April 12, 1966 D. J. LESLIE 3,245,284

ROTOR DRIVE FOR PULSATO APPARATUS

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FIG. 1.

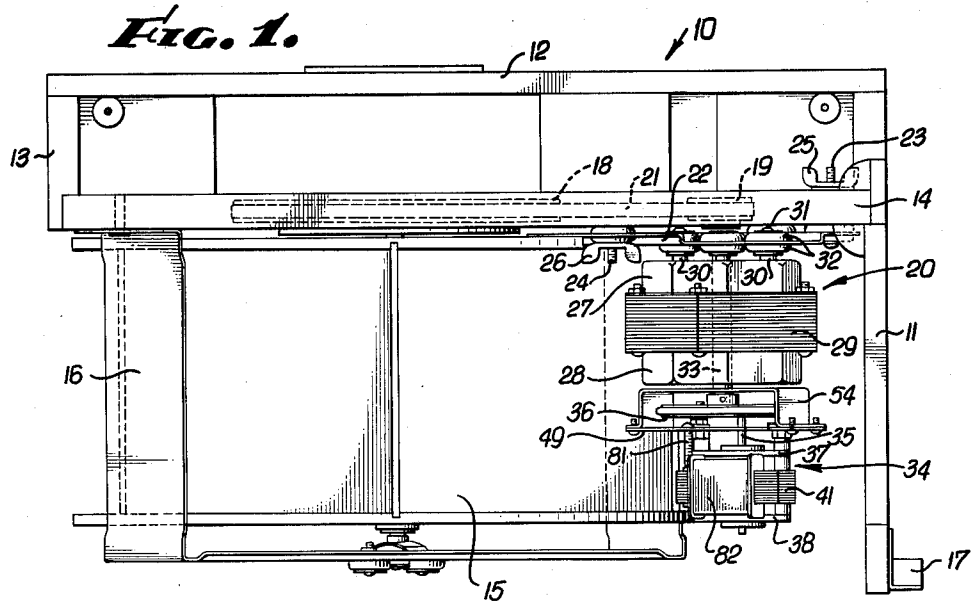

FIG. 2.

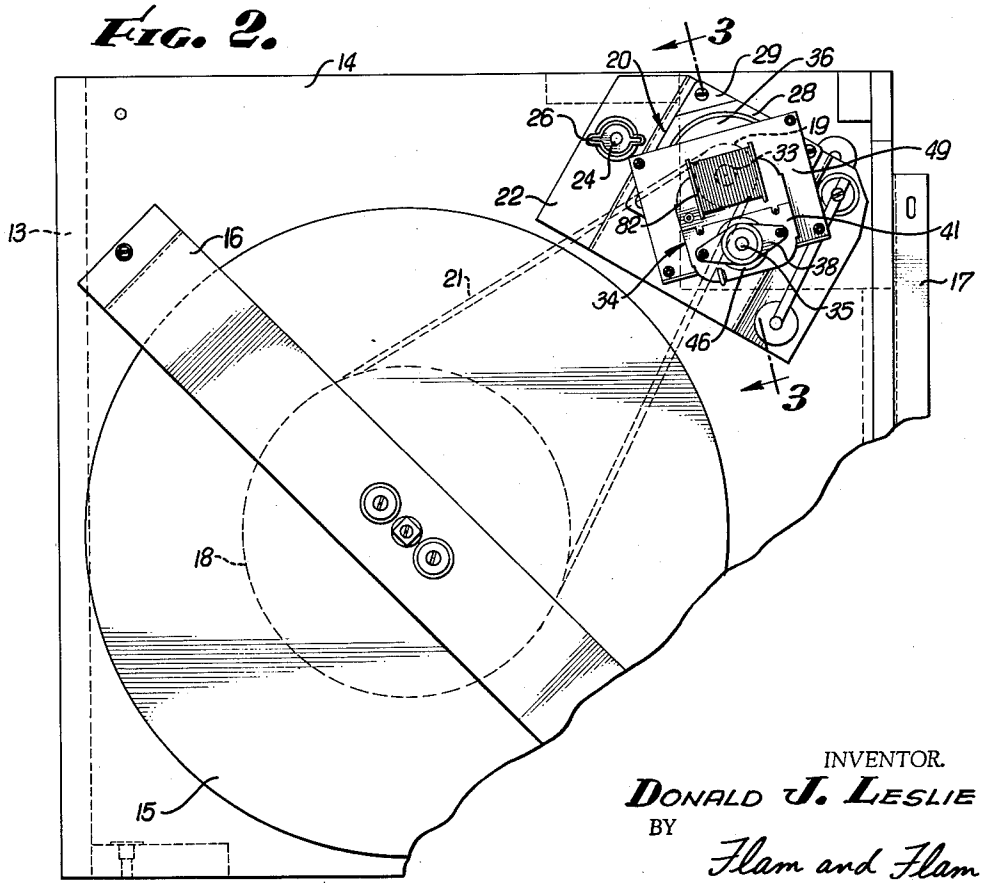

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FIG. 3.

