May 12, 1970 C. HUBACHER ET AL 3,510,999

SHOCK ABSORPTION SYSTEM

Filed Aug. 8, 1967 3 Sheets-Sheet 1

Fig. 1

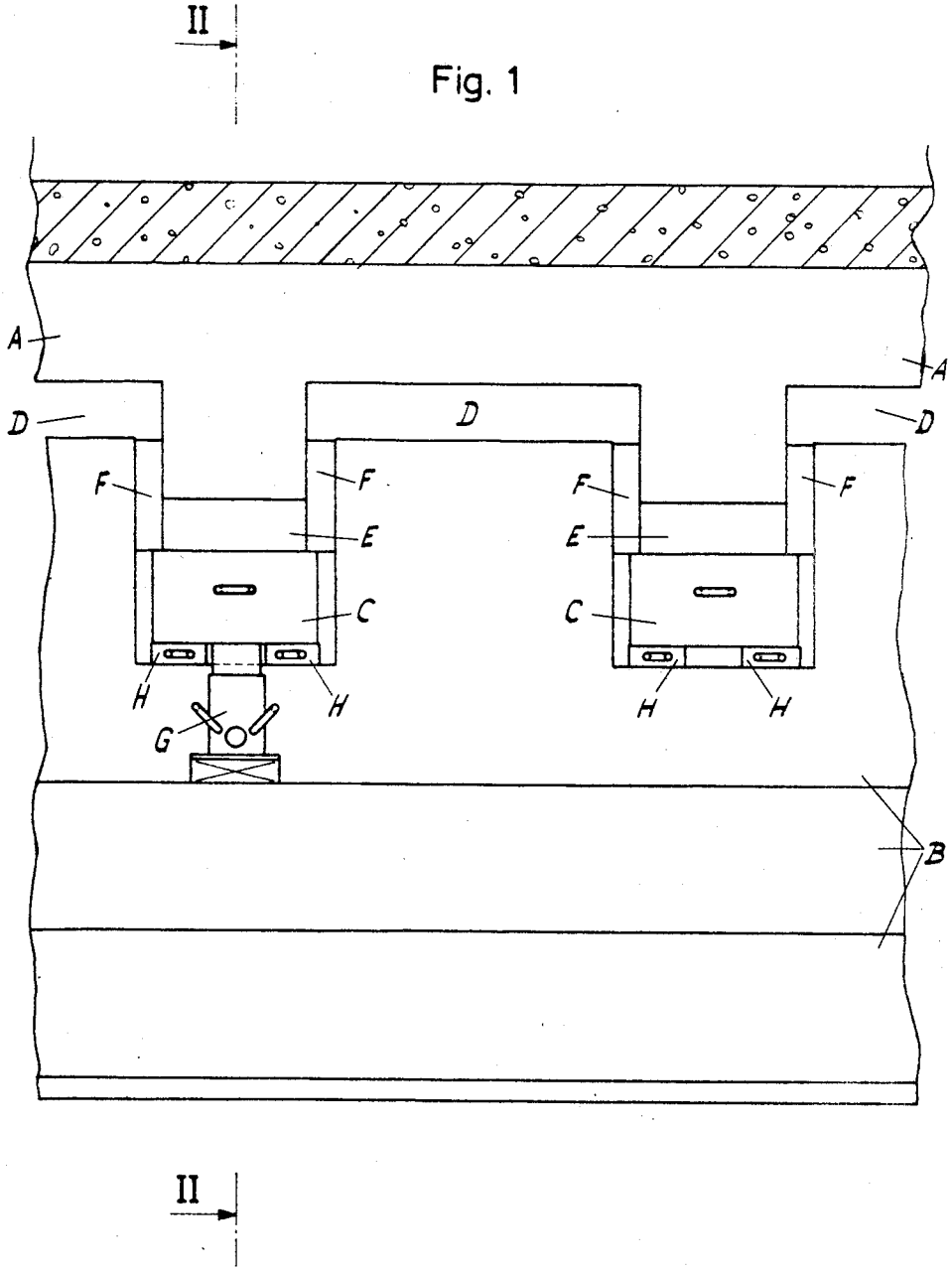
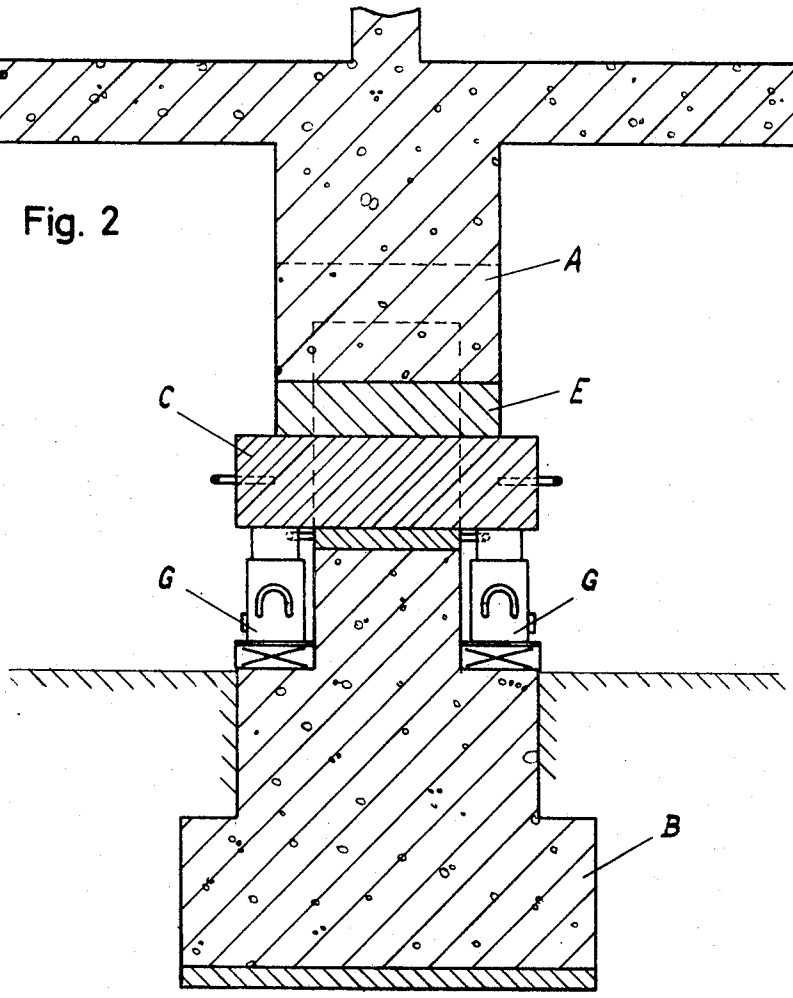


