DIFFERENTIAL PNEUMATIC AMPLIFIER WITH ADJUSTABLE GAIN

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Fig. 1

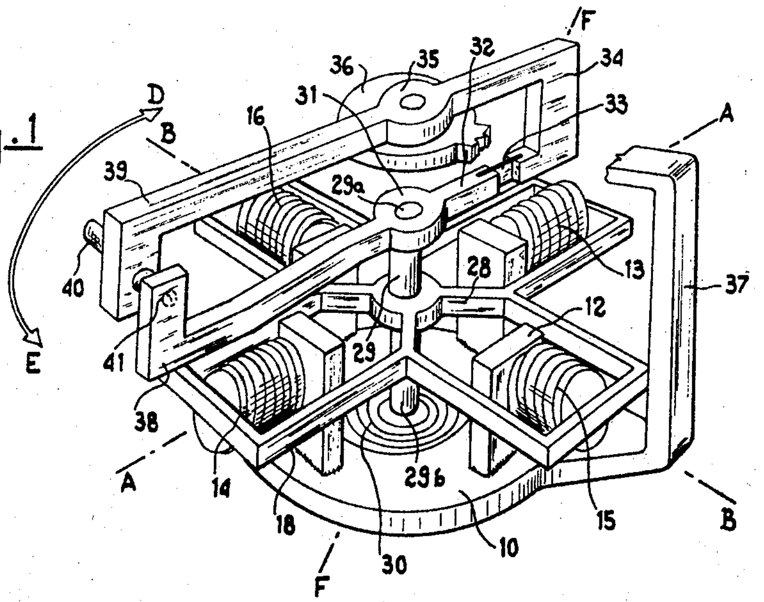

Fig. 2

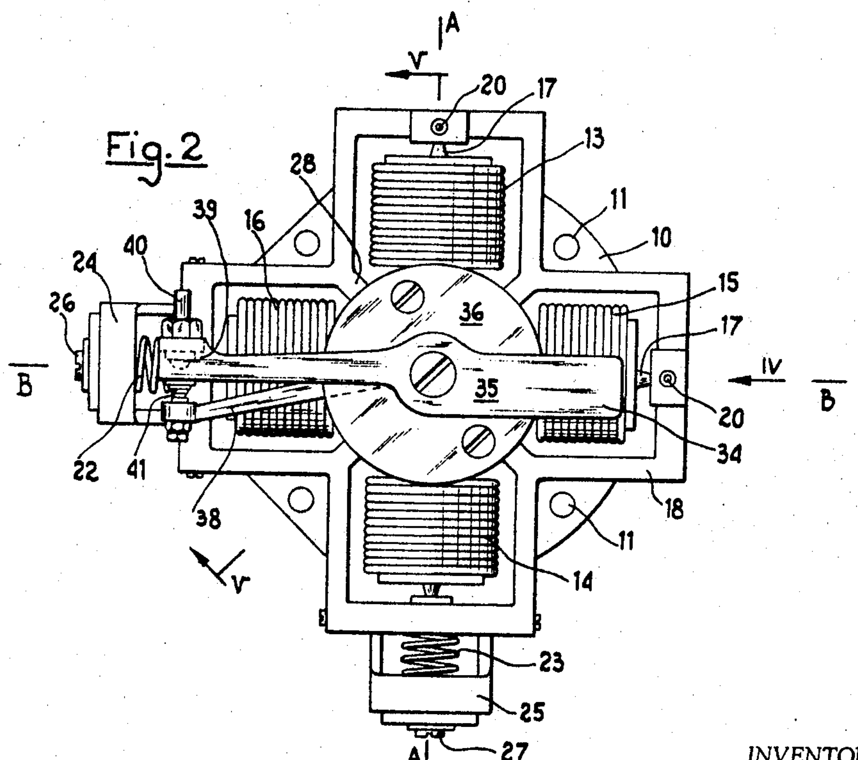

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Fig. 3

