

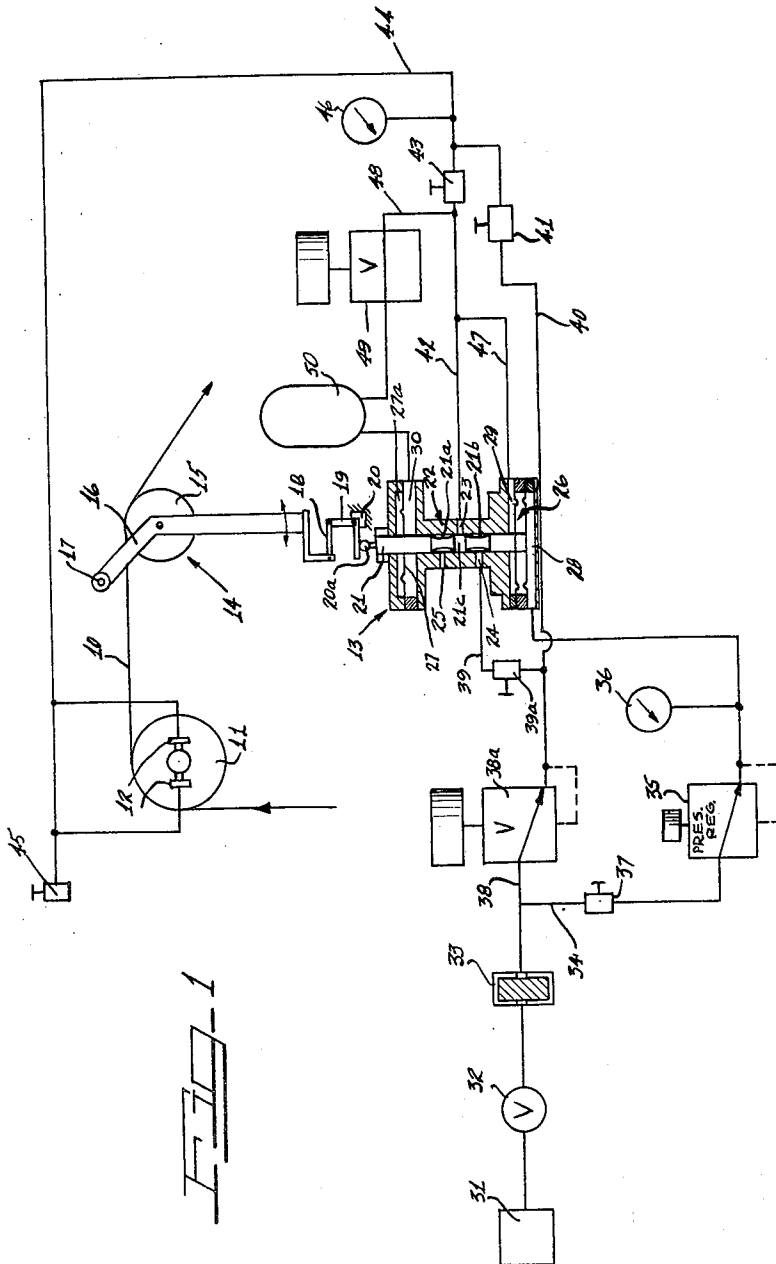
Jan. 1, 1963

E. J. JUSTUS
TENSION REGULATOR

3,071,300

Filed Aug. 2, 1960

2 Sheets-Sheet 1



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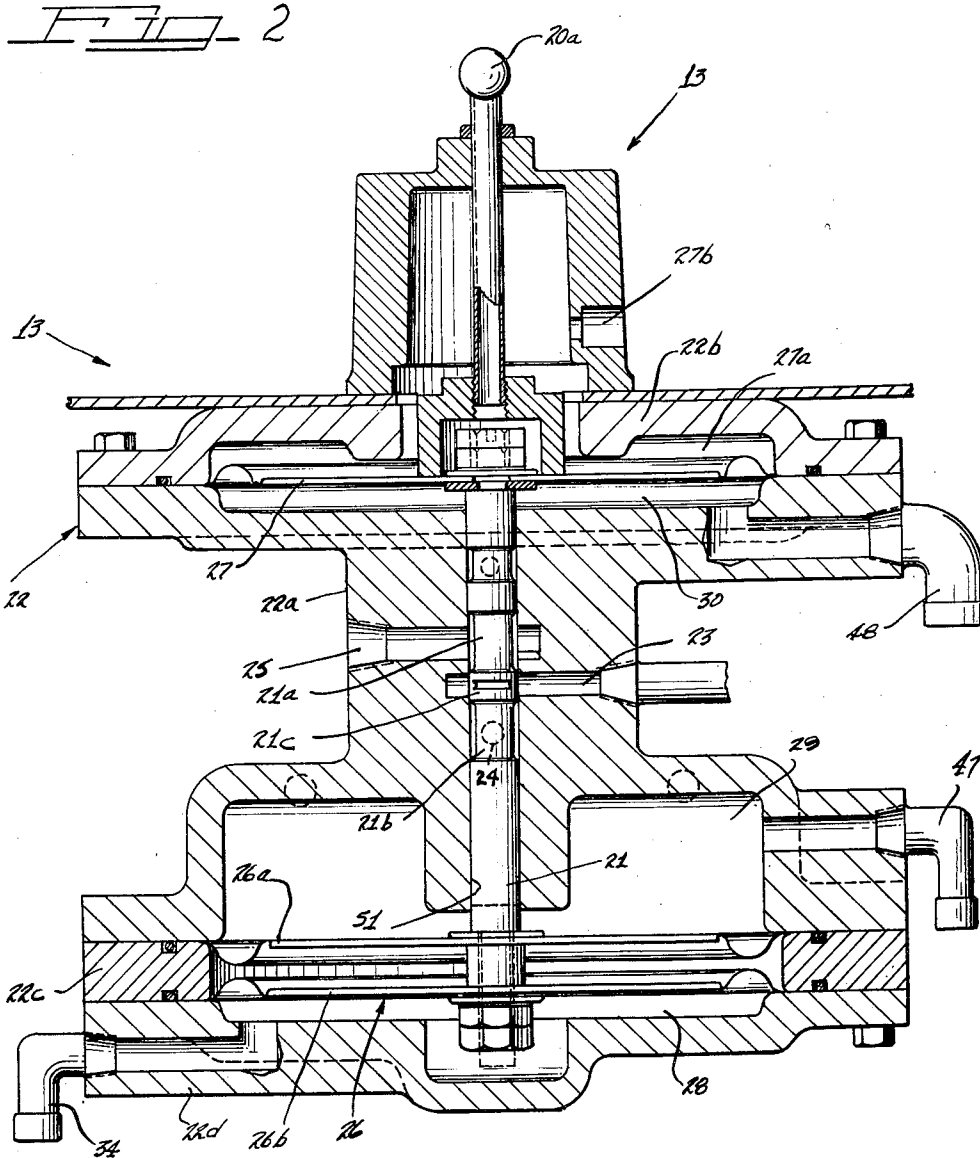
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3,071,300

TENSION REGULATOR

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The present invention relates to control means for the operation of a fluid actuated motor and, more particularly, to a tension regulator suitable for use in controlling the tension of a travelling sheet of material such as in controlling the unwinding of sheet material from a roll.

The tension regulator of the present invention contemplates generally the utilization of a fluid actuating motor, in this case an air brake, on an unwind roll having sheet material travelling therefrom, whose resistance to rotation is controlled by means responsive to the tension of the sheet material travelling from the roll. Such control means are thus used for imparting actuating fluid pressure to a fluid pressure responsive motor in response to a variation which the motor may control, in this case, variable tension on the sheet material which the air brake may control.

In the present invention, a valve means controls fluid communication between a source of fluid under pressure and the fluid pressure actuated motor or brake. The valve is changeable to increase or decrease the brake pressure and is moved from a normal position to a tension changing position by displacement of a tension responsive member such as a roll in engagement with the sheet material due to change in tension in the sheet material. The tension responsive member and the valve are returned to their normal positions to terminate the change in brake pressure by first follow-up mechanism. Second follow-up mechanism is provided to prevent overtravel of the valve and tension responsive member and consequent hunting. The tension responsive member is supported in its normal position against the force of the sheet material by a diaphragm exposed to a fluid pressure source.

