(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 116 913**
A2

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 84101354.3

(22) Date of filing: 10.02.84

(51) Int. Cl.³: E 04 G 11/16

(30) Priority: 15.02.83 DK 653/83

(43) Date of publication of application:
29.08.84 Bulletin 84/35

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI NL SE

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(54) **Formwork and method of forming buildings.**

(57) Formwork for casting buildings consisting of inner formwork with side walls and suffit formwork, and outer formwork with side walls, which surround the inner formwork with a space there between. In order to secure standardization of the form elements, the formwork is designed on basis of a modular network, while the distance between vertical planes (1), passing through the spaces between the side walls is a multiple of a modular distance. The side walls of the inner formwork and the outer formwork consist of column elements (8, 9 and 10, 11), which are placed with a bay inbetween their sides, corresponding to the modular distance (M) minus a fraction, i.e. the width of a modular zone (Z) thereof. In those bays, which are formed between column elements (8, 9 and 10, 11), there are placed filling in forms (6), the length of which correspond to the width of the bay, and whose width corresponds to a multiple of the width of the modular zone (Z).

The suffit formwork consists of structural elements (3, 4 and 5), which are supported by the columns (8, 9) of the inner formwork, and which between their mutually facing side edges form bays, the width of which correspond to the width of the bays of the side walls, and whose length correspond to a multiple of the modular zone (Z). In the bays of the suffit formwork there are placed filling in forms (6 and 7) corresponding to the filling in forms (6) of the side walls (Fig. 1).

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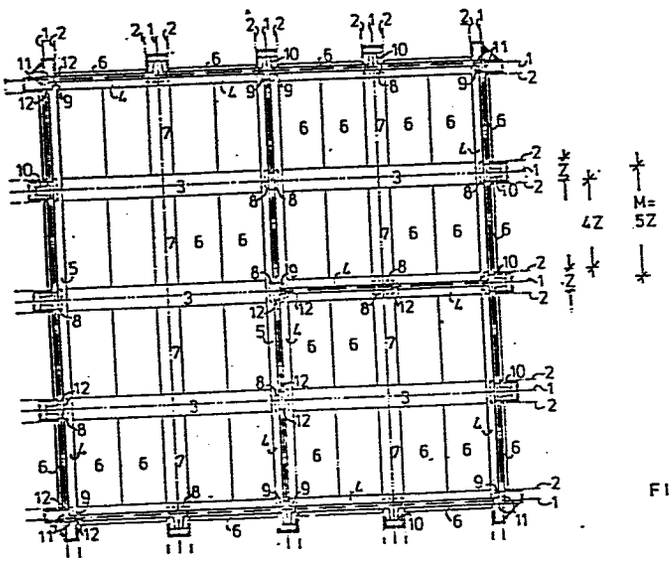

FIG. 1

Formwork and Method of Forming Buildings.

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The invention relates to formwork for casting buildings or parts of buildings, and which consists of inner formwork with outward oriented sheetings for the demarcation of corresponding inner sides of the building or part of building, and formwork for the demarcation of the under side of a floor slab, which formwork moreover has outer formwork with sheetings turned inwards for the demarcation of corresponding outer sides of the building or part of building, said outer formwork with inward oriented sheetings, when being used, is placed with an interval in relation to the inner formwork with outward oriented sheetings.

Formwork of the category mentioned above can be divided in two main groups, that is, one comprising large, heavy forms, which have to be handled by crane, and another group, which comprises light, manually handable forms.

As far as the first group is concerned, it implies a strong limitation in the choice of plan solutions, while it can only be used for the casting of the crude structure of buildings, which resuls in a considerable percentage of the walls and surfaces having to be made in subsequent processes and using other methods.

The necessary cranes and other handling and transport equipment represent in this case a very substantial cost in addition to the cost of the forms.

Within the group of manually handlable forms, as far as is known to the inventor, it has so far not been possible through the use of a few standardised form elements to make complete formwork for buildings and parts of buildings with widely varying shape and plan solutions.

It is the objective of this invention to present a type of formwork, as mentioned in the introduction, which consists of comparatively few and simple types of forms, but which can anyway be used for the construction of a rich variety of buildings or parts of buildings, including for inst. as far as partitioning of rooms and wall thicknesses is concerned.