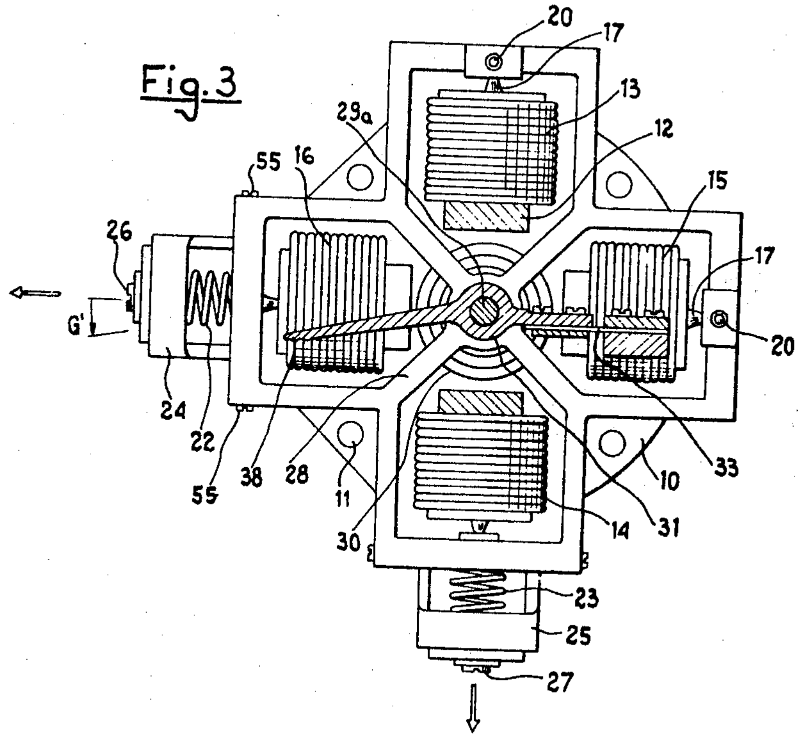

Fig. 4

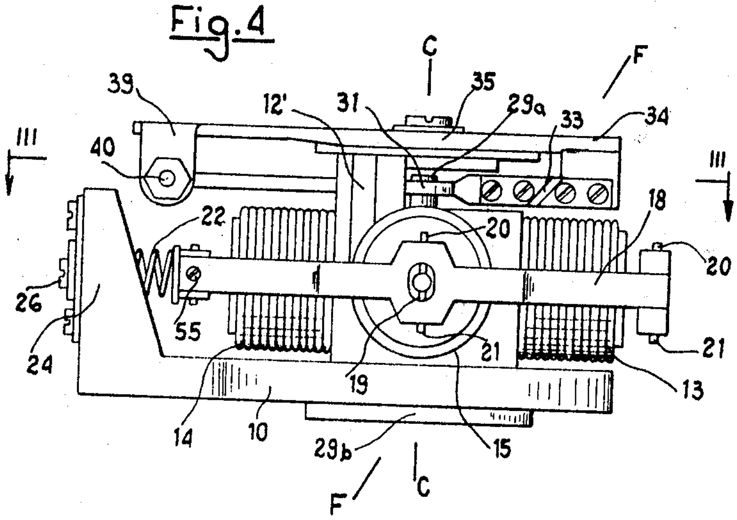

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Fig. 5

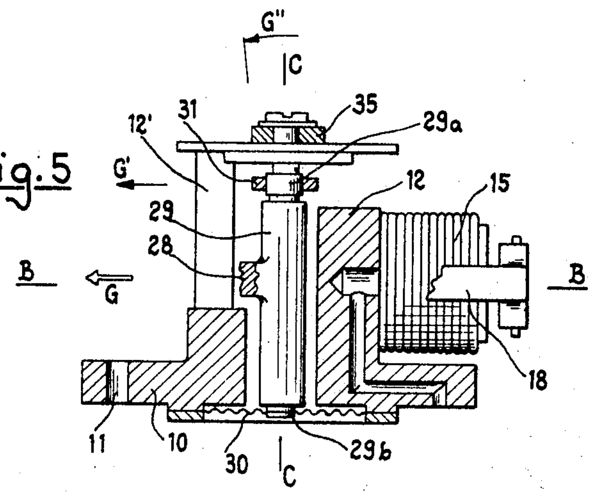
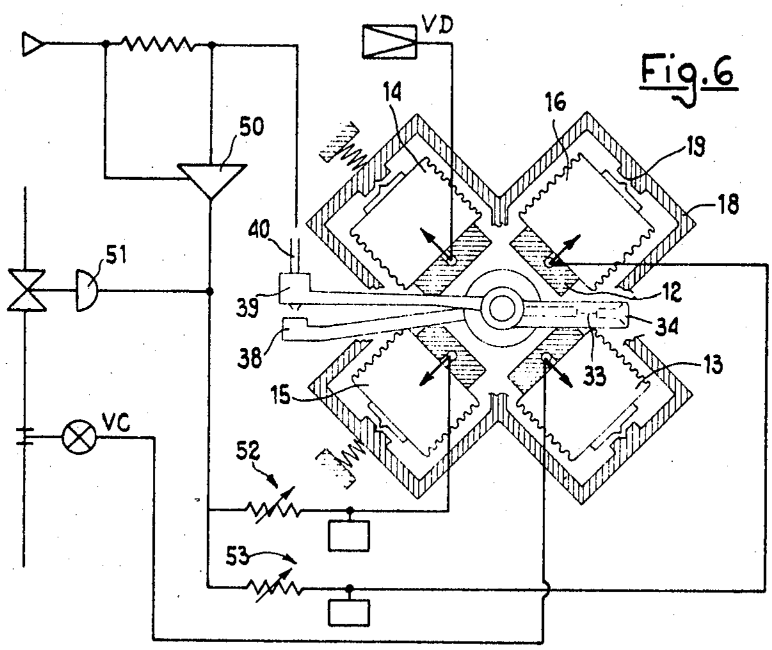