An object of the instant invention is to provide an improved control means for imparting actuating fluid pressure to a fluid pressure responsive motor such as a brake in response to a variation in operation which the motor may control.

Another object of the instant invention is to provide an improved control valve means for delivering actuating fluid pressure in response to the physical displacement of a member.

Another object of the invention is to provide a tension regulator for controlling the tension on sheet material passing over a braked roll including an air brake for the roll, an air pressure source, a tension responsive roll in engagement with the sheet material and a valve means operated by the tension responsive roll with improved means for supporting the tension responsive roll against the force of the sheet material; and with improved means for returning the roll and valve means to normal position when they have been displaced by change in tension in the sheet material.

A further object of the invention is to provide a valve for controlling fluid pressure to a brake to control the tension on sheet material with improved means for returning the valve to normal position when its position is changed, and which will prevent overtravel and hunting of the valve and obtain rapid response and more stable action for improved tension control.

Other objects and advantages will become more apparent with the teaching of the principles of the invention in connection with the disclosure of the preferred embodiment thereof in the specification, claims and drawings, in which:

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FIGURE 1 is a schematic showing of mechanism embodying the principles of the present invention for controlling the tension of travelling sheet material; and

FIGURE 2 is a detailed enlarged vertical sectional view taken through the control valve for the mechanism of FIGURE 1.

As shown on the drawings:

In FIGURE 1 a travelling sheet of material 10 moves in the direction indicated by the arrows and travels from a rotating braked roll 11 having braking mechanism 12 associated with the axle supporting the roll 11. The braking mechanism 12 includes braking shoes applied to the axle or to a brake drum carried on the axle by fluid pressure actuated devices such as diaphragms or pistons so as to apply a braking pressure proportionate to the pressure of the fluid supplied.

The pressure of the fluid supplied to the brake 12 is determined by a valve means including a control valve 13 as will be described in detail with reference to the illustration of FIGURE 2. The control valve is operated by a tension responsive member 14 which is in engagement with the travelling sheet material 10 and which moves or is physically displaced when the tension in the sheet material changes. The tension responsive member is shown as preferably being in the form of a rotatable roll 15 and the sheet material wraps around a portion of the surface of the roll 15 so that a displacing force will be applied to the roll by the sheet material.

The roll 15 is rotatably mounted on support arms 16 at its ends and the arms are pivotally supported at 17, although as will be recognized by those skilled in the art other support arrangements may be employed to permit displacement of the roll 15. The lower ends of the arms are connected to a link 18 which is pivotally connected to a bell crank 19 pivotally supported on a support 20. The lower arm of the bell crank bears against the upper end of a slidable valve piston 21 and the upper end of the piston is provided with a spherical tip 20a for the reduction of friction and ease of connection between the bell crank and valve piston 21.

The valve piston 21 is slidably mounted in a cylindrical valve body 22 provided with first, second and third passageways 23, 24 and 25. The passageway 23 provides an output pressure from the valve 13 and the passageway 24 is connected to a supply or a source of fluid pressure. The passageway 25 is open to atmosphere to permit the escape of fluid. While different fluids may be employed, air under pressure is conveniently used and is normally available in shop locations where the mechanism embodying the principles of the present invention may be conveniently employed.

The valve body 22 is arranged with chambers therein having diaphragms 26 and 27 extending thereacross connected to the valve piston 21 and dividing each of the chambers into upper and lower chambers above and below the diaphragm. The lower diaphragm 26, which is a double diaphragm, on its lower surface faces a chamber 28 filled with air at a constant pressure and functioning as a support chamber to support the weight of the roll 15 and the force of the sheet material 10 against the roll. A chamber 29 above the diaphragm 26 is subjected to a first follow-up pressure which tends to return the valve piston 21 to its normal position after it has been displaced by a change in tension of the sheet material 10. A chamber 30 is subjected to a second follow-up pressure or a damping pressure which balances the pressure in the chamber 29 but is subjected to a slight time delay when the valve piston 21 changes position. The chamber 30 is below the upper diaphragm 27 and the upper surface of the diaphragm 27 is exposed to a chamber 27a connected to atmospheric pressure.

