

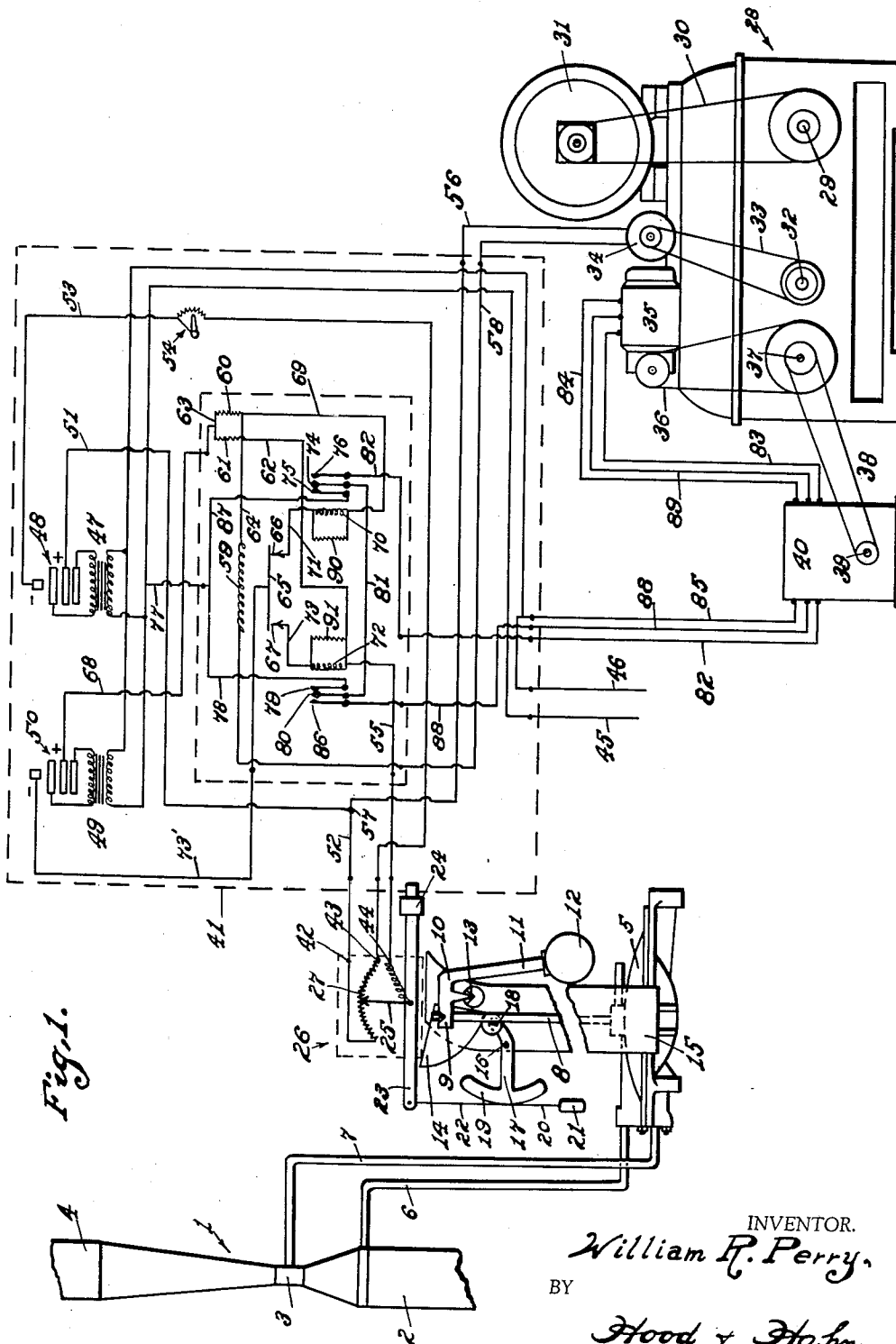
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FLOW-RATE-RESPONSIVE CONTROL MEANS

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FLOW-RATE-RESPONSIVE CONTROL
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The present application relates to a flow-rate-responsive control means, and more particularly to an organization which, in response to variations in the rate of flow of a controlling liquid, will vary the rate of operation of a given machine.