Fig. 6



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DIFFERENTIAL PNEUMATIC AMPLIFIER WITH ADJUSTABLE GAIN

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U.S. Cl. 137—86 8 Claims

ABSTRACT OF THE DISCLOSURE

An adjustable gain pneumatic amplifier includes a base supporting four bellows arranged in two pairs, the bellows of each pair being coaxial and in opposition to each other, and the bellows being spaced at 90° intervals. A rod has one end secured pivotally but non-rotatably to the base and has an outer end forming a pivot. A rigid structure is operatively engaged with the movable ends of all of the bellows and is connected to the rod intermediate its ends. The pivot end of the rod thus has a movement which is amplified with respect to the movement of such rigid structure. A modulating structure is angularly adjustably mounted on the pivot end of the rod and is adjustable between limiting positions each defined by the axis of a respective pair of bellows. The modulating system includes one rigid element which is adjustable about an axis fixed with respect to the base and coincident with the axis of the rod in the neutral position of the latter, and includes a second rigid element which is adjustable about the pivot end of the rod and has one end connected by a flexible link to the first-mentioned element. The opposite ends of the first and second elements carry the modulating means comprising a nozzle and a baffle plate positioned adjacent the discharge end of the nozzle. Adjustment means are provided for adjusting the vertical and horizontal orientations of the respective pairs of nozzles.

This invention generally concerns the technology of pneumatic devices by which the difference between two pneumatic signals can be steplessly amplified, with a pre-established gain, in the range from zero up to a maximum value. Such devices known in the art as "differential amplifiers," though their application is not restricted to mere amplification purposes, but covers a wide range of actions and operations of regulation, calculus, integration, derivation and so on, on the basis of detection of a difference between two pneumatic signals.

The main object of this invention is the provision of a differential pneumatic amplifier with adjustable gain, allowing the attainment of unusually high values of intrinsic gain, or in open circuit. At any rate, the amplifier of the invention has the most favourable features of sensitivity to differences and changes in the differences between the two applied pneumatic signals.

Another object of the invention is the provision of a differential pneumatic amplifier allowing, in addition to the above specified and further advantageous features, an unusually wide range of applications, in particular when associated with suitable connections, whereby it can be utilized, e.g. for the automatic regulation of variables (e.g. pressure, delivery, temperature and other variables), or as an arithmetical calculation unit for addition and/or the subtraction, multiplication and division of a number of pneumatic signals, as well as for more complex opera-

tions, such as the integration and derivation of pneumatic signals.

Another object of the invention consists in the provision of a differential pneumatic amplifier having the above-stated features, and fitted with regulation, adjustment and tuning-up means such as to allow a concrete realization thereof without being obliged to resort to highly complex and expensive manufacturing processes. A further object is to provide such an amplifier allowing correction compensation, within wide limits, of possible machining faults and tolerances, as well as allowing, in addition, the same amplifier to be used to achieve particular effects from the pneumatic signals that are applied thereto.

The differential amplifier according to the invention is essentially of the type having coaxially fitted pairs of means, set in opposition to one another, and in particular variable volume chambers such as bellows, small lungs or the like, located at 90 degs. with each other. Such pairs are responsive to an inlet pressure and to a counter-reaction pressure. The differential amplifier includes movable devices that are associated with said pairs of means in such a manner as to be acted upon by a force proportional to resolution of forces produced by the applied signals with adjustability of gain obtained by the orientation of the axis of a fulcrum, relative to axes along which said forces are operating.

