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SLURRY FEEDING AND MEASURING APPARATUS

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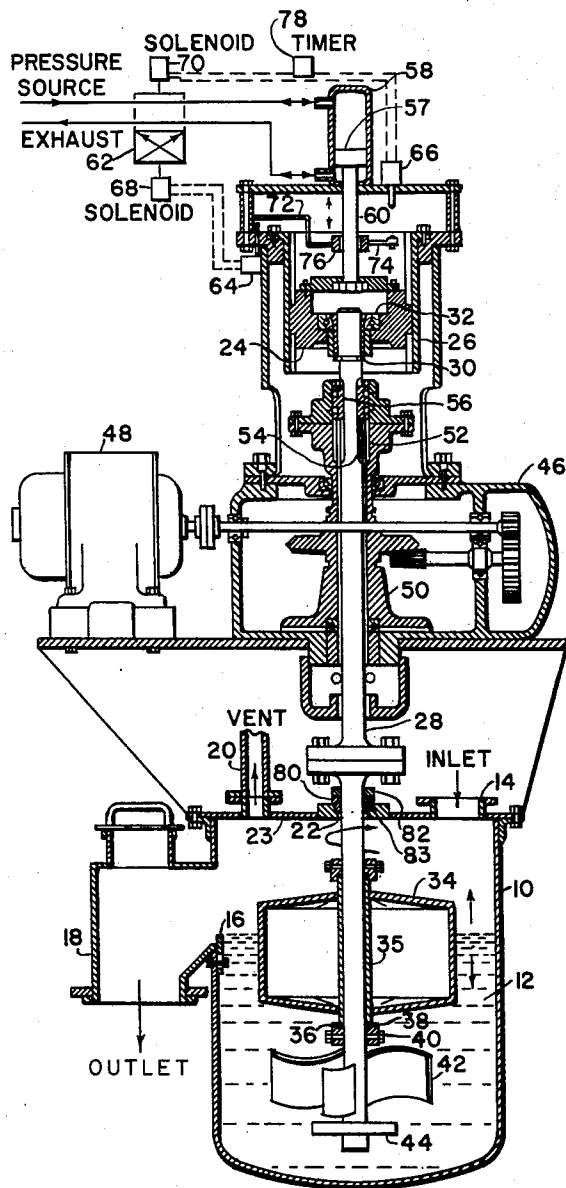


FIG. 1

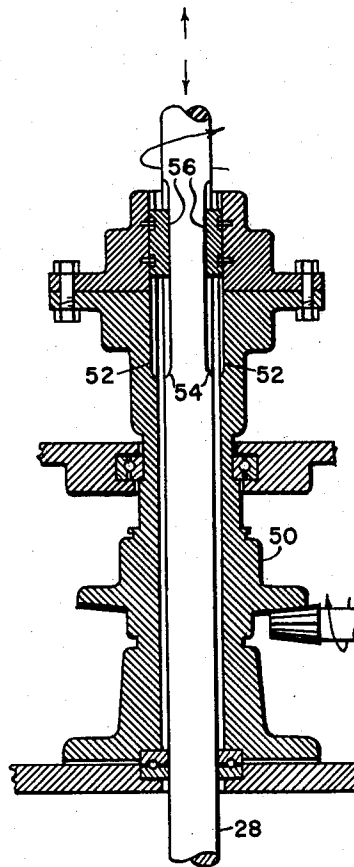


FIG. 2

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SLURRY FEEDING AND MEASURING APPARATUS

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8 Claims. (Cl. 222-229)

This invention relates to mechanism for converting a continuously flowing feed stream of solids suspended in a liquid vehicle into an intermittent feed by effecting intermittent delivery of measured volumes of slurried solids from a reservoir being fed by a continuous feed stream of said slurried solids.

Heretofore the conversion of a continuously flowing feed stream of solids suspended in a liquid vehicle into an intermittent feed, and particularly fibrous solids suspended in a liquid vehicle, has been subject to various difficulties in conventional equipment designed for handling liquids due to plugging, segregation of solids, holdup of fibrous material on valve seats, and the like.