The formwork according the present invention is characterised by, that the interval between imaginary vertical plans through each pair of opposite intervals between inner and outer formwork be a multiple of a previously selected length, the modular distance, while the inner formwork with outward oriented sheetings is composed of column elements, which are placed with a mutual distance between their sides, which corresponds to the modular distance less a fixed fraction, the width of the modular zone, of this, and while in the intervals formed by the columns of the inner formwork and the outer formwork be placed filling in panels, the length of which correspond to the distance between the sides of the adjoining columns, and the width of which correspond to a multiple

of the width of the modular zone, while the formwork for the floor slabconsists of , by the columns of the inner formwork, supported structural form elements, which between their edges facing each other demarcate intervals, the dimension of which in one direction correspond to the distance between the edges of the adjoining columns, and in the other direction perpendicular to the first one, the dimension of which corresponds to a multiple of the width of the modular zone, in which intervals is placed filling in panels.

In this way is achieved a very high degree of rationalization, concerning the elements of said formwork, since one and the same type (and size) of filling in panel can be used for the inner and outer formwork for walls as well as for the formwork of the floor slab.

Furthermore the columns which form part of the inner formwork can also be standardised to a very high degree, since, for the building up of the regular intervals of the inner forms for the walls, are needed only two types of columns, inner corner columns and intermediate columns.

However, this is only the case when the building or part of building is to have exterior walls of the same thickness all the way around, and in case the building, if it is to have partition walls, then has partition walls of the same thickness as the external walls. In case it is desire to have walls of different thicknesses in the building, then it is only necessary correspondingly to alter inner and outer corner columns.

As far as the outer formwork is concerned it can likewise be build up by using identical outer intermediate columns and identical outer corner columns, and it is only in the case, that outer walls of different thicknesses, that outer corner columns of a different size are needed.

Also for the formwork for the slabs can be used highly standardized structural elements, and in principle the composition of the formwork offers the possibility of constructing widely different building or parts of buildings, alle dependant on the number of column elements used. Further, the form elements used in the formwork can be made in suitable size for manual handling, so that the formwork can be erected and dismantled without the used of cranes or other handling equipment, and consequently the formwork is well suited for the construction of buildings in rather remote areas, or in areas, where such equipment is not readily available.

In the following the invention is described in more detail with reference to the drawing in which

fig. 1 shows a view of a way of using the formwork, seen from above,

fig. 2 a horizontal section of the formwork shown in fig

1. af the casting, according to line II-II in fig. 3 and

fig. 3 a vertical section through the formwork shown in fig. 2 following line III-III in fig. 2.

The formwork shown consists of inner formwork with four outer walls and soffit formwork, and an outer formwork with four outer walls , which surrounds the outer walls of the inner formwork with an interval for the creation of the outer walls of the building or part of building concerned. On the drawing, the centre plan of this interval is shown and marked with 1. The outer and inner formwork is made in such a way, that the distance between the centre plans 1 and each pair of opposite intervals of the external walls make out a multiple of a modular distance, in the following marked M. The outer part of the inner formwork is composed of inner corner columns 9 and intermediate columns 8. The width of the intermediate columns 8 make out a previously selected fraction of the modular distance M. In the example shown in the drawing, this width is one fifth of the modular distance M, and in the following it will be called the width of the modular zone Z.

In principle an intermediate column 8 can be placed by each of the modular centres along the intervals of the external walls between those inner corner columns, which are placed by the corners of the building, that is, in case the building is not to be equipped with partition walls. In case the building is to have partition walls, such as shown on the drawing, that is a central partition wall in the middle of the building (shown vertical in fig. 1) and a transverse partition wall, placed from the middle of the central partition wall and to the middle of one of the external walls, there is applied by the intersections between those partition walls and the exterior walls two inner corner columns 9.

The sheeting of the intermediate columns 8 form the inner surface of the outer walls, while the face of the sheeting of the columns 8 is placed with a distance corresponding to half the thickness of the outer wall, from the modular plan through the intervals of the outer walls.

These columns 8 are also placed symmetrically in relation to the corresponding modular plan 1.

