A flood protection barrier for a structure (2) is disclosed. The barrier (22) is adapted to overlie at least a portion of the outer skin of the structure (27) in the region where the structure engages with the ground (12). The barrier (22) comprises at least one impermeable sheet (58) and at least one seal means (26, 28), in which each impermeable sheet (58) is flexible, and at least one seal means (26, 28) is a means adapted to reversibly form a substantially watertight seal between an impermeable sheet (58) and at least one of the structure (2), the ground (12), or an impermeable sheet (58). The impermeable sheet (58) is sufficiently flexible to be elastically deformed by the hydrostatic pressure exerted by water (14) flooding the ground (12) adjacent to the structure to substantially conform with the contours of the structure’s skin overlain by the impermeable barrier (22).
FIG. 5
FLOOD PROTECTION APPARATUS

[0001] This invention relates to flood protection apparatus, and in particular, to apparatus for protection of buildings and other structures during flooding.

[0002] There have been numerous proposals for apparatus to prevent the ingress of flood water into a structure such as a building or some other ground level structure such as a sceptic tank. Generally, such proposals teach of means to seal the apertures in the skin of the building. Some alternative flood water prevention systems are designed for use in areas where extreme weather conditions include hurricanes and similar high winds at the same time as flooding. Such systems incorporate structurally rigid and heavy barriers to prevent the ingress of both water and wind. Both of these general types of flood barriers have disadvantages.

[0003] U.S. Pat. No. 4,488,386 (Thompson) teaches the use of a one piece, effectively tubular, flood shield assembly comprised of waterproof material of which one edge is affixed to the foundation of a building and the other edge may be drawn up the side of the building and attached to the building. Such an assembly would be very difficult and awkward to deploy especially if it were being deployed by one or a small number of people. Furthermore, the assembly described does not work if it is not possible to completely surround the whole of the building to be protected.

[0004] According to the present invention there is provided a flood protection barrier for a structure in which the barrier is adapted to overlie at least a portion of the outer skin of the structure in the region where the structure engages with the ground. The flood protection barrier is comprised of at least one impermeable sheet and at least one seal means, in which each impermeable sheet is flexible, and at least one seal means is a means adapted to reversibly form a substantially water-tight seal between an impermeable sheet and at least one of the skin of the structure, the ground, or an impermeable sheet, and in which the impermeable sheet is sufficiently flexible to be elastically deformed by the hydrostatic pressure exerted by water flooding the ground adjacent to the structure to substantially conform with the contours of the portion of the structure's skin overlain by the impermeable barrier.

[0005] It should be understood that in this context “ground” means the surface adjacent to a structure on/or in which the structure may be considered to rest.

[0006] It is advantageous to have a flood barrier which covers at least a portion of the outer skin of a structure in the region where the structure engages with the ground, rather than a flood barrier which simply seals apertures in the skin of the building, such as doors and windows. This is because a barrier of the present invention not only prevents ingress of water into the structure via such apertures, but also prevents permeation of water through the skin of the structure itself if the skin of the structure is permeable. For example, the bricks of which an average house is constructed are permeable, as is the mortar used to bind the bricks together. When water under hydrostatic pressure bears against such bricks and/or mortar water will pass through those substances, albeit not at a very high rate of flow.

[0007] Where the ground adjacent to a structure is flooded for a substantial period of time, possibly some days or weeks, a considerable amount of water could permeate through the skin of a building if a barrier according to the present invention were not provided. Any cracks in the skin of the building (whether pre-existing or caused by the flooding) will allow a greater rate of flow of water. This permeating water can cause damage to the structure of the building and its contents.

[0008] A further advantage of using a flood barrier which covers at least a portion of the outer skin of the structure is that it avoids the need to provide a separate aperture closure means for each door, window, air brick, ventilation grating, waste pipe outlet, etc in a building. This lessens the risk that an aperture may be forgotten about when the flood protection apparatus is deployed. Failure to close every aperture may have the effect of negating the purpose of closing any aperture.

[0009] The flood barrier of the present invention is particularly advantageous because the elastically deformable nature of the impermeable sheet has the effect that when there is flooding and a barrier of the present invention is in position, the hydrostatic forces exerted by the flood water against the barrier do not have to be resisted by the barrier, but are transmitted to the structure. This results in the barrier being capable of being constructed of a material which, unsupported, may not be sufficiently strong to resist the expected hydrostatic forces from the flood water. Thus, the barrier of the present invention may be considerably lighter than would otherwise be the case. This is particularly advantageous because the erection of a barrier of the present invention does not require either lifting equipment or a particularly strong individual. Thus, the barrier of the present invention may be deployed by non-specialists, and in particular, the owner or occupant of a structure.

[0010] A further advantage of the flood barrier of the present invention is that when the hydrostatic pressure exerted by flood water has caused the impermeable sheet to substantially conform with the contours of the structure's skin, the impermeable sheet may form a seal with the surface of the structure itself. This seal may not be completely water-tight but may at least limit the amount of water running down the outer skin of the structure above the barrier and then between the barrier and the skin of the structure.

