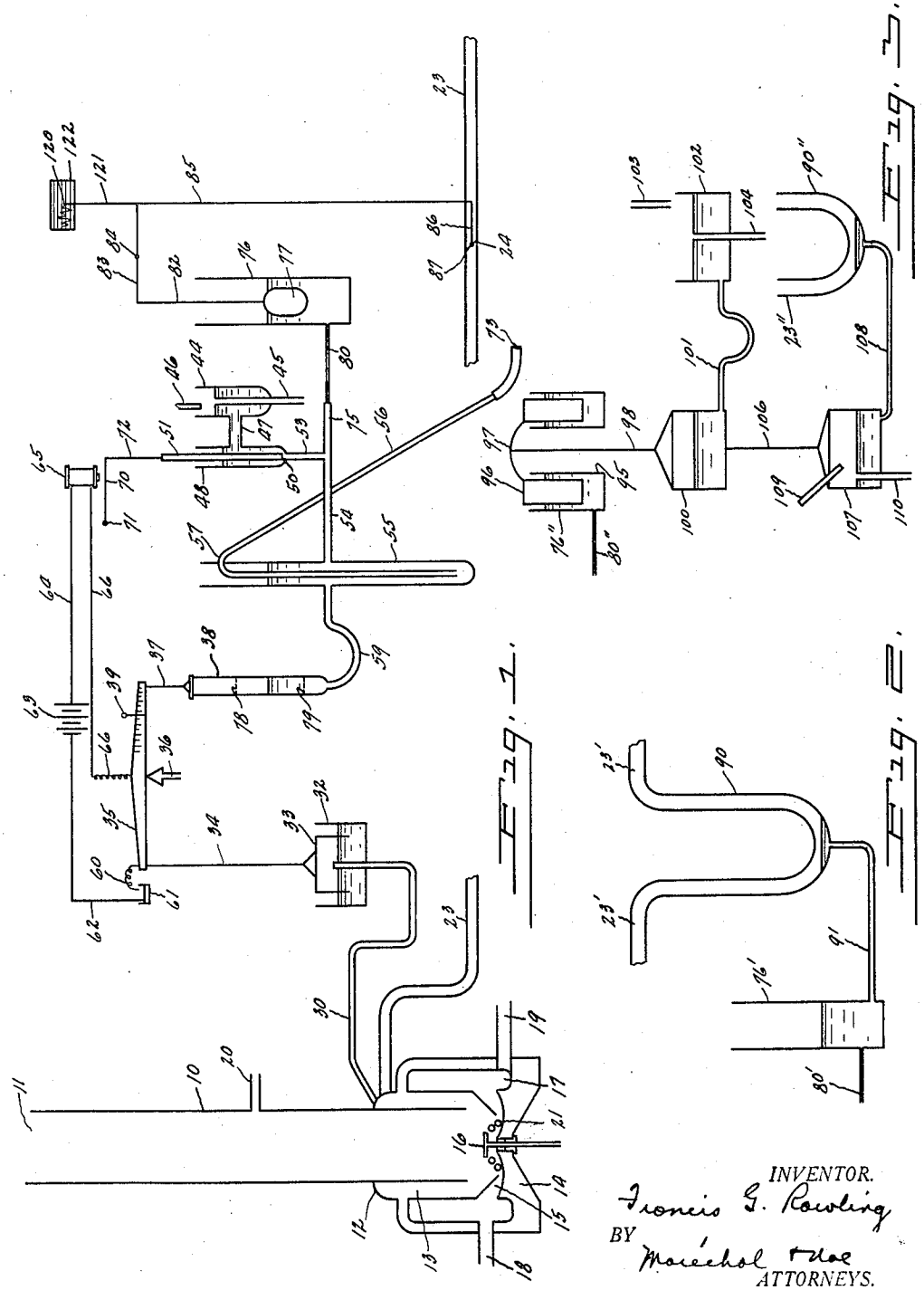
Sept. 1, 1931. F. G. RAWLING 1,821,237

CONTROL MECHANISM

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CONTROL MECHANISM

Application filed April 27, 1928. Serial No. 273,268.

This invention relates to gas control, and particularly to gas-pressure control for the chlorination of fibrous materials in the manufacture of pulp.

It is among the objects of this invention to provide gas-control apparatus, which is simple and economical in construction, and extremely sensitive in operation.

