July 7, 1953 R. DITISHEIM 2,644,294

ALARM WRIST WATCH

Filed April 24, 1952 3 Sheets-Sheet 1

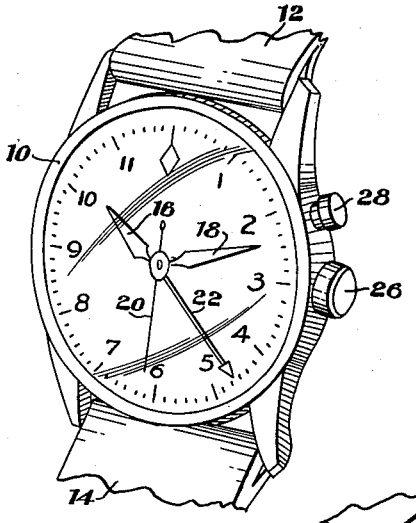

Fig. 1

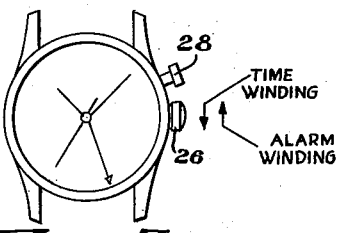

Fig. 3

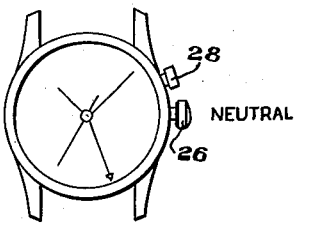

Fig. 4

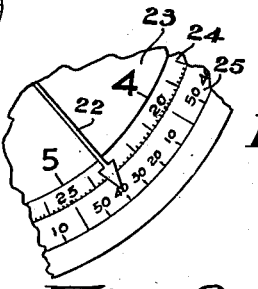

Fig. 2

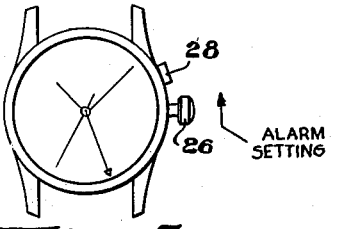

Fig. 5

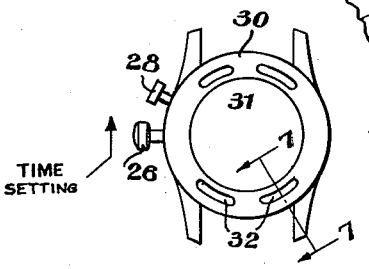

Fig. 6

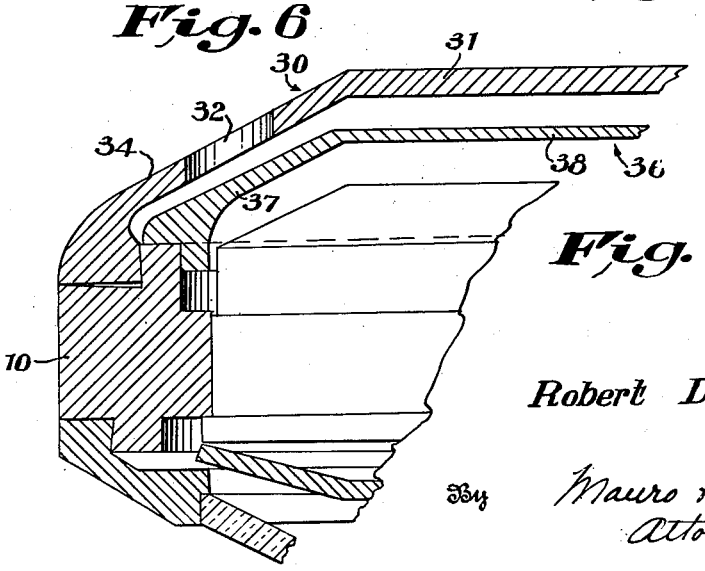

Fig. 7

