

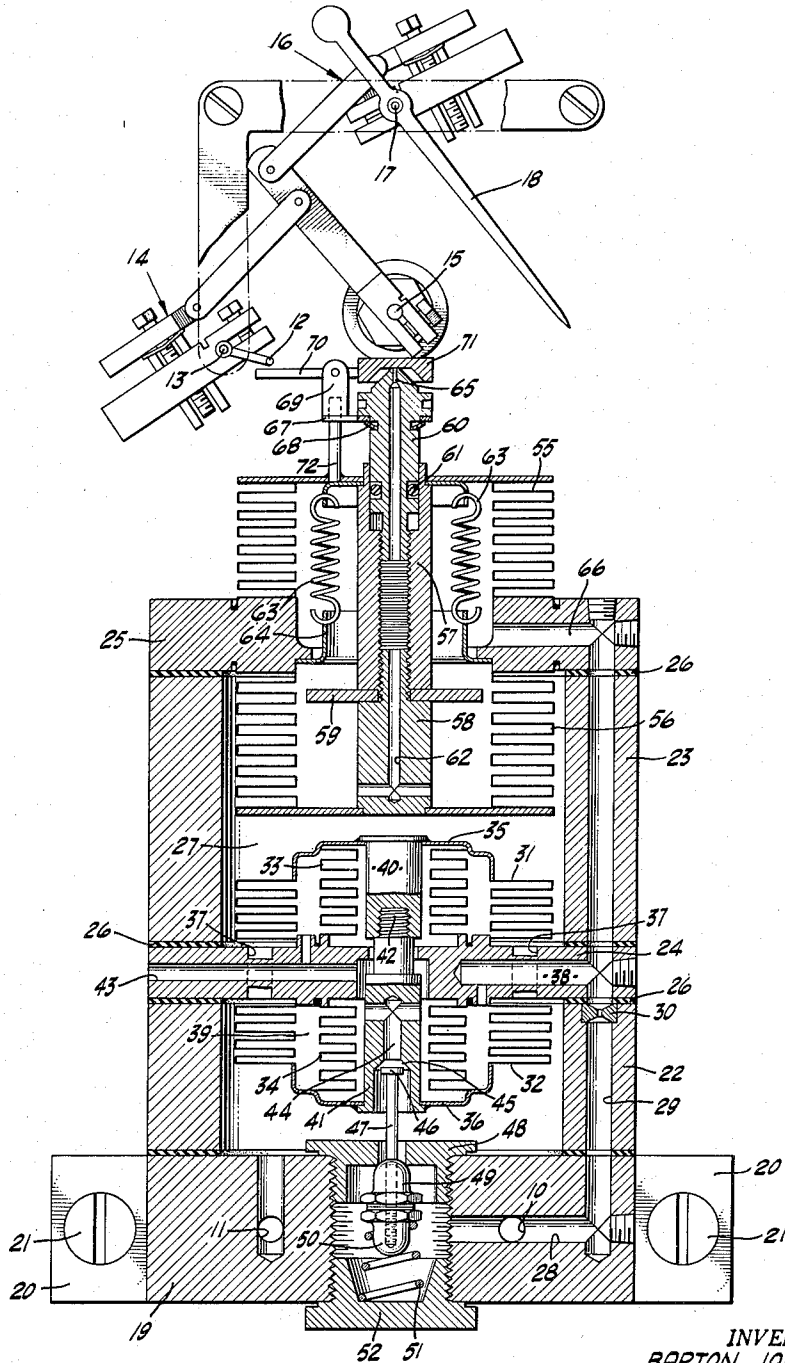
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AIR TRANSMITTER

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ATTORNEYS

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2,718,896

AIR TRANSMITTER

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This invention relates to improvements in air transmitters wherein it is desired to transmit air pressure to a receiver at a pressure which is directly proportional to the movement or position of a movable element.