An air pressure source is provided from a supply header 31 and a main shutoff valve 32 controls the supply from the header 31. The air passes through a filter 33 and is delivered to a line 34 communicating with the support chamber 28 to apply the support force to the valve piston 21. Connected in the line 34 is a shutoff valve 37 which is open for automatic operation but is closed for manual operation. In manual operation the control valve 13 is not used and the pressure to the brake may be manually controlled such as by changing the setting of a pressure regulating valve 38a. Also in the line 34 is a selectively adjustable pressure regulator 35 with a gauge 36 indicating the output air pressure of the regulator 35. For automatic operation, by increasing the output pressure of the regulator 35 the controlled tension of the sheet material 10 may be increased and correspondingly by decreasing the output pressure of the regulator 35 the controlled tension of the sheet material 10 may be decreased.

Air pressure for the control valve 13 is delivered from the header 31 through a line 38 having the manually adjustable pressure regulator valve 38a therein to regulate the supply pressure used for the brake 12. The air is delivered to the control valve passageway 24 through a line 39 having a shutoff valve 39a therein. Output air from the control valve 13 is delivered through the passageway 23 to a line 42 having a shutoff valve 43 therein. The braking air is delivered to a line 44 leading to the brake 12 and a relief valve 45 may be opened to bleed air from the line 44, although the valve 45 is closed during normal operation. A gauge 46 is connected to indicate pressure of the air in the line 44.

For manual operation of the brake, the air is delivered to the brake through a line 40 having a shutoff valve 41 therein and connecting to line 44.

For automatic operation the shutoff valve 41 is closed while the shutoff valves 37, 39a and 43 are open. To switch to manual operation, the shutoff valves 37, 39a and 43 are closed while the valve 41 is opened.

The valve piston 21 is substantially cylindrical in shape and has relieved areas 21a and 21b with a land 21c therebetween. As will be noted from FIGURES 1 and 2, when the valve piston is moved downwardly the relieved portion or passage 21a through the valve piston will afford communication between passageways 23 and 25 of the valve body thus venting the brake pressure line 42. When the valve piston 21 is moved upwardly, the relieved portion or passage 21b will afford communication between the passageways 23 and 24 to direct pressurized air to the line 42. When the valve piston 21 moves down, the land 21c will block the passageway 24, and when the piston 21 moves up the land 21c will block the passageway 25.

The pressure in the output line 42 from the control valve 13 will be immediately communicated to the first follow-up chamber 29 through a first follow-up line 47. A second follow-up line 48 leading to the second follow-up chamber 30 will also immediately be subjected to the pressure of the output line 42. In the line 48, adjacent the chamber 30 is a surge tank 50 and an adjustable bleed valve 49 is connected between the surge tank and the control line 42. This delays the change in pressure in the second follow-up chamber 30 so that it reaches a condition of balance with the first follow-up chamber 29 at a slightly later time after the piston 21 is shifted.

As an example of operation, when the tension of the sheet material 10 tends to increase so that the brake 12 must be released to maintain constant tension, the increase in tension will draw the tension responsive roll 15 downwardly to swing the arm 16 to the left or in a clockwise direction. This will pivot the bell crank 19 in a counterclockwise direction pushing the valve piston 21 downwardly. The passage 21a vents the line 42 to the atmospheric passageway 25. The drop in pressure in the line 42 will immediately be felt in the chamber 29 decreasing the downward force on the diaphragm 26 and

causing the valve piston 21 to tend to move upwardly tending to return the tension responsive roll 15 to its normal position. The drop in pressure in the line 42 will of course release the pressure on the brakes 12 decreasing the tension on the sheet material 10. This will tend to permit the roll 15 to move upwardly above its normal position and this tendency is prevented by the second follow-up or damping chamber 30. Pressure in this chamber is reduced more slowly than in the first follow-up chamber 29 since the air must bleed through the valve 49. Very shortly however the chamber 30 reaches the same pressure as the chamber 29 and the forces of the two diaphragms 26 and 27 on the valve piston 21 are again balanced. This prevents overshooting of the position of the valve piston 21 and of course the time delay factor can be varied by adjusting the opening of the bleed valve 49.

