

June 30, 1970

B. LYMAN ETAL

3,517,686

FLUID OSCILLATOR SYSTEM

Filed July 13, 1966

Fig. 1

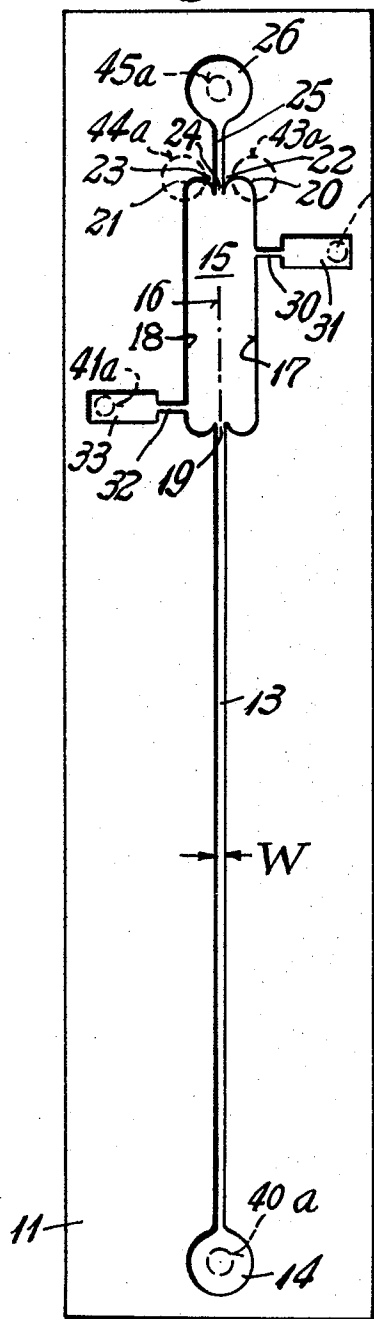


Fig. 2

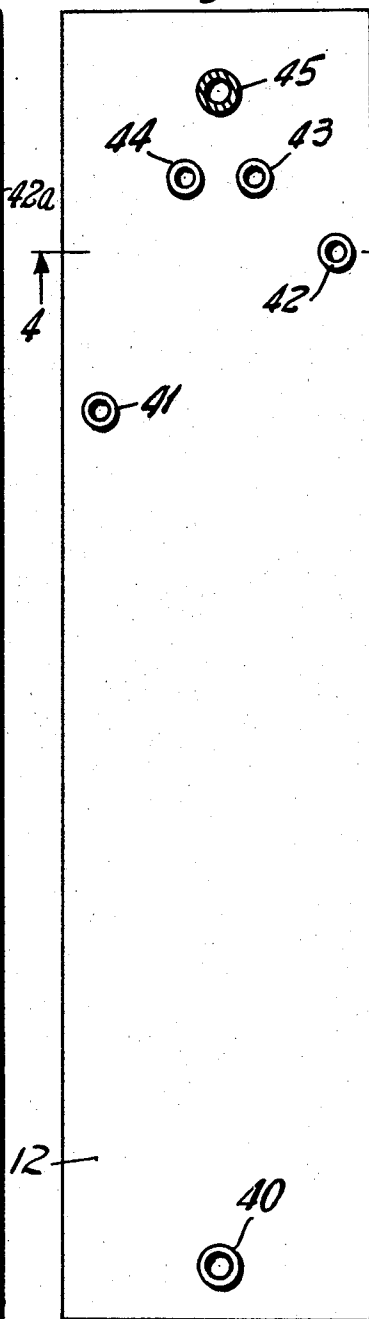


Fig. 3

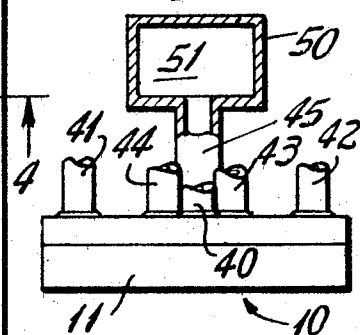


Fig. 4

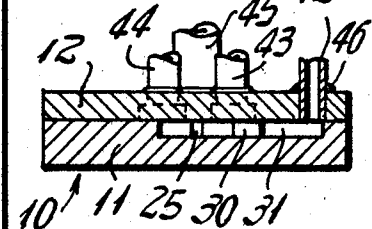
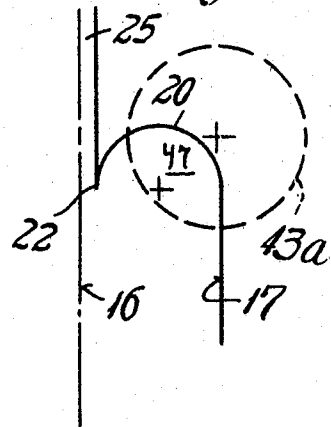
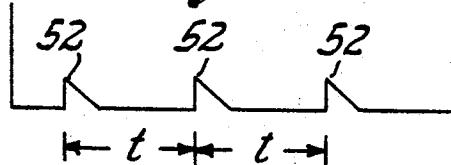


Fig. 5



P Fig. 6



INVENTORS
Brooks Lyman
BY Robert F. O'Keefe
Albert W. Scribner
ATTORNEY

1

2

3,517,686

FLUID OSCILLATOR SYSTEM

Brooks Lyman, Pound Ridge, N.Y., and Robert F. O'Keefe, Trumbull, Conn., assignors to Pitney-Bowes, Inc., Stamford, Conn., a corporation of Delaware

Filed July 13, 1966, Ser. No. 564,821

Int. Cl. F15c 1/08

U.S. Cl. 137—81.5

6 Claims

ABSTRACT OF THE DISCLOSURE

A fluidic oscillator that includes a single turbulence type fluid amplifier, to the collector of which is connected a plenum chamber and to the side of the interaction chamber of which is connected a fluid outlet line whereby the alternate automatic filling and emptying of the plenum chamber produces corresponding periodic fluid pressure changes in the said outlet line.

This invention relates to a novel pure fluid oscillator system. More particularly the invention relates to a novel fluid oscillator system wherein a single turbulence type pure fluid amplifier is used to afford a varying fluid pressure source.

Fluid oscillators have been made using wall attachment type fluid amplifiers equipped with a feed back coupling from the amplifier output line to a control line thereof. While this type of arrangement may be practical for certain relatively high frequency applications it has not been found satisfactory in many cases where relative low fluid oscillator frequencies are desired, i.e. frequencies less than say 150 cycles per second.

