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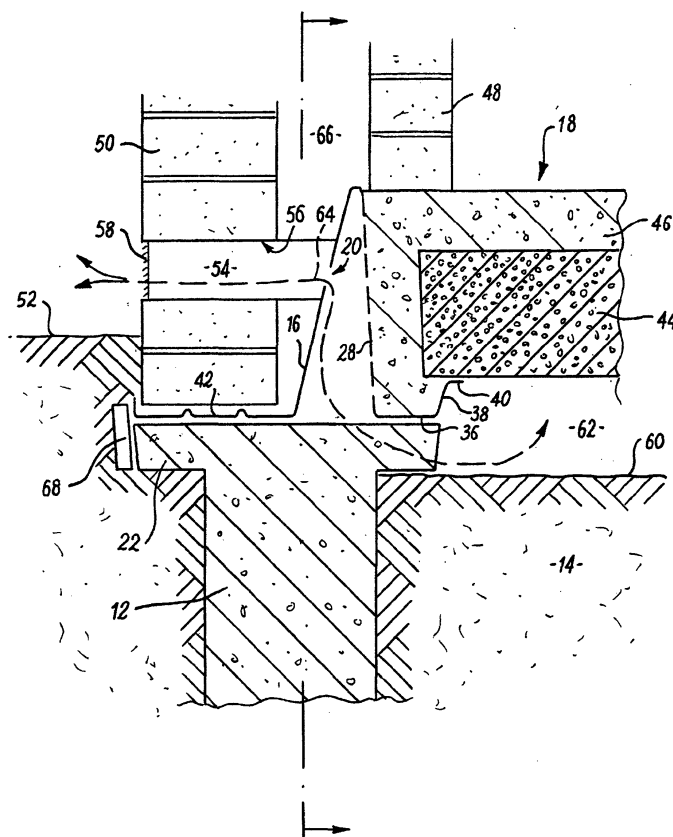
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(54) **Forming building foundations**

(57) A building structure comprises a row of ground piles 12. Elongate members 16 span between adjacent piles 12. A floor structure 18 is supported, at least in

part, by the elongate members 16. Vent apertures 20 provide venting through the elongate member 16, to the void 62 underneath the floor structure 18.



**Fig. 3**

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## Description

**[0001]** The present invention relates to a method of forming foundations for a building, and to a building foundation system formed in accordance with the method.

**[0002]** According to the present invention, there is provided a method of forming foundations for a building, in which a plurality of piles are installed in the ground, at least one elongate member is provided to span between adjacent piles and be supported by the piles, and a floor structure is provided, supported, at least in part, by the elongate member or members, wherein the elongate members are metal members having vent apertures spaced along their length to provide venting through the elongate members to the underside of the floor structure.

**[0003]** Preferably the elongate members are formed of sheet material shaped to provide at least one cavity into which settable material of the floor structure extends, the settable material and elongate member together forming a composite support member for providing support for the floor structure. The floor structure may include an insulating layer. Preferably the settable material substantially covers the insulating layer and extends into the cavity to form a continuous body of settable material.

**[0004]** The or each elongate member may be further arranged to provide support for a wall. The elongate member may have a first elongate structure for supporting a floor structure, and a second elongate structure for supporting a wall. The elongate structures may be separated by a central portion of the elongate member. The first elongate structure may comprise a flange portion for providing support for a floor structure. The first elongate structure may comprise a trough for receiving settable material of the floor structure to form, with the elongate member, a composite support member for providing support for the floor structure.

**[0005]** A skirt member may be provided to close an opening defined below the elongate member, above ground level, and between adjacent piles.

**[0006]** Preferably, the elongate members and piles cooperate to allow the elongate members to be supported by a pile at any of a range of axial positions of the elongate member relative to the pile. The piles may each be enlarged at their upper end to form a pile cap on which the elongate members may rest at any of a range of positions. A stock of elongate members may be provided, having a range of lengths to span between adjacent piles at respective separations. Preferably, the range of positions over which the elongate members may be supported is greater than or equal to the difference in length of nearest lengths in the range of lengths.

**[0007]** The invention also provides a method as defined above, in which a party wall is formed by installing a plurality of piles as aforesaid, spanning adjacent piles by two elongate members as aforesaid, the elongate

members providing support as aforesaid to respective floor structures, each elongate member and the settable material of the corresponding floor structure together forming a composite support member as aforesaid.

**[0008]** The invention also provides a building foundation arrangement, in which a plurality of piles are installed in the ground, at least one elongate member is provided to span between adjacent piles and be supported by the piles, and a floor structure is provided, supported, at least in part, by the elongate member or members, wherein the elongate members are metal members having vent apertures spaced along their length to provide venting through the elongate members to the underside of the floor structure.

**[0009]** Preferably the elongate members are formed of sheet material shaped to provide at least one cavity into which settable material of the floor structure extends, the settable material and elongate member together forming a composite support member for providing support for the floor structure. The floor structure may include an insulating layer. Preferably the settable material substantially covers the insulating layer and extends into the cavity to form a continuous body of settable material.

**[0010]** The or each elongate member may be further arranged to provide support for a wall. The elongate member may have a first elongate structure for supporting a floor structure, and a second elongate structure for supporting a wall. The elongate structures may be separated by a central portion of the elongate member. The first elongate structure may comprise a flange portion for providing support for a floor structure. The first elongate structure may comprise a trough for receiving settable material of the floor structure to form, with the elongate member, a composite support member for providing support for the floor structure.

**[0011]** A skirt member may be provided to close an opening defined below the elongate member, above ground level, and between adjacent piles.

**[0012]** Preferably, the elongate members and piles cooperate to allow the elongate members to be supported by a pile at any of a range of axial positions of the elongate member relative to the pile. The piles may each be enlarged at their upper end to form a pile cap on which the elongate members may rest at any of a range of positions. A stock of elongate members may be provided, having a range of lengths to span between adjacent piles at respective separations. Preferably, the range of positions over which the elongate members may be supported is greater than or equal to the difference in length of nearest lengths in the range of lengths.