It is another object of this invention to provide a gas pressure control apparatus of high sensitivity which is adapted to control the pressure of a gaseous chlorinating agent in apparatus for the chlorination of pulp to provide for uniform and controlled treatment of the pulp.

Other objects and advantages of the invention will be apparent from the following description when taken in connection with the accompanying drawings and appended claims.

In the drawings in which like characters of reference designate like parts throughout the several views thereof—

Fig. 1 is a diagrammatic view of gas-control apparatus constructed in accordance with this invention;

Fig. 2 is a partial diagrammatic view of of a modified form of control apparatus; and

Fig. 3 is a partial diagrammatic view of still another modified form of control apparatus.

The present invention provides gas-control apparatus which is particularly adapted for use in connection with a chlorination tower for the chlorination of fibrous stock in the manufacture of paper pulp, as disclosed in the application of John Traquair and Francis G. Rawling, Serial No. 273,242, filed April 27, 1928. And the apparatus is shown by way of illustration in connection with such a chlorination tower. But it is to be understood that the invention is not limited to this use, and may be employed generally in gas-control work.

Referring to the drawings in which a preferred embodiment of the invention is illustrated, Fig. 1 discloses a gas-pressure control apparatus for controlling the pressure within the chlorination tower 10. As described in the copending application above referred to, this tower comprises a shell open to atmosphere at the upper end as indicated at 11, into which fibrous stock of high consistency such that it is permeable to gas is fed. The lower end of the tower is surrounded by a spaced shell 12 forming an annular chamber 13. The lower end of the shell 12 is spaced from a suitable base 14 which forms therewith a water seal 15, and slushing water is introduced at the base of the tower through the hollow rotary agitating arms 16 to dilute and slush out the pulp through this water seal 15 into a surrounding annular trough 17. Additional slushing liquid is introduced through a pipe 18 to remove the stock through pipe 19 to a suitable stock chest or other treating apparatus. Chlorine gas in introduced into the tower by means of pipe 20. The fibrous stock of high consistency passes by gravity from the feeding end to the discharge end of the tower as this stock is slushed out at the base. Coils of pipe 21 are provided adjacent the base for introducing jets of air under suitable pressure into the stock to displace the excess chlorine which tends to be carried along with the stock to prevent the escape of such chlorine gas into the atmosphere. The gaseous mixture of chlorine and air passes into the annular chamber 13, and from there is withdrawn through an offtake pipe 23 having a flow-regulating means therein shown as a butterfly valve 24.

Chlorine gas, being of higher specific gravity than air, tends to travel downwardly within the shell 10 of the chlorinating tower. In order to maintain a column of chlorine gas of desired depth within the tower, the outflow of gas through the offtake 23 is controlled, such as by the valve 24, in accordance with the pressure existent at the base of the tower to provide a predetermined pressure at this point. When chlorine gas which is heavier than air is used, a pressure is formed at the base of the column which is equal to the excess weight of the chlorine gas column over a like column of air. A column of chlorine gas of the desired depth is maintained within the

tower by so controlling the pressure at the base of the tower as to just balance this excess weight of the chlorine gas column. Such pressures are quite small, and with a tower substantially 15 to 30 feet in height are of the order of .005 to .010 pounds per square inch above atmospheric equivalent to around .0005 pounds per square inch for each foot of chlorine desired in the tower. By slightly increasing the predetermined pressure effective at the base of the tower, the depth of the column of chlorine gas within the chlorinating zone of the tower is increased. Conversely, by decreasing the predetermined pressure existent at the base of the tower, the depth of the maintained column of chlorine gas is decreased. Any desired depth of column of chlorine gas within the capacity of the tower is thus readily maintained and controlled within narrow limits.

The present invention provides extremely sensitive control apparatus for effecting this desired control of the pressure at the base of the chlorination tower. As shown, a pressure pipe or passage 30 leads off from the upper end of the chamber 13 and terminates above the liquid level in a fixed container 32 and within a pressure bell 33. This pressure bell is preferably made of thin glass and is of considerable cross-section to provide for increased buoyant effect upon slight pressure changes. The lower end of the bell is immersed in a suitable liquid, such as water or kerosene. Where kerosene is used, it is preferable to provide a soda-lime tube within the pressure passage 30 to remove chlorine gas to prevent reaction with the liquid. The bell 33 is suspended by a wire 34 from one arm of a balance beam 35 fulcrumed on a knife-edge support 36, this balance beam being similar to the balance beam of an analytical balance and preferably has agate planes and agate supports. Suspended from the other arm of the balance beam 35 by a wire 37 is a counterpoise 38. A rider 39 is adapted to be adjusted over the graduated arm of the balance beam in order to provide for adjustment of the predetermined pressure at the base of the tower, and therefore for the adjustment of the height of the chlorine gas column within the tower.