In air transmitters of this type that have heretofore been developed, air pressure is supplied to a relay at a constant or substantially constant pressure. The relay serves to not only reduce the pressure and deliver it to the outlet leading to the receiver, but in turn, is controlled by a pilot which is governed by the position of a movable element. The pilot generally employed includes a nozzle through which some of the supplied air is discharged after passing through a restrictor to reduce its pressure and a flapper is engageable with the nozzle to control or modify the air that is discharged therethrough. The flapper, in turn, is actuated by the movable element. In the constructions heretofore employed, the pressure at which the air is relayed or discharged through the nozzle is usually a direct function of the air pressure that is relayed by the relay to the receiver so that if the pressure that is released to the receiver is relatively high, the pressure at which the air is supplied to the nozzle is likewise high. Conversely, if the pressure that is relayed to the receiver is relatively low, the pressure at which the air is discharged through the nozzle is likewise low. Under such circumstances, the effect of the flapper on the nozzle varies with the pressure that is transmitted to the receiver. Such variation causes a number of difficulties in an instrument of this character which is intended to be highly accurate. Calibration of the instrument becomes difficult due to the variable effects of the flapper on the nozzle. Stability of the instrument is also hindered and in many instances, there is a tendency of the instrument to "hunt" a stable condition.

It is one object of the present invention to provide an improved air transmitter of this type wherein the pressure at which the air is discharged through the nozzle is constant or substantially so throughout the entire range of pressure that is transmitted to the receiver. With such an arrangement, the effect of the flapper upon its nozzle is substantially constant or uniform regardless of the magnitude of the transmitted pressure. In this manner, calibration of the instrument is rather easily accomplished due to the relatively uniform conditions under which the pilot is functioning. Greater stability can also be secured and "hunting" is largely, if not entirely, eliminated. The construction also lends itself to the ease with which the instrument may be adjusted in "zeroing" the system, it being understood that under zero conditions in systems of this character there is usually a small amount of pressure transmitted to the receiver.

Another object of the invention is to provide an improved relay for reducing the supplied pressure and transmitting the reduced pressure to the receiver in direct accordance with the control of the pilot.

A further object of the invention is to provide a novel construction of pilot wherein operating conditions are sub-

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stantially the same regardless of the pressure controlled by the pilot.

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 drawing for an illustrative embodiment of the invention, wherein the figure is a vertical section through an air transmitter embodying the present invention.

Referring to the accompanying drawing wherein similar reference characters designate similar parts throughout, in an air transmitter of this general type the purpose of the construction is to receive air pressure from a supply source through a supply conduit 10 and to reduce this air pressure and deliver it through an outlet conduit 11 in direct proportion to the position assumed by a movable governing element 12. The situations under which an air transmitter of this type may be used are innumerable but to facilitate a clear understanding of the present invention, a typical situation and typical values will be referred to herein as follows:

The air pressure that is supplied through the supply conduit 10 may be assumed to be a constant or substantially constant pressure of approximately twenty pounds per square inch from any suitable source of supply. The pressure that is delivered through the outlet conduit 11 to the receiver may be assumed to be three pounds per square inch when the receiver is at zero. This pressure may run as high as twenty pounds per square inch. The governing element 12 is shown as being mounted on a rocker shaft 13 which is connected by means of adjustable linkage, generally indicated at 14 to a torque tube or the equivalent indicated at 15. This torque tube may be turned in any suitable manner, such as by means of a differential pressure measuring device and the rotational movement of the torque tube is also transmitted by means of adjustable linkage 16 to a rocker shaft 17 on which a pointer 18 is mounted.

Regardless of what structure may actuate it, the governing element 12 rises and falls in direct accordance therewith, the end of the governing element swinging about the axis of the rocker shaft 13 as a center. It is the position of the governing element 12 that controls or affects the pressure that is transmitted through the outlet 11 to the receiver. In other words, if the end of the governing element 12 is caused to rise from the position shown by the torque tube 15, the pressure transmitted through the outlet 11 is likewise caused to rise. Conversely, if the position of the governing element 12 falls, the pressure that is transmitted through the outlet 11 likewise falls directly in accordance therewith.

