produce any variation of the period of the pendulum.

It is known that a resistance after the passage to the vertical reduces the period, that is to say, produces an acceleration, whilst a resistance before passing the vertical produces a retardation. Consequently the balancing of these resistances permits of obtaining a compensation of these perturbing effects. From a practical point of view there is obtained the advantage that the period is rendered independent of a variation if the clock is not placed directly vertical.

This result may be obtained by imparting to the nose 20 of the operating pawl a shape such that it enables it to hook lightly into the teeth of the ratchet wheel when it drives this during the descending period of the pendulum, the light hooking simultaneously affording the advantage of withdrawing the tooth in engagement with retaining pawl, from against the nose of the latter, that is to say, into a position favourable to its movement by the operating pawl.

A particularly advantageous form of construction of this operating pawl is shown in Figs. 15, 16 and 17. The rod 19 of the pawl is secured at its rear end to a cap formed by two lugs 30, 30^1 threaded on the shaft 31 secured to the

arm 18. On this same shaft and between the two lugs is threaded a split block 32 clearly shown in Figs. 17 and 15, one of the lugs 30 in this latter figure being removed. This block is tightened on the shaft and is for the purpose of preventing any movement of the cap along the shaft 31 and to limit the swinging of the rod 19 about the same shaft.

It is known that in a clock in which the gear train, transmitting the movement to the hands by reducing gear, is composed of wheels and pinions, the same wheel train serves as increasing gear, when moving the minute hand, mounted on the shaft of the last wheel, by hand for setting the clock. It thus results that the ratchet wheel is driven at a speed which produces a disagreeable noise and is liable to damage the pivots.

For obviating this noise the retaining pawl 21 of the escapement wheel 17, which pivots about the shaft 22, is secured to a spring 33 suitably bent, which bears against the teeth of the wheel 17 when this pawl is raised by the said wheel. A braking action is thus produced, which though light, is sufficient to stop the wheel whilst setting the clock. In order that this braking is not translated into an appreciable passive resistance during the normal operation it is naturally advisable for this spring blade, when the pawl 21 is at rest, to be sufficiently spaced from the teeth of the wheel 17 that its action only comes into play at the moment at which the tooth which is in engagement with the retaining pawl is at the point of escaping.

The spring brake 33 may also be of a shape different to that shown for example, to provide its end with hooked nose suitably disposed so as to come in front of the teeth of the wheel 17 and not reaching them when this turns slowly but being projected thereon by inertia when the retaining pawl receives an impulse by reason of the rapid driving of the ratchet wheel.

This spring brake irrespective of its shape of construction, also serves as a safety member by preventing the passage of two teeth at a time as might be the case if the wheel by reason of its inertia continued to turn after having received the impulse of the operating pawl.

The mounting of pendulums of clocks of small dimensions on pivots has by reason of the small available space, the great advantage of obtaining a well guided oscillating member. This type of mounting, however, when the pendulum is heavy has the disadvantage of creating friction which does not exist with suspended pendulums and, when this friction exceeds a certain limit it may be of a nature which affects the freedom of the pendulum and consequently causes disturbances in the adjustment accompanied by an increase in the use of current. This may be remedied for example by using the magnetic attraction of a magnet for exerting an effort from the bottom upwards on the pivot 2 of the pendulum 3.

In the form of construction of Fig. 12 a magnet 25 is arranged for this purpose above the shaft 2 with a very small air gap.

In the form of construction in Fig. 13 the pendulum is formed by a magnet 26, of suitable shape, of which the rounded pole 27 in an arc of a circle is secured to the shaft 2 whilst the other pole is disposed in a manner to react in the usual manner on a fixed induction coil. A small mass of iron 28 placed above the pole 27 permits of obtaining the necessary attraction for relieving the pendulum of a considerable portion of its weight for reducing the friction at the pivots to a minimum. In the latter case the mass of iron may be replaced by the branch of a second magnet having an opposite polarity to that of the pole 27 of the pendulum. The same result may be obtained with a pendulum of which the rod is formed by a magnetised bar.

In the pendulum operated ratchet device forming the subject of the invention the isochronism is obtained, for the zone of the range of oscillations, by means of an oscillating fork 34 (Figs. 2 and 14) mounted on a shaft 35 placed below the hinge point 2 of the pendulum 3 and on the same vertical. A pin 36, secured to the rod of the pendulum 3 and at right angles to the latter and to the plane of oscillation, penetrates between the arms of the fork. The length of the latter, the position of its pivotal point, relatively to that of the pendulum as also the distance between the latter point and the pin 36 is determined in a manner that in spite of the difference of the period of the two oscillating members the linear speed of the pin is greater than that of the fork so that the oscillation of this is controlled by the pin. Under these conditions the operation is as follows:

The pin 36, during the portion of its course adjacent the vertical, oscillates freely in the opening of the fork 34, then, continuing its course meets one of the arm of this. By this reason a slight shock is produced in the descending portion of the oscillation which, as indicated above, is of a nature to correct to a certain extent the retardation of the pendulum along large arcs. This action is completed by

the return effort exerted by the fork on the pendulum.

On the return the pendulum 36 leaves the fork 34 before the vertical is reached and the operation is repeated from the opposite side.

