Feb. 14, 1933. E. P. STEWART ET AL 1,897,870

CONTROL FOR NOZZLE VELOCITY

Filed May 9, 1931 2 Sheets-Sheet 1

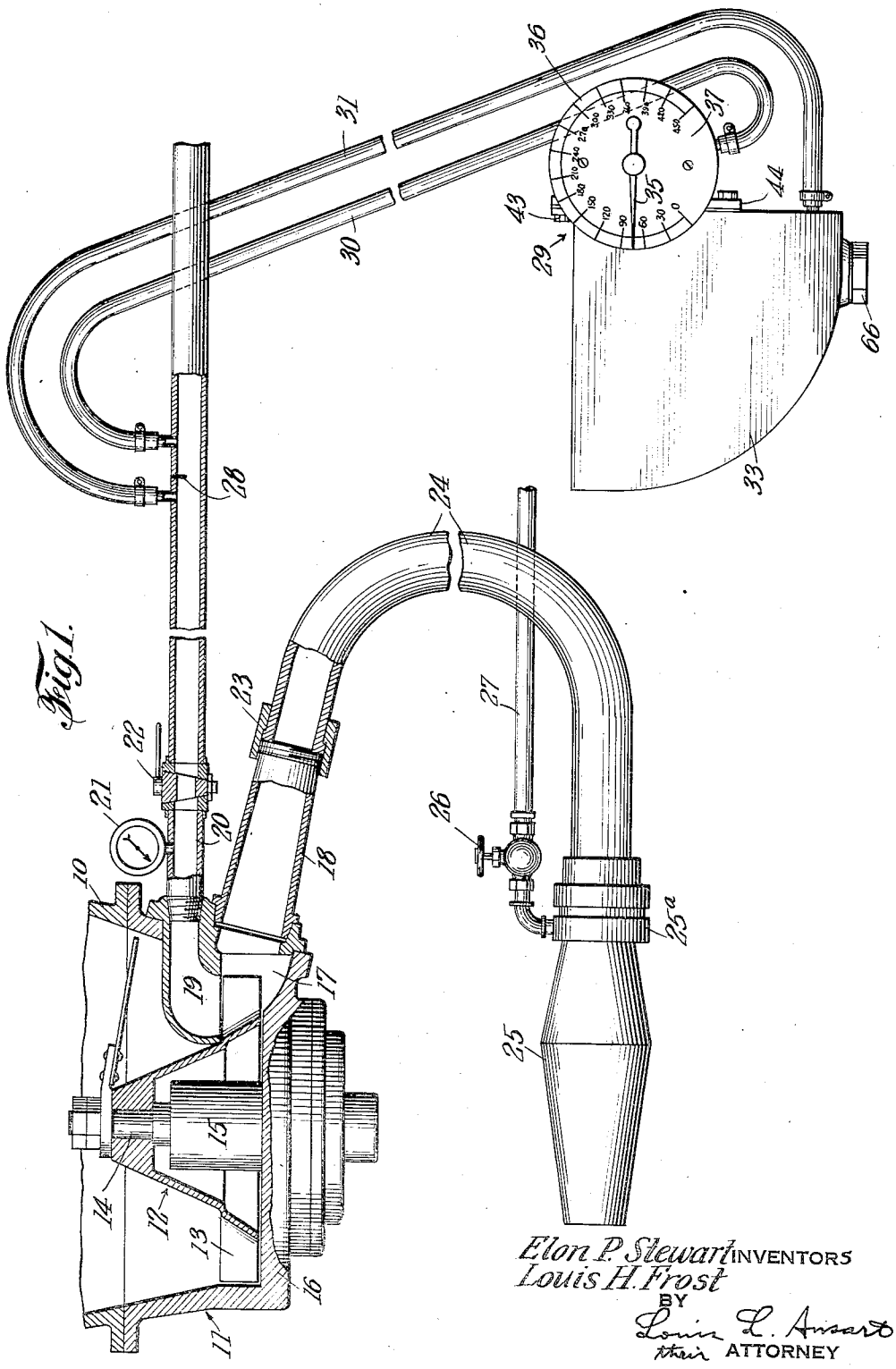

Fig. 1.