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ALARM WRIST WATCH

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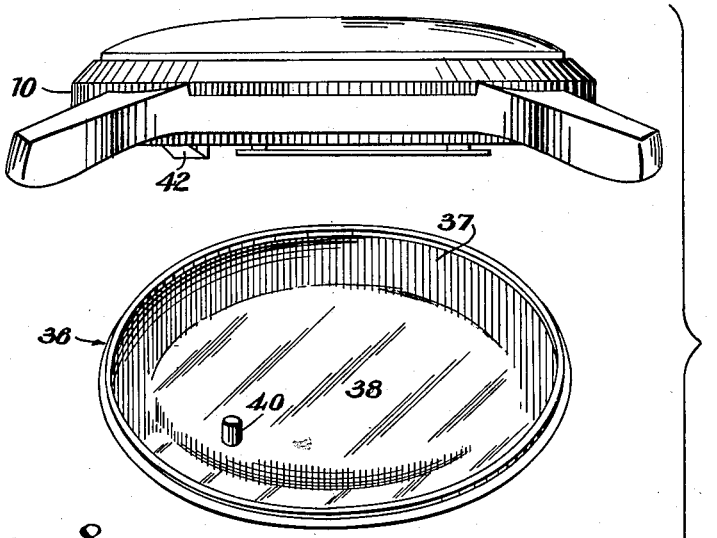
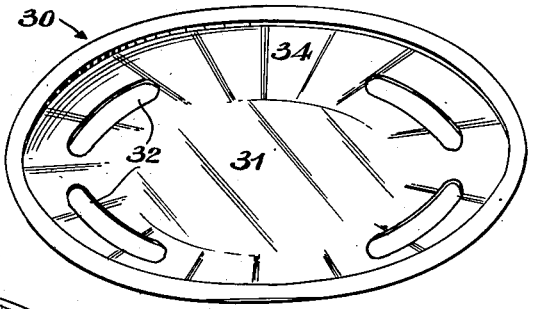


Fig. 8



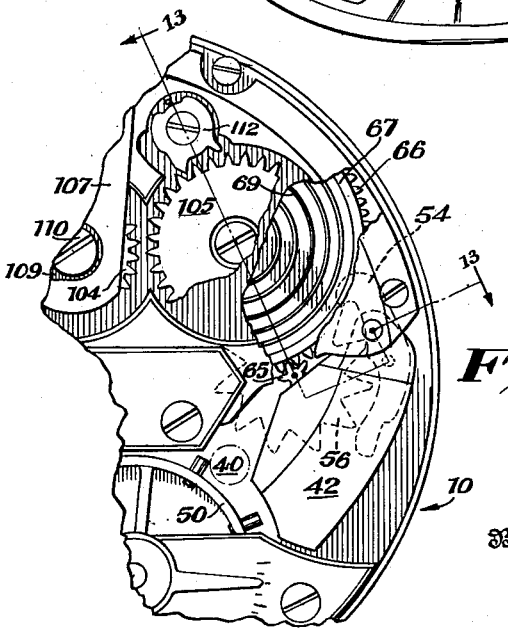


Fig. 9

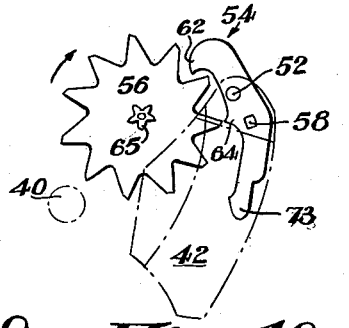


Fig. 10

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ALARM WRIST WATCH

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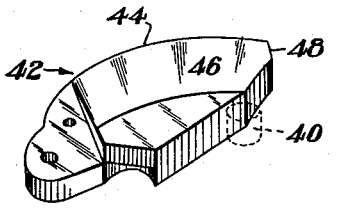

