Aug. 6, 1963 J. C. MOORE 3,100,002

VALVE STRUCTURE

Filed Sept. 19, 1960

Fig-1

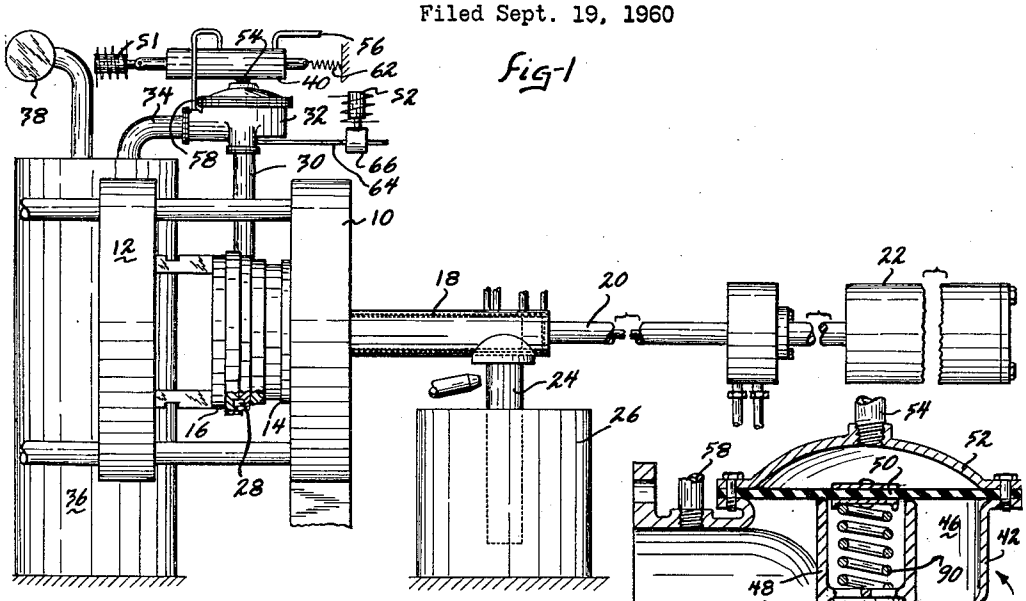


Fig-5

Fig-2

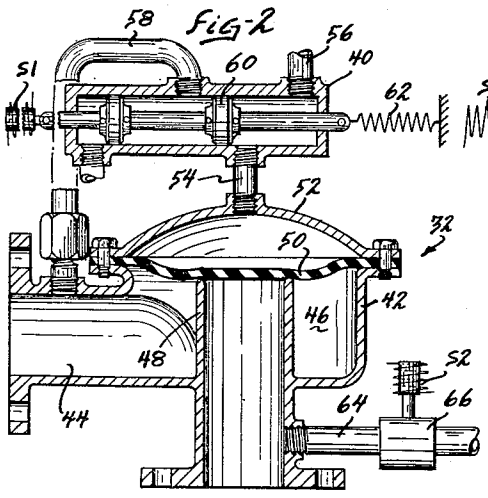


Fig-3

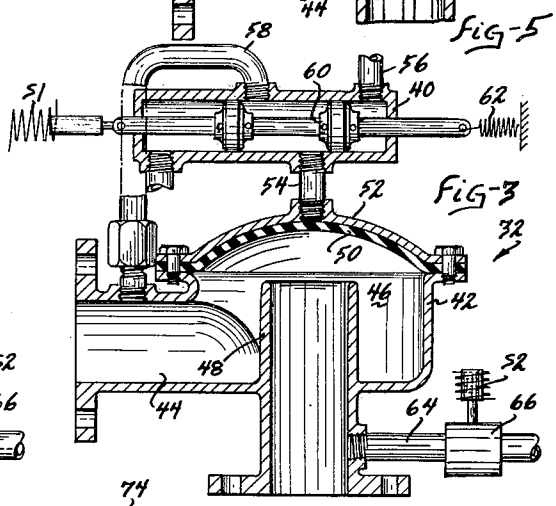
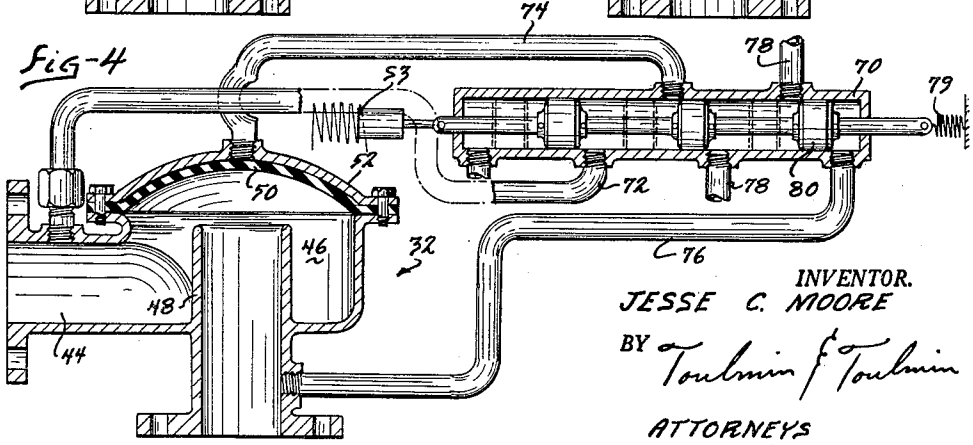


Fig-4



INVENTOR.
JESSE C. MOORE
BY Toulmin & Toulmin
ATTORNEYS

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VALVE STRUCTURE

Jesse C. Moore, Box 147, Fort Recovery, Ohio

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This invention relates to valves and is particularly concerned with a valve for controlling vacuum connections. The control of vacuum connections is many times difficult to accomplish properly because in circumstances where the vacuum is to be applied extremely rapidly it is necessary very quickly to establish an adequate flow passage for the application of the vacuum and at the same time to provide means for tightly closing the passage when the vacuum is not applied so that there is no wasting of the source of vacuum.

A particular instance of this nature is in connection with a vacuum die casting process in which the die cavity is evacuated prior to the injection therein of the molten material being cast in the cavity.

Such die casting operations, particularly where metal is being utilized, reach their highest degree of efficiency only when the cycle is timed out extremely closely so that the die cavity can be evacuated to a high degree and the metal immediately introduced into the cavity.

A system of this nature also requires that the source of vacuum be sealed off from the die cavity when the cavity is not being evacuated because the maintaining of a high degree of vacuum at the source requires that there be absolutely no leakage of gases into the source.

Having the foregoing in mind, a particular object of this invention is the provision of a valve for controlling the application of vacuum to a die casting cavity in a die casting mold or the like in which the control is extremely simple and rapid.

Another object of this invention is the provision of a vacuum control valve which has greatly increased opening and closing speed over what has been known heretofore.

