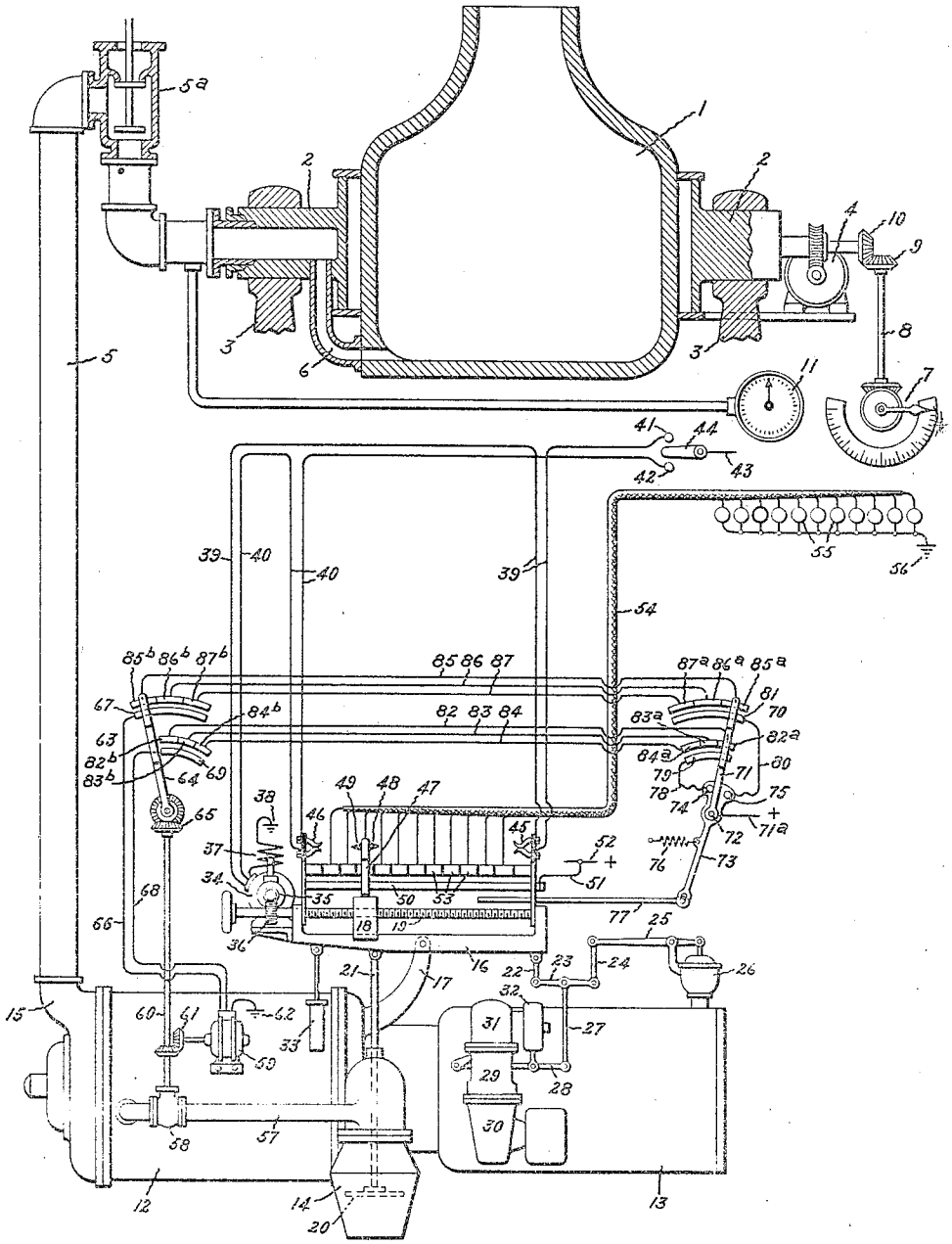
L. C. LOEWENSTEIN.

CENTRIFUGAL COMPRESSOR.

APPLICATION FILED MAR. 13, 1918.

1,325,255. Patented Dec. 16, 1919.



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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL COMPRESSOR.

1,325,255. Specification of Letters Patent. Patented Dec. 16, 1919.

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To all whom it may concern:

Be it known that I, LOUIS C. LOEWENSTEIN, a citizen of the United States, residing at Lynn, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Centrifugal Compressors, of which the following is a specification.