The transmitter embodying the present invention consists of a housing preferably formed of several parts, one of which is a base 19 having suitable attaching lugs 20 by which the same may be mounted on a panelboard or equivalent structure by means of screws 21. The inlet conduit 10 is drilled in this base and the outlet conduit 11 is similarly formed therein. On the base there are two superposed cylindrical housing elements 22 and 23 between which there is disposed a spider 24. On the upper housing element 23 there is mounted a cap 25. These parts of the housing are suitably gasketed, such as by gaskets 26 and cooperatively form a chamber 27 in the housing. The housing elements 22, 23, the spider 24, the cap 25, and the base 19 are all firmly attached together by bolts, not shown, which extend vertically through the walls of the housing elements. The inlet conduit 10 leads into a radially drilled hole 28 in the base from which a branch conduit 29 leads to the spider 24 and to the cap 25. A restrictor 30 is mounted in this branch conduit, this restrictor being in the form of a member having a small orifice therethrough which serves

to throttle down the inlet pressure that is received in the inlet conduit 10.

Within the chamber 27 there is disposed the operative members of a relay. This relay consists of a pair of opposed external bellows 31 and 32. Within each external bellows there are internal bellows 33 and 34. These bellows all have their inner ends anchored or secured to the side faces of the spider 24. Their outer or free ends are anchored or are secured on caps 35 and 36, respectively. Between the vertical apertures 37 that are formed in the spider 24 and which keep the upper portion of the chamber 27 in constant communication with the lower portion thereof there is a radial hole 38 drilled in the spider which provides communication between the branch conduit 29 above the restrictor 30 and the space or chamber 39 between the bellows 32 and 34 located on the underside of the spider. In this manner, reduced pressure which is reduced by the restrictor 30 is constantly supplied to the chamber 39 between the lower bellows. This pressure is effective to urge the lower bellows to expand downwardly.

The end caps 35 and 36, however, are caused to move in unison by means of a rigid connector made up of parts 40 and 41 that are mutually threaded together as indicated at 42. These parts are movable through the spider 24 and have shoulders engageable with the spider to limit movements of the bellows under excessive or extreme conditions. The spider 24 has also a radial outlet hole 43 drilled therein between the apertures 37 which communicate with the space around the connector made up of the parts 40 and 41. In the lower part 41 there is formed a passage 44 in which there is formed a valve seat 45 that is engageable with a valve closure 46 on a relay valve. This valve seat, when in its unseated position as shown, permits air pressure in the chamber 27 to escape through the passage 44 and the hole 43 to atmosphere. However, when the valve seat 45 is seated on the closure egress from the chamber 27 through the outlet 43 is prevented. The closure 46 is on a stem 47 that extends through a valve seat 48 screwed into the top of the base 19 and which receives air pressure directly from the inlet conduit 10.

The stem 47 slidably extends through an acorn nut 49 which constitutes a closure adapted to seat on the seat 48. The stem 47 is threaded into an acorn nut 50 so that adjustment of the closure 49 with respect to the stem 47 can be easily accomplished. The acorn nut 50 provides a spring seat for a light compression spring 51 which is also seated on a cap 52 screwed into the bottom of the base 19. As the closure 46 is of such a size that it may pass through the valve seat 48 adjustment of the closure 49 with respect to the stem is easily accomplished by unscrewing the cap 52, removing the spring 51, and allowing the entire relay valve made up of the closure 46, stem 47, and acorn nuts 50 and 49, to be removed. By screwing the nut 50 up or down on the stem 47, adjustment is readily accomplished.

With the relay as above described, it will be appreciated that the bellows 31 and 32, which are opposed, are both subjected to whatever pressure exists in the chamber 27. If, for any reason, the pressure in the chamber 39 causes the opposed bellows 31 and 32 to descend, the valve seat 45 will engage the closure 46 and close the outlet 43 against egress therethrough. If the pressure in the chamber 39 is sufficient to not only seat the valve seat 45 against the closure 46 but to depress the stem 47 and closure 49 against the spring pressure at 51 and the air pressure supplied through the inlet 10, air pressure from the inlet is permitted to enter the chamber 27 and be conducted therefrom to the outlet 11. On the other hand, if the pressure in the chamber 27 is relatively high and the pressure in the chamber 39 is reduced, allowing the bellows to rise, the closure 49 will seat, cutting off the supply of compressed air from the inlet 10 and if the bellows continue to rise, the seat 45

