

- [54] **PRESSURE-MEDIUM OPERATED
RECTANGULAR WAVE GENERATOR**
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[58] **Field of Search**..... 137/81.5;
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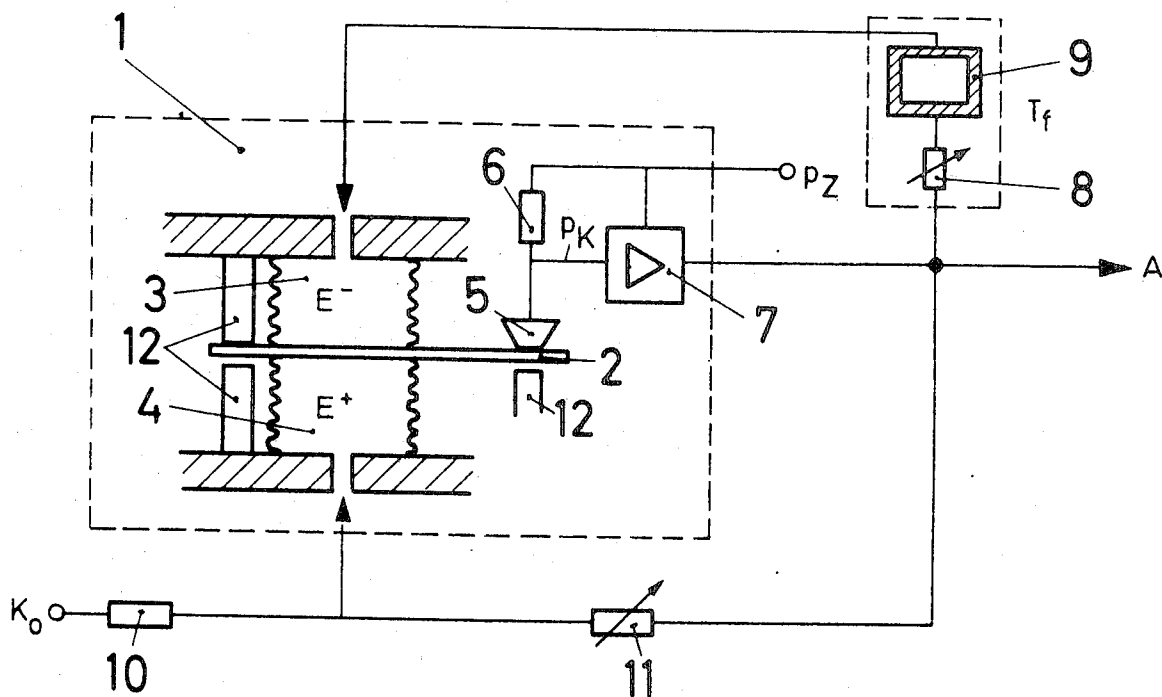
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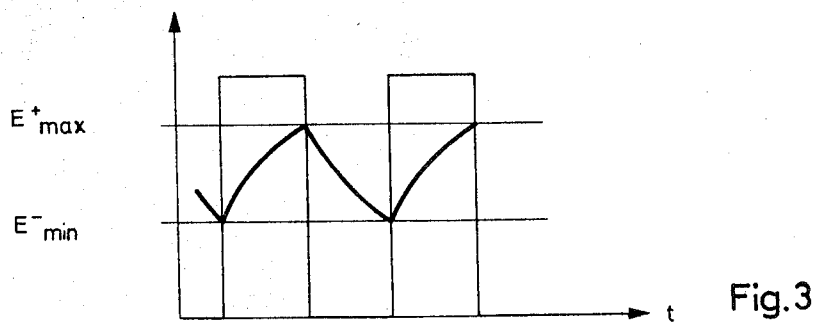
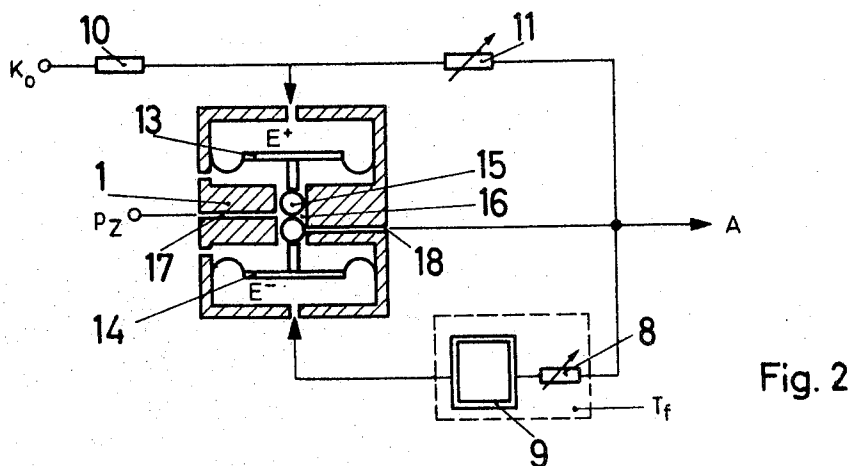
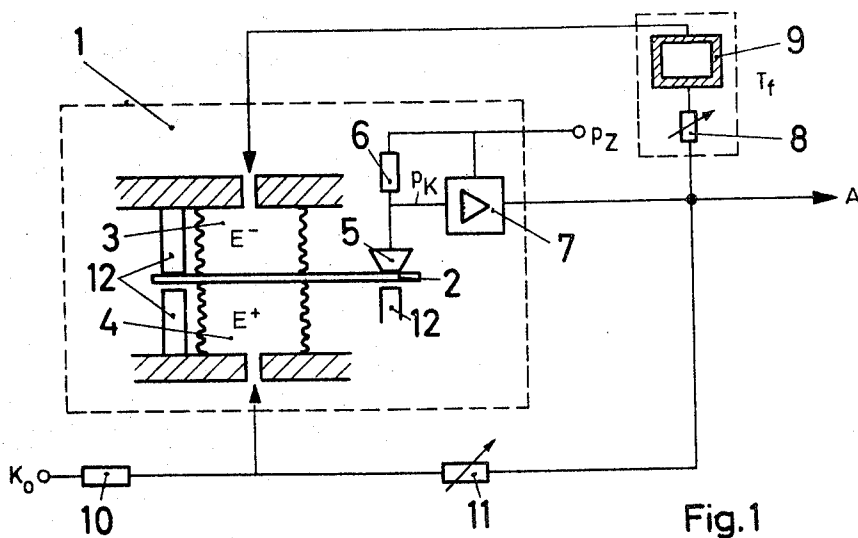
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- [57]
- ABSTRACT**