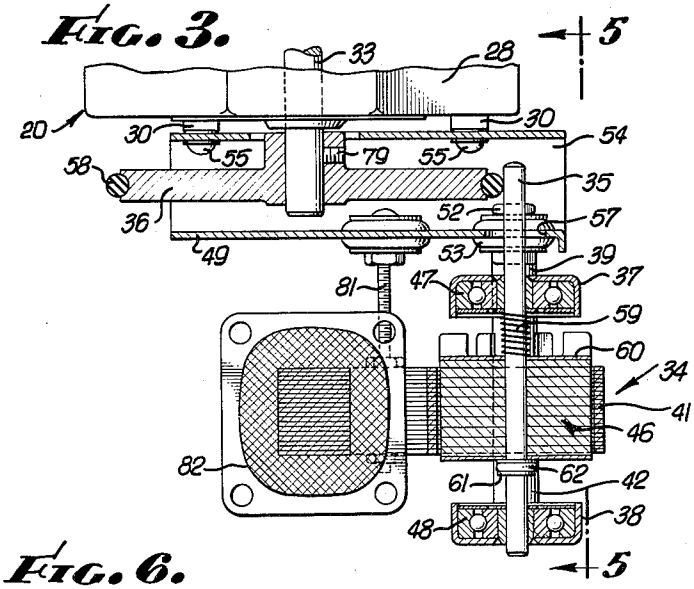


FIG. 6.

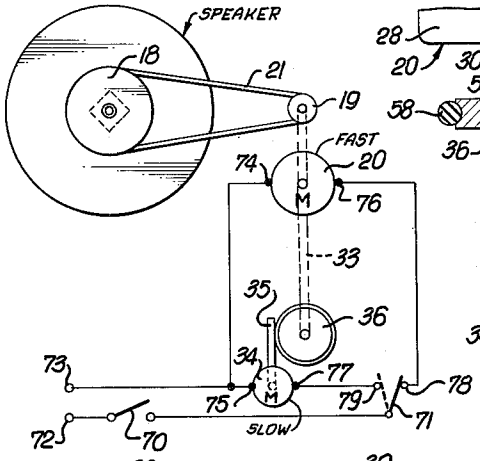
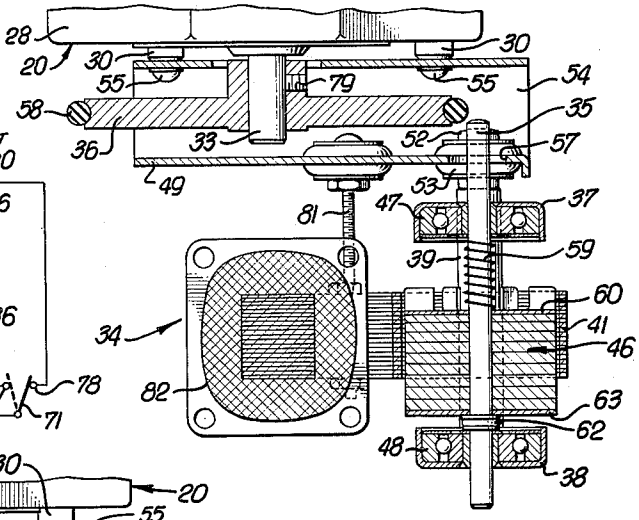


FIG. 4.



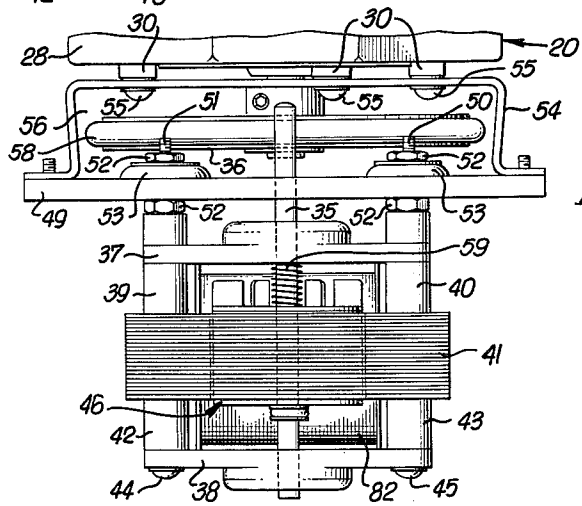


FIG. 5.

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FIG. 7.

