VARIABLE SPEED MULTI-CHANNEL PULSATO ROTOR

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FIG. 1.

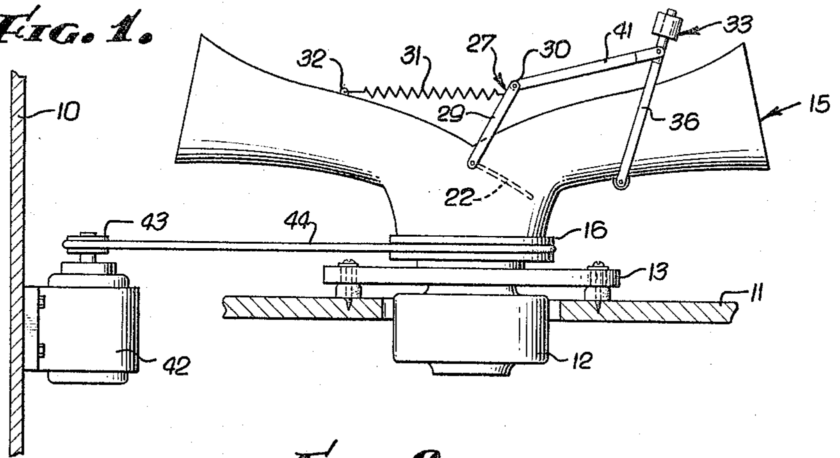


FIG. 2.

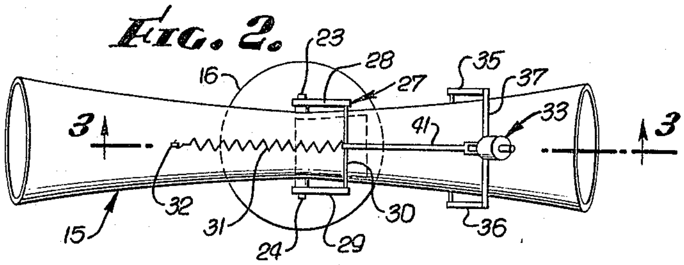
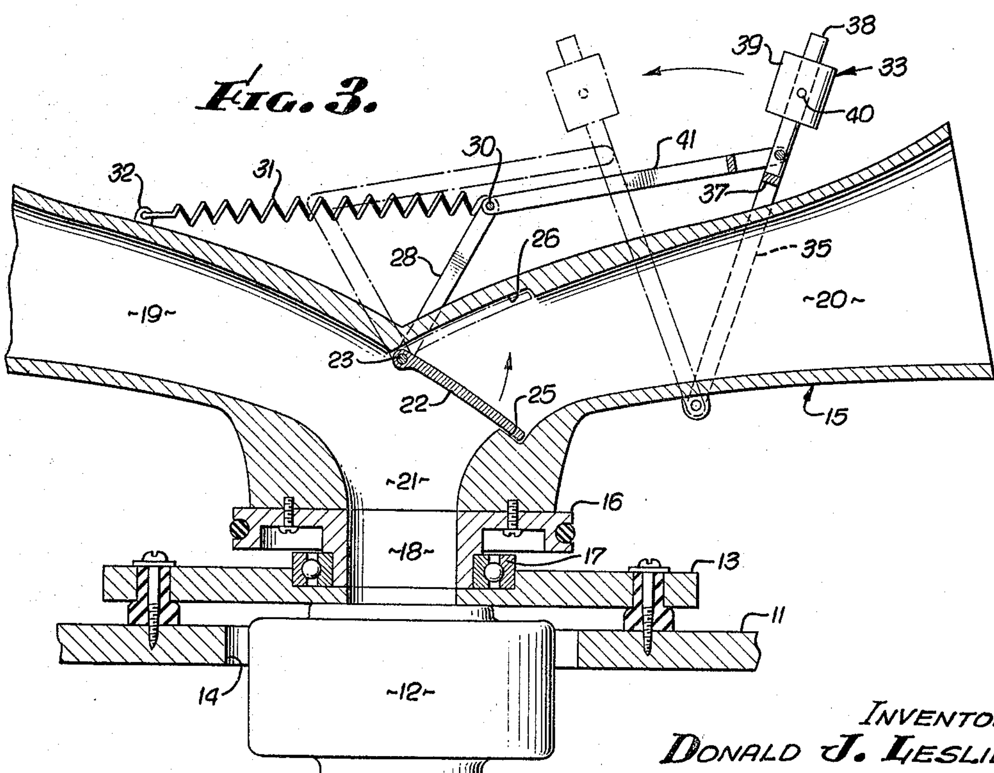


FIG. 3.