For obviating the noise which is liable to be produced by the shock between the pin 36 and the fork 34 one at least of these members may be provided with an elastic covering, or formed as an elastic member.

It is easy under these conditions, by regulating the length of the arms of the levers in question to obtain a very satisfactory correction in practice of isochronism for the pendulum amplitude.

It may be mentioned that this result affords the great advantage of not rendering the correction of the error, partly circular error, necessary by known devices which consist in tilting the contact from the vertical and from the action on the driving wheel of the wheel train, the efficiency of this method being strictly due to the vertical position of the pendulum. On the contrary with the device forming the subject of the invention a tilting of the pendulum does not produce a substantial tilting of the oscillating members in question which, at rest, always occupy a substantially constant position relatively to one another.

In the usual manner the pendulum is provided with a device enabling the height of its centre of gravity to be adjusted. This device may be constituted very simply by a screwed rod 37 (Fig. 2) parallel to the rod of the pendulum 3 and secured thereto, a nut 38 moving on this screwed rod.

There is also provided a device enabling the pendulum to be locked during transport.

This device is formed by two jaws 39, 39^1 capable of pivoting respectively on two shafts 40 and 40^1 and connected by a spring 41 (Figs. 1 and 14). These jaws are each provided with an arm 42, 42^1 the arm 42 being provided with a longitudinal slot 43 into which passes a pin 44 carried by the arm 42^1 of the jaw 39^1. One of the jaws 39, for example, carries an operating tail 49. The operation will be readily understood from an examination of the figures, Fig. 1 showing the device in the locking position and Fig. 14 the same device in the position when the pendulum is operating.

The arc of opening between the two jaws in the open position may be ensured by a notch provided at the end of the groove 43 with which the pin 44 engages.

The pendulum operated ratchet system according to the invention affords the important advantage of being capable of being applied to a clock of large dimensions hinged as usual to a spring suspension similar to those of the generality of mechanical clocks. For this purpose it may be substituted for the crutch device mounted on a pivot, which, in these clocks, serves to connect the escapement to the pendulum, as clearly shown in Fig. 18 showing the small pendulum 3 of the escapement mounted on the pivotal shaft 2 and the contact member 6.

An arm 45 secured to the pendulum 3 is terminated by a forked portion 46 which embraces the rod of a large pendulum 47 hooked to the flexible suspension 48.

Attention is called to the advantage of this application which permits of replacing the mechanical escapement in clocks of large dimensions having a large pendulum of heavy mass.

It will be seen clearly that this large pendulum which, by reason of its method of suspension by a spring, may move without appreciable friction irrespective of its weight, may be actuated easily by the small pendulum of the device, as by a mechanical escapement, but from a chronometric point of view under clearly superior conditions.

This new application permits of utilising advantageously the small oscillating induction coil 4, forming the pendulum mass, which, as stated above, may, without inconvenience, by reason of its small weight, be mounted on pivots, which ensures in a constant manner the centring of the magnet in the hole of this coil irrespective of the leaning of the clock to the front or rear, the large pendulum, by reason of its method of hinging on its suspension, always remaining vertical irrespective of this leaning which is evidently an indispensable condition of adjustment.

It will be understood that, in the known manner, the mass of the small pendulum of the device may be formed by the magnet which enters the stationary coil.

A modified construction of the operating pawl 19 consists in applying to its blade, suitably lengthened, a pin 19^1 adapted to act on the teeth instead of and in place of the nose of the pawl.

This arrangement enables the extended portion of the pawl to find a point of support on the teeth enabling the pin to engage with these with great certainty without risking the liability of causing the ratchet wheel to move through two teeth at once.

Fig. 19 shows the blade 19 and its pin 19^1 in engagement with the teeth of the ratchet wheel 17 at the moment of moving it.

Fig. 20 also shows the blade 19 at the moment of the pin 19^1 entering the teeth.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. Electric clock of the type in which the pendulum is re-energised periodically electro-magnetically, characterised in that the correction of isochronism is ensured by an oscillating fork the inner distance across which is considerably greater than the diameter of the co-acting member of the pendulum, said fork being mounted on a shaft below the hinge point of the pendulum and on the same vertical, this fork being met by a member secured to the pendulum, the length of the fork, the position of its pivotal point relatively to that of the pendulum and the distance between the pivotal point of the pendulum and the point at which contact is made with the fork being selected in such a manner that the linear speed of the point of contact on the pendulum is greater than that of the fork, the electric contact of this pendulum operated device being effected in a manner to ensure the passage of current at a favourable moment with absolute regularity and without opposing a variable mechanical resistance to the pendulum.

2. Electric clock according to Claim 1, characterised in that the electric contact adapted to ensure the operation of the apparatus is effected by means of two anchors of which one, operated by the pendulum, when contacting with the other permits of opening and closing the electric circuit with great regularity at desired moments for maintaining correctly the oscillations of the regulating member, this arrangement permitting of ensuring the brushing of the contact surfaces and thus reducing the resistance to the passage of current.

3. Electric clock according to Claim 1, wherein means are provided for relieving the pendulum and reducing friction at the pivots to a minimum.

