May 17, 1932. W. KUNZE 1,858,332

METHOD OF AND APPARATUS FOR RECORDING THE FREQUENCY OF IMPULSES

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Fig. 1.

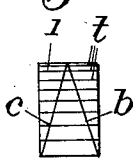


Fig. 2.

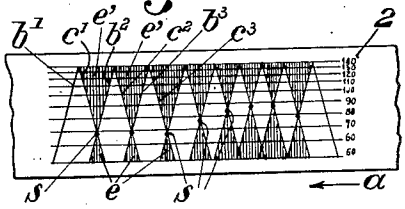


Fig. 3.

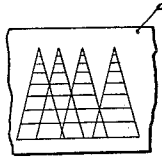


Fig. 4.

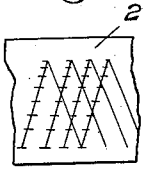


Fig. 5.

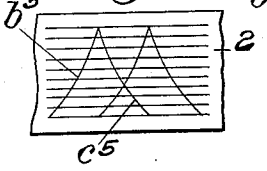


Fig. 6.

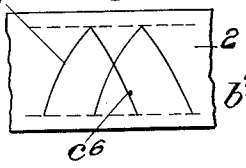


Fig. 7.

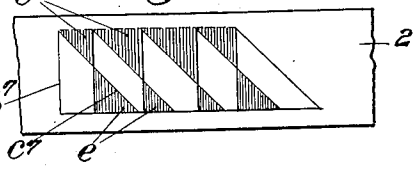


Fig. 8.

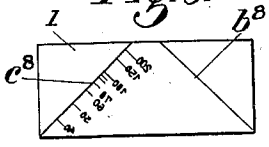


Fig. 9.

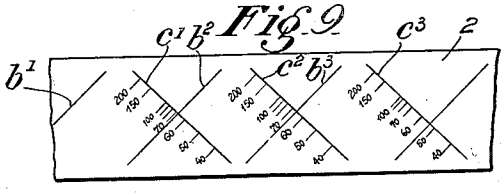


Fig. 10.

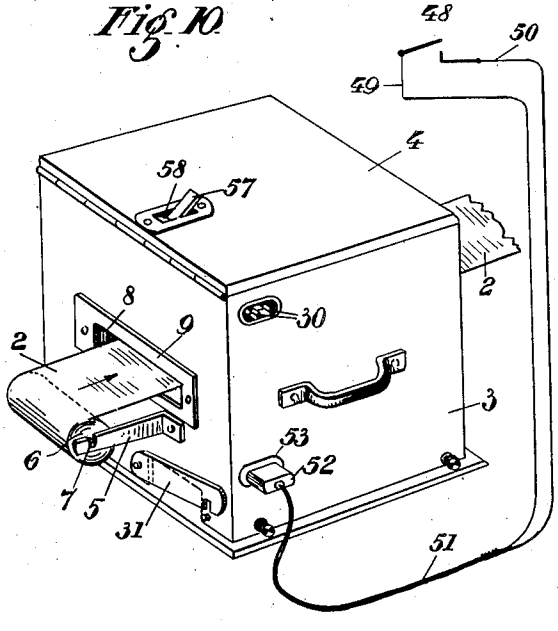
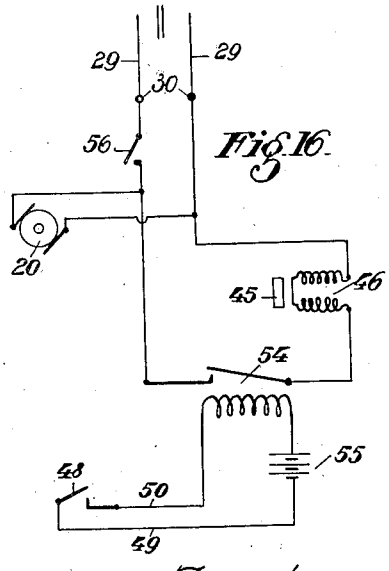


Fig. 16.



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Fig. 11.