A particular object of this invention is the provision of a differential amplifier by which all drawbacks and restrictions, inherently shown by similar devices already known in the art, are wholly obviated.

According to the invention, the differential amplifier is characterized in that the pneumatic elements are coupled coaxially in pairs, with the elements of each pair opposing each other, on two axes which substantially define a common plane. The forces produced by the input and counter-reaction signals occur in this plane and perpendicularly to each other, and all the forces act on a single, essentially rigid structural element that is connected with a member, preferably a rod, whose central portion is perpendicular to this plane. This rod extends through the intersection of the two axes. One end of this rod is pivotally connected with a fulcrum point in such a manner as to allow the rod to be swung, but not rotated, relative to a fixed point lying on a plane remote from the plane of said axes. Thus, any stress originating from a difference between the pressures as applied to componnets of said pairs, results in a moment that tends to incline the rod, which is pivotally connected with the fixed point in the plane of the vectorial resultant of forces which are produced by the differences as detected along the two action axes of pairs of elements.

According to a preferred embodiment form of the invention, the opposite end of the rod is connected, in turn, with a further rod-like shaped element or brace. The latter element is also pivotally connected, at a point spaced radially a substantial distance from the axis defined by the middle or neutral position of the rod, with a structure that can be controlledly turned on such axis, whereby the opposite rod end is caused to perform exclusively a rotary motion in space, around the axis, as defined by the straight line connecting the fulcrum and the pivotal connection point. As can be readily appreciated, such axis, together with the angular adjustment axis of the structure, defines a plane in which the angular adjustment axis lies in all cases. However, due to the angular adjustment of the structure, this plane can be oriented at different angles, adjustable at will, with respect to the axes of application of forces of the pairs of elements.

The modulating system is preferably carried by the end of the brace opposite to the pivotally connected end thereof, and by a component of the angularly adjustable structure.

Thus, two very important technical and functional features are shown by the device according to the invention, namely:

By turning the structure, the conditions under which the rod is mechanically connected with the stationary structure of device are modified, due to the fact that the rod end can be moved in space only around the axis defined by the straight line joining the fulcrum point and the pivotal connection point;

By means of a suitable relative positioning of the different fulcrum-stress application and pivotal connection points, it is possible to obtain a large mechanical amplification of the motions of the structural component which is acted upon by the elements responsive to input signals.

Thus, by minimizing the deformations of the component, the intrinsic gain is increased, and the parasitic elastic resistances, by which an error in the output signal might be caused, are reduced to negligible values.

The differential pneumatic amplifiers according to the invention can be practically realized by having recourse to different constructional solutions, whereby the particular differential pneumatic amplifier, which will be described in detail hereinafter, shall be considered as one of the possible ways in which the invention can be carried into practice, the invention being in no ways limited thereto. Reference will be made, in the course of the following description, to the accompanying drawings, wherein:

FIG. 1 is a somewhat diagrammatic perspective view of the main components of an adjustable gain differential amplifier embodying the invention, the parts being shown in one limiting position of adjustability.

FIG. 2 is a plan view of the amplifier according to the invention, with minor constructional details omitted.

FIG. 3 is a plan view and a fragmentary section, taken on the plane III—III of FIG. 4, of the amplifier.

FIG. 4 is a side view of the amplifier in the direction of the arrow IV in the FIG. 2.

FIG. 5 is a fragmentary section, taken on the foreshortened plane V—V of FIG. 2, of the amplifier.

FIG. 6 schematically illustrates the essential components of the amplifier in connection with representative pneumatic means, thus illustrating examples of application of the amplifier of the invention.

As shown in the FIGS. 1 to 5, the differential amplifier comprises a stationary body or base **10**, having suitably located holes **11**, that allow the auxiliary elements, comprising the pneumatic circuits to be fastened thereto. Base **10** is formed with upwardly projecting arms or the like **12**, to which the signal responsive elements are secured. These elements comprise bellows **13–16**, extending radially in the same horizontal plane, and spaced at 90 degs. from each other. Thus, the bellows are arranged in pairs **13–14** and **15–16**, with the two bellows in each pair located coaxially opposite with each other, thereby defining the axes A—A and B—B (see FIG. 1), that lie in the same horizontal plane and are perpendicular to each other.

