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Method and device for testing a sheet-like building element with regard to resistance to explosion pressure or earthquake effects for simulating shock waves with a small impetus

Introduction

The invention relates to a method for testing a sheet-like building element with regard to resistance to explosion pressure or earthquake effects for simulating shock waves with a small impetus, having the following method steps:

a) the building element is installed in a holding frame in a force-transferring, pressure-tight manner.

b) the holding frame provided with the building element is assembled on a wall in such a way that a pressure chamber, sealed such that it is pressure-tight with respect to the surroundings is formed between the frame sides of the holding frame, the building element and the wall.

c) at least one pressure vessel is filled with a compressible fluid until a pressure p_B prevails in the pressure vessel which is greater than a surrounding pressure p_U.

d) at least one shut-off element of a shut-off device is transferred from a shut-off position into an open position, as a result of which a free connecting cross section from the pressure vessel to the pressure chamber is created.

e) the transfer of the shut-off element of the shut-off device from the closed position into the open position takes place non-destructively and reversibly, the shut-off device being arranged in at least one connecting line between the pressure chamber and the pressure vessel.

The present invention also relates to a device by which the above-described method can be carried out.

Within the meaning of the present application, “sheet-like building elements” are understood as meaning all building elements which can be used for enclosing spaces. Examples of sheet-like building elements include any type of doors, gates and windows, as well as facade, wall or roof constructions, and parts thereof.

Prior art

The prior art discloses in particular two methods for testing resistance to explosion pressure, by which the tested components can be classified into resistance classes. The first very expensive and complex method is the so-called field trial in which the component to be tested is erected on a suitable terrain and a pressure load is produced by detonating a particular amount of an explosive at a particular distance from the component. DIN EN 13123-2 regulates the requirements and also the classification of EXR1 to EXR5, and DIN EN 13124-2 regulates the test method as such. However, due to the considerable noise and to a significant safety risk to the surroundings, field trials of this type can only be carried out in specific locations, such as in military training areas or the like and furthermore they cannot be carried out in all weather conditions.

The second standard test method is the explosion pressure test on a shock tube, the test sequence of which is regulated by DIN EN 13124-1. The classification of the tested bodies is set out in DIN EN 13123-1. For the test, a tube which is approximately 50 m long with a diameter of approximately 2 m to 3 m is divided into two regions by a steel plate which is clamped over the diameter, pressure being built up in the region of the shock tube which is remote from the test body and is known as the pressure tube, while ambient pressure is present in the region of the shock tube facing the test body. The steel plate dividing the two regions is provided with an explosive charge (for example with an X-shaped detonating cord) which is ignited after enough pressure has built up in the pressure tube, so that the steel plate is destroyed by the explosion and as a result, a connecting cross section from the pressure tube to the tube portion associated with the building element is produced. Consequently, a blast wave moves at great speed through the shock tube onto the building element to be tested and impacts it violently.

Although the detonation of the explosive in the shock tube test takes place inside the shock tube and thus in an area which is closed off from the surroundings, the test setup is very expensive and requires a great amount of space due to the dimensions of the shock tube. Furthermore, the considerable weight of the individual components of the shock tube requires appropriate technical aids during the respective installation of the steel plate, which further complicates the handling of the test setup. A further disadvantage of the shock tube test is that only components which have a diameter or edge dimension of less than approximately 2 m can be tested. Moreover, the steel plate has to be replaced after each test. Finally, in the shock tube test, it is very difficult to observe predetermined climatic conditions with low tolerances, because the test body is usually mounted outside in the open air in front of the steel plate due to the great length of the shock tube.

Numerous methods and devices are known from the prior art for testing characteristics of components, a crack test of a moulding being carried our according to DE 41 07 093 A1 and a tear strength test in paper production being carried out according to US 4 967 602 A.

Documents WO 2011/104126 A1, US 5 197 323 A and US 3 248 924 A are concerned with testing components with regard to explosion pressure, an explosive being ignited to create the pressure. US 2 659 235 is concerned with the ignitability of electric devices and DE 35 16 908 C1 is concerned with testing joint permeability coefficients and resistance to driving rain.

Document DD 151 810 A1 is also concerned with testing joint permeability coefficients and resistance to driving rain, the method also being further distinguished by simulating gusts of wind.

Object

It is the object of the present invention to provide a method for carrying out a test of sheet-like building elements with regard to resistance to explosion pressure or earthquake effects for simulating shock waves with a small impetus, which method is distinguished by a construction which is as economical and as spacesaving as possible and which also allows the simulation of diverse pressure loads. In an analogous manner, the object is also to be set for the device according to the invention.

Achievement

According to the invention, the aforementioned object is achieved in terms of method in that a relief valve connecting the pressure chamber to the surroundings is opened after the shut-off element of the shut-off device has been transferred into the closed position.

Unlike the shut-off device in the shock tube method which consists of a steel plate which is destroyed irreversibly by an explosive charge attached thereto and thus can no longer be used after the test, the shut-off device according to the present invention can be actuated in a destruction-free and reversible manner, which means that, after the pressure load has been created, the shut-off device can be closed again after different periods of time after the opening time and optionally variably in a fast or slow manner. In this way, different courses of a pressure load (peak pressure, pressure gradient, duration of load, etc.) can be simulated. Furthermore, the shut-off device is not replaced at the end of the test, so that after the tested component has been removed and a new component to be tested has been installed, the method according to the invention can be immediately carried out again as soon as the pressure vessel has been adequately refilled.

