Feb. 26, 1963 H. A. BALDWIN 3,078,675

FLUID AMPLIFIER SYSTEM

Filed Nov. 2, 1961

Fig 1

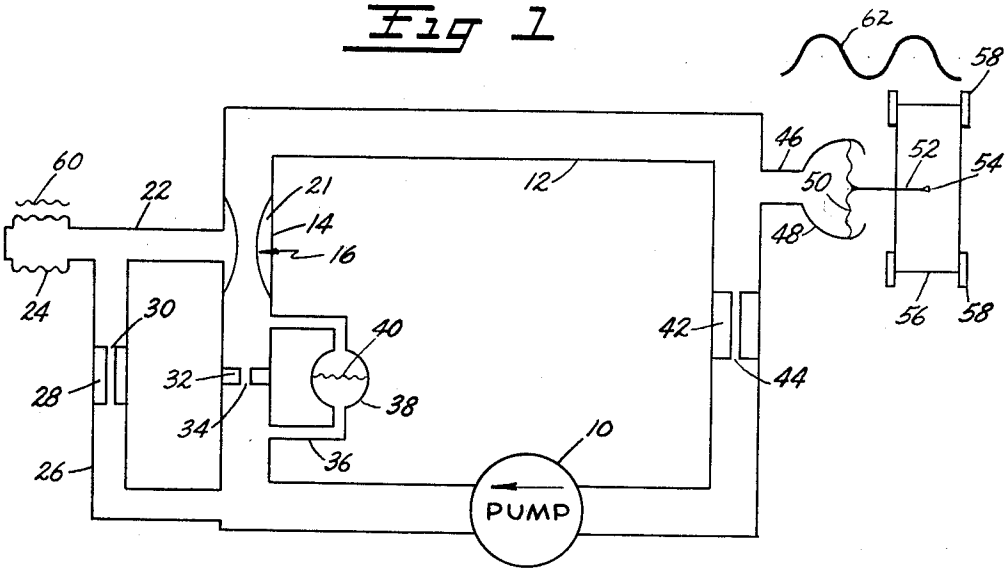


Fig 2

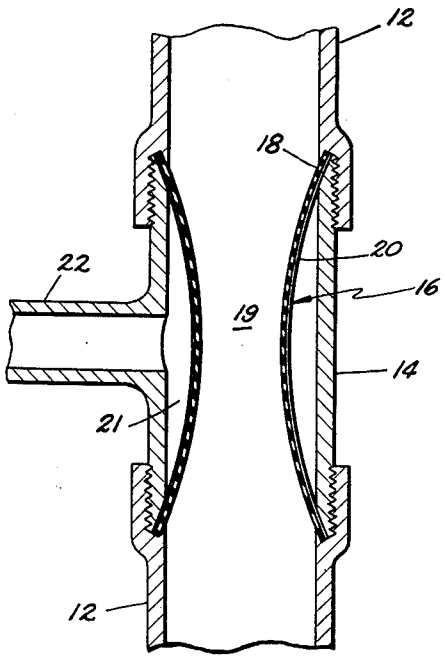
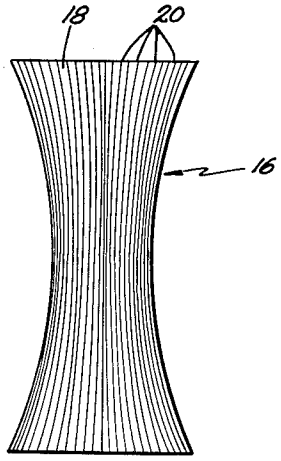


Fig 3



INVENTOR.
HOWARD A. BALDWIN
BY
Meyers & Peterson
ATTORNEYS

United States Patent Office 3,078,675 Patented Feb. 26, 1963

3,078,675

FLUID AMPLIFIER SYSTEM

Howard A. Baldwin, Tucson, Ariz., assignor to Arizona Research Foundation, Inc., a corporation of Arizona

Filed Nov. 2, 1961, Ser. No. 149,753
6 Claims. (Cl. 60—52)

This invention relates to improved hydraulic or pneumatic amplifiers, the term "fluid" hereinafter being used in a generic sense covering both of these general types of amplifiers.

Due to the widespread use of servomechanisms, various attempts have been employed in an effort to improve hydraulic and pneumatic amplifiers. While many of the amplifier systems that have been devised have proved to be generally satisfactory, nonetheless a number of these prior art systems have been quite complex and have involved pistons and various mechanical linkages that have introduced inertia problems and have rendered the systems unduly complex.