In order to further increase the sensitivity of the apparatus, means are provided for effecting a continuous oscillation of the balance beam in order to overcome the effect of inertia of the parts. For this purpose, the counterpoise 38 is preferably constructed of a glass tube to which liquid such as water is supplied and withdrawn in such a manner as to continuously change the effective weight of the counterpoise 38 to provide for a continuous oscillation of the balance beam. Liquid is continuously supplied to a fixed constant level tube 44 having an overflow pipe 45 by a pipe 46. The tube 44 is connected below the liquid level by a passage 47 with a tube 48. The lower end of the tube 48 is ground to provide a valve seat 50 on which a valve 51 is adapted to seat. The valve 51 may be formed from a glass rod having a ground end which is worked to a nice fit in the seat 50. The tube 48 is connected below the valve seat 50 by glass tubes 53 and 54 to a tube 55 provided with a siphon discharge tube 56. The upper end or bend 57 of the siphon tube is preferably positioned at a lower level than the level of liquid within the constant level chamber 44 so that the siphon is self-starting when the apparatus is put into use. Control of the rate of discharge of liquid is effected by adjustment of the elevation of the lower end of the siphon tube 56, or by selection of a tube having a flow passage of predetermined size. The supply of liquid into the system through the valve seat 50 and tubes 53 and 54 is adapted to be at a rate in excess of the discharge rate. The tube 55 is in turn connected by flexible tubing 59 with the lower end of the liquid-containing counterpoise 38, a portion of the tubing 59 thus constituting a part of the counterpoise.

When the valve 51 is raised from the seat 50, water flows into the system including the counterpoise 38 faster than it discharges through the siphon tube 56. This causes a rising water level in the counterpoise 38 which eventually overbalances the weight of the parts on the other side of the fulcrum 36 including the pressure bell 33 so that the balance beam tilts to the right-hand side as shown in Fig. 1. Carried by the balance beam 35 is a movable contact 60 which upon tilting of the balance beam 35 to the right is withdrawn from a fixed contact such as a tungsten contact or mercury cup 61. A conductor dipping within the mercury within the cup 61 is connected by a lead 62 to one side of the battery 63, the other side of the battery being connected by lead 64 to one end of a coil of an electromagnet 65. The other end of the coil is connected by a lead 66 to the metal balance beam 35 which completes the electrical circuit. Cooperating with the electromagnet 65 is an armature 70 pivoted at 71. The outer end of the armature 70 is connected by wire 72 with the valve 51.

Consequently when the electrical circuit of the electromagnet 65 is broken at the contact 61, the pivoted armature 70 falls, permitting the valve 51 to drop upon its seat 50 to shut off the supply of water to the system. The outflow of water from the system through the siphon 56 then reduces the level of water within the counterpoise 38 until the effective weight of the counterpoise

is less than the weight of the parts of the other side of the balance beam. The balance beam then tilts to the left to again close the contacts 60—61 which causes energization of the electromagnet 65 and attracts the armature 70 with consequent opening of the valve 51. The balance beam is thus kept in continuous oscillation during flow control.

