

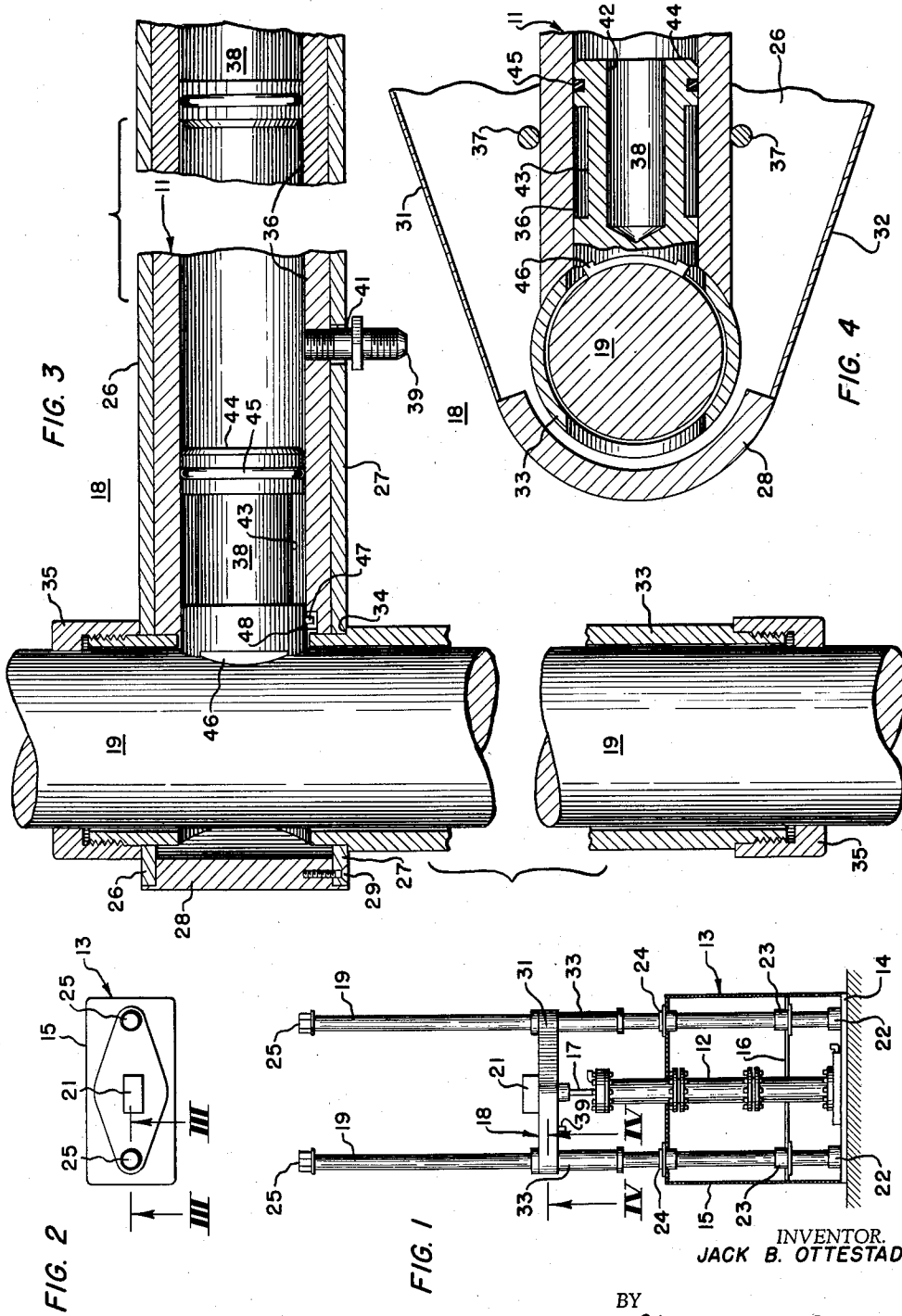
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BRAKING APPARATUS

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## BRAKING APPARATUS

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The present invention relates to an apparatus for braking a moving body, and more particularly relates to such an apparatus which is adapted to move with the body to be braked.

An application for which the present invention is particularly well suited, although it is not limited thereto, is the deceleration of work platforms or carriages which are moving at high velocities. Thus, in the field of shock-testing of components such as electronic units or the like, the behavior and reliability of such components is conventionally determined by subjecting them to high initial accelerations or G loads provided, for example, by apparatus such as that described in my copending patent application Serial No. 617,014, filed October 19, 1956.