4. Electric clock according to Claim 1, wherein the isochronisation fork meets a pin engaging between its arms, this pin being secured to the rod of the pendulum and at right angles to the latter and to the plane of oscillation.

5. Electric clock according to Claims 1 and 2 wherein one of the anchors is formed by a symmetrical member of general rectangular shape with lateral notches.

6. Electric clock according to Claims 1 and 2 wherein the other anchor is formed by a split block into which are fitted two contacts, one conducting and the other insulated.

7. Electric clock according to Claims 1 and 2, wherein the free anchor is secured to a third anchor provided with pins controlling the first wheel of wheel train which is provided with ratchet wheel teeth for moving the anchor.

8. In an electric clock according to Claim 2 driving the wheels of the clock by means of a metal blade carried at the hinge of the pendulum and forming a pawl for moving a ratchet which actuates the wheels by means of suitable members.

9. Electric clock according to Claims 1 and 8 wherein the operating pawl is terminated by a bent nose which hooks lightly on the teeth of the ratchet wheel when it passes over the wheel during the downward period of the pendulum.

10. Electric clock according to Claims 1, 8 and 9 wherein the operating pawl is hinged by means of a cap with lugs between which there is placed on the shaft a split block which prevents lateral movements and limits the oscillation of the pawl.

11. Electric clock according to Claims 1 and 8, characterised in that the retaining pawl of the ratchet is secured to a spring blade forming a brake which acts lightly on the teeth when the said ratchet is driven at a high speed.

12. Electric clock according to Claim 3, wherein the relieving of the pendulum is obtained by means of a magnet disposed with a small air gap above the pivotal axis of the pendulum.

13. Electric clock according to Claim 3, wherein, for the purpose of reducing friction at the pivot, the pendulum is formed by a magnet of which one of the poles, placed at the upper portion, is adjacent a small mass of iron or another magnet whilst the other pole is arranged to react, in the known manner, on an induction coil.

14. Electric clock according to Claim 1, wherein the pendulum may be locked during transport by means of a system of hinged jaws drawn one towards the other by a spring and each carrying arms, one of the arms being provided with an elongated groove in which moves a pin carried by one of the arms of the other jaw.

15. Application of the pendulum operated ratchet device according to the preceding claims to a heavy pendulum or one of large dimensions hinged to a spring suspension, characterised in that a small escapement pendulum mounted on pivots and provided with the various members referred to carries a crutch which drives the large suspended pendulum.

16. The employment of the pawl device

for electric clocks as illustrated by Figs. 19 and 20.

Dated this 26th day of July, 1929.

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Fig. 1.

