(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 April 2007 (19.04.2007)

PCT

(10) International Publication Number
WO 2007/043011 A2

(51) International Patent Classification:
A61H 23/02 (2006.01)

(21) International Application Number:
PCT/IB2006/053725

(22) International Filing Date: 10 October 2006 (10.10.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
171375 11 October 2005 (11.10.2005) IL

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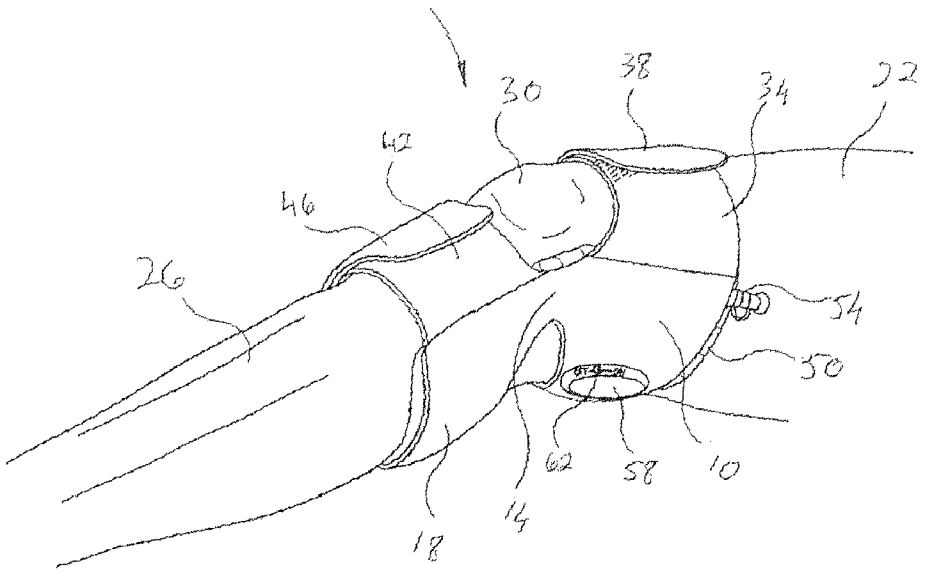
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** DEVICES AND METHOD FOR APPLYING VIBRATIONS TO JOINTS



(57) **Abstract:** A device and method for introducing sets of intcrvallic vibrations to a joint of a user. The device comprises flexible or rigid portions or members connected there between and having a shape substantially f itting the area adjacent a joint, flexible members for attaching the rigid portions or members to the area adjacent the joint, and a vibrating mechanism for introducing vibration to the joint. Each set of vibrations comprises alternating intervals of activity and resting, and the parameters of the activity intervals, such as the frequency or amplitude can vary, T he durations of the intervals as well as the periods between sets can be preset, programmed or otherwise introduced to the device.

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DEVICES AND METHOD FOR APPLYING VIBRATIONS TO JOINTS

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to medical devices in general, and to a method and devices for applying vibrations in intervals to joints and joint areas in particular.

RELATED APPLICATIONS

This application claims priority from Israeli Patent Application serial number 168520 filed on May 10, 2005 titled DEVICES AND METHOD FOR APPLYING VIBRATIONS TO JOINTS, which claims priority from Israeli Patent Application serial number 166468 filed on January 24, 2005 titled DEVICES AND METHOD FOR APPLYING VIBRATIONS TO JOINTS, the full contents of both applications is incorporated herein by reference.

DISCUSSION OF THE RELATED ART

Arthritis is a common name for over a hundred types of diseases, including Osteoarthritis, Rheumatoid Arthritis, and Fibromyalgia to name the three most common types of Arthritis.