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VARIABLE SPEED MULTI-CHANNEL PULSATO ROTOR

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FIG. 4.

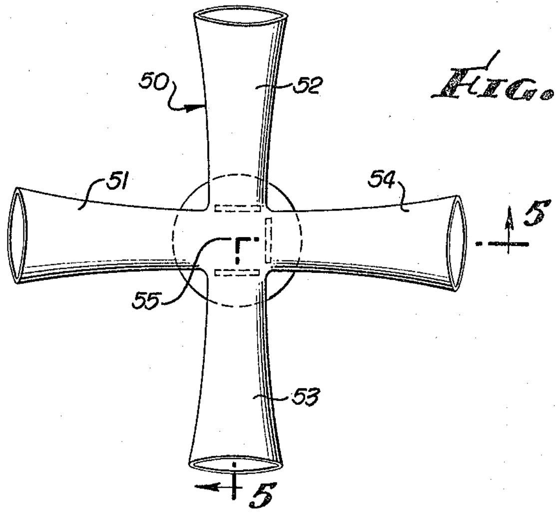


FIG. 5.

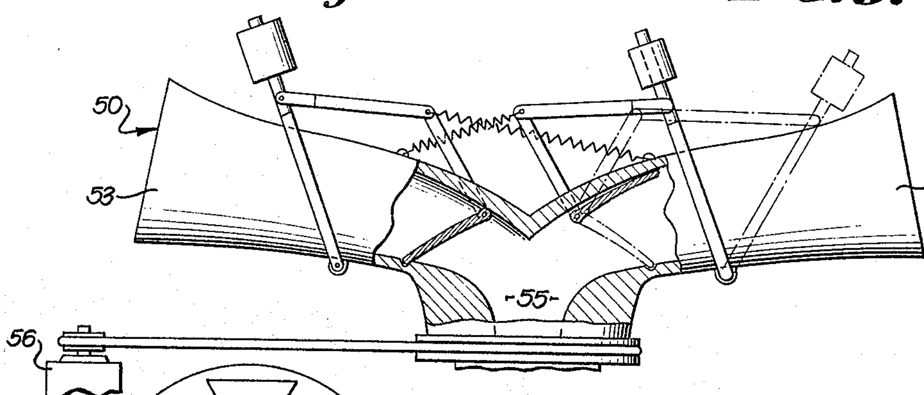
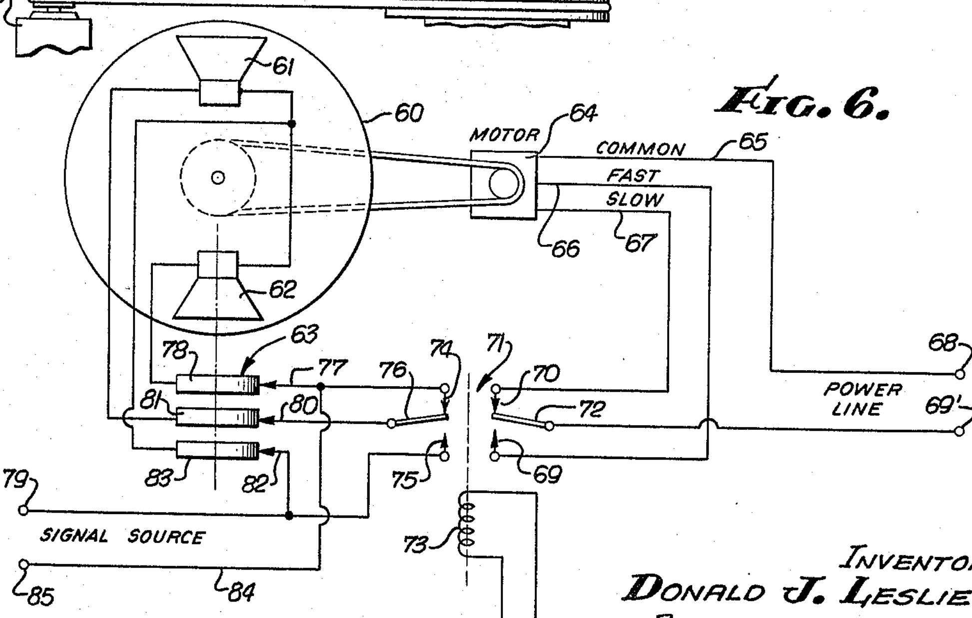


FIG. 6.