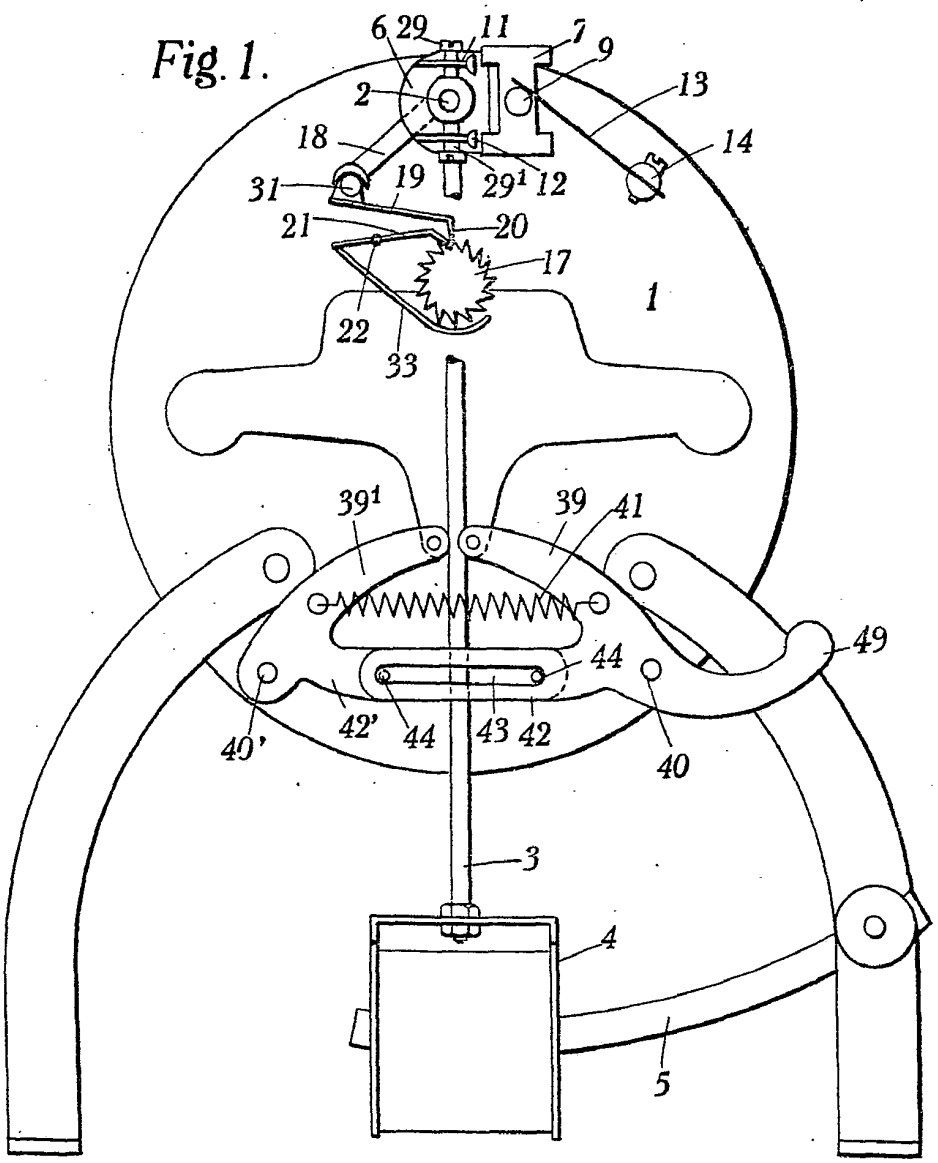

Fig. 3.

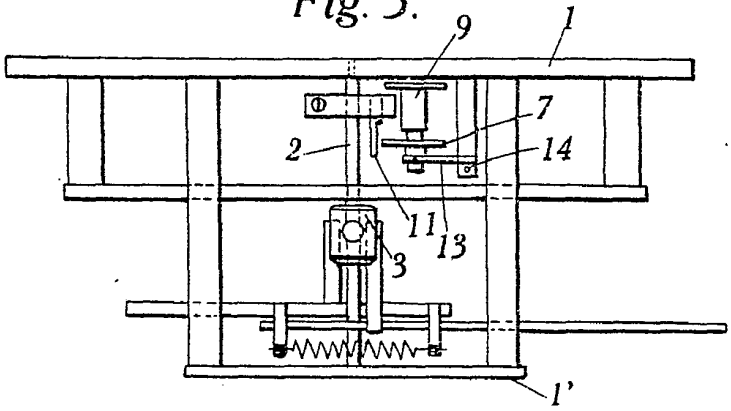

Fig. 14.

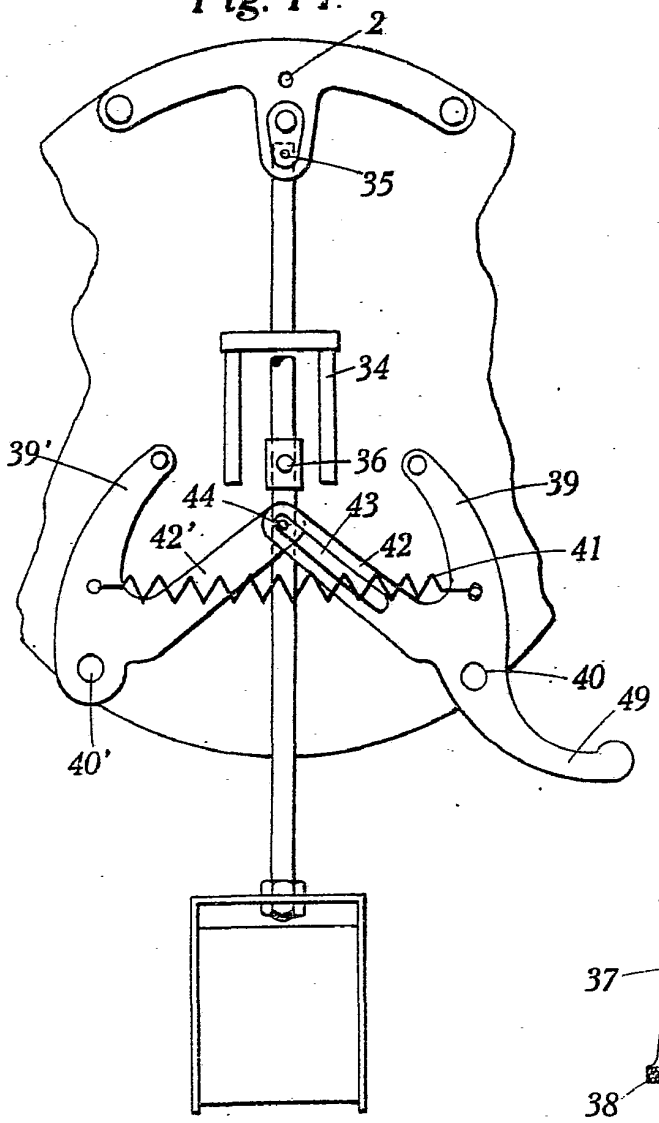

Fig. 2.

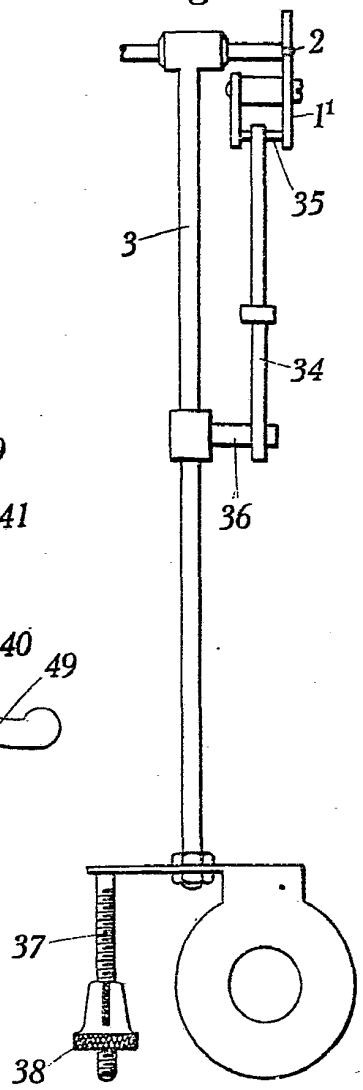

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Fig. 1.

