

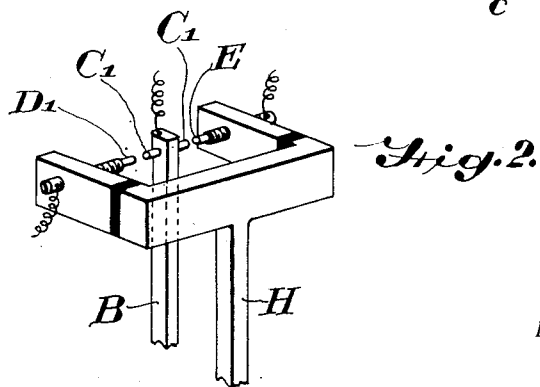
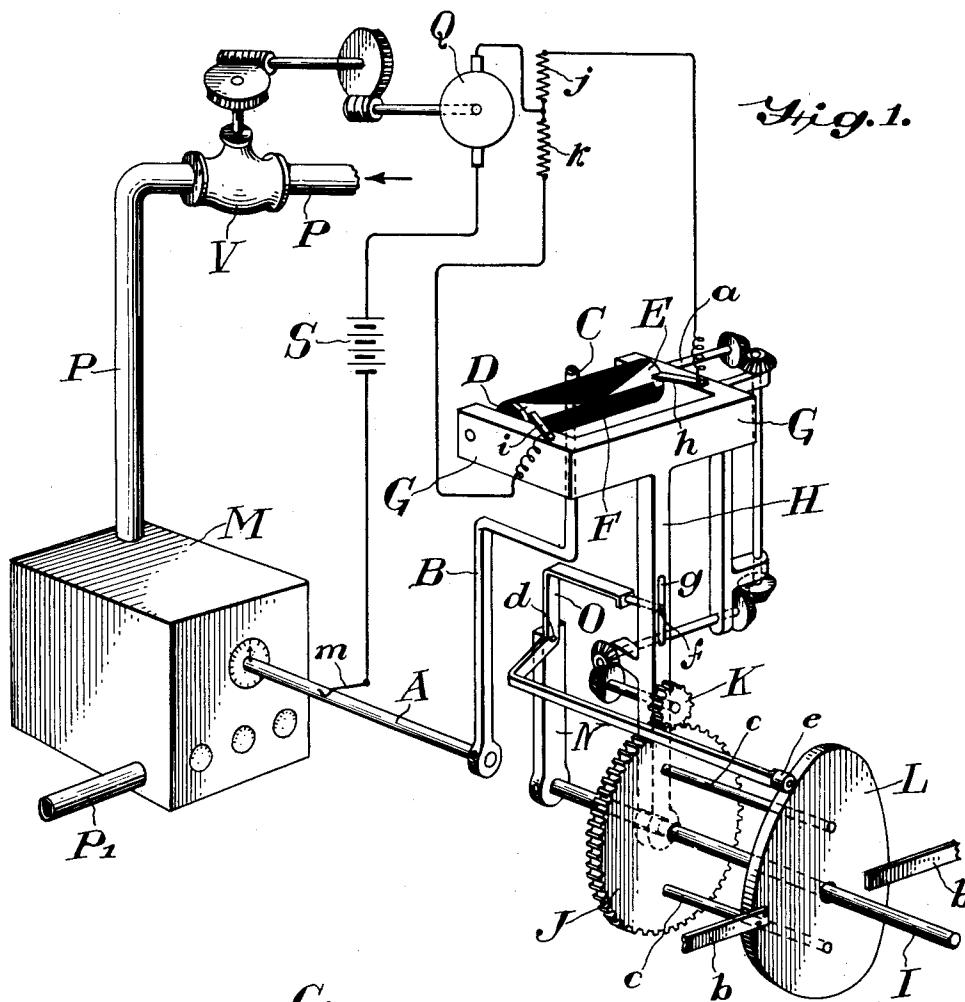
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L. BEHR

METHOD OF AND APPARATUS FOR PROCURING UNIFORM FLOW

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METHOD OF AND APPARATUS FOR PROCURING UNIFORM FLOW.