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VARIABLE SPEED MULTI-CHANNEL PULSATO ROTOR

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FIG. 7.

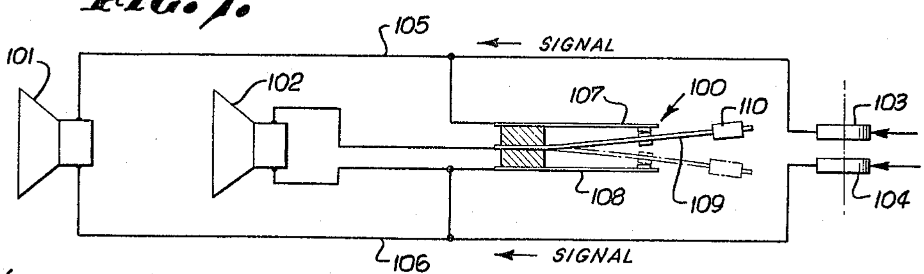


FIG. 8.

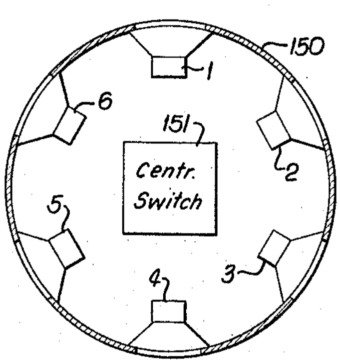
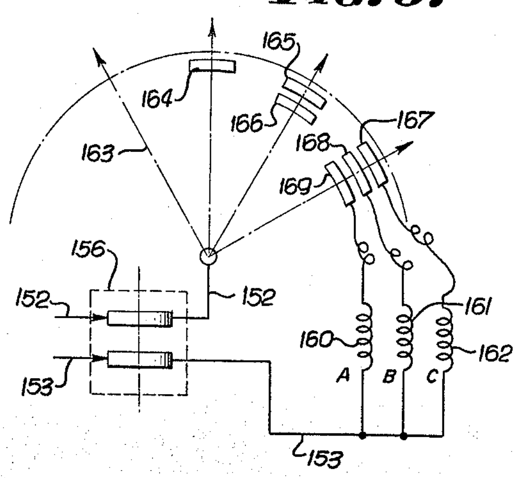


FIG. 9.



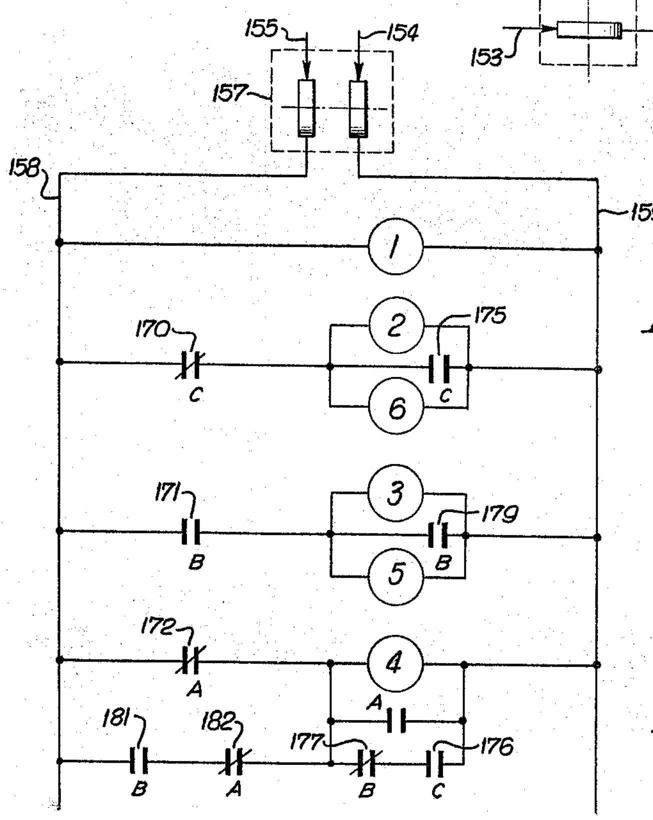


FIG. 10.