In connection with the operation of centrifugal compressors the conditions are met with in certain kinds of work which require that the volume or both the volume and pressure of the air or other fluid delivered by the compressor be increased or decreased over a wide range, and by predetermined amounts, and the object of my invention is to provide an improved regulating and controlling mechanism for a compressor for use wherever such conditions are encountered.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying specification and the claims appended thereto.

The accompanying drawing is a diagrammatic view illustrating my invention as applied to a converter used in the process of smelting metals.

Referring to the drawing, 1 indicates a converter provided with trunnions 2 carried in supports 3. The converter is adapted to be tilted on supports 3 by a motor 4 to bring the mouth of the converter to a position for discharging its contents. Air is supplied to the converter through a conduit 5 which leads to the twyers 6. In conduit 5 is a double seated valve 5^a by means of which the air supply to converter 1 can be quickly interrupted if occasion arises. It will be understood that in the converter house is suitable switch mechanism (not shown) for controlling the operation of motor 4 and the attendant is advised of the angular position of the converter by an indicator 7 operated by shaft 8 and bevel gears 9 and 10 from one of the trunnions 2. A pressure gage 11 is also provided in the converter house to indicate the pressure of the air being supplied to the converter.

Air is supplied to conduit 5 by a centrifugal compressor 12 driven by a suitable form of motor, here shown as an elastic fluid turbine 13. The inlet conduit of the compressor is indicated at 14 and the discharge conduit at 15. The turbo-compressor is equipped with a constant volume governing mechanism which automatically regulates it to cause the compressor for any particular setting of the governing mechanism to deliver a constant volume of air corresponding to such setting. The constant volume governing mechanism illustrated is one of a well known type comprising a beam 16 pivoted on a fixed support 17 and carrying a weight 18 which is adjustable along the beam. The weight 18 is adjusted by means of a threaded rod 19 which is journaled in the beam at its two ends and is fixed against longitudinal movement. The threads on rod 19 engage threads in the weight so that by turning the rod the weight will be forced back and forth along the beam. In the inlet conduit 14 of the compressor is a float 20 which rides on the air entering the compressor and is connected by a rod 21 to the beam 16. At one end beam 16 is connected by a link 22 to one end of a floating lever 23, the other end of which is connected by a link 24 to the governor lever 25 of a centrifugal governor 26. Floating lever 23 is connected by a rod 27 to the actuating lever 28 of a valve gear or regulator 29 which controls the admission of elastic fluid to the turbine 13. The valve gear 29 may be of any suitable character, a well known type being illustrated which embodies a valve chest 30 and a fluid actuated motor 31 provided with a pilot valve 32. The operation of such a valve gear is well understood and needs no detailed description. A dash pot 33 is provided to steady the movements of the beam 16.

A constant volume governing mechanism as just described operates as follows: Proper calibrations on the beam 16 indicate where the weight 18 is to be set for the desired volume of flow, and the float 20 acts on the beam 16 to tilt it so as to cause the fluid motor 31 to open and close the valve mechanism 30, which in turn admits more or less fluid to the turbine and thereby causes such regulation of the speed of the turbine as to obtain sufficient air discharge pressure from the compressor to force the proper quantity or volume of air through the air discharge conduit of the compressor. If the sliding weight 18 is set for a certain volume of air and less air flows past the float 20, the float lowers a little thus tilting the beam 16 in an anti-clockwise direction. This movement of

beam 16 lifts the pilot valve 32 by means of link 22, floating lever 23, rod 27 and lever 28, the floating lever 23 pivoting on the end of link 24, and opens the valve mechanism 30 to admit more elastic fluid to the turbine, thus causing an increase in the speed of the turbine and compressor. Increase of speed of the compressor raises the pressure of the discharged air and also the volume delivered and therefore more air passes by the float 20 tending to raise the same and place it in the correct position for the volume of air desired. On the other hand, if the volume increases then the float will rise and will tilt the beam 16 in the opposite direction. This motion will close off the valve mechanism 30 so as to admit less elastic fluid to the turbine, thus reducing the speed until the proper volume of air is delivered. The speed governor 26 is normally inactive, the turbine being wholly under the control of the constant volume governor, and only comes into play to take control in case of excess speed. In other words, it is somewhat of the nature of an emergency governor.