The inner corner columns 9 have an angular cross section and are, as far as the columns are concerned, which are placed in the corners of the building, placed with the face of their sheeting in a distance from the modular plans of the outer walls, which corresponds to half the thickness of the outer wall.

As far as the corner columns are concerned, which are placed by the junctions between the partition walls and the outer walls, in case the partition walls are of the same thickness as the outer walls, these may be shaped

in the same way as those inner corner columns, which are placed by the external corners of the building, and they are placed in a similar way as those, that is with one face of sheeting in a distance corresponding to half a thickness of the exterior wall and with their other face of sheeting in a distance of half a thickness of the partitiuon wall from the modular plan of the partition wall concerned.

Exactly the same is the case, as far as the inner corner columns 9 are concerned, which are placed in the middle of the building, that is by the intersection between partition walls, since those are also placed with their outward turned facing in a distance from the modular junction of the modular plans concerned, corresponding to half the thickness of a wall.

By the junction between the two partition walls there is further placed two intermediate colums 8 with their sheeting facing each other and with a mutual distance corresponding to the thickness of the wall.

This is also the case in those places of the central partition wall, which is placed in the middle between the transverse partition wall and the corresponding exterior walls.

All inner corner columns and all intermediate columns are shaped and placed in such a way, that they establish intervals between each other, which are of identical width, that is the modular distance M less the width of the modular zone Z, which under the conditions mentioned above correspond to an interval with a width of four Z.

Alle columns 8 and 9 have boundary flanges by their side edges. Between the columns 8 and 9 are placed filling in panels 6, the length of which corresponds to the length of the interval between the columns, that is four Z, and the width of which makes out a multiple of the width of the modular zone Z, which includes that it might have the same width os that of the modular zone.

In the present case, the width of the filling in panels is equal to two Z, and also the filling in panels have boundary flanges along their edges.

The filling in panels may suitably have a small recess along their side edges, and the columns 8 and 9 have a corresponding stopping edge along their side edges, so that the filling in panels easily can be inserted between the columns from inside and be placed with their sheeting being flush with the sheeting of the columns, where the connecting flanges of the filling in forms are connected to the connecting flanges of the columns.

The soffit forms of the inner formwork consist of structural elements, which are supported by the columns 8 and 9. These structural elements are demarcating intervals between their edges facing each other, the dimension of which in one direction (the vertical

direction on fig. 1) likewise corresponds to the modular distance M less the width of the modular zone Z, and which in the other direction perpendicular to the first direction has a length corresponding to multiple of the width of th modular zone Z.

in the version shown in the drawing, these structural elements include corner headers 4. Seen from above they have the shape of an angle, and there is placed one at each of the corners of the inner formwork.

As the building, for which the formwork shown in the drawing is to be applied, as mentioned previously, has a central partition wall and a transversal partition wall, there are placed corner headers 4 by each of the corners between the partition walls mutually and by the corners between the partition walls and the outer walls.

Each side of each of the corner headers 4 has an angle shaped cross section and has a length corresponding to the modular distance M minus one half of the thickness of the adjoining wall.

If the partition walls and the exterior walls are of the same thickness, the sides of all corner headers 4 are of identical lengths. However, it is easy to compensate for a smaller thickness of a partition wall by having correspondingly longer sides of the corner headers.

In those cases where the ends of the sides of the corner headers 4 do not meet, that is along walls longer than two modules, there is placed between the ends of the sides of the corresponding corner headers filling in headers 5, with angle shaped cross section, the length of which corresponds to a multiple of the modular length, which includes that it might have the same length as the modular width.

By the erection of the inner formwork, the joints between the ends of the headers 4 and 5 are placed on the top of the intermediate columns and in the centre plans of the columns.

The corners of the corner headers 4 are placed on top of the corner columns 9, and due to the previously explained dimensioning , the outward oriented faces of the sheeting of the corner headers 4 will be flush with the faces of the sheeting of the corresponding corner columns and the faces of the sheeting of the intermediate columns concerned.

The horisontal width of each of the headers 4,5 corresponds simultaneously with half a width of a modular zone less half a wall thickness, and the edges of the headers turning away from the corresponding wall will thus make out plans, which are placed half a width of a modular zone displaced to the side from the modular plan 1.