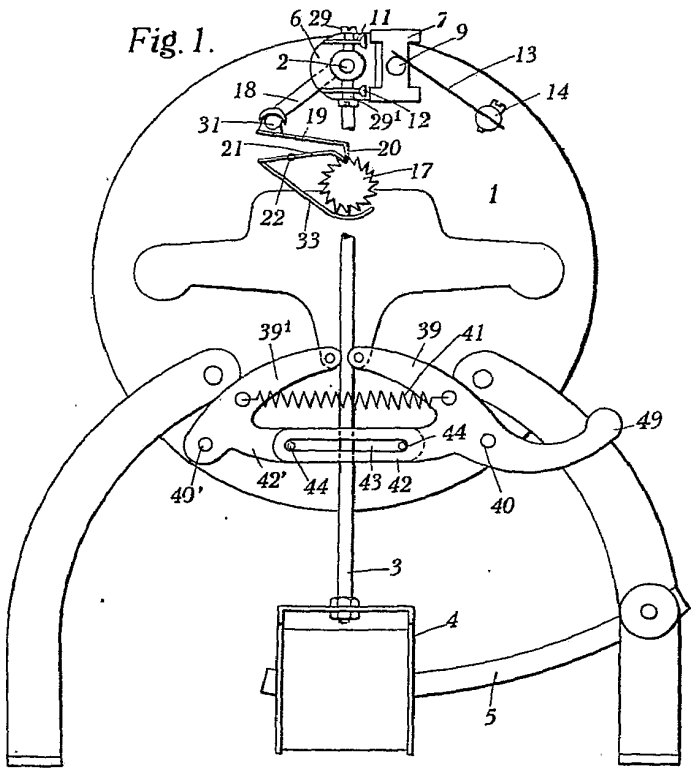

Fig. 3.

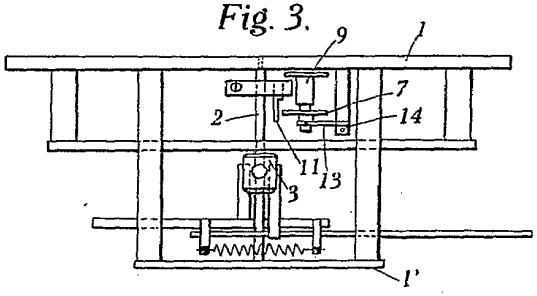

Fig. 14.

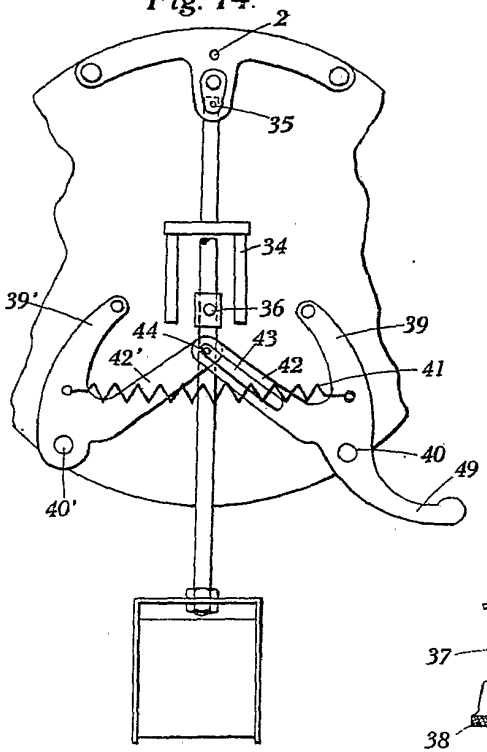

Fig. 2.

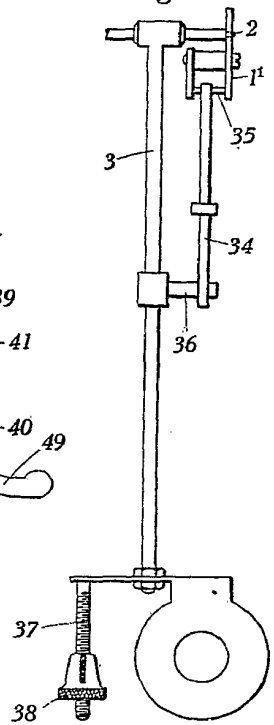

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Fig. 4.

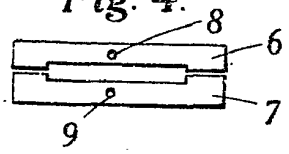


Fig. 5.

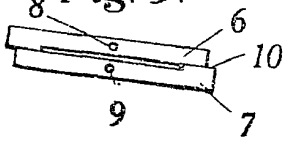


Fig. 6.