The shut-off device is located in a connecting line between the pressure vessel and the pressure chamber so that it can be configured, for example as a valve. In the present method, irrespective of the configuration of the shut-off device, a detonating explosive charge is not used; instead, the explosion pressure is simulated by opening the shut-off device, as a result of which the pressure produced in the pressure vessel suddenly passes into the pressure chamber. Thus, dangerous explosive no longer needs to be kept available.

Since an explosive charge and a very long shock tube are not used, it is possible to configure the test setup according to the invention in a significantly more compact manner, since a minimum distance between the shut-off element configured as a steel plate with an explosive charge and the test body and the opposite end of the pressure tube is no longer necessary in the shut-off element. It is thereby possible to reduce the length of the entire test setup to a few metres, whereas the length of the test setup in the shock tube method is usually 50 m. Consequently, the method can be carried out independently of the weather in protected and temperature-controlled spaces due to the lower depth measurement of the pressure chamber. Furthermore, the implementation of the method is not restricted to components of a specific size, in fact it is even possible, with a suitable configuration of the test setup, to carry out the method for components and also for brickwork surrounding them or for a concrete wall surrounding them, so that the connecting situation to the brickwork or to the concrete wall (anchor, angle or other fastening elements), or the brickwork or the concrete wall itself can also be tested for its pressure resistance.

Since a relief valve, connecting the pressure chamber to the surroundings is opened after the shut-off element of the shut-off device has been transferred into the closed position, according to the invention the load time and thereby the impetus for the component to be tested can be limited so that only a very short pressure shock can be simulated.

When the shut-off element is transferred from the open position into the closed position before a pressure equalisation has taken place between the pressure chamber and the pressure vessel, or before the pressure in the pressure chamber starts to fall again, a shock wave with a small impetus can be simulated. The occurrence and the possible effect of reflection processes can also be influenced in a specific manner.

Since the shut-off element performs an opening movement again following a closing movement, preferably after it has been previously transferred into the closed position, it is possible for all kinds of pressure effects to be simulated over a load period of time.

In terms of device, the above object is achieved by a device according to the preamble of claim 4, in which the pressure chamber has a relief valve which is connected to the surroundings and by which pressure in the pressure chamber is partly or completely relieved after the shut-off element of the shut-off device has been transferred into the closed position. By means of this device, it is possible to carry out the previously described method in a particularly simple manner, the advantages described with respect to the method applying analogously to the device.

Unlike the shock tube in which the shut-off device is arranged between the pressure tube and the actual shock tube (portion, at the end of which the test body is located) and thus must have at least the same cross section as the shock tube, the shut-off device according to the present invention is arranged in the at least one connecting line between the pressure vessel and the pressure chamber and can easily be configured as a valve or the like, the connecting line typically having a small-sized diameter.

A pneumatic fitting, in particular a ball valve, for example, is suitable as a shut-off device. In this respect, it is also advantageous if the shut-off device can be actuated by a preferably pneumatic actuating drive.

In respect of a particular flexibility during the laying of the connecting line, it can be advantageous if the connecting line is formed at least in portions by a hose which must of course have a satisfactory pressure resistance.

In order to achieve a relatively rapid pressure rise in the pressure vessel and a pressurisation, as uniform as possible, of the building element, a development of the device according to the invention provides that a plurality of connecting lines, connected in parallel with one another are provided which are each provided with a shut-off device.

However, since the shut-off devices of different connecting lines have to be actuated simultaneously during the course of the test, alternatively it can be advantageous for a plurality of connecting lines, connected in parallel with one another and respectively leading into the pressure chamber, to be connected to a common supply line which emanates from the pressure vessel and in which the shut-off device is arranged. Therefore, with a single shut-off device it is possible to supply a plurality of partial lines which lead into the pressure chamber in different locations.

In the case of a plurality of connecting lines, it is advantageous if mouth cross sections of the connecting lines have a respective distance from one another which amounts to at least 15 %, preferably at least 20 % of a maximum pressure chamber dimension. Due to the arrangement of a plurality of connecting lines to feed the pressure chamber, the pressure provided for the test to be carried out can be achieved faster and can be distributed more uniformly over the surface of the test body than would be the case with only one connecting line. In order to achieve the most uniform possible pressure distribution in the pressure chamber, the mouth cross sections should be at the aforementioned distance from one another.

As already mentioned from a procedural point of view, the device according to the invention can be of a very compact configuration. However, in this respect, it is advantageous if a depth of the pressure chamber, measured vertically to the wall, amounts to at least 10 mm, preferably at least 30 mm, more preferably at least 60 mm, even more preferably at least 120 mm per m^2 surface area of a pressure chamber surface oriented parallel to the wall. Due to this as well, a pressure equalisation is achieved over the surface of the building element, because a lateral outflow of the incoming air from the mouth cross section is facilitated since flow resistances fall.