A pneumatic rectangular wave generator including a differential pressure amplifier, one input pressure of which is derived from a pressure divider and the other input pressure is derived from the output pressure delayed by a timing element.

15 Claims, 3 Drawing Figures





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PRESSURE-MEDIUM OPERATED RECTANGULAR WAVE GENERATOR

This invention relates to an apparatus operated with compressed air for the generation of oscillations in the form of rectangular pneumatic pressure impulses, wherein the frequency of the oscillation is adjustable.

Such rectangular oscillations are required, for example, for testing the operational safety of pneumatic devices by means of a specific number of load changes.

A conventional apparatus of this type has a rotating cam disk driven by an electric motor. This cam disk periodically interrupts the air stream between a discharge jet nozzle and a mixing or collecting nozzle arrangement. In case the air stream is interrupted, no pressure signal appears at the output of the apparatus. In case the rotating cam disk leaves a free path between the discharge and mixing nozzles, a pressure signal occurs at the output, which signal is derived from an amplifier. In place of the discharge-mixing nozzle, it is also possible to utilize an outlet nozzle fed with compressed air via an input throttle. In this case, the cam disk serves as a baffle plate. The instants of turning on and turning off of the pressure are determined by the shape of the cam disk and the number of revolutions thereof. The cost of the structural components and the space requirements are high in this conventional arrangement.

The invention has the objective of providing a simple, compact, and safely operating apparatus for the generation of pneumatic rectangular oscillations.

This objective is attained by providing a differential pressure amplifier, the input pressure E^+ of which is derived from a pressure divider under the effect of the control pressure K_0 and the output pressure A of the differential pressure amplifier, the input pressure E^- of which is constituted by the output pressure A delayed by a timing element T_f .

The space requirement is reduced if the E^- input pressure chamber of the differential pressure amplifier serves as the volume (storage element) of the timing element T_f and the throttle resistors of the pressure divider and that of the timing element T_f (throttle storage element) are disposed in the housing of the differential pressure amplifier.

Furthermore, the provision is made to fashion at least one throttle resistor of the pressure divider so that it is adjustable, which may be provided by a needle valve.

The invention provides two embodiments for the differential pressure amplifier. Two elastic walls in the form of spring bellows defining on one side two input pressure chambers rest on a bottom section serving as the baffle plate for controlling a nozzle-baffle system. The cascade pressure p_K , amplified by an amplifier, forms the output pressure A of the differential pressure amplifier.