Osteoarthritis (sometimes called degenerative joint disease) is the most common type of arthritis, especially among older people. Osteoarthritis is joint disease which is primarily a disorder of the cartilage and subchondral bone. Healthy cartilage allows bones to glide over one another and absorbs energy from the shock of physical movement. The events leading to Osteoarthritis result in the

remodeling of the moveable joints thus allowing the deformed bones to rub together with the joint having deteriorating cartilage, causing pain, swelling, and loss of motion of the joint. Over time, the joint may lose its normal shape. Also, bone spurs may grow on the edges of the joint. Bits of bone or cartilage can break off and float inside the joint space. This causes additional pain and damage. Symptoms of osteoarthritis usually include joint pain, stiffness, and limited movement.

Rheumatoid arthritis (RA) is a chronic disease, mainly characterized by inflammation of the lining of the joints. It can lead to long-term joint damage, resulting in chronic pain, loss of function and disability. Rheumatoid arthritis progresses in three stages. The first stage is the swelling of the lining, causing pain, warmth, stiffness, redness and swelling around the joint. Second is the rapid division and growth of cells, which causes the lining to thicken. In the third stage, the inflamed cells release enzymes that may digest bone and cartilage, often causing the involved joint to lose its shape and alignment, more pain, and loss of movement. RA is a systemic disease, which means it can affect internal organs in the body, and a chronic disease, which may persist indefinitely.

Fibromyalgia (FM) is manifested as widespread pain affecting muscles and attachments to the bone. The patient may also exhibit tender points, specific regions that hurt when pressure is applied. Other symptoms can include fatigue, sleep disturbances, migraine headaches, irritated bowel syndrome, chest pain and nervous system symptoms such as depression.

Arthritis and other rheumatic conditions are among the most common chronic diseases, affecting over 70 million U.S. adults in 2004, and comprise the leading cause of disability among U.S. adults. Arthritis prevalence increases with

age, affecting approximately 60% of the U.S. population aged 65 or older. As a result of better identification and treatment of other chronic diseases and lower mortality from infectious diseases, adults are living longer, and the population is aging. For this reason, the number of persons living with nonfatal but disabling conditions such as arthritis or chronic joint symptoms (CJS) might be increasing. If arthritis prevalence rates remain stable, the number of affected persons aged 65 years and over will nearly double by 2030.

Multiple studies have shown connection between exposure to vibrations when a joint is in strenuous state and Osteoarthritis. This led to the creation of standards for the frequency, amplitude and length of exposure to vibrations which are considered safe for usage by a human being.

Most Arthritis treatment programs include a combination of medication, exercise, relaxation, use of heat and cold, joint protection techniques, and sometimes surgery. Israeli Patent Application serial number 166468 filed on January 24, 2995 titled DEVICES AND METHOD FOR APPLYING VIBRATIONS TO JOINTS and Israeli Patent Application serial number 168520 filed on May 10, 2995 titled DEVICES AND METHOD FOR APPLYING VIBRATIONS TO JOINTS, the full contents of which is herein incorporated by reference, disclose a device and method for applying vibrations to a joint. However, the effectiveness of these vibrations is limited, due to the protocols according to which the vibrations are applied. The intensive vibrations applied to the joint, together with substantially longer periods during which no vibration is applied, can cause damages to a joint, just as irregular high-impact training may be dangerous to the heart-lung system.

There is therefore a need in the art for an enhanced method and device for applying vibrations to joints and joint areas of a user, which are effective for the building and rehabilitation of bodily tissues on one hand and safe for the joints and their surroundings on the other hand.

SUMMARY OF THE PRESENT INVENTION

One aspect of the present invention regards a device for introducing a set of intervallic vibrations to a joint or a location in the body of a user of the device. The device comprises a wrapping member having a shape substantially fitting the joint and the area adjacent the joint; and a vibrating mechanism for introducing the set of intervallic vibrations. The set of vibrations comprises at least two intervals of vibrations and at least one interval of resting to the joint.

