Aug. 2, 1960 P. F. K. ERBGUTH 2,947,553

PIPE COUPLING FOR A PNEUMATIC FOLLOW-UP SYSTEM

Filed Nov. 7, 1955 2 Sheets-Sheet 1

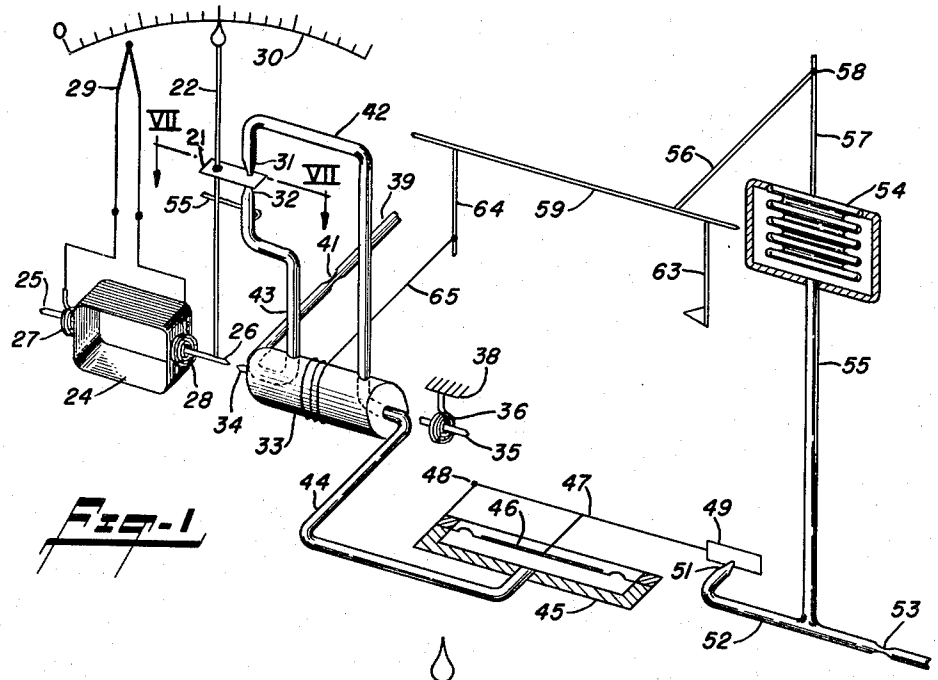



Fig-1

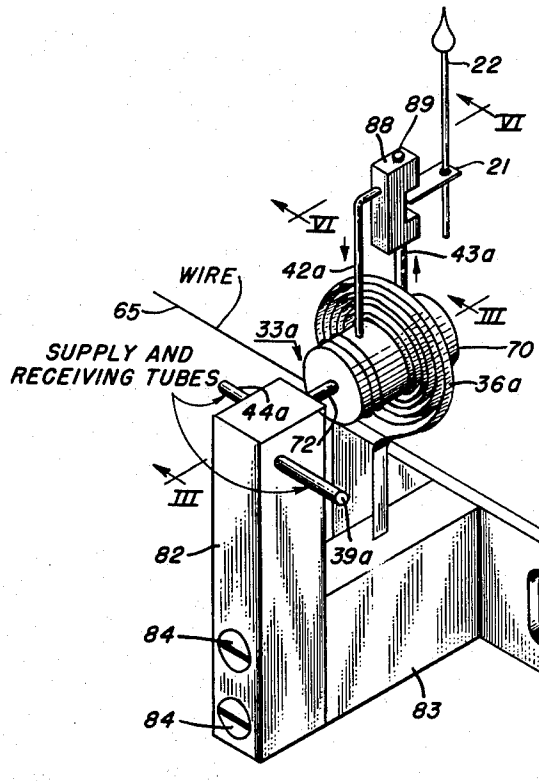



Fig-2

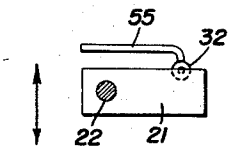



Fig-7

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Aug. 2, 1960 P. F. K. ERBGUTH 2,947,553