To the structural elements of the suffit forms are

further belonging beams, the width of which in a horizontal plan corresponds to the modular width Z, and which is placed symmetrically in relation to the corresponding modular planes 1.

In those cases where the building is not to be equipped with partition walls, those beams can span from exterior wall to exterior wall. By the version shown on the drawing, they have lengths corresponding to two modular width less the width of a modular zone., since their ends are adjacent to the free edges of the headers 4,5.

Also these edges ar furnished with connecting flanges, which are at a right angle with the sheeting of the headers, which are the upper sides of these headers.

As shown in fig. 3. each beam 3 may be furnished on its lower side with a girder construction to increase the rigidity of the beam.

Also the beams 3 have along their edges connecting flanges, which are perpendicular to the sheetings of the beams, that is the surfaces oriented upwards in fig. 1, and which are flush with the top sides of the headers 4,5.

The beams 3 are placed flush with the corresponding inner columns 8 and are connected with these and/or with the connecting flanges by the ends of the beams.

As the free edges of the headers 4,5 as mentioned previously are staggered half a modular width compared to the corresponding modular plan, and since also the edges of the beams 3 are displaced half a modular width compared to the corresponding modular plan, the opposing edges of the beams and headers demarcate intervals with a width of four times the width of the modular zone, that is exactly corresponding to the length of the previously mentioned filling in panels 6.

Seen in the direction parallel to the beams 3 there will also between the free edges of the headers be delineated distances corresponding to a multiplum of the width of the modular zone.

Consequently, between the beams 3 and the edges of opposing headers, ther can be placed filling in forms 6, as shown in fig. 1, with a width corresponding to two times the modular width.

As in the version shown in fig. 1 there exists the central partition walls already mentioned several times, with corresponding headers 4, and since these, between their free edges have a width corresponding to the width of the modular zone, the full width between external walls facing each other cannot be filled with filling in panels with a width corresponding to twice the width of the modular zone.

In order to compensate for this, there has been inserted

filling in forms 7 with a width corresponding to the width of a modular zone on each side of the central partition wall.

The filling in forms are placed facing intermediate columns 8.

Also the filling in forms 7 are furnished along their edges with connecting flanges, which are perpendicular to the sheeting of the panels concerned., so that thus all filling in panels 6 and 7 can be mutually connected, and can be connected with the beams and with the headers, so that all these soffit forms with their top sides can be placed in the same plane, that is corresponding to the under side of the floor slab.

However, the filling in forms of the soffit formwork can also, according to the present invention, possibly be provided with waffle forms or similar, or in other ways be given varying heights for the creation of openings or recesses in the floor slab.

The inner formwork, as explained above, is as mentioned previously surrounded by an exterior formwork with four side walls, which together with the outer sides of the inner formwork are forming the intervals for the casting of the exterior walls of said building.

The inner surfaces of said side walls are placed in a distance from the modular plan 1 concerned corresponding to half the thickness of the wall.

The outer forwork is composed of vertical outer intermediate columns 10, the width of which correspond to the width of the modular zone, and of outer corner columns 11.

By the version shown in the drawing, the outer intermediate columns 10 are shaped to form vertical ribs along the outer sides of the outer walls, however, naturally their facing towards the wall can also be plane.

The outer corner columns 11 have an angular cross section, and their inner sides serve as forming surfaces for the outward protruding corners of the building.

In the version shown on the drawing, the width of these forming surfaces correspond to half a modular zone plus half the thickness of the outer wall.

Consequently, it is clear,that the mutually facing side edges of the outer corner columns 11 and the outer intermediate columns 10 define intervals with a width corresponding to the the modular distance m less a width of a modular zone.

Simultaneously this is implies, that between these outer columns can be placed filling in panels corresponding to

the previously mentioned filling in panels 6, which form part of the side walls of the inner formwork and of the soffit forms.

Also the outer columns 10,11 are provided with check edges along their mutually facing side edges for guiding the filling in panels , when they are inserted into the intervals between the columns 10,11 from outside.

In order to secure the correct distance between the inner and outer formwork combined spacers and fastenings 12 are inserted between the inner and outer columns, as shown schematically in fig. 2.