**[0013]** In another aspect, the invention provides a method of forming foundations for a building, in which a plurality of piles are installed in the ground, at least one elongate member is provided to span between adjacent piles and be supported by the piles, and a floor structure is provided, supported, at least in part, by the elongate member or members, wherein the elongate members

are formed of sheet material shaped to provide at least one cavity into which settable material of the floor structure extends, the settable material and the elongate member together forming a composite support member for providing support for the floor structure.

**[0014]** The floor structure may include an insulating layer. The settable material preferably substantially covers the insulating layer and extends into the cavity to form a continuous body of settable material.

**[0015]** The elongate member or members are preferably metal members having vent apertures spaced along their length to provide venting through the elongate members to the underside of the floor structure.

**[0016]** Preferably, the elongate members and piles cooperate to allow the elongate members to be supported by a pile at any of a range of axial positions of the elongate member relative to the pile. The piles may each be enlarged at their upper end to form a pile cap on which the elongate members may rest at any of a range of positions. A stock of elongate members may be provided, having a range of lengths to span between adjacent piles at respective separations. Preferably, the range of positions over which the elongate members may be supported is greater than or equal to the difference in length of nearest lengths in the range of lengths.

**[0017]** The invention also provides a method as defined above, in which a party wall is formed by installing a plurality of piles as aforesaid, spanning adjacent piles by two elongate members as aforesaid, the elongate members providing support as aforesaid to respective floor structures, each elongate member and the settable material of the corresponding floor structure together forming a composite support member as aforesaid.

**[0018]** In another aspect, the invention provides a building foundation arrangement, including a plurality of piles installed in the ground, at least one elongate member spanning between adjacent piles and supported by the piles, and a floor structure supported, at least in part, by the elongate member or members, wherein the elongate members are formed of sheet material shaped to provide at least one cavity into which settable material of the floor structure extends, the settable material and the elongate member together forming a composite support member for providing support for the floor structure.

**[0019]** The floor structure may include an insulating layer. The settable material preferably substantially covers the insulating layer and extends into the cavity to form a continuous body of settable material.

**[0020]** The elongate member or members are preferably metal members having vent apertures spaced along their length to provide venting through the elongate members to the underside of the floor structure.

**[0021]** Preferably, the elongate members and piles cooperate to allow the elongate members to be supported by a pile at any of a range of axial positions of the elongate member relative to the pile. The piles may each be enlarged at their upper end to form a pile cap on which the elongate members may rest at any of a range

of positions. A stock of elongate members may be provided, having a range of lengths to span between adjacent piles at respective separations. Preferably, the range of positions over which the elongate members may be supported is greater than or equal to the difference in length of nearest lengths in the range of lengths.

**[0022]** Examples of the present invention will now be described in more detail, by way of example only, and with reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic vertical section through a building foundation formed in accordance with the invention;

Fig. 2 is a simplified and enlarged perspective view of an elongate member used in the foundation of Fig. 1;

Fig. 3 is a partial, enlarged section at the line 3-3 in Fig. 1;

Fig. 4 shows a party wall formed in accordance with the invention, otherwise corresponding with the view of Fig. 3;

Fig. 5 illustrates an arrangement for supporting an internal load-bearing wall, the view otherwise corresponding with Fig. 3;

Fig. 6 illustrates an arrangement similar to the arrangement of Fig. 1, with closer pile spacing;

Fig. 7 is a schematic plan view of the lay-out of piles and elongate members; and

Fig. 8 is an enlarged plan view of a pile supporting three elongate members.

**[0023]** Fig. 1 shows a building foundation 10. In this example, the foundation 10 is located at an external wall of a building. A plurality of piles 12 are installed in the ground 14. Elongate members 16 span between adjacent piles 12 and are supported by the piles 12. A floor structure 18 is provided, and is supported, at least in part, by the elongate members 16. The elongate members 16 are metal members, to be described more fully below. The metal members 16 have a line of vent apertures 20 spaced along their length to provide venting through the elongate member to the underside of the floor structure 18. The elongate members 16 also form a composite support member, with the floor structure, as will be described.

**[0024]** The piles 12 may be driven into the ground 14, or formed in-situ in a preformed hole in the ground 14. They may be made of concrete or other cementitious material and may incorporate reinforcing members. The piles are preferably enlarged at their upper ends to form pile caps 22. The pile caps can be seen from the draw-

ings to be much wider than the main body of the pile 12.

**[0025]** The top of each pile cap 22 provides a surface on which the ends of the elongate members 16 may be rested for support. The relatively large diameter of the pile caps allows the elongate members to be placed on the caps 22 at any of a range of positions, as will become apparent. Ties (not shown) may be provided to tie the elongate members to the piles 12.

**[0026]** The elongate members 16 are shown in more detail in Figs. 2 and 3. Each is formed from metal, preferably steel, and preferably by a rolling process to provide a constant cross-section along the length of the elongate members. In the example of Fig. 2, the elongate member 16 has elongate structures 24 which extend transversely to form feet to rest on the caps 22. A central section 26 is provided by side walls 28. Vent apertures 20 are formed at least in the side walls which faces the exterior of the building. Thus, ventilation air can pass through the apertures 20 from outside the elongate member 16 to within.

**[0027]** To one side of the central section 26 there is a relatively narrow trough 36 bounded by a wall 38 carrying a supporting flange 40. To the other side of the central section 26, a relatively wide supporting surface 42 is provided.

