This invention relates to improvements in motion transmitting mechanisms for air transmitters. The application is a continuation-in-part of my copending application Serial No. 530,477, filed August 25, 1955, now Patent No. 2,842,148.

Very briefly, the present invention, there have heretofore been designed air transmitters wherein a relay valve that is supplied with air under pressure is actuated by the back pressure developed by a flapper engageable with a nozzle through which air from the source of supply escapes after passing through a restrictor. When the flapper is lifted from the nozzle to permit air to be discharged through the nozzle more freely there is a minimum of back pressure. This reduction in back pressure is effective to cause the relay valve to close and to cause the pressure of the transmitted air to be reduced by releasing it to atmosphere. Conversely, when the flapper closes the nozzle back pressure developed in the nozzle quickly builds up causing the relay valve to open and thus release a greater amount of compressed air from the source of supply so that it may be transmitted to the receiver. The flapper is actuated by means of a driver or an exciter which is moved by a suitable mechanism and the function of the air transmitter is to transmit air pressure to a receiver at a pressure which will bear a direct relationship to the movements of the driver or exciter.

It has been proposed to fulcrum the flapper on a re-positioning bellows which is subject to and is influenced by the pressure of the transmitted air. The purpose of this is so that in all positions of the exciter or driver the flapper is in a position to be immediately depressed or released thereby for movement towards or away from the nozzle. In this manner, if the exciter or driver is in a position requiring the transmission of air at one pressure and shifts slightly to require the air that is transmitted to be at a lower pressure the flapper will be maintained at all times in a position so as to be instantly influenced thereby. Likewise, if the exciter or driver shifts slightly to require that the air that is transmitted to be at a higher pressure the flapper will be maintained at all times in a position with relation to the nozzle so as to be instantly influenced thereby.

Very frequently the mechanism which actuates the exciter or driver is in the form of a differential pressure responsive device of the type disclosed in my United States Letters Patent No. 2,400,048, issued May 7, 1946, wherein are two opposed metallic bellows which are subjected to the pressures between which a differential may exist. A torque tube or equivalent device transmits the motion of these bellows to the exterior of the device and this torque tube may constitute the driver or exciter of the present invention.

The metallic bellows of the differential pressure responsive device and also the metallic bellows of the air transmitter do not always linear in their movements in response to the pressures to which they may be subjected. In some instances the effect of the bellows is such that they may have a combined effect that may be regarded as a plus error wherein the movements of the bellows are greater than the movements which they should have in response to the pressures to which they are subjected. In other instances, the bellows may have a combined effect of what may be regarded as a minus error wherein the movements of the bellows are actually less than the movements that they should have in response to the pressures to which they are subjected.

A primary object of the present invention is to provide a very simple and readily adjustable mechanism of the linkage train between the torque tube or exciter of the flapper which will enable these errors, if they exist, to be easily corrected and compensated for. Consequently, regardless of what type of error the bellows may have with respect to their pressures, if in fact such error exists, the movement of the flapper may be made to conform to the pressures which are intended, re-positioning thus, a plus error, if it exists, may be corrected or neutralized, and likewise a minus error, if it exists, may be corrected or neutralized. If the bellows either inherently have no error or the combined errors of the various bellows neutralize each other the linkage train may be so adjusted that no correction or compensation is made.

More specifically, an object of the invention is to provide means for fulcruming the flapper of an air transmitter on the re-positioning bellows of the air transmitter so that the fulcruming means is movable along the length of the flapper toward and away from the nozzle and the fulcrum-providing portion thereof is swingable about an axis remote from the point where it fulcrums the flapper and is confined to a swinging movement about said axis. This axis while normally stationary, is adjustable so that by means of its adjustment a plus error, if it exists, can be corrected or neutralized and likewise a minus error, if it exists, may be corrected or neutralized, or if the bellows either inherently have no error or the combined errors of the combined bellows neutralize each other, the linkage train may be so adjusted that no correction or compensation is made.

Still another object of the invention is to provide a construction having the above-mentioned characteristics wherein the fulcruming-providing means, instead of being sidable between the re-positioning bellows and the flapper, is mounted on the re-positioning bellows for universal movement relatively thereto, thus reducing any tendency of parts to bind. In accordance with the present construction the re-positioning bellows preferably has its stationary end anchored at a point remote from the flapper and the movable end of the re-positioning bellows is located more remote therefrom. While the adjustment of the fulcruming means to compensate for plus error or minus error may cause it to assume positions that depart slightly from an exact co-axial position of the bellows, by reason of the fact that the re-positioning bellows is in effect suspended rather than supported and the departures of the fulcruming means from truly co-axial positions are usually small, this arrangement is such as to avoid objectionable distortion or abnormally loading of the re-positioning bellows.