Accordingly, it is an object of the present invention to provide improved apparatus for converting a continuously flowing feed stream of solids slurried in a liquid vehicle into an intermittent feed, which is free of disadvantages arising from plugging, segregation of solids, holdup of fibrous material on valve seats, and the like.

Another object is to provide improved apparatus of the type indicated, designed for the feeding or dispensing of slurried solids in measured quantities and at various rates according to requirements.

A further object is to provide improved apparatus of the type indicated in which the measuring function takes place on the positive displacement principle for measuring a definite given volume of solids slurried in a liquid vehicle at whatever rate may be necessary for any given slurry feeding operation.

A still further object is to provide improved apparatus of the type indicated by which the delivery of measured volumes of slurried solids are proportioned to the function or demands of some other device or equipment in connection with which the present apparatus may be installed.

Other objects will become apparent from the following description of the invention, the novel features and combinations being set forth in the appended claims.

Generally described, the present invention comprises in combination a reservoir holding a body of slurry, said reservoir being provided with an inlet and an overflow weir communicating with an outlet, a displacement member disposed in the reservoir for partial submersion in the body of slurry, a vertically reciprocating device mounted above the reservoir and operatively connected to the displacement member to impart the same vertically reciprocating motion to said displacement member as possessed by said reciprocating device, agitating means disposed in the body of slurry in the reservoir, and means for imparting a measured stroke to the vertically reciprocating device.

A preferred embodiment of the invention has been chosen for purposes of illustration and description and is shown in the accompanying drawing forming a part of the specification wherein reference symbols refer to like parts wherever they occur.

Fig. 1 is a front elevation, shown partly in section, of the apparatus according to this invention;

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Fig. 2 is an enlarged sectional view of the hollow quill gear member and shaft combination of this invention.

With reference to the drawing there is provided a covered reservoir 10 holding a body of slurry 12 and having an inlet 14 and an overflow weir 16 communicating with an outlet 18. Reservoir 10 is also provided with a fume vent 20 and a shaft opening 22 in reservoir cover 23. A crosshead 24 keyed to slide up and down with a vertically reciprocating motion is mounted in a rigid frame-work 26 above the reservoir. A vertical shaft 28 is mounted with its upper end held in crosshead 24 by means of retaining ring 30 for reciprocating motion with crosshead 24 and journaled in crosshead 24 for rotation by means of bearing 32, and extends downwardly into reservoir 10. Displacement member 34, concentrically disposed around shaft 28, is a hollow cylinder, closed at each end, and having an axial sleeve 35 through which shaft 28 extends. A gasket 36 and hold-down nut 38 on each end of sleeve 35 prevent slurry from getting between sleeve 35 and shaft 28. Displacement member 34 is affixed to shaft 28 and adjustably positioned vertically thereon by means of set screws 40 through each of hold-down nuts 38 for rotation and vertical reciprocating motion with shaft 28 and for partial submersion in slurry 12 at least during the downward stroke of each reciprocating cycle. Agitator 42 is affixed to shaft 28 below displacement member 34, and a shaft stabilizer 44 is also affixed to shaft 28 adjacent the lower end thereof. Rotary motion to shaft 28 is derived from a gear reduction unit 46, driven by motor 48, and provided with a hollow quill gear member 50 which is integral with the gear train of gear reduction unit 46 and through which shaft 28 slidably extends, hollow quill gear member 50 and shaft 28 being provided with one or more sets of adjacent matching keyways 52 and 54, respectively, in which keys 56 are inserted, keyways 54 in shaft 28 being longer than the maximum vertical stroke of shaft 28 in its vertically reciprocating motion. Crosshead 24 is connected to piston 57 in a reciprocating pressure cylinder mechanism 58 with piston rod 60, pressure cylinder mechanism 58 being actuated from a hydraulic or pneumatic pressure source (not shown) through the 4-way solenoid operated valve 62 responsive to microswitches 64 and 66 connected, respectively, to solenoids 68 and 70. Vertically adjustable arms 72 and 74, affixed to piston arm 60 by means of collar 76, contact microswitches 64 and 66, respectively, to make and break the electric current which energizes solenoids 68 and 70. Vertically adjustable arms 72 and 74 also determine the length of the reciprocating vertical stroke transmitted to crosshead 24, and thence through shaft 28 to displacement member 34 in reservoir 10. Desirably, a timer 78 in the electric circuit between solenoid 70 and microswitch 66 is employed to control the time interval between delivery of successive measured volumes of slurry to the outlet. Shaft 28 is provided with a self-seating shaft seal 80 concentrically disposed around shaft 28 adjacent to shaft opening 22 in the covered reservoir. Shaft seal 80 is beveled on at least part of its seating face and is weighted from above by means of collar 82 to facilitate self-seating in a mating seating member 83 in reservoir cover 23.