will disengage the closure 46 and allow egress from the chamber 27 through the outlet 43. It will be noted that the outlet 43 is in communication with the chamber or space between the bellows 33 and 31 so that no air leak is formed therein. The bellows 33 in the present construction performs no important function other than to form a balanced structure, it being of equal size and shape to the internal bellows 34. However, it is possible to utilize the space between the bellows 31 and 33 in adapting the construction to controllers. In a relay of this type, where the inlet pressure in the inlet 10 is twenty pounds per square inch, it is found that ordinarily one-quarter pound per square inch is required to unseat the closure 49 when the pressure in the chamber 27 is five pounds per square inch. In other words, if the pressure in the chamber 39 is just sufficient to cause the seat 45 to engage the closure 46 and thus close the outlet 43 against egress therethrough, an additional one-quarter pound per square inch is required to unseat the closure 49 and thus permit flow of compressed air from the inlet 10 into the chamber 27.

The pilot governing the action of the relay consists of two opposed bellows 55 and 56 mounted upon the upper and lower sides of the cap 25, respectively. These bellows have their caps rigidly connected by a connector made up of the parts 57 and 58 which are threadedly connected together and serve to support a washer 59 that is engageable with the cap to limit upward movement of the connector.

In the upper part 57 a nozzle 60 is threadedly mounted so that it may be adjusted relatively thereto and this nozzle is sealed against leakage thereabouts by means of an O-ring 61. A passage 62 formed in the connector provides communication between the interiors of the two bellows and the nozzle. The bellows are urged or are biased in a downward direction by means of a plurality of tension springs 63 which connect the cap of the upper bellows with a spring retainer 64 that is held against the underside of the cap 25. At the extreme upper end of the nozzle 60 there is a small orifice 65, the size of which together with the restraint of the flapper 71 governs the working pressure that is maintained in the bellows 55 and 56. This working pressure is supplied from the branch conduit 29 through a radial bore 66 in the cap. On the nozzle there is a bracket 67 that is held against an external shoulder on the nozzle by means of a split dished washer 68. This bracket has upstanding ears 69 between which the stem 70 of a flapper 71 is pivoted. The bracket 67 is held against rotation relative to the nozzle by means of a guide pin 72 that is mounted on the cap of the upper bellows and which slidably extends into the bracket. This maintains the stem 70 in alignment with the governing element 12. The weight of the flapper 71 urges the flapper down over the orifice 65 of the nozzle. However, the extent to which the flapper closes the orifice is governed by the engagement between the stem 70 and the governing element 12. Under normal conditions the flapper is slightly spaced from the end of the nozzle in the neighborhood of .001" which is variable depending upon the extent to which the stem 70 is engaged by the governing element 12.

In this form of construction of pilot it will be observed that the springs 63 urge the two bellows 55 and 56 downwardly. The working pressure that is maintained within the bellows has a neutral or balanced effect inasmuch as both bellows are of the same effective area or substantially so. However, the exterior of the lower bellows 56 being within the chamber 27 is subjected to the pressure in the chamber which is effective to urge both bellows upwardly against the action of the springs 63.

Operation

The operation of the above described construction is as follows:

In the position shown in the figure, the closure 46 has

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been disengaged by the seat 45, opening the chamber 27 through the closure 46. The closure 49 is shown as being seated, cutting off the supply of compressed air from the inlet 10 to the chamber 27. The stem 70 is illustrated as being beneath and out of engagement with the governing element 12. Consequently, the weight of the flapper 71 is free to exert its maximum effort to close the orifice 65. The closing of the orifice 65 causes the operating pressure delivered through the restrictor 30 to build up and the building up of this pressure is transmitted to the chamber 39. The increase of pressure in the chamber 39 causes the opposed bellows of the relay to descend, causing the seat 45 to engage the closure 46 and ultimately the stem 47 to unseat the closure 49, admitting compressed air to the chamber 27 from the inlet 10. As air is admitted to the chamber 27 the pressure increases and the increase in pressure is effective on the bellows 56 tending to elevate the opposed bellows 55 and 56 of the pilot. When these bellows move upwardly in unison, due to the rigid connectors 57 and 58, the nozzle 60 and the flapper, together move upwardly until the stem 70 engages the governing element 12. When the governing element 12 is engaged by the stem 70 the stem pivots on the ears 69 lifting the flapper 71 from the nozzle and allowing air to escape through the orifice 65 more readily. However, as the flapper is mounted on the nozzle and is movable therewith in all positions the relationship of the flapper with respect to the nozzle remains substantially the same except for the slight change in position involved in opening and closing the nozzle. This arrangement is conducive to consistency of operation in all positions. The opening of the orifice 65 by the flapper allows a reduction in pressure to take place within the bellows 55 and 56. This reduction in pressure causes the pressure within the chamber 39 to be correspondingly reduced, and as previously explained, a reduction in pressure in this chamber allows the bellows of the relay to tend to return to their normal or neutral position wherein the closure 49 is seated and the closure 46 is also seated. The pressure within the chamber 27 which is transmitted through the outlet 11 to the receiver is consequently commensurate with the position of the governing element 12. It will, of course, be appreciated that whatever pressure exists in the chamber 27 is effective on the bellows 56, causing the bellows of the pilot to quickly assume a stable condition wherein the flapper 71 is so spaced from the end of the nozzle that a small amount of air is continually escaping. In such position the orifice 65 is neither fully closed nor fully open.

