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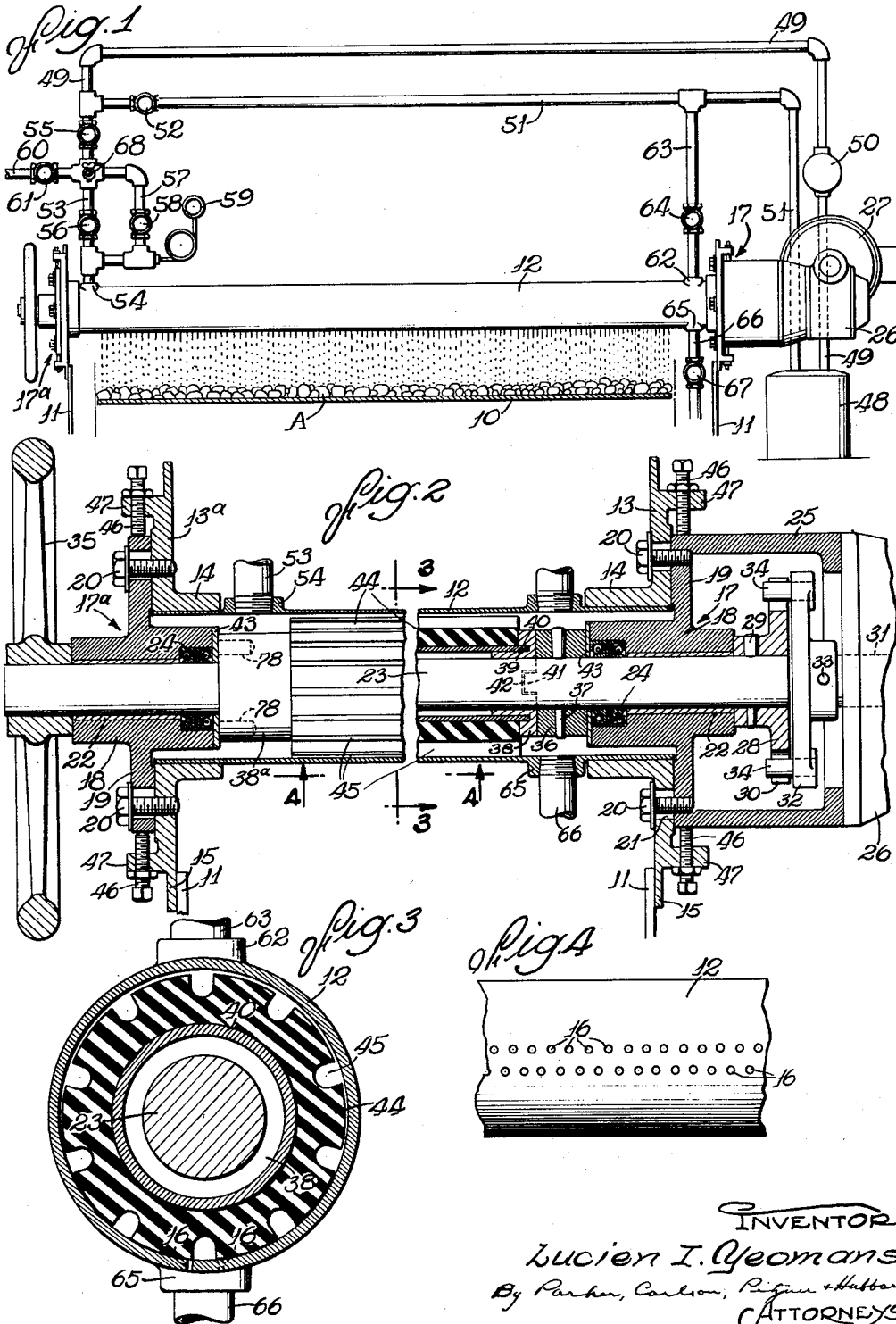
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2,290,790