PIPE COUPLING FOR A PNEUMATIC FOLLOW-UP SYSTEM

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2 Sheets-Sheet 2

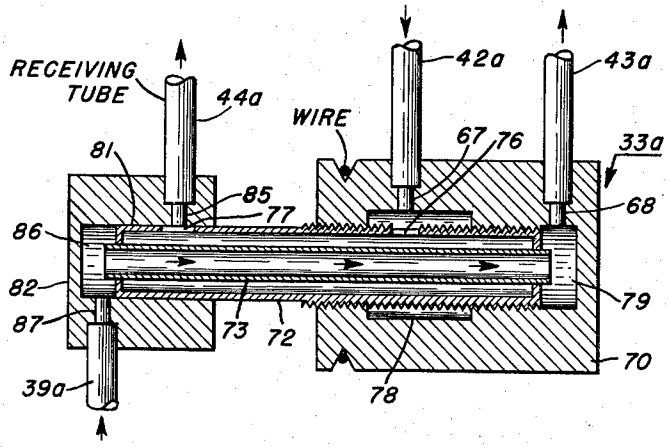



Fig-3

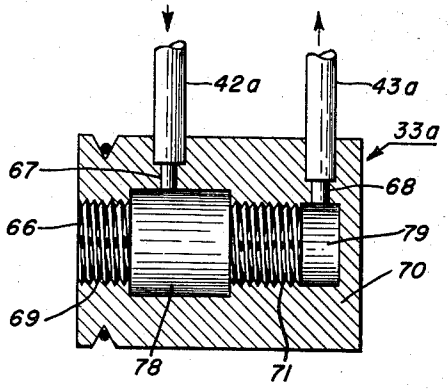



Fig-4

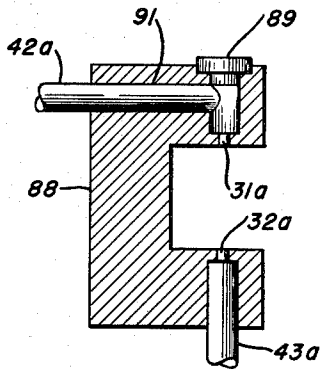



Fig-6

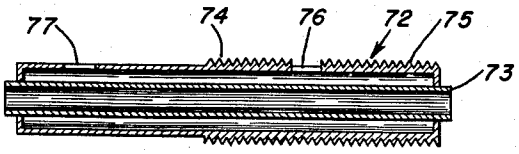



Fig-5

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# PIPE COUPLING FOR A PNEUMATIC FOLLOW-UP SYSTEM

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2 Claims. (Cl. 285—133)

This invention relates to pneumatic systems and, more particularly, to such comprising a vane carried by a rotatable pointer and movable between a nozzle from which low pressure air flows and a coaxially-disposed nozzle receiving air from the first-mentioned nozzle, except when cut off by the vane, improved means being provided for maintaining said nozzles in alignment, the system also including an improved form of coupling rotatable coaxially with the pointer and on which the nozzles are mounted, with relay means to cause the rotatable coupling to follow the movement of said pointer.

Pneumatic systems of the class contemplated by this invention comprise a device or mechanism for sensing changes in a variable condition, examples being electrical measuring instruments with pointers indicating current or voltage, and devices with parts like pointers movable in response to changes in weight, humidity, etc. Such devices may be associated with pneumatic relays or couples comprising a discharge nozzle from which an elastic fluid flows under low pressure and a cooperating receiving nozzle aligned with the discharge nozzle to receive elastic fluid therefrom, except as cut off by a vane carried by the sensing mechanism.

