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Christ et al.

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[54] **CALENDAR HAVING ADJUSTABLE BRAKE MEANS**

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[51] **Int. Cl.** **B30b 3/04**

[58] **Field of Search** ..... 100/161, 162 R, 163 R, 100/164, 165, 166, 168, 169, 170; 425/367; 72/232, 234

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[57] **ABSTRACT**

Each of the movable rolls of the calendar is associated with an adjustable brake means by which the velocity of descent of each roll can be adjusted into a pattern to effect and maintain a gap between each pair of adjacent rolls immediately upon opening of the calendar. The individual brake means are constructed as threaded studs having a bore in which a piston is mounted and to which hydraulic medium can be pumped via a restricted duct. The restricted duct cooperates with a bypass valve in the hydraulic lines to allow the hydraulic medium to flow back to a reservoir from the bore upon descent of a roll. The restricted duct of each brake means is adjustable relative to the return flow of medium so that the lower rolls are allowed to descent more rapidly than the upper rolls.

10 Claims, 6 Drawing Figures

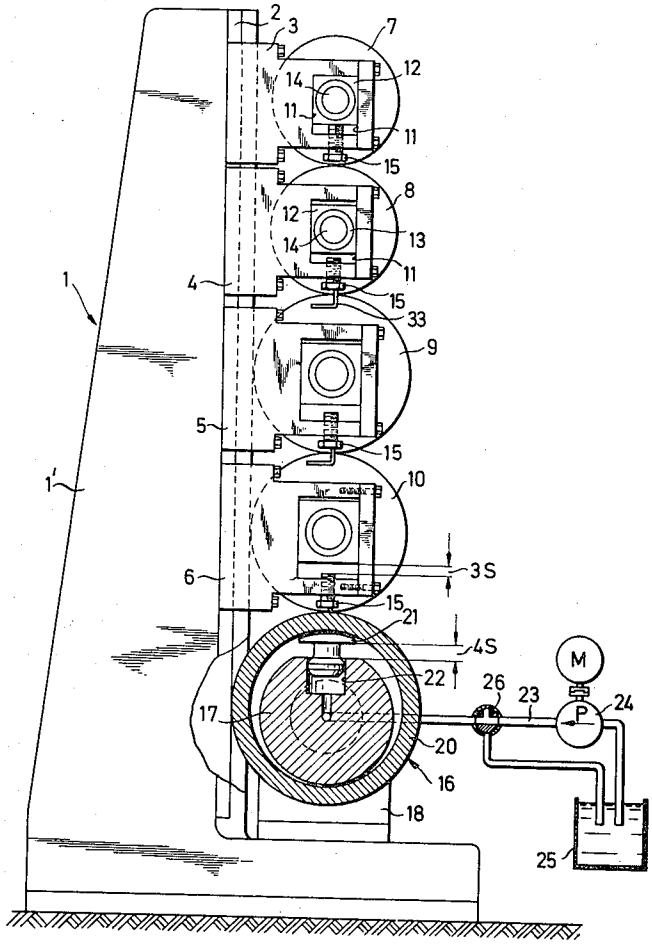

Fig.1

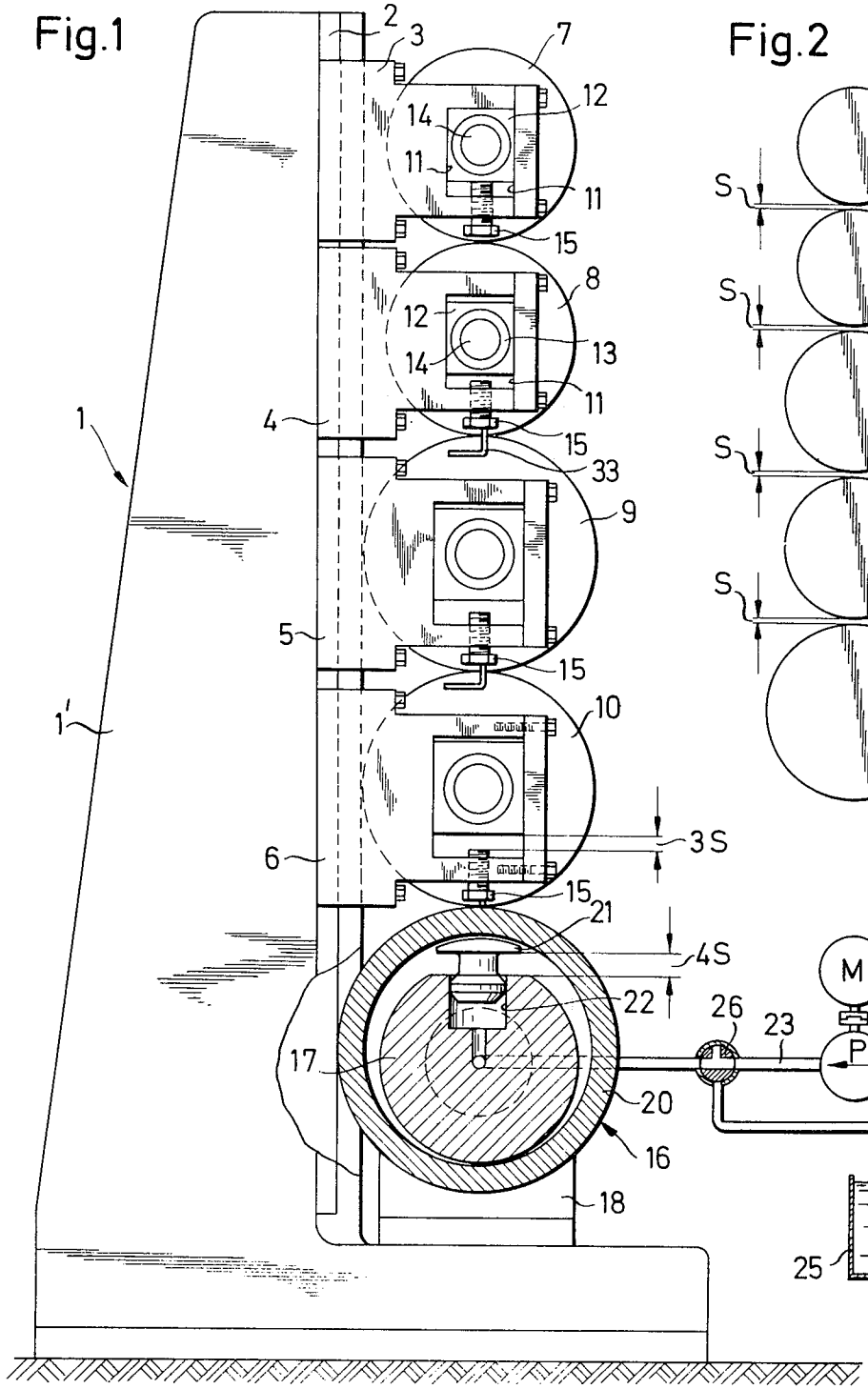
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Fig.2