[0011] There may be some instances where it is not desirable that the hydrostatic forces exerted by the flood water are wholly or partially transmitted via the barrier against certain portions of the structure. For example, where there is a window covered by the flood barrier of the present invention. Where this is the case, a cover may be placed over the aperture against which the hydrostatic pressure may act. For example, the aperture could be covered by a metal plate or any other suitably strong sheet structure. Alternatively, the impermeable sheet may incorporate rigid strengthening elements. Most preferably said elements are parallel to each other, and orientated on or in the sheet in such a fashion that the impermeable sheet may be conveniently stored. The strengthening elements are preferably bars with a cross section that has a high resistance to bending.

[0012] The sealing of the flood barrier of the present invention against the skin of the structure overlain by the flood barrier caused by the presence of flood water may, in addition to preventing the ingress of water into the structure,
also increase the security of the structure whilst flooding is taking place. This is because the flood barrier may serve to prevent potential intruders from gaining access to the inside of the structure because, for example, the doorways into that structure are blocked by the flood barrier of the present invention.

[0013] It is most preferred if the impermeable sheet of the present invention is a laminate comprising at least one layer of an impermeable material and at least one layer of a strengthening material. Most preferably, the barrier is configured so that, in use, the face of the impermeable sheet remote from the structure is comprised of a layer of strengthening material. This has particular benefit because the strengthening material will serve to protect the impermeable layer or layers from damage caused by floating or water borne objects or materials such as stone, grit and mud carried by flood waters.

[0014] The most preferred impermeable material for use in constructing the impermeable sheet is butyl rubber. Other impermeable materials may be used and may be more appropriate in certain circumstances. The most preferred strengthening material where present is a woven fabric or similar mesh-like substance. A particularly preferred strengthening material is canvas.

[0015] In a preferred embodiment of the present invention, at least one of the first seal means of the flood protection barrier is comprised of a rigid seal bar fixed to the skin of the structure or to the ground adjacent to the structure, and a seal portion of the impermeable sheet. In one preferred embodiment the seal portion of the impermeable sheet is configured to be reversibly fixed in position in a channel, the walls of which are defined by the seal bar. It is most preferred that the fixation of the seal portion of the impermeable sheet in position in the channel causes the formation of a substantially watertight seal between the seal bar and the impermeable sheet. In one embodiment of this preferred embodiment, the channel is dimensioned in cross section such that the mouth of the channel is smaller than at least a portion of the channel.

[0016] The channel defined by the seal bar may have a cross section substantially the same as an angular “C”, an oval, a pear shape, a frustoconical shape or any other shape. Most preferably, the channel is substantially oval in cross section with a mouth in the curved end of the oval such that one end of the major axis of the oval coincides with the mouth. The mouth is preferably sufficient dimension to either allow the insertion and removal of the seal portion of the impermeable sheet into and out of the channel, or to allow the seal portion of the impermeable sheet to be moved longitudinally along the channel so moving a portion of the impermeable sheet longitudinally along the mouth of the channel.

[0017] In one embodiment, the seal portion in the impermeable sheet may be configured to be expandable from a size capable of passing through the mouth of the channel or moving along the channel to a size that causes the seal to engage with the inside walls of the channel. Expansion of the seal portion has the effect that the seal portion is fixed in position relative to the seal bar and it engages with the inside walls of the channel so that it may not pass through the mouth of that channel. The expansion creates a water-tight seal between the impermeable sheet and the walls of the channel.

[0018] In this embodiment it is most preferable that the seal portion of the impermeable sheet is comprised of a gastight envelope provided with at least one inflation means in which the envelope is configured and constructed to expand to substantially fill the channel and to engage with the walls thereof when inflated. Inflation is preferably by the introduction of gas into the envelope. The gas introduced into the envelope may be of any nature, although for safety reasons it is preferred that it is not volatile.

[0019] The inflation gas may be pumped into the envelope, or be introduced from a pressurised gas source. In an alternative embodiment, the envelope is compartmentalised into two or more independently inflatable compartments. In this embodiment, each of the compartments is provided with an inflation means. The most preferred method of introducing gas into the envelope is via a gas-tight valve.

[0020] Where the seal means is an inflatable envelope, that envelope may be formed by creating a longitudinal tube along an edge of an impermeable sheet and sealing the seam and both ends of that tube in a gas-tight fashion. Alternatively, the seal portion of the impermeable sheet may be constructed independently from the sheet and subsequently permanently fixed to the sheet.

[0021] In an alternative embodiment, at least one of the walls of the channel defined by the seal bar is so configured that the wall may be inflated and deflated between a first deflated position wherein the movement of the seal portion of the impermeable sheet into or out of or along the channel is impeded and a second inflated position wherein the seal portion of the impermeable sheet in the channel is gripped by the walls of the channel and thus fixed in position relative to the seal bar. The gripping of the seal portion is preferably of sufficient force to create a water-tight seal between the walls of the channel and the seal portion.

[0022] The inflatable portion or portions of the wall or walls of the channel are most preferably comprised of a gas-tight inflatable portion provided with at least one inflation means in which the or each inflatable portion is configured and constructed to respectively expand to substantially fill the channel, or fill a sufficient portion of the channel so that when all the inflatable portions are inflated the channel is substantially filled. Inflation is preferably by the introduction of gas into the or each inflatable portion. The gas may be of any nature, although for safety reasons it is preferred that it is not volatile. The inflation gas may be pumped into the or each inflatable portion or be introduced from a pressurised gas source. In an alternative embodiment, the or each inflatable portion is compartmentalised into two or more independently inflatable compartments. In this embodiment, each of the compartments is provided with an inflation means. The most preferred method of introducing gas into the or each inflatable portion is via a gas-tight valve.

