Aug. 23, 1932. E. E. ARNOLD 1,873,807

ELEVATOR BUFFER

Filed Sept. 18, 1929

Fig. 1.

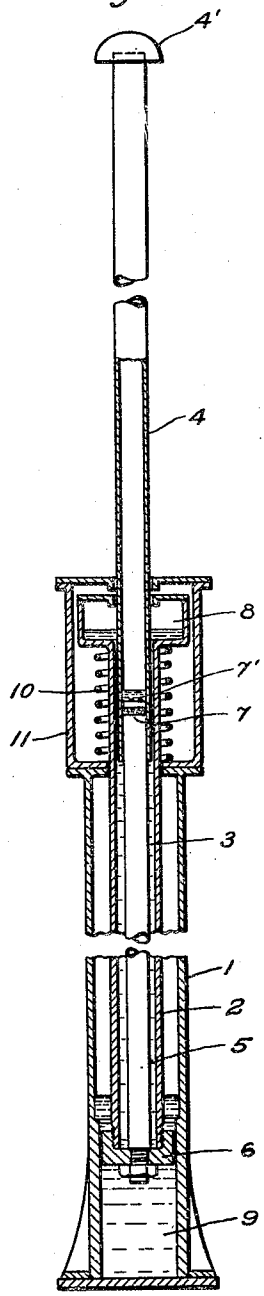
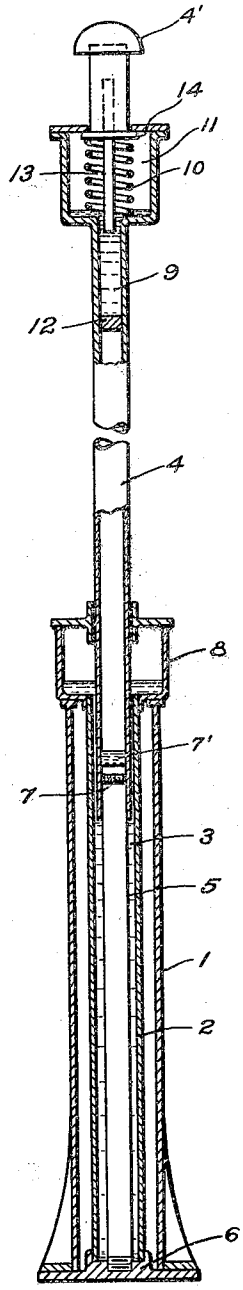



Fig. 2.




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Patented Aug. 23, 1932 1,873,807

# UNITED STATES PATENT OFFICE

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## ELEVATOR BUFFER

Application filed September 18, 1929. Serial No. 393,438.

My invention relates to fluid buffers in general and, more specifically, to buffers having relatively long operating strokes.

The trend of the development of the modern elevator is toward increased speed of operation. For example, 500 to 600 feet per minute has been considered the maximum elevator speed consistent with comfort and safety. Recent developments in electrical control have demonstrated the practicability of the use of car speeds of 900 or more feet per minute.

However, when such high speeds are employed, a new problem is presented to the elevator engineer in designing buffers and safety stops for insuring the gentle stopping of the car at the top and the bottom of the elevator shaft, in the event that the electrical control of the car fails.

While safety buffers have long been used for this purpose, they have all been designed with short strokes accommodated to the lower speeds of operation of the cars, and hence, these old buffers are inadequate to safely stop the cars from the higher speeds, since the stored energy to be arrested and absorbed by the buffer increases as the square of the speed.

The solution appears to be either the use of a greater force acting through the distance of the short stroke or the use of a lesser force acting through a much longer stroke. To exert a greater force would result in the too rapid checking of the speed of the car, thereby endangering the passengers, as well as the equipment.

However, to increase the length of the stroke of the buffer presents the problem of retrieving the buffer to its extended position after its operation. The use of springs for this purpose is limited to comparatively short-stroke buffers because of the relatively short expansion characteristic of springs, and the use of combinations of springs is not satisfactory because such combinations are unwieldy and cumbersome.