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To all whom it may concern:

Be it known that I, LEO BEHR, a citizen of the United States, residing in the city and county of Philadelphia, State of Pennsylvania, have invented new and useful Improvements in Methods of and Apparatus for Procuring Uniform Flow, of which the following is a specification.

My invention relates to a method of and apparatus for effecting synchronism between members in motion, and more particularly my invention relates to a method of and apparatus for effecting uniform or other predetermined rate of flow of fluid, as liquid, or vapor or gas, or a mixture of them, or for rendering uniform the rate of flow otherwise more or less ununiform.

My invention resides in a method and apparatus of the character hereinafter described and claimed.

For an illustration of my method and for an illustration of some of the forms my apparatus may take, reference is to be had to the accompanying drawing, in which:

Fig. 1 is a view, partly in perspective and partly in diagram, of apparatus embodying my invention and utilizable in practicing my method.

Fig. 2 is a fragmentary perspective view of a modification of part of my apparatus.

Referring to the drawing, P is a pipe through which is delivered the fluid whose rate of delivery or flow it is desired shall be maintained uniform or of other predetermined magnitude. The pipe P communicates through the valve V with the meter or similar device M from which the fluid is delivered through the pipe P¹.

The device M may be of the character of a fluid or gas meter of any suitable type, for example, a wet meter when the fluid is a gas, and is in effect any suitable structure operated or controlled by the fluid flow to effect movement or rotation whose speed is proportional or substantially proportional to the rate of flow of the fluid.

The fluid in passing through the device M causes or controls rotation of a member, as shaft A, which may be the shaft or a continuation of the shaft of a registering gear train, or may be any other shaft. Carried by the shaft A is the arm B carrying at its end the contact C, preferably a roller, adapted to engage either of the contacts D

and E carried by the insulating cylinder F 55 carried by the shaft *a* journaled in the bracket or frame G carried by the arm H, loosely pivoted upon the shaft I, preferably co-axial with the shaft A, rotated at uniform or other predetermined speed by 60 any suitable means, as for example, a nicely governed electric motor, not shown.

Concentric with the shaft I is the stationary gear J, with which meshes a pinion K which, through bevel gearing as indicated, or by equivalent means, rotates the shaft *a*, the arm H rotating approximately in fixed relation with respect to the shaft I except as controlled or modified by the cam L held stationary by the members *b, b*, the 70 gear J being held fixed, as by members *c, c* connected to the stationary cam L. Secured to the shaft I and rotating in fixed relation therewith is the arm N, upon which is pivoted at *d* the bell crank lever O, one arm 75 of the bell crank carrying the roller *e* co-acting with the cam L. On the other arm of the bell crank is carried a pin *f* extending freely through the slot *g* in the arm H, whereby, within a revolution of the shaft I, 80 the arm H partakes of somewhat different angular positions with respect to the shaft I as enforced or controlled by the cam L.

Co-acting with the contacts D and E are the brushes *h* and *i* connected, respectively, 85 through slip ring connections or equivalent, not shown, with terminals of the series field windings *j* and *k* of an electric motor whose armature Q rotates the rotatable member of the valve V through the gearing 90 illustrated, or any other suitable means. One terminal of the armature Q connects to a point between the field windings *j* and *k*, and the other terminal connects through the source of current S with the 95 aforesaid contact C, as through a brush *m* bearing upon the shaft A, with which latter the contact C is always in electrical communication. The series field windings *j* and *k* are so wound or connected that energization of one of them produces rotation 100 of the armature Q in opposite direction to that effected by energization of the other.

The contacts D and E increase in their angular or circumferential width with departure from the center of the roller F, and the brushes *h* and *i* are in communication with the contact segments E and D for 105

such lengths of time that each brush separates from its co-acting segment before that segment separates, due to its rotation, from the contact C, whatever its lateral displacement, whereby the circuit of the electric motor is broken between the brush and its contact and not between the roller C and either of the contacts E or D, whereby all arcing incident to motor circuit rupture occurs at the brushes, and not at the contact C.