[0023] In this embodiment it is preferred that the seal portion of the impermeable sheet is configured in such a fashion as to inhibit the seal portion from being pulled out of the mouth of the channel when the inflatable portions are inflated. A possible configuration of the seal portion of the impermeable sheet is to cause the edge of the sheet to be a bead, a lip, or a wedge shaped (with the thickest portion of the wedge at the edge of the sheet) cross sectioned thickening extending along the edge of the sheet. In this embodiment, it is particularly preferred that the channel is substan-
tially frustoconical in cross section with the mouth of the channel coinciding with the narrowest portion of the frustoconical shape, and the walls of the channel sloping towards the mouth are both configured as inflatable portions. With such a configuration, and when the seal portion of the impermeable sheet is configured to be wedge shaped (as discussed above), any force trying to pull the impermeable sheet out of the channel causes the seal between the channel walls and the impermeable sheet to become stronger as the force pushing the two together increases.

[0024] The channel defined by the seal bar may further include a sub channel along which the ends of strengthening elements may travel in this embodiment, the sub channel and the end of a strengthening element adapted to engage therein is so configured that the end of the strengthening element may not be pulled out of the mouth of the channel extending longitudinally along the seal bar.

[0025] The flood barrier of the present invention may be further provided with a storage means. That storage means may be located in the region of the intersection of the structure’s skin and the ground, or it may be attached to the skin of the structure at some other position. When the storage means is attached to the skin of the structure it is preferably attached so as to extend substantially vertically upwards from the intersection of the structure’s skin and the ground.

[0026] When the storage means is located in the region of the intersection of the of the structure’s skin and the ground it preferably has a longitudinal extent substantially equal to the longitudinal extent of the face or faces of the structure to be overlain by the barrier. The storage means may be sunk into a trench in the ground. This renders the storage means unobtrusive and serves to protect the storage means. Alternatively, the storage means may be fixed to the skin of the structure adjacent to the ground and a substantially water-tight seal formed between the storage means and the skin. When storage means is present, the second seal means is adapted to reversibly form a substantially water-tight longitudinally extending seal between the impermeable sheet and the storage means.

[0027] When the storage means is attached to the skin of the structure and is extending substantially vertically upwards from the intersection of the structure’s skin and the ground then the storage means preferably has a longitudinal extent substantially equal to or greater than the height of the portion of the structure that is to be overlain by the impermeable sheet.

[0028] The storage means is preferably constructed and configured to contain the impermeable sheet when not in use and to allow the impermeable sheet to be moved between a stored configuration within the storage means, and a deployed configuration wherein it overlies the skin of the structure.

[0029] In either of the two above alternatives, the storage means is preferably provided with means to substantially prevent flood water passing through the storage means and thus around an edge of the impermeable sheet.

[0030] It is most preferred that the storage means comprises a trough of substantially “U” shaped cross section, and a lid suitable for closing the mouth of the “U”. The lid is wholly removable, hinged to one edge of said “U”, or hinged to a different portion of said “U”. It is most preferred that the lid of the storage means is so configured that when the impermeable sheet is deployed, closing the lid of the storage means creates a substantially water-tight seal between the storage means and the impermeable sheet, and a substantially water-tight seal between the lid and the trough of the storage means.

[0031] It is further preferred that the trough and lid of the storage means and each seal means where the edge of an impermeable sheet is sealed to a second impermeable sheet or the outer skin of the structure (the first seal means) are so adapted that closure of the lid of the trough causes a substantially water-tight seal to be created between the storage means and an end of the first seal means adjacent to the trough of the storage means.

[0032] When the first seal means of the present invention is composed of a seal bar defining a channel, and the seal portion of the impermeable sheet is comprised of one or more inflatable envelopes, it is preferable that the seal bar adjacent the storage means is so configured that only a portion of the channel is defined by the seal bar, and that the partially defined channel is located so that closure of the lid of the storage means causes an edge of the lid to engage with the seal portion of the impermeable sheet.

[0033] Most preferably, the channel is so configured that the portion of the seal portion of the impermeable sheet is pinched between the edge of the lid and the partially defined portion of the channel. It is particularly preferred that at the position where the lid pinches the seal portion of the impermeable sheet there is an insert in the channel. The insert is preferably configured to include a pinch face against which the seal portion of the impermeable sheet may be pinched. The seal may further include a support slope extending between the pinch face and the wall of the channel onto which the insert is affixed. The insert may either be integral with the seal bar or, more preferably, fixed to the seal by a suitable, substantially water-tight, means such as by adhesive. The insert is most preferably of a material that is elastically deformable.

[0034] The lid to the storage box may be a single unit, or may be formed of two or more elements which might be hinged or otherwise joined together.

[0035] In a particularly preferred embodiment of the present invention, the impermeable sheet is stored in the storage means as a roll about an axle mounted in the storage means. When the impermeable sheet is moved to a deployed position it is unrolled from the axle. When the impermeable sheet is to be returned to its stored position from the deployed position it is rolled back onto the axle.