To operate the mechanism for the purposes of this invention, a continuous feed stream of solids suspended in a liquid vehicle is introduced via inlet 14 into reservoir 10, and the desired speed of rotation and vertical reciprocating stroke are imparted to shaft 28, and thence to displacement member 34 and agitator 42. When the level of slurry 12 in reservoir 10 reaches the overflow level of weir 16 at the bottom of the displacement member downward stroke, the mechanism becomes fully operative to deliver an intermittent measured volume of slurry

to the outlet with each succeeding cycle of operation; on the upstroke the slurry level drops below the level of the weir and there is no discharge of slurry over the weir, and on the succeeding downstroke the displacement member displaces a predetermined measured volume of slurry which overflows the weir into the outlet, the size of the measured volume being determined by the dimensions of the displacement member, the length of the displacement stroke, the total cycle time, and the slurry feed rate to the reservoir.

For the purposes of this invention the slurry holding reservoir can conveniently be a vertical cylindrical vessel as shown in the drawing. However, the invention is not limited in this respect, since the reservoir can be varied as desired both with respect to size and shape. The minimum requirement for size is that it must be large enough to provide sufficient annular space for slurry to flow around the displacement member and over the overflow weir without plugging or holdup. As for shape, the reservoir can be of various geometric configurations, the only requirement being that there are no spaces in the reservoir below the slurry level which cannot be effectively agitated. The inlet to the reservoir will, of course, be sufficiently large to accommodate the feed stream of slurry without holdup or plugging.

The overflow weir level communicating with the outlet to the reservoir automatically governs the slurry level in the reservoir, and preferably is adjustable in a vertical plane for this purpose, the outlet being sufficiently large to accommodate any desired and predetermined volume of slurry displaced from the reservoir. The shape of cutout for the weir can be varied as desired to control the nature of the overflow as the available head of slurry at the weir changes. For example, the cutout for the weir can be rectangular, inverted trapezoid, V notch, U notch, and the like as desired.

The displacement member is conveniently a rigid, closed, hollow cylinder, as illustrated, of sufficient size to displace the required quantity of slurry on the down stroke in the time interval required. However, instead of a hollow cylindrical shape, the displacement member may, if desired, be solid and may be of other geometric shapes, such as spherical, cubical, regular cone, inverted cone, or combinations of such shapes, to vary the rate of displacement of slurry as the displacement member moves through its downward stroke. In a preferred embodiment of the invention the displacement member is adjustably affixed to the shaft to facilitate raising or lowering its vertical position in the reservoir with relation to the body of slurry therein for greater or lesser submersion, as desired. This does not mean, however, that the displacement member must be partially submerged in the body of slurry for the complete reciprocating cycle. It is sufficient for the purposes of this invention if the displacement member becomes partially submerged in the body of slurry during the downward stroke sufficiently to displace and deliver the desired amount of slurry to the outlet. If desired, the displacement member could be made permanently integral with the shaft or equivalent connection to the vertical reciprocating device.

Agitation is one of the necessary functions of the mechanism of this invention in order to overcome any tendency for solids to segregate or settle out of the suspending liquid vehicle and to maintain uniform distribution of solids throughout the body of slurry in the reservoir. In the illustrated embodiment of the invention a swept-back, open impeller turbine is shown affixed to the shaft below the displacement member. However, other types of agitators, such as blades, paddles, fins, bars, and the like, are equivalent to the swept-back, open impeller turbine for the purposes of this invention. Moreover, if desired, agitator blades, paddles, fins, bars, and the like can be attached directly to the displacement member and thereby eliminate the need for a separate agitator. On the other hand, as an alternate embodiment

it is not necessary that the displacement member and agitator be on the same actuating shaft, since suitable agitation can be obtained with a separate and independent agitator disposed in the body of slurry. In the embodiment in which a separate and independent agitator is employed, it would not be necessary to impart rotary motion to the shaft or equivalent connection attaching the displacement member to the vertical reciprocating device. The degree of agitation should be sufficient to maintain uniform distribution of solids throughout the body of the slurry in the reservoir and prevent segregation or separation of solids therefrom, but should not be so vigorous as to cause substantial vortexing or splashing, since substantial vortexing and/or splashing can interfere with the proper displacement function of the apparatus.