Accordingly, one object of the present invention is to provide a fluid amplifier that is quite simple, yet which will give very satisfactory results, especially with repect to the production of an amplified signal that will be in accordance with the input or control signal. The invention also has for an aim the provision of a system possessing a relatively low amplitude distortion. Still further, the present amplifier system provides a relatively large amount of amplification. It is also within the purview of the invention to provide an amplifier system that is quite sensitive, the envisaged system utilizing a thin membrane that will be responsive to small fluctuations or changes in the input signal.

These and other objects and advantages of this invention will more fully appear from the following description, made in connection with the accompanying drawing, wherein like reference characters refer to the same or similar parts throughout the several views and in which:

FIGURE 1 is a schematic representation of one form my invention may assume;

FIGURE 2 is a sectional view illustrating the details of a flexible device constituting a very important part of the invention; and

FIGURE 3 is an elevational detail of the flexible device before installation into the system of FIGURE 1.

Referring now in detail to FIGURE 1, the system that has been selected for exemplifying the present invention includes a pump 10 and a conduit 12 extending from the discharge side of the pump to the intake side thereof. For the sake of simplicity, the conduit 12 has been depicted as being of substantially unitary construction. However, the conduit 12 can be composed of a number of sections. In this regard, attention is now directed to FIGURE 2 where a removable conduit section 14 is shown.

The removable or detachable conduit section 14 is instrumental in holding in place a flexible device denoted generally by the reference numeral 16. The ends of the conduit section 14 are shaped so as to hold the ends of the device 16 in a fluid-tight manner with respect to the ends of the conduit 12 which are threaded so as to receive the conduit section 14.

The flexible device 16 is comprised of a thin tubular membrane 18 having a throat at 19. The tubular membrane 18 is of an elastic material such as natural rubber latex or neoprene of surgical quality. The tubular membrane 18 should be quite thin and the contemplated wall thickness is on the order of 0.002 to 0.006 inch. The device 16 is further comprised of a multiplicity of fine fibers or filaments labeled 20, these fibers or filaments being preferably of nylon or glass and are disposed around the circumference of the elastic membrane

18. Although the various fibers 20 are secured to one surface of the membrane 18, it will be appreciated that these fibers 20 can be embedded in the material constituting the membrane 18. While the number of individual fibers 20, which are relatively inelastic and thus serve as tension members, is susceptible to variation, there will usually be employed several hundred to one-thousand individual fibers. Actually, the specific number of fibers can be varied depending upon the type of amplifier system and the loads that are to be encountered. The important thing to keep in mind is that the membrane 18 is quite elastic, whereas the fibers 20 are relatively inelastic. Hence, the device 16 can be flexed quite readily in a radial direction, yet the fibers 20 prevent distortion in a longitudinal direction. As the description progresses, it will be better appreciated that the specific construction of the device 16 is responsible for an amplified output corresponding closely to the input signal that requires amplification.

It will be observed, especially from FIGURE 2, that the elastic membrane 18 forms a region 21 with the conduit section 14. Leading into this region 21 is a laterally directed conduit 22 having communication with a pressure responsive device, such as a bellows labeled 24. The bellows 24 can be responsive to many different conditions. For instance, it can be deemed to be responsive to air velocity, pressure changes within a room, pressure within an enclosed chemical processing vat, and many other conditions where a record or control thereof is desired.

In the illustrated situation, an auxiliary conduit 26 extends from the discharge side of the pump 10 and has disposed therein a constriction member 28 forming a small passage or orifice 30. Thus, the variations in pressure picked up by the bellows 24 are superposed upon the pressure derived from the constriction device 28.

A second constriction member 32 is placed in the conduit 12 just before the flexible device 16, this constriction member having an orifice 34 therein. Paralleling the constriction device 32 is an auxiliary conduit 36 leading to a chamber 38 having a flexible diaphragm 40 located therein. The constriction member 32 and the diaphragm 40 act as a filter arrangement to minimize any pulsations in the discharge from the pump 10.

Still another constriction member 42 is placed in the down-stream portion of the conduit 12, this particular member having an orifice 44. Thus, restriction to flow is provided at a point before the intake to the pump 10.

Between the flexible device 16 and the constriction member 42 is a laterally extending take-off conduit 46 leading to a chamber 48 having a flexible diaphragm 50 extending thereacross. The diaphragm 50 moves in accordance with the amplified signal, and while it can perform various tasks, for the sake of simplicity it is shown as actuating an arm 52 carrying at one end thereof a stylus 54. The stylus 54 marks a moving record 56 wound on a pair of rollers 58.