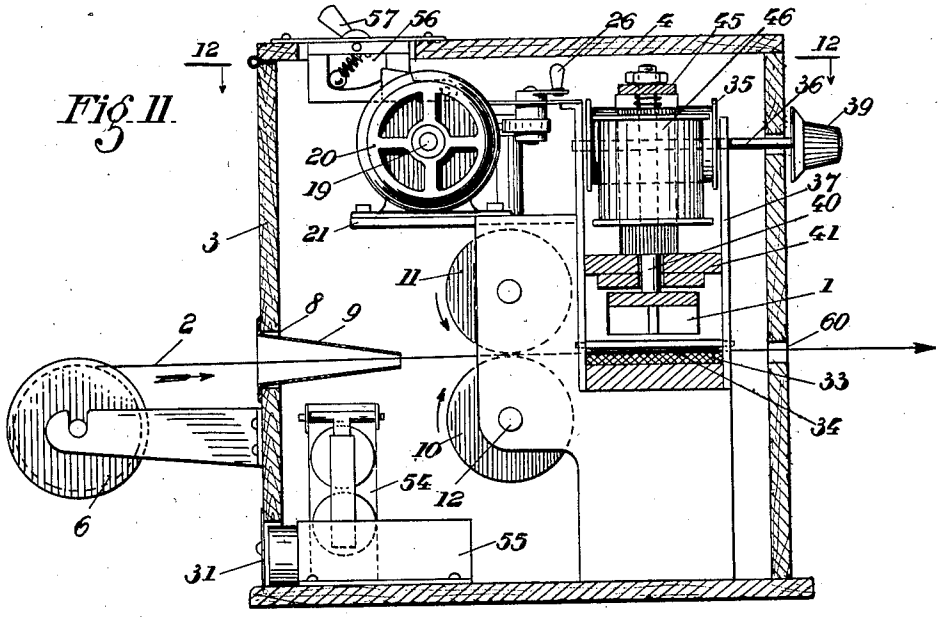
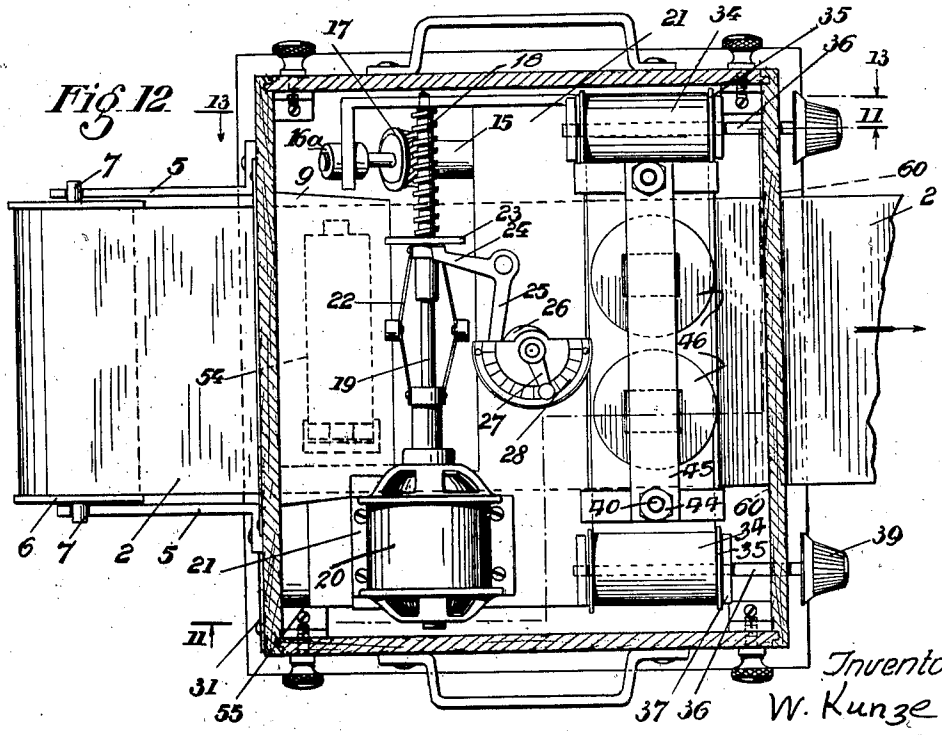


Fig. 12.



