United States Patent [19]

Selke et al.

[11] **3,782,710**

[45] **Jan. 1, 1974**

[54] **ADJUSTABLE HYDRAULIC LINEAR DECELERATOR**

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[73] Assignee: **The Sheffer Corporation,** Cincinnati, Ohio

[22] Filed: **Nov. 8, 1972**

[21] Appl. No.: **304,611**

[52] **U.S. Cl.** ..... **267/118,** 267/65 R

[51] **Int. Cl.** **F16f 5/00**

[58] **Field of Search** ..... 267/118, 65 R, 65 A, 267/65 B, 65 C, 65 D

[56] **References Cited**

UNITED STATES PATENTS

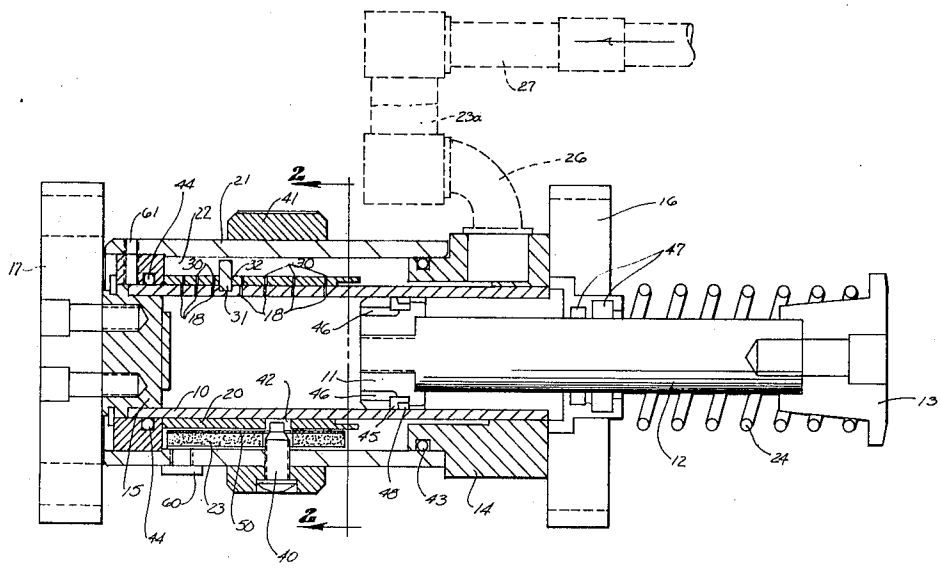
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Primary Examiner—Gerald M. Forlenza
Assistant Examiner—Lawrence J. Oresky
Attorney—John W. Melville et al.

[57] **ABSTRACT**

The application discloses an adjustable hydraulic linear decelerator, which may be either of the spring return type having an internal accumulator, or of the air return type having an external accumulator. The device comprises a cylinder having a piston which operates, upon an impact, against hydraulic fluid charged into the cylinder. The cylinder has, along a generatrix, a series of exponentially spaced apertures, and is embraced by a sleeve having along a generatrix, a series of obturating slots of the same minimum axial width as said apertures, and cooperating with said apertures respectively. The sleeve is surrounded by a reservoir tube, annularly spaced therefrom, and is coupled to said tube so that it may be rotated by rotating said tube. The sleeve also has a guide slot cooperating with a pin fixed to said cylinder to limit the extent of rotation of said sleeve to the circumferential extent of said obturating slots. The obturating slots may be angularly disposed with respect to the circumference while the guide slot is circumferential, so that, upon rotation of the sleeve between limits, the slots in effect go from an obturating position to an open position without axial movement of the sleeve. Alternatively, the obturating slots may be circumferential while the guide slot is angularly disposed, so that rotation of the sleeve is accompanied by an axial displacement thereof by substantially the width of the obturating slots. In this case the coupling is by means of a pin and slot connection to provide for the necessary axial movement.

