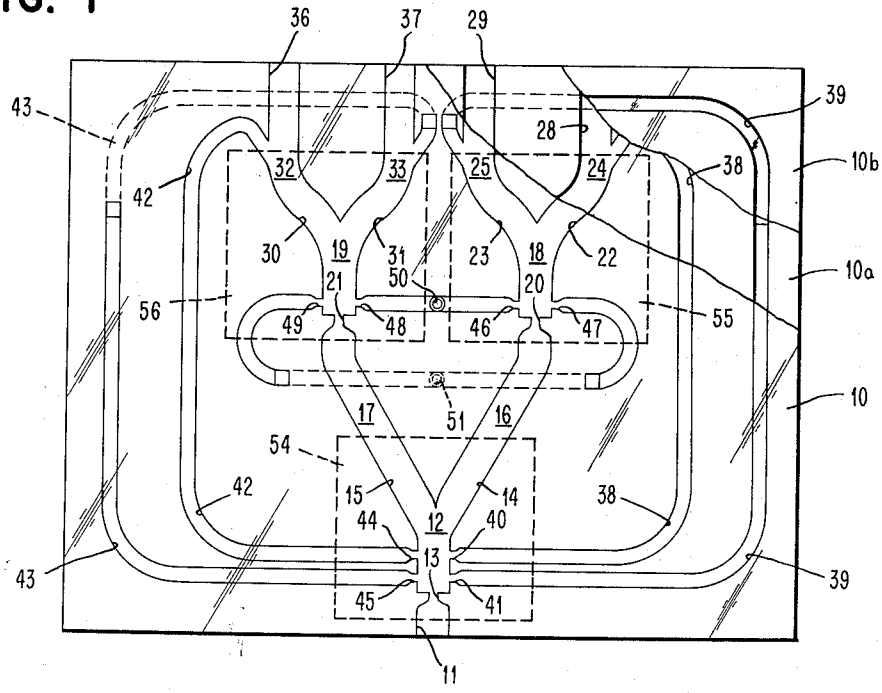
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MULTI-FREQUENCY FLUID OSCILLATOR