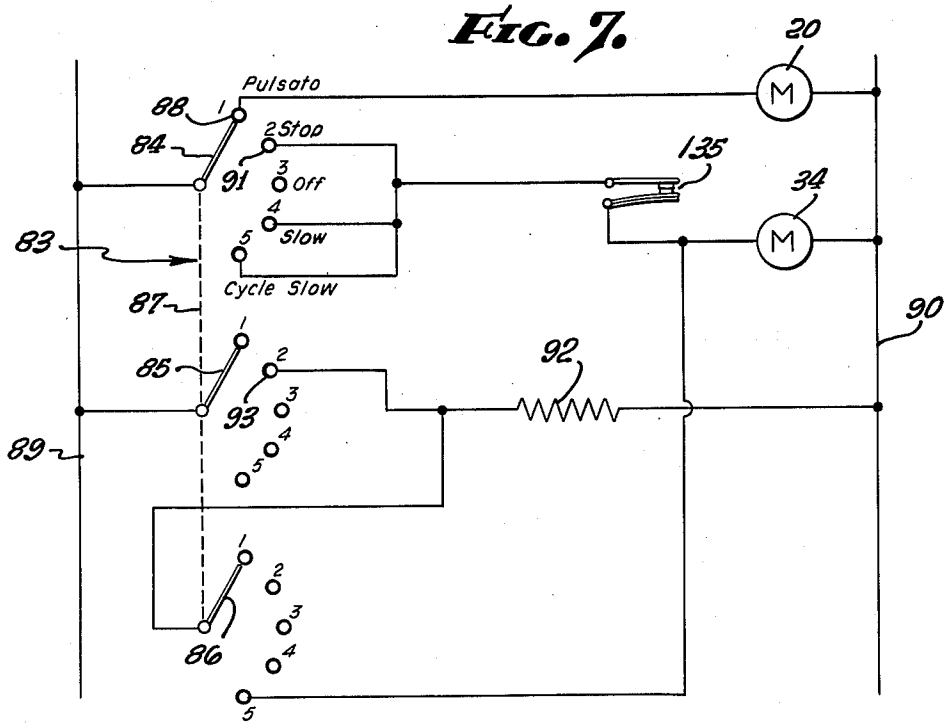

FIG. 8.

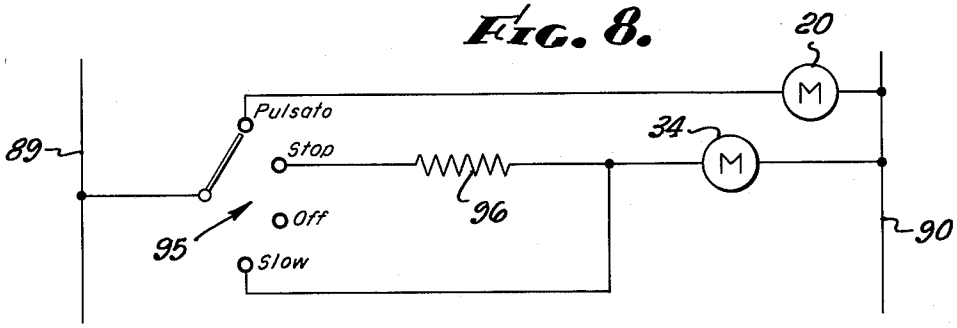

FIG. 9.

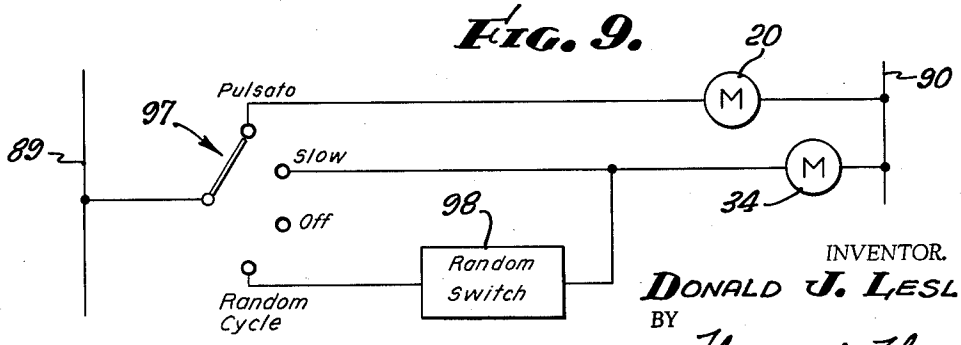

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FIG. 10.