6 Claims, 8 Drawing Figures



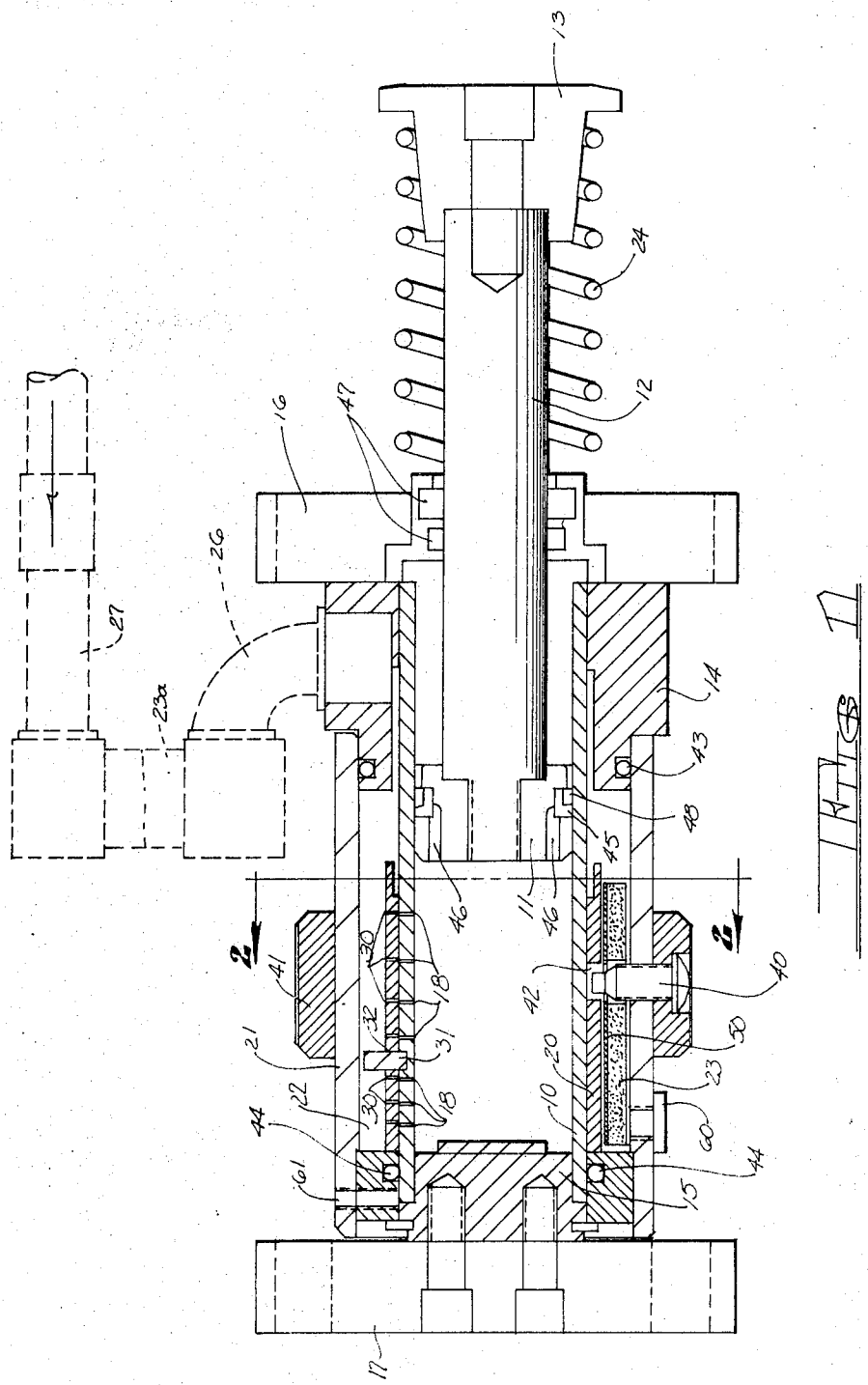

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FIG. 1

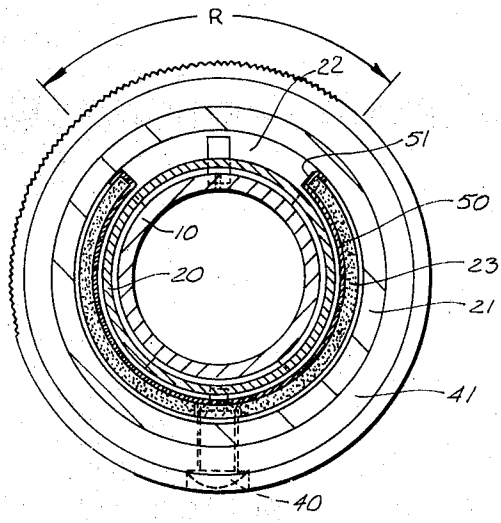


FIG 2

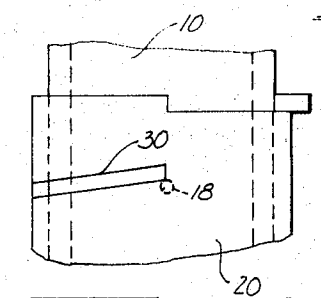


FIG 3a

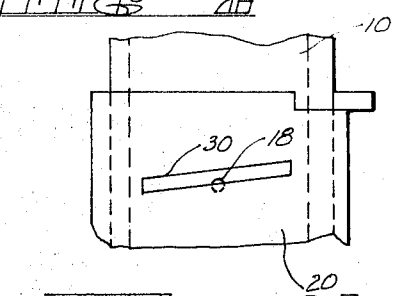


FIG 3b

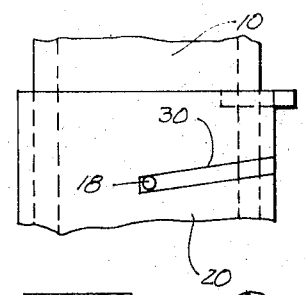


FIG 3c

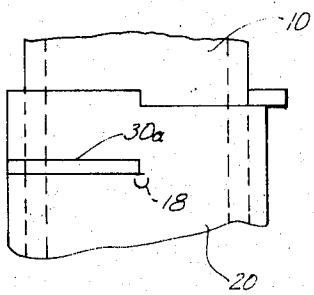


FIG 4a

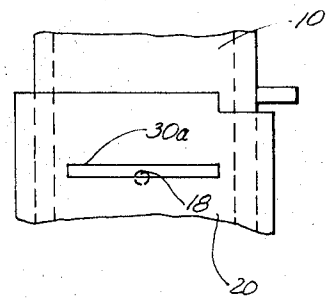


FIG 4b

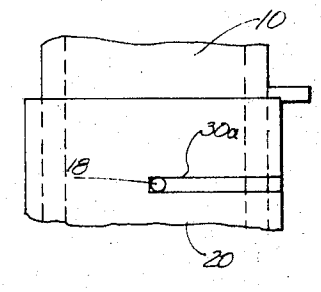


FIG 4c

ADJUSTABLE HYDRAULIC LINEAR DECELERATOR

BRIEF SUMMARY OF THE INVENTION

Hydraulic linear decelerators are well known, and many arrangements are known whereby such linear decelerators are made adjustable. The means providing adjustability are, by and large, complex, expensive to manufacture and subject to malfunction or breakage. The present invention provides for adjustability in a relatively inexpensive manner; and the device is simple, and not liable to breakage or malfunction.

The invention is equally applicable to hydraulic linear decelerators of the spring return type, having an internal accumulator, and to linear decelerators of the air return type, having an external accumulator.