The operation is as follows:

Assuming first that throughout each revolution of the shaft A its rate of rotation or speed is strictly proportional to the rate of flow of fluid through the meter or device M, and assuming that the arm H is secured to the shaft I and rotates in fixed relation therewith, in which case the cam L and the bell crank lever O will be omitted, the arms B and H rotate in the same direction, the arm H at uniform or other predetermined speed, and the arm B and contact C at a speed dependent upon the rate of fluid flow. If the rate of fluid flow is greater than the predetermined or desired uniform rate, the contact C will move in such direction as corresponds with movement toward the right, Fig. 1, thereby co-acting with the contact segment E, and accordingly the field winding *j* and armature Q of the electric motor will be traversed by current from the source S, thereby rotating the rotatable member of the valve V in such direction as to diminish the flow of fluid through the pipe P, the length of time of each energization of the electric motor depending upon the extent of deflection of the contact C, since the circumferential width of the contact E varies from the center outwardly. Accordingly, the flow of fluid to the device or meter M is diminished by steps, which steps are the greater as the rate of flow the greater exceeds the predetermined or desired uniform rate of flow. The flow of fluid through the pipe P will accordingly be diminished until the desired uniform rate of flow is attained, or it may too greatly diminish, whereby the rate of flow is below the desired predetermined or uniform rate, in which case the contact C will lag behind the arm H and therefore co-act, in similar manner, with the contact D, in which case the other series winding *k* of the electric motor will be brought into action, with the result that the rotatable member of the valve V will now be rotated in opposite sense, opening the valve and allowing greater rate of flow of fluid through the pipe P.

Accordingly, the apparatus will maintain or tend to maintain constant delivery of fluid through the pipe P¹ at a desired predetermined or uniform rate.

In case, however, the nature or structure

of the device or meter M is such that the speed of the shaft A, within a revolution, varies to strict proportionality with the rate of fluid flow through the device M, the cam L is employed, together with the bell crank arm O, and in such event the arm H is loose upon the shaft I. The cam L is given such form or contour that it compensates for the variation of the speed of the shaft A from strict proportionality with the rate of flow of fluid through the meter or device M. The cam, traversed by the roller *e*, causes therefore a rocking of the bell crank lever O upon its pivot *d*, and through the pin *f* causes the arm H to be advanced or retarded with respect to the shaft I, whereby the contacts D and E vary in their speed of rotation to compensate for the variation of speed of the shaft A from strict proportionality with the rate of fluid flow through the meter or device M. Otherwise the mode of operation is similar to that above described.

In lieu of the motor controlling contact mechanism carried by the arm H as illustrated in Fig. 1, structure such as indicated in Fig. 2 may be employed. In this case the arm B carries a contact C¹ adapted to engage either of the contacts D¹ and E¹ insulated from each other and carried by the arm H. As before, the contacts C¹, D¹ and E¹ are connected in circuit, as in Fig. 1.

It will be understood that without departing from the spirit of my invention the apparatus may be modified and varied, and that various equivalents of my apparatus or parts thereof are comprehended within the spirit of my invention.

What I claim is:

1. The method of synchronizing moving members, which comprises driving a plurality of members independently, one of them at a predetermined speed, effecting changes of speed of another of said members, and causing the magnitudes of said changes to vary in accordance with the magnitudes of changes of the positions of said members with respect to each other while in motion.

2. The method of synchronizing moving members, which consists in driving one of a plurality of members at a predetermined speed, independently driving another of said members by a motive fluid, and controlling the speed of said other of said members by changing the rate of flow of said motive fluid for a period of time dependent upon the relation to each other of the positions of said members while in motion.

3. The method of effecting predetermined rate of flow, of fluid, which consists in producing or controlling by the fluid, motion of a member at a speed dependent upon the rate of flow, producing motion of a second member at a speed representative of said predetermined rate of flow and independ-

ently of the rate of flow of the fluid, and changing the rate of flow of said fluid to an extent which varies in accordance with the relation to each other of the positions of said members.