Fig. 2



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SHOCK ABSORPTION SYSTEM

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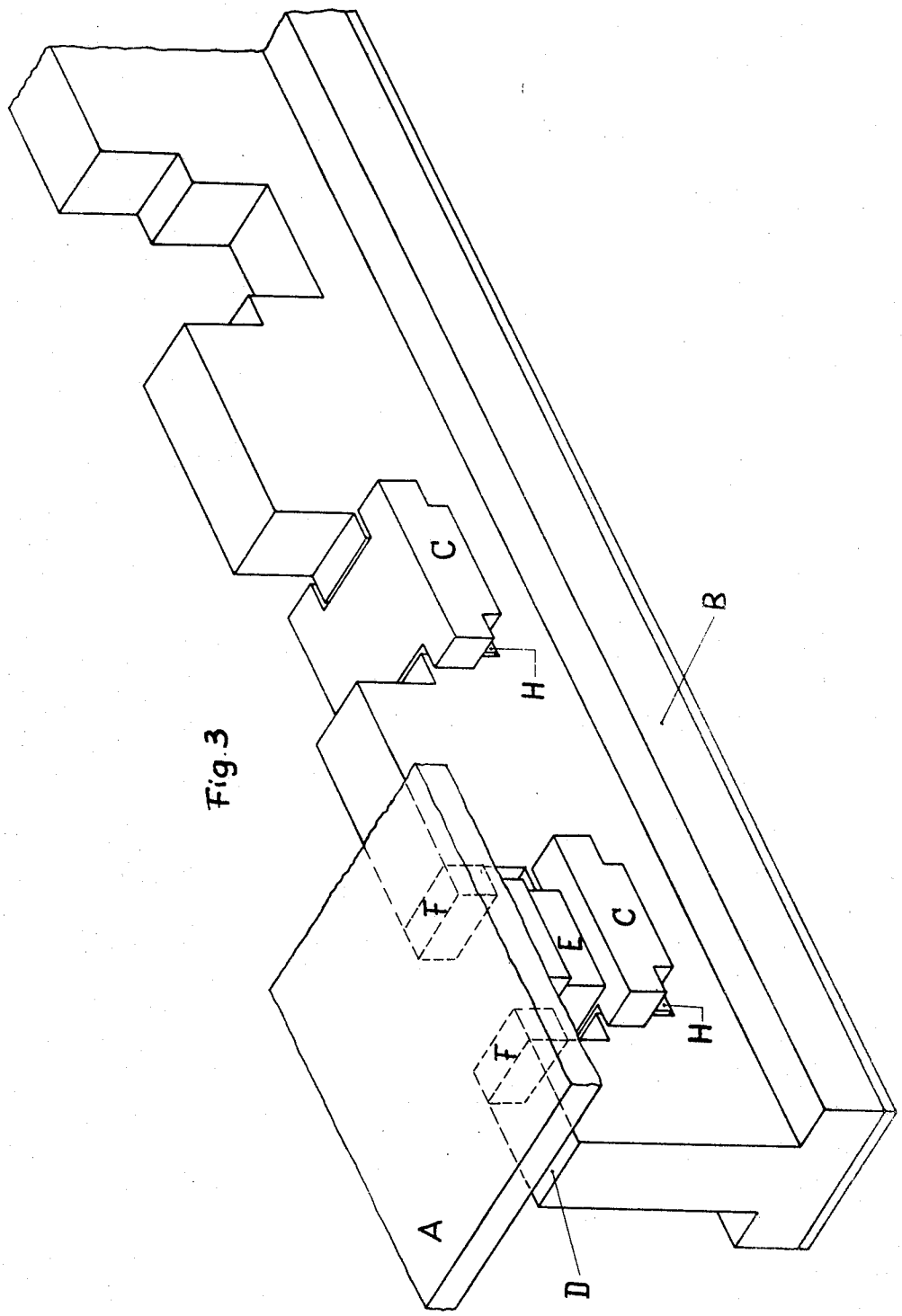


Fig. 3

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3,510,999

SHOCK ABSORPTION SYSTEM

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ABSTRACT OF THE DISCLOSURE

Shock absorption system for a structure that has a foundation and a building supported thereon, has first and second damper elements positioned in a space that extends throughout between the foundation and the building. The first damper element can take up and dampen single shocks from any direction, while the second damper elements normally can take up and dampen horizontal forces of predetermined size, but collapse upon the receipt of seismic shocks.

The invention relates to shock absorption systems, and relates more particularly to shock absorption systems for use in protecting a building supported on a foundation. Still more particularly, the invention relates to shock absorption systems for use in protecting a building from shocks transmitted by its foundation; and at the same time permitting normal horizontal forces applied to the building itself, such as wind forces or the like, to be taken up and to be transmitted to the foundation without any relative movement. More specifically, the invention relates to a shock absorption system for use in protecting a building from shocks such as earthquakes or nearby explosions.