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Fig.3

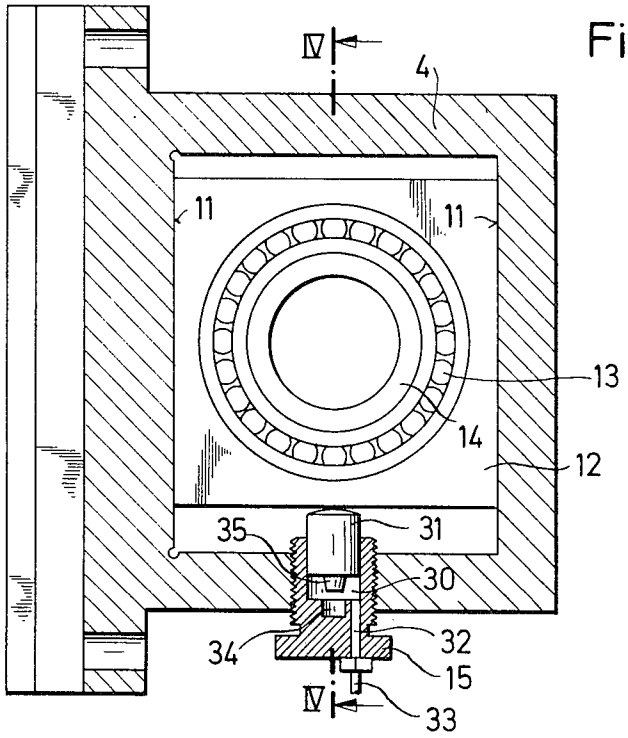


Fig.4

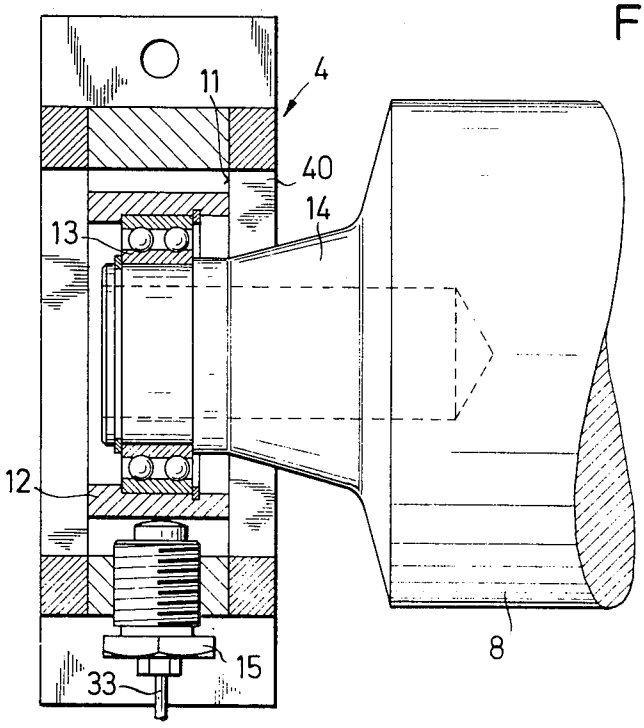


Fig.5

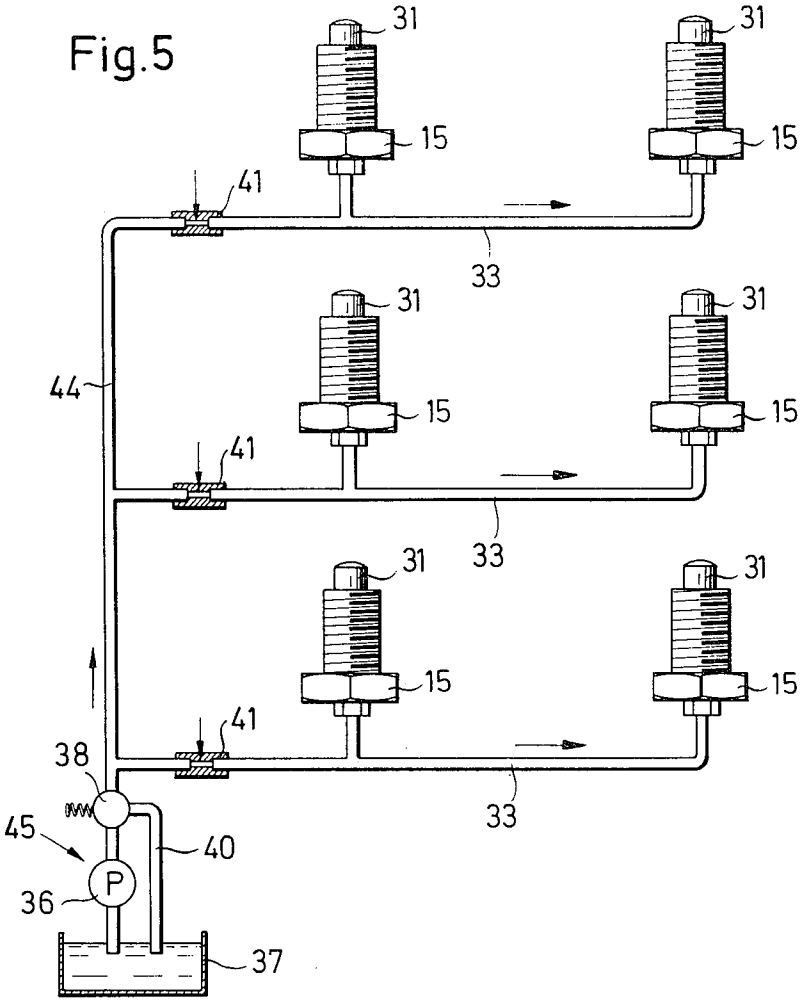
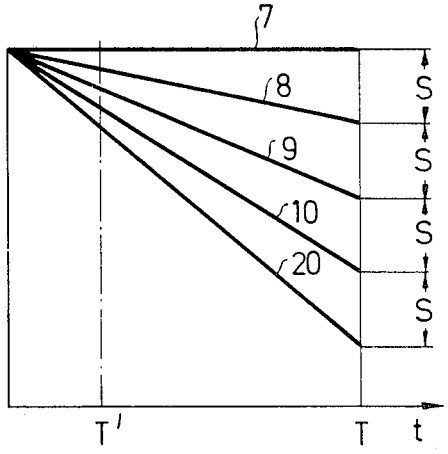