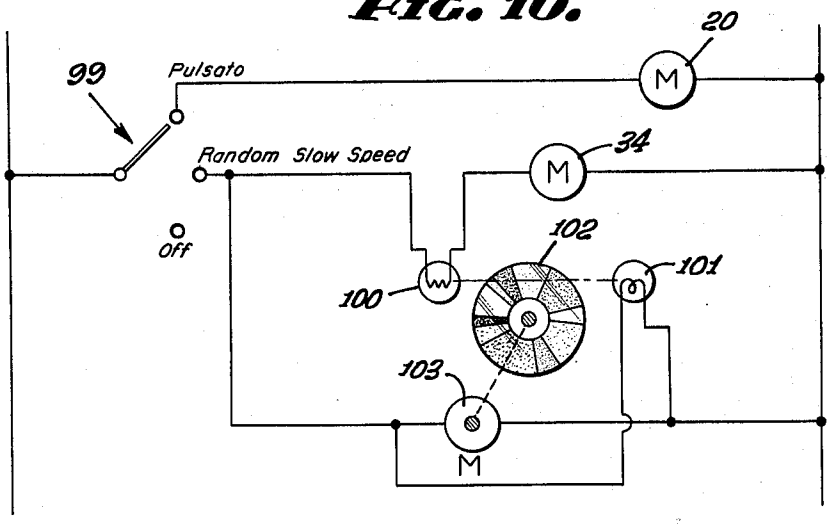
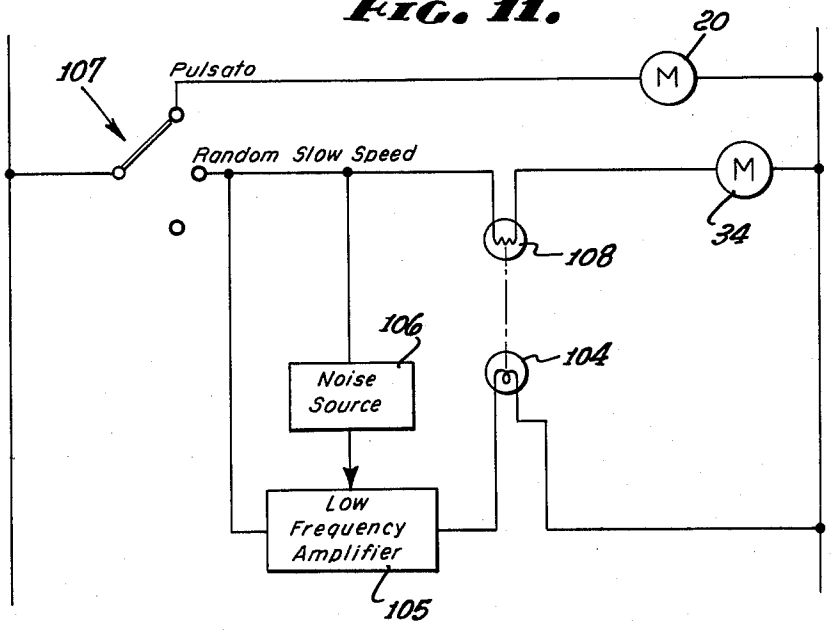


FIG. 11.



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United States Patent Office 3,245,284 Patented Apr. 12, 1966

3,245,284

ROTOR DRIVE FOR PULSATO APPARATUS

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Filed May 31, 1963, Ser. No. 284,627
19 Claims. (Cl. 74—661)

This invention relates to musical instruments, particularly electronic organs, and especially to apparatus for producing pulsato by acoustic devices. Such apparatus is shown and described in my Reissue Patent No. 23,323 dated January 9, 1951, and entitled "Rotatable Tremulant Sound Producer."

During the course of a musical composition, the organist often desires to change the type of pulsato to be added. He may, for example, desire to select acoustic pulsato, electronic pulsato, or no pulsato. These selections are customarily made by operating organ stops or switches. In some applications, the switches merely alter the course of the electrical signal from rotary pulsato apparatus to a nonrotary speaker. Alternately, the acoustic pulsato apparatus, including moving parts such as rotors, may be stopped and started by the operation of switches.

When acoustic pulsato is not desired, it may yet be desirable slowly to shift the sound source at a rate well below pulsato frequencies, as for example, two-thirds of a cycle per second. By imparting phase shifts by such means, a characteristic dullness or flatness is avoided, especially if the rate is varied to produce random phase shifts. The phase shifts so produced simulate, in general, phase shifts commonly produced by movement of swell shutters in pipe organ systems.

One of the objects of this invention is to provide a simple system whereby a rotor may produce, in addition to pulsato, phase shifts regularly or randomly.

If acoustic pulsato is controlled by starting and stopping a rotor, it is desirable to accomplish the change quickly in order to avoid certain droning sounds. One of the objects of this invention is to provide a simple, inexpensive motor drive for a pulsato rotor that is capable of braking the rotor as well as producing slow rotation.

Still another object of this invention is to provide a motor drive for performing these various functions that utilizes two quite inexpensive motors, one motor having a shaft at one end connected to the pulsato rotor, and the other end connected to the other motor only upon deenergization of the one motor and energization of the other.

Still another object of this invention is to provide a compact motor structure of this character that can be installed and replaced as a unit.

Still another object of this invention is to provide novel circuitry for controlling the two motors to achieve pulsato, slow rotation of uniform or of varying rates, or automatic braking.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several embodiments of the invention. For this purpose, there are shown a few forms in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a front elevational view of a pulsato unit incorporating the present invention;

FIG. 2 is a bottom plan view thereof;

FIG. 3 is a fragmentary enlarged sectional view taken along a plane corresponding to line 3—3 of FIG. 2;

FIG. 4 is a sectional view similar to FIG. 3 but illustrating the parts in an alternate position;

FIG. 5 is a sectional view taken along a plane corresponding to line 5—5 of FIG. 3;

FIG. 6 is a wiring diagram showing an elementary control circuit for selective operation of the motors;

FIG. 7 is a wiring diagram showing a circuit for use with the motors, whereby various modes of operation thereof may be selected; namely, pulsato, stop, off, slow, and cycle slow;

FIG. 8 is a wiring diagram illustrating a circuit for use with the motors, whereby some of the modes of operation of the form illustrated in FIG. 7 may be achieved but with different circuit elements; and

FIGS. 9, 10 and 11 each diagrammatically illustrate different control circuits for producing random operation of the slow speed motor.