A second aspect of the present invention regards a method for introducing intervallic vibrations to a joint or a location in the body of a user of the device. The method comprises: a first vibration step in which vibrations are introduced to the joint, a resting step, and a second vibration step.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

Fig. 1 is an illustration of the leg of a person wearing a knee device, in accordance with a preferred embodiment of the invention;

Fig. 2 is an illustration of the vibrating mechanism, in accordance with the preferred embodiment of the invention;

Fig. 3 is an illustration of the vibrating assembly within the vibrating mechanism, in accordance with the preferred embodiment of the invention; and

Fig. 4 is a sample activity graph of the vibrating mechanism, in accordance with the preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention overcomes the disadvantages of the prior art by providing novel devices and a method for intervallic delivery of vibrations to body parts, such as joints or other locations in the body of patients suffering from arthritis and other chronic joint symptoms.

The present invention provides devices and a method of introducing vibrations to a location in the body, wherein the vibrations are introduced in therapeutic sets, comprising alternating intervals of rest and various activity levels.

Physical training was proven to be more effective in muscle mass building as well as in heart-lung endurance, when interval training was practiced. The alternation between strenuous intervals and rest intervals enhance and improve the training effectiveness. It is even more recommended that the activity intervals are not uniform in intensity but follow a certain pattern. For example, the initial intervals can be relatively easy, then the training can become more intensive, and final intervals are also more relaxed helping the trainee's heart rate to decrease. Further research has shown that continuously vibrating the heart caused damage that sometimes led to the death of the patient. Therefore, introducing intervallic vibrations to body parts of a person, and especially to sick joints can have an effect which is improved over continuous application to the joint. The activity and rest periods, as well as the intensity of the activity intervals and the overall training structure can be preset, or programmed for a specific user, specific needs or the like. The intensity of the activity period can be controlled by the frequency and amplitude of the vibrations, which can vary together or

independently. The durations of the activity periods and of the resting periods, and the time difference between two consecutive sets can vary as well.

Referring now to Fig. 1, showing an example for a device for applying vibrations to a knee of a person. The device is presented in Israeli Patent Application serial number PCT/IL2004/001152 filed on May 10, 2005 titled DEVICES AND METHOD FOR APPLYING VIBRATIONS TO JOINTS, the full contents of which is incorporated herein by reference. The shown device is designed to be fitted around a user's knee. Rigid portions 10, 14 and 18 are preferably made of a single piece and comprise a single piece brace to support respectively the user's thigh 22, shin 26, and the side of the knee 30. Upper straps 34 and 38 wrap the thigh, and lower straps 42 and 46 wrap the shin. In addition, an inflatable internal lining 50 is spread between rigid portions 10, 14 and 18, and the user's skin or clothes, internal lining 50 is filled through an opening 54. A vibration motor housing 58 and an on/off switch 62 are located on upper rigid portion 10. The shown device is exemplary only, and many other devices, such as those shown in the abovementioned patent application, or others adhering to the underlying principles, can be designed. Some of the devices fixate the joint in a neutral anatomic position, while others allow for motion of the joint, whether active or passive motion applied by a specifically designed mechanism.

Referring now to Figs. 2 and 3, showing a possible implementation for the vibrating motor. The vibrating mechanism is enclosed in a housing, such as housing 58 of the knee device shown in Fig. 1. The vibrating mechanism comprises a power source 100, a controller 104 and a vibrating assembly 108. Power source 100 is preferably one or more batteries. Alternatively, power source 100 is an external power source, a portable power supply such as a small

rechargeable or non-rechargeable battery, a mechanical energy source, such as a charged spring, a fuel cell, a magnetic or electrical power source, other electrochemical power sources, solar panels, and the like.