The amplitude of oscillation controlled by the electrical contacts and supply valve is slight, whereby movement of the pressure bell is slight and is not sufficient to remove the lower end of the bell from the immersing liquid. The period of oscillation is controlled by the rates of supply and discharge of liquid, the size and proportion of the parts, the amplitude of swing, and other factors. Any suitable period may be used which serves to keep the balance beam moving to overcome inertia and sticking of the parts, very satisfactory results being secured with a period of 10 to 20 seconds. With a given set of parts of desired size, the oscillation may be controlled by adjustment of the elevation of the discharge end of the siphon tube, which tube should be quite long to prevent breaking of the siphon. This may be conveniently accomplished by providing a flexible piece of tubing 73 at the discharge end of the siphon tube, the end of the flexible tube being arranged for adjustment to suitable elevations. Lowering the discharge end of the siphon tube increases the rate of outflow through the siphon tube, and raising the discharge end decreases the rate of flow. An increased outflow will cause the water system including the counterpoise to fill more slowly with water but to empty more rapidly, which thereby provides a slower swinging movement of the balance beam during filling of the counterpoise and a faster swinging movement during discharge. Thus by adjustment of the end of the siphon tube, the oscillation of the balance beam in each direction is controlled. Preferably, the end of the siphon tube is set at the proper level such that the period of oscillation is divided into substantially equal periods of filling and emptying. The construction provides a water-control system which is fixed independently of the balance, and which may be of any capacity desired. The tops of all the tubes are preferably higher than the fixed overflow pipe 45 of the constant level tube 44, so that no overflow can occur except at this point.

Connected to the liquid system on the far side of the liquid supply valve 51 is a tube 75 leading to a float chamber 76 containing a float 77. As the counterpoise 38, the siphon tube 55, and float chamber 76 are interconnected, the water levels within the respective tubes tend to equalize. Due to the intermittent supply of liquid to the counterpoise 38 and consequent oscillation of the balance beam, the level of liquid within the counterpoise continuously fluctuates between an upper lever 78 and a lower level 79. This produces a surge in the system which tends to produce a fluctuating level within the float chamber 76. In order to damp out this surge effect, the float chamber 76 is connected by a tube 80 having a materially restricted bore with the tube 75. The net result is that the level of liquid in the float chamber 76 remains substantially quiet, and this level represents the mean effective level of the fluctuating levels of the counterpoise 38. If desired, a second float chamber may be provided, which is connected to the first float chamber by a restricted tube, which will entirely prevent the surging in the liquid system from affecting the level within the second float chamber; although a single float chamber as shown is generally sufficient for practical operation. The stem 82 of the float 77 is pivotally connected to one arm of a lever 83 pivoted at 84, the other arm of the lever being pivotally connected to a link 85 which in turn is pivotally connected to an arm 86 mounted upon the shaft 87 of the butterfly valve 24.

In operation, should the pressure at the base of the tower and within the chamber 13 tend to rise above predetermined normal, this increased pressure is communicated by the passage 30 to the pressure bell 33. The bell 33 is partially supported by gas trapped beneath the bell, and partially by the balance beam. The increased pressure thereby increases the buoyancy effect of the trapped gas and so reduces the effective weight of the bell, with the result that less water is required in the counterpoise 38 to balance the weight of the parts of the other side of the balance beam to maintain the parts in equilibrium. The increase in pressure of the gas in the bell raises it and raises the arm of the balance beam, thus breaking the electrical contacts and closing valve 51. The counterpoise becomes lighter owing to the action of the siphon until the parts are again in equilibrium, when the beam will continue to oscillate as before. As a result, a lower set of fluctuating levels 78 and 79 is produced in the counterpoise 38, the mean effective level of which is lower than the previous mean effective level. The level of liquid within the float chamber 76 thus falls, and lowering of the float 77 operates through the connected linkage to move the valve 24 toward open position. This permits the gases to escape through the pipe 23 from the base of the tower more rapidly to thereby bring the pressure back to predetermined normal. Conversely, when the pressure at the base of the chlo-

rinating tower falls below predetermined normal, the effective weight of the bell 33 is increased, and a higher set of fluctuating levels 78 and 79 is produced in the counterpoise 38. This gives a higher liquid level in the float chamber, and rising movement of the float 77 effects closing movement of the valve 24 in order to further restrict the outflow of gases from the base of the tower to bring the pressure back to predetermined normal. Thus small pressure fluctuations are translated by the balance into weight variations, and the proportions and buoyancy of the bell and frictionless balance beam magnify the exceedingly small pressure fluctuations into appreciable weight differences. The liquid system in turn translates the weight differences into fluctuations in liquid level. The provision of a counterpoise tube 38 of small diameter provides for a considerable fluctuation in liquid level for a relatively small difference in weight. The float chamber 76 on the other hand can be of relatively large size and contain a float of sufficient buoyancy to actuate the linkage connections to positively control the flow-regulating valve. Thus the weight differences are again magnified into relatively large fluctuating liquid levels, whereby a positively acting and extremely sensitive control is provided. When it is desired to adjust the height of the chlorine column within the tower, this is readily effected by movement of the rider 39 along the graduated balance beam, which thereby alters the control system to provide a new set of fluctuating levels within the counterpoise 38 and an altered mean effective level within the float chamber 76. This adjustment may also be effected by raising of the liquid level in the container 32 of the pressure bell 33, or by adjusting the height of the electrical contacts 60—61 in relation to the beam 35.