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VARIABLE SPEED MULTI-CHANNEL PULSATO ROTOR

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Filed Oct. 22, 1965, Ser. No. 502,121
9 Claims. (Cl. 181—27)

This invention relates to acoustic apparatus for producing pulsato, and of a type shown and described in by prior Patent No. 2,489,653. In this apparatus, rotary sound channels are provided that produce a sound radiation pattern that recurs at a rate required to produce the characteristic pulsato effect. The requisite rate of recurrence is about 5 to 8 cycles per second.

If a single sound channel is rotated, then the required angular velocity is about 400 cycles per minute. This imparts a substantial peripheral velocity to the opening of the sound channel, and a correspondingly large frequency deviation. If the speed is reduced to half, then the frequency deviation is likewise reduced; the rate of cyclic recurrence of the sound radiation pattern is also reduced to about 3 or 4 cycles per second, and the characteristic pulsato is lost. In order to restore the pulsato effect, two sound channels supplied by the same acoustic or electrical source must be used in 180° spacial relationship about the rotational axis.

The organist at times desires a full rich pulsato of the type obtained by rotating a single channel at 400 cycles per minute, and at other times desires a muted pulsato such as obtained by rotating two channels at 200 cycles, or three channels at about 133 cycles, etc. For example, a full pulsato may be appropriate for use with flute, tibia and stopped diapason tones; but only a lesser frequency deviation may be appropriate for string and reed tones.

The primary object of this invention is to provide a single pulsato apparatus capable of producing these various types of pulsato. Another object of this invention is to provide pulsato apparatus of this character in which a number of rotary sound channels are provided on a common support, and wherein a speed change is automatically accompanied by a change in the operative number of sound channels, thus ensuring that the rate of recurrence of the sound radiation pattern (as distinguished from the rate of rotation) is maintained in order to produce the characteristic pulsato effect. For this purpose, acoustic or electrical switch means are provided.

In apparatus of this character wherein the electrical-acoustic transducers are non-rotary, and only sound channels registering with the transducers are rotated, an acoustic switch is provided for closing or opening the additional sound channels provided by the horns. In apparatus of the character wherein the electrical-acoustic transducers are themselves rotated, the switching is accomplished electrically, and slip rings are used in order to conduct the electrical signals to the rotary apparatus. In the latter case, the number of control leads increases, and more complicated slip ring structures appear necessary. Another object of this invention is to provide a system of this character in which the electrical or acoustic switching is accomplished automatically within the framework of the rotary apparatus, all in response to a change in speed of the rotary apparatus. For this purpose, centrifugal devices are carried with the rotary apparatus for operating the acoustic or electrical switches.

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 side elevational view of rotary pulsato apparatus incorporating the present invention;

FIG. 2 is a top plan view of a portion of the apparatus shown in FIG. 1;

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

FIG. 4 is a top plan view generally similar to FIG. 2, and diagrammatically illustrating a modified form of the present invention;

FIG. 5 is a fragmentary sectional view taken along the offset plane corresponding to line 5—5 of FIG. 4;

FIG. 6 is a diagrammatic view illustrating a modified form of the present invention;

FIG. 7 is a circuit diagram illustrating an alternate switching arrangement for use in the system shown in FIG. 6;

FIG. 8 is a diagrammatic view of a pulsato rotor incorporating modified form of the present invention;

FIG. 9 is a circuit diagram of the relay power circuit; and

FIG. 10 is a circuit diagram of the relay control circuit.

In FIG. 1 there is illustrated a fragmentary part of a cabinet **10**. An interior support or partition **11**, mounts a driver or transducer **12** designed to convert the electrical organ signal into sound. In the present instance the driver **12** is suspended from a plate **13** that overlies an aperture **14** in the partition **11**. A horn **15** provides sound channels registering with the transducer.

A pulley bracket **16** secured to the horn **15** serves as its support, and is mounted for rotation about the axis of the driver **12** by the aid of bearing **17**.

The pulley bracket **16** has a through opening **18** that registers with the output of the driver **12**. The horn **15** has two sound channels **19** and **20** radiating from a common throat **21** that registers with the opening **18** of the pulley bracket **16**. The outer openings of the channels are spaced from the axis of rotation so as to produce orbital motion thereof.