The present application is directed to an improved form of nozzle support, in which misalignment of the nozzles is prevented by having them formed in a rigid U-shaped block so that a stream of air is directed from a nozzle opening at the inner surface of one arm of said block toward a cooperating nozzle opening at the inner surface of the other arm of said block. The present application also covers an improved form of coupling, or air bearing, supported at only one end, rather than supported between spaced bearings as has been the practice heretofore.

An object of this invention is the provision of a pneumatic system in which a vane is normally disposed in an air stream flowing between two nozzles formed in a rigid U-shaped member, and including a coupling rotatable coaxially with the vane carrying means and supported at only one end, said coupling also having air tubes issuing therefrom and communicating with the nozzles, and means effective upon movement of the vane to correspondingly rotate the coupling, thereby to maintain the vane in a throttling position in the air stream.

An object of this invention is to provide an improved form of air bearing for a pneumatic system using a rotatably mounted nozzle or nozzle couple.

An object of the invention is to provide an air bearing for a pneumatic system comprising a supporting bracket with air supply and receiving connections, a pair of concentrically-disposed tubes sealed against each other at both ends, the outer tube having a pair of radially-opening holes and being partly threaded, and a barrel carrying nozzle tubes and a nozzle couple screwed onto the threaded portion of said outer tube, whereby air can flow from the supply connection of the bracket through the inner tube to the barrel, from there through one nozzle tube to its nozzle end, if not intercepted, to the other



nozzle, through its nozzle tube back to the barrel, and from there through the outer or threaded tube to the receiving connection of the supporting bracket.

An object of this invention is to provide a rotatably mounted nozzle couple in which misalignment of the nozzles is prevented by forming each in an arm of a rigid U-shaped member adapted to be carried by nozzle tubes.

These and other objects and advantages of the invention will become apparent from the following description when taken with the accompanying drawings. It will be understood, however, that the drawings are for purposes of illustration and are not to be construed as defining the scope or spirit of the invention, reference being had for the latter purpose to the claims appended hereto.

In the drawings, wherein like reference characters denote like parts in the several views:

Figure 1 is a diagrammatic representation of an electro-pneumatic follow-up system embodying my invention;

Figure 2 is a perspective view of a preferred form of rotatable coupling carrying aligned nozzles;

Figure 3 is an axial sectional view on the line III—III of Figure 2, in the direction of the arrows, with the plane of the supply and receiving tubes rotated 90° about the axis of the coupling, so that for clarity both of said tubes appear in elevation;

Figure 4 is an axial sectional view of the coupling barrel of Figure 3 separated from the associated parts;

Figure 5 is an axial sectional view of the air bearing tube assembly of Figure 3, separated from the associated parts;

Figure 6 is a vertical sectional view on the line VI—VI of Figure 2, in the direction of the arrows, showing the details of the nozzle assembly; and

Figure 7 is a fragmentary plan and partly horizontal sectional view on the plane of the line VII—VII of Figure 1, in the direction of the arrows.

Reference is now made to Figure 1, which illustrates an electro-pneumatic follow-up system in which is proposed to be incorporated the improved air bearing and nozzle assembly of my invention. Here the condition-sensing device is an electrical instrument, such as a millivoltmeter, having a vane **21** secured to its pointer **22**. The instrument may be of conventional construction, having a wire wound movable coil **24** rotatable on pivots **25**, **26** between the poles of a permanent magnet (not shown). Each of the pivots has secured thereto a hair spring **27**, **28** which hold the coil in a given zero position until an electric current flows therethrough. Such current may be generated by a thermocouple **29** serving as a temperature-sensing element in a furnace (not shown). The instrument may include a scale **30** calibrated in suitable values as, for example, temperature.

The vane **21** is movable upon rotation of the pointer **22** between a pair of axially aligned spaced nozzles **31**, **32**. These nozzles form a pneumatic couple and are carried by a hollow coupling **33** mounted for coaxial rotation with respect to the pointer, as by the pivots **34**, **35**. A spring **36** has one end fastened to the pivot **35** and the other end to a fixed member **38**, said spring being arranged to bias the coupling **33** in a counter-clockwise direction, that is, to return it toward the left or zero position of the pointer relative to the scale **30**. A wire **65** is tightened around the coupling and has one end secured thereto and the other end to an arm or crank **64** on a shaft **59**.