In FIG. 1 there is illustrated a pulsato unit **10** that is adapted to be installed within the enclosure of an organ console. The pulsato unit **10** includes a number of elements **11**, **12**, **13** and **14** forming a four-sided frame. The frame elements **12** and **14** are generally square, and spaced apart in parallel relationship by the other frame elements **11** and **13**. The frame element **14** forms the base for suspension of a pulsato drum **15** as by the aid of the U-shaped bearing bracket **16**. A non-rotary speaker structure (not shown) is accommodated between the base plate **14** and the parallel frame member **12**. The frame member **11** has an extended end that carries an attaching backet **17** whereby the entire unit may be secured at a corner or at some other suitable position in the console cabinet.

The pulsato rotor **15** is driven by the aid of a pulley structure that includes pulley elements **18** and **19** of the rotor **15** and the motor **20** respectively, together with a belt **21**. The pulley ratio is about one to four or one to five whereby, with a four pole motor **20**, the rotor is operated at about 400 r.p.m. or almost 7 c.p.s. which is a suitable pulsato rate.

The motor structure **20** is supported on the base frame member **14** by the aid of a stamped centrally offset mounting bracket **22**. The mounting bracket **22** may be attached to the base member **14** by the aid of screws **23** and **24** and wing nuts **25** and **26**. Suitable resilient pads are interposed between the mounting bracket **22** and the base member **14** for damping purposes.

The motor **20** may be an inexpensive shaded pole motor available as a standard article of commerce. The motor **20** has end caps or brackets **27** and **28** on opposite sides of the stack of stator laminations **29**. Each end cap has a series of interiorly threaded embossments as at **30** (FIG. 3) whereby suitable attachment may be made at opposite ends of the motor. The threaded embossments **30** at the upper bearing bracket **27** (FIG. 1) serve as a means for cantilever attachment of the motor **20** to the mounting bracket **22**. For this purpose suitable screws **31** are provided. Acoustic damping pads **32** are also used with the screws **31**.

The motor shaft **33** projects through the mounting bracket **22**, and the pulley element **19** is mounted upon this end of the shaft.

When pulsato is not desired, it may be nevertheless desirable to operate the rotor **15** at a slow speed, say of the order of ten revolutions per minute, in order to produce a certain source indefiniteness. For this purpose the shaft **33** of motor **20** is operated at its other end by secondary motor structure **34**. The motor structure **34** may be a 2-pole, high-speed small inexpensive shaded pull motor such as may be available as a standard article

of commerce. The motor 34 has an extended shaft 35 capable of engaging a pulley wheel 36 attached to the depending end of the shaft 33.

The motor 34 has a pair of die cast bearing brackets 37 and 38 by the aid of which the motor is supported. The bearing bracket 37 is generally of H-shaped configuration as shown in FIG. 5 with arms 39 and 40 abutting one side of the stack of stator laminations 41. These arms 39 and 40 have aperture recesses (not shown) in alignment with holes through the stack of laminations 41. The lower bearing bracket 38 also has arms 42 and 43 provided with through apertures. Screws 44 and 45 pass through the bearing bracket arms 42 and 43 through the stack of laminations 41 to engage the apertured recesses of the arms 39 and 40 on the opposite sides of the stack. A rotor assembly 46, which includes the shaft 35, is supported by self-aligning bearings 47 and 48 carried by the brackets 37 and 38.

The upper bearing bracket 37 also serves as a means whereby the motor 34 is suspended. For this purpose the upper ends of the arms 39 and 40 are attached to a plate 49 by the aid of studs 50 and 51 projecting from the bracket arms 39 and 40. Nuts 52, together with damping pads 53 cooperate with the studs to attach the motor 34. A U-shaped bracket 54 in turn attaches the plate 49 to the main drive motor 20.

The central portion of the bracket 54 abuts the three threaded bosses 30 of the motor cap 28, and is fastened thereto by screws 55. The bracket 54 and plate 49 form space 56 in which the pulley wheel 36 is accommodated. The plate 49 has an opening 57 through which the shaft 35 projects so as to be engageable with the rim of the pulley wheel 36. A friction ring 58 is carried on the rim of the wheel 36, and which is engaged by the shaft 35. Preferably the ring 58 has a circular cross section so as to facilitate movement of the shaft into engagement with the wheel 36 in a manner presently to be described.

The shaft 35 is capable of axial movement between positions corresponding to engagement with the friction wheel 58 and clearance with respect thereto, and as depicted respectively in FIG. 3 and FIG. 4. A compression spring 59 surrounding the shaft 35 and interposed between one end ring 60 of the rotor and the bearing 47 normally urges the shaft 35 and the rotor assembly 46 to the lower limited position of FIG. 4. This limited position is determined by a stop washer 61 located just beyond the stack of rotor laminations. An O-ring 62 is interposed between the stop washer 61 and the other end ring 63 of the rotor, thereby forming a suitable cushion.