An object of my invention, therefore, is to provide a buffer for elevators having a long stroke and one which does not require the use of a long spring to retrieve it after it has been operated.

Another object of my invention is to provide a buffer, the moving parts of which have a minimum weight, thereby reducing shocks due to inertia of such parts when getting them under way at the high speed of initial contacts of the mass to be brought to rest.

Another object is to employ, in such buffers, a dense fluid medium adapted to give a higher dynamic resistance than oil so that smaller pressure areas may be employed.

Another object is to eliminate the use of long springs as a restoring means to which end, a combination is provided wherein an air cushion is made use of as a principal restoring means.

A further object is to combine, in a heavy duty buffer, parts which are simple, light in weight and economical to manufacture.

Other objects will appear in the description which follows.

My invention comprises essentially a relatively long hollow buffer ram slidably mounted upon, and telescopically engaging, a relatively stationary rod or plunger. Means are provided to entrap air within the hollow ram above the plunger which is compressed during an operating stroke and expanded to retrieve the ram.

A mass of mercury or like dense fluid is enclosed within a chamber which surrounds the stationary rod. The fluid provides a force resistant to the operating stroke of the ram 4 and is bypassed along the ram toward its free end.

A combination is thereby provided wherein two fluids are effective to yieldingly resist the motion of the buffer ram, upon an application of force thereto, and retrieve the ram

to its original position upon removal of the applied force.

My invention also embodies a novel auxiliary buffer associated with the main buffer, and in series therewith, for absorbing initially a portion of the applied force.

Figure 1 is a view, partly in section and partly in elevation, of a main buffer having an auxiliary oil buffer at the bottom of the casing for absorbing the shock of initial impact by allowing the main buffer mechanism to move as a unit for a short distance.

Fig. 2 is a similar view of a modification wherein an auxiliary buffer is mounted on the free end of the shock-absorbing ram.

Parts having the same functions will be designated by the same reference character in both figures.

In Fig. 1 is shown an outer casing 1 within which is disposed a cylinder 2 which contains a resistance fluid 3 of high density, preferably mercury. A hollow ram 4, which is the principal shock-absorbing element, has a cap 4′ on its upper end, its lower end being fitted to reciprocate in cylinder 2.

An opposing plunger 5 extends substantially the full length of the cylinder 2 and is centrally disposed within the latter to form a chamber therebetween and is fitted to slide within the ram 4. Plunger 5 and cylinder 2 are held in fixed relation by being attached to a common base 6 comprising a piston in the cylindrical casing 1.

A fluid seal is maintained between the ram 4 and the plunger 5 by means of a sealing ring 7, disposed adjacent to the upper end of the plunger 5, together with a small amount of mercury 7′ placed above its ring. By means of this seal, air is entrapped within the ram 4, thereby forming a cushion below it. The chamber between the cylinder 2 and the plunger 5 is filled with mercury or like dense fluid. When mercury is employed as the resistant fluid, it will have considerable buoyant effect on the ram 4 which, as will be seen, is always partially immersed therein. With the buoyancy of the mercury assisting the air cushion in supporting the ram 4, only a slight air pressure is necessary to maintain it in an extended position. As will be explained below, the mercury and entrapped air operates on the associated elements to retrieve the ram 4 after it has been forced into its retaining cylinder 2. It is apparent that the pressure of the air forming said cushion may be sufficient to retrieve and support the ram 4.

When the ram 4 is forced downwardly, its movement is resisted by the mercury, or other fluid, in cylinder 2 which is displaced and escapes through an annular space between the outer wall of the ram and the inner wall of the cylinder, and into overflow chamber 8. This space is provided by fitting the ram 4 into the cylinder 2 with the proper amount of clearance. By making the clearance greater or less, any desired resistance may be secured.