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METHOD OF AND APPARATUS FOR RECORDING THE FREQUENCY OF IMPULSES

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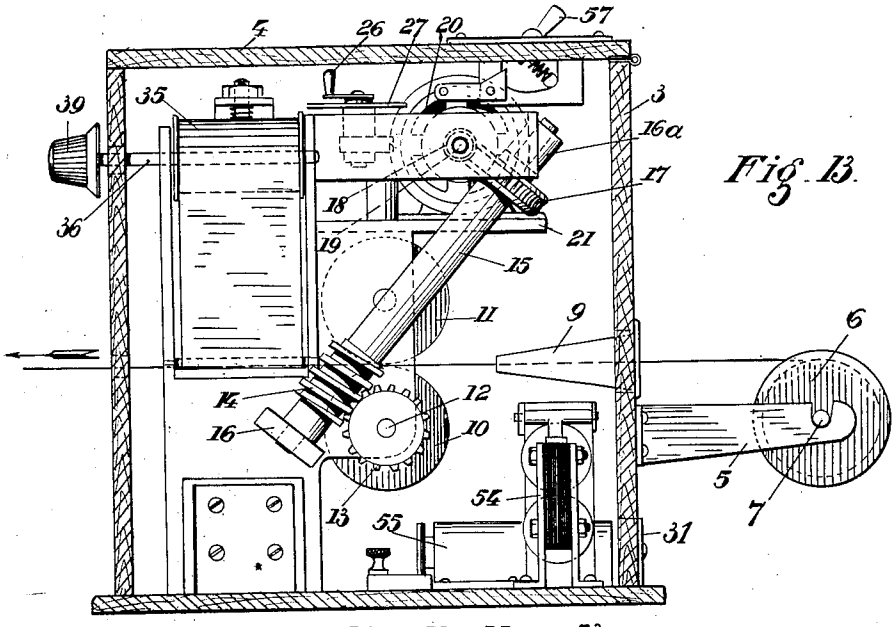


Fig. 13.

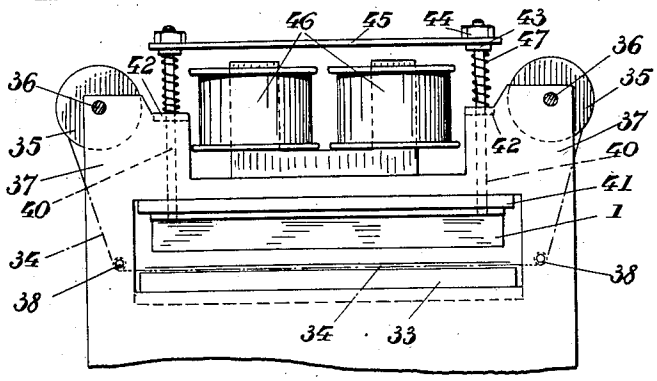


Fig. 14.

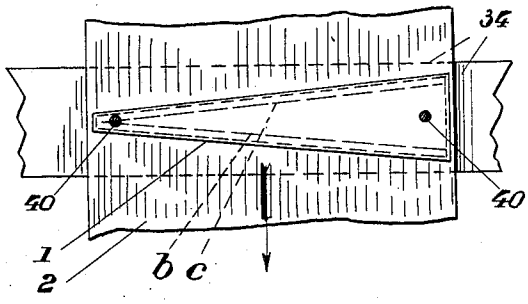


Fig. 15.

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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR RECORDING THE FREQUENCY OF IMPULSES

Application filed April 4, 1930, Serial No. 441,650, and in Germany February 11, 1928.

My invention relates to improvements in the method of and apparatus for recording the frequency of impulses, such for example as the beating of the pulse, and the object of the improvements is to provide a method and an apparatus by means of which the frequency corresponding to the time interval between two successive impulses can be directly ascertained. With this object in view my invention consists in causing each impulse to print two intersecting perpendicular or inclined transverse lines on a record surface continuously advanced at uniform velocity, the intersecting lines printed by the successive impulses being positioned relatively to one another so that the forward line of each print intersects the rear line of the previous print. On the record thus made the points of intersection of the cooperating lines are located different distances away from a base disposed longitudinally of the movement of the band, and the distance between the said points and the said base is a function of the frequency of the impulses in the same way as the distance between successive prints.