In the illustrated embodiment of the invention it will be noted that a shaft stabilizer is affixed to the shaft adjacent the lower end thereof to minimize shaft wobble. Those skilled in the art will appreciate that for certain types of slurries or liquids the lower end of the shaft could be slidably and rotatively mounted in a suitable bearing member attached to the bottom of the reservoir, in which case no shaft stabilizer would be required. For that matter, in embodiments in which a separate agitator is provided, or in which the displacement member is provided with agitating blades, paddles, fins, and the like, there would be no necessity for the shaft to extend below the displacement member.

It will be noted in the drawing that the shaft is provided with a self-seating shaft seal to close the shaft opening in the cover of the reservoir. This self-seating shaft seal is conveniently made of an inert plastic material which is nonabrasive and can be installed around the shaft by making a radial cut in the axial direction through the material and snapping it around the shaft. The shaft seal is beveled on at least part of its seating face and is weighted from above by means of a loosely fitting collar or equivalent means to facilitate self-seating. An advantage of this shaft seal is that it permits relatively large clearances between the rigid reservoir cover and the shaft so that in the event the shaft is thrown off center during operation, no damage is done to the reservoir cover or shaft. In case the shaft is momentarily thrown off center during operation, the sealing member readily adjusts itself to maintain the seal. A shaft seal of this type is particularly useful to minimize leakage of reservoir contents in case of splashing in the reservoir in embodiments of this invention in which the lower end of the shaft is not mounted in a bearing member.

In addition to agitation, the other necessary function of the apparatus of this invention is that of displacement and delivery of measured portions from the slurry body in the reservoir, and in the illustrated embodiment this function is accomplished by means of a reciprocating pressure cylinder mechanism connected through the vertically reciprocating crosshead and shaft to the displacement member. The reciprocating pressure cylinder can be either hydraulic or pneumatic, or a combination of hydraulic and pneumatic, and it will be appreciated that various solenoid operated valves, timer circuits, and the like are available for actuating such cylinders on any desired cycle and at any desired rate of travel. It will also be appreciated that other mechanical devices such as levers, cams, and the like can be employed instead of a reciprocating pressure cylinder to impart a vertically reciprocating stroke to the displacement member.

An important aspect of a preferred embodiment of this invention resides in the means for transmitting rotary motion to the shaft without interfering with simultaneous vertical reciprocating motion of the shaft. This is accomplished by providing one or more adjacent matching keyways in the shaft and in the hollow quill gear member of a gear reduction unit, through which quill the shaft

slides up and down on keys inserted in said keyways. The keyways in the shaft are of sufficient length to permit the maximum desired reciprocating stroke to be imparted to the shaft without interference from the keys in the keyways, and rotary motion is transmitted to the shaft from the gear train through said keys.

The following example illustrates application of apparatus in accordance with this invention for delivering measured volumes of a slurry of fibrous nitrocellulose suspended in water to a centrifuge for separating water from the nitrocellulose. With reference to the drawing, the reservoir employed was a cylindrical vessel with a dished bottom, having an inside diameter of 35 inches and a side wall height of 39 inches, with a straight-edged overflow weir 12 inches long. The displacement member was a cylindrical vessel having an outside diameter of 20 inches and a straight-side height of 8 inches with standard dished ends, concentrically disposed around a 3-inch diameter shaft. A six-bladed, 20-inch diameter swept-back open impeller turbine was mounted on the shaft below the displacement member, and the shaft was rotated at 84 r.p.m. by means of a gear reduction unit having a hollow quill gear member, in the manner illustrated in the drawing and described hereinbefore, and powered with a 10 H.P., 1760 r.p.m. motor. The shaft was attached to a vertically reciprocating crosshead actuated by a 3-inch diameter reciprocating hydraulic-pneumatic cylinder adjusted for a 4-inch stroke, provided with a suitable solenoid valve-timer circuit and limit switches at each end of the reciprocating stroke to operate on the following cycle:

	Seconds
Downward displacement stroke -----	1.4
Upward return stroke -----	1.4
Dwell at top of upward stroke -----	3.2
Total cycle -----	6.0

Oil pressure at 35 p.s.i.g. powered the piston in the pressure cylinder for the upstroke and air pressure at 50 p.s.i.g. powered the piston in the pressure cylinder for the downstroke.

The feed stream of slurry, containing approximately 5% of fibrous nitrocellulose suspended in water, was continuously fed to the reservoir at the rate of 36 gallons per minute, and 3.6 gallons of slurry were displaced from the reservoir once during each 6-second cycle, the above set forth conditions being adjusted to meet the requirements of a centrifuge operating on a 6-second cycle. During operation of the apparatus of this invention there was no segregation or settling of solids from the slurry, and there was no plugging or holdup of nitrocellulose at any point.

It is apparent from the above description, therefore, that apparatus according to this invention is quite useful for accomplishing the purposes of this invention. Its principal advantages reside in accomplishment of the objectives of this invention, as set forth. While particularly suited for converting a continuously flowing feed stream of solids suspended in a liquid vehicle into a measured intermittent feed, it will be evident that apparatus according to this invention is also operative and useful for converting a continuously flowing feed stream of any liquid into a measured intermittent feed.

What we claim and desire to protect by Letters Patent is:

1. Apparatus for delivery of measured volumes of solids slurried in a liquid vehicle comprising in combination a reservoir holding a body of slurry, said reservoir being provided with an inlet and an overflow weir communicating with an outlet, a displacement member disposed in the reservoir for partial submersion in the body of slurry, a vertically reciprocating device mounted above the reservoir and operatively connected to the displacement member to impart the same vertically reciprocating motion to said displacement member as possessed by said reciprocating device, agitating means disposed in the body of slurry in the reservoir, and mechanical means operatively connected to the vertically reciprocating device for imparting thereto a continuous cyclic measured reciprocating stroke.

2. Apparatus for delivery of measured volumes of solids slurried in a liquid vehicle comprising in combination a reservoir holding a body of slurry, said reservoir being provided with an inlet and an overflow weir communicating with an outlet, a vertically reciprocating device mounted above the reservoir, a vertical shaft mounted at its upper end in the reciprocating device for vertical reciprocating motion with said device and journaled therein for rotation, said shaft extending downwardly into the reservoir, a displacement member affixed to the shaft for rotation and vertical reciprocating motion with said shaft and disposed in the reservoir for partial submersion in the body of slurry at least during the downward stroke of each reciprocating cycle, agitating means disposed in the body of slurry, means for imparting rotary motion to the shaft, and mechanical means operatively connected to the vertically reciprocating device for imparting thereto a continuous cyclic measured reciprocating stroke.

3. Apparatus in accordance with claim 2 in which said overflow weir is provided with means for adjusting said weir in a vertical plane and in which said displacement member is affixed to said shaft for adjustment vertically thereon.

4. Apparatus for delivery of measured volumes of solids slurried in a liquid vehicle comprising in combination a reservoir holding a body of slurry, said reservoir being provided with an inlet and an overflow weir communicating with an outlet, a vertically reciprocating device mounted above the reservoir, a vertical shaft mounted at its upper end in the reciprocating device for vertical reciprocating motion therewith and journaled in said reciprocating device for rotation, said shaft extending downwardly into the reservoir, a displacement member affixed to the shaft for rotation and vertical reciprocating motion with said shaft and disposed in the reservoir for partial submersion in the body of slurry at least during the downward stroke of each reciprocating cycle, agitating means disposed in the body of slurry, a gear reduction unit mounted above the reservoir and provided with a hollow quill gear member integral with the gear train of said gear reduction unit, through which the shaft slidably extends, said hollow quill gear member and said shaft being provided with at least one set of adjacent matching keyways in which keys are inserted to transmit rotary motion to said shaft, said keyways in said shaft being longer than the vertical reciprocating stroke of said shaft, and mechanical means operatively connected to the vertically reciprocating device for imparting thereto a continuous cyclic measured reciprocating stroke.