In the disengaged position illustrated in FIG. 4, the rotor laminations 60 are out of alignment with the stator laminations 41. Upon energization of the motor 34, and due to the reluctance effect, the rotor assembly will be pulled into the aligned position shown in FIG. 3, and against the force of the compression spring 59. Thus, as the motor is energized, the rotor moves from a position of larger reluctance (FIG. 4) to a position of smaller reluctance (FIG. 3). In the position of FIG. 3, the shaft 35 easily rides over the O-ring 58, compressing it slightly, thus establishing engagement with the pulley wheel 36. The area of contact is yet sufficiently small to permit the spring 59 to retract the rotor assembly 46 when the motor 34 is de-energized.

By the use of two standard inexpensive motors 20 and 34, alternate modes of operation of the pulsato rotor 15 are possible. A wiring diagram is depicted in FIG. 6. A main switch 70, upon closure, connects a switch arm 71 of a double throw selector switch to one source terminal 72. The other source terminal 73 is directly connected to one terminal 74 of the motor 20 as well as to one terminal 75 of the motor 34. The other terminals 76 and 77 of the motors 20 and 34 respectively connect to opposite contacts 78 and 79 cooperable with the switch arm 71.

When the switch arm 71 is in the full line position illustrated, the motor terminal 76 is connected via contact 78 and the switch arm 71 to the source terminal 72, and the motor 20 is operated. The other terminal 77 of the motor 34 is open circuited and accordingly the spring 59 positions the rotor assembly to the inactive position of FIG. 4. However, upon movement of the switch arm 71 to the dotted line position, the motor 20 is de-energized and the motor 34 is operative. Accordingly, the shaft 35 is moved upwardly by the reluctance effect and slow rotation is imparted to the shaft 33 at a ratio corresponding to the diameters of the shaft 34 and the pulley wheel 36. Using a two pole motor, the ratio is approximately one to twenty to produce a rotation of about 10 r.p.m.

Depending upon the orientation of the pulsato unit 10 in the cabinet, the weight of the rotor assembly 46 may assist or oppose the compression spring 59. Accordingly, depending upon the particular installation, an appropriate spring 59 is chosen.

Depending upon the desired slow speed of the rotor 15, the pulley 36 can be changed after first unloosening the set screw 79. An adapter sleeve can then be telescoped over and fastened to the projecting end of the shaft 35, or alternately the position of the rotor on the mounting plate 49 can be changed.

In order to stabilize the motor 34, a stud 81 is attached to the stack of stator laminations 41 at a place adjacent the relatively heavy coil structure 82. The stud 81 passes upwardly through the plate 49 and is suitably attached thereto.

By quickly moving the switch 71 from the full-line position to the dotted-line position of FIG. 6, the rotary apparatus is braked by the action of the motor 34 in its slow speed mode. The rotary apparatus is quickly braked to the speed of the motor 34.

In the arrangement illustrated in FIG. 7, the motors 20 and 34 are provided as before. A selector switch 83 is provided that has five positions: pulsato, stop, off, slow, and cycle slow. The selector switch 83, may, by way of example, be of the rotary type having three separate arms 84, 85 and 86, all operated in unison as indicated by the dotted line 87.

In the first position corresponding to pulsato, a circuit is established to the main motor 20 via contact arm 84 and a contact 88. Thus, one side of the arm 83 connects to one line 89 of the source, and the contact 88 connects to one side of the motor 20. The other side of the motor connects to another line 90 of the source. The pulsato motor 20 is operated only when the switch 83 is in this first position.

When the switch 83 is moved to the second or "stop" position, a circuit is established for the slow motor 34 in series with normally closed thermal contacts 135. Thus, the arm 84 now engages a contact 91 that connects to one side of the motor 34 via the thermal contacts 135. The other side of the motor 34 connects to the line 90.

A heater 92 is also energized when the selector switch 83 is moved to the second or "stop" position. Thus, the arm 85 is connected to the line 89, and a contact 93 engaged by the arm at the second position is connected to one side of the heater 92. The other side of the heater connects to the other line 90.

When the selector switch 83 is first moved to the "off" position, a circuit for the slow motor 34 is established, and the rotary apparatus is braked. After a period of time the heater 92 causes the thermal contacts 135 to open and the apparatus coasts to a final stop.

At the third position all of the circuits are open, corresponding to "off."

At the fourth position of the selector switch 83, the heater 92 is out of circuit but a circuit is established to the slow motor via the thermal contacts 135 which in this case remain closed. Accordingly, the motor 34 continues to operate the rotary apparatus at slow speed.

At the fifth position of the selector switch **83**, the heater **92** is now placed in parallel to the slow motor **34** and thus in serial dependency upon the thermal contacts **135**. For this purpose, the switch arm **86** is connected to one side of the heater **92**, and the contact **93** engaged by the arm **86** is connected to the corresponding side of the motor **34**, the other side of the heater **92** remaining connected to the line **90**. Thus, when the selector switch **83** is at the fifth position, the heater **92** will derive energization for a period of time until the thermal contacts **135** open. The circuit for the heater **92** is then interrupted and accordingly the contacts **135** are permited to cool and close. Upon reclosure, both the motor **34** and the heater **92** are energized. Depending upon the rate of heat flow, the slow motor **34** is operated for certain periods of time, producing a desirable effect.