If conditions change so as to change the position of the torque tube 15 and elevate the governing element 12, the weight of the flapper 71 again tends to close the orifice 65, bringing about an increase of pressure in the bellows 55 and 56 and an increase in pressure in the chamber 39. This increase in pressure in the chamber 39 may be effective to admit more air to the chamber 27 from the inlet 10 as previously explained, with the result that the same operation is to take place as previously explained until the stem 70 reengages the governing element 12, causing the flapper to open the orifice 65.

On the other hand, if the torque tube 15 should be so actuated as to depress or lower the governing element 12, this depresses the stem 70, lifting the flapper 71 and thus opening the orifice 65. The opening of the orifice 65 to a wider or greater extent allows air to escape through the nozzle more readily. This causes a reduction in pressure within the bellows 55 and 56 which reduction is transmitted to the chamber 39. When the pressure in the chamber 39 is reduced the bellows of the relay tend to rise into their normal position, causing the seat 45 to disengage the closure 46 and allow some of the pressure in the chamber 27 to be released through the outlet 43. A release of the pressure in the chamber 27 reduces the pressure that is transmitted to the receiver through the outlet 11. It is also effective to reduce the

force acting on the lower bellows 56 and permit the springs 63 to lower both bellows of the pilot. As the upper bellows is lowered the nozzle and the flapper are also lowered until the stem 70 is just about to disengage the governing element 12. When this occurs the flapper 71 returns to its normal position only slightly spaced from the end of the nozzle and a new set of conditions in equilibrium is quickly obtained.

It will be appreciated that with this type of arrangement the pressure within the bellows 55 and 56 of the pilot and within the chamber 39 is substantially a constant. The only sensible variation that is required in the pressure is that pressure that is necessary to unseat the closure 49 after the closure 46 has been seated on the seat 45. At a working pressure of five pounds per square inch this excess of pressure required to unseat the closure 49 need only be about one-quarter pound per square inch. Consequently, under any set of conditions the variation in the operating pressure discharged through the orifice 65 and tending to lift the flapper 71 is substantially the same, the variation being only about one-quarter pound per square inch. This is true regardless of what the pressure may be in the chamber 27 that is transmitted through the outlet 11 to the receiver. Consequently, calibration with respect to the scale traversed by the pointer 18 is greatly facilitated. An also greater stability can be secured and variations due to "hunting" are avoided. The arrangement is such that zeroing of the instrument can be easily accomplished. Thus, if a certain position of the governing element 12 corresponds to a zero position of the pointer 18, and in such position it is desired that the pressure in the outlet 11 be three pounds per square inch, it is possible to easily adjust the nozzle and the flapper by merely screwing the nozzle 60 up or down with respect to the part 57 until conditions are such that the flapper will be opened the required distance to cause a three pound pressure to be delivered through the outlet 11 while the governing element 12 is in the position stated.

From the above-described construction it will be appreciated that the improved air transmitter has a number of advantages not only in ease of calibration, ease of adjustment, accurate transmission of pressure to the outlet 11, but also in the ease of manufacture, assembly, and maintenance.