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FIG. 1



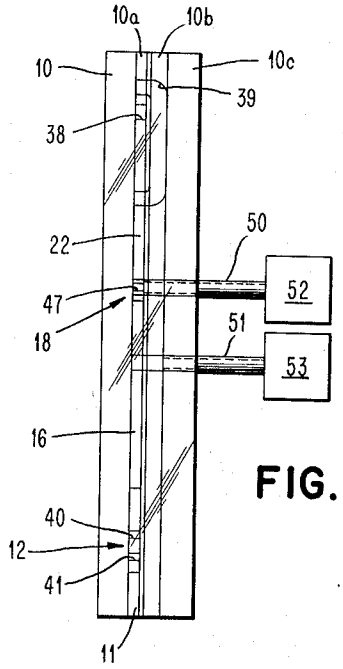


FIG. 1a

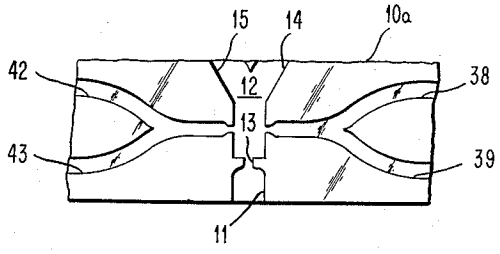


FIG. 2

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FIG. 3

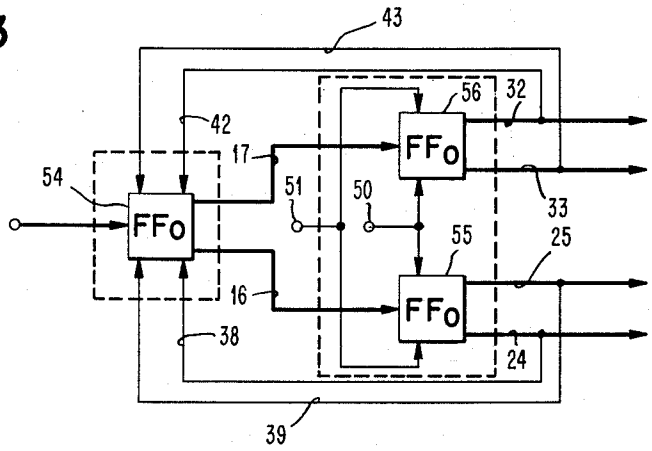
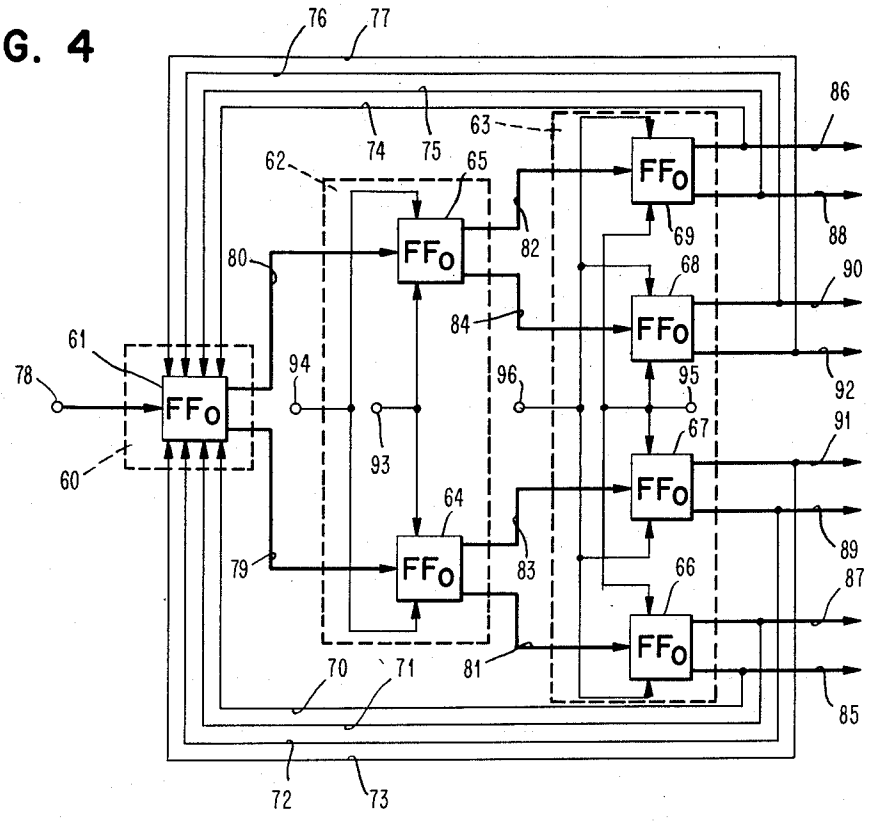


FIG. 4



United States Patent Office 3,117,593 Patented Jan. 14, 1964

3,117,593

MULTI-FREQUENCY FLUID OSCILLATOR

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17 Claims. (Cl. 137—624.14)

This invention relates to a pure fluid oscillator, and more particularly, to one having a plurality of stable non-simultaneous output frequences.

Pure fluid devices have become of increasing interest in those fields which require the characteristics of ruggedness and reliability together with relatively small physical size and intermediate response times. These devices generally employ no moving parts other than a power stream of fluid which may be selectively switched into different output channels by other control fluid streams which interact at right angles with the stream to be switched. Pure fluid amplifiers have been developed in which a control stream of relatively low energy is used to deflect the power stream of relatively high energy. By providing one or more output channels to which the power stream may be directed by said control stream, the proportion of the power stream within an output channel may be varied in accordance with the value of the control stream so that a utilization device associated with the output channel receives power far greater than that of a control stream, but proportional thereto.

Among other pure fluid devices which have recently been developed are monostable and bistable flip-flops and free running multi-vibrators. In the bistable flip-flop, the power stream is deflected into one of two output channels by a temporarily applied control stream pulse, after which said power stream is maintained in the output channel until a different control stream pulse subsequently switches it into the other output channel where its flow is thereafter maintained. This basic device may be converted into a free running multi-vibrator by providing a negative feedback passageway from each of the output channels back to an associated control stream orifice in such a fashion that the power stream flow through an output channel results in a control stream which switches the power stream to the other output channel. The power stream switches back and forth between the output channels in cyclic fashion, with the frequency normally depending upon the finite length of the negative feedback passageway. Therefore, in order to change the frequency of the free running multi-vibrator of the prior art, there has to be a change in the physical dimension of the device, such as changing the finite length of the feedback passageway. Prior art multi-vibrators therefore have typically been limited to but one frequency.

The present invention, on the other hand, is designed to selectively provide any one of a plurality of stable non-simultaneous output frequencies depending upon which one of a plurality of feedback passageways is selected by control means. Essentially, a fluid power jet stream is alternately deflected into a pair of output channels each of which has connected thereto a plurality of negative feedback passageways. Each passageway is of a different finite length and directs a portion of the power stream in the output channel back to an associated control orifice designed to switch the power stream into the other output channel. Control means are provided so that only one of the feedback passageways associated with each output channel is effective in producing the switching control stream.