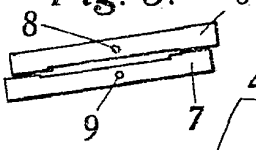


Fig. 7.

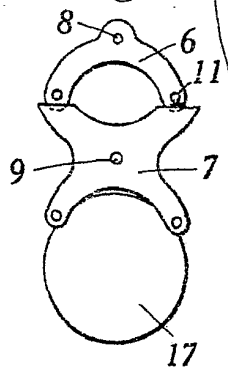


Fig. 8.

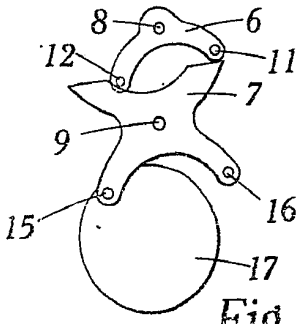


Fig. 9.

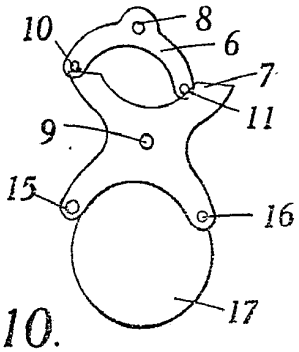
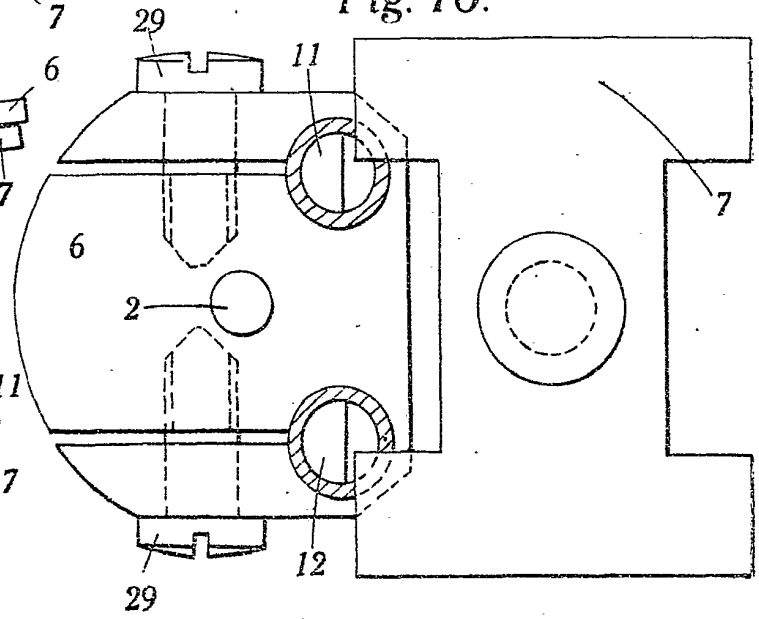


Fig. 10.



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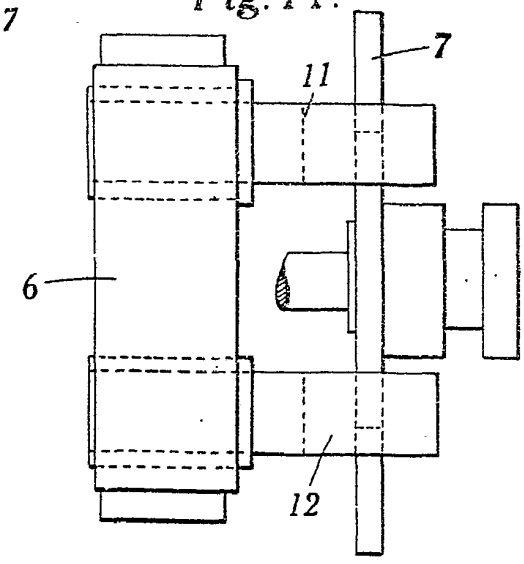

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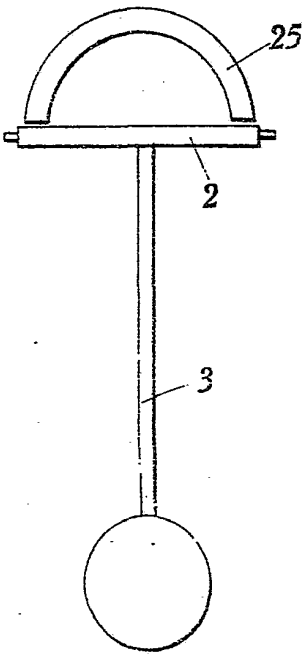

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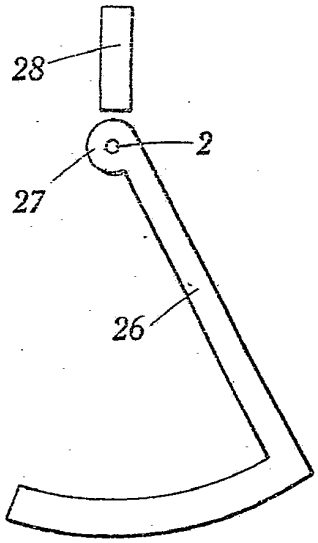