The primary object of the present invention is to provide a mechanism which will operate to supply chemical to a flowing liquid at varying rates, depending upon the rate of flow of the liquid. More specifically, the primary object of the invention is to provide mechanism, responsive to the rate of flow of sewage, to supply to the flowing sewage chemicals at a rate proportional to the rate of flow of the sewage. A further object of the invention is to provide mechanism for automatically adjusting the speed ratio between the input shaft and the output shaft of a variable speed transmission, in accordance with variations in the rate of flow of a flowing liquid. Further objects of the invention will appear as the description proceeds.

To the accomplishment of the above and related objects, my invention may be embodied in the form illustrated in the accompanying drawing, attention being called to the fact, however, that the drawing is illustrative only, and that change may be made in the specific construction illustrated and described, so long as the scope of the appended claims is not violated.

The single figure is a diagrammatic illustration of my control means, connected to control the operation of a variable speed transmission in accordance with the rate of flow of liquid through a Venturi tube.

In the drawing, I have illustrated a Venturi tube indicated generally by the reference numeral 1, and comprising the usual inlet portion 2, throat 3, and outlet 4. Associated with said Venturi tube is a diaphragm housing 5 which is formed to provide a chamber communicating, through a conduit 6, with the Venturi inlet 2; and a second chamber communicating, through the conduit 7, with the Venturi throat 3; said two chambers being separated by a flexible and fluid tight diaphragm. Operatively connected to the diaphragm is a pull rod 8 which is suitably connected to one arm 9 of a bell crank lever 10, the other arm 11 of which carries a weight 12; said lever 10 being mounted, as at 13, for oscillation about a fixed pivot point. Said lever 10 further carries a cam 14.

The lever assembly is suitably supported upon a standard 15 on which is pivotally mounted, as at 16, a lever 17 carrying a roller 18 which is operatively engaged by the cam 14. At its other end,

the lever 17 carries a grooved segmental member 19 to one end of which is attached a cable 20 supporting a weight 21. To the other end of said segment is secured a cable 22 which is connected to one arm of a lever 23 carrying, at its opposite end, an adjustable weight 24. Said arm 23 is pivoted, intermediate its ends, and carries the insulated swinging contact arm 25 of a potentiometer indicated generally by the reference numeral 26. Said contact arm is, of course, adapted to sweep the resistance coil 27 of said potentiometer. The ends of the coil 27 are respectively connected to terminals 42 and 43; and the contact arm 25 is connected to a terminal 44, through the usual flexible lead. The cam 14 is so contoured as to cause the arm 25 to move in increments directly proportional to incremental variations in the flow rate through the venturi 1.

It will be obvious that, as the flow rate through the venturi 1 decreases, the diaphragm and its connected push rod 8 will tend to rise to swing the arm 25 in a counterclockwise direction; and, as the flow rate through the venturi increases, the diaphragm and its connected rod 8 will tend to move downwardly to swing the arm 25 in a clockwise direction over the coil 27.

The reference numeral 28 indicates generally an enclosed variable speed transmission of the well known "Reeves" type. Said transmission comprises a constant-speed shaft 29 which is driven, through a belt or other suitable driving means 30, by a motor 31 mounted upon the housing of said transmission. The variable speed shaft 32 of said transmission is connected, by a belt or other suitable driving means 33, to drive a direct current generator 34 of the type which is provided with permanent magnet fields and which, therefore, delivers a direct current voltage which is directly proportional to its speed of rotation. Hereafter, said generator 34 will be referred to as a generator.