Air is fed to the coupling **33** by means of a tube **39**, the pressure of the air being transmitted thereto being desirably reduced as by passing through a flow restrictor **41**. Air is supplied to the tube **43** feeding the discharge nozzle **32** from the left hand hollow interior of the coupling **33**. Air is supplied to the right hand hollow interior of the coupling **33** which is, of course, separated from the left

hand hollow interior cavity thereof, by means of a tube **42**. From the interior cavity at the right hand, air passes through tube **44** to an air relay **45**. The structural details of the coupling will be described hereinbelow with reference to Figures 2 to 5, inclusive, and the structural details of the nozzle couple will be described with reference to Figures 2 and 6.

The air relay **45** comprises a chamber closed by a diaphragm **46** connected to a lever **47** that is pivoted to the relay housing as indicated at **48**. At its other end, the lever carries a flapper **49**, normally disposed adjacent to nozzle **51** from which air flows. The nozzle **51** is supplied with air under pressure, through a tube **52**, which contains a flow restrictor **53**. In general, the air pressure within the tube **52** is of the order of pounds per square inch. On the other hand, the pressure of the air in the tube **43** is very low, in the range of less than 3 inches of water, thereby eliminating adverse reaction between the vane and the air stream flowing between the discharge nozzle **32** and the receiving nozzle **31**. When the pressure in the tube **44** decreases, due to the vane passing further into the air stream between the nozzles **32** and **31**, from an assumed balanced condition in which the leading or up-scale (that is, to the right as viewed in Figure 1), edge of the vane **21** is disposed substantially in the center of the air stream, the diaphragm **46** moves downwardly, moving the flapper **49** closer to the nozzle **51**, and correspondingly effecting an increase in pressure in the tube **52** and the bellows assembly **54**, connected thereto by the tube **55**. It will be understood that in practice one edge of the vane **21** normally is disposed in the air stream and it is the movement of this vane in the air stream which inhibits more or less the flow of air from the discharge nozzle to the receiving nozzle.

Upon an increase in air pressure in tube **52**, the bellows **54** is compressed. A rod **57** has its lower end secured to the bottom of the bellows and its upper end pivotally-connected, as at **58**, to a crank **56** that is secured to the shaft **59**. Consequently, a compression of the bellows results in a counter-clockwise rotation of the shaft **59** and a clockwise rotation of the coupling **33** by means of the crank or arm **64** and the operating wire **65** against the action of the biasing spring **36**. It will be apparent, then, that an upscale movement of the pointer, resulting in a movement of the vane further into the air stream, results in a corresponding rotation of the coupling **33** until the vane again occupies substantially its initial, or throttling, position in the air stream. In order to prevent movement of the vane **21** beyond the air stream upon upscale deflection of the pointer a suitable stop **55** is secured to the nozzle **32**. The shaft **59** may also operate an arm **63** carrying a pen cooperating with a movable chart (not shown) to form a recorder. Obviously, such record will correspond to the position of the instrument pointer, or the instantaneous state of the variable condition under consideration.

A down-scale movement of the pointer **22**, or one to the left as viewed in Figure 1, results in the vane **21** being moved further out of the air stream, increasing the air flow into the receiving nozzle **31**, whereupon the air pressure in the tubes **42**, **44**, and in the air relay chamber **45** is increased. This results in a reverse operation, whereby the diaphragm **46** moves upwardly, moving the flapper **49** farther from the nozzle **51**, and correspondingly effecting a decrease in pressure in the tubes **52**, **55**, and the connected bellows assembly **54**. This causes the bellows assembly **54** to expand, resulting in a clockwise rotation of the shaft **59** and a counter-clockwise rotation of the coupling **33** by the return or biasing spring **36**.