Fig.6



CALENDAR HAVING ADJUSTABLE BRAKE MEANS

This invention relates to a calendar having a plurality of superjacent rolls which are lowered when the calendar is opened.

Calendars have been known in which a plurality of rolls are mounted in superjacent relation and have been provided with means to effect a separation of the rolls upon opening of the calendar. Generally, such calendars require the rolls to be opened as rapidly as possible, that is, the rolls must be removed from each other in such a way that a gap is produced between each set of rolls. To this end, it has been a common practice to lower the bottom roll while the rolls which are disposed thereabove strike against abutments with the exception of the top roll which remains in position. This, however, involves the disadvantage that the movable rolls initially move downwardly together in a block with the upper rolls successively striking against respective stop abutments. The formation of a gap between the rolls therefore begins at the top and continues downwardly until the roll which is the second to the bottom has struck its stop abutment.

This method of operation also suffers from the disadvantage of requiring a substantial amount of time until the last gap is formed and the calendar is therefore open. In order to minimize these times, the rolls have been allowed to drop down freely without, as far as possible, deceleration. However, this results in large impact forces when the stop abutments are struck. Thus, the calendars must then be constructed so that these large impact forces can be absorbed not only by the stop abutments but also by the bearings on the bearing trunnions of the calendar rolls. Generally, this has required large bearings with corresponding bearing housings. These bearings together with the trunnions again have a detrimental effect in the operation of the calendar because their weight causes the ends of the rolls to be deformed and results in high edge pressures.

Accordingly, it is an object of the invention to reduce the impact forces of the descending rolls of a calendar during opening of the calendar.

It is another object of the invention to reduce the size and weight of the bearings required to journal a roll in a calendar.

It is another object of the invention to control the descent of a roll in a calendar during opening of the calendar.

It is another object of the invention to effect a rapid opening of a calendar without creating large impact forces upon the stop abutments for the rolls of the calendar.

It is another object of the invention to avoid deformation of the ends of a calendar roll as well as high edge pressures.

It is another object of the invention to effect the immediate formation of gaps between the rolls of a calendar upon opening of the calendar.

Briefly, the invention provides a calandar having a plurality of superjacent rolls, at least some of which are movably mounted to descend upon opening of the calendar against respective stop abutments, with a plurality of individually adjustable brake means for adjusting the velocity of each roll during descent. The pattern of braking is such that the lowermost rolls move at a greater descending velocity than the uppermost rolls, that is, the lower the roll; the greater the velocity of descent.

The brake means ensure that the opening of all gaps between the rolls can commence simultaneously because of the different velocities of motion. Moreover, the brake means effect a reduction in the speed at which the rolls strike against their stop abutments so that the bearings and bearing trunnions of the individual rolls can be constructed of a smaller size than hitherto. As a result, cantilevered loads, which cause edge pressure at the roll ends, are reduced.

The brake means may advantageously contain a hydraulic cylinder with a piston which is sealingly guided therein and bears against a bearing part of a roll. In addition, the cylinder is provided with a duct for passage of a hydraulic medium into and out of the cylinder under the piston as well as with an adjustable restrictor in the duct for throttling the flow of medium. This provides a reliable brake means which acts uniformly, alters its properties only slightly, for example when compared with friction brakes, and moreover can be adjusted with the necessary degree of precision.