In order to dispense with linkage connections between the float and the flow-controlling means, a construction such as disclosed in Fig. 2 may be used. In this form, the offtake pipe 23′ is provided with a U-bend or return bend 90. The float chamber of the control system similar to that described in Fig. 1 is indicated at 76′ and the restricted passage connecting the float chamber with the liquid system of the counterpoise is indicated at 80′. A pipe connection 91 leads from the float chamber 76′ below the liquid level to the lower end of the return bend 90 of the offtake pipe 23′. Thus liquid accumulates in the lower portion of the return bend 90 up to the level of the liquid within the float chamber 76′ and serves to restrict or control the outflow of gases therethrough. In this form, the float may be dispensed with, the chamber 76′ functioning as a variable level chamber, and these fluctuations in level communicated to the return bend 90 function in the manner of a valve to control flow through the pipe 23′. When pressure increases above predetermined normal at the base of the tower, then the falling level within the float chamber 76′ produces a lower level of liquid within the U-bend 90 to thereby permit a more rapid discharge of gases through the offtake pipe 23′. Conversely, a pressure below predetermined normal at the base of the tower results in a higher water level within the float chamber 76′, which equalizes in the return bend 90 to increase the choking effect on the outflow of gases through the offtake pipe 23′.

In order to still further increase the sensitivity of the control apparatus, a construction as shown in Fig. 3 may be provided. The float chamber 76″ is connected through the restricted pipe 80″ to be responsive to the balance beam system in the same manner as described in Fig. 1. In this form, the float chamber is constructed of an annular shape having a central opening 95. An annular float 96 is provided connected by spiders 97 to a depending stem 98 which extends down through the opening 95. Carried by the stem 98 is a variable liquid-level chamber 100 which is movable with the float 96. The chamber 100 is in turn connected by a flexible tube 101 with a fixed constant level chamber 102 having a liquid-supply pipe 103 and an overflow 104. Suspended from the chamber 100 by a wire 106 is a movable constant level chamber 107, also movable with the float 96. The chamber 107 is in turn connected by a flexible tube 108 with the lower end of a U-bend or return bend 90″ in the gas offtake pipe 23″. The constant level chamber 107 is provided with a liquid-supply pipe 109 and an overflow pipe 110.

In the operation of this form of the invention, movement of the float 96 is magnified to increase the sensitivity of the control. Thus, a falling liquid level within the float chamber 76″ with a consequent lowering of the float 96 causes a lowering of the variable liquid-level chamber 100. The supply chamber 102 being fixed and having a constant level maintaining means, the level of liquid within the chamber 100 is maintained at the level of the liquid within the chamber 102. When the chamber 100 moves downwardly, an increased amount of liquid enters the chamber 100 to increase the effective weight of the float system, which causes a further lowering of the float within the supporting liquid within the float chamber 76″. Thus the constant level chamber 107 is moved downwardly an added amount in addition to the normal movement which would result from the falling water level in the flow at chamber 76″. Conversely, a rising of the

water level in the float chamber 76″ with resultant rising movement of the float 96 effects a reduction in the amount of water within the chamber 100 to thereby decrease the effective weight of the float system with a resultant magnifying of the rising movement of the float system. This construction is particularly advantageous in connection with the control of corrosive gases, for the float chamber 76″ and the control system is entirely separated from the gas pipe 23″ and there is no danger of contamination of the liquid within the counterpoise system by the corrosive gases. Further this construction compensates for any evaporation of the liquid in the return bend 90″ due to gas flowing through the pipe 23″. The constant level chamber 107 having the supply pipe 109 and overflow pipe 110 effects automatic adjustment at all times for any evaporation of liquid within the U-bend 90″.

A pressure-control apparatus is also preferably provided for the chlorine gas-inlet pipe 20 to control the introduction of the chlorinating agent in accordance with the pressure existent within the tower. In this case, the connections are so arranged that rise of pressure above predetermined normal moves the flow-regulating means toward closing position to reduce the supply of chlorine, and reduction in pressure below predetermined normal effects opening movement of the flowing-control means to increase the supply of chlorine gas to the tower.