A particularly space-saving arrangement is obtained by employing the differential pressure amplifier disclosed in my copending Application, Ser. No. 84,630, filed Oct. 28, 1970, now U.S. Pat. No. 3,682,199, wherein two elastic walls are in operative connection with two balls of identical diameter displaceably arranged in a bore of constant diameter and wherein, in a conventional manner, a feed duct for the compressed air is disposed in alignment with the contact point of the balls, and wherein at least one outlet duct is provided terminating at a spacing of one-half the ball diameter from the feed duct into the bore.

The invention will be explained in greater detail with reference to the accompanying drawing, wherein:

FIG. 1 is a schematic diagram of a rectangular wave oscillation generator with a differential pressure amplifier,

FIG. 2 is a schematic diagram of a rectangular wave generator using the differential amplifier according to copending U.S. application Ser. No. 84,630, now U.S. Pat. No. 3,682,199, and

FIG. 3 is an illustration of the pressure curve at the input and output of the amplifier.

In FIG. 1, the differential pressure amplifier 1 includes a support piece 2 fashioned as a baffle plate, on which the spring bellows 3 and 4 rest. The baffle plate 2 closes and opens the discharge nozzle 5 which is in communication, via the input throttle 6, with the air supply duct p_z . The cascade pressure p_K is fed to the amplifier 7, the output pressure of the latter forming the output signal A of the generator. The output pressure A is fed, via the timing element T_f , consisting of the adjustable throttle resistor 8 and the chamber 9, to the E^- input pressure chamber of the differential pressure amplifier 1, this pressure chamber being defined by the spring bellows 3. The E^+ input pressure, applied to the chamber defined by the spring bellows 4, is derived from a pressure divider formed by the throttle resistors 10 and 11. The pressure K_0 is applied to the resistor 10, and the output pressure A is applied to the resistor 11 which can be fashioned as a needle valve. The stroke of the bottom section 2 is limited by the stop 12.

In FIG. 1, when the baffle plate 2 keeps the discharge nozzle closed, the amplifier 7 is fully driven and the output pressure A reaches the maximum value p_z . In this case, the pressure p_z and the pressure K_0 are present at either side of the pressure divider. Assuming that the flow Q of compressed air through a throttle resistor is proportional to the applied pressure difference, the following results for the pressure E^+ in accordance with the pressure divider equation:

$$E^+ = (1/1 + \lambda) p_z + (\lambda/1 + \lambda) K_0$$

wherein λ is the ratio of the throttle resistors. If K_0 is adjusted to the value $p_z/2$, and the throttle resistances are equally large, then the following value is obtained for E^+ :

$$E^+ = \frac{3}{4} p_z = E^+_{max}$$

$$\lambda = 1 \quad K_0 = p_z/2$$

The output pressure A is likewise present at the resistor of the timing element T_f . Therefore, the pressure E^- rises with respect to time in accordance with an e -function to this pressure A . Once E^- has attained the value of E^+_{max} , the baffle plate is lifted off the discharge nozzle and the output pressure A drops. This pressure drop affects, without any time delay, the E^+ input pressure via the pressure divider. E^+ also drops simultaneously with A . The timing element T_f , however, prevents that E^- drops. Therefore, $E^- > E^+$ and the amplifier is controlled from $A = p_z$ to $A = p_0$ (atmospheric pressure). According to the pressure divider equation, the following value is now attained for E^+ :

$$E^+_{min} = (\lambda/1 + \lambda) K_0 = \frac{1}{4} p_z$$

The pressure E^- drops with respect to time in accordance with an e -function. Once E^- reaches the value of E^+_{min} , the baffle plate approaches the nozzle 5, the out-

put pressure A rises and controls the amplifier, via the pressure E^+ , so that A varies from $A = 0$ to $A = p_z$.

The embodiment according to FIG. 2 uses the differential pressure amplifier according to my copending U.S. application, Ser. No. 84,630 exhibiting a closed type of construction. The diaphragms 13 and 14 are in operative connection with the balls 15 displaceably arranged in the bore 16. The supply duct 17 for the compressed air lies in alignment with the contact point of the balls, and the outlet duct 18 terminates in the bore 16 at a spacing of one-half the ball diameter.