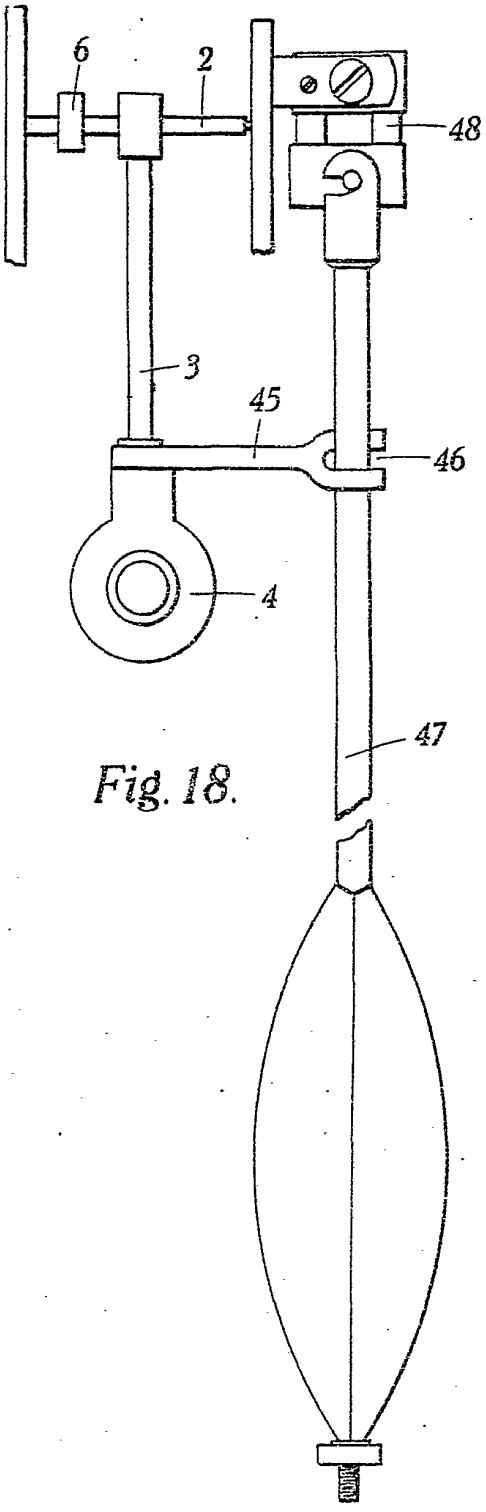

Fig. 18.

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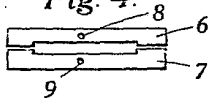
Fig. 4.



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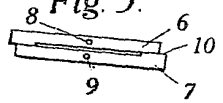

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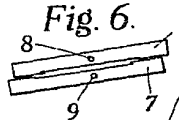

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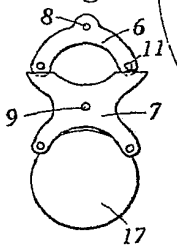

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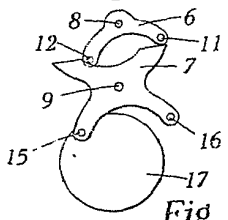

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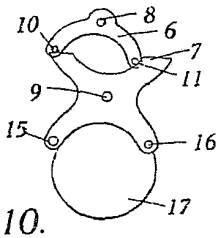

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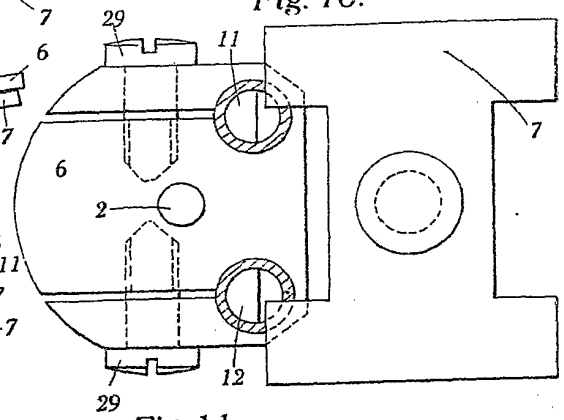

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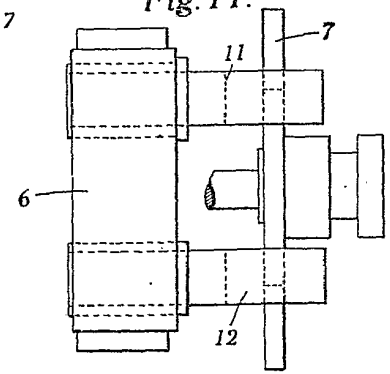

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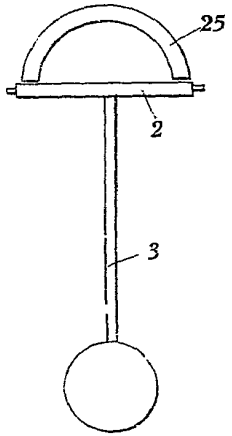

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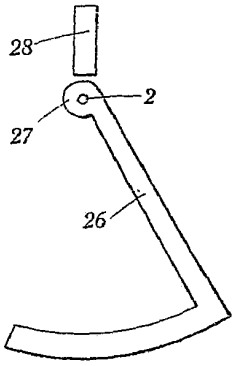