In the past it has been proposed to provide for shock absorption of this type, and the proposals of the prior art included measures that aimed at the following:

(a) To enable the building, or parts of the building, to be subjected to such shocks without experiencing either a total destruction or any heavy damage;

(b) To protect the building in such a manner that any series of shocks or waves may not induce vibrations in the building that lie in the proximity of its natural frequency;

(c) To make provisions so that the amplitude of the shocks would not be increased by an inappropriate foundation or by the possibility of lifting the building off the foundation;

(d) To separate the building from the soil by construction means; and

(e) To provide for a damping layer between the foundation and the building.

The instant invention is based on the last two aims, and has among its principal objects to provide for a separation of the building from its foundation, and to provide for damping between the foundation and the building thereon.

Generally, the instant invention provides for a foundation and a building supported thereon, wherein the foundation as well as the building each have projections and recesses, and each projection of the foundation is disposed opposite a recess of the building and vice versa; the foundation and building define therebetween throughout the opposite contours a space that allows for horizontal and vertical mutual motions between foundation and building, and damper elements and, respectively, sustaining elements are provided in at least some sections of the said space.

The instant invention has the advantage, as compared to proposals of the past, to admit not only vertical motions but simultaneously also horizontal motions. The amplitudes, frequencies and speeds observed heretofore during earthquakes can be accommodated in all directions, and after the shocks have receded, the building will automatically resume its original position relative to the foundation. Thus, a building provided with the instant shock absorption system will need to follow the movements of the foundation only to a much dampened degree and with corresponding time lags. In the event of catastrophies, such as during earthquakes, movements of the building in all directions relative to its foundation and its building soil, has been rendered possible by this invention up to the maximum predictable amplitude, so that the building due to its inertia will remain at rest.

In accordance with a preferred embodiment, the instant invention provides that each support point may be easily and without much effort in labor or material be adjustable and replaceable.

With the above and other objects of the invention in view, the invention consists in the novel construction, arrangement and combination of various devices, elements and parts, as set forth in the claim hereof, certain embodiments of the same being illustrated in the accompanying drawings and described in the specification.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description, taken in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary elevational view, partly in section, of a foundation and a wall of a building supported thereon;

FIG. 2 is a fragmentary sectional view, taken on the line II—II of FIG. 1; and

FIG. 3 is a fragmentary perspective view.

In carrying the invention into effect in the embodiments which have been selected for illustration in the accompanying drawings and for description in this specification, there is provided a foundation B on which there is supported a building A of which one wall is shown in the drawing. Between the foundation B and the building A there is provided a space or slit D that extends throughout the opposite contours of the foundation B on one hand and the building A on the other.

As best shown in FIGS. 1 and 3, the building A and the foundation B are in kerf and tenon relationship, in that each has projections and recesses, and each projection of one is disposed opposite a recess of the other. The arrangement, however, is such that a certain distance is kept throughout the opposite contours along the space D between the building A and the foundations B. In this manner, the building A is separated from the foundation B, so that if during an earthquake the foundation B is shaken, the building A is sufficiently remote therefrom so as to permit vertical as well as horizontal movements simultaneously by the foundation B.

Horizontal forces will be taken up in all normal cases, for instance where those forces are due to wind, by sustaining elements F that are provided in the vertical sections of the space D. The sustaining elements F transmit these horizontal forces from the tenons of the building A onto the respective tenons of the foundation B. In the event of a catastrophe, however, for instance during horizontal earthquake movements, and corresponding movements of the foundation B, the sustaining elements F will be overloaded, and will collapse, thereby freeing the relative movement of the foundation B as compared to the building A.

The sustaining elements F preferably are composed of special mixtures of various kinds for instance of the type commercially known as hard foam.