The mounting of the pilot bleed nozzle 60 and the positioning of the sensing flapper 71 on one end of a pair of opposed bellows whose floating ends are rigidly connected; the feeding of the air to the nozzle through the interior of the bellows and the positioning of the entire pilot assembly such that transmitted air pressure in the chamber 27 is effective on the exterior of the bellows 56, produces a construction having a constant sensitivity at all positions regardless of any stabilized output pressure. The use of opposed bellows whose floating or free ends are rigidly connected in the relay valve together with the porting with relation thereto as illustrated is such that the transmitted air pressure has no effect upon them as to their position. Their position is controlled or determined solely by the pilot nozzle pressure which is determined by the position of the flapper 71 with respect thereto. Other advantages of the present construction will be appreciated by those skilled in the art.

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. An air transmitter comprising a housing providing a chamber, a spider in said chamber, a pair of opposed bellows in the chamber mounted upon the spider, means connecting the outer ends of the bellows to cause them to move in unison, a second pair of opposed bellows mounted on a wall of the housing, one of the second bellows being disposed in said chamber, means connecting the outer ends of the bellows of the second pair to cause them to move in unison, a nozzle mounted on the outside bellows

of the second pair and connected to the interiors thereof so as to receive fluid therefrom, spring means biasing the bellows of the second pair towards said chamber, a flapper engageable with the nozzle to control egress therefrom pivotally supported on the second pair of bellows so as to be movable therewith, means for actuating the flapper relatively to the nozzle, a supply conduit leading to the housing, a restrictor in a branch of said conduit leading to the interiors of both sets of bellows, there being an inlet from the supply conduit leading into said chamber, there being two outlets from said chamber and a relay valve controlling the inlet and one of the outlets.

2. An air transmitter comprising a housing providing a chamber, a spider in said chamber, a pair of opposed bellows in the chamber mounted upon the spider, means connecting the outer ends of the bellows to cause them to move in unison, a second pair of opposed bellows mounted on a wall of the housing, one of the second bellows being disposed in said chamber, means connecting the outer ends of the bellows of the second pair to cause them to move in unison, a nozzle mounted on the outside bellows of the second pair and connected to the interiors thereof so as to receive fluid therefrom, spring means biasing the bellows of the second pair towards said chamber, a flapper engageable with the nozzle to control egress therefrom pivotally supported on the second pair of bellows so as to be movable therewith, means for actuating the flapper relatively to the nozzle, a supply conduit leading to the housing, a restrictor in a branch of said conduit leading to the interiors of both sets of bellows, there being an inlet from the supply conduit leading into said chamber, there being an outlet through a wall of the chamber, a second outlet through the connecting means of the first-mentioned pair of bellows and through the spider, and a relay valve controlling the inlet and the outlet through

the connecting means of the first-mentioned pair of bellows.

3. An air transmitter comprising a housing providing a chamber, a spider in said chamber, a pair of opposed bellows in the chamber mounted upon the spider, means connecting the outer ends of the bellows to cause them to move in unison, a second pair of opposed bellows mounted on a wall of the housing, one of the second bellows being disposed in said chamber, means connecting the outer ends of the bellows of the second pair to cause them to move in unison, a nozzle adjustably mounted on the outside bellows of the second pair and connected to the interiors thereof so as to receive fluid therefrom, spring means biasing the bellows of the second pair towards said chamber, a flapper engageable with the nozzle to control egress therefrom pivotally supported on the second pair of bellows so as to be movable therewith, means for actuating the flapper relatively to the nozzle, a supply conduit leading to the housing, a restrictor in a branch of said conduit leading to the interiors of both sets of bellows, there being an inlet from the supply conduit leading into said chamber, there being two outlets from said chamber, and a relay valve controlling the inlet and one of the outlets.

References Cited in the file of this patent

UNITED STATES PATENTS

2,240,243	Mason	Apr. 29, 1941
2,302,014	Fausek	Nov. 17, 1942
2,310,298	Kuhl	Feb. 9, 1943
2,380,858	McMahon	July 31, 1945
2,413,584	Side	Dec. 31, 1946
2,461,026	Bilyeu	Feb. 8, 1949
2,556,436	Moore	June 12, 1951