Likewise mounted upon the housing of the transmission 28 is reversible electric motor 35, connected, through a belt or other suitable driving means 36, to drive the screw shaft 37 of the transmission 28, said screw shaft being arranged, in accordance with standard practice, to shift the elements of the transmission 28 to vary the output speed of the transmission. Said shaft 37 is connected, by a belt or other suitable driving means 38, to drive the shaft 39 of a limit switch 40 connected in the energizing circuit for the motor 35; so that, as the motor 35 drives the shaft 37, the shaft 39 will likewise be driven to break the energizing circuit for the motor 35 at 55

either limit of practical operation of the shaft 37 to prevent damage to the transmission 28.

Operation of the motor 35 is under the domination of relay mechanism mounted in a cabinet 41; and, in turn, operated in accordance with the voltage developed by the generator 34 and a voltage proportional to the rate of flow through the venturi 1 and resultant from the position of the contact arm 25 of the potentiometer 26. Line wires 45 and 46, carrying alternating current, supply a transformer 47, the secondary winding of which impresses a reduced voltage alternating current upon a dry metallic disc type rectifier 48. Said line wires also supply the same alternating current to a second transformer 49, the secondary winding of which supplies a reduced voltage alternating current to a second rectifier 50.

The output direct current voltage of the rectifier 48 is impressed across the coil 27 of the potentiometer 26 through wires 51 and 52, connected to terminal 42, and wire 53, connected, through a rheostat 54, to terminal 43; the rheostat 54 being manually adjustable to vary the voltage impressed upon the coil 27. As is clearly shown in the drawing, the wire 51 is connected to the positive output terminal of the rectifier 48, so that the terminal 42 will be of positive polarity with respect to all points along the coil 27. It will therefore be apparent that the terminal 42 will be of positive polarity with respect to the wire 55 which is connected to the terminal 44 of the potentiometer 26; and that the voltage measured between the wires 52 and 55 will be the output voltage of the potentiometer.

The positively polarized lead 56 from the generator 34 is connected, at 57, with the positive wire 51 of the potentiometer circuit. The negative lead 58 of the generator and the negative output lead 55 of the potentiometer are connected together, in series with the movable coil 59 of a permanent magnet type galvanometer, and through the coils 60 and 61 of a resistor, the wire 55 being connected to one end of the coil 61 by a wire 62, the opposite end of said coil 61 being connected to one end of the coil 60 through a wire 63, the opposite end of the coil 60 being connected to one end of the coil 59 through a wire 64, and the opposite end of the coil 59 being connected to the wire 58.

Since the wires 56 and 52 are connected together at 57, differences in the output voltages of the potentiometer 26 and the generator 34 will determine the direction and intensity of the currents flowing through the galvanometer coil 59. Obviously, whenever the output voltages of the potentiometer 26 and the generator 34 are equal, the galvanometer 59 will stand in a neutral position.

The galvanometer coil 59 mechanically carries the usual needle 65 which carries contact points at its opposite ends for cooperation, respectively, with contact points 66 and 67.

The wire 68, which is connected to the positive terminal of the rectifier 50, leads to the wire 63 which is connected to the resistors 60 and 61. Wire 69 leads from the resistor 60 to one end of a coil 70 which, at its opposite end, is connected by a wire 71 to the contact point 66. Wire 62 leads from the resistor 61 to one end of a coil 72, the opposite end of which is connected by a wire 73 to the contact point 67. A wire 73' connects the negative terminal of the rectifier 50 with galvanometer needle 65. Thus, when the galvanometer needle 65 is turned to make contact

with the contact point 66, the coil 70 will be energized; and when said needle is turned to make contact with the contact point 67, the coil 72 will be energized.