**[0028]** The flange 40 is used to support an insulating layer 44 of the floor structure. The layer 44 may, for example, be a layer of polystyrene material. The upper surface of the layer 44 is covered by a layer of settable material, preferably cementitious material such as concrete. In addition to covering the layer 44, the concrete 46 is allowed to flow, prior to setting, past the edge of the layer 44 and down into the trough 36, thus filling the trough 36 and the gap between the edge of the layer 44 and the corresponding wall 28. Thus, the wall 28 is adjacent a vertical wall of concrete 46 and the trough 36 is filled with concrete. The concrete and the elongate member 16 thus together form a composite beam structure whose strength is determined not solely by either the metal or the concrete, but by the combination of both elements.

**[0029]** The concrete layer 46 preferably finishes at approximately the same level as the upper edge of the walls 28. An internal block or brick skin 48 is supported by the concrete 46, close to the elongate member 16.

**[0030]** The supporting surface 42 is used to support the outer brick skin 50 of the wall. At a level above ground level 52 outside the building, bricks of the skin 50 are replaced with vent structures 54 which provide an open vent channel 56 through the outer skin to the vent apertures 20, covered at the external surface of the skin 50 by a mesh 58.

**[0031]** Ground level within the building is at the level 60, below the level 52. A void 62 therefore exists below the layer 44 and above ground level 60.

**[0032]** It will be apparent from this description that a ventilation path 64 is provided, indicated by a broken arrow on Fig. 3. The path 64 extends from outside the

building, through the vent structure 54 into the wall cavity 66, through apertures 20 into the interior of the elongate member 16, under the trough 36 (except in the vicinity of a pile cap 22) to the void 62. Thus, ventilation of the void 62, to the exterior of the building, is provided.

**[0033]** A strip of skirt material 68 is preferably provided, running horizontally between adjacent pile caps 22 to close the aperture defined below the elongate member 16, above the inner ground level 60 and between the pile caps. This prevents the ingress of material from outside the building, into the void 62.

**[0034]** Fig. 4 shows an arrangement for forming a party wall in accordance with the invention. Many components and features illustrated in Fig. 4 are the same or closely correspond with features and components of the arrangements previously described and are thus given the same reference numeral, or a reference numeral accompanied by an appropriate suffix.

**[0035]** In the arrangement of Fig. 4, a single line of piles 12 and pile caps 22 are used to support two parallel elongate members 16A. Each elongate member 16A has substantially the same profile as that part of an elongate member 16 (Fig. 2) from the peak of the central section 26, and including the trough 36. The troughs 36 face in opposite directions and can thus each support a corresponding floor structure of the type described above, including insulating layers 44 and concrete 46. Thus, the edges of the two floor structures are supported by respective elongate members 16A but by the same line of piles 12. Each in turn supports a respective skin 70 of the party wall arrangement, leaving a cavity 72 therebetween.

**[0036]** In this arrangement, there is ventilation of the voids 62 between pile caps 22 into the cavity 72, but not externally of the building. However, the voids 62 will be ventilated at the edges of the buildings in the manner described above in relation to Figs. 1 to 3.

**[0037]** It will be apparent from the arrangement shown in Fig. 4 that the concrete 46 again forms, together with the elongate members 16A, a composite beam structure for supporting the floor structure, in the manner described above in relation to Fig. 3.

**[0038]** Fig. 5 shows a further alternative arrangement. This arrangement is for supporting an internal load-bearing wall 74. Again, many features are the same as, or correspond with previously described features and are thus given the same reference numerals or corresponding reference numerals and a letter suffix.

**[0039]** In this arrangement, a line of piles 12 and pile caps 22 (only one of which is shown) support elongate members 16B in the form of a shallow trough 76 having side walls 78 carrying transversely extending flanges 80. The profile of the walls 78 and flanges 80 corresponds with that of the features 40, 42 of the arrangement shown in Fig. 3, and are again used to support respective insulating layers 44. These are covered by concrete 46. A gap 82 is left between the edges of the insulating layers 44, allowing the concrete 46, prior to

setting, to flow down into the gap 82, thereby filling the trough 76. Again, a composite beam is formed by the combination of the trough 76 and the concrete within it. This composite beam spans between adjacent pile caps 22, to provide support for the floor structures. The composite beam also provides sufficient strength to allow the load-bearing wall 74 to be built along the line of the elongate member 16B.

**[0040]** It can be seen from Fig. 1 that a gap 86 exists above each pile cap 22, between the ends of the elongate members 16 supported by that cap 22. This gap 86 can provide additional ventilation to the space 30. However, a gap as large as that illustrated in Fig. 1 will, not be present in all arrangements, as can be seen by considering Fig. 4.

**[0041]** In Fig. 6, the ends of the elongate members 16 are much closer together than in Fig. 1, so that the corresponding gap 86A is reduced almost to nothing. This reduces the ventilation between the ends of the elongate members 16, so that ventilation provided by the vent apertures 20 becomes more significant. Furthermore, it can be seen that with an arrangement like that of Fig. 6, and assuming that all elongate members in Figs. 1 and 6 are of the same overall length, the spacing between piles 12 is less in Fig. 6 than in Fig. 1.

**[0042]** Consequently, it can be understood that the ability of the pile caps 22 to support the end of an elongate member over a range of axial positions of the elongate member relative to the cap allows a single length to be used with a range of different pile separations or alternatively, a particular pile spacing could be used with a range of different lengths of elongate member.

**[0043]** In a preferred arrangement, elongate members would be provided in a range of stock sizes, perhaps ranging from 2m to 4m and with an increment of about 300mm between lengths. The increment should be less than or equal to the range of support provided by the caps 22. Consequently, a particular length can be used for spanning between two piles at any range from a lower limit to an upper limit, the length of that range being determined by the size of the pile cap 22. As the pile spacing is increased so that the upper limit is exceeded, or is reduced so that the lower limit is not met, so the next longest or shortest standard length can be used. This results in a continuum of possible pile separations being available, by appropriate choice of standard lengths. There is no requirement to cut elongate members to length during installation, and ventilation is maintained in all arrangements, by virtue of the apertures 20.