The turbine and compressor are in a housing separate from that in which the converter is located, and it is desirable to have the operator in the converter house control the compressor in accordance with the needs of the converter. In other words, it is desirable to adjust the weight 18 along the beam 16 from a distance. I accordingly mount on the beam 16 a motor 34 which has a worm 35 on its shaft meshing with a worm wheel 36 on threaded rod 19. Motor 34 is of the split field type having one winding for driving it in one direction and a second winding for driving it in the opposite direction, and in series with both windings is a magnetic brake 37 which when neither motor winding is energized brakes the motor armature shaft. The two motor windings are grounded on one side as indicated at 38, and are connected on the other side by conductors 39 and 40 to contacts 41 and 42 which may be connected to a source of power, as indicated by conductor 43, by means of a double-throw switch 44. At opposite ends of beam 16 are pairs of spring contacts 45 and 46, the contacts 45 being in conductor 39 and the contacts 46 being in conductor 40. Carried by weight 18 is an insulated contact finger 47 provided on its outer end with wedge shaped projections 48 and 49 of suitable insulating material. When the weight 18 reaches the end of its movement toward the right, projection 48 enters between contact fingers 45 wedging them apart and opening the motor circuit through conductor 39, and when weight 18 reaches the end of its movement toward the left, projection 49 enters between contact fingers 46 wedging them apart and opening the motor circuit through conductor 40. This prevents over travel of weight 18 in either direction. Contact finger 47 travels over a long contact member 50 connected by conductor 51 to a source of power, indicated by line wire 52, and over a series of contacts 53 connected by a cable 54 to a series of indicators 55, here shown as electric lights, which are grounded on one side, as indicated at 56. The indicators 55 show the position of weight 18 on beam 16 and they are suitably located in the converter house adjacent the switch 44. If found desirable, suitable indices may be placed adjacent each indicator 55 to show the volume of flow to which it corresponds.

As is well known, under certain conditions of light load, a centrifugal compressor pulsates and to overcome this a pulsation preventing valve mechanism is provided. Such a mechanism may comprise a throttle valve for throttling the inlet of the compressor, a valve either for wasting air from the discharge side of the compressor or for passing air from the discharge side to the inlet; or a suitable combination of the two. According to my invention a pulsation preventing valve mechanism is provided together with automatic means for actuating it so as to prevent the occurrence of pulsations. To this end a by-pass conduit 57 is provided which connects the discharge side of the compressor to the inlet side, and in it is a valve 58 adapted to be opened and closed by a motor 59, the shaft of which is connected to the valve stem 60 by a bevel gearing 61. Motor 59 is of the split field type being provided with two windings grounded as indicated at 62, one winding driving the motor in a direction to open the valve, and the other in a direction to close it. 63 indicates a controller having a contact arm 64 which is driven by a bevel gearing 65 from the valve stem 60. One winding of motor 59 is connected by a conductor 66 to a contact 67 of controller 63, and the other winding of motor 59 is connected by conductor 68 to a contact 69 of controller 63. At 70 is a second controller provided with a contact arm 71 loosely mounted on a shaft 72. Also mounted on shaft 72 is an actuator 73, upon which are two projecting contact pins 74 and 75. When actuator 73 is turned on shaft 72 one of the contact pins 74 or 75 (depending upon which way the actuator is turned) will engage the contact arm 71 and move it over the contacts of controller 70. Actuator 73 is biased to the position shown in the drawing by a spring 76 and is adapted to be moved by a push rod 77, the end of which is engaged by the weight 18 when the weight reaches a position on beam 16 at which pulsations are likely to occur. The lower end of contact arm 71 is connected to a souce of electrical energy here indicated

as a line wire 71ª. Contact pin 74 is connected by conductor 78 to contact 79 and contact pin 75 is connected by conductor 80 to contact 81. Conductors 82, 83 and 84 connect contacts 82ª, 83ª and 84ª of controller 70 to contacts 82ᵇ, 83ᵇ and 84ᵇ of controller 63, and conductors 85, 86 and 87 connect contacts 85ª, 86ª and 87ª of controller 70 to contacts 85ᵇ, 86ᵇ, and 87ᵇ of controller 63.

For explaining the invention it may be assumed that the turbo-blower is to pass through a cycle in which it is started up first at a low volume and then the volume is gradually increased by steps, as the chemical process in the converter progresses. For example, it may be desirable to deliver in the first instance 2500 cu. ft. of air per minute at a pressure of approximately 2 pounds and then to increase the volume delivered until a volume of 25,000 cu. ft. per minute at a pressure of approximately 20 pounds is reached. Assuming that the weight 18 stands in the position shown in the drawing, the operator in the converter house will move the switch 44 into engagement with contact 41. This will close a circuit from line wire 43 through the switch 44 and conductor 39 to the motor 34 and to ground at 38, and one winding of motor 34 will be energized and the motor 34 operated to turn the threaded rod 19 in a direction to drive the constant volume governor weight 18 toward the right. As it moves toward the right the operator by means of the indicators 55 can tell the position which the weight has reached, the contact finger 47 closing successive circuits through the indicators 55, as is obvious. When the weight 18 has reached the position for the desired minimum volume the switch 44 is opened. The constant volume governing mechanism will regulate the compressor to deliver the volume of air for which the weight is thus set. Now when it is desired to increase the volume of air the operative moves the switch 44 into engagement with contact 42. This closes a circuit from line wire 43 through switch 42 and conductor 40 to the other winding of motor 34 and to ground at 38. The motor 34 is then operated in a direction to move the weight 18 toward the left and the circuit is kept closed until the weight has moved the necessary distance to set it for the volume of flow now desired. This can be repeated as often as necessary during the process, the weight 18 being successively set for the volumes desired at any time.