The same clearance is maintained between ram 4 and cylinder 2 throughout their entire lengths. As the ram is forced down into the cylinder, the above mentioned annular space is lengthened. Owing to the high surface tension of mercury and the increase in length of the space through which it must flow, its resistance to flow is correspondingly increased. I thereby obtain the desired characteristic of increased resistance of the shock-absorbing element as it approaches its limit of travel.

It is desirable, in heavy duty high-speed buffers of this type, to absorb the initial shock of impact of the applied force, by utilizing the combined shock-absorbing effect of two buffers operating in series at the instant of impact and for a limited portion of the stroke. This I accomplish by using a long-stroke fluid-resistance buffer comprising a solid plunger and a short-stroke auxiliary buffer with a spring retrieving means associated therewith. This provides a sufficiently effective arrangement wherein a relatively large amount of fluid is displaced.

Such an auxiliary buffer may comprise an auxiliary buffer chamber 9 at the bottom of the casing 1, as shown in Fig. 1, and this chamber is filled with oil or like fluid. Base 6, together with cylinder 2 and ram 5, is disposed to reciprocate and operate as a piston in chamber 9, but, as shown, it is loosely fitted in the cylinder whereby an annular clearance space is provided to permit the oil in the chamber to pass therethrough.

A chamber 11 is provided at the top of casing 1, and a spring 10 is seated in its lower part to bear, at its upper end, against the bottom of over-flow chamber 8. Spring 10 operates, through cylinder 2, to retrieve base 6 and the parts moving in unison therewith. Base 6 is depressed by the force exerted upon ram 4, which force is transmitted to the piston 6 through the fluid in cylinder 2 and the air above ram 5, whereupon piston 6 is moved downwardly upon the oil in chamber 9 and, at the same time, compresses spring 10 in the chamber 11. The downward movement of the piston 6 in chamber 9 is resisted by the oil in the chamber as it flows around the piston passing from below to above it as it descends. Upon removal of the applied force, spring 10 acts against the base of chamber 8 to force piston 6 and its associated parts upwardly, and the displaced oil will be returned from casing 11 into chamber 9, thereby restoring the base 6 to its original position.

Fig. 2 shows another form of my invention wherein the auxiliary buffer is attached to the upper or free end of ram 4. This modification also includes a series buffer action, as is embodied in Fig. 1, except that the applied force is first exerted on the aux-

iliary buffer instead of on the main buffer. The adding of inertia to ram 4, by this construction, is largely compensated because the initial shock is absorbed mainly by the auxiliary buffer, very little of it being transmitted to the main buffer ram 4.

In this modification, the main buffer elements are similar, in construction and function, to corresponding elements in Fig. 1. Casing 1, cylinder 2, and ram 5 are concentrically mounted on base 6 which, in this embodiment, does not reciprocate as a piston but is integral with the pedestal of the buffer. Ram 4 reciprocates in cylinder 2 and functions in the same manner as in the structure shown in Fig. 1. I provide a fluid seal 7 adjacent to the upper end of ram 5 to entrap air within ram 4. This air, aided by the resistance fluid, operates to retrieve ram 4 in the same manner as in Fig. 1. Overflow chamber 8 receives the displaced fluid from cylinder 2.

In Fig. 2, the auxiliary buffer is located on the free end of ram 4. An oil reservoir 9 is formed within the upper portion of ram 4, by a partition 12, within which an auxiliary plunger 13 is slidably mounted in concentric spaced relation thereto. A spring 10 is provided to support the auxiliary plunger 13 and retrieve the latter after a downward stroke thereof. A chamber 11, in communication with the open end of chamber 9, serves as an overflow reservoir and also provides a base for seating spring 10, the upper end of which bears against a shoulder 14 on auxiliary plunger 13.

Either embodiment of my invention, when used in connection with elevators, is placed in the well of the elevator shaft at the end of travel of the elevator car or the counterweight. The object is to check the movement of the car or the like before it comes against the bottom of the elevator shaft. The car, proceeding downwardly in the shaft at a substantial rate of speed, strikes the buffer cap 4′ with high initial shock, causing the ram 4 to suddenly start moving downwardly.