Therefore, it is an object of the present invention to provide a multi-frequency pure fluid oscillator for selectively generating one of a plurality of stable output frequencies.

Another object of the present invention is to provide a multi-frequency pure fluid oscillator having a plurality of negative feedback passageways associated with each of its output channels, said passageways being of different finite lengths.

Yet another object of the present invention is to provide a multi-frequency pure fluid oscillator whose repetition rate is varied according to the length of a selected negative feedback passageway which provides a switching control stream.

In the preferred embodiments of the invention, the means for selecting a particular one of the feedback passageways comprises a pure fluid control stream which is introduced into an output channel for directing the power stream therein into only one of the feedback passageways connected therefrom. Therefore, the preferred embodiment of the multi-frequency oscillator requires no mechanical valves or gates in order to determine which of the feedback passageways is to be selected.

Accordingly, another object of the present invention is to provide a multi-frequency pure fluid oscillator in which means are provided in each of the output channels for introducing control streams therein in order to divert a portion of the power stream into only one of a plurality of negative feedback passageways.

A further object of the invention is to provide pure fluid means for changing the frequency of a pure fluid oscillator.

The novel concept of the present invention may be employed to design pure fluid oscillators having two or more stable non-simultaneous output frequencies. Therefore, yet another object of the present invention is to provide a multi-frequency pure fluid oscillator having a wide range of stable frequencies.

These and other objects of the present invention will become apparent during the course of the following description which is to read in conjunction with the drawings, in which:

FIGURE 1 is a plan view of one embodiment of the invention which is capable of generating dual frequencies;

FIGURE 1*a* is a side elevation view of the embodiment in FIGURE 1;

FIGURE 2 shows a possible modification of a portion of the embodiment in FIGURE 1;

FIGURE 3 is a block diagram representing the embodiment of FIGURE 1; and

FIGURE 4 is a block diagram representing another embodiment of the invention having four different stable frequencies.

Referring first to FIGURE 1, reference numeral **10** generally refers to the body of the device which contains an interconnected system of fluid ducts in the manner shown. Body **10** may be transparent to show the duct arrangement. Fluid is introduced to the device via input channel **11** by means of a pump or compressor not shown in any of the figures. The fluid under pressure in channel **11**

issue into a chamber 12 as a fluid power jet stream via a nozzle orifice 13. Chamber 12 is formed by the converging two outer walls 14 and 15 of the respective output channels generally indicated by 16 and 17.

Each output channel 16 to 17 in turn exits into respective chambers 18 or 19 via respective nozzle orifices 20 or 21. Chamber 18, for example, is formed by the converging outer walls 22 and 23 of respective output branches 24 and 25. In similar fashion, chamber 19 is formed by the converging two outer walls 30 and 31 of respective outer branches 32 and 33.

One of a pair of negative feedback passageways 38 or 39 is respectively bled from the output branches 24 or 25 and utilized to connect the associated output branch with one of a pair of control orifices 40 or 41 which is placed in the side wall 14 of chamber 12 at a location downstream from the power stream orifice 13. The feedback passageways 38 and 39 are constructed to have different finite lengths X and Y, respectively, as measured between the associated output branch and feedback control orifice. In like fashion, a pair of negative feedback passageways 42 and 43 are bled from respective output branches 32 and 33. Each of these feedback passageways 42 and 43 also returns a portion of power stream fluid flowing in its associated output branch to one of the control orifices 44 and 45, respectively, which are positioned in the side walls 15 of chamber 12 at a location downstream from the power stream orifice. Each of the passageways 42 and 43 has a different respective finite length X and Y, such that passageways 38 and 42 are of equal length X, while passageways 39 and 43 are of equal length Y which differs from the length X.

It will be noted in FIGURE 1 that each of the chamber 12 side walls 14 and 15 is offset with respect to the power stream orifice 13. In like fashion, the side walls of chambers 18 and 19 are also set back or offset with respect to their associated orifices 20 and 21. This configuration of the chamber wall permits the power stream from orifice 13 to be locked onto a wall 14 or 15 of the output channel to which it is directed, as well as being locked onto one of the output branches associated with its output channel, until a control stream from one of the orifices 41, 40, 44, or 45 is generated to divert the power stream into the other of its output channels. This operation will be substantially described in fuller detail.