The upper structure or building A transmits its loads through its aforesaid tenons to elastic damper elements E. The material of the damper eleemnts E is so selected that the damper elements E can take up earthquake shocks of a magnitude of 7, 8, 9, or 10 mm. of durations and directions heretofore observed to which the foundation B is

subjected, without transmitting the shocks directly to the building A. The damper elements E are so constructed that while the building A is at rest, the damper elements E will be deformed in accordance with the magnitude of the shocks, such as compressed and shifted, without imparting to the building A the rapidly and strongly increasing reaction forces.

The material of the damper elements E is so selected that it will neither be destroyed nor lastingly (permanently) be deformed in any direction by the aforesaid application of forces. The material has a sufficiently large restoring force to re-establish automatically the original position of the building A relative to the foundation B after the shocks have passed. Means may be provided to prevent the damper elements E from being ejected or even moved from their position relative to the foundation B; for instance, plates with protuberances may be glued onto the damper elements E for that purpose; and the arrangement is such that during the occurrence of horizontal shifting movement, the resulting restoring forces are transmitting from the foundation B to the building A.

In accordance with a preferred embodiment, the damper element E are composed of a special elastic material, such as specially treated natural rubber mixtures, or similar material.

As best shown in FIG. 2, the elastic damper elements E are positioned on stub beams C which in turn are supported by supported means such as movable intermediate layers H which may be composed of any suitable material such as steel or wood. Each damper element E transmits its load, by means of the intermediate removable layers H, onto the foundation B.

Hydraulic presses G may be positioned below the beams C, for the purpose to raise each beam C temporarily, thereby rendering possible to exchange any damper element E that may have been damaged during the preceding catastrophe or which may have lost some of its elasticity through aging. For this purpose, the beam C will be lifted by the hydraulic presses G slightly, and thereupon the operator will remove the intermediate layers H.

Thereafter, the operator will lower the beam C with the aid of the hydraulic pressse G to a position which, however, due to the removal of the intermediate layers H, can now be lower than the beam C had previously occupied. This additional lowering releases the damper element E which can now be removed, and a new damper element E be put in its place instead. Thereafter, the beam C will again be lifted with the aid of the hydraulic presses G, and the intermediate layers H put again into their places. Thus, the new damper element E will be subjected to the load of the building A.

During the aforesaid exchange operation, or an adjusting operation, the building A may be supported from the foundation B by suitable blocks within that part of the space D that is disposed between a tenon of the foundation B and a recess of the building A. This contrasts with the usual supporting arrangement shown in the drawing wherein each supporting damper element E is disposed between a recess of the foundation B and a tenon of the building A.

In the foregoing description, it has been assumed that the building H has walls in two perpendicular directions, as this is the case in most normal high altitude buildings. If these walls extend only in one direction, however, the tenons would need to be profiled accordingly.

We wish it to be understood that we do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

Having thus described the invention, what we claim as new and desire to be secured by Letters Patent is as follows:

1. In a building structure, a foundation and a horizontal barrier supported thereon, shock absorbing means interposed between said foundation and said supported barrier, said foundation including a plurality of spaced upwardly projecting extensions and said barrier including spaced downwardly projecting extensions disposed in the spaces between said upwardly projecting extensions, said shock absorbing means comprising damper elements supported by upwardly facing surfaces in the spaces between said upwardly projecting extensions and engaging the ends of said downwardly projecting extensions, said damper elements being operable to absorb shocks from multiple directions, said shock absorbing means further including sustaining elements disposed between the sides of said upwardly and downwardly projecting extensions, said sustaining elements being adapted to absorb horizontally oriented shocks of a predetermined magnitude and being collapsible under the influence of shocks exceeding said predetermined magnitude, said sustaining elements being capable of replacement upon collapse by elevating said barrier and temporarily removing the load from said foundation.

2. In a building structure, as claimed in claim 1, a stub beam disposed in each of the spaces between said upwardly facing surface and the end of said downwardly projecting extension.

3. In a building structure, as claimed in claim 2, and support means comprising an intermediate layer interposed between each of said upwardly facing surfaces and said stub beam.

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HENRY C. SUTHERLAND, Primary Examiner

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