METHOD OF DISTRIBUTING FLUID IN ACCURATELY MEASURED QUANTITIES

Filed Aug. 31, 1938

2 Sheets-Sheet 1



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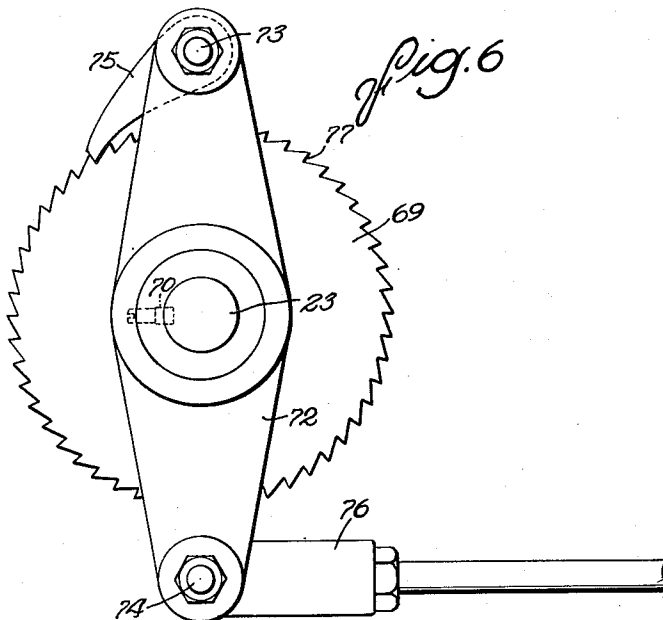
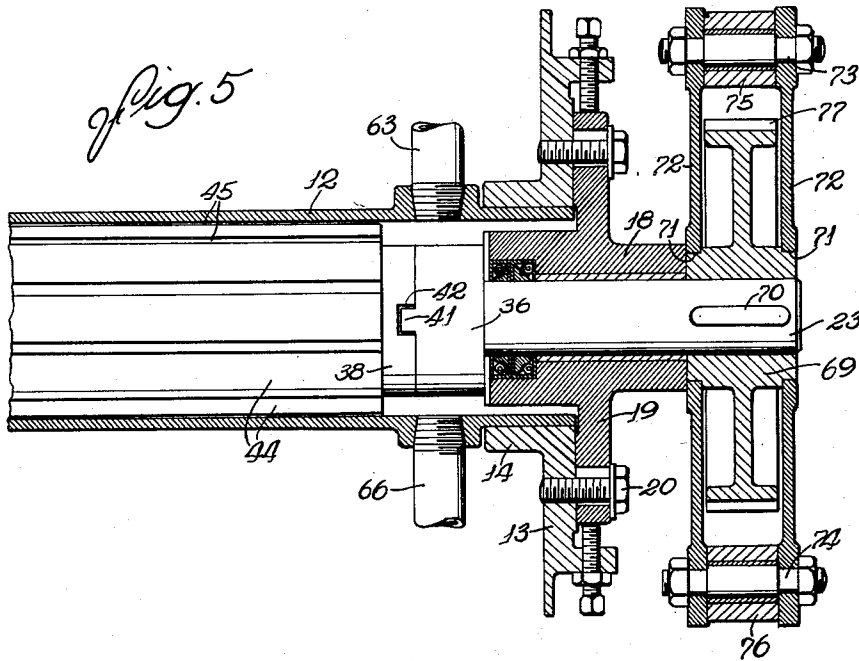
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METHOD OF DISTRIBUTING FLUID IN ACCURATELY MEASURED QUANTITIES

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6 Claims. (Cl. 117—104)

The invention relates generally to a method of distributing fluid in accurately measured quantities and has as its general aim the provision of a new and improved method of this nature for effecting such distribution uniformly over a large area.

Many industries today use manufacturing processes or practices in which it is important to effect a uniform distribution of fluid over a large area while controlling with a high degree of accuracy the quantity of fluid distributed per unit of area. For example, the addition of water to the cloth on cloth shrinking machines, or the application of water to the repellent rolls of offset printing presses, should be uniform and accurate as to the quantity of water added. Other examples are in the application of hot water or other fluids to sheets of cloth, paper, metal or the like ahead of a roller, distributor or wiper; in the feeding of drops of oil for the lubrication of extensive machinery; in the application of identifying drops of paint to lumps of coal, or other bulk materials, and in the addition of fluid to material contained in a mixing machine as in the addition of water, oil, molasses, or the like, to sand mixtures in foundry core-sand mixers.