The ducts of each brake means is connected to a common hydraulic feed means for delivering the hydraulic medium at a constant adjustable pressure. This enables a positive pressure to be formed in the cylinder to produce an upwardly orientated force which acts on the piston and counteracts the weight of the bearing and of the bearing trunnion at the affected roll end. Preferably, the pressure can be selected so that the hydraulic force that acts on the piston just compensates for the weight of the bearing and of the bearing trunnion of the affected roll. This measure eliminates the cause of edge pressure which will otherwise occur.

The feed means also includes a reservoir of hydraulic medium, a pump for pumping the medium from the reservoir into each duct and a bypass valve downstream of the pump for returning the medium from each duct to the reservoir upon opening of the calendar. This provides a limitation on the pressure that acts in the individual cylinders in a simple manner and also enables the hydraulic pressure medium to be bypassed from the individual cylinders of the brake means through the bypass valve if the calendar is opened. This results in a particularly simple lay-out of the hydraulic system.

The brake means may be constructed so that the cylinder has a surface defining a limiting position of a roll when the calendar is open. Further, the cylinder can be adjustably mounted to vary this position. For example, the cylinder can be in the form of a screwthreaded stud having a bore in which the piston is guided. This measure renders any additional adjustability of the brake means superfluous because it is adjusted together with the stud. This results in a substantial simplification of the calendar.

In addition, a secondary brake means is provided for each movable roll for braking the descent of each roll immediately prior to completion of the descent of the affected roll. This secondary brake means is formed by a closed recess in the cylinder and an extension on the piston for entering into the recess upon movement of the piston into the cylinder. This further reduces the impact forces when the rolls strike the stop abutment stud. Additional braking is made possible by virtue of the fact that the individual rolls are already spaced from each other by the action of the brake elements.

Thus, the additional braking has practically no effect on the opening time of the calendar.

These and other objects and advantages of the invention will become more apparent from the following detailed description and appended claims taken in conjunction with the accompanying drawings in which:

FIG. 1 diagrammatically illustrates a side view in partial section of a calendar according to the invention;

FIG. 2 diagrammatically illustrates the gaps between the individual rolls when the calendar is open;

FIG. 3 illustrates a sectional view through a bearing system of the roll end of one of the rolls with a hydraulic brake means according to the invention;

FIG. 4 illustrates a sectional view substantially along line IV—IV of FIG. 3;

FIG. 5 illustrates a hydraulic circuit diagram of the brake means of the invention; and

FIG. 6 illustrates a time-distance diagram to explain the opening operation of the calendar in accordance with the invention.

Referring to FIG. 1, the calendar includes a stand 1 which may be constructed as a frame and which contains, for example, two vertical side parts 1'. Each of these side parts 1' is provided with a guide 2 on which bearing housings 3,4,5,6 of rolls 7,8,9,10 are mounted in superjacent relation. The bearing housings 3–6 are adjustable along the respective guides 2 in any suitable manner and, in turn, are each provided with guides 11 in which bearing blocks 12 of the individual rolls 7–10 are guided. Each bearing block 12 contains a bearing 13 in which a trunnion of a roll 7–10 is rotatably supported. A support means, in the form of a stop abutment screw or stud 15, is also provided in each bearing housings 3–6 to limit downward motion of the bearing blocks 12 and to support the rolls in spaced relation to each other to define gaps S of predetermined size upon opening of the calendar. These stop abutment screws 15 are adjustable to vary the gaps S between the individual rolls 7–10 as shown in FIG. 2 when the calendar is open. The top roll 7 is provided with a stud 15' which abuts the bearing block 12 of the roll 7 into an uppermost position as shown. This is because the uppermost roll 7 is not moved downwardly during an opening operation.

The calendar also has a pressure cylinder 16 which serves as a bottom roll. This cylinder 16 contains a stationary support element 17 which is mounted on pedestals 18 which, in turn, are mounted on the stand 1. The cylinder also includes a roll barrel 20 which is carried on hydrostatic support elements 21 and which is rotatable about the support member 17 to support the rolls 7–10 upon closing of the calendar. The hydrostatic support elements 21 are in the form of pistons which are guided in cylinder bores 22 of the support member 17. In order to lift the support elements 21, a means such as a hydraulic system is connected into the bores 22. This system includes a duct 23 which communicates each bore 22 with a reservoir 25 of hydraulic medium and a pump 24 in the duct 23 for pumping the hydraulic medium into the bore 22. Return ducts (not shown) are also used to return any medium which discharges from leakage points in the system to the reservoir. The lifting of the support elements 21 causes the roll barrel 20 to move towards the rolls 7–10 and to lift and press the rolls 7–10 together to establish a substantially uniform line pressure between the rolls 7–10 and cylinder 16.