5. Apparatus for delivery of measured volumes of solids slurried in a liquid vehicle comprising in combination a reservoir holding a body of slurry, said reservoir being provided with an inlet and an overflow weir communicating with an outlet, a vertically reciprocating device mounted above the reservoir, a vertical shaft mounted at its upper end in the reciprocating device for reciprocating motion therewith and journaled therein for rotation, said shaft extending downwardly into the reservoir, a displacement member affixed to the shaft for rotation and vertical reciprocating motion with said shaft and disposed in the reservoir for partial submersion in the body of slurry at least during the downward stroke of each reciprocating cycle, agitating means disposed in the body of slurry, a gear reduction unit mounted above the reservoir and provided with a hollow quill gear member integral with the gear train of said gear reduction unit, through which the shaft slidably extends, said hollow quill gear member and said shaft being provided with at least one set of adjacent matching keyways in which keys are inserted to transmit rotary motion to said shaft, said keyways in said shaft being longer than the vertical reciprocating stroke of said shaft, and mechanical means operatively connected to the vertically reciprocating device for imparting thereto a continuous cyclic measured reciprocating stroke.

6. Apparatus for delivery of measured volumes of solids slurried in a liquid vehicle comprising in combination a reservoir holding a body of slurry, said reservoir being provided with an inlet and an overflow weir communicating with an outlet, a vertically reciprocating device mounted above the reservoir, a vertical shaft mounted at its upper end in the reciprocating device for reciprocating motion therewith and journaled therein for rotation, said shaft extending downwardly into the reservoir, a displacement member affixed to the shaft for rotation and vertical reciprocating motion with said shaft and disposed in the reservoir for partial submersion in the body of slurry at least during the downward stroke of each reciprocating cycle, agitating means disposed in the body of slurry, a gear reduction unit mounted above the reservoir and provided with a hollow quill gear member integral with the gear train of said gear reduction unit, through which the shaft slidably extends, said hollow quill gear member and said shaft being provided with at least one set of adjacent matching keyways in which keys are

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inserted to transmit rotary motion to said shaft, said keyways in said shaft being longer than the vertical reciprocating stroke of said shaft, and a reciprocating pressure cylinder mechanism operatively connected to said vertically reciprocating device and responsive to adjustable sensing means to impart a measured stroke to said device.

6. Apparatus for delivery of measured volumes of solids slurried in a liquid vehicle comprising in combination a reservoir holding a body of slurry, said reservoir being provided with an inlet and an overflow weir communicating with an outlet, a crosshead keyed to slide up and down with a vertically reciprocating motion in a rigid framework above the reservoir, a vertical shaft mounted at its upper end in the crosshead for reciprocating motion therewith and journaled therein for rotation, said shaft extending downwardly into the reservoir, a displacement member concentrically disposed around the shaft and adjustably affixed to said shaft for rotation and vertical reciprocating motion with said shaft, said displacement member being positioned on said shaft for partial submersion in the body of slurry in the reservoir, agitating means affixed to the shaft below the displacement member, a shaft stabilizer affixed to the shaft adjacent the lower end thereof, a gear reduction unit mounted above the reservoir and provided with a hollow quill gear member integral with the gear train of said gear reduction unit,

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through which the shaft slidably extends, said hollow quill gear member and said shaft being provided with at least one set of adjacent matching keyways in which keys are inserted to transmit rotary motion to said shaft, said keyways in said shaft being longer than the vertical reciprocating stroke of said shaft, and a reciprocating pressure cylinder mechanism connected to the crosshead, and responsive to adjustable sensing means to impart a measured stroke to the crosshead.

7. Apparatus in accordance with claim 6 in which the reservoir is provided with a cover having an opening through which the shaft extends, and in which a self-seating shaft seal is concentrically disposed around the shaft to close said opening.

8. Apparatus in accordance with claim 7 in which said shaft seal is beveled on at least part of its seating face and weighted from above to facilitate self-seating.

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