When the formwork is being applied, it is mounted on a previously cast floor slab, on which is placed a sill 15 largely consisting of structural forms corresponding to the header forms 4,5, which form part of the soffit forms of the inner formwork, and which consequently make out the lowest form surfaces between the junctions between the lower floor slab and the outer walls, respectively partition walls. To this sill is connected the lower ends of the inner columns 8 and 9, and the top ends of these same are connected by means of the header forms 4,5 and the beams 3, as explained previously.

The height of the inner columns (between the upper surface of the sill and the under side of the header) is preferably made corresponding to a multiple of the width of the modular zone, in order that there can be applied filling in panels, as shown in fig. 3, possibly supplemented by a filling in panel 7, the width of which is equal to the width of the modular zone, all depending upon the size of the basic modular distance.

By the formwork shown in the drawing, the modular distance is equal to 120 cm, that is coresponding to a width of a modular zone of 24 cm. It has to be understood, that also other modular distances may be used, and that the width of the modular zone can be made another fraction that on fifth of the modular distance, for inst. corresponding to one third, one forth etc.

Fourthermore, naturally the width of the filling in forms need not correspond to the width of one or two modular zones, however, with the dimentions mentioned in the foregoing, such dimensioning of the filling in panels resuls in easily handlable units.

For the supply of the building concerned with window and door openings, it is immediately understood that there may be placed corresponding frames, see 13 and 14 in fig. 2 between inner and outer formwork.

When the formwork is erected in the way described above, the casting of the cavities between the inner and the outer formwork and between the formwork of the partition walls, which like the forming surfaces of the outer walls are build up from filling in panels 6, which are inserted between the inner intermediate colums 8 and the

inner corner columns 9 placed inside the building.

Furthermore, it is obvious, that the formwork according to the present invention, can be build up with many other basic plans than the one shown in the drawing, since the observance of the construction principles as explained in the foregoing always will result in a very substantial standardization of the elements used, especially as far as the filling in panels are concerned.

Additionally, it is obvious, that the thickness of the outer wall can be changed just through the alteration of the outer corner columns 11 placed by the outer corners of the building. In case the width of the flanges of the outer corner column 11 is increased, and in case the outer columns 11 are placed with a corresponding larger distance from the inner corner columns 9, a correspondingly increased thickness of the outer wall is obtained.

If the width of the flanges of the outer corner columns 11 is chosen less that shown in the drawing, and placed in a correspondingly reduced distance from the inner corner columns 9, a corresponding reduction of the thickness of the outer wall will be the result.

By the application of outer corner columns 11 with different widths of flanges, the building can further be given outer walls with different thicknesses of the outer wall.

In these cases, the vertical modular plane 1 in the interval of the outer wall indeed will not represent the centre plan of the interval, but anyway the modular principle will be complied with, and the sectioning of the structure with standard intervals will remain unchanged.

The outer corner columns 11 and the inner corner columns 9 just have to be framed and placed in such a way, that their two by two mutually facing edges are placed in vertical plans which are displaced sideways half the width of the modular zone compared to those modular plans, which establish the modular centre concerned.

As indicated above, the partition walls can be made with a thickness differing from the thickness of the outer walls, that is in the inner formwork to apply corner columns 9 with corespondingly larger or smaller width of flanges, and to use corresponding ly formed corner columns by the intersections between partition walls and outer walls.

In this case only it is also necessary to assure that the corresponding and mutuaslly facing side edges of the columns delienate intervals with a width, which corresponds to the modular distance M less the width of the modular zone Z.

In case the building concerned is to be of one floor only, the roof slab can just be struck-off with the desired thickness.

In case the building is to contain more than one floor, a sill 15, as indicated in fig. 3, should appropriately be placed corrresponding to that sill 15, which is placed on the lower floor and with the under surface of said sill in the same plane as the upper side surface of the desired floor slab, so that in this way there can be cast kickers in continuation of external walls and partition walls, whereby the forming and casting of the following floor is facilitated.

A further advantage of the formwork according to the present invention is, that the header arrangement consisting of the forms 4 and 5 are establishing a well defined structural frame, which due to the firm connection with the columns 8 and 9 is fixing the width of the intervals between the columns, so that thus the accumulation of tolerances can be avoided.