In order to permit the hydrostatic support element 21 to descend, a means such as a three way valve 26 or other change over element is disposed in the duct 23 of the hydraulic system downstream of the pump 24 for venting the system. The three way valve 26 enables the pump 24 to be disconnected from the cylinder bores 22 and connected to the reservoir 25. In this case, the hydraulic support elements 21 descend into the lowest positions so that the calendar opens. The maximum displacement of the support element 21 is greater than the sum of the possible gaps S between the individual rolls 7–10 and cylinder 16 when the calendar is open.

Referring to FIG. 2, the gaps S which are assumed to be identical in the interests of simplicity, but which may also be unequal, are disposed between the rolls 7,8,9,10 and cylinder 16 (which acts as a bottom roll) when the calendar is open. The gaps S are defined by adjustment of the individual stop abutment screws 15. The stop abutment screw 15 of the roll 10 must be adjusted so as to permit the roll to descend by the distance 3S (FIG. 1). The roll barrel 20 of the bottom roll 16 is then lowered by the amount 4S. It is to be noted that these values are only examples and apply to a calendar with five rolls and identical gaps S when the calendar is open.

Referring to FIG. 3, each bearing housing of the movable rolls, for example the housing 4, has a stud 15 threadably mounted in the bottom. Each stud 15 is provided with a brake means which is constituted by a hydraulic cylinder 30 formed by an axial bore in the stud and a piston 31 which is sealingly guided in the cylinder 30 and bears from below against the bearing block 12. In addition, the cylinder 30 communicates with a hydraulic duct 33 through a port 32. The top surface of the cylinder 30 also defines a limiting position for the roll 8. This surface can be varied by adjusting the position of the stud 15 in the housing 4.

A secondary brake means is also incorporated in the stud 15 and is formed by a recess 34 in the cylinder 30 and an extension 35 on the piston 31.

As shown in FIG. 3, the extension 35 is slightly tapered so that upon plunging into the substantially cylindrical recess 34, the gap between the recess 34 and the extension 35 is progressively reduced.

Referring to FIG. 4, each roll, such as roll 8 has a trunnion 14 at each end which is journalled by the bearing 13 in a bearing block 12. As shown, the bearing block 12 is slidably mounted between the two guides 11 as well as between side parts 38, 40 which guide the block 12 axially of the roll axis. The bearing block 12 can be constructed, for example, as described in U.S. Patent Application Ser. No. 455,301, filed Mar. 27, 1974.

Referring to FIG. 5, the hydraulic circuit of the various brake means in the studs 15 include the respective ducts 33 which are connected to a common feed duct 44 which extends from a hydraulic feed means 45. The feed means 45 comprises a reservoir 37 of hydraulic medium and a pump 36 adapted to deliver the hydraulic medium, for example oil, from the reservoir 37. The feed duct 41 also contains a bypass valve 38 downstream of the pump 36 which maintains a selected pressure in the feed duct 34 and permits the excess delivered medium to bypass through a bypass duct 40. Adjustable restrictors 41 are also connected into the ducts 33 of two brake means of one roll to throttle the flow of medium.

The pressure maintained in the cylinders **30** by the feed means **35** in normal operation of the calendar is defined by the bypass valve **38**. This ensures, on the one hand, that the cylinders **30** and the entire system is filled with oil. On the other hand, it is possible to select the pressure so that the force that acts on the pistons **31** compensates for the weight of the bearing block **12**, the bearing **13** and the bearing trunnion **14**, this weight being the cause of edge pressure at the affected end of the roll **8**.

If the calendar is to be suddenly opened, for example in the event of an operational breakdown, the roll barrel **20** of the cylinder **16** is lowered as rapidly as possible by resetting the three-way valve **26** (FIG. 1). The rolls **8, 9, 10** which were previously supported on the barrel **20** will then thrust with their weight on the pistons **31** of the respective brake means. This, in turn, causes a discharge of oil from the cylinders **30**. However, this discharge is decelerated by the restrictors **41**. Since the bypass valve **38** is set to a relatively low pressure which will then be exceeded, the oil flowing from the ducts **33** through the restrictors **41** will be discharged via the bypass duct **40**.