Referring now to Figures 2 to 5, inclusive, for preferred details of the rotatable coupling **33** and the parts associated therewith, it will be seen that this coupling, here designated **33***a*, is in the form of a cylindrical member, or barrel **70** shown in detail in Figure 4, having a hollow cavity **66**. This barrel portion also has two radial holes **67**, **68** and is partly threaded, as indicated at **69** and **71**. Preferably, a fine thread, such as 100 threads per inch, is used. The barrel **70** carries the nozzle tubes, here designated **43***a*, **42***a* communicating respectively with the apertures **68** and **67**, as shown most clearly in Figure 4.

Threaded into the barrel is an outer tube or shaft **72** carrying coaxially therewith an inner tube or hollow shaft **73**. The outer tube **72** carries threads **74** and **75** respectively, fitting the threads **69** and **71** of the barrel. The inner tube **73** is open at its ends, and the outer tube **72** is closed around the circumferential space between the ends of the tubes but has radial openings **76** and **77**. The opening **76** communicates with the chamber **78** formed between the barrel **70** and the exterior surface of the tube **72** and from which the aperture **67** extends. The inner tube **73** communicates with end chamber **79** in the barrel **70**, from which the aperture **68** extends.

The other end of the tube **72** is non-rotatively supported in a bore **81** in a column or pillar **82**, secured to a base or bracket **83** by means of screws **84**, as shown in Figure 2. The aperture **77** in the outer tube **72** communicates with an aperture **85** in the column **82** from which extends receiving tube **44***a*, corresponding with the tube **44**, of Figure 1. Air is supplied to the end cavity **86** in the column **82** through aperture **87** therein, by means of supply tube **39***a* corresponding with the tube **39** of Figure 1.

As shown in Figure 2, the biasing hair spring **36***a* is, in the present embodiment, secured to the barrel **70**, its outer end being anchored to the base or bracket **83** in any desired manner as by means of an overlying clip (not shown). From this description it will be seen that the coupling **33***a* is supported by only one end of the outer tube **72**. Undesired axial movement is prevented by the threaded engagement between said outer tube and the barrel **70**, the coacting threads being very fine.

It will be understood that during operation the flow of air through the nozzle tubes **42***a*, **43***a*, shown in Figure 2, is identical with the flow of air through the nozzle tubes **42**, **43** of the Figure 1 arrangement, the improvements residing in the structural details of the rotatable member which requires only a single bearing and in the construction of the nozzles per se.

The construction of the nozzles is shown in Figure 6. Here there is shown a U-shaped block **88**, of suitable material. A small diameter hole is drilled through the arms of the block to form the discharge nozzle **32***a* and the receiving nozzle **31***a*. An enlarged diameter bore is then drilled part way through each arm, the bore in the lower arm accommodating the nozzle tube **43***a* and the bore in the upper arm being closed by a plug **89**. A lateral bore **91** is also formed in the upper arm, such bore communicating with the said first bore formed in such arm and accommodating the nozzle tube **42***a*. Such arrangement results in the precise alignment of the discharge and receiving nozzles **32***a* and **31***a*, respectively.

Referring back to Figure 3, it will now be clear that the flow of air through the rotatable couple is as follows: supply tube **39***a*, aperture **87**, inner tube **73**, chamber **79**, aperture **68** and nozzle tube **43***a* which connects directly to the discharge nozzle **32***a* shown in Figure 6. The return flow of air is through the receiving nozzle **31***a* and nozzle tube **42***a* (Figure 6), then through the aperture **67** (Figure 3) chamber **78**, radial hole **76** in the outer tube **72**, the space between the outer and inner tubes, radial aperture **77**, aperture **85** and tube **44***a*. The latter tube **44***a* corresponds to the tube **44** shown in Figure 1. In a low pressure air system the fine threads of the tube **72** and the barrel **70** results in very little escape of air between these two parts. A completely sealed system may be provided by applying a light coating of a suitable grease on these cooperating threads.