Each of the chambers 18 and 19 has a pair of control orifices situated in opposite side walls for the purpose of diverting a power stream issuing from respective orifices 20 or 21 into one of its two output branches. For example, control orifices 46 and 47 are provided such that a control stream issuing from the former diverts the power stream into output branch 24, while a control stream from the latter diverts the power stream into output branch 25. In similar fashion, control orifices 48 and 49 are provided in chamber 19 for respectively diverting the power stream from orifice 21 into either output branch 32 or output branch 33. In the preferred embodiment of the invention, where equal intervals are desired between adjacent generated output pulses at each frequency, either the pair of orifices 46 and 48 or the pair of orifices 47 and 49 are simultaneously supplied with fluid under pressure via respective input passageways 50 or 51. These passageways 50 and 51 are more readily observed in FIGURE 1*a* which is a side elevation view of the embodiment in FIGURE 1. The control fluid in one of these passageways is selectively provided by sources 52 or 53, but normally only one of the sources is activated at any time depending upon the desired output frequency of the device.

As before mentioned, the physical geometry of the device shown in FIGURE 1 is such as to cause the power stream from orifice 13 to maintain its flow within an output channel and output branch to which it is diverted even after the initial diverting control stream has been terminated. For example, if the power stream from orifice 13 is diverted to flow into output channel 16 and from there into output branch 24, its velocity is such as to create a low pressure boundary layer region between it and the outside walls 14 and 22. The boundary layer phenomenon is well-known in the fluid amplifier art. The region of low pressure thereby causes the power stream to lock onto these walls where it there remains until a condition is reached in which this boundary layer region is destroyed or disrupted. If the power stream from orifice 13 has instead been diverted to output channel 16 and from there into output branch 25, a boundary layer region is also created to maintain the power stream flow in this path.

The operation of the device in FIGURE 1 is as follows. Assume that a constant output power stream issues via orifice 13 into chamber 12. If there is some asymmetry in the physical geometry of chamber 12 (for example, the opening to output chamber 16 may be slightly larger than the opening of output channel 17) the power stream is initially diverted into said output channel where it adheres to outside wall 14 due to creation of the boundary layer. Upon this power stream issuing from orifice 20 into chamber 18, it is diverted into either output branch 24 or output branch 25 depending upon whether source 52 or source 53 is activated at this time. If source 52 is activated, then a fluid control stream constantly issues from control orifice 46 which impinges upon the power stream from orifice 20 and diverts said power stream into output branch 24 where it locks onto the side wall 22. Conversely, if source 53 is energized instead of source 52, then a control stream issues from orifice 47 to impinge upon the power stream and so divert the latter into output branch 25 where it thereafter maintains its flow.

Assume for the purpose of this description that source 52 is energized so that a power stream from orifice 20 is forced into output branch 24 because of a steady, relatively small flow of fluid existing through orifice 46. As soon as the fluid power stream begins to flow through output branch 24, a portion of it is bled through the opening to feedback passageway 38. This fluid traverses feedback passage 38 and issues as a feedback control stream from orifice 40 in the wall of chamber 12. A certain finite length of time is required for the emergence of this control stream from orifice 40 after the power stream initially begins to flow in output branch 24. This time is directly proportional to the length of feedback passageway 38.

The feedback control stream from orifice 40 is capable of dispersing the boundary layer along side wall 14 of channel 16 to thereby force the power stream to instead enter output channel 17. Fluid flow in channel 16 and branch 24 is consequently terminated so that control stream flow in feedback passage 38 also ceases. However, as soon as the power stream begins to flow in output channel 17, it locks onto side wall 15 (because of the boundary layer effect) where it is maintained even after termination of the feedback control stream from orifice 40. Upon the power stream now issuing from orifice 21 into chamber 19, it is deflected or diverted into output branch 32, if control source 52 remains energized, due to the fact that a control stream issues from orifice 48. In so passing through output branch 32, a portion of the power stream is tapped by feedback passageway 42 which returns same to orifice 44 as a control stream pulse after a finite period of time determined by the length of passageway 42. Since passageways 38 and 42 are of equal length X in the preferred embodiment, this means that the time intervals between successive output pulses from branches 28 and 36 are equal. Thus, the traversing of feedback passageway 42 by a portion of the power stream output fluid causes said power stream to again switch from output channel 17 into output channel 16, where the above described cycle of events repeats itself under the assumption that source 52 remains energized.