For carrying out my improved method I make use of an apparatus comprising means for moving a record band at uniform velocity, a stamp carrying a type representing the lines to be printed, and means for pressing the stamp in dependence of the impulses on the band.

For the purpose of explaining the invention several examples embodying the same have been shown in the accompanying drawings, in which the same letters of reference have been used in all the views to indicate corresponding parts. In said drawings,

Fig. 1 is a diagrammatical end view showing the stamp and the type formed thereon,

Fig. 2 is a diagrammatical elevation showing a record surface made from paper or other suitable material and having a series of prints made thereon by means of the stamp shown in Fig. 1,

Figs. 3 to 7 are similar elevations showing modifications of the signs printed thereon,

Fig. 8 is an end view similar to the one illustrated in Fig. 1 and showing a modification of the type of the stamp,

Fig. 9 is an elevation showing a record band having prints made thereon by means of the stamp shown in Fig. 8,

Fig. 10 is a perspective view showing the recording apparatus,

Fig. 11 is a sectional elevation of the apparatus taken on the line 11—11 of Fig. 12,

Fig. 12 is a sectional plan view of the apparatus taken on the line 12—12 of Fig. 11, certain parts being omitted,

Fig. 13 is a sectional elevation taken on the line 13—13 of Fig. 12,

Fig. 14 is an elevation showing the printing mechanism,

Fig. 15 is a top plan view of the printing stamp, the record band, and the inking ribbon, and

Fig. 16 is a diagram showing the electrical connections of the apparatus.

In the example shown in Fig. 1 the stamp 1 carries a type in the form of an isosceles triangle the normal of which is disposed transversely of the direction of the movement of the band 2, and scale marks t parallel to the base of the triangle and extending from one side of the stamp to the other. When moving the band 2 in the direction of the arrow a at uniform velocity and printing thereon by means of the stamp the scale marks t produce continuous lines on the band. If desired the said scale marks may be shorter than is shown in Fig. 1. For example they may extend between the sides of the triangle, in which case the record shown in Fig. 3 is produced on the band. In another modification only one of the sides of the triangle is equipped with scale marks intersecting the said line, so that the record shown in Fig. 4 is produced.

If the time interval between the successive printing operations is constant the distance between the successive triangles printed on the band is constant. The record shown in Fig. 2 has been produced by impulses made at non-uniform time intervals, so that also the distances between the successive prints are different.

The line c of one print intersects the line b of the following print at s, and the said point of intersection s is shifted towards

the base of the triangle in the degree as the distance between the successive prints is increased. The normals of the triangles e' indicated by perpendicular shading and included between the top parts of the successive prints are directly proportional to their bases, and therefore they are functions of the time interval between successive impulses, which time interval is inversely proportional to the frequency of the prints and the primary impulses. The normals of the triangles e' and those of the triangles e are at the same ratio. Thus the normals of the triangles e directly indicate the frequency to be ascertained, and a curve produced by connecting the points s represents the frequency.

By reason of the said inverse proportion equal sections of the normals do not correspond to equal differences of the frequency, but as the frequency is increased the distance between the successive scale marks representing the same is gradually reduced, as is shown in Fig. 1. If it is desired to have scale marks of even pitch I compose the type of the stamp from two concave lines, as is indicated in Fig. 5. By providing types in which the lines b^5 and c^5 are differently curved any desired pitch of the scale marks may be obtained. In the modification shown in Fig. 6 the type is composed of convex lines b^6 and c^6, whereby the pitch of the scale marks is more irregular than in case of straight lines.

It is not necessary to dispose the sides of the type symmetrically of a transverse line disposed perpendicularly to the direction of the movement of the band, but the lines may be disposed relatively to each other at different angles, provided that one line of one print intersects the other line of the next print. For example I may provide a type b^7, c^7, as shown in Fig. 7 in the form of a right-angled triangle having one of its catheti parallel to the direction of the movement of the band, or I may provide types in which the intersecting lines are at other angles to the band.