4. The method of effecting uniform rate of flow of fluid, which consists in producing or controlling by the fluid, motion of a member at a speed dependent upon the rate of flow, producing motion of a second member at a speed representative of said uniform rate of flow and independently of the rate of flow of the fluid, and changing the rate of flow of said fluid to an extent and for a period of time which varies in accordance with the relation to each other of the positions of said members.

5. The method of effecting predetermined rate of flow of fluid, which consists in producing or controlling by the fluid, motion of a member at a speed dependent upon the rate of flow, producing motion of a second member at a speed representative of said predetermined rate of flow and independently of the rate of flow of the fluid, controlling the flow of fluid in accordance with the relation to each other of the positions of said members, and varying the speed of one of said members to compensate for variations of speed of said first member from proportionality to the rate of flow of said fluid.

6. The method of effecting uniform rate of flow of fluid, which consists in producing or controlling by the fluid, rotation of a member at a speed dependent upon the rate of flow, producing rotation of a second member at a speed representative of said uniform rate of flow and independently of the rate of flow of the fluid controlling the flow of fluid in accordance with the relation to each other of the positions of said members, and varying the speed of rotation of said second member to compensate for variations of speed of said first member from proportionality to the rate of flow of said fluid.

7. Apparatus for effecting synchronism between moving members comprising means for driving one of said members at a predetermined speed, and means controlling the speed of another of said members to accord with the speed of said one of said members comprising means for changing the speed of said other of said members to an extent and for a period dependent upon the extent of change of relation to each other of the positions of said members.

8. Apparatus for effecting a predetermined rate of fluid flow comprising a member moving at a speed dependent upon the rate of flow of said fluid, a second member moving at a speed independent of the rate of flow of said fluid and representative of said predetermined rate of flow, and means

for changing the rate of flow of the fluid to an extent dependent upon the extent of change of the positions of said members with respect to each other.

9. Apparatus for effecting a uniform rate of fluid flow comprising a member moving at a speed dependent upon the rate of flow of said fluid, a second member moving at a speed independent of the rate of flow of said fluid and representative of said uniform rate of flow, and means for changing the rate of flow of the fluid to an extent dependent upon the extent of change of the positions of said members with respect to each other.

10. Apparatus for effecting a predetermined rate of fluid flow comprising a member moving at a speed dependent upon the rate of flow of said fluid, a second member moving at a speed independent of the rate of flow of said fluid and representative of said predetermined rate of flow, means for changing the rate of flow of the fluid in response to the relation to each other of the positions of said members, and means for varying the speed of one of said members to compensate for variations of speed of said first member from proportionality with the rate of flow of said fluid.

11. Apparatus for effecting a uniform rate of fluid flow comprising a member rotating at a speed dependent upon the rate of flow of said fluid, a second member rotating at a speed independent of the rate of flow of said fluid and representative of said uniform rate of flow, means for changing the rate of flow of the fluid in response to the relation to each other of the angular velocities of said members, and means for varying the speed of said second member to compensate for variations of speed of said first member from proportionality with the rate of flow of said fluid.

12. Apparatus for effecting predetermined rate of flow of fluid comprising a contact rotating at a speed dependent upon the rate of flow of said fluid, contact structure rotating at a speed representative of said predetermined rate of flow, electro-responsive means controlled by the co-action of said contact and contact structure while rotating, and means controlling the rate of flow of said fluid controlled by said electro-responsive means.

13. Apparatus for effecting predetermined rate of flow of fluid comprising a contact rotating at a speed dependent upon the rate of flow of said fluid, a pair of contacts varying in extent in opposite senses rotating at a speed representative of said predetermined rate of flow, a reversible motor controlled by said contact and pair of contacts while rotating, and means controlled by said motor for varying the rate of flow of said fluid.

14. Apparatus for effecting predetermined rate of flow of fluid comprising a contact

rotating at a speed dependent upon the rate of flow of said fluid, contact structure rotating at a speed representative of said predetermined rate of flow, electro-responsive means controlled by the co-action of said contact and contact structure while rotating, means controlling the rate of flow of said fluid controlled by said electro-responsive means, and means for varying the speed of said contact structure to compensate for variations of speed of said contact from proportionality with the rate of flow of said fluid.