The cross section of the connecting line or the sum of the cross sections of the connecting lines should advantageously be less than 20 %, preferably less than 15 %, more preferably less than 10 %, still more preferably less than 5 %, still more preferably less than 3 % of a surface of the pressure chamber oriented parallel to the wall. Although an overall great flow cross section reduces the pressure losses because the friction is lower, smaller cross sections have the advantage that the usable shut-off devices are economical and are readily available.

In this respect, the wall can be composed of a plate facing the pressure chamber and of profiles which reinforce said plate on its side remote from the pressure chamber and are connected to the plate, which profiles have a clear spacing from one another of at most 200 mm, preferably at most 100 mm.

A particularly simple and stable construction is achieved when the frame sides of the holding frame are composed of a basic profile formed as a rectangular, U-shaped or double-T profile and of a clamping profile arranged on the side remote from the pressure chamber and preferably formed as a flat profile, the clamping profile preferably projecting above the basic profile in the direction of an opening, defined by the holding frame, and supporting the building element.

According to an embodiment of the device according to the invention, two pressure vessels are provided which are used, either simultaneously or with a time lag, for pressurising the pressure chamber via a respective, associated shut-off device. As a result, a plurality of identical or different peak pressures can be simulated in identical or different periods of time.

The length of the at least one connecting line should advantageously amount to between 1 m and 10 m, preferably between 2 m and 5 m, where the advantage of a small pressure loss with a short length of the connecting line is opposed to the disadvantage of a low flexibility with regard to the position of the pressure chamber relative to the pressure vessel with a short connecting line, so that a particular conflict of interests has to be considered.

Embodiment

The invention will become particular clear by referring to the following embodiments concerning a respective device according to the invention.

Fig. 1: is a vertical sectional view through a pressure chamber of a first device according to the invention,

Fig. 2: is a view of a wall of the pressure chamber according to Fig, 1,

Fig. 3: is a horizontal sectional view through the pressure chamber according to Fig, 1,

Fig. 4: is a horizontal sectional view through an alternative pressure chamber with a wall part, and

Fig. 5: is a schematic compressed air connection diagram of the device according to figures 1 to 4.

Fig. 1 is a vertical sectional view through a pressure chamber 6 of a device 1 according to the invention for testing the resistance of a building element 2, configured as a steel security door 14, to a pressure effect. The device 1 comprises a holding frame 3 which is composed of four frame sides each in the form of a square tube. The steel security door 14 is fastened peripherally to the holding frame 3 by anchor-type fastening means which will not be described here in detail. The holding frame 3 is connected by screws 4, distributed over the periphery thereof, to a wall 5 which is arranged at a distance parallel to the holding frame 3, and in order to create a fluid-tight pressure chamber 6, arranged between the wall 5 and the holding frame 3 is a chamber frame 7 which is positioned aligning with the holding frame 3 and is also constructed analogously to the holding frame 3. Sealing strips 8 which are 3 mm thick are respectively provided peripherally between the wall 5 and the chamber frame 7 and also between the chamber frame 7 and the holding frame 3. In Fig. 1, in this way a pressure chamber 6 is produced which, when the steel security door 14 is installed, has for example a depth T corresponding to the depth of the chamber frame 7 of 120 mm.

For reasons of greater rigidity, provided peripherally on the side of the holding frame 3 remote from the chamber frame 7 is a flat profile 9 which aligns outwardly with the holding frame 3 and projects inwardly above the holding frame 3 and, in the event of the fastening means failing, would prevent the building element 2 from being flung out of its holding frame 3.

The wall 5 which forms the back wall of the pressure chamber 6 and is formed by a 10 mm thick steel plate is reinforced on its side, remote from the pressure chamber 6 by profiles 10 which extend horizontally over the width of the device 1 and are formed from steel tube profiles, and profiles 10 running above one another have a clear spacing of 120 mm from one another. The profiles 10 are welded on the edge over their entire length with the rear side of the wall 5.

Fig. 2 shows a rear view of the pressure chamber 6 according to Fig. 1, in which it is possible to see the wall 5 with the horizontally running profiles 10 and the screw connection of the wall 5 to the chamber frame 7, to the holding frame 3 and to the flat profile 9. A dashed line 11 represents the inside contours in each case of the frame sides.

Arranged mid-height of the device 1 are three mutually spaced apart welded nipples 12 to which a connecting line (not shown) to a pressure vessel (also not shown) is respectively connected to supply the pressure chamber 6 with the pressure provided for carrying out the test. The connecting lines can be pipelines and/or hoses which are either respectively fed from the pressure vessel or are firstly merged into a supply line, the supply line leading to the pressure vessel which, in this case, contains a single shut-off element.

Depending on the type of pipeline guidance, either all the connecting lines or the connecting line have/has a shut-off element (not shown in the figure), for example in the form of a ball valve, by which the supply of pressure to the pressure chamber 6 can be initiated, stopped or re-initiated. Before a test is carried out, pressure is produced in the pressure vessel for example by a compressor (not shown) and after reaching the required pressure, the shut-off element or elements are opened, so that the pressure wave of an explosion is simulated in the pressure chamber.

In addition to the three welded nipples 12, the pressure chamber 6 also has a relief valve (not shown) which is preferably also arranged in the wall 5 of the device 1 and via which the pressure in the pressure chamber 6 can be partly or completely relieved. A pressure relief of this type is necessary in order to limit the duration of the pressure effect on the building element which is to be tested.