Such an accumulation is often very inconvenient in those cases, in which a number of form panels are joined side by side, which situation is avoided in the present construction in consequence of the establishment of well defined bays through the use of sills, columns and headers.

Furthermore it is an advantage by the present construction, that all the structural elements of the formwork, that is, the sills, columns, headers and beams are placed within areas, which spread half the width of a modular zone inward from the vertical plans through the outer modular lines of the modular grid, and those areas, which spread half the width of a modular zone on both sides of the vertical planes, which pass through the inner modular lines of the modular grid.

The demarcation lines of these areas are marked on the drawing with reference lines 2.

By the ground floor of the form of execution shown in the drawing, the lower ends of the columns of the outer formwork 10, 11 and the under edges of the lower filling in panels in the walls of the outer formwork could be placed on the top surface of a sill, the upper surface of which is flushing with the sill 15 if the inner formwork.

The columns of the outer formwork, which are made in two parts, will thus stand up above the suffit forms of the inner formwork corresponding to a width of a modular zone above the under surfaces of the outer side of the headers 4, 5. These standing up ends of the columns of the outer formwork wille be used in the case shown to carry the sill 15 of the next floor. After the casting of a floor the process is continued upwards, as is seen in fig 3, which shows a section of an intermediate floor.

If it is intended to provide the formwork with one or more subsections of smaller dimensions, it is possible to use for such subsections the same modular zone, however in connection with a smaller submodule being a fraction of the "main" module M.

CLAIMS

1. Formwork for casting buildings or parts of buildings, and which consists of inner formwork with outward oriented sheetings for the demarcation of corresponding inner sides of the building or part of the building, and suffit formwork for the demarcation of the under side of a floor slab, which formwork moreover has outer formwork with sheetings turned inwards for the demarcation of corresponding outer sides of the building or part of building, said outer formwork with inward turning sheetings, when being used, is placed with interval in relation to the inner formwork with outward oriented sheetings, w h e r e i n the distance between imaginary vertical planes (1) through each pair of opposite intervals between inner and outer formwork be a multiple of a previously selected length, the modular distance (M), while the inner formwork with outward oriented sheetings is composed of column elements (8,9 and 10,11 respectively), which are placed with a mutual distance between their sides, which corresponds to the modular distance (M) less a fixed fraction, the width of the modular zone (Z), of this, and while in the intervals formed by the columns of the inner formwork and the outer formwork (8,9 and 10,11 respectively) be placed filling in panels (6 and 7), the length of which corresponds to the distance between the sides of the adjoining columns, and the width of which corresponds to a multiple of the width of the modular zone, while the formwork for the floor slab consists of, by the columns (8,9) of the inner formwork, supported structural form elements (3,4,5), which between their edges facing each other demarcate intervals, the dimension of which in one direction correspond to the distance between the edges of the adjoining columns, and in the other direction perpendicular to the first one the dimension of which corresponds to a multiple of the width of the modular zone, in which intervals are placed filling in panels (6, 7).

2. Formwork according to claim 1, w h e r e i n said imaginary vertical plans (1) through each pair of opposite intervals between inner and outer formwork make out the centre plan of said intervals.

3. Formwork according to claim 1, w h e r e i n in the inner formwork placed column elements (8,9), for the forming of partition walls, which column elements are placed at modular centres, and which are placed with a mutual distance between their sides, which corresponds to the modular distance (M) less a fixed fraction, the width of the modular zone (Z), of this, and while in the intervals formed by the columns of the inner formwork (8,9) be placed filling in panels for the casting of partition walls and corresponding to the filling in panels (6) of the inner and outer formwork.

4. Formwork according to claim 1, w h e r e a s the structural form elements of the formwork for floor slabs include corner headers (4), which, seen from above, have the shape of an angle, and in case the building is to have partition walls, then also by each corner between partition walls mutually and between partition walls and the side walls of the inner formwork, the sides of the angle of the corner headers (4) have a length, which practically correspond to the modular distance minus half of the thickness of the adjoining wall, and that between the ends of these corner headers (4) in those cases, when they are not adjoining, are placed filling in headers (5), the length of which correspond to the modular distance (M) or a multiple thereof.