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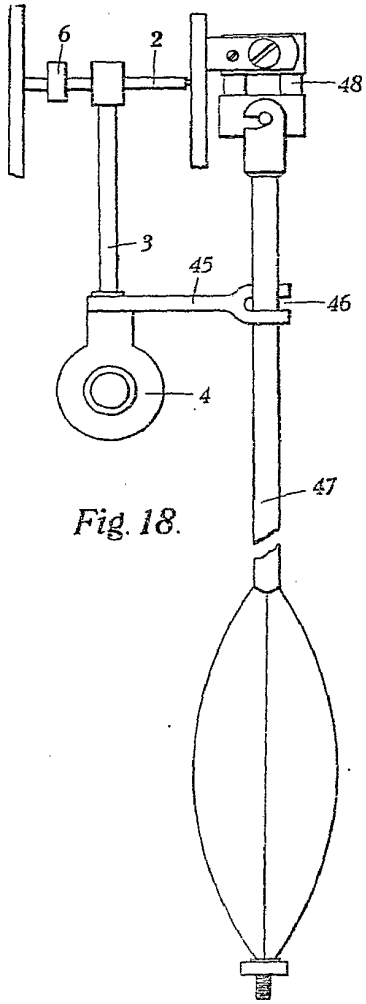

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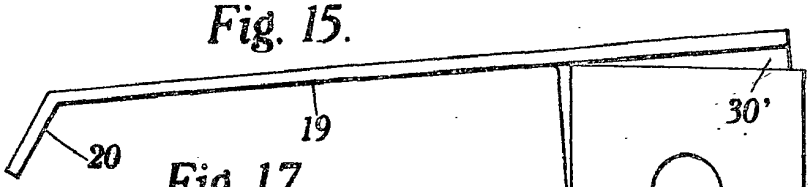
Fig. 15.



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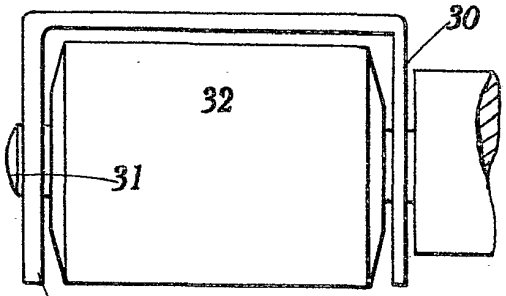

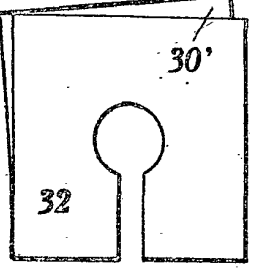

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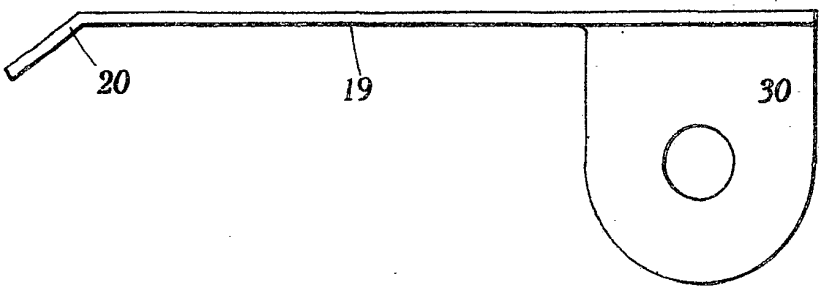


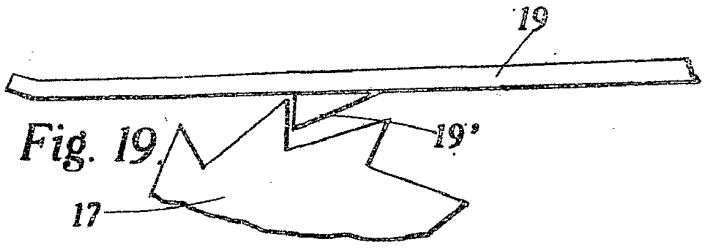
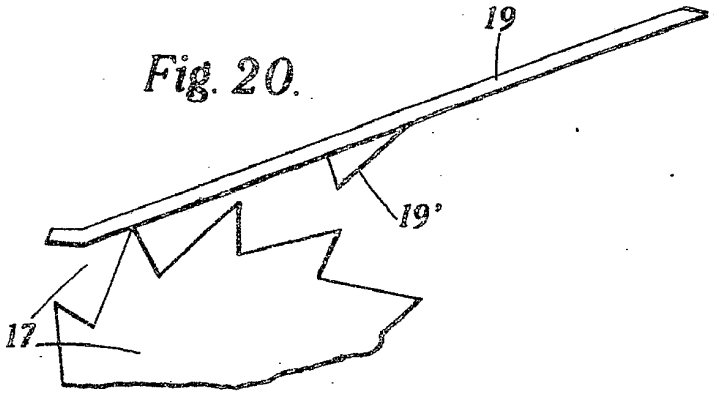


Fig. 19.

Fig. 20.



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