It will be apparent that once a component or unit is subjected to a desired high initial acceleration, the carriage or structure supporting the unit should be slowed or retarded as quickly as possible to keep the length of the test structure to a minimum. The arresting gear or energy absorption devices used by the prior art to accomplish this desired retardation have not been completely satisfactory for various reasons, including their unwieldy nature, unpredictable operation, weight, expense, and difficulty of maintenance. Typical examples of previous energy absorption devices are collapsed lead block, stretched steel traps, and hydraulic shock absorbers, each of which is unwieldy or relatively complex in nature. Moreover, these prior devices are generally not sufficiently compact to be moved or carried with the body to be tested, and a desirable simplicity and reduction of parts in the deceleration apparatus is consequently lost. Further, the deceleration provided by certain of such devices is destructively abrupt and incapable of adjustment, in contrast to the desired retardation which is characterized by an adjustable and controlled deceleration-time pattern.

Accordingly, the present invention comprises a braking or deceleration apparatus which may be carried by the carriage to which the test specimen or work piece is mounted. The apparatus is adapted to act in braking fashion against the columns or rails which serve to support or guide the carriage, is compactly contained within the carriage, and includes fluid-actuated piston elements which provide the braking or retarding action by reason of their frictional engagement with the carriage supporting rails. The degree of retardation is controllable by adjusting the fluid pressure applied against the piston elements, and it will be apparent that the deceleration-time pattern is repeatable, cycle for cycle, merely by maintaining a constant pressure against the piston elements.

Although a particular application or use for the present apparatus will hereinafter be described, it is to be understood of course that the particular application is merely by way of example, and not by way of limitation. For example, the present apparatus is also adapted for use in braking the platens of metal forming machinery.

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These platens do not generally travel at the higher velocities of shock-testing carriages, but the problem of braking is essentially the same, and as will be apparent, the present invention is effective to provide such braking. The present device will be described in connection with an actuator of the type set forth in the abovesaid patent application Serial No. 617,014, although, as will be apparent, the particular type of actuator for driving the work platform or test carriage is not critical.

The level of initial thrust provided by the abovesaid actuator is relatively large with respect to the braking action provided by the present deceleration apparatus, so that fluid pressure may be applied to the braking elements of the present apparatus during the complete stroke of the actuator. Since the braking effect of the present apparatus will be so comparatively negligible during the initial portion of the actuator stroke, the decelerative effect of the apparatus will thereby be desirably postponed until the end of the actuator stroke, at which time the piston elements will desirably slow and limit the actuator stroke. But for the use of some such braking apparatus, the decelerative effect of friction and gravity forces would be incapable of slowing the carriage and limiting its travel to an acceptable degree, and the length of side rails would be prohibitive. Moreover, as will become more apparent in the description herein-after made, the present apparatus is relatively inexpensive to fabricate, comparatively easy to maintain, compact, and light in weight.

It is therefore an object of the present invention to provide an improved braking apparatus which is adapted to move with the body to be braked.

It is another object of the present invention to provide a unique light-weight apparatus for braking a moving body, and which is characterized by braking elements actuated by fluid pressure.

A further object of the present invention is the provision of a novel deceleration apparatus which is adapted to retard a moving body in a manner characterized by a predetermined and controlled deceleration-time pattern.

Another object of the invention is to provide an improved energy absorption device for slowing a carriage movable upon rails, and which is adapted to frictionally engage such side rails by means of a plurality of braking elements acting under the influence of fluid pressure.

Still another object of the present invention is the provision of braking apparatus which is characterized by light weight, simplicity of operation, ease of manufacture, and compactness.

Other objects and features of the present invention will be readily apparent to those skilled in the art from the following specification and appended drawings wherein is illustrated an embodiment of the invention, and in which:

Figure 1 is an elevational view of the braking apparatus of the present invention mounted in operating relationship with an actuator and the carriage and supporting structure for such actuator;

Figure 2 is a plan view of that which is illustrated in Figure 1;

Figure 3 is a sectional view taken along line III—III of Figure 2; and

Figure 4 is a sectional view taken along the line IV—IV of Figure 1.

Referring to the drawings, there is illustrated an embodiment of the braking apparatus of the present invention which is generally designated 11, and which is adapted for association with an actuator of the type described and fully set forth in the above-said copending patent application Serial No. 617,014. Such actuator is generally designated 12, and is illustrated in association

with usual supporting structure 13, which includes a base plate 14 resting upon the floor, a box-like housing 15 rigidly secured to base plate 14 and serving to enclose the greater part of actuator 12, and an intermediate plate 16 which is fixed to housing 15 to rigidify the supporting structure 13, as will be apparent. The lower end of actuator 12 rests upon base plate 14, and the upper end thereof extends through a suitable opening cut in the upper or cover portion of housing 15. Actuator 12 also extends through an opening provided in plate 16, and in this manner actuator 12 is securely maintained in operative position to drive its thrust column 17 against a body support structure, work platform, or carriage 18.