Briefly, the linear decelerator of the present invention comprises a cylinder containing hydraulic fluid, and a piston operating against said fluid when it receives an impact. The outboard end of the piston is of course provided with an impact receiving member. The cylinder is provided with a number of apertures for the escape of hydraulic fluids; and these are arranged along a generatrix of the cylinder and are exponentially spaced as is well known in the art. The cylinder is snugly embraced by a sleeve which is provided with a number of obturation slots, one for each of said apertures, and of the same minimum axial width as said apertures. The sleeve also has a guide slot cooperating with a pin fixed to said cylinder, to limit the extent of rotation of said sleeve to the circumferential extent of said obturation slots. The sleeve is surrounded by a reservoir tube, annularly spaced therefrom, and is coupled to said tube so as to be rotated within said limits when said tube is rotated. The obturation slots and guide slots are so arranged that at one limit of rotation the apertures are entirely closed, and at the other limit of rotation they are entirely open. Infinite adjustability is provided between said limits. Obturation may be achieved by disposing the obturation slots at an angle to circumference, the guide slots being circumferential. Thus rotation of the sleeve takes place without axial displacement thereof and the effective portion of the obturation slots moves gradually across the apertures. The axial displacement between the ends of each obturation slot will be substantially the axial width of an obturation slot. Alternatively, the obturation slots may be circumferential, and the guide slot may be angularly disposed, whereby rotation of the sleeve is accompanied by axial displacement thereof. The amount of displacement between the aforesaid limits will be substantially the axial width of the obturation slots.

The use of external accumulator, air return, arragements for linear deceleartors is well known, and need not be described in detail. Similarly the use of internal accumulator, spring return, arrangements is well known, wherein the internal accumulator comprises a body of nitrogen filled, closed cell, cellular material. One novel feature of the present invention resides in the provision of a shield for said body, to protect it from the jets of hydraulic fluid and turbulence thereof resulting from the linear decelerator receiving an impact load.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a longitudinal cross sectional view of a spring return, linear hydraulic decelerator having an internal accumulator, according to the present invention. An air accumulator is indicated as an alternative, in broken lines.

FIG. 2 is a cross sectional view taken on the line 2—2 of FIG. 1.

FIGS. 3*a*, 3*b* and 3*c* are fragmentary diagrammatic plan views of the adjusting sleeve, showing the relationship between an aperture in the cylinder and an obturation slot in three positions of rotation of the sleeve, according to one embodiment.

FIGS. 4*a*, 4*b* and 4*c* are views similar to FIGS. 3*a*, 3*b* and 3*c*, according to another embodiment.

DETAILED DESCRIPTION

Referring first to FIG. 1, there is shown a hydraulic linear decelerator comprising a cylinder **10** within which a piston **11** operates. The piston **11** is mounted on the end of a piston rod **12** which, at its outboard end is provided with an impact receiving member **13.**

The cylinder may be formed as a part of a brazement including the head **14** at one end and the head **15** at the other end. Mounting flanges **16** and **17** may be provided for the heads **14** and **15** respectively.

Snugly embracing the cylinder **10** is a sleeve **20.** A reservoir tube **21** is annularly spaced from the sleeve **20** and extends between the heads **14** and **15.**

It will be noted that the cylinder **10** is provided with a series of apertures **18** which are disposed along a generatrix of the cylinder **10** and are arranged in an exponential manner. This sort of arrangement is well known in connection with hydraulic linear decelerators. As the piston **11** moves toward the left upon receiving an impact, the oil within the cylinder **10** is forced out through the apertures **18** and the piston gradually closes off one aperture after another so as to bring the piston to a gradual stop. Forgetting for a moment the presence of the sleeve **20,** the oil which passes through the apertures **18** enters the annular space **22** between the cylinder and the reservoir tube. If the device is a spring return internal accumulator decelerator, an accumulator member **23** is provided in the space **22** and this member will be described in more detail hereinafter. The piston rod **12** and its associated parts are returned to initial position when the load is removed by means of the spring **24.** If the linear decelerator is to be an air return type with an external accumulator, the internal accumulator **23** is omitted as is the spring **24** and instead an accumulator **23***a* (shown in broken lines) is connected to the flow opening **25** by means of a pipe **26** and air is supplied to the accumulator at a predetermined pressure through the pipe **27.**

Returning now to the structure of the cylinder and sleeve and the manner of adjustment of the linear decelerator, the sleeve is provided with a number of slots **30** equal to the number of apertures **18.** These slots **30** have an axial extent equal to or greater than the diameter of the apertures **18.** Secured to the cylinder is a pin **31** which operates in a slot **32** in the sleeve **20.** In this way the pin and slot determine the extent of rotation of the sleeve **20.** The extent of this rotation is indicated in FIG. **2** by the angle R.