An acoustic switch for closing and opening the channel **20** is provided. This switch is in the form of a closure plate **22**, movable from full line closed position illustrated in FIG. 3 to the phantom line open position while the channel **19** remains in communication with the throat. The closure **22** is mounted for limited angular movement about an axis transverse to the horn and perpendicular to the horn axis. For this purpose the closure **22** carries stub shafts **23** and **24** (FIG. 2) that project through bearing apertures in the sides of the horn.

Rotation of the shafts **23** and **24** in a clockwise direction as viewed in FIG. 3 causes the valve **22** to be positioned across the channel **20** adjacent to the throat **21**. This movement of the closure is limited by an interior shoulder **25**. Upon movement of the shaft in the opposite angular direction, the valve **22** moves into a shallow recess **26** in the upper portion of the horn, thus fully opening the channel **20**.

In order to move the valve, a linkage structure is provided. The linkage comprises a crank **27** that includes two arms **28** and **29** fixed respectively to the shafts **23** and **24**, and a connecting bar or yoke **30**. The arms **28** and **29** extend along the sides of the horn, and the bar **30** extends across the top. The arms **28** and **29** lie in a plane offset approximately 90° from the valve **22**. The crank **27** is thus freely reciprocable over the top of the horn as the closure moves between its limited positions. A tension spring **31** normally urges the crank **27** in a counterclockwise direction as viewed in FIG. 3 in order to open the channel **20**. Thus one end of the spring **31** is affixed to the connecting bar **30** and its other end to an apertured boss **32** formed on the horn **15**. A weight assembly **33** counterbalances the spring **31** and closes the channel before the horn reaches a speed of 400 revolutions per minute.

The weight assembly includes a rocker **34** pivoted on the horn beneath the channel **20** for movement about an axis parallel to that of the closure **22**. The rocker **34** has arms **35** and **36** that extend upwardly along opposite sides of the horn and a connecting portion **37**. A rod **38** projecting upwardly from the connecting portion **37** adjustably mounts a weight **39**, as by a set screw **40**. The rocker **34** is connected to the crank **27** by the aid of a link **41**, pivoted at its ends respectively to the rod **38** and the connecting bar **30**. Accordingly centrifugal force urges the rocker **34** in a clockwise direction as viewed in FIG. 3 to close the valve **22**. When the horn **15** is rotated at low speeds, corresponding substantially to about 200 cycles per second, the spring **31** overpowers the centrifugal force of the weight **39** and causes the channel **20** to be opened.

At low speed, both channels are operative, causing a recurrence in the sound radiation pattern at the rate of approximately 400 cycles per second. However, when the horn **15** is rotated at about 400 cycle per second, there is but one operative sound channel **19**, and again the rate of recurrence of the sound radiation pattern is 400 cycles per second. In both instances the characteristic pulsato rate is achieved.

In order to rotate the horn **15**, the motor **42** is provided (FIG. 1) that may be mounted upon the inside of the cabinet wall **10**. The motor **42** has a pulley **43** connected to the pulley bracket **16** by the aid of a flexible belt **44**. The motor **42** may be a two speed motor controlled by a simple double throw switch, not shown.

In the form illustrated in FIGS. 4 and 5 a still more versatile pulsato apparatus is provided. In this instance four sound channels **51**, **52**, **53**, and **54** are provided that are equiangularly spaced about the axis of the device. As in the previous form, these sound channels all communicate with a common throat **55** that registers with the non-rotary transducer. When the horn **50** is rotated at 100 r.p.m., all four channels **51**, **52**, **53**, and **54** are open. When the horn is rotated at 200 r.p.m. two opposite channels **52** and **53** are closed, whereby only the diametrically disposed channels **51** and **54** operate. When the horn **50** is rotated at 400 revolutions per minute the channels **52**, **53** and **54** are closed, and only the channel **51** is operative. In all three instances the characteristic recurrence rate of the sound radiation pattern is about 400 cycle per minute. Yet the intensity of pulsato or frequency deviation is substantially changed.

In order to close the channels **52**, **53**, and **54** centrifugal devices are provided for each channel, substantially in accordance with the form illustrated in the FIGS. 1 to 3. The only essential difference is that the weights for the channels **52** and **53** are substantially increased whereby closure is effected before the horn reaches a speed of approximately 200 cycles per second. Optionally, adjustment could be made in the position of the weights or in the spring constants. It will also be understood that the common linkage could be provided for operating the valves for both channels **52** and **53**.