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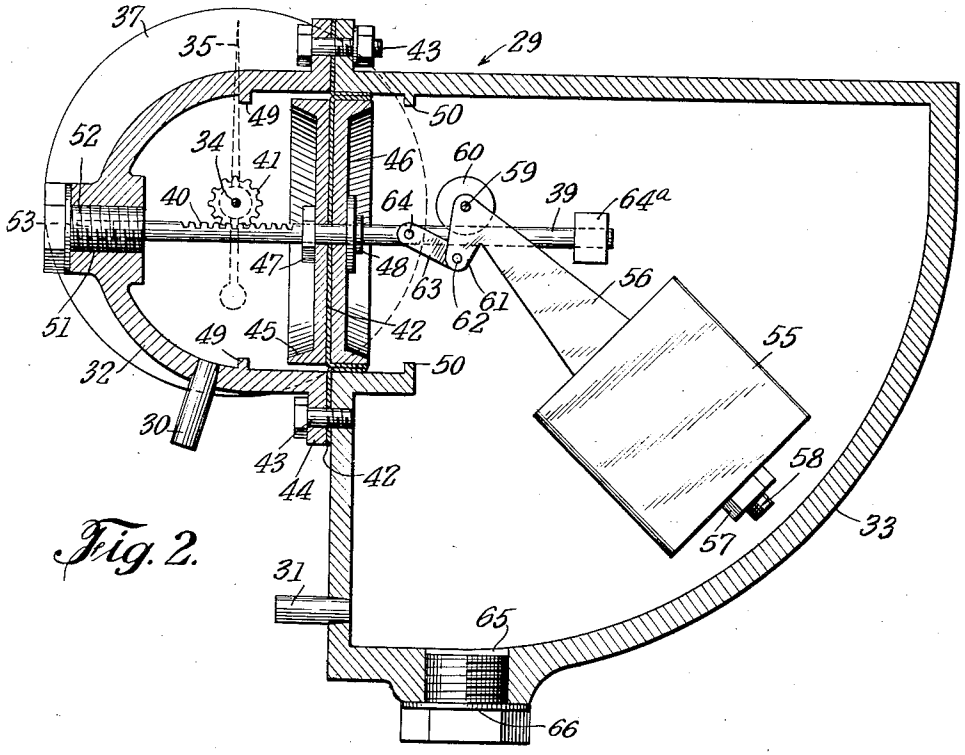

Fig. 2.

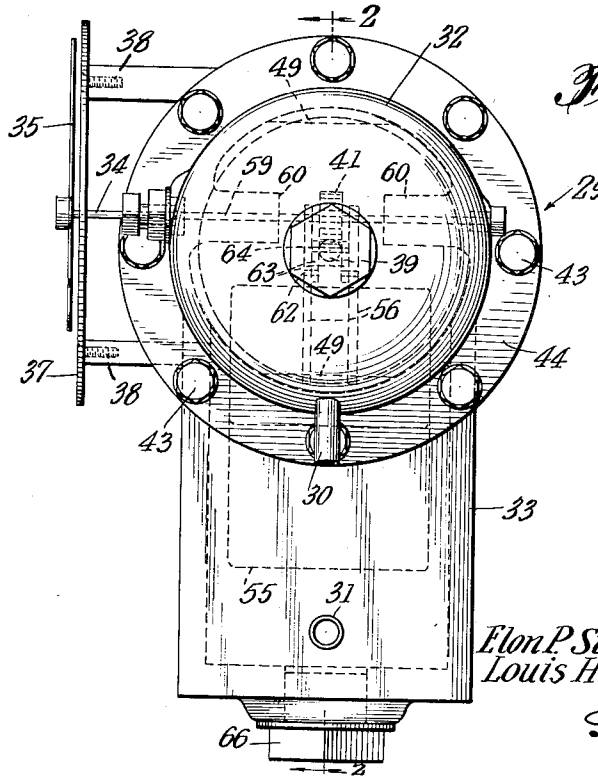

Fig. 3.

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UNITED STATES PATENT OFFICE

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CONTROL FOR NOZZLE VELOCITY

Application filed May 9, 1931. Serial No. 536,233.

The invention relates to control of nozzle velocity and more particularly to control of nozzle velocity in connection with apparatus, such as a "cement gun".

In general practice, suitable material, such as sand or cement in a mixture of proper proportions, is forced under suitable air pressure from a "cement gun" and through a suitable hose to a nozzle where the mixture is hydrated. The material is driven from the nozzle in a stream and at high velocity against a base or backing. Under these conditions the material is pneumatically tamped to form a dense mass called "gunite".