[0036] The flood barrier of the present invention is preferably further provided with one or more support means in which said support means are so located and configured that they hold the impermeable sheet loosely against the skin of the structure whilst deploying the flood barrier according to the present invention and/or when there is no flood water flooding the ground adjacent to the structure. This prevents the impermeable sheet slumping and not being in the correct position when flooding occurs. One preferred support means is a number of peg holes into the skin of the structure which are so located to correspond with eyelets in the vertically uppermost portion of the impermeable sheet when in use.
The eyelets are aligned with the peg holes and pegs pushed through the eyelets into the peg holes so as to retain the impermeable sheet in position. Alternative support means, but which operate in substantially the same fashion, may be burr fasteners—the male part thereof being attached to either the skin of the structure or the impermeable sheet and the female part of the burr fastener being attached to the other of the impermeable sheet or the skin of the structure, or vice versa; or the incorporation of one or more magnets into one or both of the skin of the building and the impermeable sheet, if one or more magnets are incorporated into only one of the building skin and the impermeable sheet then a material that is attracted to a magnet is incorporated into the other of the building skin and the impermeable sheet.

[0037] In an alternative embodiment, the preferred support means is a cross bar engaged with the edge of the impermeable sheet which vertically uppermost when deployed. That cross bar is preferably of a cross section which is resistant to bending of the cross bar in the direction that the impermeable sheet would pull the cross bar. The cross bar may be provided with one or more support legs. Most preferably each support leg is hinged to the cross bar and may rotate about the hinge from a position substantially parallel to and adjacent to the cross bar, to a position where the end of the support leg remote from the hinge engages with the ground. In the latter ground engaging position, the support leg may help prevent bending of the cross bar. Incorporation of the support legs into the apparatus of the present invention allows the use of a longer cross bar than might otherwise be possible without increasing the cross sectional size, and thus the weight, of the cross bar.

[0038] The flood barrier of the present invention may be comprised of a flexible sheet constructed to have the dimensions of the entire portion of the skin of the structure to be overlain. Alternatively, and more preferably, the impermeable sheet of the flood barrier of the present invention may be constructed from a plurality of impermeable sheets joined to one another so as to form a single impermeable sheet of appropriate dimensions. It is preferred that the impermeable sheet of the flood barrier be constructed from a number of smaller impermeable sheets because it renders the storage, transportation and erection of the flood barrier of the present invention easier.

[0039] The means of joining the individual impermeable sheets is one that forms a substantially water-tight joint. In one preferred embodiment, a means for joining individual impermeable sheets is a waterproof zip. An alternative preferred embodiment is to employ a removable seal bar configured and constructed from a pair of first seal means as described above. Both of said first seal means are incorporated into a single combined seal bar. The combined seal bar may optionally be fixed to the skin of the structure. An advantage of this alternative embodiment is that the combined seal bar will help support the impermeable sheets in position until flood water causes the impermeable sheets to be pushed against the skin of the structure. A further advantage is that because the seal bar does not need to be fixed to the structure, the apparatus of the present invention can be used in locations where it would be unacceptable to fix a seal means permanently to the skin of the structure.

[0040] The present invention will be further described and explained by way of example with reference to the accompanying drawings in which:

[0041] FIG. 1 shows a first building surrounded by a first embodiment of a flood barrier according to the present invention;

[0042] FIG. 2 shows the details of a flood barrier of a first embodiment of the present invention of FIG. 1 along section A-A';

[0043] FIG. 3 shows the frontage of a second building protected by a second embodiment of a flood barrier according to the present invention;

[0044] FIG. 4 shows details of the flood barrier of FIG. 3 along section B-B';

[0045] FIG. 5 shows details of an alternative embodiment of the flood barrier of FIG. 3 along section B-B';

[0046] FIG. 6 shows the frontage of a third building protected by a third embodiment of a flood barrier according to the present invention;

[0047] FIG. 7 shows details of the flood barrier of FIG. 6 along section C-C'; and

[0048] FIG. 8, 9 and 10 show details of examples of embodiments of said seal bars according to the present invention.

[0049] Referring to FIG. 1, a building (2) is provided with four substantially vertical outside walls (4, 6, 8 and 10). Building (2) is situated on the ground (12).

[0050] The ground (12) is flooded to a level (14) by flood water. The flood water is prevented from entering the building (2) via the door (16), windows (18) or air brick (20) or any other apertures in the building skin, by a flood protection barrier (22). Flood barrier (22) extends across the lower portion of each of walls (4, 6, 8 and 10) of the building (2).

[0051] With reference to FIG. 2, the flood barrier (22) is comprised of an impermeable sheet (24) and a rigid channel (26). Rigid channel (26) is fixed to the portion of wall (6) adjacent to the ground (12) by means not shown. Rigid channel (26) is likewise fixed to the portions of the other walls (4, 8 and 10) adjacent to the ground (12). A sealant (not shown) is placed between the wall (6) and rigid channel (26) before fixation of rigid channel (26) to each of the walls (4, 6, 8, 10) occurs. Most preferably, the sealant is a flowable sealant which will subsequently set, for example a silicone sealant. Rigid channel (26) is, as shown, configured to have a cross section that is substantially the shape of an angular "C".

[0052] The impermeable sheet (24) is provided along one edge with a means (28) for sealingly engaging with and locking into the rigid channel (26). The means (28) comprises a longitudinal envelope (30) created by doubling over a longitudinal edge of the impermeable sheet (24) and, where the edge of impermeable sheet (24) is adjacent to the impermeable sheet (24) creating a gas-tight seal (32). The gas-tight seal (32) may be formed by a combination of stitching through both layers of impermeable sheet (24) and a sealant, such as a silicone sealant. Alternative known means for creating a gas-tight seal may be employed.