In the embodiment shown in FIGS. **3***a* to **3***c*, the slots **30** are disposed at a small angle to the circumference while the slot **32** in which the pin **31** engages is truly circumferential. As seen in FIG. **3***a*, at one limit of rotation of the sleeve **20,** the aperture **18** is completely ob-

turated. At the other end of the limit of movement, as seen in FIG. 3*c*, the aperture **18** is completely open. In FIG. 3*b*, at a midpoint, it will be seen that the slot **30** has opened one-half of the aperture **18.** Thus, there is provided an infinite adjustability for each of the slot-aperture combinations between the fully closed position of FIG. 3*a* and the fully opened position of FIG. 3*c*. In this embodiment, the sleeve **20** does not move axially and it is the angularity of the slots **30** which provides the obturation effect. It will be clear that one end of each slot **30** is disposed at an axial distance from the other end of the slot equal to or greater than the diameter of the aperture **18.**

According to another embodiment, as seen in FIGS. 4a to 4c inclusive, the slots **30***a* are truly circumferential but the slot **32** is disposed at an angle as were the slots **30** in FIGS. 3*a* to 3*c*. In this embodiment, the sleeve **20** moves axially as it is rotated; and again in FIG. 4a the aperture **18** is completely closed and in FIG. 4*c* the aperture is completely open, while in FIG. 4*b* at a midpoint in the rotation of the sleeve **20,** the aperture is one-half open. In this embodiment therefore the movement of the slot with respect to the aperture is achieved by an actual axial movement of the sleeve **20** with respect to the cylinder **10.**

The sleeve **20** is coupled to the reservoir tube **21** by means of a pin **40.** The reservoir tube **21** is preferably provided with a knurled ring **41** which may be rotated manually. By virtue of this construction, as the knurled ring **41** and the tube **21** are rotated, the pin **40** carries with it the sleeve **20.** It will be noted that the pin **40** engages in a slot **42** in the sleeve **20.** The slot **42** is axial and is only of such width as to allow for the axial movement of the sleeve necessitated in the embodiment described in connection with FIGS. 4*a* to 4*c*. There is no play between the pin **40** and the sleeve **20** in a direction normal to the paper. It will be observed that in accordance with conventional practice the inside of the reservoir tube is sealed by means of O-rings at **43** and **44** in conventional manner. As is also well known, means must be provided to permit oil above the cylinder to flow back below the cylinder during a return stroke of the piston rod **12.** This is accomplished by means of the usual ring valve **48** operating in an annular recess **45** communicating with the apertures **46** in the end of the piston. The piston rod **12** is sealed by means of the usual glands **47.**

Turning now to the accumulator **23,** which is used with a spring return arrangement, as shown in solid lines in FIG. **1,** the accumulator comprises a partial sleeve constituted of a nitrogen filled, closed cell, cellular member. The member **23** fills the annular space between the sleeve and the reservoir tube **21** except for the angular portion indicated at R in FIG. **2** which is the angular extent of the slots **30** and the area through which the pin **31** moves. It should be understood that when an impact is received by the member **13** and the piston **11** is moved toward the left in FIG. **1,** the oil is forced from the space within the cylinder through the apertures **18** and slots **30** into the space **22** under great pressure. Thus the jet action and turbulence in the oil tends to destroy the integrity of the accumulator material **23.** This problem is overcome, according to the present invention, by the provision of a thin sheet metal shield **50** which extends around the inside of the member **23,** and is flanged over the exposed ends at **51.** This feature adds a great deal to the life of the accumulator and preserves it from disintegration.