Another object of the invention is to provide a novel method for distributing fluid material in drops of uniform size over material which is moving relatively thereto while maintaining a uniform rate of distribution.

More specifically stated, another object is to provide a new and improved method for distributing fluid over the surface of relatively moving material to be treated which includes the steps of effecting the discharge of fluid as a plurality of drop-like particles, each uniformly containing a predetermined quantity of fluid controlled by the pressure on the fluid, and correlating the rate of discharge with the speed of relative movement between the distributing means and the material.

Other objects and advantages will become apparent in the following description and from the accompanying drawings, in which:

Figure 1 is a side elevational view on a reduced scale of apparatus embodying the features of the invention, the fluid flow system being illustrated somewhat diagrammatically.

Fig. 2 is a view on an enlarged scale taken partially in longitudinal axial section through the distributor mechanism.

Fig. 3 is a cross sectional view through said mechanism taken approximately along the line 3—3 of Fig. 2.

Fig. 4 is a view looking toward the drop dis-

charging outlets or ports and is taken as indicated by the lines 4—4 of Fig. 2.

Fig. 5 is an enlarged view showing in axial section a modified form of driving means.

Fig. 6 is a fragmentary end elevation of the modified form of driving means.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment, but it is to be understood that I do not thereby intend to limit the invention to the specific form disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

According to the present invention, the process includes the steps of effecting the distribution of a large number of drop-like particles of fluid material (for convenience hereinafter termed "drops") while controlling and maintaining uniform the quantity of material in each of the drops by means of the pressure on the fluid at the point of distribution as represented by one or more apertures of predetermined area, and determining the total quantity of fluid distributed and the rate of distribution by the duration of the periods during which distribution occurs, the rate of distribution being correlated with the rate of movement of the material over which the drops are being distributed relative to the distributing mechanism to achieve a desired concentration of drops over a unit area of the material.

Merely for purposes of illustration, an embodiment of the invention has been shown in apparatus which is adapted for association with an endless material conveyor 10 having stationary supporting means 11 forming a part of the conveyor frame or parts associated therewith. It should be understood, however, that the conveyor is representative of any suitable means for effecting relative movement at a substantially constant rate between material to be treated and the distributing mechanism.

The distributing mechanism may best be described with reference to Fig. 2. A hollow tube 12 of substantial diameter and length is supported at each end in stationary relation to the conveyor. In this instance, end supports for the tube are in the form of brackets 13 and 13^a having circular bosses 14 to which the ends of the tube 12 are sealed, as by a brazing or welding operation. The brackets extend radially from the bosses 14 and have peripheral extensions 15

through which the brackets may be suitably secured to the stationary supporting means 11 on the conveyer frame. In this instance, the parts are welded together and the brackets rest on the supporting means. However, the extensions permit the brackets to be suspended from suitable hangers if that arrangement is more convenient. Apertures 16 (see Figs. 3 and 4) are formed in the surface of the tube 12 directly opposite to the conveyer and preferably are arranged to extend longitudinally of the tube in one or more sets of aligned apertures. The bosses 14 define openings in the brackets through which the interior of the tube 12 is accessible.

Adjustably secured to the brackets 13 and 13^a are bearing members 17, 17^a having axially concentric elongated bearings 18 and radial flanges 19 which are tapped at a plurality of points to receive the ends of screws 20 extending through oversized apertures 21 in the brackets 13, 13^a. The bearings 18 are dimensioned to extend in part into the openings defined by the bosses 14 and, in the present instance, the ends of the tube 12 and the bearings are of substantially less diameter than the encircling parts. Preferably, the bearings are provided with such means as bronze sleeves 22 to receive a drive shaft 23 of sufficient length to extend through and outwardly beyond the ends of the bearings. Oil seals 24, or the like, of conventional form may also be interposed between the shaft and the bearings.