In Fig. 8 I have shown a stamp 1 in which the portions b^8 and c^8 of the type are inclined at angles of 45° to the direction of the movement of the band. Fig. 9 shows the band 2 having a record printed thereon by means of the type b^8, c^8, the record having been indicated in the said figure in the same way as in Fig. 2 by the characters c^1, b^2, c^2, b^3, etc. In the type shown in Fig. 8 only the line c^8 is provided with scale marks. By disposing the portions b^8 and c^8 perpendicularly of each other the reading of the figure corresponding to the points of intersection can be readily ascertained.

Also in the construction shown in Fig. 8 the lines b^8 and c^8 may be shaped along a curve so as to produce a pitch of the scale marks following any desired rule, the said scale marks having for example uniform pitch, and it is not necessary to draw both lines along a curve, but one may be straight and the other one, for example the line b^8, curved. When thus constructing the type the frequency of the impulses can be ascertained for each print, and in case of uniform pitch the curve connecting the points of intersection of the successive prints truly represents the variation of the frequency, because the said uniform pitch of the scale marks drawn along the line c^8 is uniform also when projected on a line parallel to the direction of the movement of the band.

If desired the band 2 may be provided with a scale extending the whole length thereof. But a band thus prepared can be used only in connection with a stamp in which the lines composing the type have a relative form corresponding to the said scale, and it is necessary to adjust the band transversely of the direction of the movement thereof relatively to the stamp. Therefore I prefer to print the scale by the stamp.

In Figs. 10 to 15 I have illustrated an apparatus for making the record of the frequency of the impulses. As shown the operative parts of the apparatus are disposed in a box 3 having a lid 4 hinged thereto. To the outside of the said box 2 brackets 5 are fixed which provide a support for the trunnions 7 of a spool 6 having a band of paper wound thereon. From the said spool the band of paper 2 is taken and passed through a slot 8 made in the rear wall of the box and continued within the same by a slotted guiding member 9. Within the box the band 2 is passed between two feed rollers 10 and 11, and the said feed rollers supply the band to the printing mechanism, whereupon it is removed from the box through a slot 60.

By means of the rollers 10 and 11 uniform movement is imparted to the band 2, the roller 10 is operated by means of a worm gearing 13 secured to the axis 12 thereof, and the said worm gearing is driven by means of a worm 14 mounted at the end of an inclined shaft 15 disposed in bearings 16 and 16a. To the upper end of the said shaft a worm gearing 17 is secured which is in mesh with a worm 18 provided on the shaft 19 of an electromotor 20. The said electromotor is mounted on a plate 21 disposed above the pair of rollers 10 and 11. The shaft 19 of the said motor carries speed regulating means, and as shown the said regulating means are in the form common in talking machines and comprising a centrifugal governor 22, a brake 23, 24, controlling means 25, 26, 27 for the brake, and scale marks 28. By means of the said regulating mechanism the circumferential velocity of the motor and the feed rollers 10 and therefore the velocity of the record band 2 may be regulated.

The stamp 1 cooperates with a platen 33 preferably made from elastic material such

as caoutchouc, and slightly above the said platen an inking ribbon 34 is movable transversely of the apparatus. The record band 2 is passed between the inking ribbon 34 and the platen 23 so that a record is printed thereon when pressing the stamp 1 downwardly. The stamp 1 is angular in cross-section, and its face carries a type composed of two ribs *b* and *c* disposed relatively to each other at an acute angle, the said type printing on the record band 2 angular lines. Thus, when continuously moving the band 2 a system of lines is printed by the successive printing operations of the stamp, which is illustrated in Fig. 2, in whch however, there are no longitudinal lines. The inking ribbon is wound on spools 35 disposed above the printing mechanism and having their axes 36 mounted in a frame 37. The inking ribbon is guided on guide rollers 38. To the ends of the axes 36 projecting outwardly and through the wall of the box 3 buttons 39 are secured by means of which the inking ribbon may be advanced by hand in one or the other direction. I have found that ordinarily hand operated means for advancing the ribbon are sufficient. But I wish it to be understood that I do not limit myself to this feature and that in some cases mechanical means are provided for advancing the inking ribbon.