The primary object of the instant invention is to provide a simple, practical, low cost pure fluid oscillator system which may be arranged to afford most any desired operational frequency of less than 150 cycles per second.

Another object of the invention is to provide a relatively low frequency fluid oscillator system wherein a turbulence amplifier is arranged to automatically control alternate fluid flows through two separate flow lines.

Another object of the invention is to provide an improved fluid oscillator system having a control means for interrupting the fluid output pulse sequence as desired.

Other objects of the invention will become apparent as the disclosure progresses.

In the drawings:

FIG. 1 is a plan view and shows the configuration for the turbulence amplifier used in the instant fluid oscillator system.

FIG. 2 is a plan view in partial section of the instant oscillator system and particularly illustrates the cover plate construction of the instant device.

FIG. 3 is a lower end view of the apparatus shown in FIG. 2.

FIG. 4 is a cross sectional view taken along section line 4—4 of FIG. 2.

FIG. 5 is a diagrammatic sketch (enlarged four times from FIG. 1) illustrating the size and location of the vent holes in relation to the interaction chamber of the instant turbulent amplifier.

FIG. 6 is a diagrammatic sketch illustrating the fluid pressure output pulses generated by the present fluid oscillator system.

The instant fluid oscillator system comprises in essence a turbulent amplifier which is provided with a supplemental output line and which is coupled to a means for cyclically increasing to a predetermined level the loading on the collector of the amplifier.