By instead energizing source 53 and deenergizing source 52, the frequency of power stream oscillation between output channels is made to decrease. This occurs in the

following manner. With source 53 energized, control streams emerge from both orifices 47 and 49 which in turn deflect the power stream into output branches 25 or 33, respectively. Thus, if the power stream from orifice 13 is initially deflected into output channel 16, it is subsequently diverted into output branch 25 by the control stream from orifice 47. A portion of its flow therein is tapped by feedback passageway 39 which is physically longer than feedback passageway 38. Consequently, there is a greater pulse lag time between initiation of power stream flow in branch 25 and emergence of a switching control stream pulse from orifice 41. The control stream from orifice 41 breaks the boundary layer adjacent wall 14 and thereby diverts the power stream into output channel 17. When flowing in channel 17, the power stream is now diverted into output branch 33 by virtue of the control stream from orifice 49. Since feedback passageways 39 and 43 are assumed to be of equal length Y in the present embodiment, the same pulse lag time is incurred by the fluid stream when passing through passageway 43 as is incurred in passageway 39. Therefore, at some time subsequent to the diverting of the power stream into output channel 17, a control stream pulse issues from orifice 45 to switch the power stream flow back again into output channel 16 where the cycle repeats itself.

By therefore providing a plurality of negative feedback passageways associated with each output channel, as well as means to selectively switch a portion of the power stream flow into only one of said passageways, the frequency of the device may be changed to any one of two stable non-simultaneous frequencies. In FIGURE 1, the higher of the two possible frequencies is obtained by energizing source 52, whereupon the generated output pulses are detected at the outputs of branches 28 and/or 36. The lower of the two frequencies is sampled from branches 29 and/or 37 and is obtained by energizing source 53.

FIGURE 2 shows a slight modification which can be made in the arrangement of the control orifices in the side walls of chamber 12. In FIGURE 2, only one control orifice is provided on each side of the power stream. Into this orifice feed two of the feedback passageways. For example, the fluid in either feedback passageway 38 or 39 issues into chamber 12 via a single orifice instead of through respective individual orifices 40 or 41 as shown in FIGURE 1. In like fashion, feedback passageways 42 and 43 terminate in a common control orifice instead of individual orifices. Fluid flow within only one of the feedback passageways connected to the common orifice is sufficient to switch the power stream into the other output channel.

The embodiment of FIGURE 1 may also be viewed as an input fluid bistable flip-flop in combination with two output fluid flip-flops. The input flip-flop is seen as comprising the fluid duct system enclosed by the dash rectangle 54, and is one having two output channels where each channel has associated therewith a plurality of logical OR control inputs. In other words, the power stream can be diverted into an output channel (for example, 16) by a control input signal applied to either one of the orifices 44 or 45. In similar fashion, the power stream can be diverted into the other output channel 17 by either one of applied control inputs as represented by a control stream issuing from orifices 40 or 41. The two output flip-flops may be considered as comprised by the interconnected fluid ducts enclosed in respective dash rectangles 55 and 56. As shown in FIGURE 1, the power stream input channel of flip-flop 55 is connected to the output channel 16 of flip-flop 54, with flip-flop 55 itself having two output channels 24 and 25 into one of which the power stream is diverted according to which of its two control inputs is present. In similar fashion, flip-flop 56 derives its input power stream from output channel 17 of flip-flop 54, whereupon said power stream is diverted into either one or the other of its output channels 33 or 32.

FIGURE 3 of the drawings is a block diagram of the embodiment of FIGURE 1 when the latter is interpreted as being comprised of the above defined logical elements. For example, flip-flop 54 is represented by a rectangle enclosing the letters FF_0 showing that it is a fluid bistable flip-flop having OR control inputs. The heavy black lines indicate the power stream input and output channels as well as fluid ducts which couple together the power stream paths of different fluid devices. The lighter lines show control stream paths. The arrow head on a control input indicates the direction of shift of the power stream within a device if a signal (in the form of a control stream) is applied thereto. Rectangular blocks 55 and 56 represent fluid flip-flops each having only one control input associated with each output channel. The feedback passageways and channels are numbered corresponding to FIGURE 1. FIGURE 3 may therefore be interpreted as a shorthand or logical representation of the device in FIGURE 1.