A movable structural element, indicated as a whole at **18**, is acted upon, preferably through the medium of pins **17** or other swingable biasing means, by the end of each bellows opposite to that by which the associated bellows is connected with an arm **12** of base **10**. Element **18** is preferably shaped in such a manner as to extend around each bellows. Pins **17** are preferably designed to act upon cups **19** (see FIG. 4), that can be vertically adjusted by means of the screws **20, 21**, as well as upon cups similar to cups **19**, but diametrally opposite thereto, and that can be horizontally adjusted by means of the screws **55** (see FIG. 3). Obviously, recourse might be had also to other suitable means to ensure an even transmission of forces in the direction of the axes of the bellows, without inducing bending stresses, or moments, between the different components.

Adjusting springs **22** and **23**, which are coaxial with the respective axes B—B and A—A, have inner ends engaged with the element **18**, as best seen in FIG. 2. Such springs react against fixed extensions **24** and **25** of stationary base body **10**, and their calibration can be changed at will by respective adjusting screws **26** and **27**.

Movable structural element **18** is connected, e.g. by means of a spider-shaped central section **28**, with a rod **29**, whose axis, when rod **29** is in its neutral position corresponding to the balance of all forces, is perpendicular to the plane defined by axes A—A and B—B, and extends through the intersection of these axes.

The lower end **29*b*** of rod **29** is pivotally connected with a fulcrum point at the center of stationary base body **10**, in such a manner as to allow rod **29** to be swung, but not rotated. Such particular connection is preferably obtained by means of a membrane **30**, as shown in FIG. 5. As can be noticed in the same figure, the connection point **29*b*** is at a level higher than the plane defined by axes A—A and B—B, and which plane is indicated by the line B—B in FIG. 5. Thus, any force applied to movable structure **28**, in this plane, will tend to swing rod **29** around its fulcrum at **29*b***, and in the direction defined by the resultant of the forces in such plane.

The upper end **29*a*** of rod **29** forms a bearing rotatably engaged in an intermediate portion **31** of a rod-like component or brace **32–38** having two arms, and which is thus angularly adjustable about the axis of rod **29**. One arm **32** of the brace is hingedly connected, preferably by means of a short elastic blade **33** and at a point spaced at a substantial distance radially from the upper end **29*a*** of rod **29**, to an arm **34** of a structure **35**. Structure **35** is supported by a structural element **36** in such a manner as to be angularly adjustable about the vertical axis C—C, which is coincident with the axis of rod **29** when rod **29** is in its middle or neutral position. Element **36** is rigidly connected with the base structure **10** (such rigid connection is shown in the FIG. 1, by way of example only, as comprising an outer structure **37**). However, such connection may be made in practice by extending upwardly one or more of the arms **12** of base body **10**, as shown by numeral **12′** in the FIGURES 4 and 5.

The modulator system or element of the pneumatic amplifier is supported by the second arm **38** of brace **32—32–38**, and by the opposite arm **39** of rotary structure **35**. Such system may consist, according to an already known technical solution, of a nozzle **40**, that cooperates with a baffle plate **41** located opposite thereto.

The structure **35** can be angularly adjusted in either direction, as indicated by D–E in FIG. 1, between the two respective directions defined by axes A—A and B—B, and such adjustment of structure **35** obviously results in a similar adjustment of the brace **32, 38**, due to the hinge connection established by the flexible blade **33**. Thus, the hinge connection point, as defined by blade **33**, will always lie in the vertical plane defined by said structure **35** and vertical axis C—C.

Therefore, the upper end **29*a*** of rod **29**, and the intermediate portion **31** of brace **32–38** associated therewith, can be moved in space along an arc of a circle only. The center of such arc is positioned on the straight line F—F connecting the fulcrum point **29** and the hinge connection point **33**. A vertical plane (i.e. a plane perpendicular to the plane defined by axes A—A and B—B) is defined by line F—F and axis C—C. The plane defined by line F—F and axis C—C can be angularly adjusted in either direction, clockwise or counter-clockwise about axis C—C.

As hereinafter used, the term "orientation plane" is intended to signify the plane of the elements **34, 35, 38** and **39** as adjusted angularly, about axis C—C, and between limits defined by the axes A—A and B—B. Such an angular adjustment, effected by the operator of the amplifier, is known from the prior art wherein, however, it is generally effected by adjustment of a nozzle.