Before the horn reaches a rotational speed of 200 cycles per second the valves for the channels **52** and **53** close in response to the centrifugal force of the weight or weights, the valve for the channel **54** remaining open. Before the horn reaches the rotational rate of 400 r.p.m. the valve for the sound channel **54** also closes. Suitable adjustable speed motive means may be provided for the horn **50**.

In the form illustrated in FIG. 6 a pulsato rotor **60** is illustrated but in this instance mounts to speakers

structures **61** and **62** at diametrically opposite positons thereof. Since the electrical-acoustic transducers associated with the speakers **61** and **62** rotate with the drum **60** a slip ring assembly **63** is necessary in order to conduct the organ signal to the speakers from external leads.

The drum **60** is operated by a two speed motor **64** shown as having three leads **65**, **66** and **67**. The high speed may be about twice low speed, and by way of example, 380 revolutions per minute. The lead **65** cooperates with one element **68** of a connector cooperable with a power source. The other leads **66** and **67** respectively connect to contact **69** and **70** of a relay structure **71**. The relay structure **71** includes an arm **72** connected to the other element **69'** of the power connector. The arm **72** is engageable alternately with the contact **69** and the contact **70** upon energization or de-energization of a relay coil **73**. Thus upon operation of the relay coil **73**, a circuit is effected to the motor by the aid of leads **65** and **66**, and upon de-energization of the relay coil **73**, a connection is effected to the motor by the aid leads **67** and **65**. These alternate connections provide fast and slow operation by well known means.

The relay **71** also has contacts **74** and **75** cooperable with an arm **76** for determining operation of either one or both of the speakers **61** and **62**, all in accordance with the fast or slow operation of the motor **64**. The contact **74** connects via a brush **77** and one element **78** of the slip ring assembly **63** to one side of the speaker **62**. The other contact **75** connects with one element **79** of a connector to which the organ signal is applied. The arm **76** connects to a brush **80** and through a second element **81** of the slip ring assembly **63** to one side of the speaker **61**. The connector element **79** cooperable with the signal source also cooperates via a brush **82** and slip ring element **83** with the other side of both speakers **61** and **62**. A lead **84** joins the other element **85** of the connector to the brush **77** and the relay contact **74**.

When the relay coil **73** is de-energized and the motor **64** thus operated at slow speed, both speakers **61** and **62** are connected to the organ output by the aid of connector elements **79** and **85**. The circuit for the speaker **62** may be traced as follows: connector element **85**, lead **84**, brush **77**, slip ring assembly element **78**, speaker **62**, lead **86**, slip ring element **83**, brush **82** and connector element **79**. A circuit for speaker **61** may be traced from connector element **85**, lead **84**, relay contact **74**, arm **76**, brush **80**, slip ring element **81**, speaker **61**, lead **86**, slip ring element **83**, brush **82** to the connector **79**. When the relay coil **73** is energized and the motor operated at fast speed, the speaker **61** is removed from circuit and furthermore short-circuited. Thus the circuit for the speaker **62** remains as before, independent of the relay contacts **74** and **75** and arm **76**. However, the previous circuit traced for the speaker **61** via contact **74** is now interrupted, and instead the speaker **61** is short-circuited as follows: relay contact **75**, arm **76**, brush **80**, element **81**, speaker **61**, lead **86**, element **83**, brush **82** back to the relay contact **75**. By short-circuiting the speaker **61**, currents induced in its coil damp sympathetic vibrations. Accordingly, no sound issues from the speaker so short-circuited.

The system of FIG. 6 operates to achieve a recurrence rate of the sound radiation pattern that is the same whether the drum is rotated at low or high speed.

In the form of the invention illustrated in FIG. 7, a switch assembly **100** is carried within the rotary drum. Only two slip ring elements **103** and **104** are provided for conducting the signal from the organ output. The slip ring elements **103** and **104** respectively cooperate with leads **105** and **106** across which the speaker **101** is directly connected. Thus the speaker **101** is continuously energized independently of the speed of operation of the drum. The speaker **102**, however, is connected across the leads **105** and **106** only when the drum is operated at low speeds.

Thus the switch **101** includes opposite contacts **107** and **108** and switch arm **109** moved by a centrifugal weight **110**. In the full line position corresponding to low speed, the contact **107** is engaged. This completes the circuit for the speaker **102** as follows: lead **105**, contact **107**, switch arm **109**, lead **111** to one side of the speaker **102**, lead **112** to the other signal lead **106**. When the drum is operated at approximately 400 cycles per second, the weight **110** causes the switch arm **109** to move to the phantom line position and to engage the contact **108**. In this position the leads **111** and **112** are connected together and speaker **102** accordingly is short-circuited.