15. Apparatus for effecting predetermined rate of flow of fluid comprising a contact rotating at a speed dependent upon the rate of flow of said fluid, a pair of contacts varying in extent in opposite senses rotating at a speed representative of said predetermined rate of flow, a reversible motor controlled by said contact and pair of contacts while rotating, means controlled by said motor for varying the rate of flow of said fluid, and means for varying the speed of said pair of contacts to compensate for variations of speed of said contact from proportionality with the rate of flow of said fluid.

16. Apparatus for effecting predetermined rate of flow of fluid comprising an arm rotating at a speed depending upon the rate of flow of said fluid, a second arm rotating at a speed representing said predetermined rate of flow of said fluid, a pair of contacts carried by said second arm, means for rotating said contacts while rotating with said second arm, a contact carried by said first named arm co-acting with said pair of contacts, an electro-motive-device operating in opposite senses under control of said contacts, and means controlled by said motive device controlling the flow of said fluid.

17. Apparatus for effecting predetermined rate of flow of fluid comprising a contact rotating at a speed dependent upon the rate of flow of said fluid, contact structure rotating at a speed representative of said predetermined rate of flow, a motive device controlled by said contact and contact structure, means controlled by said motive device controlling the flow of said fluid, a cam whose surface represents departure of speed of said contact from proportionality with the rate of flow of said fluid, a cam follower, said cam and its follower varying the angular position of said contact structure with respect to said contact.

18. The combination with two separately driven members, of means for synchronizing the movement of said members, comprising a pair of electrical contacts carried by one of said members, a third electrical contact carried by the other one of said members and normally in spaced relation to the said pair of contact members, and electro-responsive speed-control means to which said pair of

contacts are oppositely connected, the said third contact serving to complete the circuit through said electro-responsive means by engaging with one of said first mentioned contacts at one relative rate of movement by its supporting member, and closing said circuit through the other one of said pair of contacts upon relative displacement of the said driven members in the opposite direction.

19. The combination with two separately driven members, of means for controlling the relative movements of said members, comprising a pair of electrical contacts carried by one of said members, a third electrical contact carried by the other one of said members and normally in spaced relation to the said pair of contact members, and electro-responsive speed-control means to which said pair of contacts are oppositely connected, the said third contact serving to complete the circuit through said electro-responsive means by engaging with one of said first mentioned contacts at one relative rate of movement by its supporting member, and closing said circuit through the other one of said pair of contacts upon relative displacement of the said driven members in the opposite direction.

20. The combination with two separately driven members, of means for controlling the relative movements of said members, comprising a pair of electrical contacts carried by one of said members, a third electrical contact carried by the other one of said members, and electro-responsive speed-control means to which said pair of contacts are oppositely connected, the said third contact serving to complete the circuit through said electro-responsive means by engaging with one of said first mentioned contacts at one relative rate of movement by its supporting member, and closing said circuit through the other one of said pair of contacts upon relative displacement of the said driven members in the opposite direction.

21. The combination with two movable members, of means for controlling relative speeds thereof comprising electro-responsive means for effecting acceleration or retardation of one of said members, two electrical contacts carried by one of said members and oppositely connected to the electro-responsive means, and a third electrical contact carried by the other one of said members for closing the circuit through one or the other of said two electrical contacts as the relative speeds of said two members vary.

22. The combination with two rotatable members, of means for controlling the relative speeds thereof comprising electro-responsive means for effecting acceleration or retardation of one of said members, two circumferentially spaced electrical contacts carried by one of said members and oppositely

connected to said electro-responsive means, and an electrical contact carried by the other one of said members and normally disposed in intermediate spaced relation to said two contacts, whereby the circuit through one or the other of the said two contacts and the electro-responsive means may be closed as the relative speeds of the said two members vary.