Fig. 3 is a horizontal sectional view through the pressure chamber 6 according to Fig. 1, where it can be seen that the steel security door 14 to be tested is fitted with a side part which is not shown due to the section in the vertical sectional view according to Fig. 1. Here, the chamber frame 7 is welded together with the wall 5.

Fig. 4 is a horizontal sectional view through an alternative pressure chamber 6′ according to the present invention, which pressure chamber only differs from the pressure chamber 6 according to Fig. 1 in that the building element 2′ to be tested is a wood window 14′ with a brickwork 15 surrounding it, as well as connecting means between the wood window 14′ and the brickwork 15.

Finally, Fig. 5 is a pneumatic connection diagram of a test setup, for example with a pressure chamber according to Fig. 1, the connecting lines 16 from the pressure chamber 6 to one or two pressure vessels 17-1, 17-2 being shown schematically. Leading out from the two pressure vessels 17-1, 17-2 is a respective supply line 18 via three connecting lines 16 in each case, into the pressure chamber 6, altogether all 6 connecting lines each being fitted with a shut-off element 19. Alternatively, it is also possible for the two supply lines to each be fitted with a shut-off element so that the requirements for the precision of a simultaneous actuation of the shut-off elements 19 located in the connecting lines 16 can be reduced, though a single relatively large and thus relatively expensive shut-off element has to be used.

The pressure vessels 17-1, 17-2 are each fed with compressed air by a compressor 20 (or alternatively by a single common compressor), the shut-off elements 19 remaining in the blocking position until an adequate pressure is attained in one or both pressure vessels 17-1, 17-2. For testing the building element 2, either the compressed air of one pressure vessel 17-1 or 17-2 can be used, or the compressed air of both pressure vessels 17-1, 17-2 can be used simultaneously. An alternative test of the building element 2 can also provide that the building element 2 can firstly be subjected to the compressed air of one pressure vessel 17-1 and, after the pressure chamber 6 has been relieved of pressure via a relief valve 21, the building element is subjected to the compressed air of the second pressure vessel 17-2 in order to simulate a second pressure wave which impacts with a time lag.

The shut-off elements 19 and the relief valve are controlled by a control device 22 which can be operated or programmed via a computer 23.

In order to check the pressure in the pressure chamber 6, said pressure chamber is fitted with at least one pressure sensor 24, the recorded data of which are detected by the control unit 22 for checking purposes. In the computer 23, it is possible to save the control times for different test procedures which can differ in respect of the maximum pressure, the pressure gradient in the rise phase and fall phase, the impetus, the exposure time and also the use of the pressure vessels. By appropriately setting the aforementioned parameters, it is thus possible to carry out an earthquake simulation in which light to heavy pressure loads occur recurrently over a relatively long period of time. Furthermore, by appropriately setting the parameters, accidents in refining can be simulated, the load of which is characterised by a slow build-up of pressure (low gradient) with a low peak pressure and a long exposure time.

The reference signs in the figures represent the following:

1	device
2, 2′	building element
3	holding frame
4	screw
5	wall
6, 6′	pressure chamber
7	chamber frame
8	sealing strip
9	flat profile
10	profile
11	dashed line
12	welded nipple
13	side part
14	steel security door
14′	wood window
15	brickwork
16	connecting line

17-1, 17-2	pressure vessel
18	supply line
19	shut-off element
20	compressor
21	relief valve
22	control device
23	computer
24	pressure sensor
T	depth

Patentkrav

1. Fremgangsmåde til at teste et fladt bygningselement (2, 2') med hensyn til modstand over for eksplosionstryk eller jordskælvsvirkninger til at simulere chokbølger med små stød under anvendelse af de følgende fremgangsmådetrin:

a) bygningselementet (2, 2') er installeret i en fastholdelsesramme (3) på en kraft-overførende, tryktæt måde,

b) fastholdelsesrammen (3) forsynet med bygningselementet (2, 2') monteres på en væg (5) på sådan en måde at et trykrum (6, 6') forseglet tryktæt med hensyn til omgivelserne er dannet mellem rammesiderne af fastholdelsesrammen (3), bygningselementet (2, 2') og væggen (5),

c) mindst en trykbeholder (17-1, 17-2) fyldes med en komprimerbar væske, indtil et tryk p_B dominerer i trykbeholderen (17-1, 17-2) der er større end et omgivende tryk p_U,

d) mindst et afspærringselement (19) af en afspærringsindretning overføres fra en afspærringsposition til en åben position, som resultat hvoraf et frit forbindelsestværsnit fra trykbeholderen (17-1, 17-2) til trykrummet (6, 6') dannes.

e) overførslen af afspærringselementet (19) af afspærringsindretningen fra den lukkede position til den åbne position sker ikke-destruktivt og reversibelt, hvor afspærringsindretningen er indrettet i mindst en forbindelseslinje (16) mellem trykrummet (6, 6') og trykbeholderen (17-1, 17-2),

kendetegnet ved følgende fremgangsmådetrin:

f) en sikkerhedsventil (21) der forbinder trykrummet (6, 6') med omgivelserne åbnes efter afspærringselementet (19) af afspærringsindretningen er blevet overført til den lukkede position.