Fig. 11

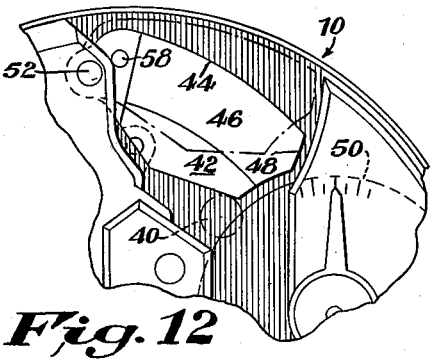

Fig. 12

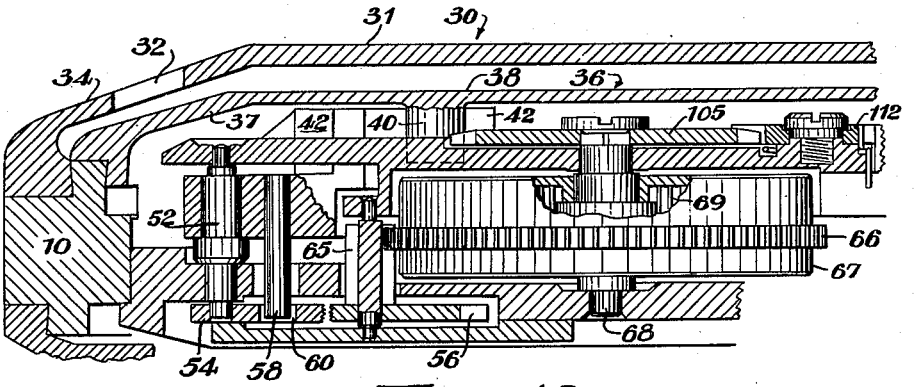

Fig. 13

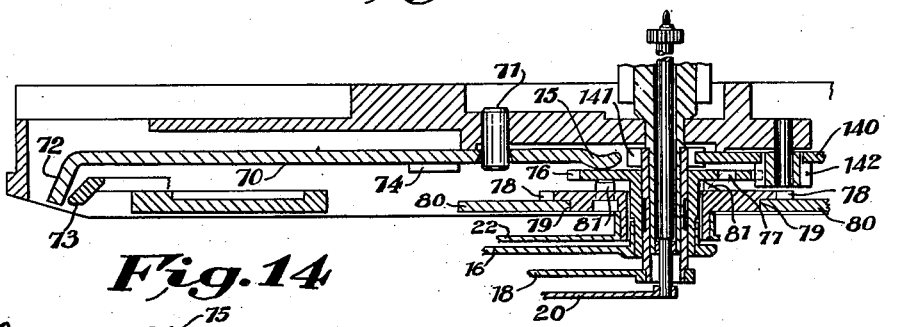

Fig. 14

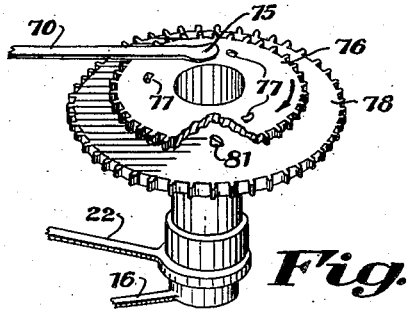

Fig. 15

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UNITED STATES PATENT OFFICE

2,644,294

ALARM WRIST WATCH

Robert Ditisheim, La Chaux-de-Fonds, Switzerland

Application April 24, 1952, Serial No. 284,166
In Switzerland September 27, 1943

7 Claims. (Cl. 58—57.5)

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This invention relates to an alarm wrist watch having numerous novel features of construction which will be detailed and described hereinafter.

This application is a continuation in part of application Serial No. 4,491, filed January 27, 1948, which in turn is a continuation in part of application Serial No. 550,976, filed August 24, 1944, both abandoned.

Whereas there are successful examples of small alarm clocks and of pocket alarm watches on the market, the relatively large size of these pieces and the available space therein for the installation of bells, chimes and the like, strong operating springs, and clappers or hammers, has not made their design difficult. There is ample room in the cases of such pieces to permit the inclusion of alarm mechanisms without special difficulty.

It is clear that if resort has been had to such devices, the most obvious approach, namely, that of fitting the alarm mechanism in a wrist watch case of conventional size and shape, has been the most difficult of attainment. I claim this attainment for my invention, which comprises an alarm wrist watch which varies imperceptibly in size and appearance from ordinary wrist watches, yet contains the mechanisms which permit operating, winding and setting of an alarm having remarkable audibility and duration.

The size and appearance of the alarm wrist watch constituting the invention cannot be overemphasized, since it will be found that any such watch which differs appreciably in these features from an ordinary wrist watch, will prove to be impracticable as well as unpopular. The most frequent dimensions found in round wrist watches for men are a case diameter of about 33 mm. and a thickness of about 9 mm. My alarm wrist watch has an outer diameter of 34 mm. and its maximum thickness or height measured at the center of the glass is 12 mm.

Among the principal objects of the invention, and hence the advantages thereof, reside in the following:

a. The provision of a separately spring-driven hammer means adapted in size and shape to fit into a highly limited space in the watch interior, yet so designed that a kinetic striking energy of strong proportions and long duration is delivered. The average sounding time of alarm wrist watches made according to my invention is 23 seconds. This sounding time never falls below 18 seconds and often lasts 27 seconds.

b. An acoustic diaphragm adapted to be sounded by the hammer, scientifically designed to provide the maximum vibrating surface, and

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possessing a vibration frequency of the most efficient order, namely, about 1800 periods per second, which frequency is the most audible to the human ear. The diaphragm is furthermore designed to occupy the least space possible in the direction of thickness of the watch, to provide a dust proof inner cover for the mechanism, and at the same time to provide the inner wall of a resonant chamber in conjunction with the outer back cover.