From FIGURE 3, it is obvious that the novel principle of the present invention may be extended in order to increase the number of stable frequencies which may be obtained from a device of this nature. As an example, FIGURE 4 is a block representation of a pure fluid oscillator having four stable output frequencies. In this embodiment, an input level 60 is comprised of a single bistable pure fluid flip-flop 61 with four OR control inputs associated with each of its output channels 79 and 80. Following this input level, two secondary levels 62 and 63 are provided, with each level comprised of a plurality of fluid flip-flops whose number depends upon the number of output channels from the prior level. For example, the first secondary level 62 is comprised of two flip-flops 64 and 65 each of which has its power stream provided by a different one of the two output channels from input level 60. Each flip-flop 64 and 65 has only one control input associated with each of its output channels. Since each flip-flop 64 and 65 has two output channels therefrom, there are four output channels 81 through 84 from the first secondary level 62. Therefore, the next higher secondary level 63 contains four flip-flops 66 and 69, each of which has its power input channel connected to a different one of the four output channels from level 62. There are, therefore, eight output channels 85 through 92 from level 63 in the manner indicated.

Within each of the secondary levels 62 and 63, the flip-flops may be equally divided into first and second groups depending upon whether they are associated with the first or the second output channels 79 or 80 from input level 60. For example, within level 62, flip-flop 64 may be considered as comprising the first group, while flip-flop 65 is in the second group. Likewise, within level 63, flip-flops 66 and 67 are in the first group while flip-flops 68 and 69 are in the second group. Branching from the output channels 85, 87, 89, and 91 of the flip-flops in the first group of level 63 are a plurality of feedback passageways 70, 71, 72, and 73, respectively, which are connected to the control inputs associated with the second output channel 80 of input flip-flop 61. Feedback passageways 70 through 73 have different finite lengths. In similar fashion, a group of feedback passageways 74, 75, 76, and 77 are connected between the output channels 86, 88, 90, and 92 from the second group of level 63, and those control inputs of flip-flop 61 which are associated with the first output channel 79.

The control inputs to each of the flip-flops in the secondary levels 62 and 63 are provided by selectively energizable pressure sources similar to those shown in FIGURE 1. Thus, each level 62 and 63 has individual thereto two pressure sources only one of which is energized or actuated at any one time. If the oscillator is to operate at its highest stable frequency, then the pressure

sources associated with ducts 93 and 95 are energized. A power stream in output channel 79 from flip-flop 61 is thereby diverted to output channel 81 of flip-flop 64 due to the presence of a control stream provided by the source connected to duct 93. In turn, the power stream in channel 81 is diverted to output channel 85 of flip-flop 66 by virtue of the energized pressure source connected to duct 95. A switching control stream is thereby tapped from channel 85 via feedback passageway 70 which returns same to flip-flop 61 in order to switch the power stream therein from channel 79 to channel 80. The still energized pressure sources connected to ducts 93 and 95 now enable the power stream to traverse a path which includes channels 82 and 86. Since the feedback passageway 74 associated with output channel 86 is of the same finite length as passageway 70, the power stream remains in output channel 80 for the same length of time as in channel 79. Upon the feedback control stream pulse subsequently arriving at one of the OR inputs to flip-flop 61 via feedback passageway 74, the power stream is again switched, this time from output channel 80 to output channel 79 where the cycle repeats itself. Thus, since feedback passageways 70 and 74 are shown to be the shortest in length, the frequency of the oscillator is highest when these passageways are utilized.

If the next shortest feedback passageways 71 and 75 are to be employed, thus permitting the device to generate a lower frequency than that described above, the pressure source connected to duct 93 remains energized, while that connected to duct 95 is deactivated. Instead, the source connected to duct 96 is activated. This combination of control sources permits the power stream to traverse a path through the first group of flip-flops in each level, which paths comprises output channels 79, 81, and 87. Upon the power stream switching from channel 79 to channel 80, the path through the second group in each level is comprised of channels 80, 82, and 88. Thus, the output from the oscillator is derived at either output channels 87 or 88, to which are respectively connected the feedback passageways 71 or 75 used to provide a switching control stream to flip-flop 61 at some time subsequent to initiation of power stream flow in one of the output channels 79 or 80.

By energizing pressure sources connected to ducts 94 and 95, feedback passageways 72 and 76 may be selected in order to permit generation of clock pulses at a still lower frequency. In similar fashion, by providing control stream fluid to ducts 94 and 96, the longest feedback passageways 73 and 77 are now responsive to fluid flow in output channels 91 and 92 for applying the switching feedback control stream pulses. For this fourth combination of energized control stream sources, the oscillator of FIGURE 4 generates its lowest stable output frequency.