When the tension of the sheet material 10 tends to be reduced due to extrinsic factors so that the brake 12 must be tightened, the tension responsive roll 15 will temporarily swing upwardly moving the valve piston 21 upwardly so that the passage 21b connects the control line 42 to the pressure line 39. As the pressure in the control line 42 increases, the pressure in the first follow-up chamber 29 will immediately increase again moving the valve piston 21 downwardly and returning the tension responsive roll 15 to its normal position. The increase in tension on the brake 12 will tend to tighten the sheet material 10 so that the roll 15 has a tendency to be moved downwardly past its normal position. This is prevented by the build-up or increase in pressure in the second follow-up chamber 30 due to the leakage of air through the bleed valve 49 into the surge chamber 50.

As illustrated in FIGURE 2, the valve body 22 is formed of a central body portion 22a suitably cored and drilled to provide a central cylindrical bore 51 for the valve piston 21 and to provide the passageways for connection of the air lines. At the upper end is attached a plate 22b and at the lower end an annular ring 22c is clamped in place by a plate 22d with the plates being suitably held to the body section 22a by bolts. Appropriate annular gaskets are provided to seal the diaphragms which are clamped in place. The lower diaphragm 26 is formed of upper and lower portions 26a and 26b secured to the valve piston 21. The upper chamber 27a above the upper diaphragm 27 is vented at 27b. Other portions of the valve are of suitable construction as will be appreciated by those skilled in the art.

Thus it will be seen that I have provided an improved tension control mechanism for moving sheet material which meets the objectives and advantages hereinabove set forth. The mechanism is reliable and provides a responsive system for obtaining improved control avoiding fluctuation and hunting and obviating disadvantages present in devices heretofore available.

The drawings and specification present a detailed disclosure of the preferred embodiments of the invention, and it is to be understood that the invention is not limited to the specific forms disclosed, but covers all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by the invention.

I claim as my invention:

1. Tension control means for sheet material comprising a rotating roll having sheet material travelling therefrom, a fluid pressure responsive brake for said roll, a source of fluid under pressure, valve means having a movable valve member and connected between said fluid pressure source and said brake for controlling the operation of the brake, a tension responsive member in engagement with the sheet material to be movable in response to change in tension of the sheet material and connected to the valve means to control the operation of the brake as a function of position change, said valve member and said tension responsive member intercon-

nected to be co-movable between a normal position and tension changing positions in which the force applied by the brake to the sheet material is increased or decreased, first follow-up means responsive to movement of the valve member to one of said tension changing positions to restore the valve means to normal position, and second follow-up means preventing substantial movement of the valve member out of normal position immediately after it has been restored to normal position by said first follow-up means.

2. Tension control means for sheet material comprising a rotating roll having sheet material travelling therefrom, a fluid pressure responsive brake for said roll, a source of fluid under pressure, valve means having a movable valve member and connected between said fluid pressure source and said brake for controlling the operation of the brake, a tension responsive member in engagement with the sheet material to be movable in response to change in tension of the sheet material and connected to the valve means to control the operation of the brake as a function of position change, said valve member and said tension responsive member interconnected to be co-movable between a normal position and tension changing positions on each side of said normal position in which the force applied by the brake to the sheet material is increased or decreased, first follow-up means responsive to movement of the valve member to one of said tension changing positions to restore it to normal position, and second follow-up means preventing substantial movement of the valve member past normal position immediately after it has been restored to normal position by said first follow-up means.

3. In a mechanism having a moving sheet of material to be maintained at a uniform tension, a rotating roll having the sheet material travelling therefrom, a fluid pressure responsive brake for said roll, a source of fluid under pressure, valve means having a movable valve member and connected between said fluid pressure source and said brake for controlling the operation of the brake, a tension responsive member in engagement with the sheet material to be movable in position in response to change in tension and connected to the valve means to control the operation of the brake as a function of position change, said valve member and tension responsive member interconnected and co-movable between a normal position and a tension changing position in which the force applied by the brake is changed, means applying a resilient supporting force to the tension responsive member urging it against the sheet material, and follow-up means preventing the tension responsive member from substantially moving past said normal position from the tension changing position with change in brake force.