From the foregoing disclosure it will be seen that I have provided a pneumatic follow-up system responsive to changes in a variable condition as, for example, tem-

perature. The system is self-balancing and any displacement of the vane **21** results in a corresponding follow-up rotation of the aligned nozzles to thereby return the system to its initial balancing, or throttling point, since the position of the rotatable coupling carrying the aligned nozzles will always correspond to the position of the instrument pointer. The actual deflection of the instrument can be recorded by a pen actuated by the arm **63** of Figure 1, movable in accordance with the rotation of the rebalancing shaft **59**. Also, since the air pressure effective to move the bellows assembly **54**, varies in accordance with the position of the instrument pointer, suitable remotely-positioned indicating and/or control apparatus can be actuated by connecting the same to the tube **55**.

While I have described a specific pneumatic system including an improved form of coupling and nozzle assembly, it will be apparent that my pneumatic follow-up arrangement is not restricted for use with a condition-sensing device of electrical character. Any movable pointer or lever system may be utilized to move the vane in the air stream.

Having now described my invention in detail in accordance with the requirements of the patent statutes, those skilled in this art will have no difficulty in making changes and modifications in the individual parts or their relative assembly in order to meet specific requirements or conditions. Such changes and modifications may be made without departing from the scope and spirit of the invention, as set forth in the following claims.

I claim:

1. A rotatable coupling member for a pneumatic system comprising a first supporting member with a bore, a pair of coaxially-disposed tubes telescoped with respect to and sealed against each other at both ends, one end portion of the outer of said tubes being non-rotatably supported in said bore and the other end portion thereof having external threads, a barrel with a cavity internally threaded and fitted on said external threads, a pair of nozzle tubes extending radially from said barrel and axially spaced therealong, an enlargement in said cavity intermediate the ends of said threads, one of said nozzle tubes communicating with said enlargement and the other nozzle tube communicating with the end portion of said cavity beyond the ends of said coaxially-disposed tubes, an air supply connection with the bore of said supporting member beyond the supported end of said coaxially-disposed tubes, and an air receiving connection with said bore short of said supported end, an aperture in said outer tube communicating with said receiving connection and another aperture in said outer tube communicating with said enlargement, whereby air can flow from the supply connection of the supporting member through the inner tube to the barrel, from there through one nozzle tube and through the other nozzle tube back to the barrel, and from there through the outer tube to the receiving connection of the supporting member.

2. A rotatable coupling member; for a pneumatic follow-up system having a vane movable by a member



in response to changes in a variable condition, a pair of axially-aligned nozzles disposed on opposite sides of the vane and carried by a member supported at only one end, means normally maintaining an air stream between the nozzles, air-operated means responsive to changes in the air pressure within one of the nozzles as brought about by movement of the vane in the air stream, and mechanism responsive to the said air-operated means to rotate the member in correspondence with the movement of the vane; comprising a rotatable coupling member including a fixed supporting member with a bore, a pair of coaxially-disposed tubes telescoped with respect to and sealed against each other at both ends, one end portion of the outer of said tubes being non-rotatably supported in said bore and the other end portion thereof having external threads, a barrel with a cavity internally threaded and fitted on said external threads, a pair of nozzle tubes extending radially from said barrel and axially spaced therealong, an enlargement in said cavity intermediate the ends of said threads, one of said nozzle tubes communicating with said enlargement and the other nozzle tube communicating with the end portion of said cavity beyond the ends of said coaxially-disposed tubes, an air supply connection with the bore of said supporting member beyond the supported end of said coaxially-disposed tubes, and an air receiving connection with said bore short of said supported end, an aperture in said outer tube communicating with said receiving connection and another aperture in said outer tube communicating with said enlargement, whereby air can flow from the supply connection of the supporting member through the inner tube to the barrel, from there through one nozzle tube and through the other nozzle tube back to the barrel, and from there through the outer tube to the receiving connection of the supporting member.


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