5. Formwork according to claim 1, w h e r e a s the inner formwork includes a sill structure (15) with corner sills (4) and filling in sills (5) similar in shape and dimensions to the headers mentioned in claim 4.

6. Subsection for a formwork according to claim 1 characterized by a submodule being a fraction of the module (M), and by an unchanged modular zone (Z).

7. Method of forming for casting buildings or parts of buildings using formwork as described in claim 1 to 6.

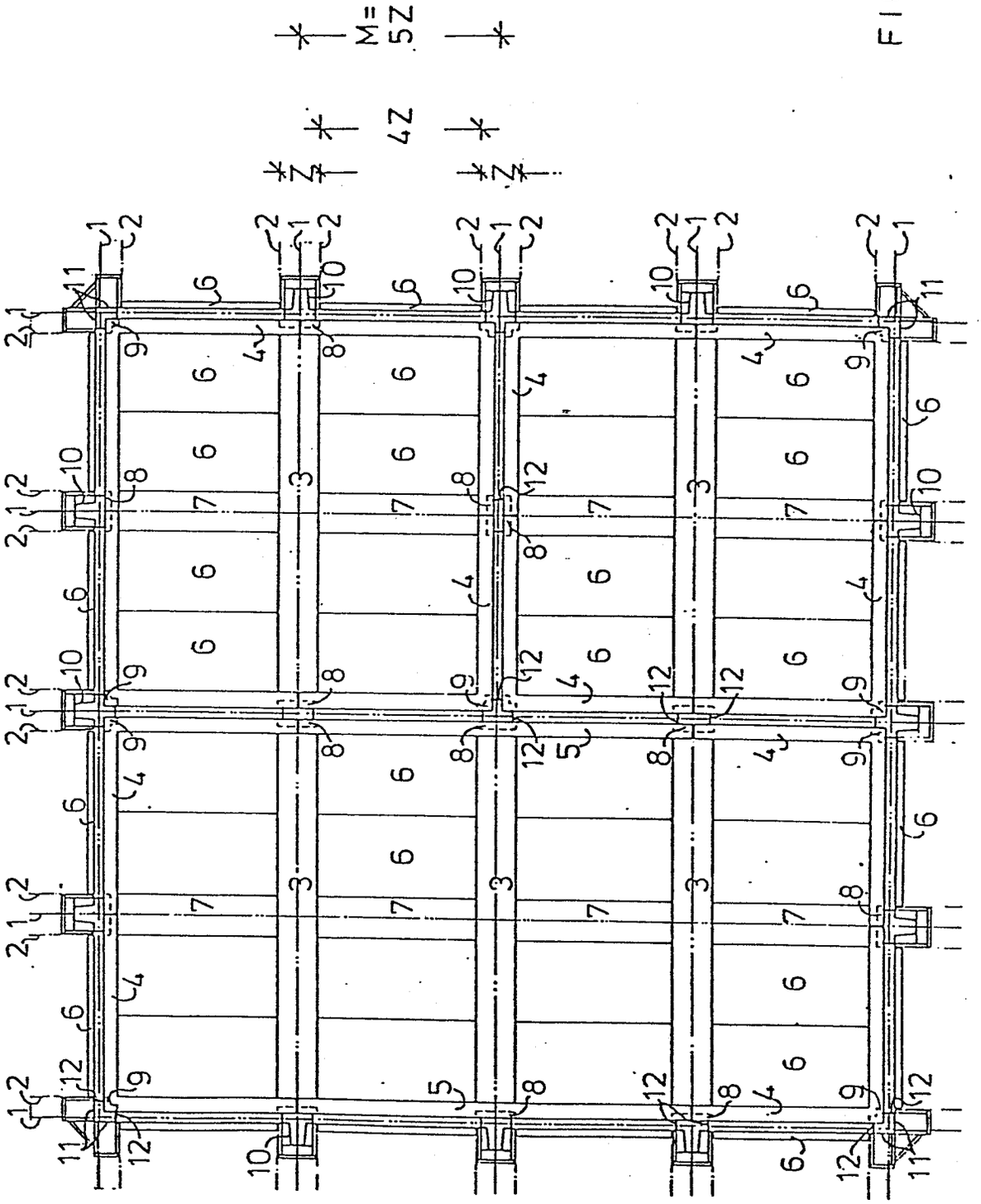

FIG. 1

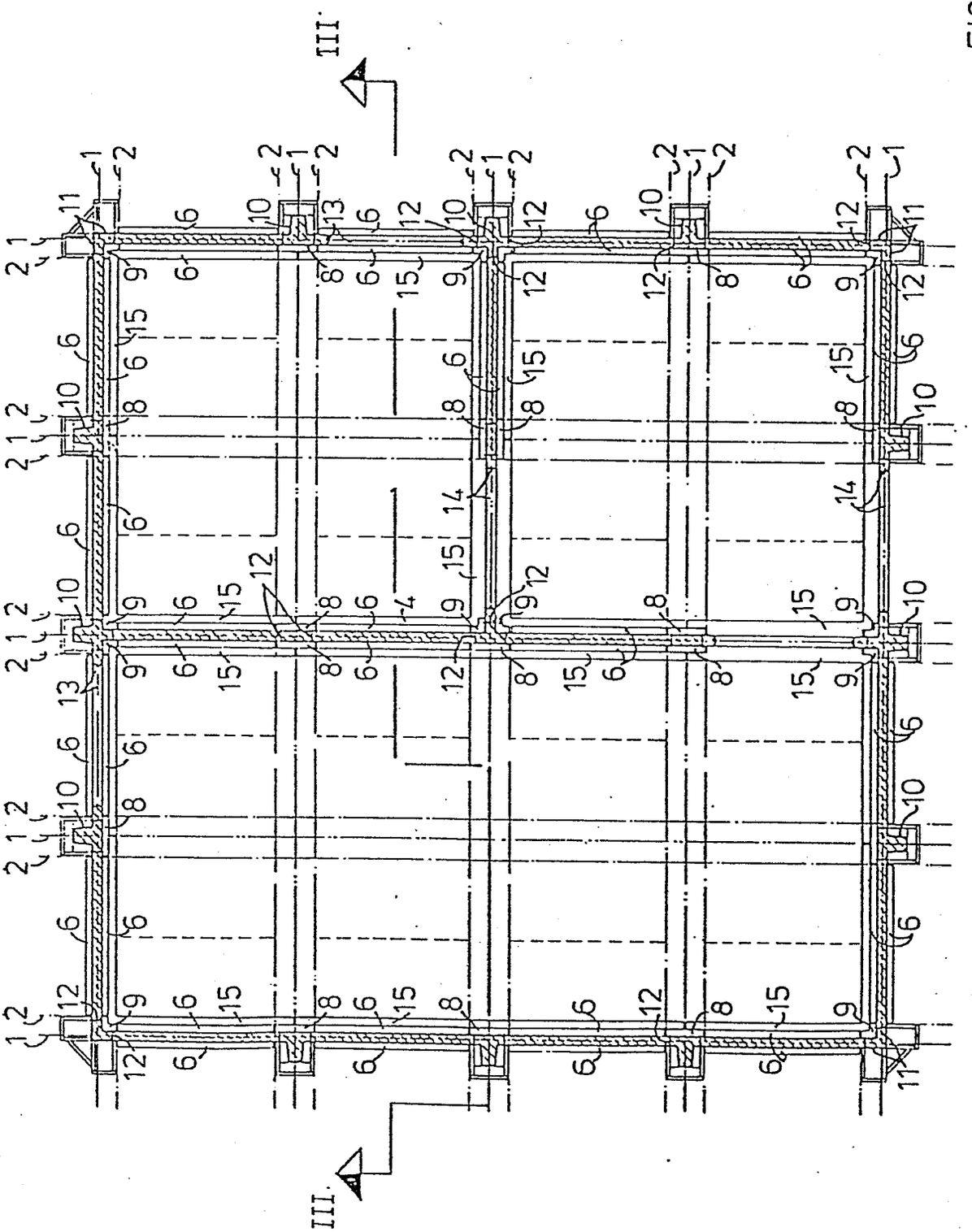

FIG. 2

FIG. 3