The spacing or distance between nozzle **40** and the surface of baffle or flap member **41** can be varied only by a force which is not directed in the orientation plane, that is, the force must have a component perpendicular to the orientation plane. Such adjustment is known in the art and is shown, for example, in Weiss et al. U.S. Patent No. 3,090,395. However, in the Weiss et al. patent, the components of the plane of the nozzle are adjusted. In both Weiss et al. and the present invention, the adjustment is effected by adjusting the nozzle about the axis of the star-shaped bellows arrangement.

In the invention amplifier, brace **38** cannot be actually rotated about axis C—C, but it is pivotally connected by link **33** to part **34**, and is connected, at the end **29*a***, to rod **29**. Rod **29**, in turn, is pivotally connected at its end **29*b*** to the stationary base **10**. Consequently, point **29*a*** is common both to brace **32–38** and to rod **29**, and the two pivotal connections, at **33** and at **29*b***, conjointly define the axis F—F about which point **29*a*** and brace **32–38** can be swung upon motion of rod **29** effected by the bellows through the components **18** and **28**. As a matter of fact, the motion of interest is the one causing a variation of the spacing of nozzle **40** from the baffle **41** and this movement effects such variation of such spacing.

Conversely, end **29*a*** of rod **29** can be shifted by any force having a component normal to the orientation plane. Thus, as shown in the FIG. 5, should the movable structure **18** be acted upon by a force G perpendicular to the orientation plane rod **29** would be swung to the left by such force, with consequent shifting, in the direction G′, of its upper end **29*a***. Such shifting is amplified in the ratio of the distance between ends **29*a*** and **29*b*** of rod **29** to the distance between point **28**, wherein the force is applied to rod **29**, and the fulcrum point **29*b***.

Brace **32–38**, carrying the baffle **41**, is pivotally connected, at link **33**, to the angularly adjustable rigid structure **34–35–38** carrying the nozzle **40**. Upon motion of the upper part **29*a*** of rod or post **29**, brace **32–38** is subjected to a scissor-like motion relative to the rotatable structure **34–35–38**. Thus, baffle or flap **41** is moved only upon rocking or tilting of post or rod **29**.

With reference to FIGS. 1–4, it should be noted that these figures illustrate the amplifier in one of its limiting positions, namely, generally in the plane of the axis A—A. The other limiting position is when the parts **33**, **29*a*** and **29*b*** are in the plane of axis B—B. In the position shown in the drawings, forces on bellows **13** and **14** cannot exert any rocking force on post **29**, but forces on bellows **15** and **16** can exert a rocking force on this post or rod. The illustrated position corresponds to the upper adjustment limit with respect to the axis B—B. Generally, an adjustable device is operated well within its adjustable limits, and therefore it is sensitive to forces applied to both pairs of bellows.

From what precedes, it can be readily appreciated how the initially stated effects and technical advantages can be obtained by the device according to the invention.

It will be clear that the operation of the amplifier results in a condition of equilibrium being set up between the moments applied to the movable components, and which condition results from the attainment of a balance of forces as transduced by the bellows **13–16**. The condition is that, while these forces can produce a resultant acting on the movable structure **18** and directed in the planes in which lie the axes of the bellows, the moments can be applied only by that component of the resultant, if present, which is normal to the orientation plane of the angularly adjustable structure. Thus, for modulating purposes, the amplifier is responsive only to forces that are exerted normally to the plane wherein the adjustable structure is oriented, meaning exclusively under the conditions where it is intended that the amplifier should operate. FIG. 6 shows an example of the application of the amplifier, with certain elements, generally present in association with such an amplifier, being omitted.

By assuming that a given variable VC, which may be any physical magnitude, as e.g. a pressure, a rate, a temperature or the like, is to be kept at a required constant value VD, the pneumatic signals VC and VD are applied in opposition to respective bellows **13** and **14**, thereby producing diametrically opposing forces, which are vectorially added, and applied to movable structure **18**. The vectorial sum of such forces is applied to rod **29**, thereby inducing the above described moments only as a function of any component lying in a plane normal to the plane of orientation of the angularly adjustable structure. The amplification of the signal is thus a function of the angularly adjusted orientation of such structure.

The signal, as modulated by the nozzle **40**, is fed to an amplifying relay **50**, wherein both the pressure and flow rate of the nozzle are amplified. The output signal from relay **50** is fed (usually through changeover devices, not shown) to regulating device **51**, as well as to a feedback net, of which the bellows **15**, **16** and the units **52**, **53** form part. Each such unit comprises a capacitance and a variable resistor. The bellows **15–16**, respectively, are the negative and positive feedback bellows since the signals acting therein, result in moments, relative to the hinged connection point, defined by spring blade **33**, which respectively tend to bring the flap baffle, or plate **41** away from or nearer to the nozzle **40** of the modulating system.