2. Fremgangsmåde ifølge krav 1, **kendetegnet ved at** afspærringselementet (19) er overført fra den åbne position til den lukkede position inden en trykudligning har fundet sted mellem trykrummet (6, 6') og trykbeholderen (17-1, 17-2) eller inden trykket i trykrummet (6, 6') begynder at falde igen.

3. Fremgangsmåde ifølge et hvilket som helst af kravene 1 eller 2, **kendetegnet ved at** afspærringselementet (19) udfører en åbningsbevægelse igen efter en lukningsbevægelse, fortrinsvis efter den tidligere er blevet overført til den lukkede position.

4. Indretning (1) til at teste et fladt bygningselement (2, 2') med hensyn til modstand over for eksplosionstryk eller jordskælvsvirkninger til at simulere chokbølger med lav impuls omfattende

a) en fastholdelsesramme (3) hvorpå bygningselementet (2, 2') kan fastgøres på en kraft-overførende, tryktæt måde,

b) en væg (5), hvorpå fastholdelsesrammen (3) kan monteres på sådan en måde at et trykrum (6, 6') forseglet tryktæt med hensyn til omgivelserne er dannet mellem rammesiderne af fastholdelsesrammen (3), bygningselementet (2, 2') og væggen (5),

c) en trykbeholder (17-1, 17-2), der kan fyldes med et komprimerbart medie op til et tryk p_B der er større end det omgivende tryk p_U,

d) mindst en forbindelseslinje (16), der fører fra trykbeholderen (17-1, 17-2) til trykrummet (6, 6') og

e) en afspærringsindretning omfattende et afspærringselement (19) der, i en lukket position af afspærringselementet (19), adskiller trykbeholderen (17-1, 17-2) og trykrummet (6, 6') fra hinanden med hensyn til tryk og, i en åben position af afspærringselementet (19), frigør et forbindelsestværsnit,

f) afspærringselementet (19) kan overføres fra den lukkede position til den åbne position og vice versa og afspærringsindretningen er indrettet i den mindst ene forbindelseslinje (16),

kendetegnet ved at

g) trykrummet (6, 6') omfatter en sikkerhedsventil (21) der er forbundet med omgivelserne, der er udformet til delvist eller fuldstændigt at lette trykket i trykrummet (6, 6') efter afspærringselementet (19) i afspærringsindretningen er blevet overført til den lukkede position.

5. Indretning ifølge krav 4, **kendetegnet ved at** afspærringsindretningen er et pneumatisk armatur, især en kuglehane.

6. Indretning ifølge krav 4 eller 5, **kendetegnet ved** en fortrinsvis pneumatisk drivmekanisme hvormed afspærringsindretningen kan aktiveres.

7. Indretning ifølge et hvilket som helst af kravene 4 til 6, **kendetegnet ved at** forbindelseslinjen (16) er udformet mindst i sektioner med en slange.

8. Indretning ifølge et hvilket som helst af kravene 4 til 7, **kendetegnet ved at** en flerhed af forbindelseslinjer (16) forbundet parallelt med hinanden hver er forsynet med en afspærringsindretning.

9. Indretning ifølge et hvilket som helst af kravene 4 til 7, **kendetegnet ved at** en flerhed af forbindelseslinjer (16) der er forbundet parallelt med hinanden og der hver kommer ind i trykrummet (6, 6') er forbundet med en fælles forsyningslinje (18) der kommer fra trykbeholderen, i hvilken forsyningslinje afspærringsindretningen er indrettet.

10. Indretning ifølge et hvilket som helst af kravene 4 til 9, **kendetegnet ved at** mundstykketværsnittene af forbindelseslinjerne (16) hver har en afstand fra hinanden, der er mindst 15 %, fortrinsvis mindst 20 % af en maksimal trykrumsdimension.

11. Indretning ifølge et hvilket som helst af kravene 4 til 10, **kendetegnet ved at** en dybde (T) af trykrummet (6, 6') målt vinkelret på væggen (5) er mindst 10 mm, fortrinsvis mindst 30 mm, mere fortrinsvis mindst 60 mm, endnu mere fortrinsvis mindst 120 mm pr. m^2 areal af en trykrumsoverflade opstillet parallelt med væggen (5).

12. Indretning ifølge et hvilket som helst af kravene 4 til 11, **kendetegnet ved at** tværsnittet af forbindelseslinjen (16) eller summen af tværsnittene af forbindelseslinjerne (16) er mindre end 20 %, fortrinsvis mindre end 15 %, mere fortrinsvis mindre end 10 %, endnu mere fortrinsvis mindre end 5 %, stadig mere fortrinsvis mindre end 3 % af et areal af trykrummet (6, 6') opstillet parallelt med væggen (5).

13. Indretning ifølge et hvilket som helst af kravene 4 til 12, **kendetegnet ved at** væggen (5) består af en plade der vender mod trykrummet (6, 6') og profiler (10) der forstærker den sidstnævnte på dens side der vender væk fra trykrummet (6, 6') og forbundet med pladen, idet profilerne har en tydelig afstand mellem hinanden på højest 200 mm, fortrinsvis højest 100 mm.