The bearing member 17 at the right-hand side of the apparatus as illustrated includes an outwardly extending, axially concentric wall 25 which, at its outer end, is rigidly connected with a housing 26 for a speed reduction gear mechanism of suitable type. This mechanism is preferably part of a unit that includes a driving motor 27 (Fig. 1). Within the space defined by the wall 25, a radially flanged collar 28 is rigidly secured, as by a pin 29, to the end of the shaft 23. Formed peripherally in the flange of the collar are a pair of opposed circumferentially elongated recesses 30, each of which extends through an arc of approximately 90°. The driven shaft 31 from the speed reduction gear mechanism is arranged to extend to a point adjacent to the shaft 23 and carries at its end a flanged collar 32 which is pinned, as at 33, to the shaft 31 and carries a pair of studs 34 arranged to extend into the recesses 30 in the flanged collar 28. This arrangement provides a lost motion driving connection to the shaft 23. At its opposite end, beyond the bearing member 17^a, the shaft 23 carries a hand wheel 35 by means of which the shaft may be rocked independently of the driving connection. The purpose of this arrangement will be hereinafter more fully described.

The shaft 23 has a collar 36 pinned, as at 37, thereto adjacent to the inner end of the bearing 18 on the right-hand bearing member 17. Adjacent to the inner face of the collar 36, and to the inner face of the bearing 18 on the left-hand bearing member 17^a, are sleeves 38, 38^a mounted slidably and rotatably on the shaft 23. These sleeves 38, 38^a have annular recesses 39 (see the right-hand sleeve 38 in Fig. 2) which face toward each other to receive the opposite ends of a tube 40. The sleeves and the ends of the tube are brazed or welded together, or are otherwise permanently joined. A driving connection between the collar 36 and the adjacent sleeve 38, which is releasable by relative endwise movement, is afforded by means of diametrically

opposite tongues 41 (see Figs. 2 and 5) on one member, in this instance the collar 36, engageable in complementary recesses 42 in the other member. If desired, sealing washers 43 may be interposed between the collar 36 and the adjacent bearing 18 and between the sleeve 38^a and its associated bearing.

The tube 40 is greater in diameter than the shaft 23 and provides internal support for a distributor roll 44. This roll is preferably formed of rubber or equivalent material vulcanized or suitably bonded to the tube 40 and is externally finished to have a uniform outer cylindrical surface, the diameter of which is less than the internal diameter of the tube 12. Peripherally, the distributor roll has a series of longitudinally extending recesses 45 therein, the number of which is determined by factors to be hereinafter considered.

The recesses and the intervening peripheral portions of the distributor roll constitute respectively grooves and lands or ridges for coaction with the apertures 16 in the tube 12 intermittently to open and close said apertures in the rotation of the distributor roll. The roll, accordingly, is arranged to run in contact with the internal surface of that portion of the tube 12 in which the series of apertures 16 are located (see Fig. 3). The adjustment of the distributor roll to this relationship is permitted by the arrangement of the screws 20 and the oversized apertures 21, and accuracy of adjustment may be obtained by such means as a plurality of opposed set screws 46, carried by lugs 47 on the brackets 13, for adjustable engagement with the bearing members.

The distributor mechanism may be connected in any suitable type of flow system for delivering the treating fluid under a uniform but variably adjustable pressure. While this pressure may be applied by gravity, it is preferred to create the pressure by a force pump, or the like, which may also be employed to maintain a circulating flow of the fluid. Referring to the form of flow system diagrammatically illustrated in Fig. 1, a supply tank for fluid 48 has connected thereto a feed line 49 in which a force pump 50 is interposed. A return line 51 to the supply tank communicates at a distance therefrom with the line 49, and the return line is controlled by a suitable valve 52. A pipe 53 is connected with the feed line 49 ahead of the valve 52 and also to a nipple 54 at one end of the distributor tube 12. A valve 55 controls the conduit 53 adjacent to its point of connection with the feed line 49, and beyond this valve is a second valve 56 located in the conduit 53 intermediate the ends of a by-pass line 57, both ends of which communicate with the conduit 53. The by-pass conduit includes an orifice or pressure reduction valve 58, and a pressure gauge 59 on the low pressure side of the valve 58. A conduit 60 controlled by a valve 61 communicates with the conduit 53 between the valves 55, 56 and leads to a source of flushing fluid, for example, a water main. Connected between the return line 51 and a nipple 62, located on the tube 12 at the end thereof opposite the nipple 54, is a line 63 controlled by a valve 64. At the same end of the tube is a nipple 65 communicating with a drain line 66 controlled by a valve 67.