The gain adjustment is effected by changing the orientation of the plane in which lie the connection points **29*a***, **29*b*** and 33, by adjusting this plane about the axis C—C. Such adjustment results in a change in the resulting lever arm of the forces produced by the input signals acting in the bellows **13** and **14**, limited to the lever arm of the resultant of forces produced by the feedback signals acting in the bellows **15** and **16**. Such gain adjustment is generally conventional.

Obviously the abovedescribed amplifier can be modified and adapted to manifold functions and operating requirements. Thus, it might be operated as a regulator having a proportional action only, by fitting a spring in place of the bellows **16**, which spring is to be calibrated in such a way as to exert a force which is, as a rule, equal to the force exerted by a signal whose pressure is equal to 50% of the variation range. Obviously, the feedback circuit must be modified and directly connected with the feedback bellow **15**. Even in this latter case, the regulator will act as an amplifier, with a gain that can be adjusted in a range from zero up to a maximum value. Since both bellows **13** and **14** have a like useful cross-section, a balance between the moments produced by the signals VD and VC is established when said signals are of like value (or pressure).

Conversely, the spring that is fitted in place of bellows **16**, will produce a moment tending to bring the components of modulating system nearer to, or further way from each other, according to the magnitude of the signal that is fed to negative feedback bellows **15**.

Under such conditions, by adjusting the angularly adjustable structure to a suitable orientation, the responsivity to differences between the signals VD and VC can be modified, due to the abovedescribed relation between the orientation of the angularly adjustable rigid structure, and the moments that can be applied to components thereof.

The device as shown in FIG. 6, or associated with the variable units **52** and **53**, is adapted to operate with an integral action, since the time constant, as defined by the unit **53** inserted in the positive feedback circuit, can be modified in such a way as to obtain the required integration of the input signal error, while a derivative action can be obtained by inserting the variable unit **52** in the negative feedback circuit, in such a manner that this latter will cause an advance effect (derivation of the inlet error signal) by the part of the regulator.

It is, therefore, apparent that the pneumatic amplifier according to the invention can be advantageously utilized as a pneumatic regulator, capable of exerting three actions (namely proportional, integrating and derivative actions) in industrial processes. Moreover, in accordance with the auxiliary devices that can be connected with the amplifier, this latter can be utilized as a regulator having a proportional-integrating, and proportional-derivative action. In addition, by applying to bellows **16** a signal fed from a variable outside source, independent from the regulator output, it is possible to adapt the regulator for a proportional, or a proportional-derivative, action with manual reset.

Moreover, the designs that are shown as examples in the FIGS. 2 to 5, allow many adjustments to be carried-out in the amplifier. In fact, by means of horizontal adjustments **55**, made at the reaction point of bellows which are opposite to bellows that are provided with the vertical adjustments **20, 21**, it will be possible to regulate, in either horizontal and vertical directions, the application points of forces as exerted by the transducer bellows on the movable structure **18**. It is also possible to shift, in either horizontal and vertical senses, the direction of forces exerted by the bellows, in order to rectify possible assembly inaccuracies, and/or differences in the effective areas of pressure application. It is also possible to introduce a gain of the positive feedback higher than that of negative feedback, thereby increasing the inherent amplifier gain.

In addition by having recourse to the many possible circuit designs, the abovedescribed amplifier can be utilized as a pneumatic computer unit, or for signal or signal differences processing.

Moreover, recourse may be made to different constructional solutions and design variants of the abovedescribed device, in order to adapt it to different local conditions or application requirements. Thus, an amplifier that operates on the basis of the balance of moments produced, relative to a movable hinge (i.e. the spring blade **33**), might be converted in such a manner as to operate on the basis of a balance of motions, by disengaging the upper end **29*a*** of rod **29** and by associating one of the modulator system components therewith, while the other component of same system can be fitted in such a way as to be able to rotate round the axis C—C. Additionally, the connection of one end of each bellows with the rod **29** can be established, rather than by the outer movable structure **18**, by having the bellows inner ends converged toward rod **29**. In such latter case, all bellows will have their outer ends connected with and supported by the stationary structure of device.