FIG. 3 shows the chronological characteristic of the pressures. The output pressure A surges from atmospheric pressure p_0 to the supply air pressure p_z once the pressure E^- , dropping in accordance with an e-function, has reached the value E^+_{min} . The pressure E^- rises in accordance with an e-function and moves toward the value $A = p_z$. Once E^- has reached the value E^+_{max} , A surges back from p_z to p_0 . The frequency of the rectangular generator is determined by the timing element T_f , the time constant of which is adjustable at the throttle resistor 8. The pressure K_0 and the resistance ratio λ of the pressure divider 10, 11 determine the magnitude of the input pressure E^+ .

I claim:

1. Pneumatic rectangular wave generator comprising a differential pressure amplifier having first and second inputs and an output, a pressure divider including at least first and second throttle resistors connected in series between a source pressure and said output of said amplifier, the point of connection of said throttle resistors being connected to said first input of said amplifier, and a delay element connecting the output of said amplifier to said second input thereof.

2. Pneumatic rectangular wave generator as defined in claim 1 wherein at least one of said first and second throttle resistors is adjustable.

3. Pneumatic rectangular wave generator as defined in claim 1 wherein said differential pressure amplifier includes first and second pressure chambers associated with said first and second inputs, said delay element having a chamber which is built into said second pressure chamber of said amplifier.

4. Pneumatic rectangular wave generator as defined in claim 3 wherein said first and second throttle resistors of said divider are disposed within said differential pressure amplifier.

5. Pneumatic rectangular wave generator as defined in claim 1 wherein said differential pressure amplifier includes first and second pressure chambers defined by elastic walls and joined by a baffle plate displaceable in response to the differential pressure in said first and second pressure chambers, and a nozzle disposed adjacent said baffle plate and connected to a source of pressure so that the pressure from said nozzle is regulated by said baffle plate, and a pressure amplifier connected to the input of said nozzle and providing an output which serves as the output of said differential pressure amplifier.

6. Pneumatic rectangular wave generator as defined in claim 5 wherein at least one of said first and second throttle resistors is adjustable.

7. Pneumatic rectangular wave generator comprising a differential pressure amplifier having first and second inputs and an output, a pressure divider including at

least first and second throttle resistors connected in series between a source pressure and said output of said amplifier, the point of connection of said throttle resistors being connected to said first input of said amplifier, and a delay element connecting the output of said amplifier to said second input thereof, wherein said differential pressure amplifier includes first and second pressure chambers defined by elastic walls, first and second balls of identical diameter displaceably arranged in the bore of a housing, said balls being operatively connected to the elastic wall of a respective one of said first and second pressure chambers so as to be displaced by movement thereof, said housing being provided with a pair of output bores spaced by the diameter of the balls and in alignment so as to be valved by said balls and an input bore providing said input pressure to said balls for application to said output bores in a controlled manner.

8. Pneumatic rectangular wave generator as defined in claim 7 wherein at least one of said first and second throttle resistors is adjustable.

9. Pneumatic rectangular wave generator comprising a differential pressure amplifier having first and second inputs and a single output, a pressure divider including at least first and second throttle resistors connected in series, a pressure source for applying pressure to said first throttle resistor, said output of said amplifier applying pressure to said second throttle resistor, and the point of connection of said throttle resistors being connected to said first input of said amplifier, and a timing delay element connecting the output of said amplifier to said second input for applying pressure to said second input as a function of said output pressure.

10. Pneumatic rectangular wave generator as defined in claim 9, wherein at least one of said first and second throttle resistors is adjustable.

11. Pneumatic rectangular wave generator as defined in claim 9, wherein said timing delay element is responsive only to said output pressure.

12. Pneumatic rectangular wave generator as defined in claim 9, wherein said differential pressure amplifier includes first and second pressure chambers associated with said first and second inputs, said delay element having a chamber which is built into said second pressure chamber of said amplifier.

13. Pneumatic rectangular wave generator as defined in claim 12, wherein said first and second throttle resistors of said divider are disposed within said differential pressure amplifier.

14. Pneumatic rectangular wave generator as defined in claim 9, wherein said differential pressure amplifier includes first and second pressure chambers defined by elastic walls and joined by a baffle plate displaceable in response to the differential pressure in said first and second pressure chambers, and a nozzle disposed adjacent said baffle plate and connected to a source of pressure so that the pressure from said nozzle is regulated by said baffle plate, and a pressure amplifier connected to the input of said nozzle and providing an output which serves as the output of said differential pressure amplifier.

15. Pneumatic rectangular wave generator as defined in claim 14, wherein at least one of said first and second throttle resistors is adjustable.

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