In this circulatory system, the apparatus may be readily conditioned for various operative requirements by manipulation of the several valves. Prior to actual operation, a circulation to agi-

tate the material in the supply tank is obtained by closing all of the valves except the valve 52, the pump being in operation. This causes material to be drawn from the tank 48 through feed line 49 and returned thereto through the line 51. As a preliminary to distributing operation, a circulating flow is produced through the distributor mechanism by opening the valves 55, 56, 58 and 64, and closing the valves 52, 61 and 67. This flow system comprises feed line 49, conduit 53 and by-pass conduit 57, tube 12, line 63 and return line 51. To operate, the valves 52 and 55 are open and the valves 61, 56, 64 and 67 are closed, and the valve 58 is opened and adjusted to produce a required operating pressure in the tube 12 as indicated by the gauge 59. The flow in this operative setting is from the tank 48 through feed line 49, part of conduit 53, by-pass conduit 57 and pressure reduction valve 58, and tube 12 for distribution, the excess fluid being bypassed to the tank through the return line 51. During this cycle, the distributor mechanism is in operation to drive the distributor roll 44 to effect a discharge of drops of fluid from the roll. Should it become necessary or desirable to interrupt drop distribution, the initial circulating flow may be reestablished by closing valves 55, 64 or the distributor roll driving motor 27 may be stopped and the roll shaft 23 manipulated by means of the hand wheel 35 to position one of the lands of the roll in closing relation to the apertures 16, thereby preventing further discharge of drops from the tube 12. Incidentally, the distributor roll is adjusted to an aperture sealing position whenever the distributing mechanism is idle. If the interruption of operation is momentary, the setting of the system for operation need not be changed since the fluid will circulate to and from the tank through the lines 49 and 51. For interruptions of longer duration, while the distributor roll is idle and in aperture-closing position, it will in many instances be advisable to open the valves 56 and 64 to include the tube 12 in a circulatory line. When operation is to be discontinued, the system may first be washed out by closing valves 55 and 64, while opening valves 52, 61, 56, 58 and 67. During this setting, fluid circulates into and out of the supply tank 48 through lines 49, 51 and a flushing flow of water or other suitable fluid takes place through conduits 60 and 53, by-pass conduit 57, tube 12 and drain line 66. During this operation, the valve 56 is preferably closed part of the time to insure a flow through by-pass conduit 57 and pressure reduction valve 58. To discontinue operation entirely, the pump 50 is stopped, the valve 61 is closed, and a pet cock 68 in the conduit 53 behind the valve 55 is opened to permit the washing fluid to drain from the system.

In order to obtain an accurate distribution of fluid, a number of operative factors should be taken into consideration. Since the present apparatus is eminently suitable as a means for applying drops of identifying color to such bulk materials as coal, this environment will be used as an example in the discussion of these factors. Thus, the conveyor 10 may represent the delivery boom which conveys lumps of coal, designated A (Fig. 1), distributed relatively evenly over the conveyor surface, to a disposal point at a known uniform rate of speed. Usually, indicating color spots will be applied primarily to the better grades of coal in which the lumps are of substantially uniform size. The tube 12 of the distributor apparatus is mounted to extend across

the width of the boom and in this environment will be spaced above the material on the boom such a distance as will produce a color spot of desired size by the spread of the drops when they strike the coal. The number of lumps of coal which will pass the distributor apparatus in any given period of time may be calculated with a fair degree of accuracy and the number of drops for each lump of coal will be determined by the average size of the lumps. From these factors, the number of drops which must be discharged in any given period of time, for example, in each minute, may be determined.