In the form of the invention illustrated in FIG. 6, two slip ring assemblies, such as shown in my prior Patent No. 3,014,192 may be provided, one at the top of the rotary apparatus and another at the bottom. Each assembly includes two slip ring elements. Only three of the four available slip ring elements need be used. In the form illustrated in FIG. 7, only a single two element slip ring assembly is necessary.

In the form illustrated in FIG. 8, drum **150** in this instance mounts six speakers **1**, **2**, **3**, **4**, **5**, and **6**, all equiangularly spaced about the axis of the drum. This rotary assembly is designed to operate at any one of four speeds: 66 revolutions per minute with all six speakers connected to the source; 133 revolutions per minute with only three equiangularly spaced speakers connected to the source; 200 revolutions per minute with only two diametrically disposed speakers connected; and finally 400 revolutions per minute with only one speaker connected. It will be understood of course, that the phase relationship of energization of the speakers **1**, **2**, **3**, **4**, **5**, and **6** is all the same, and as more fully explained in my prior Patent No. 3,100,024.

In order appropriately to connect the speakers **1** to **6**, a centrifugal switching device **151**, carried by the drum **150** is provided. The device **151** cooperates with only four external leads, **152**, **153**, **154**, and **155** illustrated in FIGS. 9 and 10. These external leads connect to the centrifugal switch **151** through two slip ring assemblies **156** (FIG. 9) and **157** (FIG. 10). The leads **152** and **153** conduct to the slip ring assembly **156**, power for operating logic elements to be hereinafter described. The leads **154** and **155** conduct the electrical output of the organ to the slip ring assembly **157**. Internal leads **158** and **159** connect to the external leads through the assembly **157**. Across the internal leads, the speaker **1** is permanently connected. The other speakers **2**, **3**, **4**, **5**, and **6** are controlled by a logic network carried by the rotor. This network incorporates logic elements in the form of three relays A, B, and C. These relays have coils **160**, **161**, and **162** that may be energized by power supplied by leads **152** and **153**.

The relay coils **160**, **161**, and **162** are operated in accordance with the position of the centrifugal switch arm **163**. The arm **163** connects through the slip ring assembly **156** to one of the power leads **152**. A common side of the relays **160**, **161**, and **162** all connect through the slip ring assembly **156** to the other of the power leads **153**. The switch arm **163** sweeps past a series of contact segments connected to the coils. The arm **163** has four defined positions in accordance with the speed of operation of the rotor, and is indicated by the legends. In the first position, corresponding to 66 r.p.m., the arm **163** engages no segments. In the next position, corresponding substantially to 133 r.p.m., the arm **163** engages a segment **164** to energize coil **162** of relay C. At the next position, corresponding substantially to 200 r.p.m., segments **165** and **166** are engaged thus to energize coils **161** and **162** of relays C and B. At the final position of the contacting arm **163**, corresponding substantially to 400 r.p.m., segments **167**, **168**, and **169** are all engaged resulting in energization of the coils of all relays C, B and A.

When the arm **166** is at the 66 r.p.m. position circuits are effected for all speakers. Thus speakers **2** and **6** have a circuit that includes the normally closed contacts **170** of the relay C. Speakers **3** and **5** have a circuit including a normally closed contacts **171** of the relay B. Speaker **4** has a circuit including normally closed contacts **172** of the relay A. Thus all speakers are operative.

When the arm **163** arrives at the 133 r.p.m. position, relay contacts **170** open, thus disconnecting speakers **2** and **6** from the leads. Normally open shunt contacts **175** of relay C close to short-circuit both speakers **2** and **6**. Speakers **3** and **5** remain in circuit due to the fact that relay B is yet de-energized. But speaker **4** is disconnected by virtue of the opening of contacts **172**. At the same time a short-circuit path is effected by the aid of normally opened contacts **176** of relay C and normally closed contacts **177** of relay B that together shunt speaker **4**. Accordingly equiangularly spaced speakers **1**, **3**, and **5** operate and thus produce the characteristic recurrence rate of the sound radiation pattern.