[0053] The envelope (30) is provided with an inflation/deflation means (not shown) such as a gas-tight valve. The gas-tight valve is so located on envelope (30) that it projects
away from the rigid channel (26) both during and after inflation of the envelope (30).

[0054] When the flood water rises to level (14) the flood water exerts hydrostatic forces (34) against the submerged portion of impermeable sheet (24). The impermeable sheet (24) is thus forced against the wall (6) as shown in FIG. 2. As may be seen in FIG. 2, where there is a contour in the surface of the wall (6) such as a recess formed by air brick (20), the impermeable sheet (24) is moulded into that contour by the hydrostatic forces (34). This has the effect that the impermeable sheet (24) is substantially supported in all areas that are submerged by the flood water. Above the level of the flood water, the impermeable sheet (24) is not forced against the wall (6) except in the uppermost region where a peg (36) engages in a peg hole (38). The peg (36) passes through an eyelet (40) in the impermeable sheet (24) and holds the portion of the impermeable sheet (24) in the region of the eyelet (40) against the wall (6).

[0055] The peg (36) is used to hold the impermeable sheet (24) against the wall (6) to prevent the otherwise floppy impermeable sheet (24) falling downward due to gravity and, quite possibly, allowing the flood water over the top of the impermeable sheet (24). The peg (36) and the peg hole (38) are adapted to releasably engage the peg (36) and may be constructed in any appropriate fashion.

[0056] In addition to the impermeable sheet (24) and rigid channel (26), the flood barrier of the present invention may further include support portions for the impermeable sheet (24). Such support portions may either be adapted to prevent the impermeable sheet (24) being pushed into apertures where there will be no support for the impermeable sheet (24), or where it is not desired that the impermeable sheet (24) bears upon the aperture closure means. For example, if it is not desired that the impermeable sheet (24) bears upon the window panes through (18). Accordingly, a support means would be placed across the windows (18) to prevent that occurring. The support means may take the form of a mesh or a solid board (neither of which are shown).

[0057] Alternatively, the support means (42) may be comprised of a contoured support unit for covering features in wall (6) that may pierce or tear the impermeable sheet (24). As shown in FIG. 2 a cistern overflow outlet (44) is potentially sharp and, as such, support means (42) prevents the impermeable sheet (24) from bearing on the end of the outlet (44) if the water level (14) gets that high. It is particularly preferred that the support means (42) has a rounded profile so as to avoid the generation of sharp edges which may cause piercing or tearing of the impermeable sheet (24). Further support means may be provided at the corners of the building where two walls intersect. Again, this is to seek to prevent the sharp edges formed by a pair of intersecting walls piercing or tearing the impermeable sheet (24).

[0058] Impermeable sheet (24) may be a single length of impermeable material joined together by a watertight sealing means, for example by a waterproof zip, where the two ends of that length meet. Alternatively, the impermeable sheet (24) may be comprised of a plurality of smaller impermeable sheets (24) each of which are joined to their adjacent sheets by a waterproof joining means, such as a waterproof zip. The latter is preferred because it will thus be easier to store, move and erect the flood barrier (22) of the present invention.

[0059] Where the building (2) to be protected is not free standing, or, for whatever reason, the flood protection barrier (22) is not to fully surround said building, it is preferred that additional fixed channels (26) are orientated substantially vertically at the horizontal ends of the portion of building (22) that it is desired to be protected. The impermeable sheet (24) may be appropriately adapted to provide an envelope (30) that has an appropriate configuration to engage with all of the rigid channels (26).

[0060] When the flood protection barrier (22) is not in use, the or each impermeable sheet (24) is stored in an appropriate location and the open mouth of the or each rigid channel (26) is closed with a cap (not shown). The purpose of the cap is to prevent detritus accumulating within the rigid channel (26).

[0061] With reference to FIG. 3, a portion of a building (50) is shown. The building (50) is substantially larger than the portion shown and may, for example, form part of an industrial unit or other commercial premises. Located in the face of building (50) adjacent to the ground (12) is a doorway (52) and a display window (54). To protect the doorway (52) and the display window (54) from imminent flooding a flood prevention barrier (56) has been erected.

[0062] The flood prevention barrier (56) is comprised of an impermeable sheet (58) which is sealed by a substantially watertight seal to the skin of the building (50) by seal means (60) either side of the doorway (52) and the display window (54).

[0063] The seal of seal means (60) is substantially as the seal means (26, 28) as illustrated in FIG. 2 in connection with the first embodiment of the present invention. As such, no further discussion of seal means (60) is necessary. Alternative seal means may be used. Examples of such seal means are as illustrated in FIGS. 8, 9 and 10.

[0064] With reference to FIG. 4, the impermeable sheet (58) is stored as a roll (61) about an axle (62) located in a storage means (64) set into the ground (12). The impermeable sheet (58) passes in and out of the storage means (64) via a slot (65).

[0065] The impermeable sheet (58) is sealed against the movement of water beneath the lowermost portion of the impermeable sheet (58) by way of a seal means (66) extending along the length of the storage means (64). The seal means (66) is comprised of a rigid channel (68) which is substantially “U” shaped. The channel (68) is so located that it mouths toward the impermeable sheet (58), and the open mouth of the channel (68) is adjacent to the slot (65). Located within rigid channel (68) is an inflatable envelope (70) extending the length of rigid channel (68). When the inflatable envelope (70) is inflated it expands to force the impermeable sheet (58) against the wall of the storage means (64) towards which the channel (68) mouths. When envelope (70) is inflated to a sufficient pressure, a watertight seal will be formed between the envelope (70) and the impermeable sheet (58), and between envelope (70) and rigid channel (68). This will create a watertight seal preventing flood water entering into storage means (64).