Referring to FIGS. 1-4 a laminated construction is illustrated for the turbulence amplifier unit 10. Unit 10

comprises a lower grooved plate 11 and an upper cover plate 12 which is sealingly secured by any suitable means to said lower plate so as to thereby establish the flow passage network to be described below. The configurations of the fluid flow passages are largely determined by the nature of the grooves, chambers, etc. that are formed in the upper face of said lower plate 11 and particular reference to FIGS. 1 and 5 will be made in connection with a detailed description of the shape and extent of such grooves and chambers. The instant turbulence amplifier includes an emitter which is essentially defined by an elongated straight groove 13 which has an upstream end that communicates with a supply chamber 14 and a downstream end that communicates with an interaction chamber 15. Chamber 15 is substantially symmetrically arranged with respect to the longitudinal axis 16 of the emitter groove 13 and includes two longitudinal side walls 17 and 18. The downstream end of interaction chamber 15 is formed with two concave end walls 20 and 21 which terminate at projections 22 and 23 that extend slightly upstream in the chamber 15, as illustrated in FIG. 1, and define a collector orifice or opening 24 for the instant turbulence amplifier. The collector of the instant unit 10 is essentially defined by an elongated straight groove 25 which is coaxially disposed with respect to the emitter groove 13. The upstream end of the collector groove 25 communicates with said interaction chamber while the downstream end thereof communicates with an output chamber 26.

A laterally extending supplementary output line or groove 30 is also formed in the upper face of plate 11, one end thereof communicating with a downstream portion of the interaction chamber 15 through side wall 17, while the other end thereof communicates with an outlet chamber 31. The axis of groove 30 is disposed substantially normal to the axis 16 of the emitter groove 13. A laterally extending control line or groove 32 is formed in plate 11, one end thereof communicating with an upstream portion of the interaction chamber through the opposite side wall 18 of the chamber 15, while the other end thereof communicates with a signal chamber 33. The axis of groove 32 is also disposed substantially normal to the axis 16 of the emitter groove 13.

The lower plate, which is grooved as above described, is sealingly covered by the plate 12 as illustrated in FIGS. 2-4. The cover plate 12 is formed with a plurality of suitable holes or bores which are respectively adapted to receive a plurality of tubular fittings 40-45, the latter being respectively secured in said bores by any suitable means such as soldering, brazing, etc. as is illustrated at 46 of FIG. 4. The tubular fittings 40, 41, 42, 43, 44, 45 are located in the cover plate at the positions shown in FIG. 2 and respectively communicate with the various grooves and chambers in the amplifier at points denoted by the dotted line circles 40a, 41a, 42a, 43a, 44a, 45a, respectively, of FIG. 1. The tubular fitting 40 is adapted to be pneumatically coupled to a fluid pressure source and fittings 43 and 44, which are provided for venting purposes, operatively communicate with the respective side portions of the downstream end of the interaction chamber 15. Only the lower portions 47, FIG. 5, of the symmetrically arranged vent holes formed in the cover 12, as represented by the said dotted line circles 44a and 43a of FIG. 1 overlap the interaction chamber 15, these overlapping portions collectively representing the effective exhaust or venting area for the instant amplifier. These vent holes afford exhaust conduit means having a predetermined fluid flow impedance. The fitting 41 may be connected to a means for generating a fluid input signal that is capable of controlling the operation of the instant turbulence amplifier, while fitting 42 is connected so as to supply oscillating fluid pressure to a downstream device. The fitting 45

is connected to a closed container 50, FIG. 3, having therein a plenum chamber 51 of predetermined volume, the chamber 51 acting as a predetermined impedance or load with respect to the collector of the instant turbulence amplifier.

The configuration of the groove and chamber arrangement formed in plate 11 is shown to actual scale in FIG. 1; the width W of groove 13 having a value of .015 inch. The actual diameter of holes 43a (see FIG. 5) and 44a is .062 inch. All the above described grooves and chambers have substantially rectangular cross sectional shapes, the depth of grooves 13, 24, 30, 32 and chamber 15 being approximately .015 inch and the width of the grooves 30 and 32 being .008 inch. It will be understood that various other ranges and combinations of dimensions may be used here.