**[0044]** This is illustrated further in Fig. 7. A first wall 90 is formed from three elongate members 16 supported by a line of four piles 12. The inner two piles 12 also support elongate members extending transversely from the wall 90, such as might occur within the footprint of a building, for a dividing wall. A second wall 92 is also defined by three elongate members 16 supported by piles 12. Again, the inner piles 12 support further elongate members extending transversely away from the wall 92. However, it is to be noted that the separation of piles 12 in the two walls 90, 92 is not the same. However, each wall is made solely from elongate members of stock length, as described above. Thus, appropriate choices of length and pile position enable a wide range of foundation geometries to be created without any components being required to be bespoke in form.

**[0045]** Fig. 8 shows an example of a pile cap 22 supporting the ends of three elongate members 16. The shape of each elongate member, in plan, is not square at its end but rather, the corners are cut at an angle. This ensures that gaps remain between ends for ventilation, even when three elongate members are supported by the same cap.

**[0046]** Many variations and modifications can be made to the apparatus described above, without departing from the scope of the present invention. In particular, many different profiles of elongate member could be used. Other shapes of pile cap 22 could be envisaged.

**[0047]** Whilst endeavouring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

## Claims

1. A method of forming foundations for a building, in which a plurality of piles are installed in the ground, at least one elongate member is provided to span between adjacent piles and be supported by the piles, and a floor structure is provided, supported, at least in part, by the elongate member or members, wherein the elongate members are metal members having vent apertures spaced along their length to provide venting through the elongate members to the underside of the floor structure.
2. A method according to claim 1, in which the elongate members are formed of sheet material shaped to provide at least one cavity into which settable material of the floor structure extends, the settable material and elongate member together forming a composite support member for providing support for the floor structure.
3. A method according to claims 1 or 2, in which the floor structure includes an insulating layer.
4. A method according to claim 3 when dependent on claim 2, in which the settable material substantially covers the insulating layer and extends into the cavity to form a continuous body of settable material.

5. A method according to any of the preceding claims, in which the or each elongate member is further arranged to provide support for a wall.
6. A method according to claim 5, in which the elongate member has a first elongate structure for supporting a floor structure, and a second elongate structure for supporting a wall. 5
7. A method according to claim 6, in which the elongate structures are separated by a central portion of the elongate member. 10
8. A method according to claims 6 or 7, in which the first elongate structure comprises a flange portion for providing support for a floor structure. 15
9. A method according to any of claims 6 to 8, in which the first elongate structure comprises a trough for receiving settable material of the floor structure to form, with the elongate member, a composite support member for providing support for the floor structure. 20
10. A method according to any of the preceding claims, in which a skirt member is provided to close an opening defined below the elongate member, above ground level, and between adjacent piles. 25
11. A method according to any of the preceding claims, in which the elongate members and piles cooperate to allow the elongate members to be supported by a pile at any of a range of axial positions of the elongate member relative to the pile. 30
12. A method according to claim 11, in which the piles are each enlarged at their upper end to form a pile cap on which the elongate members may rest at any of the range of positions. 35
13. A method according to any of the preceding claims, in which a stock of elongate members is provided, having a range of lengths to span between adjacent piles at respective separations. 40
14. A method according to claim 13 when dependent on claims 11 or 12, in which the range of positions over which the elongate members may be supported is greater than or equal to the difference in length of nearest lengths in the range of lengths. 45
15. A method according to claim 2 and any of claims 3 to 14 when dependent on claim 2, in which a party wall is formed by installing a plurality of piles as aforesaid, spanning adjacent piles by two elongate members as aforesaid, the elongate members providing support as aforesaid to respective floor structures, each elongate member and the settable material of the corresponding floor structure together forming a composite support member as aforesaid. 50
16. A building foundation arrangement, in which a plurality of piles are installed in the ground, at least one elongate member is provided to span between adjacent piles and be supported by the piles, and a floor structure is provided, supported, at least in part, by the elongate member or members, wherein the elongate members are metal members having vent apertures spaced along their length to provide venting through the elongate members to the underside of the floor structure. 55
17. An arrangement according to claim 16, in which the elongate members are formed of sheet material shaped to provide at least one cavity into which settable material of the floor structure extends, the settable material and elongate member together forming a composite support member for providing support for the floor structure.
18. An arrangement according to claim 16 or 17, in which the floor structure includes an insulating layer.
19. An arrangement according to claim 18 when dependent on claim 17, in which the settable material substantially covers the insulating layer and extends into the cavity to form a continuous body of settable material.
20. An arrangement according to any of claims 16 to 19, in which the or each elongate member is further arranged to provide support for a wall.
21. An arrangement according to claim 20, in which the elongate member has a first elongate structure for supporting a floor structure, and a second elongate structure for supporting a wall.
22. An arrangement according to claim 21, in which the elongate structures are separated by a central portion of the elongate member.
23. An arrangement according to claims 21 or 22, in which the first elongate structure comprises a flange portion for providing support for a floor structure.
24. An arrangement according to any of claims 21 to 23 when dependent on claim 17, in which the first elongate structure comprises a trough for receiving settable material of the floor structure to form, with the elongate member, a composite support member for providing support for the floor structure.
25. An arrangement according to any of claims 16 to

24, in which a skirt member is provided to close an opening defined below the elongate member, above ground level, and between adjacent piles.

**26.** An arrangement according to any of claims 16 to 25, in which the elongate members and piles cooperate to allow the elongate members to be supported by a pile at any of a range of axial positions of the elongate member relative to the pile.

**27.** An arrangement according to claim 26, in which the piles are each enlarged at their upper end to form a pile cap on which the elongate members may rest at any of the range of positions.