The restrictors **41** of the rolls **8, 9, 10** are adjusted so that the rolls which are disposed in a lower position move more rapidly than those disposed thereabove. These conditions are illustrated in the diagram of FIG. **6**. The individual lines which diagrammatically indicate the dropping motion of the individual rolls are provided with the reference numerals of the affected roll. For example, the roll **7** remains in its top position. The roll **8** descends slowly to drop by the distance **S** at the time T. The rolls **9** and **10** move more rapidly to traverse the distances **2S** or **3S**, respectively, during the same period of time. The barrel **20** of the bottom roll **16** descends most rapidly to traverse the distance **4S** in the same space of time.

As may be seen by reference to FIG. **6**, the mutual removal of the rolls from each other begins at the moment at which the calendar opens. For example, gaps between all rolls already exist at an earlier time T'. By contrast, the gaps between the individual rolls were hitherto formed progressively downwardly from above, the last gap being formed last, that is, in the present case only at the time T.

Since the operation of opening of all rolls beings immediately, it is possible for the individual rolls to be additionally decelerated immediately before they strike the limiting surface of the studs **15** without substantially affecting the opening operation of the calendar which is practically already open. This additional deceleration is provided by the recess **34** and the extension **35** of the secondary brake means. When the extension **35** plunges into the recess **34**, the oil disposed therein must discharge through the gap between both. The tapered shape of the extension **35** causes a progressive reduction of the gap so that the bearing block **12** is smoothly decelerated.

Although the invention is explained by reference to a calendar with a pressure roller with a roll barrel that is supported on hydrostatic support elements, it will be clear that the invention is not confined to this embodiment but can be applied generally to different systems of calendar.

What is claimed is:

1. In combination with a calendar having a plurality of superjacent rolls, at least some of said rolls being movably mounted to descend upon opening of the calendar; a plurality of individually adjustable brake means associated with each movable roll for adjusting the velocity of each said roll during descent whereby the lowermost rolls move at a greater descending velocity than the uppermost rolls.

2. The combination as set forth in claim **1** wherein each brake means includes a hydraulic cylinder, a piston slidably mounted in said cylinder in sealed relation therewith for abutting a respective movable roll, a duct in said cylinder for passage of a hydraulic medium into and out of said cylinder under said piston, and an adjustable restrictor in said duct for throttling the flow of hydraulic medium therethrough.

3. The combination as set forth in claim **2** wherein each duct of each brake means is connected to a common feed means for delivering the hydraulic medium at a constant adjustable pressure.

4. The combination as set forth in claim **3** wherein said feed means includes a reservoir of hydraulic medium, a pump for pumping the hydraulic medium from said reservoir into each said duct, and a bypass valve downstream of said pump for returning the hydraulic medium from each duct to said reservoie upon opening of the calendar.

5. The combination as set forth in claim **2** wherein said cylinder has a surface defining a limiting position of a movable roll, and wherein said cylinder is adjustably mounted to vary said position.

6. The combination as set forth in claim **2** wherein said cylinder is a screwthreaded stud having a bore therein slidably receiving said piston.

7. The combination as set forth in claim **2** further comprising a secondary braking means within said brake means, said secondary braking means including a recess within said cylinder and an extension on said piston for entering into said recess upon movement of said piston into said cylinder.

8. The combination as set forth in claim **1** further comprising a secondary brake means for each movable roll for braking the descent of said movable roll immediately prior to completion of the descent of said movable roll.

9. In combination with a downwardly movable roll of a calendar; an adjustable brake means for adjusting the descending velocity of said roll during descent, said brake means including a hydraulic cylinder, a piston slidably mounted in said cylinder in sealed relation for abutting said roll, a duct in said cylinder for passage of a hydraulic medium into and out of said cylinder under said piston, and an adjustable restrictor in said duct for throttling the flow of hydraulic medium therethrough.

10. The combination as set forth in claim **9** further comprising a secondary brake means for braking the descent of said roll immediately prior to completion of the descent of said roll.

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