[0066] To hold the flood barrier (56) in the correct position whilst awaiting flooding, the uppermost edge of impermeable sheet (58) is provided with a number of eyelets (72) through which pegs (not shown) may be passed. Said pegs
will, in turn, engage with peg holes (not shown), so as to hold the impermeable sheet (58) in place.

[0067] In an alternative embodiment, the uppermost edge of the impermeable sheet (when deployed) is fixed to a longitudinally extending bar (not shown). Said bar is preferably rigid. This embodiment is particularly beneficial because it enables the easy lifting of the impermeable sheet into the deployed position by either mechanical or manual means. Furthermore, the ends of the bar may be fixed to the seal means (60) at one or more predetermined positions by known fixing means.

[0068] When it is desired to deploy, or store the flood barrier (56) the impermeable sheet (58) is either unrolled from or rolled onto the axle (62) either by human power or by automated means. When the impermeable sheet (58) is stored within storage means (64) it is preferred that the slot through which impermeable sheet (58) passes into and out of the storage means (64) be closed by a cap. This will prevent dirt and other detritus entering the storage means (64).

[0069] With reference to FIG. 5, the impermeable sheet (58) is stored as a roll (61) about an axle (62) located in a storage means (64) set into the ground (12). The impermeable sheet (58) passes in and out of the storage means (64) via a slot (120). Slot (120) is defined by lid portion (122) and wall (126) of storage means (64).

[0070] Storage means (64) has a lid (128) comprised of lid elements (122) and (124). Removal of lid (128) or one of the lid elements (122) or (124) from storage means (64) permits access to the inside of said storage means. Lid (128) is configured so that when lid (128) is moved into a fully closed position, slot (120) is either fully closed, when impermeable sheet (58) is not deployed, or the edge of lid element (122) abuts onto impermeable sheet (58) with sufficient force to create a substantially water-tight seal between lid element (122) and impermeable sheet (58) when impermeable sheet (58) is deployed as shown in FIG. 5. The configuration of lid elements (122) and (124) is such that sufficient abutment force between lid element (122) and impermeable sheet (58) is generated upon closure of the lid.

[0071] In the example of lid (128) illustrated in FIG. 5, the abutment force is generated by virtue of lid element (124) being so configured that it acts effectively as a wedge when brought into contact with lid element (122) and abutment face (130) of storage means (64). Lid element (124) is provided with means, not shown, to enable a user to force lid element (124) in the direction indicated by arrow (132). Such means may be threaded screws, cams, or other known mechanical devices. In this embodiment storage means (64) is required to be sufficiently rigid that forcing lid element (124) in the direction of arrow (132) causes lid element (122) to move toward the left as viewed in FIG. 5 rather than deforming wall (134) of storage means (64) to bend towards the right as illustrated in FIG. 5.

[0072] Alternative configurations for lid (128) may be envisaged. Other preferred configurations include lid (128) having two or more hinges running substantially parallel to the longitudinal axis of storage means (64). Said hinges are most preferably waterproof and so arranged that lid (128) may, in an open position, be in the form of a concertina or substantially folded, and the set of flattening lid (128) causes the edge of lid (128) remote from wall (134) of storage means (64) against impermeable sheet (58).

[0073] With reference to FIG. 6, a portion of a building (80) is shown. The building (80) is substantially larger than the portion shown and may, for example, form part of an industrial unit or other commercial premises. Located in the face of the building (80) adjacent to the ground (12) is a doorway (82) and two windows (84). To protect the doorway (82) and the windows (84) from imminent flooding a flood prevention barrier (86) has been erected.

[0074] The flood prevention barrier (86) is comprised of an impermeable sheet (58) which is sealed by a substantially water-tight seal to the skin of the building (80) by seal means (90) substantially adjacent to the intersection of the skin of the building (80) and the ground (12) and seal means (92) extending substantially vertically from the end of the seal means (90) to a height sufficient for the uppermost corner (94) of the impermeable sheet (58) to engage with the seal means (92).

[0075] The impermeable sheet (58) is stored in a roll (96) about an axle (98) located in a storage means (100). The storage means (100) is fixed to the skin of the building (80) in such a fashion that there is a substantially water-tight seal between the edge of storage means wall (102) adjacent the skin of the building (80) and the skin of the building (80). This substantially water-tight seal is not shown.

[0076] The wall (102) of the storage means (100) is substantially "L" shaped in cross-section in a plane substantially perpendicular to the longitudinal axis of the storage means (100). The edge of the wall (102) of the storage means (100) remote from the skin of the building (80) is formed into or is engaged with a pivot means (104) about which a storage flap (106) hinges. The storage flap (106) may hinge about the pivot (104) in an anti-clockwise direction from the position shown in FIG. 7 until the flap (106) substantially overlies a portion of the wall (102) of the storage means (100). The flap (106) is prevented from hinging in a clockwise direction from the position shown in FIG. 7 by one or more stops (108).