**28.** An arrangement according to any of claims 16 to 27, in which a stock of elongate members is provided, having a range of lengths to span between adjacent piles at respective separations.

**29.** An arrangement according to claim 28 when dependent on claims 26 or 27, in which the range of positions over which the elongate members may be supported is greater than or equal to the difference in length of nearest lengths in the range of lengths.

**30.** A method of forming foundations for a building, in which a plurality of piles are installed in the ground, at least one elongate member is provided to span between adjacent piles and be supported by the piles, and a floor structure is provided, supported, at least in part, by the elongate member or members, wherein the elongate members are formed of sheet material shaped to provide at least one cavity into which settable material of the floor structure extends, the settable material and the elongate member together forming a composite support member for providing support for the floor structure.

**31.** A method according to claim 30, in which the floor structure includes an insulating layer.

**32.** A method according to claim 31, in which the settable material substantially covers the insulating layer and extends into the cavity to form a continuous body of settable material.

**33.** A method according to any of claims 30 to 32, in which the elongate member or members are metal members having vent apertures spaced along their length to provide venting through the elongate members to the underside of the floor structure.

**34.** A method according to any of claims 30 to 33, in which the elongate members and piles cooperate to allow the elongate members to be supported by a pile at any of a range of axial positions of the elongate member relative to the pile.

**35.** A method according to claim 34, in which the piles are each enlarged at their upper end to form a pile cap on which the elongate members may rest at any of the range of positions.

**36.** A method according to any of claims 30 to 35, in which a stock of elongate members are provided, having a range of lengths to span between adjacent piles at respective separations.

**37.** A method according to claim 36 when dependent on claims 34 or 35, in which the range of positions over which the elongate members is supported is greater than or equal to the difference in length of nearest lengths in the range of lengths.

**38.** A method according to any of claims 30 to 37, in which a party wall is formed by installing a plurality of piles as aforesaid, spanning adjacent piles by two elongate members as aforesaid, the elongate members providing support as aforesaid to respective floor structures, each elongate member and the settable material of the corresponding floor structure together forming a composite support member as aforesaid.

**39.** A building foundation arrangement, including a plurality of piles installed in the ground, at least one elongate member spanning between adjacent piles and supported by the piles, and a floor structure supported, at least in part, by the elongate member or members, wherein the elongate members are formed of sheet material shaped to provide at least one cavity into which settable material of the floor structure extends, the settable material and the elongate member together forming a composite support member for providing support for the floor structure.

**40.** A method according to claim 39, in which the floor structure includes an insulating layer.

**41.** A method according to claim 40, in which the settable material substantially covers the insulating layer and extends into the cavity to form a continuous body of settable material.

**42.** A method according to any of claims 39 to 41, in which the elongate member or members are metal members having vent apertures spaced along their length to provide venting through the elongate members to the underside of the floor structure.

**43.** A method according to any of claims 39 to 42, in which the elongate members and piles cooperate to allow the elongate members to be supported by a pile at any of a range of axial positions of the elongate member relative to the pile.

44. A method according to claim 43, in which the piles are each enlarged at their upper end to form a pile cap on which the elongate members may rest at any of the range of positions. 5
45. A method according to any of claims 39 to 44, in which a stock of elongate members is provided, having a range of lengths to span between adjacent piles at respective separations. 10
46. A method according to claim 45 when dependent on claims 43 or 44, in which the range of positions over which the elongate members is supported is greater than or equal to the difference in length of nearest lengths in the range of lengths. 15
47. A method of forming foundations for a building substantially as hereinbefore described and with reference to any of the accompanying drawings. 20
48. A building foundation arrangement substantially as hereinbefore described and with reference to any of the accompanying drawings.
49. Any novel subject matter or combination including novel subject matter disclosed herein, whether or not within the scope of or relating to the same invention as any of the preceding claims. 25