c. A back cover designed to form, in conjunction with the diaphragm beneath, a resonant chamber of the maximum diameter possible, yet to provide means for egress of the alarm sound which means cannot be muffled by the wrist of the wearer. By reason of the selected design, these objects are attained while avoiding a distorted or bulky appearance at the back of the watch, and without adding objectionably to its thickness. The size and shape of the chamber are attuned to the vibrational rate of the diaphragm to provide maximum amplification of the sound vibrations.

d. A separate alarm spring and special connecting and driving means with the hammer to insure rapid oscillation of the latter, together with means for releasing and turning off the alarm.

Further details concerning the foregoing, and other advantages of the invention will be discussed in connection with the drawings, wherein:

Fig. 1 is a general perspective view of the alarm wrist watch;

Fig. 2 is a fragmentary enlargement showing details of the dial tracks not visible in Fig. 1;

Figs. 3–5 are diagrammatic views showing the various button and stem positions for winding and setting;

Fig. 6 is a diagrammatic view of the back of the watch, also showing the button and stem position for time setting;

Fig. 7 is a sectional view of the lines 7—7 of Fig. 6, in enlarged scale, showing the rear cover, diaphragm, and sound chamber;

Fig. 8 is an exploded view, partly isometric, showing the relation between the watch body, diaphragm and rear cover;

Fig. 9 is a fragmentary plan view, parts being broken away, showing the alarm driving mechanism and alarm hammer parts;

Fig. 10 is a diagrammatic detail view of a portion of Fig. 9 showing the star wheel and anchor for oscillating the alarm hammer;

Fig. 11 is an enlarged perspective view of the alarm hammer;

Fig. 12 is a fragmentary detail illustrating the extreme positions of the alarm hammer when operating;

Fig. 13 is a partial sectional view taken on line 13—13 of Fig. 9;

Fig. 14 is a partial section through the central shaft assembly and the alarm release lever;

Fig. 15 is a fragmentary perspective view of parts of the alarm releasing mechanism shown in section in Fig. 14.

Referring now to the drawings, Fig. 1 illustrates in perspective view a watch in accordance with my invention, the case being designated generally by numeral 10, and a wrist strap or the like by numerals 12, 14. In addition to the usual hour hand 16, minute hand 18 and sweep second hand 20, the watch is provided with an alarm setting hand 22. In Fig. 1, because of its scale, the dial and indicia thereon are not fully illustrated, but these may be seen in Fig. 2 which is an enlarged fragmentary view of the dial between the hours four and five. In this view an inner hour track 23, a seconds-minutes track 24, and an outer alarm track 25 are shown. From this view it will be seen that the alarm track between each hour is divided into six ten-minute intervals, and that the alarm setting hand 22 is set to go off at four-forty o'clock. The same indicia are carried between the other hours on the alarm track. The winding and setting mechanism is not a part of the present invention but a very satisfactory method of controlling the separate winding and setting of the two mechanisms (the alarm and the timing mechanisms) is illustrated in Figs. 3–5. Details of the construction of gear trains, etc., for such winding and setting mechanisms are described and claimed in my U. S. Patent No. 2,554,402 of May 22, 1951.

Thus, the winding and setting of the watch both as to time and alarm, and the control of the ringing of the alarm, are accomplished by the manipulation of two controls, a stem 26 occupying the usual position of a wrist watch stem, and a button 28. As is described in said U. S. Patent 2,554,402, the two controls are inter-connected in such a way that whenever the stem is depressed to its lowest position, against the outer rim of case 10, the button 28 is moved to an outer position, while if the button 28 is depressed, stem 26 is forced to an outer position. With this interconnection in mind, the operation of the button and stem to accomplish the various control and adjustment functions will readily be understood by referring to Figs. 3 to 6, the description of the internal mechanism employed being set out in detail in said U. S. Patent No. 2,554,402.

Referring now to Fig. 3, stem 26 is shown depressed in the lowest of three possible positions against the rim of case 10, button 28 therefore being in the outermost of its three possible positions, and the watch is in condition for the winding of its two power springs, one for the driving of the time mechanism and the other for the driving of the alarm mechanism. As so adjusted, a right hand rotation of stem 26 (that is, towards 12 o'clock) will wind the alarm spring, while a left-hand rotation (towards 6 o'clock) will wind the time spring. When both of the springs are wholly or partially unwound, the natural to-and-fro rotation of stem 26 will wind both of these springs until one of them becomes fully wound, whereupon rotation of the stem will be permitted only in the direction necessary to fully wind the other.