As may be observed from the above descriptions of FIGURES 3 and 4, the principles of the present invention may be employed to construct fluid oscillators having multi-stable states of operation of two or more frequencies. With respect to FIGURE 4, it may be possible to add still more secondary levels of flip-flops so as to increase the number of frequencies in which the device may operate. Also, although all of the embodiments shown in FIGURES 1 through 4 have been described as operating in a symmetrical mode, i.e., with equal intervals between adjacent generated output pulses (due to the fact that pairs of equal length feedback passageways are always selected), it is evident that these devices could be operated in an asymmetrical mode by merely selecting pairs of passageways of unequal length. As an example, in FIGURE 1 control streams from orifices 47 and 46 may be simultaneously energized in order to make output branch 29 and output branch 36 parts of the power stream path for each cycle of operation. If this is done, then feedback passageways 39 and 42 are selected. Thus, the power stream remains in output channel 16 for a longer period of time than spent by it in output channel 17, due to the fact that a longer delay is encountered by the feedback switching control stream pulse in passageway 39.

It should also be noted here that the boundary layer memory effect may not be absolutely necessary in output channels 24, 25, 32, and 33 of FIGURE 1 (or in the secondary levels of FIGURES 3 and 4). It is helpful and desirable from the standpoint that the power of the control jet streams required to position the power jet stream is thereby minimized. However, since these control streams from nozzles 46–48 or 47–49 are continuous, the principle of momentum exchange between control stream and power stream could be utilized to maintain power stream flow in the selected output channel. Furthermore, the memory characteristic essential to the input flip-flop 54 might alternatively be provided by adding external positive feedback paths which would provide control streams to maintain power stream flow in an output channels 16 or 17, instead of relying on the boundary layer effect. The term "flip-flop" thus is to be construed in both specification and claims as covering any one of a variety of fluid devices which has two output signal pressure levels.

It may also prove desirable in certain environments to provide but a single significant output channel, with different length negative feedback passageways associated therewith for diverting the power stream away from entering said output channel. Further means, such as an asymmetrically positioned divider knife edge in chamber 12, might then be used to direct the power stream back into the significant output channel when once the feedback control stream terminates, under the assumption that there would be no stable memory characteristic at the time that the power stream is not entering the output channel. Consequently, many modifications and alterations of the preferred embodiments may be apparent to persons skilled in the art without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. A multi-level pure fluid device comprising:

(*a*) an input level consisting of a single fluid bistable flip-flop having 2^N OR control inputs for each of its first and second output channels, where the exponent N is a positive integer greater than zero;

(*b*) N secondary levels, each *n*th level consisting of 2^n fluid flip-flops separated equally into first and second groups where the exponent n is a positive integer from 1 to N, with each secondary fluid flip-flop having one control input for each of its first and second output channels;

(*c*) fluid ducts interconnecting the power stream input channels of the first and second group flip-flops in the $n=1$ secondary level with said first and second output channels, respectively, of said input level flip-flop;

(*d*) fluid ducts interconnecting the power stream input channels of the first and second group flip-flops in any remaining *n*th secondary level one with different output channels of the first and second group flip-flops, respectively, of the $(n-1)$th secondary level;

(*e*) a first group of 2^N feedback passageways each having a different pulse lag time characteristic and each connected between a different one of the output channels from the first group flip-flops in the Nth secondary level and a different control input associated with the second output channel of said input level flip-flop;

(*f*) a second group of 2^N feedback passageways each having a different pulse lag time characteristic and each connected between a different one of the output channels from the second group flip-flops in the Nth secondary level and a different control input

associated with the first output channel of said input level flip-flop; and

(g) means for selectively energizing certain ones of the control inputs to the flip-flops in each of said N secondary levels so as to successively direct a fluid power stream, in alternating fashion, through each level of said device to one output channel of the flip-flops in each of the first or second groups of said Nth secondary level.

2. A device according to claim 1 wherein N=1.

3. A device according to claim 1 wherein said input level flip-flop is designed with a boundary layer memory characteristic.

4. A device according to claim 1 wherein each of said secondary level flip-flops is designed with a boundary layer memory characteristic.

5. A device according to claim 1 wherein said last named means energizes those control inputs which alternatingly direct the power stream through two output chanels of said Nth secondary level to which are connected feedback passageways having equal pulse lag time charatceristics, one in each of said first and second groups of passageways.

6. A device according to claim 5 wherein N=1.

7. A device according to claim 1 wherein each first group feedback passageway is of a different finite length from the others of said first group, and each second group feedback passageway is of a different finite length from the others of said second group.