In moving the selector switch **83** which a pulsato position to "off," at least momentary engagement is made with the contact **91**. This results in some braking of the pulsato rotor depending upon the speed that the switch **83** is moved. If the switch is moved deliberately and slowly, substantial braking will be produced.

In the form of the invention illustrated in FIG. 8, a selector switch **95** has four positions, corresponding to pulsato, stop, off and slow. In the "stop" position, the slow motor **34** is energized through a thermistor **96** so designed that it is capable of attaining a resistance value adequate to preclude rotation of the slow motor **34**. Thus, as the "stop" contact is first engaged, the motor has minimum resistance and the rotational energy of the apparatus is dissipated. Ultimately and due to the action of the increasing resistance of the thermistor **96**, the motor **34** stops.

In the "off" position, of course no circuits are effective.

In the "slow" position of the selector switch **95**, a circuit is established to the motor **34** independently of the thermistor **96**.

In the form of the invention illustrated in FIG. 9, a selector switch **97** is illustrated that has four positions: pulsato, slow, off, and random cycle. The pulsato, off, and slow positions are the same as in the form of FIG. 8. At the random cycle position, the slow motor **34** is placed in circuit with a switch **98** that operates randomly to open and close by any suitable means. For example, the switch **98** may be operated by an irregular cam driven by a motor. The motion of the drum is thus irregular and a desirable effect is achieved.

In the form of the invention illustrated in FIG. 10, a selector switch **99** has three positions corresponding to pulsato, random slow speed, and off. In the random slow speed position, an energization circuit is established to the slow motor **34** in serial dependency with a variable impedance element in the form of a photoresistive cell **100**. A light source **101** affects the cell **100** in varying degrees depending upon the position of a disc **102**. The disc **102** has filters of various densities and arcuate widths for shielding more or less of the light from the source **101** from the cell **100**. The disc **102** is driven by a motor **103**, the energization circuit of which is also established when the selector switch **99** is at the random slow speed position. The light source **101** may be electrical, and, as illustrated, its energization circuit parallels the motor **103**. As the disc **102** rotates, more or less resistance is in circuit with the motor and the motor **34** operates at varying speeds rather than in interrupted fashion.

The form illustrated in FIG. 11 is similar to that illustrated in FIG. 10, except that the light source **104** in this instance is made variable, thereby avoiding the necessity of a variable density or variable configuration disc. For this purpose, the light source **104** is operated by an amplifier **105** driven by a suitable noise source **106**. The amplifier **105** and noise source **106** are energized when the selector switch **107** is moved to the random slow speed position. The amplifier **105** emphasizes low frequency noises so that the change in resistance of the photoresistive cell **108** takes place at an adequately slow rate to permit the motor **34** to follow the same.

The inventor claims:

1. In apparatus for producing pulsato by the aid of a rotary device: a main drive motor for operating said rotary device, and having a shaft; means coupling one end of said shaft to said rotary device; said coupling means and said main drive motor being designed to operate said rotary device at a rate to impart pulsato; a secondary drive motor having a stator and an axially movable rotor assembly; said rotor assembly being movable between alternate positions of larger and smaller reluctance with respect to said stator, and movable to the position of smaller reluctance upon energization of said secondary drive motor; means causing the rotor assembly to move to the position of larger reluctance upon deenergization of said secondary motor; and axially separable coupling means between the rotor assembly and the other end of said shaft and operable upon movement of said rotor assembly to said position of smaller reluctance; said axially separable coupling means and said secondary drive motor being designed to operate said rotary device at a small fraction of its pulsato speed for producing indefiniteness in source location.

2. The combination as set forth in claim **1** in which said axially separable coupling includes a pulley wheel mounted on said other shaft end and a shaft forming a part of said rotor assembly movable to engage and disengage said pulley wheel.

3. The combination as set forth in claim **2** together with a friction ring interposed between said rotor assembly shaft and said pulley wheel, and shaped so as to form a wedge therebetween.

4. The combination as set forth in claim **2** together with a friction ring having a generally circular cross-section and mounted on the rim of said pulley wheel for wedging between the rotor assembly shaft and the said pulley wheel rim to establish a friction driving connection.

5. In apparatus for producing pulsato by the aid of a rotary device: a support for the rotary device; a main drive motor for operating said rotary device, and having a pair of end brackets and a shaft accessible beyond the end brackets; means mounting one of the end brackets to the support; means coupling said rotary device to the shaft end adjacent said one end bracket; said coupling means and said main drive motor being designed to operate said rotary device at a rate to impart pulsato; a secondary drive motor attached to and suspended by the other end bracket of said main drive motor, and having a stator and an axially movable rotor assembly; said rotor assembly being movable between alternate positions of larger and smaller reluctance with respect to said stator, and movable to the position of smaller reluctance upon energization of said secondary drive motor; means causing the rotor assembly to move to the position of larger reluctance upon deenergization of said secondary motor; and axially separable coupling means between the rotor assembly and the other end of said shaft and operable upon movement of said rotor assembly to said position of smaller reluctance; said axially separable coupling means and said secondary drive motor being designed to operate said rotary device at a small fraction of its pulsato speed for producing indefiniteness in source location.