A still further object of this invention is the provision of a vacuum valve having a flow passage therethrough of such adequate proportion that small particles of material such as metal particles that might be drawn from the die will pass directly through the valve and will not interfere with the operation thereof.

A still further object is the provision of a vacuum valve, especially for use with die casting machines having vacuum systems which can be operated extremely rapidly without setting up noise or vibration as will occur, for example, in connection with piston type or poppet type valves.

Still a further object of this invention is the provision of a large capacity valve for controlling vacuum application which is light in weight and easily installed and maintained and which can be operated by a relatively small quick acting pilot valve.

A still further object of this invention is the provision of a valve for controlling the application of vacuum from a source to a work station which is pilot operated and in connection with which the pilot area is easily maintained free of foreign matter.

A still further object of this invention is the provision of a pilot operated vacuum application control valve which is readily applicable to widely varying circumstances and the combination therewith of a pilot control valve.

These and other objects and advantages will become more apparent upon reference to the drawings in which:

FIGURE 1 is a rather diagrammatic representation of a vacuum die casting installation utilizing a vacuum control valve according to the present invention in the vacuum system;

FIGURE 2 is a vertical sectional view through the control valve and the pilot valve pertaining thereto drawn at enlarged scale and showing the vacuum control valve closed;

FIGURE 3 is a view like FIGURE 2 which shows the pilot valve shifted, and the vacuum control valve open;

FIGURE 4 is a view like FIGURE 3 but shows the vacuum control valve connected to a different type of pilot valve; and

FIGURE 5 is a fragmentary view showing the manner in which a spring could be provided for assisting in the opening of the vacuum control valve.