With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figure 1 is a sectional view of an air transmitter illustrating the motion transmitting mechanism embodying the present invention as having been applied thereto;

Fig. 2 is a partial view in horizontal section taken substantially upon the line 2-2 upon Fig. 1 in the direction indicated;

Fig. 3 is a partial view in vertical section taken sub-
stantially upon the line 3–3 upon Fig. 1 in the direction indicated; and
Fig. 4 illustrates positions assumed by parts at one extreme of one adjustment. Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, the transmitter illustrated on Fig. 1 is generally similar in construction to the construction disclosed in my United States Letters Patent No. 2,718,896, and consists of abon 18 to which compressed air is supplied from a source of supply through an inlet port 11. The compressed air after passing through a filter 12 retained in place by a removable nut 13, passes into a valve chamber 14. A portion of the air supplied to the valve chamber 14 is conducted through a passage 15, see Fig. 3, to a restrictor 16. After passing through the restrictor this portion of the air is conducted by means of passages 17 and 18 to the interior of a lower bellows 19 which is mounted on the underside of a horizontal partition plate 20.
Within the bellows 19 there is an inner bellows 21 which is also mounted on the underside of the partition plate 20 and the lower ends of both bellows are connected together to a rigid connecting stem 22. The air that is conducted from the restrictor 16 through passages 17 and 18 is discharged into the space between the two bellows and from this space it finds egress through passages 23 and 24 to a nozzle 25 through which air is more or less continuously discharged. The nozzle 25 is threadedly mounted for vertical adjustment on a nozzle holder 26.
On the upper side of the partition plate 20 there are two bellows, the outer bellows being indicated at 27 and the inner bellows being indicated at 28. The upper ends of both bellows are connected together and to the upper end of the rigid connecting stem 22. The effective areas of the outer bellows 19 and 27 are equal to each other, and in a similar manner, the effective areas of the inner bellows 21 and 28 are equal to each other. The stem 22 being a rigid stem, causes the outer or movable ends of all of the bellows 19, 21, 27, and 28 to move vertically in unison. The space between the inner bellows 27 and 28 is connected through passages 29 and 30 to an upper housing, generally indicated at 31, and to atmosphere through an outlet port 32 therein.
Within the stem 22 there is a valve seat 33 on which a valve closure 34 is adapted to seat. This valve closure 34 as shown in Fig. 14a valve closure 36 is threadedly mounted such as by being threaded thereon and locked in adjusted position by means of a locknut 37. The lower valve closure 36 is adapted to seat on a seat 38 arranged at the top of chamber 14. In the stem 22 there is a transversely extending bore or passage 39 which is located above the valve seat 33 and which discharges into the interior of the inner bellows 21 when the closure 34 is open or in unseated position. From the inner bellows 21 air that is allowed to escape from chamber 40 when closure 34 is opened or unseated may find egress through passages 29 and 30 to atmosphere at 32 and 41 indicates the outlet which is connected to the chamber 40 through a filter 42 and a passage 43. A filter is preferably employed at this point due to the fact that under certain conditions there may be a tendency toward back flow from the receiver to the chamber 40. It will be appreciated from the above described construction that if flow of air through the nozzle 25 is restricted so that the back pressure developed by such a restriction is effective on the bellows 19 and 21 to urge these bellows to expand. When these bellows expand downwardly they cause the seat 33 to engage the closure 34, thus closing the chamber 40 against the escape of air. The closure 36 may be unseated under these circumstances, allowing compressed air from the inlet 11 to enter the chamber 49 and to pass therefrom to the outlet 41 and thence to the receiver. The upper bel-
low 27 is externally subjected to whatever pressure exists in the chamber 40, passages 44 in the partition 20 providing free communication between the top and bottom of the chamber through the partition plate. If air is allowed to escape more freely through the nozzle 25 the back pressure that is effective on the bellows 19 and 21 is reduced and these bellows are consequently permitted to contract. When these bellows contract the stem 22 is lifted so that the compression spring 45. The valve seat 33 may be lifted above the closure 34 and air in the chamber 40 may consequently be allowed to escape to atmosphere through passages 39, 29, 30, and 32. This escape of air from the chamber 40 reduces the pressure of the air that is transmitted to the receiver through the outlet 41. It will thus be understood that if egress of air through the nozzle 25 is retarded, that the pressure transmitted through the outlet 41 to the receiver will be increased, and conversely, if the restriction on the nozzle 25 is reduced, the pressure of air transmitted to the receiver through outlet 41 will be decreased.
On top of the chamber 40 there is mounted a re-positioning bellows 50, the exterior of which is subject to whatever pressure exists in the top of chamber 40. The interior of the re-positioning bellows 50 is subjected merely to atmospheric pressure from port 32. This re-positioning bellows has its stationary end secured to a cap 51 and its movable end secured to a plate 52 that is fastened to a disc or plate 53 by means of a bolt 54. The plate or disc 53 serves as a spring seat for a compression spring 55. In this arrangement it will be observed that the re-positioning bellows has its upper end stationary and its lower end movable, movement of the bellows 50 being largely in response to the pressure in the chamber 40.
The head of the bolt 54 is coned out or countersunk at 56 to provide a seat for a ball 57 at the bottom of a stem 58. A thin metal pin 59 is threaded for adjustment onto the stem 58 and extends through a slot 60 that extends longitudinally of the flapper 61. A fulcrum pin 62 extends through the pin 59 and bears against the underside of the flapper 61 and serves to fulcrum the flapper intermediate its ends on the top of stem 58 which, in turn, is supported by its ball 57 on the lower and movable end of the re-positioning bellows 50. The end of the flapper 61 that is remote from nozzle 25 is connected to an arm 63 on a crank 64 or a driving shaft 65. This driver shaft or exciter may be oscillated by any suitable mechanism such as for example a differential pressure responsive means of the type disclosed in my prior United States Letters Patent No. 2,400,048.
The connection between the flapper and the arm 63 may be in the form of a flexible section of sheet metal 66 which forms a type of hinge connection connecting the arm 63 with the flapper. When the exciting or driving shaft 65 turns in one direction it is effective to depress the end of the flapper 61, causing it to fulcrum on the fulcrum pin 62 and to be elevated with respect to the nozzle 25. Conversely, if the exciting or driving shaft 65 rotates in the opposite direction the arm 63 is elevated and flapper 61 is fulcrumed on the fulcrum pin 62 to approach the nozzle 25 more closely.
As above explained, the action of the various bellows frequently is not linear and the combined actions of all of the bellows may result in either a plus error or minus error, or no error at all. To take care of these errors a fulcrum pin 62 is located on the end of an arm 67 which, in turn, has a parallel pin 68 that is parallel to the fulcrum pin 62. Pin 68 is rotatably mounted on a bracket 69 that is rotatably adjustable by means of a screw 70 on a plate 71. The plate 71 is transversely adjustable with relation to a supporting boss 72 on a screwed stud 73 that extends through a slot 74 in the plate. Fine adjustment of this plate in a transverse direction is accomplished by means of an adjusting screw 75.
It will be appreciated by the above-described construction that lateral adjustment of plate 71 produces a lateral adjustment of fulcrum pin 62 and that this varies the two arms of the flapper 61 considering this flapper as a simple lever. Thus, the distance between the fulcrum pin 62 and arm 63 and the distance between fulcrum pin 62 and nozzle 25 can be varied by adjusting the lateral position of plate 71 and consequently the position of the fulcrum pin 62. Consequently, calibration, particularly the range of calibration, can be easily accomplished by merely adjusting the position of plate 71.