23. The combination with two movable members, of means for controlling relative speeds thereof comprising electro-responsive means for effecting acceleration or retardation of one of said members, two electrical contacts carried by one of said members and oppositely connected to the electro-responsive means, a third electrical contact carried by the other one of said members for closing the circuit through one or the other of said two electrical contacts as the relative speeds of said two members vary, and means for moving the said two contacts into position to be engaged by said third contact member for a period of time varying with the relative speeds of said movable members.

24. The combination with two movable members, of means for controlling the relative speeds thereof comprising a contact device rotatable with respect to one of said members and in definite relation to the movement thereof, a contact device carried by the other one of said members in position to be intermittently engaged by said rotatable contact device upon changes in angular velocities of said movable members, and an electro-responsive speed changing device in circuit with said contact devices.

25. The combination with two rotatable members, of means for controlling the relative speeds thereof comprising two contact members carried by and rotatable with respect to one of said members, a contact member carried by the other one of said rotatable members in position to be moved into the path of said rotatable movement of one of said two contact members as the relative speeds of said rotatable members vary, and an electro-responsive speed-changing device oppositely connected to said two contact members.

26. The combination with two movable members, of means for controlling the relative speeds thereof, comprising a pair of rotatable contacts varying in extent in opposite senses and driven by one of said members, a third contact carried by the other one of said members in position to engage one of said pair of contacts at a point determined by the degree of variation in speed of one of said members, and an electro-responsive speed-changing device to which said pair of contacts are oppositely connected.

27. The combination with two movable members, of means for controlling the relative speeds thereof, comprising a rotatable

contact of varying width, and a contact carried by the other one of said members in position to engage said rotatable contact for a time determined by the degree of variation in speed of one of said members.

28. The combination with two movable members, of means for controlling the relative speeds thereof, comprising a movable contact whose engaging surface is of varying width, and a contact carried by the other one of said members in position to engage said movable contact for a time determined by the degree of variation in speed of one of said members and by the width of said movable contact where engaged by said second contact.

29. The method of effecting uniformity in cycles of movement of a movable member subject to non-uniformity of motion during a cycle, which consists in producing movement of a second member at a speed representative of a uniform rate of recurrence of said cycles, controlling by said second member the rate of cyclic movement of said first named member, and varying the speed of movement of said second member to compensate for variations in speed of said first member from uniformity during a cycle of movement thereof.

30. The method of effecting uniformity as between periods of movement by a member moving at non-uniform rate during said periods, which consists in moving a second member at a speed representative of the desired periodicity, controlling the movement of the first named member by said second member, and varying the speed of movement of one of said members to compensate for said non-uniform rate of movement.

31. The method of effecting uniformity of movement by two members through definite periods, where one of the members is subject to non-uniform movement within such period, which consists in varying the speed of the other one of said members to compensate during each period for said non-uniform movement.

32. Apparatus for effecting uniformity in cyclic movement of a member that is subject to non-uniformity of motion during a cycle of movement, comprising a second member moving at a rate of speed representative of the desired rate or recurrence of said cycles and controlling the rate of movement of the first named member, and means for varying the speed of one of said members to compensate for said non-uniformity of movement within a cycle.

33. The combination with two movable members, one of which is subject to non-uniformity of motion during each cycle of movement thereof, of means for effecting uniformity in recurrence of cycles of movement by said members, and means for varying the speed of the other one of said mem-

bers within a cycle to compensate for said irregularity of movement of the first named member.

34. The combination with two members
5 normally movable through a cycle during a predetermined period of time, the movement of one of such members being non-uniform during said cycle, of means for varying the speed of the other one of said members to
10 compensate for said non-uniform movement.

35. The method of controlling the rate of flow of a continuous stream of fluid, which consists in rotating a member by said fluid at a rate proportionate to its rate of flow,

independently rotating another member at a 15 predetermined speed, changing the rate of flow of the fluid to extents dependent upon the extents of variations in the difference between the angular velocities of said members, and independently varying the angular 20 velocity of one of said members to compensate for cyclic non-uniformity of rate of flow of said fluid.

In testimony whereof I have hereunto
affixed my signature this 19th day of Janu- 25
ary, 1921.

LEO BEHR.