As has been said, an increase in the flow rate through the venturi 1 will swing the arm 25 in a clockwise direction to increase the output voltage of the potentiometer 26. Assuming that, before such increase, the organization has been in balanced operation, such increase in the output voltage of the potentiometer will cause a current flow through the coil 59 in such a direction as to swing the galvanometer needle 65 into contact with the contact point 66, thus energizing the coil 70. Such energization of the coil 70 will shift contact element 74 out of contact with element 75 and into contact with element 76, thus closing an energizing circuit for the motor 35 which may be traced as follows: line wire 45, wire 77, wire 78, contact element 79, contact element 80, wire 81, contact element 74, contact element 76, wire 82, limit switch 40, wire 83, motor 35, common lead 84, limit switch 40, wire 85, and line wire 46. Energization of the motor 35 through the above-traced circuit will cause operation of said motor in such a direction as to increase the speed of the output shaft 32 of the transmission 28.

Conversely, when a decrease in the flow rate through the venturi 1 causes counterclockwise movement of the arm 25, the output voltage of the potentiometer will be decreased, so that the output voltage of the generator 34 will exceed the output voltage of the potentiometer, and a current will flow through the coil 59 in such a direction as to swing the galvanometer needle 65 into contact with the contact point 67, so energizing coil 72. Such energization of the coil 72 will shift the contact element 80 into contact with element 86 to close a circuit which may be traced as follows: line wire 45, wire 77, wire 87, contact 75, contact 74, wire 81, contact 80, contact 86, wire 88, limit switch 40, wire 89, motor 35, common wire 84, limit switch 40, wire 85, and line wire 46. Energization of the motor 35 through the last-traced circuit will cause operation of the motor in the opposite direction to reduce the speed of the output shaft 32 of the transmission 28.

As has been shown, an increase in the rate of flow of liquid through the venturi 1 will result in an increase in the speed of the shaft 32, by operation of the motor 35. As the speed of the shaft 32 increases, the speed of the generator 34 will likewise be increased to increase the output voltage thereof; and, when the output voltage of the generator 34 reaches a value equal to the output voltage of the potentiometer, in its momentary setting, the needle 65 will be returned to neutral position, thereby deenergizing the motor 35. Similarly, when the motor 35 is energized to reduce the speed of the shaft 32 as a result of a decrease in the flow rate through the venturi which causes a decrease in the output voltage of the potentiometer 26, the motor 35 will continue to operate only until the speed of the generator 34 has been reduced sufficiently to reduce the output voltage thereof to a value equal to the output voltage of the potentiometer.

Reference has been made to the resistors 60 and 61; but nothing has been said about their function. It will be remembered that both of said resistors are connected in series with the galvanometer coil 59 in the energizing circuit for said coil. When the galvanometer coil 59 is energized to swing the needle 65 into contact with

one of its associated contact points, as, for instance, the point 66, a current will flow in a circuit including the resistor 60; said current having its source at the rectifier 50. That current flow develops a voltage across the resistor 60, which voltage increases the intensity of the current flowing through the galvanometer coil 59, thereby tending to pull the galvanometer needle 65 more firmly into contact with the contact point 66. Conversely, when the coil 59 is energized to swing the needle into contact with the contact point 67, a voltage is developed across resistor 61, which again increases the intensity of the current flowing through the coil 59. Obviously, the current-flow increase effected by the development of voltage across the resistor 61 is in a direction opposite to the current increase resulting from the development of voltage across the resistor 60; but in either case, the tendency of the voltage development across the energized resistor is to increase the intensity of the current flowing through the coil 59.

When the generator 34 reaches its new optimum speed, after operation of the motor 35 in one direction or the other, to cause the needle 65 to swing out of contact with the contact point 66 or the contact point 67, the current flow from the rectifier 50 through the resistor 60 or 61 immediately stops, thus removing the additive effect of said resistors to the current intensity through the coil 59, and permitting the needle 65 to move farther away from the contact point with which it has been in contact, to guard against reclosing of the relay circuit as a result of mechanical vibration, or the like.

Bridged across the coil 70 is a resistor 90 for the suppression of arcing at the contact point 66; and a similar resistor 91 is bridged across the coil 72.