My device provides for initial rapid movement of the ram 4 through the use of buffers in series with low initial fluid resistance which increases rapidly toward the end of the stroke, as hereinbefore described.

In the operation of the embodiment shown in Fig. 1 the force of the downwardly moving body is transmitted, through ram 4, to the cylinder assembly 2 and thence to piston 6. Under the action of the applied force, resistance fluid 3 will begin to yield and bypass around ram 4 to chamber 8. At the same time, the fluid in chamber 9 will begin to yield and pass around piston 6 through the annular clearance space, shown in Fig. 1, thereby allowing piston 6 and ram 4 to move simultaneously.

For the first portion of the stroke, and until piston 6 reaches the bottom of chamber 9, the action of the two buffers will be in series, which will allow a comparatively rapid movement of ram 4. By the time the auxiliary buffer has completed its stroke, the initial impact shock will have been absorbed, and the inertia of the falling body will have been somewhat checked. The complete retardation of the car will be accomplished by the action of the resistance fluid 3 alone as the ram 4 is forced farther into cylinder 2. Owing to the increased resistance of the fluid, as the ram 4 moves downwardly in cylinder 2, the inertia of the falling car will be rapidly absorbed, and the car brought to rest without shock.

During the downward movement of ram 4, air, entrapped therein by the seal 7 on the upper end of ram 4, is compressed. At the same time, the depth of the immersion of the ram in the fluid 3 is increased, and spring 10 is compressed.

When the car is lifted from the buffer, the ram 4 will be retrieved to its original position by the action of the compressed air within it, aided by the buoyant effect of the resistance fluid 3 upon it. The spring 10 will operate to force the piston 6 and elements assembled therewith upwardly to their original position, thereby completely restoring the buffer to its original condition.

The operation of the modified structure shown in Fig. 2, in which the auxiliary buffer is placed free at the end of ram 4, is similar, so far as the action of the main buffer elements are concerned, but their cooperation is somewhat different. In this form, the initial shock is absorbed mainly by the auxiliary buffer, very little being transmitted to ram 4. The rapid initial movement is also obtained by the simultaneous series action of the two buffers.

When the car first engages the buffer cap 4′, the auxiliary plunger 13 is driven downwardly at a high rate of speed and the liquid 9 passes through the clearance around the auxiliary plunger to the overflow chamber 11. The flow of the liquid around the auxiliary plunger 13 at a high rate of speed affords considerable resistance which reacts downwardly on the ram 4 and the latter is accelerated. By the time the auxiliary plunger 13 is completely depressed, the ram 4 has been accelerated to move at a speed substantially equal to that of the car. Since the hollow ram 4 was not instantly accelerated to the speed of the car by direct engagement therewith, but was gradually accelerated to the speed of the car during the stroke of the auxiliary plunger 13, the terrific impact shock is avoided.

As the hollow ram 4 is depressed further into the cylinder 2, the resistance of the fluid 3 passing upwardly around the hollow ram 4 to the chamber 8 completely retards the car and brings it to a smooth stop.

After the car is lifted from the buffer, the buoyancy of the resistance fluid 3 and the action of the compressed air entrapped in the hollow ram 4 restores the latter to its normal elevated position. The spring 10 and the liquid associated with plunger 13 also restores it to its normal position and the device is reset for another operation.

While I have described my invention as applied to elevators, it is obvious that it may be used to check the movement of many other bodies operating in many other relations. I prefer mercury as a resistance fluid in the main buffer, but it should be understood that other similar fluids may be employed.

I claim as my invention:

1. In a fluid-resistance buffer, the combination of a cylinder, a ram disposed to reciprocate within said cylinder, and a fluid within said cylinder operative to bypass the ram and produce a buffer action with respect to the movement of said ram, with means associated with said ram to form an air chamber, and means to compress the air in said chamber during an operative stroke of said ram, whereby the air, when compressed, is effective to retrieve said ram.