Fig. 4 illustrates the watch in its neutral position, in which the stem is disconnected from both the winding and setting trains. This position stops the ringing of the alarm, and is achieved by slightly depressing button 28 to its intermediate position, which automatically raises stem 26 also to its intermediate position. Alternatively, button 28 may be completely depressed, which would raise the stem 26 to its outermost position, and the latter may then be partly depressed, which will raise the button to the midpoint as indicated in this figure. As so adjusted, the alarm will be prevented from ringing, and in the event that the alarm spring is completely run down, this position also prevents the alarm hammer from knocking idly against the sounder diaphragm. If it is desired to have the alarm sound when the watch reaches the time setting corresponding to the position of alarm hand 22, then stem 26 is completely depressed, returning the watch to its Fig. 3 adjustment, and the alarm will sound at the pre-set time (that is, when hour hand 16 reaches the position of alarm hand 22).

With button 28 depressed as in Fig. 5 which, as stated above, also raises the stem 26 completely, a rotation of the stem or its crown in a right-hand direction (towards 12 o'clock) turns the alarm setting hand 22 counterclockwise around the dial. Rotation of stem 26 in the other (left-hand) direction does not disturb the position of hand 22. The fully depressed position of button 28 also shuts off the alarm.

The setting of the hour and minute hands 16 and 18 is accomplished first by moving button 28 to its outermost position. This is done by fully depressing stem 26. (Button 28 should not be pulled out.) Stem 26 is then pulled out of its outermost position without (as in the case of Fig. 5) making any use of the button. Button and stem thus being fully out, as in Fig. 6, stem 26 is connected to the setting train for the hour and minute hands and will move these in a clockwise direction when the stem is rotated in a left-hand direction (toward 6 o'clock). As in the case of setting the alarm hand, turning the stem in the wrong direction does nothing, and causes no damage since a slippage in the gear train is provided.

In this way, the single stem 26 controls both the winding of the two mainsprings, as well as the setting of both the time hands and the alarm hand and the use of such a unitary control greatly simplifies the adjustment and use of the watch, as compared with mechanism in which separate controls are provided for the time and alarm functions. Simultaneously, the stem and cooperating button provide alarm-locking positions to prevent premature release thereof.

Fig. 6 is a reverse view of the watch, showing the rear cover plate 30 provided with sound ports 32.

I have found that, in order to achieve a sufficient volume of sound, it is necessary to provide, instead of the usual alarm bell or the like, a resonating plate of substantial dimensions as compared with the diameter of the watch, but which is necessarily of quite small thickness in order to be capable of vibrating at a frequency near the point of maximum aural acuity of the average person. It is not desirable to use the rear cover of the watch for this diaphragm, not only because it would be of inadequate strength, but also because any contact with the wrist or other object would so damp

the vibrations of the plate as to make them very weak. I have therefore provided a separate sounding diaphragm lying inside the rear cover of the watch, said cover acting as a means to space the sounding diaphragm from contact with the wrist and having ports which couple the vibrations of the diaphragm acoustically with the outer air. Moreover, advantage is taken of the necessity for this spacing means to provide a resonant chamber between the diaphragm and the cover plate, this chamber being so dimensioned as to reinforce and amplify the sound produced by the vibrations of the diaphragm.

As best shown in Figs. 6, 7 and 8, the sound ports **32** in the rear cover **30** are located upon the bevelled rim portion **34** thereof, which prevents the closing of these perforations even when the watch is pressed firmly against the wearer's wrist, and provides free egress for sound produced by the diaphragm **36**, as amplified by the chamber between the diaphragm **36** and cover **30**. As best seen in Fig. 7, both the cover **30** and diaphragm **36** are bevelled and provided with any usual form of snap engagement so as to be snapped on or coupled with the case ring or band **10**.

The diaphragm **36** comprises a central flat area **38** surrounded by an integral bevelled rim **37** sloping toward and coupled with the case ring **10**. The central flat area **38** is shown as thinner than the bevelled rim **37** but bevelled rim **37** is not so thick as to make it completely rigid. While the thickness of the rim at the very edge may be several times that of the central area, the increase in thickness is gradual. In fact, the bevelled shape of rim **37** makes it more flexible and capable of vibrating with the central flat portion **38** of the diaphragm **36**. In other words, at least a portion of the rim is capable of vibrating with the center portion. In the dimensions set forth below illustrative dimensions of the central area **38** and rim **37** to give a vibrational frequency of approximately 1800 per minute are given, since this frequency is the point of maximum hearing acuity for average persons. When it is stated that the central flat area **37** and the bevelled rim **37** of the diaphragm are integral it is understood that this means that these parts are formed as one single piece of metal.