Preferably a permanent record of the gas pressures prevailing at the base of the chlorination tower is made by suitable recording apparatus for process control purposes. This may be accomplished, as shown in Fig. 1, by means of a pen 120 attached to the float system of the float chamber 76 by a link 121. This pen is positioned to trace a recording line on a traveling chart 122 driven by suitable conventional clock mechanism (not shown,) the chart being calibrated to read directly in pressure units, inches of chlorine within the tower, or other desired units.

While the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. Apparatus of the character described, comprising a pressure chamber, a pipe therefor, means for controlling fluid flow through said pipe, means responsive to pressure within said chamber for translating and magnifying pressure fluctuations into weight differences, means for translating said weight differences into liquid level variations, and means controlled by said liquid level variations for regulating said flow-controlling means.

2. Apparatus of the character described, comprising a pressure chamber, a pipe therefor, means for controlling fluid flow through said pipe, mechanism responsive to pressure within said chamber for regulating said flow-controlling means, said mechanism including an oscillatory balance beam, a knife-edge support for said balance beam, a member responsive to fluid pressure within said pressure chamber supported from one side of said balance beam, and a liquid containing counterpoise supported from the other side of said balance beam.

3. Apparatus of the character described for maintaining a predetermined pressure, comprising a pressure chamber, a pipe therefor, means for controlling fluid flow through said pipe, mechanism responsive to pressure within said chamber for regulating said flow-controlling means to maintain a substantially constant pressure within said pressure chamber, said mechanism including an oscillatory balance beam, a knife-edge support for said balance beam, a member responsive to pressure within said pressure chamber supported from one side of said balance beam, a counterpoise supported from the other side of said balance beam, and means independent of said pressure chamber for varying the effective weight of said counterpoise to induce oscillation of said beam during flow control to increase the sensitivity of said control.

4. In control apparatus of the character described, an oscillatory member, a knife-edge support providing a stationary fulcrum therefor, a pressure-responsive member supported from said oscillatory member, a counterpoise therefor, and means for continuously varying the weight of said counterpoise to thereby impart a continuous oscillatory movement to said member.

5. In control apparatus of the character described, an oscillatory member, a knife-edge support therefor, a pressure-responsive member supported from said oscillatory member, a liquid-containing counterpoise therefor, and means for supplying liquid to said counterpoise in a manner to continuously vary the effective weight thereof so as to induce continuous oscillation thereof.

6. In control apparatus of the character described, an oscillatory member, a knife-edge support therefor, a pressure-responsive member supported from said oscillatory member, a liquid-containing counterpoise therefor, and means for supplying and withdrawing liquid from said counterpoise in a manner to induce continuous oscillation thereof.

7. In control apparatus of the character described, an oscillatory member, a knife-edge support therefor, a pressure-responsive member supported from said oscillatory member, a liquid-containing counterpoise therefor, means for supplying liquid to said counterpoise, means for withdrawing liquid from said counterpoise, the construction being such that oscillation of said oscillatory member is effected, and means responsive to the movement of said oscillatory member for controlling the liquid content of said counterpoise.

8. In control apparatus of the character described, an oscillatory member, a knife-edge support therefor, a pressure-responsive member supported from said oscillatory member, a liquid-containing counterpoise therefor, means for supplying and withdrawing liquid from said counterpoise in a manner to impart an oscillatory movement to said member, a valve for controlling the liquid content of said counterpoise, and means responsive to movement of said oscillatory member for controlling the positioning of said valve, said valve controlling means including an electrical circuit, and a switch therein adapted to be opened and closed by movement of said oscillatory member.

9. In control apparatus of the character described, an oscillatory member, a knife-edge support therefor, a pressure-responsive member supported from said oscillatory member, a liquid-containing counterpoise therefor, means for supplying liquid to said counterpoise, and a float chamber in communication with said counterpoise below the normal liquid level therein, the liquid level in said float chamber being responsive to and controlled by the level of liquid in said counterpoise.