14. Indretning ifølge et hvilket som helst af kravene 4 til 13, **kendetegnet ved at** rammesiden af fastholdelsesrammen (3) består af en grundprofil udformet som en rektangulær, U-formet eller dobbelt-T-formet profil og en fastspændingsprofil indrettet på den side der vender væk fra trykrummet (6, 6') og fortrinsvis udformet som en flad profil (9), hvor fastspændingsprofilen rager ud over grundprofilen i retningen af en åbning defineret af fastholdelsesrammen (3) og støtter bygningselementet (2).

15. Indretning ifølge et hvilket som helst af kravene 4 til 14, **kendetegnet ved** to trykbeholdere (17-1, 17-2) der, ved hjælp af en tildelt afspærringsindretning i hvert tilfælde, anvendes enten samtidigt eller med en tidsforskydning ved udsættelsen af trykrummet (6, 6') for tryk.

16. Indretning ifølge et hvilket som helst af kravene 4 til 15, **kendetegnet ved at** længden på den mindst ene forbindelseslinje (16) er på mellem 1 m og 10 m, fortrinsvis mellem 2 m og 5 m.

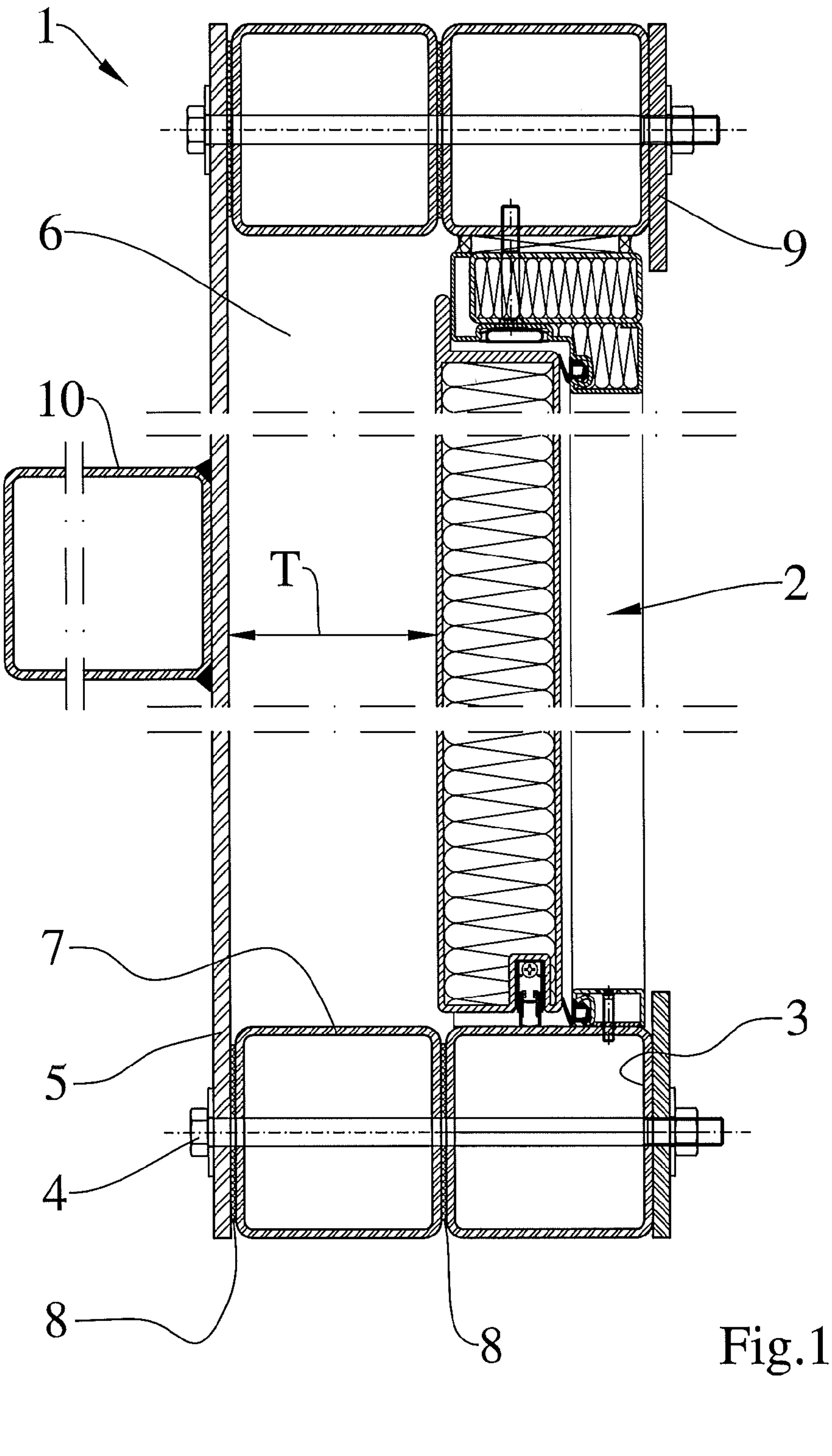

Fig.1

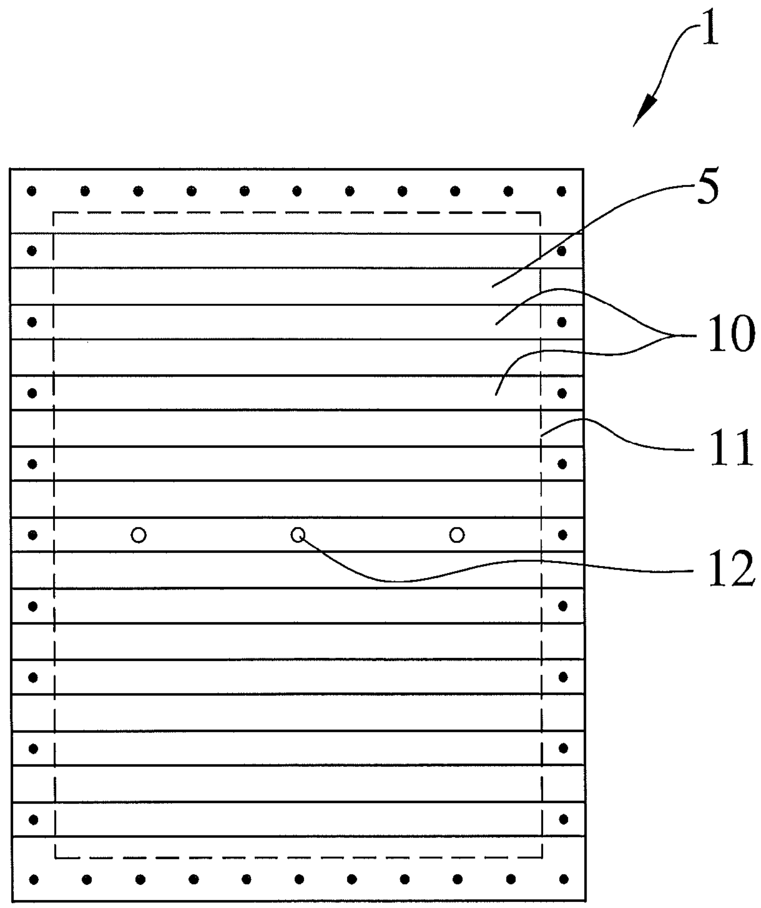

Fig.2

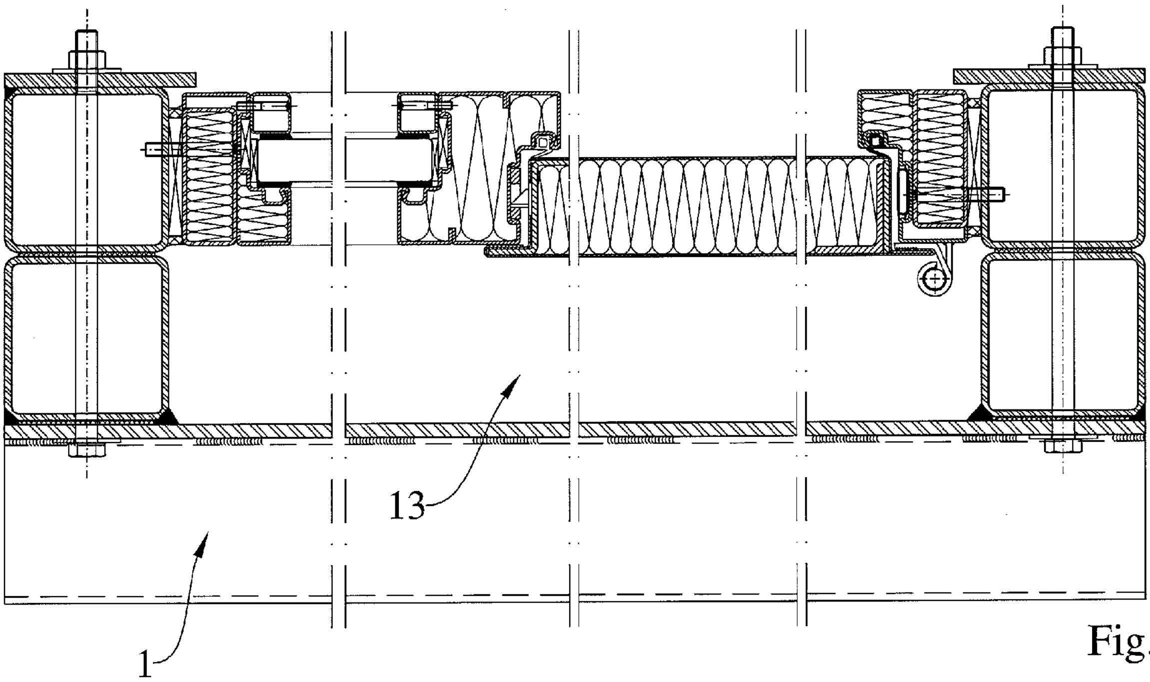

Fig.3

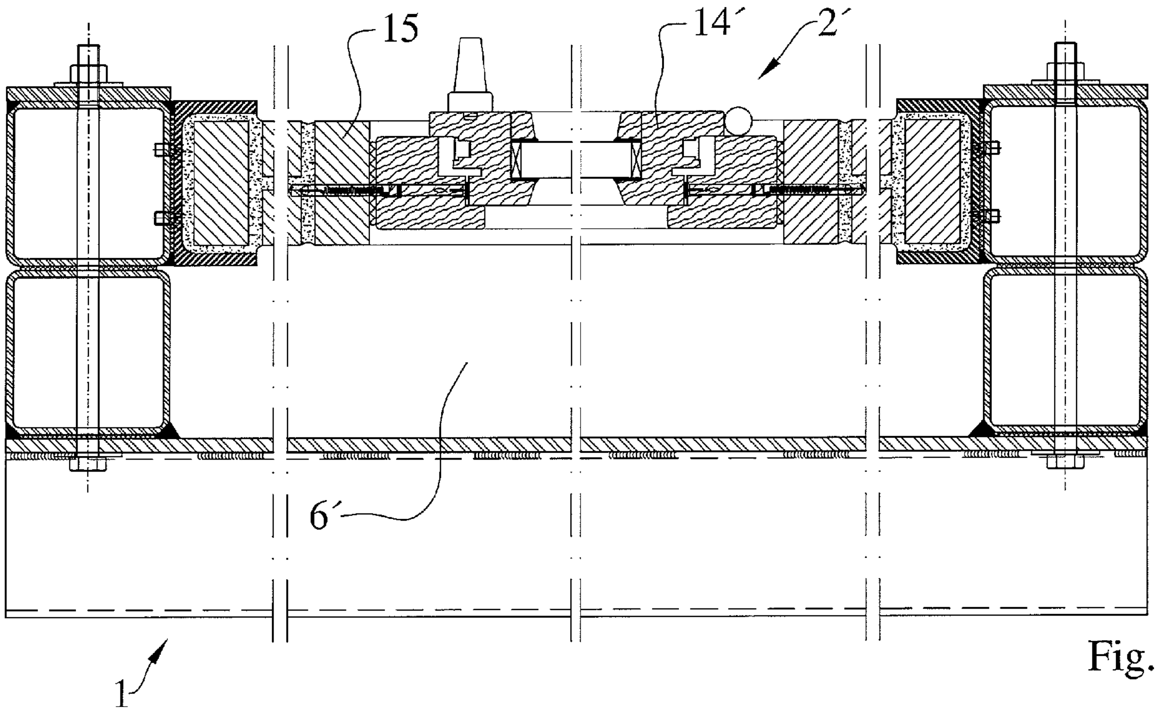

Fig.4

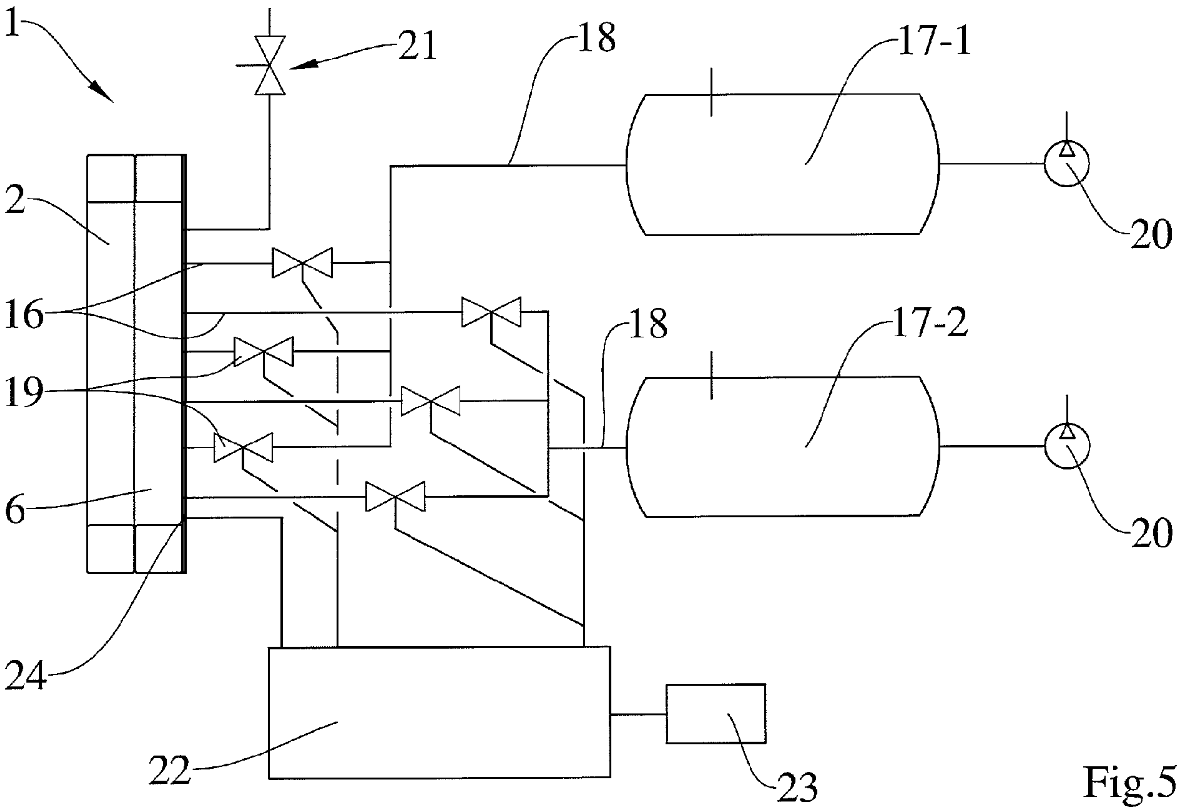

Fig.5