The dimensions of course can be varied depending on the vibrational frequency desired and on the metal employed for the diaphragm **36**.

For a watch, which is approximately 34 mm. in outside diameter, the dimension of a very satisfactory diaphragm having the requisite characteristics are as follows:

Overall diameter: approximately 30 mm.
Diameter of central flat area: approximately 24 mm.
Thickness of central flat area: approximately .24 mm.
Depth (from seat on case to flat area): approximately 1.90 mm.

The beveled rim may be of substantially uniform thickness or may be of gradually increasing thickness between the flat area **38** and the edge which couples with the ring **10**. Thus the thickness of the rim may be between approximately 0.23 mm. and 0.80 mm. In the construction shown in the drawing the rim is approximately 0.40 mm. thick at the central part of the area between the flat area **38** and the coupling edge.

The size of the pin or stud **40** can be varied, the minimum size is imposed by the requirement that the pin be rigid and must not bend but must transmit the energy of the hammer to the membrane. The maximum size is limited because its increase would injure the acoustic qualities of the membrane. Although the pin is shown as circular in cross section it may be of any convenient cross sectional shape. The pin should have the rigidity etc., equivalent to that of a solid cylindrical pin of 1.0–2.8 mm. in diameter.

The rigid projecting pin or stud **40** (Fig. 8) set approximately 7 mm. from the center of diaphragm **36**, projects a short distance toward the interior of the swatch and is adapted to be struck by the alarm hammer, thus setting diaphragm **36** to vibrating. The vibrations of the flat area **38** are reinforced by and/or transmitted to the rim **37** and even to the case band **10** due to the one piece construction of the flat area **38** and rim **37** and the coupling between rim **37** and case band **10**.

The cover plate **30**, since it does not vibrate, has no critical thickness; however, its shape with relation to the diaphragm beneath has certain desirable characteristics, as follows: It is provided with a flat central portion **31** complementary to that of the diaphragm beneath, and thus also of a diameter of about 24 mm. The cover plate is of a depth to provide a space of approximately .65 mm. between the flat portions **31** and **38** of cover and diaphragm. The arrangement is best seen in Figs. 7 and 8. This cover design not only provides (with the diaphragm) an acoustic sound chamber of excellent quality, but the cover affords a minimum addition to the thickness of the watch compatible with its purpose. Also the flat outer face of portion **31** provides a desirable seat for the watch on the wearer's wrist.

The alarm hammer, and its driving mechanism will next be described with reference to Figs. 9–12. The hammer generally designated at **42**, is of special shape, dimensions and weight calculated to deliver the best striking force available in the permissible space. From Fig. 11 especially, it will be seen that the back of hammer **44** is curved to conform to the inner wall of case **10**. This permits hammer **42** to be withdrawn the fullest distance possible from pin **40** on the return stroke. Also, hammer **44** is given a beveled top rear edge **46** so that it will clear the beveled rim portion **37** of diaphragm **36**. A cutaway inner tip is also provided at **48** to give clearance from the balance **50**.

Hammer **44** is pivoted by means of arbor **52** for lateral reciprocation oscillation between the case **10** and **40** (see full and dotted positions, Fig. 12). Alarm lever or anchor **54** is pivoted to the end of arbor **52** and is actuated by the rotation of star wheel **56**. The oscillatory movement of anchor **54** is transmitted to hammer **44** by means of the connecting pin **58** fixed in hammer **44** and fitting loosely in an opening **60** in anchor **54**. Figs. 10 and **13** best illustrate this connection.

The anchor **54** is fitted with a pair of catches or teeth **62** and **64** so shaped that the rotation of the star wheel **56** contacts and repels first one and then the other alternatively, thus providing the oscillation of anchor **54** and hammer **44** connected therewith. When the star wheel (rotation in direction of arrow) strikes catch **62** (Fig. 10), the hammer is swung toward pin **40**. This movement brings catch **64** into position to be struck by the star wheel, which action swings

anchor 54 and hammer away from the pin and also returns catch 62 into contact with the star wheel 56. This action takes place with extreme rapidity.