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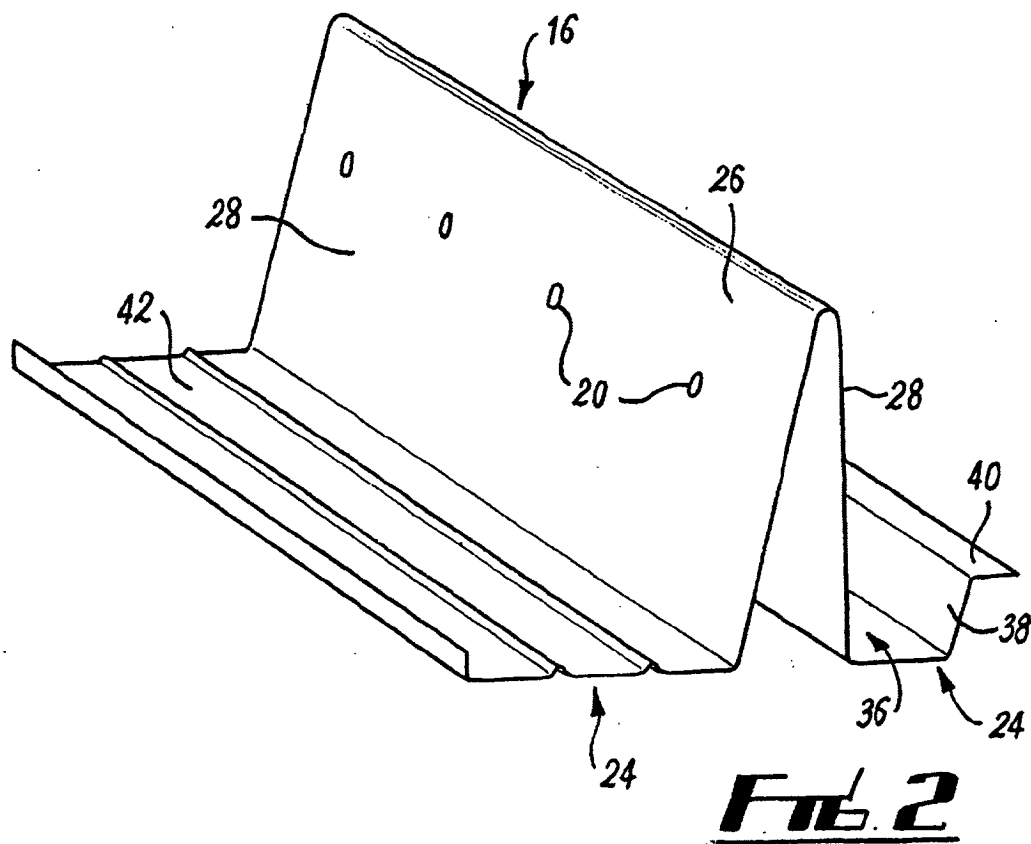
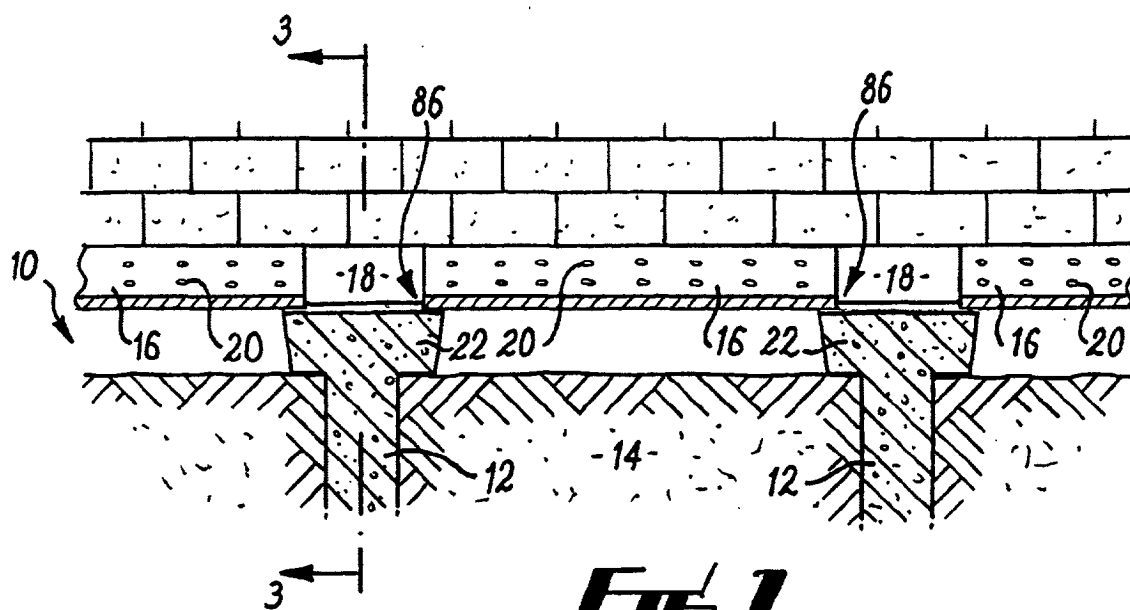
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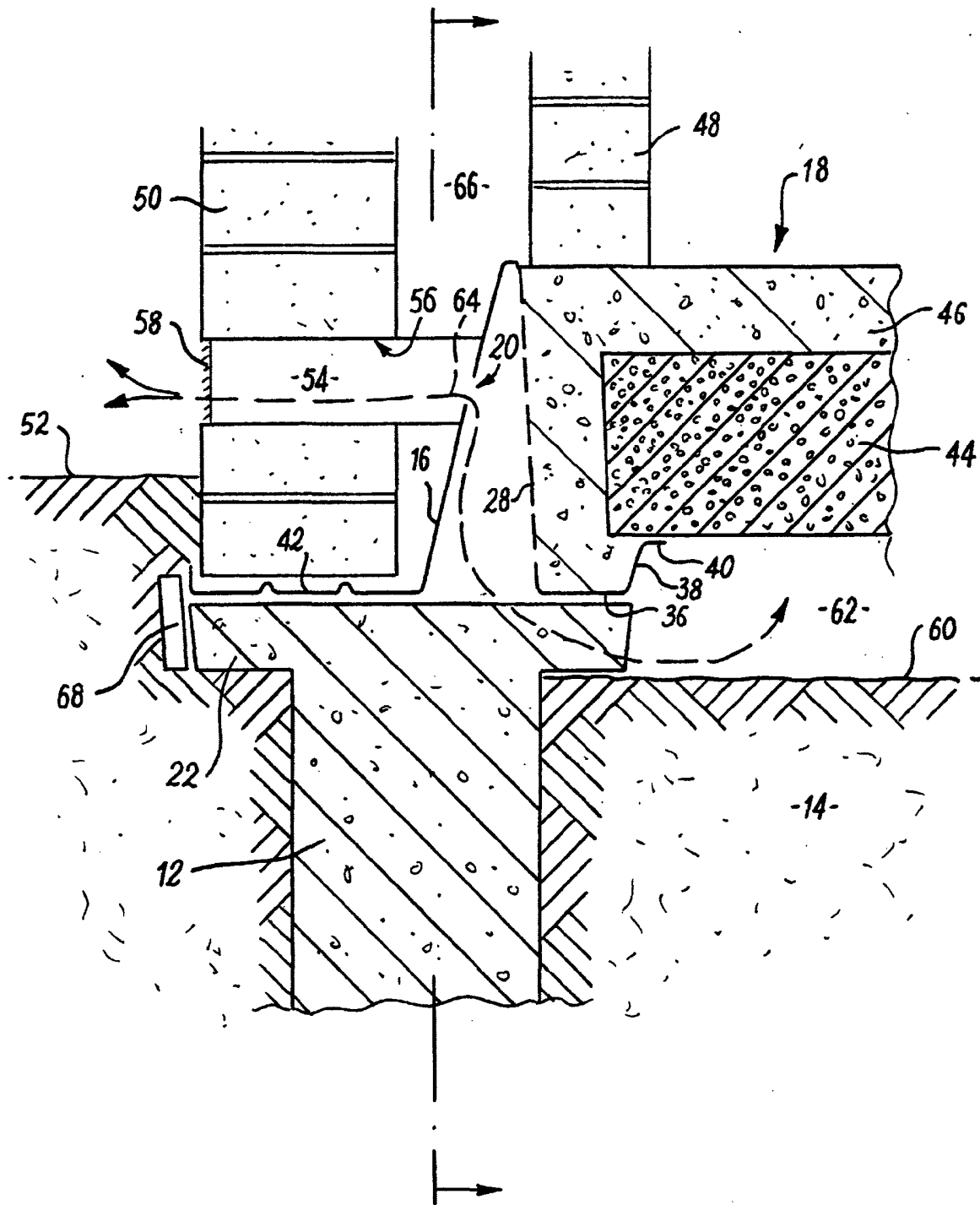