In order to obtain uniformity in the "gunite", various conditions, including those relating to velocity of the material as it leaves the nozzle and to the amount of material carried by the air current, should be uniform. Heretofore attempts have been made by skilled investigators to find some way of gauging the velocity of the air stream and material leaving the nozzle, but no satisfactory method or device for measuring this velocity was developed due to the fact that it is impracticable to introduce measuring devices or pressure connections of any sort in the nozzle or in the material hose leading to the nozzle. In general such devices are soon stopped up and clogged with the material and are rendered ineffective. In certain cases pressure gauges have been provided at the line of pipe or hose leading to the nozzle to indicate the desirability of adjusting the usual valve in this line but even when the pressures are known there has been no satisfactory basis for judging velocity and regulating the current of air accordingly. In connection with the present invention it has been found especially desirable to know the velocity of the material as it leaves the nozzle, inasmuch as the quality of the "gunite" is found to depend upon the velocity at which the material is supplied.

An important object of the invention relates to the provision of improved apparatus of the character specified. Further objects of the invention relate to the provision of means connected with the air supply line for blowing material from machines, such as the "cement-gun" and adapted to indicate the velocity at the nozzle, means for measuring the flow of fluids, and an improved method for determining velocities at the nozzle of the "cement-gun" and like machines.

In carrying out the invention, the air supply line, leading to the "cement-gun" at the point where the mixture of material is blown therefrom, is provided with a suitable aperture to produce differences of pressure at opposite sides thereof, and a measuring device connected with the supply line so as to be controlled by the flow of air therethrough and so calibrated as to indicate the velocity at the nozzle in terms of any suitable unit of velocity.

Other objects and advantages will appear upon consideration of the following description and of the accompanying drawings, in which:—

Fig. 1 is a fragmentary view, partly in section, illustrating apparatus embodying an approved form of the invention.

Fig. 2 is a section taken on the line 2—2 of Fig. 3; and

Fig. 3 is an elevation, viewed from the right in Fig. 1, of the measuring device.

Referring to the drawings, 10 indicates part of a receptacle commonly referred to as the lower tank of the "cement gun". This tank is open at its bottom and registers with the open upper end of a base 11 in which is mounted a rotary device or feed wheel 12 having a conical surface directing the material in the tank 10 outwardly and downwardly into pockets 13 open at the top and bottom as well as their outer sides. It will be noted that the partitions between the pockets 13 are shaped so as to conform at their outer ends and bottoms with the corresponding portions of said base 11. The feed wheel 12 is carried by a shaft 14 projecting upwardly through a bearing 15 which may be integral with the bottom 16 of said base 11. The lateral inner surface of the base 11 adjacent to the pockets 13 is continuous except at one point at which there is provided an opening 17 communicating with an outlet member 18.

Above the feed wheel at the outlet opening 17, is an inlet 19 which receives the supply of compressed fluid, such as air, from any

suitable source, the air being supplied, for example, through a pipe 20 threaded into the outer end of said inlet 19. As here shown, the pipe 20 is equipped with a pressure gauge 21 and a valve 22 by which the amount of air passing to the inlet 19 may be regulated. Communicating with the outlet member 18 by a suitable coupling 23 is a material hose 24 through which material from the pockets 13, brought into the path of the air current from the inlet 19, is carried to nozzle 25 where the material is hydrated in the usual manner by water supplied to the water ring 25*a* through hose 27, the amount of water supplied to the water ring being regulated by a valve 26. The shaft 14 may be actuated by any suitable means preferably an air motor (not shown) receiving compressed air from the same source of supply as the inlet 19.

The structure thus far described is substantially the same as in "cement guns" in general use.

Heretofore attempts have been made to regulate the flow of material by manipulating the valve 22 so as to maintain the desired pressure as indicated on the pressure gauge 21. However, the pressure, as indicated by the gauge 21, does not give an accurate idea of the velocity at the nozzle.

According to the present invention, the velocity at the nozzle is determined by measuring the flow of air through the feed wheel 12 by means of a suitable flow meter connected with the pipe 20 and provided with a suitable scale to read the velocity in terms of the desired units. According to the preferred form of the invention, use is made of a suitable orifice which may be formed by providing a thin segmental plate 28 projecting into the pipe or hose 20. The flow of air past the segmental orifice creates a differential pressure between the spaces at opposite sides of the orifice, and this pressure bears a fixed relation to the quantity of air passing through the orifice.