[0077] The flap (106) is comprised of a rigid portion (110) and a deformable portion (112). When the flap (106) is in the position shown in FIG. 7 the deformable portion (112) bears against the impermeable sheet (58) as it extends from the roll (96) and over the surface of the wall (80). When there is flooding, the flood water (not shown) bears upon the face of the flap (106) remote from the roll (96) and exerts hydrostatic pressure on that face. The hydrostatic pressure impels the flap (106) toward the roll (96) in a clockwise direction from the position shown in FIG. 7. The hydrostatic pressure forces the deformable portion (112) against the impermeable sheet (88) so causing a substantially water-tight seal to be developed between the two.

[0078] When the impermeable sheet (58) is to be rolled onto or off the roll (96) then the flap (106) may be hinged about the pivot (104) in an anti-clockwise direction from the position shown in FIG. 7 so as to allow room for the impermeable sheet (88) to either be deployed from or returned to the roll (96).

[0079] The seal of seal means (90) and (92) is substantially as seal means (26, 28) as illustrated in FIGS. 2, 8, 9 or 10 in connection with the first embodiment of the present invention. As such, no further discussion of the seal means (90) and (92) is necessary. Alternative seal means may be used.
The upper edge of the flood barrier (88) is held in the correct position whilst awaiting flooding in the same fashion as the flood barrier (56) as illustrated in FIG. 3. As such, no further discussion of this aspect of the present invention will be entered into.

With reference to FIG. 8, a seal bar (140) is comprised of seal bar elements (142) and (144). Seal bar elements (142) and (144) are adapted to abut each other along abutment line (146). The faces of seal bar elements (142) and (144) that meet on abutment line (146) are so configured as to define a channel (148). Channel (148) is substantially oval in cross section and has an open mouth (150). The major axis of channel (148) and abutment line (146) substantially coincide. Mouth (150) likewise coincides with abutment line (146).

Seal bar (140) is adapted to have the seal portion of the impermeable membrane (not shown) passing longitudinally along channel (148) with a single thickness of the impermeable membrane extending through mouth (150). Inflation of the sealing portion of the impermeable membrane will bring said sealing portion into intimate contact with the faces of the walls of seal bar elements (142) and (144) creating a substantially water-tight seal between the seal bar (140) and the impermeable membrane. Inflation will also prevent movement of the impermeable membrane in the sealing portion of the impermeable membrane along the length of the channel (148).

Seal bar (140) is adapted to be affixed to the outer skin of a building by means not shown. Said means may be mechanical means such as screws, adhesives, or other appropriate means. Face (152) of seal bar element (144) is adapted to abut the skin of the building.

With reference to FIG. 9, a seal bar (160) defines two channels (162) and (164). Channels (162) and (164) have mouths (163 and 165 respectively). Mouths (163) and (165) face substantially away from each other, i.e. in substantially opposite directions. Seal bar (160) is adapted to engage with the seal portions located on the edge of two sheets or portions of an impermeable sheet. The mouth (163) of channel (162) is closed by a flexible rubber flap (166) which prevents dirt and debris entering channel (162). In a similar fashion, mouth (165) of channel (164) is closed by a flexible rubber flap (168) serving the same purpose as flap (166).

Seal bar (160) is shown as having screw holes (170) which may be used to affix seal bar (160) to the outer skin of a building. Seal bar (160) may, however, be used without attaching said seal bar to the outside of a building. The seal bar is structurally integral within itself and does not require attachment to the skin of a building to enable it to perform its function. The seal bar (160) is particularly preferred for use where both the impermeable sheets engaging with the seal bar are in substantially the same plane as each other in the region of the seal bar.

With reference to FIG. 10, the seal bar (180) is of substantially the same construction as seal bar (170) as illustrated in FIG. 9, with the exception that the seal bar (180) is configured so as to be adapted for use on corners of buildings where the free space between the faces of the intersecting walls is approximately 270°. Use of such a seal bar is particularly desirable on such corners because the seal bar may be made of a sufficiently tough material not to be damaged by the forces involved with flooding and the sharpness of the corner. As with seal bar (160), seal bar (180) may either be attached to the outer skin of a building, or may be used free standing.

1. A flood protection barrier for a structure in which the barrier is adapted to overlie at least a portion of the outer skin of a structure in the region where the structure engages with the ground, in which the barrier comprises at least one impermeable sheet and at least one seal means, in which each impermeable sheet is flexible, and at least one seal means is a means adapted to reversibly form a substantially watertight seal between an impermeable sheet and at least one of the structure, the ground, or an impermeable sheet, and in which the impermeable sheet is sufficiently flexible to be elastically deformed by is the hydrostatic pressure exerted by water flooding the ground adjacent to the structure to substantially conform with the contours of the structure's skin overlain by the impermeable barrier.

2. A flood protection barrier according to claim 1 in which at least one seal means is adapted to reversibly form a substantially watertight seal between two edges of impermeable sheet.

3. A flood protection barrier according to claim 1 in which the at least one seal means is adapted to be fixed to the outer skin of the structure.

4. A flood protection barrier according to any of claims 1 to 3 in which at least one seal means is adapted to reversibly form a substantially watertight seal between an edge of an impermeable sheet and the outer skin of a building or the ground.

5. A flood protection barrier according to any preceding claim in which at least one seal means comprises a rigid seal bar defining a channel and a seal portion of the impermeable sheet in which the seal portion is configured to be reversibly fixed in to said channel, said fixing causing a substantially water tight seal to be formed between the seal bar and the impermeable sheet.