The size of the apertures 16 will depend generally on the nature of the fluid to be distributed, a more viscous fluid usually requiring a larger aperture. Roughly stated, however, the diameter of the apertures should be sufficiently large to avoid undesirable restriction of the flow so that high fluid pressures would be required. At the same time, the diameter of the apertures should not be so great that the fluid would tend to flow therefrom in a free stream. The number of apertures may vary rather widely, and it is usually preferable to use a large number of closely spaced apertures where material in relatively small lumps is being treated. The number of drops discharged in any given period of time is determined by the number of apertures in the tube 12, the number of grooves 45 in the distributing roll 44, and the speed of rotation of the roll. The quantity of material discharged in any drop is determined by the diameter of an aperture, the pressure on the fluid at the aperture, and the duration of the period the aperture is open. This last factor is in turn governed by the width of a recess 45, and the speed of rotation of the distributor roll. All of the structural factors above considered may be fixed for apparatus used in any particular environment and variable control of the operation of the device may be had merely by adjusting the fluid pressure in the system, which determines the quantity of material in any drop and by varying the speed of rotation of the distributor roll to discharge a desired number of drops from the mechanism per unit of time. While the term "drop" has been used herein to identify the form of the fluid ejected from the mechanism, this term should not be considered as a limitation only to a naturally formed drop, since in operation, and due to the discharge of the fluid under pressure, the so-called "drops" will in most instances be the equivalent of a cylindrical particle or "slug" of fluid of fixed diameter and of a length determined by the pressure on the fluid and the interval the apertures are open.

It may facilitate an understanding of these factors if a typical relationship in an apparatus for applying color spots to coal is set forth, the figures being approximate. A loading boom, having a 60" width is driven to deliver coal in the form of 2" cubes at the rate of one hundred and seventy tons per hour. At an approximation of fifty three hundred coal cubes per ton, and at an estimated allowance of five drops of one minim each per cube, the quantity of fluid in gallons per ton may be estimated, from which the number of gallons required per hour and the number of drops per minute may be derived. Under the conditions above mentioned, approximately seventy five thousand drops per minute will be required. A suitable fluid for applying color spots to coal may be a water soluble paint having a viscosity not much greater than that of water.

The distributor tube 12 is, as shown, provided with two series of apertures 16 which extend through the distance of 60" in accordance with the width of the conveyer. If the apertures are spaced one-half of an inch apart, adequate coverage will be obtained and the ratio between the number of apertures and the number of drops required per minute determines the number of drops which must be discharged per minute from each aperture. Presuming that the distributor roll is provided with ten recesses 45, the rotational speed of the distributor roll will be one-tenth of the number of drops required per minute from each aperture. It has been found that an aperture one-eighth of an inch in diameter is suitable for water soluble paint and, since this will be the diameter of the discharged drop, its length will be approximately three-tenths of an inch to produce a drop containing one minim of fluid. Therefore, the pressure on the fluid at the apertures is determined as being that pressure which will effect a discharge of a drop of this size through an aperture in the brief interval during which the aperture is open. The amount of pressure required under the relationship above set forth cannot be stated with any degree of accuracy, since it will vary with changes in temperature, atmospheric conditions, and the like, but the amount of pressure will be roughly in the range of from three to five pounds per square inch. By observance of the operation of the mechanism, exactly the proper pressure may be obtained by slight adjustments of the pressure reduction valve 53. Likewise, the rapidity of distribution may be conveniently advanced or retarded by varying the speed of the distributor roll. The other factors, once having been determined, require no adjustment.