Therefore, if a fluctuating pressure is applied to the bellows 24, such as that denoted by the waveform 60, an amplified waveform at the flexible diaphragm 50 will result, this output waveform having been denoted by the reference numeral 62. Because the frequency response is a function of the velocity of the liquid or gas being pumped through the system, the invention will also find utility in the amplification of frequencies in the audio range with an A.-C. power gain.

Having presented the foregoing information, it is believed that an understanding of the manner in which my amplifier system functions will be readily understood from the ensuing operational sequence. With the pump 10 in operation, it will be appreciated that a flow of fluid occurs through the orifice 34 and passes through the throat 19 of the flexible device 16. Owing to the fibers 20, the thin tubular membrane 18 is not moved or carried in a

longitudinal direction with the flow of fluid. However, because of the high flexibility of the membrane 18 in a radial direction, the throat 19 can be easily made to assume various diameters.

Accordingly, the signal 60 which is conveyed via the conduit 22 to the region 21 will cause the diameter of the throat 19 to vary in accordance with the fluctuations of the signal 60. When the signal 60 increases, then the throat 19 will become more constricted and will provide more resistance to fluid flow through the flexible device 16.

The variations thus produced at the device 16 will be reflected in what occurs at the flexible diaphragm 50. When the flow has been restricted by reason of a constriction of the throat 19 then the pressure impressed upon the diaphragm 50 will be lessened and there will be a relative movement of the stylus 54 to the left as viewed in FIGURE 1. On the other hand, when there is a decrease in pressure of the signal 60, there will be an increase in pressure at the diaphragm 50 and the stylus 54 will be moved to the right.

Consequently, the waveform 62 varies in magnitude with respect to the waveform 60, although it is out of phase with the input signal. The power gain from my fluid amplifier system is dependent upon the work required to change the size of the throat 19 compared to the resulting pressure-volume variation that is occasioned by the fluid passing through the throat of the device 16. The point to be appreciated, though, is that the output signal or waveform 62 does have a magnitude which is in accordance at any given moment with the magnitude of the signal 60. The amplified signal 62 is therefore available for a variety of purposes, depending largely upon the particular application to which my amplifier system is put.

It will, of course, be understood that various changes may be made in the form, details, arrangements and proportions of the parts without departing from the scope of my invention as set forth in the appended claims.

What is claimed:

1. A fluid amplifier system comprising a rigid conduit, a thin tubular membrane of elastic material having a plurality of relatively inelastic fibers extending axially along said tubular membrane and secured thereto substantially throughout their entire length, respective means anchoring the ends of said tubular membrane to spaced locations within said conduit in a fluid-tight manner, means for forcing fluid under pressure through a throat of said tubular membrane, and means for introducing a control fluid under pressure into a region between said conduit and said tubular membrane to constrict the cross section of said tubular membrane in accordance with said control pressure to thereby produce an amplified pressure signal in said conduit representative of said control pressure.

2. A fluid amplifier system comprising a pump, conduit means extending from the discharge side of the pump to the intake side thereof, a thin tubular membrane of elastic material disposed in one portion of said conduit means and having its ends anchored in a fluid-tight manner to the interior of said conduit means so that fluid from said pump flows through a throat of said tubular membrane, said tubular membrane having a plurality of relatively inelastic fibers secured to and extending axially along one surface thereof, means for introducing a pressure signal to be amplified into a region between said conduit means and said tubular membrane to constrict the cross section of the throat of said membrane in accordance with variations in said pressure signal, and means connected to said conduit means after said tubular membrane for sensing changes in pressure due to changes in said signal.

3. A fluid amplifier system in accordance with claim 2 including a first rigid constriction means in said conduit means located between said pump and said tubular membrane and a flexible diaphragm means paralleling said diaphragm.

4. A fluid amplifier system in accordance with claim 3 including a second rigid constriction means in said conduit means located between said sensing means and said pump.

5. A fluid amplifier system in accordance with claim 4 including auxiliary conduit means connected to said conduit means at a point between said pump and said first constriction means and extending to a point between said signal means and said region between said conduit means and said tubular membrane.

6. A fluid amplifier system in accordance with claim 2 including a load device connected to said sensing means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,372,393	Ray	Mar. 27, 1945
2,895,505	Bachus	July 21, 1959
2,982,511	Connor	May 2, 1961