Likewise, many different designs may be resorted to, in order to ensure the connection of bellows, and of all other components, with the single signal feeding ducts, and the like.

It should be noted that an important feature of the invention amplifier is that the arm **32** is substantially shorter than the arm **38**, which latter carries the baffle **41**, and that the arm **34**, at least considered from its pivot axis to a point aligned with the end of arm **32**, is substantially shorter than the arm **39** carrying the nozzle **40**. This will be apparent from the drawings. This results, upon pivoting or tilting of the rod **29**, in an amplification of the resulting relative movement of nozzle **40** and baffle **41**, and this amplification is in addition to the amplification due to the fact that the resultant of the forces is applied at an intermediate portion of the rod **29** and delivered to the brace **32–38** at the upper free end of the rod **29**.

What we claim is:

1. In an adjustable gain differential pneumatic amplifier, of the type including a modulator system comprising a nozzle directed toward a baffle, with the nozzle and baffle being supported for variation of the spacing thereof, and resiliently deformable elements arranged in two pairs with the elements of each pair arranged in coaxial opposition on a respective axis and with the two axes intersecting at right angles and lying in a common plane, the elements being commonly connected to at least one component of the modulator system, the variation of such spacing being effected by the resultant of pneumatic forces applied to the elements and deforming the same, and the resultant of the pneumatic forces being determined by angular adjustment of the modulator system about the intersection of the two axes and substantially parallel to the common plane of the latter: the improvement comprising, in combination, a support base; mounting means on said support base mounting said deformable elements; a movable structure connected to all of said deformable elements and moved thereby in accordance with the resultant of pneumatic forces applied to said deformable elements; and motion amplifying means interposed between said movable structure and said modulator system to amplify the variation of such spacing relative to the movement of said movable structure.

2. In an adjustable gain differential pneumatic amplifier, the improvement claimed in claim **1**, in which said motion amplifying means comprises a rigid component mounted on such support base for angular adjustment about a mean axis extending through the intersection of said two axes and perpendicular to the common plane of the latter, said rigid component extending in both directions from said mean axis and having a first end and a second end; a movable component having a first end pivotally connected to the first end of said rigid component and having a second end opposite said second end of said rigid component; said nozzle being supported on the second end of one of said components and said baffle being supported on the second end of the other of said components; and connecting means connected to said movable structure and to an intermediate portion of said movable component and transmitting to said intermediate portion the resultant motion of said movable structure; whereby the amplitude of said resultant motion is amplified at said second end of said movable component to amplify the variation of such spacing with respect to the movement of said movable structure.

3. In an adjustable gain differential pneumatic amplifier, the improvement claimed in claim **2**, in which the spacing of said second end of said rigid component from said mean axis is greater than the spacing of said first end of said rigid component from said mean axis, and the spacing of said second end of said movable component from said intermediate portion thereof is greater than the spacing of said first end of said movable component from the intermediate portion thereof.

4. In an adjustable gain differential pneumatic amplifier, the improvement claimed in claim **2**, in which said connecting means comprises an elongated member pivotally connected at one end to said support base and at its opposite end to said intermediate portion of said movable component, said connecting means being connected to said movable structure at a point intermedite its ends whereby to effect further amplification of the transmitted motion.

5. In an adjustable gain differential pneumatic amplifier, the improvement claimed in claim **4**, in which said connecting means is pivotally connected to said support base through the medium of a deformable diaphragm.

6. In an adjustable gain differential pneumatic amplifier, the improvement claimed in claim **2**, in which said first end of said movable component is connected to this first end of said fixed component by a strip of flexible material.

7. In an adjustable gain differential pneumatic amplifier, the improvement claimed in claim **4**, in which said connecting means is a rod and said movable component is angularly adjustable about the end of said rod to which it is connected; the axis of said rod, in the neutral position of said movable structure, being coincident with said mean axis; said movable component being angularly adjustable about said mean axis conjointly with said rigid component with the limits of the angular adjustment being defined by said two axes.

8. In an adjustable gain differential pneumatic amplifier, the improvement claimed in claim **7**, in which said movable component and said rod define a plane which includes the line connecting the pivotal connection of said movable component to said rigid component to the point of connection of said rod to said support base; said rod and said movable component, responsive to displace-

ment of said movable structure, curving in an arc centered on said connecting line, whereby said movable component has a scissor-like movement with respect to said rigid component.

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ALAN COHAN, *Primary Examiner.*