Star wheel 56 is carried by a pinion 65 meshing with the toothed crown 66 of the alarm barrel 67 mounted on barrel arbor 68. The barrel 67 contains an alarm spring 69 (Figs. 9 and 13).

The alarm mechanism thus far described is responsible for the long and steady period of alarm which characterized the watch of my invention. To give some measurements, which have proved to be very satisfactory, the hammer according to the invention has a weight which varies between 0.625 gm. and 0.630 gm. The maximum length of the hammer from its point of pivot (arbor 52) is approximately 9 mm. The distance along the hammer from pivot point to the striking point of pin 40 is approximately 7 mm.

The alarm mainspring 69, when wound, has a maximum torque, measured statically, of approximately 353 gram-millimeters. This torque diminishes theoretically in a linear manner up to the value corresponding to the total release of the spring, after a rotation of about 12 turns. The total energy furnished by the alarm spring is approximately 0.01 kilogram-meter, calculated as follows:

$$\underbrace{\tfrac{1}{2}\times 353 \text{ gr. mm.}}_{\text{(mean value of the torque)}}\times 12 \text{ turns}\times 2\times \underbrace{0.8}_{\text{(spring efficiency)}}=$$

$$10700 \text{ gr. mm.}=0.0107 \text{ kg. m.}$$

By providing a toothed crown 66 on the alarm barrel 67 having a diameter of approximately 10 mm. connected with pinion 65 of about 1 mm. diameter and carrying a star wheel 56 provided with eleven teeth, it will be seen that, since the alarm hammer will reciprocate one complete cycle each time a star wheel tooth passes anchor 54, a hammer beat of approximately 110 strokes per barrel revolution will result. Since spring 69 will rotate the barrel 67 an average of 12 rotations per wind, the total average hammer beats per winding are approximately 1,320, or 55 beats per second figured on an average alarm duration of 24 seconds.

With this spring power, hammer weight, and driving connections as described, a long and steady oscillation of the hammer is thereby achieved. The inertia of the hammer is delicately attuned to the spring power so that a rapid exhaustion of the spring is not possible, yet the hammer may be oscillated freely by the spring even when the latter has lost nearly all of its potential energy. Thus a highly economical and efficient use of the available spring power is provided.

The means for releasing the alarm at the desired time will next be described with reference to Figs. 13, 14, 15 and 18. A release lever 70, loosely mounted on a pivot pin 71, has a curved catch portion or tip 72, which in the position shown in Figs. 14 and 18 engages an extension 73 of anchor 54, catch 72, by holding anchor 54, and hence star wheel 56, motionless, prevents the alarm from ringing until the desired time for it to go off.

The inner tip 75 of release lever 70, provided with a convex bearing surface, is pressed by the action of a lever spring 74 against the inner face of the cannon wheel 76 carrying hour hand 16. Cannon wheel 76 is pierced by three unequally spaced holes 77, only one of which is visible on Fig. 14. Wheel 78, to which is attached the alarm setting hand 22, rests in a frictional bearing 79 provided by the spring yoke holder 80 (see Figs. 14 and 18). On the inner face of wheel 78 are provided three projecting pins 81, likewise unequally spaced so as to coincide and enter holes 77 in cannon wheel 76, as the latter rotates under the action of the time movement. With the setting hand 22 at a single setting, it will thus be seen that all three pins 81 and holes 77 will coincide only once each twelve hours. Fig. 15 is a detail of this arrangement. When pins 81 meet and enter holes 77, the cannon wheel is forced toward the wheel 78 by the spring action of release lever 70 impelled by spring 74. This movement is accompanied by an upward tilting movement of the end of lever 70 carrying catch 72, still influenced by spring 74. Catch 72 is freed from engagement with extension 73 of anchor 54, and anchor 54 is thus free for operation by star wheel 56 as previously described, causing the alarm to sound.

If after the alarm has sounded, the setting of alarm hand 22 is left unchanged, the continued rotation of the hour hand cannon wheel 76 will cause the holes 77 to move away from pins 81 on wheel 78, the holes 77 being forced up the inclined faces of pins 81 until holes 77 and pins 81 are disengaged. When this is accomplished, the parts are returned to the position shown in Fig. 14, with lever 70 again locking the alarm driving mechanism. Naturally, a movement of the alarm is set to another point immediately after sounding, will in like manner set the parts in alarm setting wheel 78, as when the alarm is set to another point immediately after sounding, will in like manner set the parts in the alarm-off position of Fig. 14.