8. A device according to claim 7 wherein N=1.

9. In a pure fluid device wherein a fluid power jet stream under pressure maintains its flow in either one of first or second output channels to which it is diverted, the combination comprising:

(a) first and second feedback passageways of respectively different finite lengths X and Y each associated with said second output channel to thereby introduce a fluid control stream into said device for diverting said power stream into said first output channel;

(b) third and fourth feedback passageways of respectively different finite lengths X and Y each associated with said first output channel to thereby introduce a fluid control stream into said device for diverting said power stream into said second output channel;

(c) first means associated with said first output channel for selectively diverting a portion of the power stream therein to either said third or said fourth feedback passageway, said portion acting as said control stream; and

(d) second means associated with said second output channel for selectively diverting a portion of the power stream therein to either said first or said second passageway, said portion acting as said control stream.

10. A device according to claim 9 wherein said first means comprises a pair of control orifices located in said first output channel one of which selectively applies a fluid control stream thereto for diverting said power stream in the manner defined above, and said second means comprises a pair of control orifices located in said second output channel one of which selectively applies a fluid control stream thereto for diverting said power stream in the manner defined above.

11. In a pure fluid device wherein a fluid power jet stream under pressure maintains its flow in either one of first or second output channels to which it is diverted, the combination comprising:

(a) first and second control orifices located adjacent said power stream each adapted to introduce a respective first or second fluid control stream into said device either of which diverts said power stream into said first output channel;

(b) third and fourth control orifices located adjacent said power stream each adapted to introduce respective third or fourth fluid control streams into said device either of which diverts said power stream into said second output channel;

(c) first and second feedback passageways connected between said second output channel and said first and second control orifices, respectively, where said first feedback passageway has a finite length X and said second passageway has a different finite length Y;

(d) third and fourth feedback passageways connected between said first output channel and said third and fourth control orifices, respectively, where said third feedback passageway has a finite length X and said fourth feedback passageway has a different finite length Y.

(e) first means located in said first output channel for selectively diverting a portion of the power stream therein to either said third or said fourth feedback passageway for providing either said third or said fourth control stream, respectively; and

(f) second means located in said second output channel for selectively diverting a portion of the power stream therein to either said first or said second feedback passageway for providing either said first or said second control stream, respectively.

12. A device according to claim 11 where said first means comprises a pair of control orifices located in said first output channel one of which selectively applies a fluid control stream thereto for diverting said power stream in the manner defined above; and said second means comprises a pair of control orfices located in said second output channel one of which selectively applies a fluid control stream thereto for diverting said power stream in the manner defined above.

13. In a pure fluid device wherein a fluid power jet stream under pressure maintains its flow in at least a first output channel to which it is diverted, the combination comprising:

(a) first and second feedback passageways of respectively different finite lengths X and Y each associated with said first output channel to thereby introduce a fluid control stream into said device for diverting said power stream away from said first output channel;

(b) first means associated with said first output channel for selectively diverting a portion of the power stream therein to either said first or said second feedback passageway, said portion acting as said control stream; and

(c) second means for diverting said power stream back into said first output channel subsequent to its diversion away therefrom.

14. A device according to claim 13 wherein said first means comprises a pair of control orifices located in said first output channel one of which selectively applies a fluid control stream thereto for diverting said power stream in the manner defined above.

15. A device according to claim 13 wherein said second means comprises a second output channel into which said power stream is diverted from said first output channel and through which it maintains its flow, third and fourth feedback passageways of respectively different finite lengths X and Y each associated with said second output channel to thereby introduce a fluid control stream into said device for diverting said power stream into said first output channel, and third means associated with said second ouput channel for selectively diverting a portion of the power stream therein to either said third or said fourth feedback passageway with said portion acting as said control stream.

16. A device according to claim 15 wherein said first means comprises a pair of control orifices located in said first output channel one of which selectively applies a fluid control stream thereto for diverting said power stream, and said third means comprises a pair of control orifices located in said second output channel one of which

selectively applies a fluid control stream thereto for diverting said power stream in the manner defined above.

17. In a pure fluid device wherein a fluid power jet stream under pressure maintains its flow in at least a first output channel to which it is diverted, the combination comprising:

(*a*) first and second feedback passageways having respectively different pulse lag time characteristics each associated with said first output channel to thereby introduce a fluid control stream into said device for diverting said power stream away from said first output channel;

(*b*) first means associated with said first output channel for selectively diverting a portion of the power stream therein to either said first or said second feedback passageway, said portion acting as said control stream; and

(*c*) second means for diverting said power stream back into said first output channel subsequent to its diversion away therefrom.

No references cited.