4. In a mechanism having a moving sheet of material to be maintained at a uniform tension, a rotating roll having the sheet material travelling therefrom, a fluid pressure responsive brake for said roll, a source of fluid under pressure, valve means having a movable valve member and connected between said fluid pressure source and said brake for controlling the operation of the brake, a tension responsive member in engagement with the sheet material to be movable in position in response to change in tension and connected to the valve means to control the operation of the brake as a function of position change, said valve member and tension responsive member interconnected and co-movable between a normal position and a tension changing position in which the force applied by the brake is changed, means applying a resilient supporting force to the tension responsive member urging it against the sheet material, follow-up means applying a force to the valve member in a direction preventing it from substantially travelling past normal position from tension changing position with change in brake force and operative in response to change in fluid pressure to the brake, and a fluid bleed time delay

means for delaying the application of said force by the follow-up means.

5. An apparatus for controlling the tension in a moving sheet of material comprising a rotating roll having the sheet material travelling therefrom, a fluid pressure responsive brake for said roll, a source of fluid under pressure, valve means having a movable valve member and connected between said fluid pressure source and said brake and having an output pressure for controlling the operation of the brake, a tension responsive member in engagement with the sheet material to be movable in response to change in tension of the sheet material and connected to the valve means to control the operation of the brake as a function of position change, said valve member and said tension responsive member being mechanically connected to be co-movable between a normal position and displaced positions, a first fluid actuated follow-up means connected to the output pressure of the valve means and connected to apply a force to the valve member to restore it to normal position, a second fluid actuated follow-up means connected to the output pressure of the valve means and connected to apply a force to the valve member in opposition to the first follow-up means, and a bleed valve connected between the valve means and the second follow-up means to delay the application of said force of the second follow-up means.

6. An apparatus for controlling the tension in a moving sheet of material comprising a rotating roll having the sheet material travelling therefrom, a fluid pressure responsive brake for said roll, a source of fluid under pressure, valve means having a movable valve member and connected between said fluid pressure source and said brake for controlling the operation of the brake, a tension responsive member in engagement with the sheet material to be movable in response to change in tension of the sheet material and connected to the valve means to control the operation of the brake as a function of position change, said valve member and said tension responsive member interconnected and co-movable between a normal position and tension changing positions in which the force applied by the brake to the sheet material is increased or decreased, follow-up means responsive to movement of the valve member to one of said tension changing positions to restore the valve member to normal position, a fluid pressure responsive support for said tension responsive member urging it against the sheet material, and means for selectively controlling the fluid pressure supplied to said pressure responsive support so that the tension of the sheet material may be controllably selected.

7. Apparatus comprising a rotating roll having sheet material travelling therefrom, an air brake for said roll, a control valve cylinder, a first passageway in said cylinder communicating with the brake, a second passageway in said cylinder spaced from the first passageway and communicating with an air pressure source, a third passageway in said cylinder spaced from the first and second passageways and communicating with the atmosphere, a control valve piston in said cylinder adapted to selectively open and close said passageways to effect communication therebetween, air pressure responsive flexible diaphragm means drivingly engaging said piston, means mechanically connected to said piston and engaging the sheet material for moving said piston with change in tension of the sheet material, and an air pressure line communicating between said first passageway and said diaphragm means for applying a force to the piston as a function of pressure in said first passageway.

8. Apparatus comprising a rotating roll having sheet material travelling therefrom, an air brake for said roll, a control valve cylinder, a first passageway in said cylinder communicating with the brake, a second passageway in said cylinder spaced from the first passageway and communicating with an air pressure source, a third passageway in said cylinder spaced from the first and second passageways and communicating with the atmosphere, a

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control valve piston in said cylinder adapted to selectively open and close said passageways and effect communication therebetween, air pressure responsive flexible diaphragm means drivingly engaging said piston, means mechanically connected to said piston and engaging the sheet material for moving said piston with change in tension of the sheet material, a first air pressure line communicating between said first passageway and said diaphragm means for applying a force to restore the piston when it has been moved, a second air pressure line communicating between said first passageway and said dia-

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phragm means for applying a force in opposition to the force of the air pressure from said first air pressure line to prevent overtravel of the piston, and an air bleed restriction in said second pressure line to delay the application of force.

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