Carriage 18 is slidably movable along and extends laterally between a pair of ways, columns, or side rails 19, and is adapted to carry a workpiece or test specimen 21 upon its upper surface, as illustrated. Upon firing of actuator 12, it will be apparent that specimen 21 will be driven with carriage 18 along side rails 19, thereby subjecting specimen 21 to the particular thrust or G loads of which actuator 12 is capable.

Side rails 19 are rigidly anchored in position by securement to structure 13, and rigidly carry, respectively, lower end fittings 22, intermediate fittings 23, and upper end fittings 24. Fittings 22 rest upon base plate 14, fittings 23 are securely fastened to intermediate plate 16, and fittings 24 are rigidly secured to the cover plate of housing 15 whereby rails 19 are maintained vertical and parallel and are restrained against upward and downward movement, as viewed in Figure 1. Rails 19 are each capped at their upper ends with a stop nut 25 to positively limit upward travel of carriage 18 in the event apparatus 11 carried by carriage 18 should fail to operate for some unforeseen reason.

As best illustrated in Figures 3 and 4, carriage 18 comprises a substantially diamond shaped upper cover 26, a similarly shaped lower cover 27, and a pair of arcuate end members 28, only one of which is illustrated in Figures 3 and 4. Members 28 are located at opposite ends of covers 26 and 27 and serve to assist in maintaining covers 26 and 27 in parallel, spaced apart relationship, covers 26 and 27 each being secured to members 28 by a plurality of machine screws or the like, as at 29. In addition, a pair of side covers 31 and 32 are welded or otherwise secured to the ends of members 28 and to the edges of plates 25 and 26 to form a substantially closed diamond-shaped container which serves to house braking apparatus 11, as will be seen.

Covers 26 and 27 are provided at their lateral end portions with vertically aligned openings for the accommodation of support tubes 33. The upper portions of tubes 33 fit within and through these openings, while the lower portions of tubes 33 are slightly larger in diameter as compared to the upper portions whereby they each abut lower cover 27 at a peripheral shoulder 34. It is noted also that the inner diameter of each tube 33 is sufficiently greater than the outer diameter of the corresponding rail 19 so that no interference occurs therebetween and a freely slidable spaced relationship exists.

The upper and lower ends of each tube 33 are threaded to accept, respectively, a pair of threaded retainer nuts 35 each of which has an inwardly directed annular shoulder portion adapted to slidably contact tube 33 whereby the shoulder portions of nuts 35 provide the bearing contacts between carriage 18 and rails 19. For this purpose, nuts 35 may be made of any suitable bearing material, such as bronze or the like, to prevent sticking and galling. It will be apparent that the upper retainer nut 35 also serves to maintain tube 33 and the assembly of covers 26 and 27 in rigid relationship.

Braking apparatus 11 includes a cylinder 36 which is disposed laterally between support tubes 33 and within the space defined between upper cover 26 and lower cover 27. The ends of cylinder 36 are cut in arcuate form so as to closely abut and mate with tubes 33, and the upper

and lower surfaces of cylinder 36 are formed or cut to present flat faces to covers 26 and 27. Thus the bearing area of covers 26 and 27 against cylinder 36 is adequate to prevent cylinder 36 from rolling out of position, and a plurality of retainer bolt and spacer assemblies 37 are provided to assist in this regard. Assemblies 37, only two of which are illustrated, are rigidly fixed in vertical relationship between covers 26 and 27 along the length of cylinder 36, and maintain cylinder 36 in position by bearing against cylinder 36 at their sides.

Cylinder 36 serves to slidably accommodate a pair of pistons 38, only one of which is illustrated, which are operable outwardly toward side rails 19 under the urging of fluid pressure admissible through a pressure fitting 39 located between pistons 38. Fitting 39 is disposed through a suitable opening 41 provided therefor in lower cover 27, and is threaded into a threaded bore provided in the lower face of cylinder 36 whereby fluid communication may be had between the interior of cylinder 36 and a fluid pressure line (not shown) connected to fitting 39.