Electromagnetic means are provided for operating the stamp 1. The stamp is carried by two rods 40 directed upwardly therefrom and guided in a plate 41 and bearings 42, the plate 41 limiting the upward movement of the stamp. At their top ends the rods 40 carry collars 43 and a plate 45 of soft iron fixed in position by nuts 44 screwing on the rods 40, the said plate 45 providing the armature of an electromagnet 46. Between the collars 43 and the bearings 42 coiled springs 47 are located which tend to elevate the armature 45 and the stamp 1 away from the record band. When closing the circuit of the electromagnet the armature 45 is attracted for forcing the printing stamp downwardly and producing a print on the record band.

The mechanism shown herein for feeding the feed rollers 10 and 11 and the location of the said rollers in front of the printing mechanism are important for the reason that the record band, which is momentarily arrested by the printing operation, is not put under tension, as would be the case if the rollers were provided at the rear of the printing mechanism. If the feeding rollers were disposed at the rear of the printing mechanism so as to pull the record band through the same it might happen that the feed rollers slide on the band during the printing operation, which would interfere with the uniform movement of the record band. With the construction of the feeding mechanism and the printing mechanism shown in the figures the feeding of the band by the feed rollers 10 and 11 may continue while the band is momentarily arrested by the printing stamp, the said band being merely slightly bent outwardly between the feeding rollers and the printing mechanism, so that the slight irregularity is immediately compensated by the acceleration of the bent portion of the band after printing. Thereby the band has a slightly intermittent movement within the printing mechanism, but on an average the feed of the band by the feed rollers is perfectly uniform.

For closing the circuit of the electromagnet in dependence of the pulsating movement the frequency of which is to be measured any desired contact making device may be provided. In Figs. 10 and 16 I have shown a contact making device in the form of a switch 48 operated by an apparatus receiving the pulsations to be measured. The arms of the said switch are connected by leads 49 and 50 combined into a cable 51 with a plug 52 cooperating with contacts 53 mounted on the box 3. The contact making device is preferably operated by low voltage current, while the motor 20 and the electromagnet 46 are operated by high voltage current. Therefore a relay 54 is disposed within the casing 3 the primary terminals of which are connected with the leads 49 and 50, while the secondary terminals of the said switch are connected in series with the electromagnet 46, the electromotor 20 and the net, the leads 29 of the net being adapted to be connected to terminals 30 provided on the box. Low voltage current is taken from a battery 55 adapted to be passed into the box 3 through a gate 31. The battery 55 may be a primary battery such as are usual in pocket lamps. The lid of the box carries a switch 56 having a handle 57 passed outwardly through a slot 58, the said switch controlling the supply of current from the mains to the apparatus.

While in describing the invention reference has been made to particular examples embodying the same I wish it to be understood that my invention is not limited to the constructions shown in the drawings, and that various changes may be made in the general arrangement of the apparatus and the construction of its parts without departing from the invention.

I claim:

1. The herein described method of making a record of the frequency of impulses, which consists in printing a pair of lines disposed angularly of each other in accordance with the said impulses on a record surface, and moving the said surface transversely of the said lines at a velocity such that the forward line printed by an impulse is intersected by the rear line of the preceding impulse.

2. An apparatus for making a record of the frequency of impulses, comprising means for moving a record surface, and means for printing a pair of angular lines in accordance

with said impulses on said record surface, the velocity of the movement of said surface being such that the forward line printed by an impulse is intersected by the rear line printed by the preceding impulse.

3. An apparatus for making a record of the frequency of impulses, comprising means for moving a record surface, and means for printing a pair of angular lines one of which is a curved line in accordance with said impulses on said record surface, the velocity of the movement of said surface being such that the forward line printed by an impulse is intersected by the rear line printed by the preceding impulse.

4. An apparatus for making a record of the frequency of impulses, comprising means for moving a record surface, and means for printing a pair of angular lines one of which is a curved line in accordance with said impulses on said record surface, the velocity of the movement of said surface being such that the forward line printed by an impulse is intersected by the rear line printed by the preceding impulse, the relative shape of said means for printing lines being such that the distances between the points of intersection of said lines and a line located longitudinally of the movement of the record surface are proportional to the frequency of the impulses.

In testimony whereof I affix my signature.

WERNER KUNZE.