The operation of the instant device will now be described. Fluid, e.g. air, from a suitable pressure source flows through fitting 40, chamber 14, emitter groove 13 and into the interaction chamber 15. The elongated nature of the emitter 13 causes a laminar type air jet to issue from the downstream end 19 of the emitter and to flow down the length of interaction chamber 15 and into the upstream end 24 of the collector groove 25. This essentially laminar fluid flow will cause the pressure in the collector groove 25 and the plenum chamber 51 to increase until a predetermined pressure loading at the collector exists at which time the laminar flow in the fluid jet received by the collector groove 25 becomes turbulent with much of the fluid then exhausting through the venting fittings 43, 44. Under these turbulent flow conditions the fluid impact pressure at the collector opening 24 begins to decrease and the fluid then under higher pressure in the plenum chamber 51 commences to flow back into chamber 15 through the collector groove 25. At this time then fluid is being directed into chamber 15 from both the emitter and collector ends thereof and a rapid increase in the pressure in the chamber 15 and output groove 30 occurs in that the amplifier venting means is momentarily unable to conduct away the relatively large amount of fluid then being pumped into said chamber 15. The sudden pressure increase in output line 30 initiates a fluid pressure output pulse or flow through the fitting 42. This output pulse is of short duration because the said reverse flow of fluid from the plenum chamber 51 to the interaction chamber 15 soon effectively empties chamber 51 whereupon only the normal amount of fluid then enters chamber 15 by way of the emitter groove 13. This causes the output pulse or flow in fitting 42 to terminate thus restoring in chamber 15 those pressure conditions which will permit the reestablishment of a laminar flow in the emitter jet. This in turn causes the pressure in collector groove 25 and chamber 51 to again rise until it again reaches said predetermined pressure level whereupon another automatic pressure switching cycle commences. The above explanation of why the instant oscillator system produces the automatic cyclic pressure switching action is somewhat conjectural.

The automatic cyclic switching of the amplifier operation back and forth between a laminar flow state, wherein fluid flows into the collector groove 25, and a turbulent flow state, wherein fluid flows out through outlet fitting 42 constitutes a reliable low speed fluid oscillator system. It has been found that such a system has reasonably precise timing characteristics for any given set of structural conditions and fluid supply pressure conditions. FIG. 6 illustrates the rather uniform period of time *t* between the successive pressure "spikes" 52 as measured at the outlet fitting 42. The following table of operation for the instant type of oscillator system was derived using a FIG. 1 type turbulent amplifier having various sized chambers 51, the emitter groove width W being .015 inch and the air supply pressure being approximately 1 p.s.i.

Volume of chamber 51, cubic inches	Period (t), milliseconds	Frequency, cycles per second
29	2,500	.4
3	650	1.53
6	140	7.14
.375	15	66.7

The operational fluctuations from the above noted time and frequency values did not vary more than approximately 3%. The maximum frequency obtained here was approximately 125 cycles per second.

If it is desired to interrupt the operation of the instant oscillator system a fluid pressure signal may be introduced into the signal fitting 41 whereupon the automatic alternate mode switching of the turbulence amplifier ceases and the amplifier remains in the said turbulent operational mode for as long as said signal remains applied.

The instant type of relatively low frequency fluid oscillator system has been tested and found to be relatively accurate in producing a predetermined sequence of timed fluid pulses.

What is claimed is:

1. A fluid oscillator system comprising:

an emitter adapted to issue a laminar jet of fluid;

a collector operatively positioned with respect to said emitter so as to be capable of receiving fluid flow from said emitter;

means defining an interaction chamber between said emitter and collector;

means for venting said interaction chamber;

means defining a fluid plenum chamber, said plenum chamber communicating with said collector;

means defining an output line that communicates with said interaction chamber;

said laminar jet of fluid from said emitter initially causing said plenum chamber to be filled so that the resultant operative loading at the amplifier collector causes said laminar jet of fluid to become turbulent, a reverse fluid flow then occurring from said plenum chamber to said interaction chamber which reverse flow causes a temporary pressure rise in said output line whereafter a laminar fluid flow is automatically reestablished in said interaction chamber and said plenum chamber is again filled, the successive pressure increases in said output line being in substantially uniform timed sequence; and

fluid conduit means defining a control line which communicates with said interaction chamber so that when a control signal is applied through said control line said successive pressure increases in said output line are interrupted.