The diameters of the holes **18** and the dimensions of the slots **30** will naturally depend upon the size of the linear decelerator and the magnitude of the impacts which it must decelerate. It should be pointed out that with very small units the last few of the exponentially arranged holes might have to be so close together that they would interfere. This can be avoided by elongating the holes in a circumferential direction so as to retain the area requirements while also meeting the space requirements.

In filling the linear decelerator with hydraulic fluid, use is made of the fill opening **25.** Bleeding openings are provided which, when the unit has been fully charged, is plugged by means of the plug **60.** At **61** is shown a set screw by means of which the position of the sleeve with respect to the cylinder may be fixed after a desired position of adjustmenthas been found. It will be understood that with a spring return device the filler opening **25** will be plugged in a conventional manner and if the device is to be an air return device, then the tube **26** is attached in place of the filler plug.

It will be understood that numerous modifications may be made without departing from the spirit of the invention. No limitation not expressly set forth in the claims is intended and no such limitations should be implied.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A linear decelerator comprising a cylinder, and a piston reciprocable therein, said cylinder containing hydraulic fluid ahead of said piston, a rotatable sleeve surrounding said cylinder, a number of apertures in said cylinder, exponentially spaced along a generatrix of said cylinder, a number of obturation slots in said sleeve equal to the number of said apertures and exponentially spaced along a generatrix of said sleeve, the axial extent of each of said apertures being substantially equal and the axial extent of said obturation slots being at least as great as that of the respective apertures, there being an obturation slot for each aperture, a reservoir tube surrounding said sleeves in annularly spaced relation thereto, means coupling said sleeve to said reservoir tube so as to be rotatable by rotation of said reservoir tube, a guide slot in said sleeve and a pin secured to said cylinder and engaging in said guide slot to limit the rotational movement of said sleeve to the circumferential length of said obturation slots, rotational movement of said sleeve producing an axial displacement of the obturation slots with respect to their respective apertures; said obturation slots at one limit of rotation of said sleeve obturating said apertures, and at the other limit of rotation of said sleeve fully opening said apertures, whereby the action of said decelerator may be adjusted by rotation of said reservoir tube.

2. The structure of claim **1,** wherein said obturation slots are disposed parallel to each other and at an angle to the circumference of said sleeve, and said guide slot is circumferentially disposed, whereby rotation of said sleeve is circumferential without axial displacement, and obturation is obtained by virtue of the angular disposition of said obturation slots.

3. The structure of claim **1,** wherein said obturation slots are disposed circumferentially, and said guide slot is disposed at an angle to the circumference of said

sleeve, whereby rotation of said sleeve is accompanied by axial displacement thereof to produce obturation of said apertures.

4. The structure of claim **3,** wherein the coupling between said sleeve and reservoir tube comprises a pin fixed with respect to said reservoir tube, said pin cooperating with an axial slot in said sleeve, said axial slot having a width to snugly accommodate said pin, and a length sufficient for axial movement of said sleeve between obturating and fully open positions of said obturation slots.

5. The structure of claim **1,** wherein a nitrogen filled, closed cell, cellular member is disposed within said reservoir tube and surrounding said sleeve except over the circumferential extent of said obturation slots, to serve as an internal accumulator.

6. The structure of claim **5,** wherein a thin sheet metal shield is provided to protect said internal accumulator from hydraulic fluid jets and turbulence, said shield being of substantially the axial length of said accumulator, being disposed between said accumulator and said sleeve, and having flange portions extending around the circumferential ends of said accumulator.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,782,710 Dated January 1, 1974

Inventor(s) Donald A. Selke, Layne F. Tekulve, Richard S. Schmid

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 50, "flow" should be --- fill ---.

In the Drawing, Figure 1, there should be a reference numeral "25" with a lead line to the rectangular configuration into which the pipe 26 leads.

Signed and sealed this 8th day of April 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334