Occasion may some times arise in connection with this apparatus when it is desirable to regulate the speed of motor 34 so that it will move the constant volume governor weight 18 through a given range during a certain period of time. The usual converter process is such that the time required to carry it out can be definitely ascertained. For example, a given converter process may require two hours, and during such period it may be desirable to gradually increase the volume of air delivered by the compressor to the converter from 2500 cu. ft. per minute to 25,000 cu. ft. per minute. Under these circumstances the motor 34 may be so geared to the rod 19 and its speed so controlled that it will move the weight 18 from the minimum volume setting to the maximum volume setting in exactly two hours. For such operation the switch 44 will be set against contact 41 continuously and need be operated by hand only when the movement of the weight is to be stopped for any reason. If found desirable, a simple rheostat control may be used in connection with switch 44 whereby the speed of motor 34 may be regulated, or other suitable means may be provided. It will be understood that the figures above given are only by way of illustration and are not to be taken as in any way limiting my invention.

When the constant volume governor weight 18 is moved to the right to such a point that the volume to be delivered is so small that pulsations are likely to occur, the weight strikes the end of rod 77 and pushes it toward the right, thus turning the actuator 73 on the shaft 72. The first movement of actuator 73 moves the contact pin 74 out of engagement with contact arm 71 and the contact pin 75 into engagement therewith. This closes a circuit from line wire 71ª through contact pin 75, conductor 80, contact 81, the end of contact arm 71, contact 85ª, wire 85, contact 85ᵇ, the end of contact arm 64, contact 67, conductor 66, and one winding of motor 59 to ground at 62. This operates the motor 59 in a direction to open valve 58. As the valve 58 begins to open the stem 60 through gearing 65 moves the contact arm 64 of controller 63 in a clockwise direction until its upper end moves from engagement with contact 85ᵇ into engagement with contact 86ᵇ. This opens the circuit through motor 59 and leaves the valve 58 in a partly open position, the arrangement being such that it is open sufficiently far to prevent pulsation of the machine at the particular volume for which the constant volume governor is then set. If now the weight 18 is moved still farther toward the right to set the compressor for a yet smaller volume, then the contact pin 75, which is now in engagement with contact arm 71, will move it in an anti-clockwise direction bringing the end of it into engagement with contacts 83ª and 86ª. This again closes the circuit through motor 59 as follows: from line wire 71ª, contact 75, conductor 80, contact 81, end of contact arm 71, contact 86ª, conductor 86, contact 86ᵇ, the end of contact arm 64, contact 67, conductor

66 and the one winding of motor 59 to ground at 62. This causes the motor 59 to operate to further open the valve 58 until such time as the end of contact arm 64 shall have been moved from engagement with contact 86^b into engagement with contact 87^b. If now the weight 18 is moved still farther toward the right to cause the compressor to deliver a still less amount of air then the actuator 73 will move the contact arm 71 from engagement with contacts 83^a and 86^a into engagement with contacts 84^a and 87^a which, in the manner already explained, will again close the circuit on the one winding of the motor 59 causing the valve 58 to be opened still further. In case the constant volume governor weight 18 is moved toward the left the spring 76 will cause the actuator 73 to move in a clockwise direction, the rod 77 following the movement of the weight 18. This will first move the contact pin 75 out of engagement with contact arm 71, and the contact pin 74 into engagement therewith. If we assume, for example, that the contact arm 71 has been moved into engagement with contacts 84^a and 87^a and that contact arm 64 has been moved into engagement with contact 84^b, then when contact pin 74 engages arm 71 a circuit will be closed as follows: from line wire 71^a, contact pin 74, conductor 78, contact 79, intermediate portion of contact arm 71, contact 84^a, conductor 84, contact 84^b, intermediate portion of contact arm 64, contact 69, conductor 68, the other winding of motor 59 to ground at 62. This will operate motor 59 in a direction to move valve 58 toward closed position. At the same time, contact arm 64 will be moved in a counter-clockwise direction, and as soon as it passes from engagement with contact 84^b into engagement with contact 83^b, the motor circuit will be opened and the movement of valve 58 toward closed position will cease. Now, upon further successive movements of weight 18 toward the left, the arm 71 will be moved first into engagement with contact 83^a and then into engagement with contact 82^a closing successive circuits through motor 59 and moving the valve 58 back to closed position. By this arrangement the pulsation preventing valve 58 will be automatically operated to prevent the occurrence of pulsations.