Referring to the drawings somewhat more in detail, in FIGURE 1 there is shown a die casting machine having a stationary platen 10 and a movable platen 12 which carry the parts 14 and 16 respectively of a die having a cavity into which molten material is to be injected. In this case metal is to be injected into the die cavity although it will be evident that molten plastic could be treated in a machine of this nature as well as metal.

For handling metal there is an injection or shot cylinder 18 in which extends reciprocable plunger 20 actuated by a motor 22. Extending downwardly from cylinder 18 toward the end thereof remote from the die is a supply tube 24 leading into a crucible 26 or some other source of molten material.

The die parts 16 and 14, when closed, have means at 28 defining a space about the parting line of the die that is employed for evacuating the die cavity.

According to conventional practices, there may be thin passages leading from the die cavity outwardly along the parting line of the die so that when the space about the parting line is evacuated, gases in the die cavity will be drawn therefrom. These thin passages will, of course, be of such dimensions that the molten material injected into the die cavity chill and set up therein without flowing completely out into the space about the die.

The aforementioned space is connected to a relatively large conduit 30 leading to one port of a vacuum control valve 32 constructed according to the present invention.

The valve has another port connected by conduit 34 with a tank 36 which is evacuated by vacuum pump 38 and thus forms a large source of vacuum. The opening and closing of valve 32 is under the control of pilot valve 40 connected with valve 32.

The construction and operation of the valve 32 and pilot valve 40 is illustrated in FIGURES 2 and 3 wherein it will be seen that valve 32 has a body 42 having a lateral passage 44 that connects with the aforementioned conduit 34. Conduit 34 is thus communicated with a large annular space 46 within the body. The outer surface of this annular space is formed by the wall of body 42 and the inner surface is formed by the inner tubular portion 48 which is a part of the body and which extends downwardly to communicate with the aforementioned conduit 30 leading to the die cavity. The upper end of tubular por-

tion 48 and the upper surface of the body part 42 are in substantially the same plane and there extends across the upper open side of the body part a diaphragm 50 adapted for engaging the upper end of tubular portion 48 and sealing the interior thereof from annular cavity 46.

A cover member 52 is clamped to the body part and thus clamps the diaphragm in position while sealing the periphery thereof. Member 52 also defines a pilot chamber above the diaphragm 50 which is utilized for causing movement of the diaphragm between its open and closed positions.

The movement of the diaphragm is under the control of the aforementioned pilot valve 40 which will be seen to have a port connected by the pilot conduit 54 with the space above the diaphragm 50. The pilot valve also has another port communicating via conduit 56 with the atmosphere or with a source of air under pressure.

A third port in the pilot valve is connected by conduit 58 with passage 44 in the valve body. Since passage 44 is continuously in communication with tank 36 through conduit 34, it will be evident that conduit 58 is continuously at vacuum pressure and that, accordingly, movement of the valve member 60 of pilot valve 40 can be availed of for connecting the space above diaphragm 50 alternately with the vacuum source and with conduit 56.

When the pilot valve member 60 is in its FIGURE 2 position, and which is accomplished by energization of a solenoid S1 that moves the pilot valve against the bias of spring 62, the top of the diaphragm is connected either with atmosphere or with a source of fluid pressure. In either case, the vacuum standing in annular passage 46 will draw the diaphragm downwardly into sealing engagement with the upper end of the tubular portion 48.

Upon de-energization of solenoid S1, spring 62 will prevail and valve member 60 will be shifted to its FIGURE 3 position and in which position the conduit 54 is connected with conduit 58 so that suction is applied to the upper surface of diaphragm 50 which will cause it to move with extreme rapidity to its FIGURE 3 position thus uncovering the upper end of the tubular portion 48 so that gases will be exhausted from the die cavity upwardly through conduit 30 and tubular portion 48 into annular space 46 of the valve body and thence through passage 44 and conduit 34 to tank 36. Due to the substantially unrestricted nature of the passage through the conduits and valve body, any foreign material, such as metal particles or the like that are drawn upwardly into the valve will pass therethrough and thus will not interfere with subsequent operations of the valve.