This difference in pressure is utilized to operate a suitable instrument or meter 29 which is connected by suitable ducts 30 and 31 with the pipe 20 at the high pressure and low pressure sides respectively of the segmental orifice formed at the segmental plate 28. The duct 30, which may be in the form of a flexible hose, is connected with a section or portion 32 of the device 29 so as to communicate with the interior thereof, and the duct 31, which also may be in the form of a flexible hose or tube, is connected with the interior of a casing member 33 also forming a part of the device 29.

The portion 32 of the casing 39 may be in the general form of a dome connected at its substantially circular open end with a corresponding opening in the casing member 33. Projecting through the dome-like portion 32 and parallel to the plane of division of the casing members 32 and 33, is a shaft 34 carrying at one end an index or pointer 35 to cooperate with a suitably calibrated scale 36 on a member or disc 37 through which the shaft 34 passes. Leakage of air where the shaft 34 projects from the casing may be prevented in any suitable manner. The disc 37 may be supported from the main body of the device 29 in any suitable manner as by means of bars 38 (Fig. 3). To operate the pointer 35 use is made of a rod 39 mounted for reciprocation axially of the dome-like member 32. At one side the rod 39 is provided with teeth 40 forming a rack to cooperate with the pinion 41 mounted on the shaft 34 which carries the index 35.

The rod 39 is moved longitudinally by differences in pressure at the interior of the casing members or sections 32 and 33 and to this end passes centrally through a diaphragm 42 of suitable material, such as rubber, clamped between adjacent portions of the casing members 32 and 33 by suitable means including bolts 43 passing through a flange 44 on the dome-like member 32 and corresponding portions of the casing member 33. The diaphragm 42 is supported at opposite sides by the pistons or piston members 45 and 46 which fit loosely enough in the opening between the casing sections to permit the rubber diaphragm to fold between the piston members and adjacent walls of the two casing members 32 and 33. The piston members 45 and 46 are held in position on the rod 37 by any suitable means such as members 47 and 48 fixed on the rod 39. On opposite sides of the diaphragm 42 the casing members 32 and 33 are provided with stops 49 and 50, respectively, preferably in the form of rings.

At the center of the dome-like member 32 it is provided with a bore 51 into which is threaded a screw plug 52 provided at its interior with a bore 53 which extends to its inner end and receives the corresponding end of the rod 39 for guiding purposes. The inner end of the bore 53 may also serve as a stop to limit the movement of the rod 39 in that direction under urging of the weight 55 removably secured on arms 56 by means including a nut 57 screwed on a projection 58 connected with said arms 56. The arms 56 are on the opposite sides of the rod 39 and are pivoted on a shaft 59 above the rod 37 and mounted in bearings 60 projecting inwardly from opposite sides of the casing member 33. Each arm 56 is flat and in the form of a bent lever having a portion 61 extending below the rod 39 and pivoted at 62 to a link 63 which in turn is pivoted at 64 to the rod 39. By inspection of Figs. 1 and 3, it will be seen that the weight 55 tends to turn the pointer 35 back to the zero reading where the rod 39 may be stopped by engagement with the bottom of the bore 53 in the screw plug 52. Preferably the casing section 33 is shaped

to correspond with the swinging movement of the weight 55 on the arms 56. In its reciprocation the rod 39 is guided at one end in the screw plug 52 and at its other end in the bearing 64*a*.

At its lower part the casing section 33 may be provided with a bore 65 normally closed by as screw plug 66 to enable adjustment of the weight 55 by means of the nut, the arrangement being such that the weight 55 may assume a position with the nut 57 immediately above the bore 65.