Each piston 38 is made to be fairly light in weight, being internally bored at 42 and provided with an annular reduced diameter portion 43 for material removal and consequent weight reduction. By this means each piston 38 is highly responsive to fluid pressure acting through fitting 39 and against its inner face 44. In addition, fluid tight relationship between each piston 38 and the inner walls of cylinder 36 is promoted by the provision of a suitable pressure seal or O ring 45 in a peripheral groove at the inner end portion of piston 38.

The outer end of each piston 38 is formed to accommodate a brake element, face, or shoe 46 which is made of a suitable brake material, such as asbestos or the like, for frictional engagement with its associated side rail 19. Shoe 46 is securely fastened to the outward face of piston 38 by any suitable means, but preferably by the process of adhesive bonding well known to those skilled in the art.

To permit shoes 46 of pistons 38 to come into frictional engagement with side rails 19, tubes 33 are each provided with a transverse bore therethrough. Each piston shoe 46 may thus be urged through the wall of tube 33 and against a rail 19 by the action of fluid pressure within cylinder 36.

Each piston 38 is maintained in operative orientation with respect to its associated rail 19 by a stop means or short pin 47 which is secured to piston 38, as best illustrated in Figure 3, and which is carried within a slot 48 formed in the outward end of cylinder 36. It will be apparent that inward and rotational movements of each piston 38 are thus limited by contact or engagement between its stop pin 47 and associated slot 48 so that pistons 38 are always in position to be urged into functional engagement with side rails 19.

In operation, fluid pressure is admitted to cylinder 36 while carriage 18 is in the downward position illustrated in Figure 1. This urges pistons 38 into functional or braking engagement with side rails 19. Next, actuator 12 is fired and thrust column 17 is thereby urged upwardly against carriage 18. Since the retarding or braking force provided by pistons 38 acting against rails 19 is relatively small compared to the upward force exerted by actuator 12 against carriage 18, carriage 18 will be urged upwardly by thrust column 17. The desired initial high G or acceleration forces generated by actuator 12 are thus operative upon specimen 21 carried by carriage 18. As the initial high value of thrust of actuator 12 decays, the braking effect of braking apparatus 11 is increasingly felt, and carriage 18 will be comparatively gradually snubbed to a standstill somewhat short of stop bolts 25. If desired, the pressure applied to cylinder 36 may be applied substantially instantaneously after a predetermined upward travel of carriage 18, or the pressure may be varied in accordance with some

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predetermined pattern. In any event, it will be apparent that the retardation, deceleration, or braking of carriage 18 can be made to conform to a predetermined deceleration-time pattern if desired, and that the braking action provided by apparatus 11 may be adjusted and controlled. Moreover, it will also be apparent that by reason of the actuation of both pistons 38 by a common fluid pressure within cylinder 36, the braking action of apparatus 11 is stabilized and balanced between the pair of side rails 19.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

I claim:

1. A braking apparatus adapted for movement with respect to a pair of ways, said apparatus comprising support means in slidable encompassing engagement with said ways, said support means having bore means, a cylinder, a pair of pistons carried within said cylinder and arranged to be urged into frictional engagement with said pair of ways through said bore means, respectively, and means for admitting fluid pressure to said cylinder between said pair of pistons thereby to effect a substantially balanced braking action by said pair of pistons against said pair of ways whereby relative movement between said support means and said pair of ways is retarded in stabilized manner.

2. A braking apparatus for movement with respect to way means, said apparatus comprising support means in slidable encompassing engagement with said way means, said support means having bore means, a cylinder, a pair of pistons carried within said cylinder and arranged to be urged into frictional engagement with said way means through said bore means, means including a fluid inlet located between said pair of pistons for admitting fluid pressure to said cylinder thereby to effect engagement between said pair of pistons and said way

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means whereby relative movement between said support means and said way means is retarded, and stop means disposed between said cylinder and said pair of pistons to limit travel of said pair of pistons away from said way means whereby said pair of pistons will be maintained in operative orientation with respect to said fluid inlet.

3. In the combination of a body support structure, in slidable encompassing engagement with a pair of rails, an actuator for effecting movement of said body support structure along said pair of rails; an improved apparatus for braking said body support structure during said movement, said apparatus comprising an open-ended cylinder mounted within said body support structure with the open ends thereof adjacent said pair of rails, a pair of pistons carried within said open ends, respectively, of said cylinder, brake shoes carried by said pair of pistons, stop elements disposed between said cylinder and said pair of pistons to maintain said pair of pistons in position adjacent said pair of rails, and means for admitting fluid pressure to said cylinder thereby to effect engagement between said pair of rails and said brake shoes of said pair of pistons whereby said body support structure is restrained against movement.

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