Reference is now made to Fig. 3, depicting a schematic illustration of a preferred embodiment of vibrating assembly vibrating assembly 108 of Fig. 2. The vibrating assembly comprises an actuator, such as electrical, magnetic or electromagnetic motor 204, a shaft 208, and an eccentric weight 212. Actuator 204 can also comprise other energy delivering mechanism to deliver energy to shaft 208 thereby rotating said shaft on its axis or causing a hammer like device to repeatedly hit a surface. Other energy delivering mechanism can further comprise other knocking vibration generators such as hammering that involves rotating and non rotating engines. When actuator 204 rotates, shaft 208 which is concentric with motor 204 rotates as well, thus rotating weight 212, which is eccentrically mounted on shaft 208. When rotating about shaft 208, weight 212 creates a vibration in rotation since it is shaped as a sector of a cycle and is eccentric with said shaft 208. The vibration is transferred to the device to which the vibrating assembly is attached thereto. In the disclosed invention, the vibrations are transferred to the rigid parts of the joint devices, to the lining and to the relevant joint and body parts, form all directions. In addition, the vibrations are further transported to other body parts.

Referring now back to Fig. 2, controller 104 can be an industrial off-the-shelf programmable control circuit that activates and deactivates vibrating assembly 108 according to a protocol. In a preferred embodiment, the control circuit is an electrical circuit the comprises a timing circuit, which controls the points of time at which the motor switched on and off and the speed of the motor

and a Field Effect Transistor (FET) to power the motor itself. In an alternative embodiment, controller 104 further comprises a LED indicator (not shown) and an audio indicator such as a buzzer (not shown) providing an audio and/or a visual indication or alerts to the user. In the preferred embodiment of the invention, the timing circuit is based on a PIC16LF873A chip.

In the preferred embodiment of the present invention the controller 104 activates and deactivates the vibrating assembly so as to provide intervallic vibration to the joint of the user. The electronic circuit comprises a programming interface, which can be connected via connection 116 to a general purpose computer (not shown) or to a dedicated device 112 which enable the programming of the device. If the interface connects to a general purpose computer, a dedicated application is supplied for programming the unit. Persons skilled in the art will appreciate that connection 116 can be wired, wireless, or it can use any currently known communication methods and protocols, such as RF, Bluetooth, or any method that will be known in the future. In another preferred embodiment, programming device 112 can be embedded in controller 104 which can be equipped with buttons or other programming controls. The user himself or medical personnel sets the treatment intervals according to a required protocol, setting the activity and rest intervals, and the frequencies for the activity intervals. The amplitude of the vibrations is also influenced by the frequency, since low radial velocity generates low amplitude and high radial velocity generates high amplitude. In another preferred embodiment, the device can comprise two or more motors for setting different amplitudes, or two or more weights having different weights or different shapes, such that different amplitudes are generated.

Referring now to Fig. 4, showing a graph of an exemplary activation of the device. The graph shows the frequency of the vibrations introduced by the device as a function of time. The device vibrates the user's joint and joint area at 5 Hz. for a set comprising two equal periods 304 and 308, wherein between the periods there are 30 second resting periods 312 and 316. Then a set comprising two 30-second periods 320 and 324, during which the device vibrates at 15 Hz., again with 30 second resting intervals 328 and 332 is introduced, and eventually the device again applies a set of two 30-second activity of periods of 5 Hz. 336 and 340 with 30 second resting interval 344.

This pattern of starting with low frequency, increasing the frequency and then reducing it again has proven to be especially healthy and efficient to various body mechanisms. Therefore, since the devices introduce vibrations to all types of body tissues, including bone, muscle, tendons, nerves, connecting tissues, a synovial, synovial fluid (synovia or joint fluid), skin, and blood vessels present at the area of the joint, this effect is expected to be beneficial for the user. The typical range of introduced frequencies is between about 0.5 Hz to about 500 Hz, which are within the range considered safe for joints, and the activity intervals are typically between 2 seconds and 10 minutes long.

The intervallic vibrations can be set to be repeated at fixed or changing times of a day, according to a weekly, monthly or any other schedule, or to start operating a predetermined time after the device is turned on.

The proposed devices and principles propose a novel treatment for arthritis and other joint symptoms. The treatment includes introducing intervallic vibrations to a joint and its region, while fixating the joint, enabling the joint to move or deliberately moving the joint in predetermined directions and ranges.