If the valve 22 in the air supply line 20 is closed, there will be no flow of air through the pipe and consequently no differences in pressure at opposite sides of the plate 28. Under these conditions the weight will swing downwardly to bring the nut 57 immediately above the bore 65, the exact position being determined by engagement of the left end of the rod 39 (Fig. 2) with the end of the bore in the screw plug 52. At this time the pointer 35 should be positioned at the zero indication of the scale 36. At the time the piston member 45 is in engagement with the stop ring 49, the portion of the diaphragm 42 extending from the piston members 45 and 46 to the diaphragm clamping portions of the casing sections 32 and 33 will be straightened out and stretched to its limit. Upon opening the valve 22 the air will begin to flow through the supply pipe 20 and there will be differences of pressure at the opposite sides of the thin plate 28 at the measuring aperture. The pressure transmitted through the line 30 will be greater than that transmitted through the line 31 and consequently the piston members 45 and 46 will be forced to the right against the action of the weight 55 thus causing the pointer 35 to move away from the zero reading of the scale 36. If the differences in pressure are sufficiently great the rod 39 will be forced to the right (Fig. 2) until the right hand piston member 46 comes into engagement with the stop or stop ring 50.

The difference in pressures at opposite sides of the thin plate orifice bears a fixed relation to the quantity of air passing through the orifice and the velocity at the nozzle bears a fixed relation to the quantity of air passing through the orifice for a given pressure and temperature. By suitable calculations the scale of the measuring instruments may be calibrated to read directly velocities at the nozzle in suitable units. Each nozzle requires a correspondingly calibrated scale and if the nozzles are changed the scales must be changed.

The link motion between the weight 55 and the reciprocating rod 39 is so designed as to substantially transform square root velocity variation, which would ordinarily produce unequal division of the scale, into graduations of uniform length, as illustrated in Fig. 1 Such designing may be worked out in any suitable way as, for example, by the use of graphic methods. With a scale calibrated in this manner the desired velocity at the nozzle can, within a reasonable degree of accuracy, be maintained by manipulating the valve 22. If, however, the nozzle is changed, a new scale 36 on a corresponding disc 37, is substituted for the one previously in use. For this purpose the index 35 should be readily removable to permit interchange of discs 37.

Although the differential meter is shown as connected with the air supply line merely by lines of hose, it should be understood that, in actual practice, the differential meter would be attached to the machine for movement therewith. It should also be understood that the meter 29 is also adapted for use with flows, velocities and pressures encountered in use with Pitot measurements. For this use, however, the meter would preferably be larger than required for use with the "cement-gun".

It should be understood that the apparatus and method may be changed in various ways and that certain features may be used without others without departing from the true spirit and scope of the invention.

Having thus described our invention, we claim:—

1. In apparatus of the class described, the combination with a duct, means to supply comminuted material thereto at one end and means including a compressed air supply line to blow the material through said duct and out of its discharge end, of means for producing a differential pressure in said air supply line in accordance with the rate of flow of air therethrough, and means responsive to such differential pressure including a movable index and a scale to cooperate with said index calibrated in terms of velocity at said discharge end of the duct.

2. In apparatus of the class described, the combination with a nozzle, a material hose leading to said nozzle, means to supply comminuted material to the hose at one end thereof, means including a compressed air supply line to blow the material through said hose and out of the nozzle and means for wetting said material as it passes through said nozzle, of means connected with said supply line and operable by the flow of air therethrough for indicating the velocity at the discharge end of said duct, such indicating means including an index movable proportionally to the air flow and a scale calibrated to cooperate with said index to indicate nozzle velocities in terms of the desired unit of velocity.

3. In apparatus of the class described, the combination with a nozzle, a material line leading thereto, means to supply comminuted material to the material line and means including a compressed air supply line to blow the material through said material line and nozzle, of means for indicating the velocity

at the nozzle including a segmental orifice device in the air supply line, a pressure-controlled instrument connected with said line at opposite sides of said orifice and including a movable index and a scale calibrated to cooperate with said index to indicate the nozzle velocity in terms of the desired unit of velocity.

4. The method which includes introducing comminuted material into a hose having a nozzle, supplying compressed air from an air supply line to blow said comminuted material through the nozzle, creating differential pressures in the air supply line in accordance with the rate of flow therethrough, measuring said differential pressures in the air supply line, and computing from such measurements the nozzle velocities in terms of the desired unit of velocity.

5. The method which includes introducing comminuted cementitious material into a hose having a hydrating nozzle, blowing comminuted material through said hose and nozzle by means of compressed air from an air-supply line, creating a differential pressure in the air-supply line in accordance with the rate of flow therethrough, measuring the differential pressure and computing from the measurements the nozzle velocities, and regulating the flow in the air-supply line to produce the desired velocity at the nozzle.

In testimony whereof we affix our signatures.

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