It will be understood that since the vacuum connection to the diaphragm on the top thereof is from a point in the vacuum passage that is down stream from the underside of the diaphragm, the degree of suction on the back of the diaphragm will be slightly higher than that on the underside so the diaphragm will remain in its open position even though there is substantially no loss of vacuum through the valve.

Upon energization, solenoid S1 will return the pilot valve member 60 to its FIGURE 2 position, and the space above the diaphragm 50 will either be connected to the atmosphere or to a source of fluid under pressure and in either case diaphragm 50 will quickly return to its FIGURE 2 position.

It will many times be of advantage to relieve the space inside tubular portion 48 or suction. For example, relief of this suction will permit easier opening of the die at the end of the injection cycle and by at least slightly pressurizing the inside of tubular portion 48, some assistance will be effected in opening the die and any dust or any other foreign material therein be blown out.

This can be accomplished by connecting a conduit 64 into the side of tubular portion 48 and connecting the conduit either to the atmosphere or to a source of air under pressure and controlling the conduit by a valve 66 having an actuating solenoid S2. Solenoid S2 will operate to open valve 66 only after diaphragm 50 is closed as in FIGURE 2, and immediately prior to opening of the die.

FIGURE 4 illustrates a modification in which a different type pilot valve is employed. In FIGURE 4 the pilot valve 70 has a port connected by conduit 72 with the suction side of valve 32, another port connected by conduit 74 with the upper side of diaphragm 50, a port connected by conduit 76 with the interior of tube portion 48, and other ports connected by conduit means 78 with the atmosphere. A spring 79 is provided for normally biasing valve member 80 into a position for connecting conduits 72 and 74 for opening the vacuum valve whereas solenoid S3 is provided which, when energized, moves valve member 80 into position to connect both conduits 74 and 76 with conduit means 78 thereby to admit atmospheric pressure to the upper side of the diaphragm whereupon it will close. At the same time, atmospheric pressure is admitted to the inside of the tubular portion 48. In cases where it might be desired to have extremely rapid operation of the diaphragm, there may be provided a spring 90 bearing on the diaphragm in one direction or the other so that even more rapid operation of the diaphragm in the desired direction can be had.

It will be understood that the particular application of the valve illustrated and the particular pilot valve control arrangement are subject to variation. For example, the pilot valve could form an integral part of the vacuum control valve, or it can be located in a position remote therefrom. Remote location of the pilot valve would, of course, slow down the operation of the main valve but would be of benefit when the main valve itself was inaccessible. The main valve could be employed in this manner, for example, for controlling conduits located underground. Further, in this connection, it will be evident that the valve has application for controlling fluid under pressure as well as suction so long as the pressure supplied to the top of the diaphragm is sufficient to cause closing thereof when desired.

Accordingly, it is not intended the present invention be regarded as limited solely to the control of the application of suction but is intended also to be considered in the light of controlling pressure fluids as well.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions; and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claim.

I claim:

In a large capacity valve particularly adapted for controlling the application of vacuum; a pan shaped valve body open at the top, a first port of large area opening laterally from said valve body adapted for connection with a source of vacuum, straight conduit means integral with said valve body extending vertically along the central axis thereof and terminating at the top at about the level of the top of the valve body and extending out the bottom of the valve body to define a second port also of large area for connection with a space to be evacuated, the area in said valve body around the conduit means being at least as great as that of said conduit means, a flexible diaphragm extending across the top of the valve body, a cover member deeply concave downwardly fixed to the valve body and sealingly clamping the diaphragm thereto, said diaphragm having a lower position in which it engages the upper end of said conduit means and seals it off from the inside of said valve body and having an upper position spaced from the conduit, in which position there is communication between said conduit means and the valve body, a pilot valve of substantial size, a connection from the pilot valve to the first port, another connection from said pilot valve to the inside of said cover, and another connection from the pilot valve to the atmosphere, and a valve member movable in the pilot valve for controlling said connections for alternately connecting the inside of said cover with the first port or with the atmosphere, there

also being a connection from the pilot valve to said conduit means and said pilot valve member being operable simultaneously to connect the inside of the cover and the inside of the conduit means with the atmosphere.

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