10. In control apparatus of the character described, an oscillatory member, a knife-edge support therefor, a pressure-responsive member supported from said oscillatory member, a liquid-containing counterpoise therefor, means for supplying and withdrawing liquid from said counterpoise to produce fluctuating levels within said counterpoise to impart a continuous oscillatory movement to said oscillatory member, a float chamber in communication with said counterpoise below the normal liquid level therein, and means for damping out fluctuations in water level within said float chamber due to the continuous fluctuations within said counterpoise produced by the continuous oscillation thereof, whereby the liquid level in said float chamber is responsive to and controlled by substantially the mean liquid level within said counterpoise.

11. Apparatus of the character described, comprising a pressure chamber, a pipe therefor, means for controlling flow through said pipe, mechanism responsive to pressure within said chamber for regulating said flow-controlling means, said mechanism including a balance beam, a liquid-containing counterpoise carried thereby, a float chamber connected thereto, and means responsive to the level of liquid within said float chamber for regulating said flow-controlling means.

12. Apparatus of the character described, comprising a pressure chamber, a pipe therefor, means for controlling flow through said pipe, mechanism responsive to pressure within said chamber for regulating said flow-controlling means, said mechanism including a balance beam, a liquid-containing counterpoise carried thereby, a float chamber connected thereto, means responsive to the level of liquid within said float chamber for regulating said flow-controlling means, and means for magnifying the effect of level fluctuation within said float chamber upon said level-responsive means to increase the sensitivity of the regulation.

13. Apparatus for the character described, comprising a pressure chamber, a fluid pipe therefor having a return bend, liquid within said return bend for constricting the fluid flow passage to control fluid flow therethrough, an oscillatory balance beam, a pressure member responsive to pressure within said chamber supported by said balance beam, a liquid-containing counterpoise supported by said balance beam, and means responsive to the position of said balance beam and counterpoise for controlling the liquid within said return bend to control fluid flow through said pipe.

14. Apparatus of the character described, comprising a pressure chamber, a fluid pipe therefor having a return bend, liquid within said return bend for constricting the fluid flow passage to control fluid flow therethrough, an oscillatory balance beam, a pressure member responsive to pressure within said chamber supported by said balance beam, a liquid-containing counterpoise supported by said balance beam, a float chamber, a liquid connection between said counterpoise and said float chamber, a float therein, means for magnifying the effective movement of the float, and means responsive to the position of the float for controlling the liquid level within said return bend for controlling fluid flow through said pipe.

15. Apparatus of the character described, comprising a pressure chamber, a fluid pipe therefor having a return bend, liquid within said return bend for constricting the fluid flow passage to control fluid flow therethrough, an oscillatory balance beam, a pressure member responsive to pressure within said chamber supported by said balance beam, a liquid-containing counterpoise supported by said balance beam, means respon-

sive to the position of said balance beam and counterpoise for controlling the liquid within said return bend to control fluid flow through said pipe, and means for supplying fresh liquid to said return bend to compensate for evaporation of liquid due to fluid flow through said pipe.

16. Apparatus of the character described, comprising a pressure chamber, a pipe therefor, means for controlling fluid flow through said pipe, means responsive to pressure within said chamber for translating pressure fluctuations within said chamber into weight differences, a liquid chamber, means for translating said weight differences into liquid level variations in said liquid chamber, and means responsive to said liquid level variations for regulating said flow controlling means.

17. In control apparatus of the character described an oscillatory member, a knife-edge support therefor intermediate the ends thereof, a pressure bell supported from one side of said oscillatory member, a counterpoise supported from the other side of said oscillatory member, and means for imparting a continuous oscillatory movement having a period in excess of four seconds to said member to overcome the inertia of the parts and increase the sensitivity thereof.

18. In control apparatus of the character described, an oscillatory member, a knife-edge support therefor, a pressure-responsive member supported from said oscillatory member, a liquid-containing counterpoise therefor, means for intermittently supplying liquid to said counterpoise including a valve controlled supply pipe, means responsive to movement of said oscillatory member for controlling said valve, and a siphon discharge for said counterpoise.

19. Apparatus of the character described, comprising a pressure chamber, a pipe therefor, means for controlling fluid flow through said pipe, an oscillatory balance beam, a pressure member responsive to pressure within said chamber supported by said balance beam, a liquid-containing counterpoise supported by said balance beam, a float chamber, a float therein, a liquid connection between said counterpoise and said float chamber, a variable liquid level chamber supported by said float and movable therewith, a fixed constant level chamber connected to said variable level chamber, and means responsive to movement of said float for controlling said flow-controlling means.