The devices are portable and easy to use, and the treatment is painless, pleasant, and provides immediate pain reduction as well as function improvement and delayed disability. The activity and resting periods, as well as the frequency and the amplitude of the vibrations can be preset, programmed or otherwise introduced to the device.

The proposed embodiments for the devices are exemplary only and are intended merely for indicating possible embodiments facilitating the presented principles. The presented components of the proposed invention can be used separately or concurrently. A device can be used with one type of lining or another, or with no lining at all, while the device itself is of a fixating type or of a joint-moving type. More than one device can be used simultaneously, with identical, similar or different activation protocols. Embodiments other than the shown can be used for the discussed joints, and additional devices using the disclosed principles can be designed for further joints, such as the neck, the hip, the spine, the jaws, the nose and others. Another possible embodiment comprises introducing two or more vibratory mechanisms into one of the abovementioned devices. In addition, simpler embodiments, comprising a strap with or without lining and one or more vibration mechanisms are possible as well. Given such embodiments, a combination of two or more such straps can be used, for examples on two sides of a joint, thus also providing the user with vibrations from multiple directions. The two or more vibration motors, supplying vibrations to the joint from two or more directions, can then be activated simultaneously, alternately, or according to any required combination. Additionally, the device can comprise one or more sensors, either for a vibration or to a body parameter, such as temperature, blood pressure, pulse or the like, and the vibrations can be

intensified, weakened, stopped or the like according to the measurements taken by the sensor.

It will be appreciated by persons skilled in the art that the present invention is not limited to what has been particularly shown and described hereinabove. Rather the scope of the present invention is defined only by the claims which follow.

CLAIMS

What is claimed is:

1. A device for introducing an at least one set of intervallic vibrations to a joint or a location in the body of a user of the device, the device comprising:

   an at least one wrapping member having a shape substantially fitting the joint and the area adjacent the joint; and

   an at least one vibrating mechanism for introducing the at least one set comprising at least two intervals of vibrations and at least one interval of resting to the joint.

2. The device of claim 1 wherein the vibrating mechanism comprises a programming mechanism.

3. The device of claim 1 wherein the vibrating mechanism comprises an interface for connecting to a computer.

4. The device of claim 1 wherein the two intervals of vibrations have equal or different durations.

5. The device of claim 1 wherein during the two intervals, vibrations are introduced at equal or different frequencies and at equal or different amplitudes.

6. The device of claim 1 further comprising an at least one sensor or a connection to a sensor.

7. The device of claim 6 wherein the vibrations are affected by an at least one measurement taken by the at least one sensor or reported through the at least one connection to a sensor.

8. A method for introducing intervallic vibrations to a joint or a location in the body of a user of the device, the method comprising:

an at least one first vibration step in which vibrations are introduced to the joint;

an at least one resting step; and

an at least one second vibration step.

9. The method of claim 8 wherein the first vibration step differs from the second vibrating step in an at least one parameter.

10. The method of claim 9 wherein the parameter is the duration of the step or the frequency of the vibration or the amplitude of the vibration.

11. The method of claim 8 further comprising a step of measuring an at least one value by an at least one sensor.

12. The method of claim 11 further comprising a step of changing the first or the second vibrating step or the at least one resting step according to the at least one value.