2. A fluid oscillator system comprising:

a main body;

said main body having an elongated supply line formed therein, said supply line being adapted to be coupled to a source of fluid pressure and to issue a laminar jet of fluid from the downstream end thereof;

said main body having an interaction chamber formed therein, said chamber communicating with the downstream end of said supply line;

said main body having a fluid receiving collector line formed therein, the upstream end of said collector line communicating with said interaction chamber and being arranged to receive fluid flowing from said supply line across said interaction chamber;

said main body having at least one fluid venting line formed therein that communicates with said interaction chamber;

means defining a pressure loading chamber, said loading chamber communicating with said collector line;

said main body having an output line formed therein which communicates with said interaction chamber; the flow of fluid from said supply line automatically alternating between laminar flow that is directed into

5

said collector line and turbulent flow at least part of which flows into said output line, the resultant intermittent fluid flow through said output line affording an oscillating fluid pressure source;

said main body having a control line formed therein which communicates with said interaction chamber and which is operable when a control signal is applied therethrough to control the fluid flow through said interaction chamber.

3. Apparatus as defined by claim 2 wherein said loading chamber is substantially closed except for its connection with said interaction chamber.

4. A fluid oscillator system comprising:

a turbulence type fluid amplifier having an interaction chamber, an emitter and a collector, said emitter normally issuing a laminar jet of fluid which is received by said collector;

means defining a predetermined fluid vent for said interaction chamber;

means for applying a predetermined pressure loading to the collector of said turbulence amplifier; and an output line communicating with said interaction chamber;

the flow of fluid through said interaction chamber automatically alternating between a laminar flow that is directed into said collector and a turbulent flow a portion of which flows into said output line, the resultant intermittent fluid flow through said output line affording an oscillating fluid pressure source.

5. Apparatus as defined by claim 4, additionally comprising:

control means for interrupting the intermittent flow of fluid through said output line.

6. A fluid oscillator system that automatically switches between laminar and turbulent fluid flow conditions comprising a main body:

said main body having an elongated supply line formed therein that is arranged to be coupled to a source of fluid pressure so as to effectively define an emitter that is adapted to issue a laminar jet of fluid from the downstream end thereof;

said main body having an interaction chamber formed therein, said chamber communicating with the downstream end of said emitter;

said main body having a fluid receiving line formed therein that effectively defines a collector, the upstream end of said collector communicating with

6

said interaction chamber and being arranged in substantial axial alignment with said emitter so as to receive fluid flowing from said emitter across said interaction chamber;

said main body having at least one fluid venting line formed therein that communicates with said interaction chamber at a point adjacent the downstream end of said interaction chamber; means for establishing a predetermined fluid flow impedance in said venting line;

means defining a pressure loading chamber, said loading chamber communicating with said collector;

said main body having an output line formed therein which communicates with said interaction chamber;

the said laminar jet issuing from said emitter initially flowing into said collector thereby filling said pressure loading chamber until at a particular pressure level said laminar jet automatically becomes turbulent and a reverse fluid flow occurs through said collector whereby fluid enters said interaction chamber from both said emitter and said collector so that the said impedance in said venting line causes a portion of the fluid flow entering said interaction chamber to flow out through said output line in the form of a pressure pulse of relatively short duration until the said pressure loading chamber is substantially emptied whereupon said laminar jet is automatically reestablished so as to start the next cycle of automatic switching back and forth between said laminar and turbulent fluid flow conditions and thus automatically generating successive fluid pressure pulses in said output line.

References Cited

UNITED STATES PATENTS

1,628,723	5/1927	Hall	137—81.5	XR
3,159,168	12/1964	Reader	137—81.5	
3,204,652	9/1965	Bauer	137—81.5	
3,228,410	1/1966	Warren et al.	137—81.5	
3,258,023	6/1966	Bowles	137—81.5	
3,269,419	8/1966	Dexter	137—81.5	
3,272,215	9/1966	Bjornsen et al.	137—81.5	
3,295,543	1/1967	Zalmanzon	137—81.5	
3,362,421	1/1968	Schaffer	137—81.5	
3,275,015	9/1966	Meier	137—81.5	

SAMUEL SCOTT, Primary Examiner