20. The method of controlling fluid pressure which comprises translating fluid pressure fluctuations into weight differences, translating the weight differences into liquid level variations, and regulating the pressure in accordance with liquid level variations.

21. The method of controlling fluid pressure which comprises translating and magnifying fluid pressure fluctuations into weight differences, translating and magnifying the weight differences into liquid level variations, and regulating the pressure in accordance with liquid level variations.

22. The method of controlling fluid pressure which comprises translating and magnifying fluid pressure fluctuations into weight difference, translating and magnifying the weight differences into liquid level variations, magnifying the liquid level variations, and regulating the pressure in accordance with the magnified liquid level variations.

23. Apparatus of the character described, comprising a pressure chamber, a pipe therefor, means for controlling fluid flow through said pipe, means responsive to pressure within said chamber for translating and magnifying pressure fluctuations into weight differences, means for maintaining said translating means in substantially continuous movement to overcome inertia of the parts and increase the sensitivity thereof, and means controlled by said translating means for regulating said flow controlling means.

24. Apparatus of the character described, comprising a pressure chamber, a pipe therefor, means for controlling fluid flow through said pipe, means responsive to pressure within said chamber for translating and magnifying pressure fluctuations into weight differences, means for maintaining said translating means in substantially continuous movement to overcome inertia of the parts and increase the sensitivity thereof, means for translating said weight differences into liquid level variations, means for rendering the continuous movement of said first translating means substantially ineffective with respect to the liquid level of said second translating means, and means controlled by said liquid level variations for regulating said flow controlling means.

25. In control apparatus of the character described, an oscillatory member, a stationary knife edge support therefor intermediate the ends thereof, a pressure responsive member supported from one side of said oscillatory member, a counterpoise supported from the other side of said oscillatory member, means for imparting a continuous oscillatory movement to said member, and means for varying the period of continuous oscillation of said member.

26. In control apparatus of the character described, an oscillatory member, a knife edge support therefor, a liquid containing counterpoise supported by said oscillatory member, means for intermittently supplying liquid to said counterpoise including a valve controlled supply pipe, means responsive to movement of said oscillatory member for controlling said valve, and a liquid discharge for said counterpoise.

27. In control apparatus of the character described, an oscillatory member, a knife edge support therefor, a liquid containing counterpoise supported by said oscillatory member, means for supplying liquid to said counterpoise, means for withdrawing liquid from said counterpoise, said supply means having a supply rate in excess of the rate of discharge from said withdrawal means, a valve for controlling said supply means, and means responsive to the movement of said oscillatory member for controlling the positioning of said valve.

28. In control apparatus of the character described, an oscillatory member, a knife edge support therefor, a liquid containing counterpoise supported by said oscillatory member, a valve controlled liquid supply tube, a siphon discharge tube, connections between said supply tube and said siphon tube and said counterpoise providing a connected liquid system, a float chamber, and a connection from said float chamber to said liquid system beyond said valved supply tube.

29. Apparatus of the character described comprising a pressure chamber, a fluid pipe therefor having a return bend, liquid within said return bend for constricting the fluid flow passage to control fluid flow therethrough, an oscillatory lever, a member responsive to pressure within said pressure chamber supported by said lever, a liquid containing counterpoise supported by said lever, a float chamber, a liquid connection between said counterpoise and said float chamber, a float therein, a variable liquid level chamber supported by said float and movable therewith, a fixed constant level chamber connected to said variable level chamber, and means supported by said float and movable therewith for controlling the liquid level within said return bend to thereby control fluid flow through said pipe.

30. Apparatus of the character described comprising a pressure chamber, a fluid pipe therefor having a return bend, liquid within said return bend for constricting the fluid flow passage to control fluid flow therethrough, an oscillatory lever, a member responsive to pressure within said pressure chamber supported by said lever, a liquid containing counterpoise supported by said lever, a float chamber, a liquid connection between said counterpoise and said float chamber, a float therein, a constant level chamber supported by said float and movable therewith, a liquid supply therefor, an overflow therefor and a liquid connection between said constant level chamber and said return bend for controlling the liquid level within said bend to thereby control fluid flow through said pipe.

In testimony whereof I hereto affix my signature.

FRANCIS G. RAWLING.