When the arm **163** moves to the 200 r.p.m. position, relays B and C both operate. Speakers **2** and **6** are disconnected as before. Speakers **3** and **5** are now also disconnected by virtue of the opening of contacts **171**. Short-circuiting contact **179** operated by relay B isolate speakers **3** and **5**. Speaker **4**, however is reconnected through an alternate path that includes normally open relay contacts **181** of relay B and normally closed relay contacts **182** of relay A. At the same time, the short-circuit path previously provided by the relay contacts **176** is operated by operation of the normally closed relay contacts **177**. Accordingly diametrically opposite speakers **1** and **4** operate, and the characteristic recurrence rate for the sound radiation pattern is again produced.

At the third position of the arm **163** all relays operate. Speakers **2**, **3**, **5**, and **6** are disconnected as previously described. Speaker **4** is likewise disconnected by opening of the relay contacts **182**. At the same time a short-circuit path is provided by normally open relay contacts **183** operated by relay A.

The segments engaged by the arm **163** have a suitable angular extent to insure operation despite a slight change or deviation in the speed of operation of the drum. It will be understood of course that coupled to the drum **150** are suitable motive means for achieving rotation at the selective rates.

The inventor claims:

1. In apparatus for producing acoustic pulsato: a support mounted for rotation about an axis; means forming a plurality of angularly spaced sound channels on the support, said sound channels having sound emitting openings spaced from the axis of said support; means imparting rotation to the support at selected rates for determining the intensity of pulsato produced by the sound emitting openings of said channels; and switching means changing the operative number of sound channels in accordance with the rate of rotation of said support in order to maintain substantially constant, the rate of recurrence of the sound radiation pattern produced by said sound channels whereby the characteristic pulsato rate is maintained despite changes in the rate of rotation of said support.

2. The combination as set forth in claim **1** in which said switching means comprises a closure for at least one of said sound channels, and centripetal-centrifugal actuator means carried by said support and coupled to said closure to open the same below a selected speed and to close the same above a selected speed.

3. The combination as set forth in claim **1** in which there are four equiangularly spaced sound channels, said switching means comprising a closure for three of said channels; first centripetal-centrifugal actuator means for closing the closures of those two of the sound channels that are diametrically opposite each other, and only when said support reaches a speed of at least about 200 revolutions per minute; and second centripetal-centrifugal actuator means for closing the closure of the remaining sound channel, and only when said support reaches a speed of at least about 400 revolutions per minute.

4. The combination as set forth in claim **1** in which a plurality of speakers are mounted on said support and register with said sound channels respectively; and a switch for determining the rate of rotation of said support; and a common actuator for said switch and said switching means.

5. The combination as set forth in claim **1** in which a plurality of speakers are mounted on said support and register with said sound channels respectively and a centripetal-centrifugal actuator mounted on the support for operating said switching means in accordance with the rate of rotation of said support.

6. The combination as set forth in claim **1** in which a pair of speakers are mounted on said support and register with a pair of sound channels located diametrically on said support; slip ring means carries by the support and cooperable with external leads connected to the organ output said switching means including a centripetal-centrifugal switch having one position below a speed of about 400 revolutions per minute, and a second position at a speed of about 400 revolutions per minute; circuit means connecting one of said speakers to said slip ring means and dependent upon said switch being in its said one position; circuit means short-circuiting said one of said speakers and dependent upon said switch being in its said second position; and circuit means connecting the other of said speakers to said slip ring means independently of said switch.

7. The combination as set forth in claim **1** in which

a plurality of speakers are mounted on said support and register with said sound channels respectively; said switching means changing the number of speakers connected to the signal source; and means for short-circuiting those speakers disconnected from the signal source for damping sympathetic vibrations thereof.

8. The combination as set forth in claim **1** in which six speakers are equiangularly mounted on said support and register with said sound channels respectively; circuit means cooperable with said switching means to connect all of said speakers to a signal source when said support is rotated at a rate of about 66 revolution per minute, to connect alternate speakers to said signal source when said support is rotated at a rate of about 133 revolutions per minute, to connect diametrically disposed speakers to said signal source when said support is rotated at a rate of about 200 revolutions per minute, and to connect only one of said speakers to said signal source when said support is rotated at a rate of about 400 revolutions per minute.

9. The combination as set forth in claim **8** together with a logic circuit carried by said support and a speed responsive element for operating said circuit means.

References Cited by the Examiner

UNITED STATES PATENTS

2,114,680	4/1938	Goldsmith	179—1
3,084,585	4/1963	Wayne	84—1.24
3,100,024	8/1963	Leslie	181—27

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