2. In a fluid-resistance buffer, the combination of a cylinder, a hollow ram disposed to reciprocate within said cylinder, and a fluid of high density within said cylinder, said fluid being displaced upon a movement of said ram to yieldingly retard the motion thereof, with means for entraining air within said ram, and means associated with said ram for compressing said air during an operative stroke of said ram, whereby the air, when compressed, is effective to retrieve said ram.

3. A buffer comprising a cylinder containing a fluid, an overflow chamber at the upper end thereof, a plunger centrally disposed within said cylinder and held in a fixed relation thereto, a hollow ram arranged to slide over said plunger and other fluid means compressible between said plunger and ram for yieldably holding said hollow ram in a raised position.

4. A buffer comprising a cylinder containing a fluid, an overflow chamber at the upper end thereof, a hollow ram slidable within said cylinder, an opposing plunger slidable in said hollow ram, said cylinder and said opposing plunger having a common base, and means tending to hold said hollow ram in a raised position comprising air entrapped within said hollow ram by said opposing plunger.

5. A buffer comprising a cylinder containing mercury, an overflow chamber at the upper end thereof, a rod centrally disposed within said cylinder, a base common to said cylinder and said rod, a hollow ram slidable within said cylinder and over said rod, whereby the buoyancy of said mercury acts upon said hollow ram to maintain the latter in a raised position.

6. A fluid-resistance buffer comprising a cylinder containing a fluid, a hollow ram normally held in an extended position and slidable within said cylinder in contact with said fluid, an opposing plunger disposed to slide within said hollow ram and an air cushion between said ram and plunger, said air cushion and the buoyancy of said fluid being effective to restore said hollow ram to its extended position after displacement thereof.

7. In a buffer, an outer casing, a rod centrally disposed within said casing, a hollow cylinder intermediate said casing and said rod and spaced from the latter, a fluid within said space, a hollow ram slidable over said rod to engage and displace said fluid and an air cushion within said hollow ram above said rod.

8. In a buffer, an outer casing, a rod centrally disposed within said casing, a hollow cylinder intermediate said casing and said rod and spaced from the latter, mercury within said space and a hollow ram slidable over said rod to engage and displace said mercury, whereby the buoyancy of said mercury tends to maintain said ram in its raised position.

9. A buffer comprising a cylinder, a plunger centrally disposed within said cylinder and fixed with respect to the same to form an annular space between them, a hollow ram slidable within said annular space, mercury within said space tending to float said hollow ram and acting as a resistance fluid during the downward stroke of said ram, an air space within said hollow ram and above said mercury and sealing means carried by said centrally disposed ram and interposed between said air space and said mercury to entrain air within said space, whereby the compression of said air between the plunger and the ram acts to return the said hollow ram to its raised position.

10. In a buffer, an outer casing, a rod centrally disposed within said casing, a cylinder intermediate said casing and said rod and spaced from the latter, a fluid within said space, a hollow ram slidable over said rod to engage and displace said fluid, and an air cushion within the hollow ram above said rod, said cylinder and said rod being mounted on a common base to form a unit slidable within said casing and an auxiliary fluid reservoir within said casing and below said base.

11. In a buffer, an outer casing, a rod centrally disposed within said casing, a cylinder intermediate said casing and said rod and spaced from the latter, a fluid within said space, a hollow ram slidable over said rod to engage and displace said fluid, an air cushion within the hollow ram above said rod and an auxiliary buffer mounted on said hollow ram.

12. In fluid-resistance-buffer mechanism, a main buffer comprising a cylinder containing a fluid, a hollow ram slidable within said cylinder, an opposing plunger disposed to slide within said hollow ram, said cylinder and said opposing plunger being mounted upon a common base, a fluid seal between said hollow ram and said opposing plunger to maintain an air cushion therebetween and an auxiliary buffer on said hollow ram to take up the initial shock upon sudden actuation thereof.

In testimony whereof, I have hereunto subscribed my name this 4th day of September, 1929.

EDWIN E. ARNOLD.