If it is desired to change the relation of speed of the shaft 32 to flow rate through the venturi 1, such a change may be effected by manual adjustment of the rheostat 54, whereby the speed of the shaft 32 with relation to a given mechanical position of the contact arm 25 will be varied.

I claim as my invention:

1. In combination, a conduit, means in said conduit for creating a head differential in fluid flowing through said conduit, an electric generator, means including a variable-speed transmission for driving said generator, and means dominating said transmission and jointly responsive to variations in said head differential and in the voltage output of said generator for controlling the speed of said generator in accordance with the rate of flow of fluid through said conduit.

2. In combination, a variable speed transmission, a reversible electric motor operable, upon energization, to vary the output speed of said transmission, a circuit for energizing said motor, switch means controlling said circuit, a conduit, means responsive to variations in the rate of flow of fluid in said conduit to close said switch means to energize said motor, and means responsive to variations in the output speed of said transmission as a result of operation of said motor to open said switch means to deenergize said motor.

3. In combination, a variable speed transmission, a reversible electric motor operable, upon energization, to vary the output speed of said transmission, a circuit for energizing said motor to run in one direction, a second circuit for energizing said motor to run in the opposite direction, switch means controlling said circuits,

a conduit, and means for controlling said switch means, comprising a permanent-magnet-type galvanometer, circuits for energizing the coil of said galvanometer to swing in opposite directions to open and close relay circuits dominating said switch means, means for impressing upon said coil a voltage of a value varying directly in response to the rate of flow of fluid through said conduit, and means for impressing upon said coil a bucking voltage of a value varying in response to the output speed of said transmission.

4. In combination, a variable speed transmission, a reversible electric motor operable, upon energization, to vary the output speed of said transmission, a circuit for energizing said motor to run in one direction, a second circuit for energizing said motor to run in the opposite direction, switch means controlling said circuits, a conduit, an electric means for controlling said switch means, said last-named means comprising means developing a voltage variable in accordance with the rate of flow of fluid through said conduit, and means for generating a voltage bucking said first-mentioned voltage and variable in accordance with the output speed of said transmission.

5. In combination, a conduit, a variable speed transmission, and means for controlling the output speed of said transmission in accordance with the rate of flow of fluid through said conduit, comprising a reversible electric motor operable, when energized to run in one direction, to increase said output speed and, when energized to run in the opposite direction, to decrease said output speed, energizing circuits for said motor, a magnetic switch controlling each of said circuits, an electrically-operated two-way switch controlling circuits for alternatively energizing said magnetic switches, means responsive to the rate of flow of fluid through said conduit to impress a variable voltage upon said electrically-operated switch, and means responsive to the output speed of said transmission to impress a bucking variable voltage upon said electrically-operated switch.

6. In combination, a conduit, a variable speed transmission, and means for controlling the output speed of said transmission in accordance with the rate of flow of fluid through said conduit, comprising a reversible electric motor operable, when energized to run in one direction, to increase said output speed and, when energized to run in the opposite direction, to decrease said output speed, energizing circuits for said motor, a magnetic switch controlling each of said circuits, circuits for alternatively energizing said magnetic switches, an electrically-operated two-way switch controlling said last named circuits, a circuit including a potentiometer and said electrically-operated switch, said potentiometer having a movable arm, an oppositely-polarized circuit including a variable-voltage generator and said electrically-operated switch, means for positioning the movable arm of said potentiometer in accordance with the rate of flow of fluid through said conduit, and means connecting the output shaft of said transmission to drive said generator.