We shall now take up and consider the various features of the construction as described above.

In the arrangement above described, it will be appreciated that lateral adjustment of plate 71 produces a movable along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper, means confining its movements along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper, means confining its movements along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper, means confining its movements along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper.

2. In an air transmitter, an exciting crank arm, a nozzle, and a flapper therefor, a re-positioning bellows subjected to the transmitted pressure, means fulcruming the flapper on the re-positioning bellows pivotally mounted on the re-positioning bellows, means connecting the flapper to the exciting crank arm, said fulcruming means being movable along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper, means confining its movements along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper.

3. In an air transmitter, an exciting crank arm, a nozzle, and a flapper therefor, a re-positioning bellows subjected to the transmitted pressure, means fulcruming the flapper on the re-positioning bellows pivotally mounted on the re-positioning bellows, means connecting the flapper to the exciting crank arm, said fulcruming means being movable along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper, means confining its movements along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper.

4. In an air transmitter, an exciting crank arm, a nozzle, and a flapper therefor, a re-positioning bellows subjected to the transmitted pressure, means fulcruming the flapper on the re-positioning bellows, means connecting the flapper to the exciting crank arm, said fulcruming means being movable along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper, means confining its movements along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper.

5. In an air transmitter, an exciting crank arm, a nozzle, and a flapper therefor, a re-positioning bellows subjected to the transmitted pressure, means fulcruming the flapper on the re-positioning bellows, means connecting the flapper to the exciting crank arm, said fulcruming means being movable along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper, means confining its movements along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper.

6. In an air transmitter, an exciting crank arm, a nozzle, and a flapper therefor, a re-positioning bellows subjected to the transmitted pressure, means fulcruming the flapper on the re-positioning bellows, means connecting the flapper to the exciting crank arm, said fulcruming means being movable along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper, means confining its movements along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper.

7. In an air transmitter, an exciting crank arm, a nozzle and a flapper therefor, a re-positioning bellows subjected to the transmitted pressure, means fulcruming the flapper on the re-positioning bellows, means connecting the flapper to the exciting crank arm, said fulcruming means being movable along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper, means confining its movements along the length of the flapper and swingable about an axis remote from the point where it fulcrums the flapper.
arm and the nozzle, said fulcruming portion being movable along the length of the flapper, and means restricting movements of the fulcruming portion of the stem to movements through an arc, the axis of which is remote from the point where it fulcrums the flapper.

8. In an air transmitter, an exciting arm, a nozzle and flapper therefor, a re-positioning bellows subjected to the transmitted pressure, said re-positioning bellows having its anchored end most adjacent the flapper and its movable and remote therefrom, a stem mounted for universal movement on the movable end of the re-positioning bellows and having a fulcruming portion engageable with the flapper intermediate the exciting crank arm and the nozzle, said fulcruming portion being movable along the length of the flapper, means restricting movements of the fulcruming portion of the stem to movements through an arc, the axis of which is remote from the point where it fulcrums the flapper.

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