6. The combination as set forth in claim **5** in which said axially separable coupling includes a pulley wheel mounted on said other shaft end and a shaft forming a part of said rotor assembly movable to engage and disengage said pulley wheel.

7. The combination as set forth in claim **6** together with a friction ring interposed between said rotor assembly shaft and said pulley wheel, and shaped so as to form a wedge therebetween.

8. The combination as set forth in claim 6 together with a friction ring having a generally circular cross-section and mounted on the rim of said pulley wheel for wedging between the rotor assembly shaft and the said pulley wheel rim to establish a friction driving connection.

9. In apparatus for producing pulsato by the aid of a rotary device, the combination with said rotary pulsato device of: first and second motor means for operating said rotary device respectively at pulsato rates and at rates corersponding to a small fraction of pulsato rates; a selectively operable energization circuit for said first motor means; a selectively operable energization circuit for the second motor means; and selectively operable time delay means for interrupting the energization circuit for said second motor means.

10. In apparatus for producing pulsato by the aid of a rotary device, the combination with said rotary pulsato device of: first and second motor means for operating said rotary device respectively at pulsato rates and at rates corresponding to a small fraction of pulsato rates; a selectively operable energization circuit for said first motor means; a selectively operable energization circuit for the second motor means and functioning in accordance with the passage of time for producing non-uniform operation of said second motor means.

11. In apparatus for producing pulsato by the aid of a rotary device, the combination with said rotary pulsato device of: first and second motor means for operating said rotary device respectively at pulsato rates and at rates corresponding to a small fraction of pulsato rates; a selectively operable energization circuit for said first motor means; a selectively operable energization circuit for the second motor means; and selectively operable means functioning in accordance with the passage of time for cyclically interrupting the energization circuit of said second motor means.

12. In apparatus for producing pulsato by the aid of a rotary device, the combination with said rotary pulsato device of: first and second motor means for operating said rotary device respectively at pulsato rates and at rates corresponding to a small fraction of pulsato rates; a selectively operably energization circuit for said first motor means; a selectively operable energization circuit for the second motor means; selectively operable time delay means for interrupting the energization circuit for said second motor means; and selectively operable means for cyclically interrupting the energization circuit of said second motor means.

13. In apparatus for producing pulsato by the aid of a rotary device, the combination with said rotary pulsato device of: first and second motor means for operating said rotary device respectively at pulsato rates and at rates corresponding to a small fraction of pulsato rates; a selectively operable energization circuit for said first motor means; a selectively operable energization circuit for the second motor means; and selectively operable means functioning in accordance with the passage of time for interrupting the energization circuit of said second motor means at random intervals.

14. In apparatus for producing pulsato by the aid of a rotary device: first and second motor means for operating said rotary device respectively at pulsato rates and at rates corresponding to a small fraction of pulsato rates; a selectively operable energization circuit for said first motor means; a selectively operable energization circuit for the second motor means including a variable impedance element; and selectively operable means for randomly varying the impedance of said element for producing nonuniform rotation of said second motor means.

15. The combination as set forth in claim 14 in which said impedance varying means comprises a light source energized at random intensity, and in which said variable impedance element comprises a photosensitive element affected by said source.

16. The combination as set forth in claim 14 in which said impedance varying means comprises a light source in combination with a movable shield therefor having a light transmission characteristic dependent upon position, and in which said variable impedance element comprises a photosensitive element receiving luminous flux from said source in dependence upon said shield.

17. In apparatus for producing pulsato by the aid of a rotary device; first and second motor means for operating said rotary device respectively at pulsato rates and at rates corresponding to a small fraction of pulsato rates; a selectively operable energization circuit for said first motor means; a selectively operable energization circuit for the second motor means including an impedance element that increases its resistance as a function of time thereby reducing the energization of said second motor means.

18. In apparatus for producing pulsato by the aid of a rotary device, the combination with said rotary pulsato device of: first and second motor means for operating said rotary device respectively at pulsato rates and at rates corresponding to a small fraction of pulsato rates; a selectively operable energization circuit for said first motor means; a selectively operable energization circuit for the second motor means and a selector switch having successive switching positions corresponding, first, to energization of said first motor means, second, to energization of said second motor means and, third, to off.

19. In combination: a pulsato device; means mounting the pulsato device for rotation about an axis; motive means for imparting rotation to said rotary device; and selectively operable means for determining high and low rates of rotation of said rotary pulsato device, the high rate of rotation producing pulsato, and the low rate of rotation producing phase shifts.

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DON A. WAITE, *Primary Examiner.*