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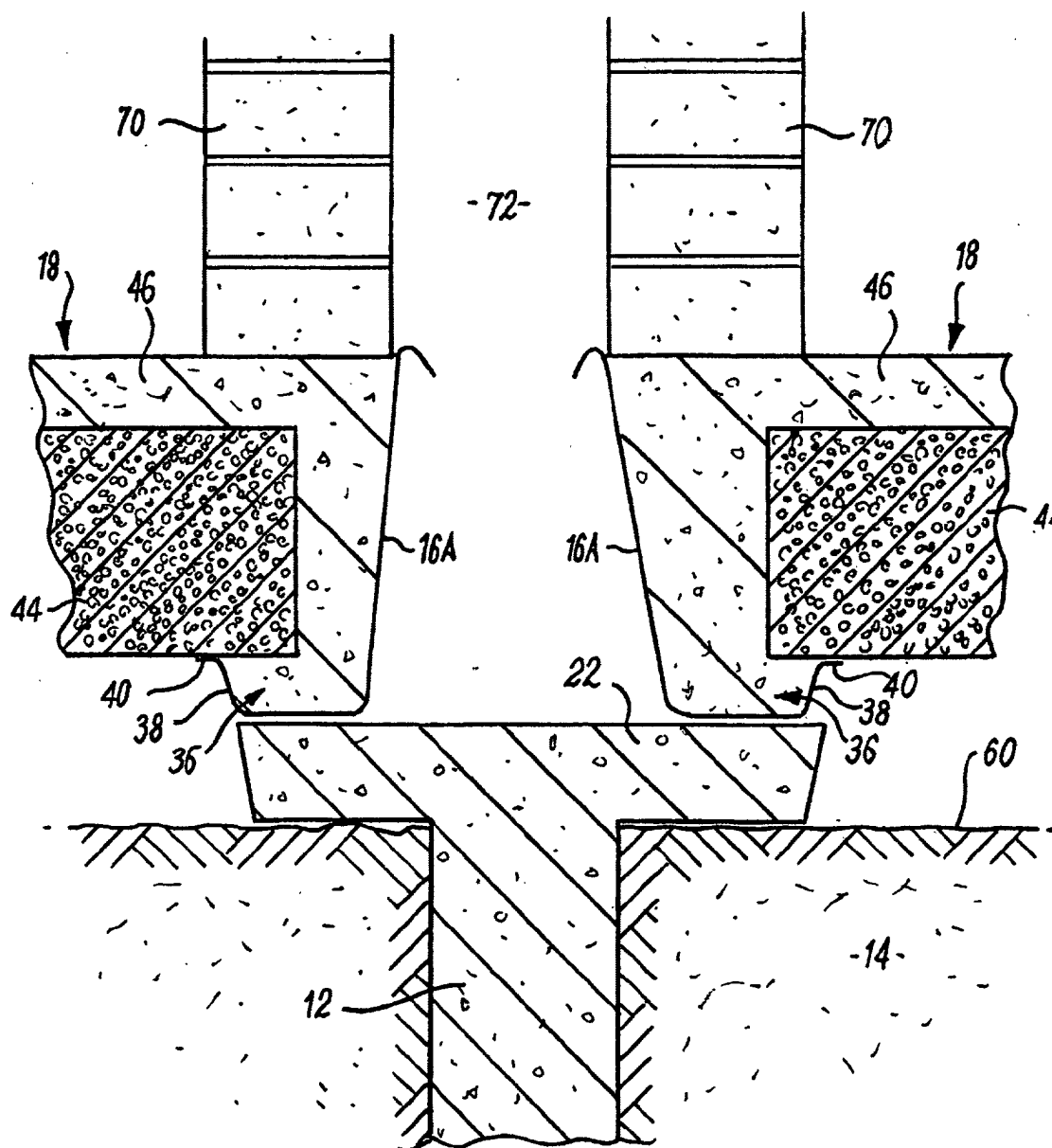
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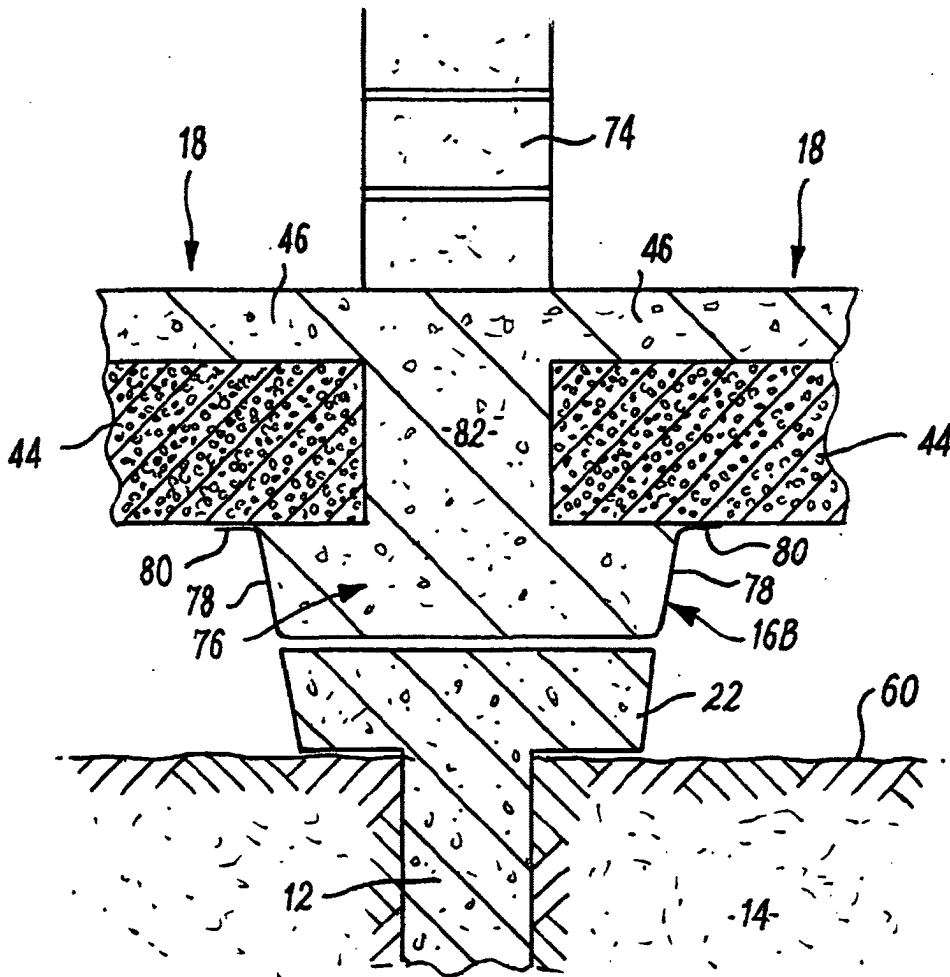