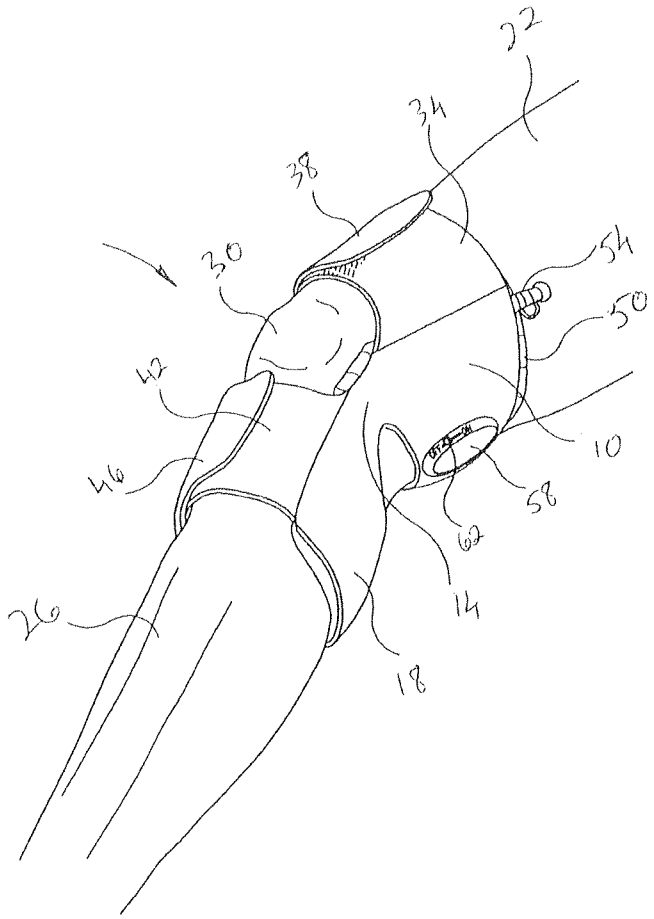


FIG. 1

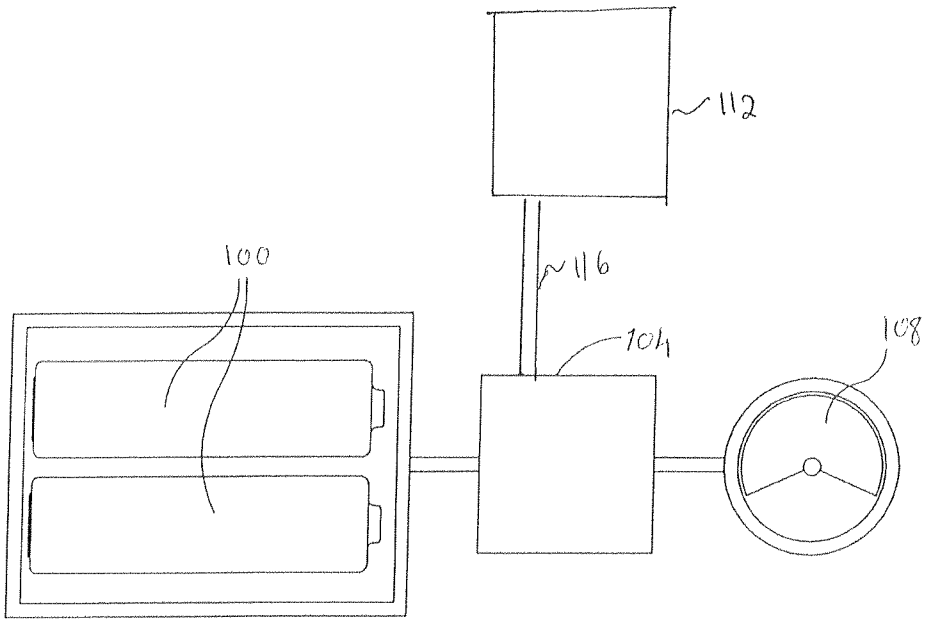


FIG. 2

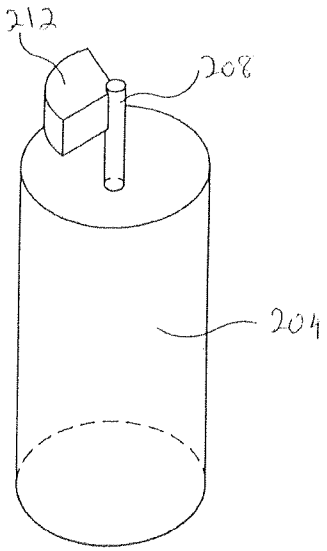
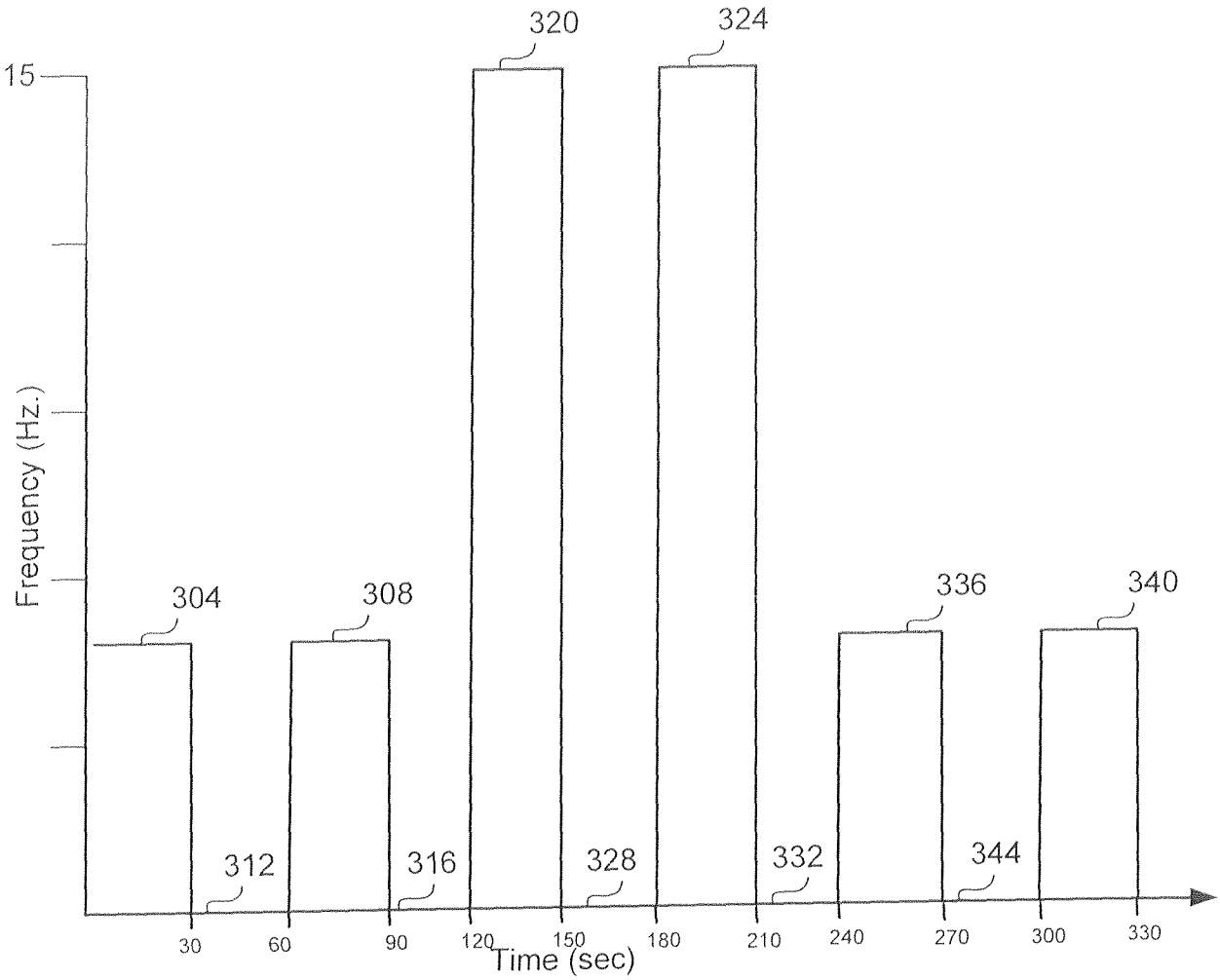


FIG. 3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324
15
Frequency (Hz.)
304
308
336
340
312
316
328
332
344
30
60
90
120
150
180
210
240
270
300
330
Time (sec)

FIG. 4