With my improved system it will be seen that the operator in the converter house has the centrifugal compressor completely under his control, and that he can regulate it to carry out any desired process with accuracy and expedition.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. In combination, a centrifugal compressor, a constant volume governor mechanism therefor, a motor for setting it, means located at a point remote from the compressor for controlling the motor, and automatic means actuated by the governor mechanism for indicating at such point the setting of the governor mechanism.

2. In combination, a centrifugal compressor, a constant volume governor mechanism therefor, a motor for setting it, means located at a point remote from the compressor for controlling the motor, means for indicating at such point the setting of the governor mechanism, a pulsation preventing valve mechanism, and automatic means controlled by the setting of the volume governor mechanism for controlling said valve mechanism.

3. In combination, a centrifugal compressor, a constant volume governor mechanism therefor, comprising a beam and a weight, an electric motor for adjusting the weight along the beam, a switch located remote from said compressor for controlling the motor, and an automatic electric indicator located adjacent said switch and actuated by said weight for indicating the adjustment of the constant volume governor weight.

4. In combination, a centrifugal compressor, a constant volume governor mechanism therefor, comprising a beam and a weight, an electric motor for adjusting the weight along the beam, a switch located remote from said compressor for controlling the motor, an electric indicator located adjacent said switch for indicating the adjustment of the constant volume governor weight, a pulsation preventing valve mechanism, and means actuated by the setting of said weight for controlling said valve mechanism.

5. In combination, a centrifugal compressor, a constant volume governor mechanism therefor, comprising a beam and a weight, an electric motor for adjusting the weight along the beam, a switch located remote from said compressor for controlling the motor, an electric indicator located adjacent said switch for indicating the adjustment of the constant volume governor weight, and means for automatically opening the motor circuit when the governor weight reaches an extreme position.

6. In a system of the character described, the combination of a centrifugal compressor, a pulsation preventing valve mechanism therefor, an electric motor for operating it, a constant volume governor mechanism for the compressor, and means actuated by the

setting of said volume governor mechanism for controlling the motor of said pulsation preventing valve mechanism.

7. In a system of the character described, the combination of a centrifugal compressor, a pulsation preventing valve mechanism therefor, an electric motor for operating it, a constant volume governor mechanism for the compressor comprising a beam and a weight adjustable thereon, and means actuated by the setting of said weight along the beam for controlling the motor of said pulsation preventing valve mechanism.

8. In a system of the character described, the combination of a centrifugal compressor, a pulsation preventing valve mechanism therefor, means for operating it, governor mechanism for the compressor, and means actuated by the setting of said governor mechanism for controlling said pulsation preventing valve mechanism.

9. In combination, a converter, a centrifugal compressor located remote from the converter for supplying air thereto, a constant volume governor for the compressor comprising a beam and a weight, a motor for adjusting the weight, a switch located adjacent the converter for controlling said motor and electrical indicating means located adjacent the converter and controlled by said weight for indicating the position of the weight on the beam.

10. In combination, a converter, a centrifugal compressor located remote from the converter for supplying air thereto, a constant volume governor for the compressor comprising a beam and a weight, a motor for adjusting the weight, a switch located adjacent the converter for controlling said motor, means for automatically opening the motor circuits when said weight reaches either of its extreme positions and electrical indicating means located adjacent the converter and controlled by said weight for indicating the position of the weight on the beam.

11. In combination, a converter, a centrifugal compressor located remote from the converter for supplying air thereto, a constant volume governor for the compressor comprising a beam and a weight, a motor for adjusting the weight, a switch located adjacent the converter for controlling said motor, electrical indicating means located adjacent the converter and controlled by said weight for indicating the position of the weight on the beam, a pulsation preventing valve mechanism, and means controlled by the movement of said weight for automatically controlling it.

In witness whereof I have hereunto set my hand this eighth day of March, 1918.

LOUIS C. LOEWENSTEIN.