The watch which is constructed as set forth above is still very compact as will be apparent from its dimensions and the sounding diaphragm with its flat center portion and integral rim portion is smaller than any practical audible diaphragm known to applicant. The sound produced is not a ringing sound due to the fact that the edges of the rim of the diaphragm do not have freedom of movement but instead are coupled to the ring of the watch. The result is a specific diaphragm tone similar to that of a cricket. It can be heard at least 20–75 feet away depending on the threshhold level of the surrounding noise. The coupling between the case band and the rim of the diaphragm apparently gives the muffled tone to the sound and in fact when the case of the watch is held while the diaphragm is being sounded the vibrations can be felt in the said case band.

I claim:

1. A watch of a size adapted to be worn on the wrist and having an audible alarm system comprising in combination, a case band, a sounding diaphragm, and a watch movement including a hammer means within said case band, said sounding diaphragm extending over the area opposite to the face of said watch so as to substantially completely cover one side of the space surrounded by said case band, said sounding diaphragm being of one piece and comprising a flat, thin, central portion and a relatively rigid, annular rim portion sloping from the central portion toward said case band and coupling said diaphragm with said case band, a stiff projection on said diaphragm extending into the space occupied by said watch movement, said hammer means including a hammer which is adapted to percussively strike the said stiff projection of said sounding diaphragm.

2. The watch as set forth in claim 1 in which

the stiff projection is a pin formed on the vibratable central portion of said diaphragm.

3. The watch as set forth in claim 1 in which the central portion of said diaphragm is of the order of 0.25 millimeter in thickness and in which the rim portion of said diaphragm gradually increases in thickness from the central portion to the edge thereof.

4. A watch of a size adapted to be worn on the wrist and having an audible alarm system comprising in combination, a case band, a sounding diaphragm adjacent the side thereof which is adapted to contact the wrist of the wearer, spacing means containing open spaces adapted to hold said sounding diaphragm out of contact with the wrist of the wearer, and a watch movement including a hammer means within said case band, said sounding diaphragm extending over the area opposite to the face of the watch so as to substantially completely cover one side of the space surrounded by said case band, said sounding diaphragm being of one piece of metal and comprising a flat, thin, central portion, and a rigid, annular rim portion sloping from the central portion into contact with an inner edge of said case band, a stiff projection on said diaphragm extending into the space occupied by said watch movement, said hammer means including a hammer which is adapted to percussively strike the stiff projection of said sounding diaphragm.

5. A watch of a size adapted to be worn on the wrist and having an audible alarm system comprising in combination, a case band, a sounding diaphragm, a rear plate and a hammer means within said case band, said sounding diaphragm being of one piece of metal extending across the inner edge portion of said case band and inside of the said rear plate and comprising a flat, thin, central portion and an annular rim portion, projecting means on said sounding diaphragm extending into the space defined by said case band, said rear plate having a substantially flat continuous central portion which is adjacent to, substantially coextensive with, but spaced from the flat portion of said sounding diaphragm so as to form a resonant chamber between said sounding diaphragm and said rear plate, said rear plate also having a rim portion adapted to secure the said rear plate to said case band and containing openings in its said rim portion,

said hammer means including a hammer which is adapted to be positively reciprocated back and forth in a plane parallel to the plane of the said flat central portion of said sounding diaphragm so as to strike the said projecting means of said sounding diaphragm at one end of its path of movement, means for positively moving said hammer back and forth a number of times.

6. A watch of a size adapted to be worn on the wrist and having an audible alarm system comprising in combination, a case band, a sounding diaphragm, a rear plate and a watch movement including a hammer means within said case band, said sounding diaphragm being of one piece of metal extending about the inner edge portion of said case band and inside of the said rear plate and comprising a flat, thin, central portion and a rigid, annular rim portion adapted to couple with and secure the said sounding diaphragm to said case band, the said rim and center portion of the diaphragm being substantially continuous so as to form a dust proof rear cover for said watch movement, said rear plate having a substantially flat continuous central portion which is adjacent to, substantially coextensive with, but spaced from the flat portion of said diaphragm so as to form a resonant chamber between said diaphragm and said rear plate, said rear plate also having a rim portion adapted to secure the said plate to said case band and containing openings in said rim portion, said hammer means including a hammer which is adapted to percussively vibrate said diaphragm.

7. The watch as set forth in claim 6 in which the central portion of said diaphragm is of the order of 0.25 millimeter in thickness and in which the rim portion of said diaphragm gradually increases in thickness from the central portion to the edge thereof.

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