6. A flood protection barrier according to claim 5 in which the channel has a cross section such that the mouth of the channel is dimensionally smaller than at least a portion of the channel.

7. A flood protection barrier according to claim 6 in which the channel has a cross section that is substantially “C” shaped or oval.

8. A flood protection barrier according to any of claims 5 to 7 in which the seal portion of the impermeable sheet is comprised of a gas-tight envelope provided with at least one inflation means in which the envelope is configured and constructed to expand to substantially fill the channel and engage with the walls thereof when inflated.

9. A flood protection barrier according to claim 8 in which the gas-tight envelope is compartmentalised into two or more independently inflatable compartments.

10. A flood protection barrier according to any of claims 5 to 9 in which the seal portion of the impermeable sheet is structurally integral with the sheet.

11. A flood protection barrier according to any of claims 5 to 10 in which the seal portion of the Impermeable sheet is constructed independently from said sheet and subsequently and permanently fixed to the sheet.
12. A flood protection barrier according to any of claims 5 to 10 in which the seal portion of the impermeable sheet is comprised of a tube within which an inflatable envelope may be located.

13. A flood protection barrier according to any of claims 5 to 7 in which at least one wall of the channel is configured to be inflatable and deflectable between inflated and deflated positions, and the seal portion of the impermeable sheet is adapted to be gripped by the walls of the channel.

14. A flood protection barrier according to claim 13 in which the seal portion of the impermeable sheet is adjacent the edge of the sheet, and said edge is provided with a bead, or a lip.

15. A flood protection barrier according to claim 2 or 3 in which the at least one seal means is comprised of a water-tight zip, in which each impermeable sheet bears one half of a watertight zip on the edge of the sheet to be joined, and said halves are adapted to reversibly inter-engaging with each other.

16. A flood protection barrier according to claim 2 or 3 in which the at least one seal means is comprised of a rigid seal bar bearing on it, two halves of watertight zips, and in which each impermeable sheet bears one half of a watertight zip on the edge of the sheet to be joined each half of a watertight zip.

17. A flood protection barrier according to any preceding claim in which the storage means comprises a storage means in which the storage means is constructed and configured to contain the impermeable sheet when not in use and allow the impermeable sheet to be moved between a stored configuration and a deployed configuration.

18. A flood protection barrier according to claim 17 in which the storage means is located in the region of the intersection of the structure's skin and the ground, the storage means having a longitudinal extent substantially equal to the longitudinal extent of the face or faces of the structure to be overlain by the barrier.

19. A flood protection barrier according to claim 18 in which the storage means is sunk into a trench in the ground.

20. A flood protection barrier according to claim 17 in which the storage means is fixed to the skin of the structure adjacent the ground, and there is a substantially watertight seal between the storage means and the skin.

21. A flood protection barrier according to any of claims 17 to 20 in which the storage means is provided with means to substantially prevent water passing through the storage means so as to pass around an edge of the impermeable sheet.

22. A flood protection barrier according to any of claims 17 to 21 in which the storage means is comprised of a trough with a lid, and closure of the lid cause the formation of a substantially watertight seal between the lid and the trough, and the impermeable sheet if said sheet is in a deployed position.

23. A flood protection barrier according to any of claims 17 to 22 in which the storage means further comprises an axle mounted therein and in which the impermeable sheet may be stored as a roll about the axle.

24. A flood protection barrier according to any preceding claim in which the barrier is provided with two longitudinally extending seal means adapted to engage with one or two impermeable sheets in a substantially watertight manner, each seal means being fixed to the skin of the structure with a substantially watertight seal between the skin of the structure and the seal means, and the longitudinal axis of the seal means having a substantially vertical orientation.

25. A flood protection barrier according to any preceding claim in which the impermeable sheet is a laminate comprising at least one layer of an impermeable material, and at least one layer of a strengthening material.

26. A flood protection barrier according to claim 25 in which the barrier is configured so that, in use, the face of the impermeable sheet remote from the structure is comprised of a layer of strengthening material.

27. A flood protection barrier according to claim 25 or 26 in which the strengthening material is a woven fabric.

28. A flood protection barrier according to any preceding claim in which the impermeable sheet is at least partially comprised of one or more of butyl rubber, polyvinyl chloride and latex.

29. A flood protection barrier according to any preceding claim in which the impermeable sheet includes at least one longitudinally extending strengthening element.

30. A flood protection barrier according to claim 29 in which each strengthening element is a rigid bar.

31. A flood protection barrier according to claim 29 or 30 in which each strengthening element is located on or in the impermeable sheet in such a fashion that the strengthening element is substantially horizontal when the impermeable sheet is deployed.

32. A flood protection barrier according to any of claims 29 to 31 in which each strengthening element extends between two edges of the impermeable sheet and each end of at least one strengthening element is configured and adapted to engage with a restraining means located adjacent to said edges of the impermeable sheet when deployed.

33. A flood protection barrier according to claim 32 in which the restraining means is configured to prevent an end of a strengthening element engaged therein moving in a direction parallel to the longitudinal axis of the strengthening element.

34. A method of protecting a structure from flooding in which a flood protection barrier according to any of claims 1 to 33 is installed on or around a structure.

35. A method according to claim 34 in which the structure is a domestic dwelling or a commercial premises.