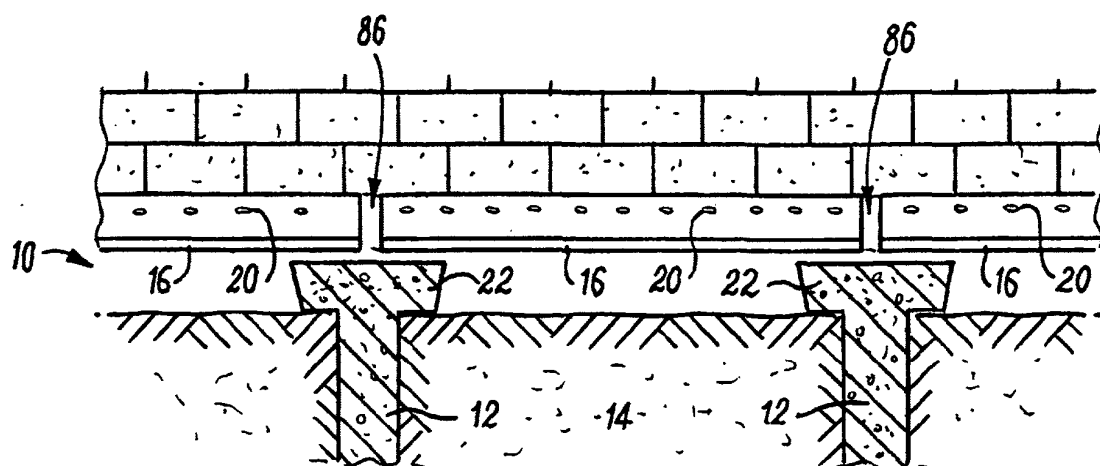
**FIG. 3**



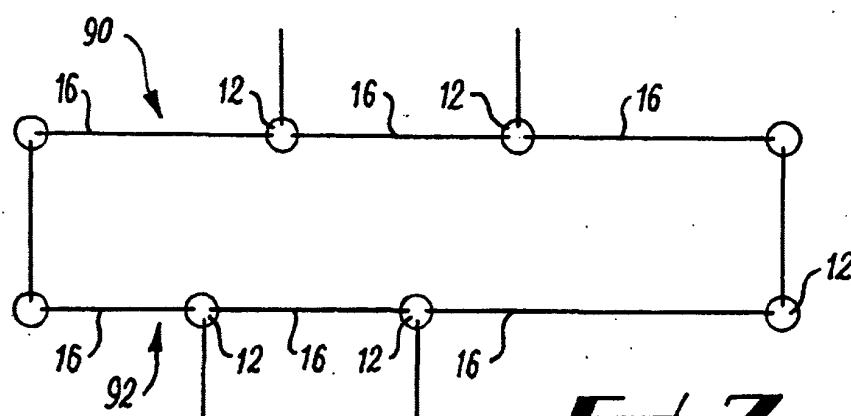
**Fig. 4**



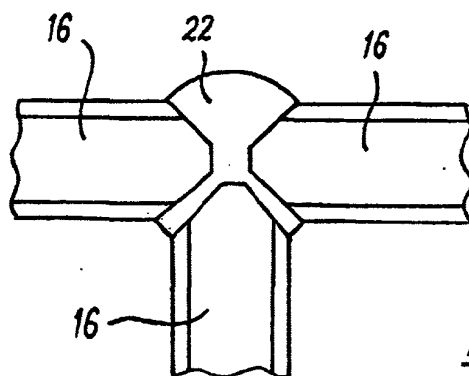
**FIG 5**



**FIG. 6**



**FIG. 7**



**FIG. 8**