Under some circumstances, it may be desirable to drive the shaft 23 intermittently instead of continuously. To this end, such means as an intermittent ratchet drive mechanism, as shown in Figs. 5 and 6, may be used in place of a drive through a speed reduction gearing. In the modified form of drive, all parts of the distributor mechanism to, but not inclusive of, the flanged collar 28, remain unchanged. As shown in Fig. 5, the flanged collar 28 has been replaced by a ratchet 69 keyed, as at 70, to the shaft 23. Each end of the hub of the ratchet is of reduced diameter, as at 71, and is finished to provide a bearing for a pawl arm 72. The pawl arms extend diametrically of the ratchet oppositely beyond the periphery thereof and are connected at their opposite ends by transverse bolts 73, 74. One of the bolts, in this instance the upper bolt 73, pivotally supports a pawl 75 (Fig. 6) between the arms 72, while the other bolt 74 is loosely connected with the end of an arm 76 having a connection with a crank (not shown) or other source of reciprocatory movement. The pawl cooperates with a series of teeth 77 on the ratchet and the parts are related so that the distributor roll will be advanced a predetermined distance, depending on the characteristics of the distributor roll.

From the foregoing, it will be evident that the present invention provides a novel method of distributing fluid over a relatively moving surface with a high degree of accuracy and that the method may be expeditiously carried out by new and improved apparatus which is simple in construction and may be easily maintained in operative condition. The apparatus may be quickly conditioned for operation and may be changed from one operative flow system to another without difficulty.

Should it be necessary to disassemble the apparatus for inspection or repair, it is only necessary to remove the hand wheel 35 and the left-hand bearing 17^a to expose the left-hand sleeve 38^a of the distributor roll assembly, which, being mounted loosely on the shaft 23, may be readily withdrawn from the tube 12. To facilitate this withdrawal operation, tapped bores 78 (Fig. 2) in the outer side of the sleeve 38^a may be provided to receive headed screws for engagement by a pulling implement. According to the present invention, the quantity of material in the drops of discharged fluid may be determined and maintained by control of the pressure on the fluid in the tube 12. The quantity of fluid in the discharged drops will be uniform and the number of drops delivered by the apparatus per unit of time may be accurately determined and maintained uniform by controlling the driven speed of the distributor roll.

I claim as my invention:

1. The method of distributing fluid in accurately measured quantities over a relatively moving surface which includes the steps of delivering fluid simultaneously to a plurality of discharge apertures of uniform dimensions, intermittently and simultaneously opening and closing said apertures, the duration of these periods being predetermined to produce a single drop at each aperture during each open period thereof, and effecting the discharge of uniform and measured quantities of fluid through the open apertures by a controlled amount of pressure on the fluid at the apertures.

2. The method of distributing fluid in accurately measured quantities as drops or unitary particles of uniform size which includes the steps of delivering fluid to a plurality of discharge apertures of uniform dimensions, intermittently opening said apertures, the duration of the open periods being constant and being predetermined to an interval that will produce a single drop at each aperture, and effecting the discharge of uniform quantities of fluid under pressure through the open apertures while determining the quantity of fluid discharged through each aperture during an open period by controlling the amount of pressure on the fluid at the apertures.

3. The method of distributing fluid in the form of a plurality of drop-like discharges of uniform size each containing an accurately determined quantity of fluid which comprises the steps of delivering fluid under controlled pressure to a plurality of like apertures, moving alternating aperture-closing and opening means relative to said apertures to close and open them respectively, and controlling the speed of such relative movement to fix the time said apertures are open to that period in which a single drop will be discharged through each aperture.

4. The method of distributing fluid in drop-like particles of uniform size which includes the steps of delivering fluid under a predetermined pressure to a plurality of apertures of uniform size, and at regular closely-spaced intervals momentarily opening said apertures.

5. The method of applying spots of color or other indicating fluid to lumps of coal which includes discharging toward the coal during its movement on a conveyer or the like a plurality of uniform particles of the indicating fluid in drop-like form distributed evenly across the surface of moving coal, the rate of discharge of the drop-like particles being correlated with the speed of movement of the conveyer, and the

quantity of material in each drop-like particle being controlled by the discharging pressure.

6. The method of distributing fluid in accurately measured quantities in the form of drops or unitary particles of uniform size which includes the steps of discharging fluid through a plurality of identical apertures by moving a plu-

5 rality of conducting channels successively and momentarily into registration with said apertures, such registrations of the channels with the apertures being for like intervals of time, and the fluid in said channels being under the same pressure.

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