7. In combination, a conduit, a variable speed transmission, and means for controlling the output speed of said transmission in accordance with the rate of flow of fluid through said conduit, comprising a reversible electric motor operable, when energized to run in one direction, to increase said output speed and, when ener-

gized to run in the opposite direction, to decrease said output speed, energizing circuits for said motor, a magnetic switch controlling each of said circuits, circuits for alternatively energizing said magnetic switches, an electrically-operated two-way switch controlling said last named circuits, means including a potentiometer operable to develop a variable voltage, for impressing a variable voltage upon said electrically-operated switch, means including a variable-voltage generator for impressing a bucking variable voltage upon said electrically-operated switch, means for varying the output voltage of one of said voltage-impressing means in accordance with the rate of flow of fluid through said conduit, and means for varying the output voltage of the other of said voltage-impressing means in accordance with the output speed of said transmission.

8. In a device of the class described, a conduit, a variable-speed transmission, a potentiometer having a contact arm, means operable to shift said contact arm and to hold the same in various predetermined positions in accordance with the rate of flow of fluid through said conduit, means responsive to the position of said contact arm to control the output speed of said transmission, so that each position of said arm results in a predetermined output speed of said transmission, and means for varying the relation between the position of said arm and the output speed of said transmission.

9. In combination, a variable speed transmission, a reversible electric motor operable, upon energization, to vary the output speed of said transmission, a circuit for energizing said motor to run in one direction, a second circuit for energizing said motor to run in the opposite direction, switch means controlling said circuits, a conduit, and means for controlling said switch means, comprising a permanent-magnet-type galvanometer, circuits for energizing the coil of said galvanometer to swing in opposite directions to open and close relay circuits dominating said switch means, means for impressing upon said coil a voltage of a value varying in accordance with the rate of flow of fluid through said conduit, means for impressing upon said coil a bucking voltage of a value varying in accordance with the output speed of said transmission, and means adjustable to vary the voltage developed by any given rate of flow of fluid through said conduit.

10. In combination, a variable speed transmission, a reversible electric motor operable, upon

energization, to vary the output speed of said transmission, a circuit for energizing said motor to run in one direction, a second circuit for energizing said motor to run in the opposite direction, switch means controlling said circuits, a conduit, and means for controlling said switch means, comprising a permanent-magnet-type galvanometer, circuits for energizing the coil of said galvanometer to swing in opposite directions to open and close relay circuits dominating said switch means, means for impressing upon said coil a voltage of a value varying in accordance with the rate of flow of fluid through said conduit, means for impressing upon said coil a bucking voltage of a value varying in accordance with the output speed of said transmission, and means adjustable to vary preliminarily the voltages developed by one of said voltage-impressing means.

11. In combination, a conduit, means in said conduit for creating a head differential in fluid flowing through said conduit, a machine, means including a variable-speed transmission for driving said machine, an electric generator driven at variable speeds through said transmission, and means dominating said transmission and responsive jointly to variations in said head differential and in the voltage output of said generator for controlling the output speed of said transmission in accordance with the rate of flow of fluid in said conduit, whereby the speed of said machine and of said generator will be controlled.

12. In combination, a variable speed transmission, a reversible electric motor operable, upon energization, to vary the output speed of said transmission, a circuit for energizing said motor to run in one direction, a second circuit for energizing said motor to run in the opposite direction, switch means controlling said circuits, a conduit, and means for controlling said switch means, comprising a permanent-magnet-type galvanometer, circuits for energizing the coil of said galvanometer to swing in opposite directions to open and close relay circuits dominating said switch means, means for impressing upon said coil a voltage of a value varying in accordance with the rate of flow of fluid through said conduit, an electric generator driven at speeds variable in accordance with the output speed of said transmission for impressing upon said coil a bucking voltage of variable value, and means adjustable to vary the voltage developed by any given rate of flow of fluid through said conduit.

WILLIAM R. PERRY.

CERTIFICATE OF CORRECTION.

Patent No. 2,164,019.

June 27, 1939.

WILLIAM R. PERRY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 19, claim 4, for "an delectric" read and electric; page 4, first column, line 45, claim 9, for the word "valve" read value; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 8th day of August, A. D. 1939.

Leslie Frazer,

Acting Commissioner of Patents.

(Seal)