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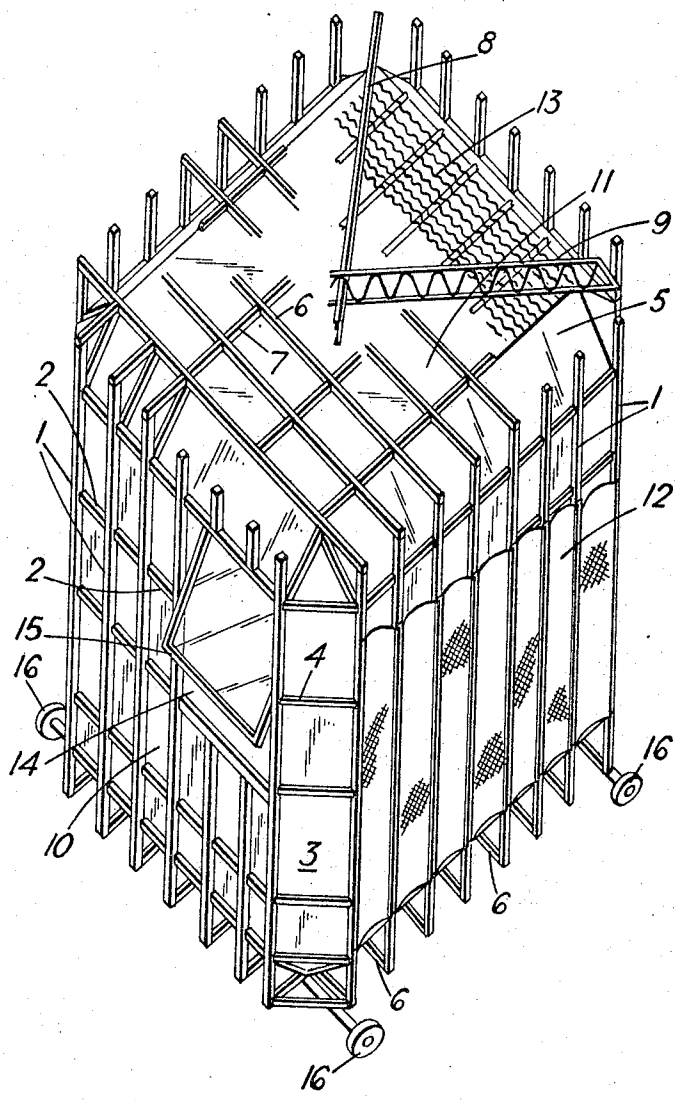
PREASSEMBLED SUBENCLOSURES ASSEMBLED TO FORM BUILDING CONSTRUCTION

Filed Dec. 19, 1963 7 Sheets-Sheet 1

Fig. 1.



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PREASSEMBLED SUBENCLOSURES ASSEMBLED TO FORM BUILDING CONSTRUCTION

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Fig. 2.

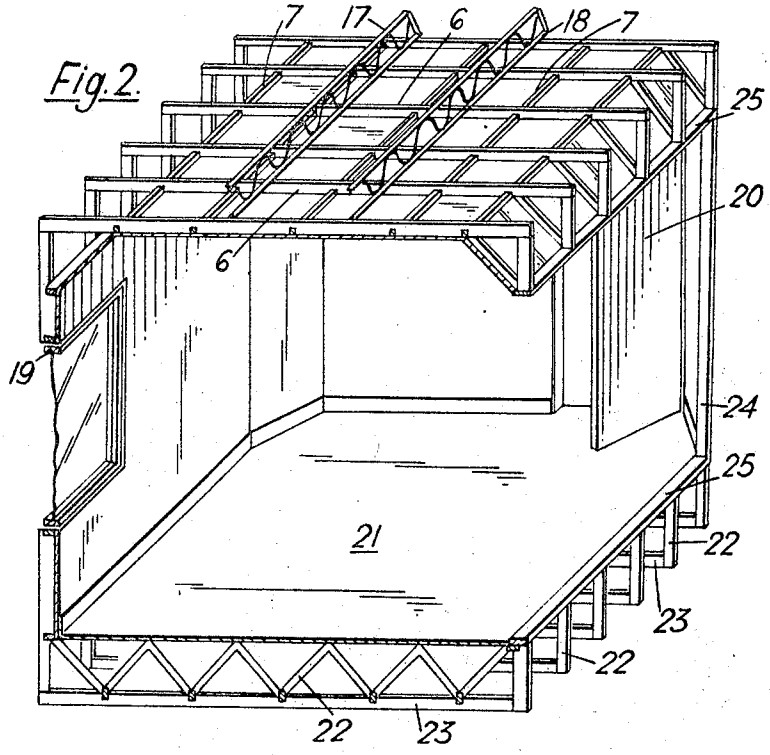

Fig. 4.

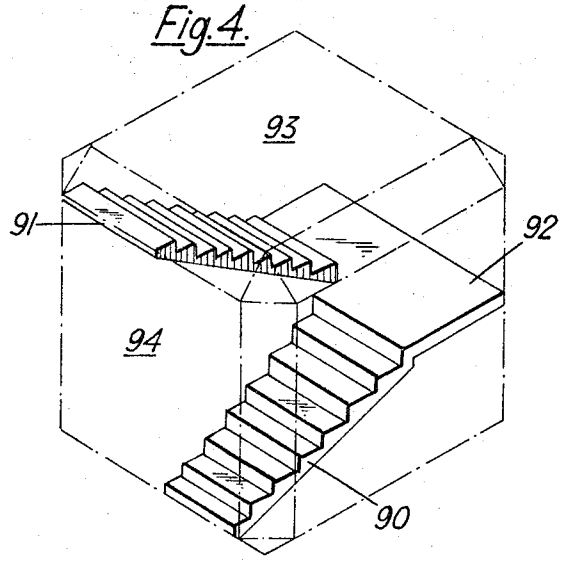

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Fig. 3.

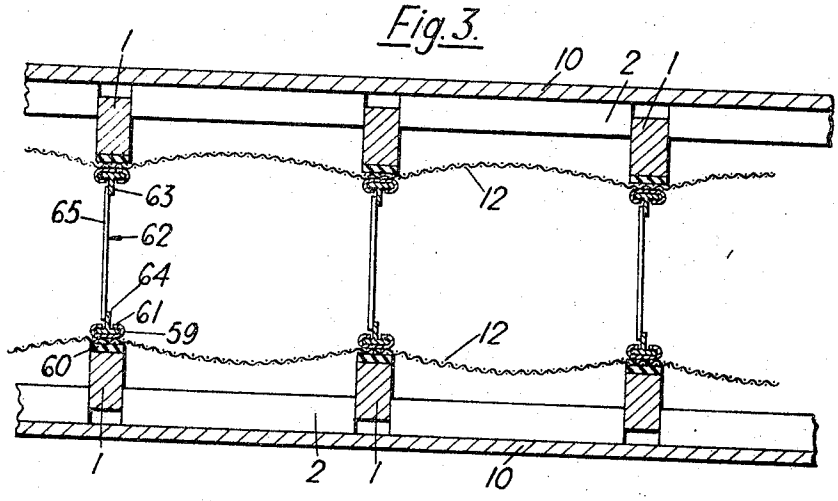
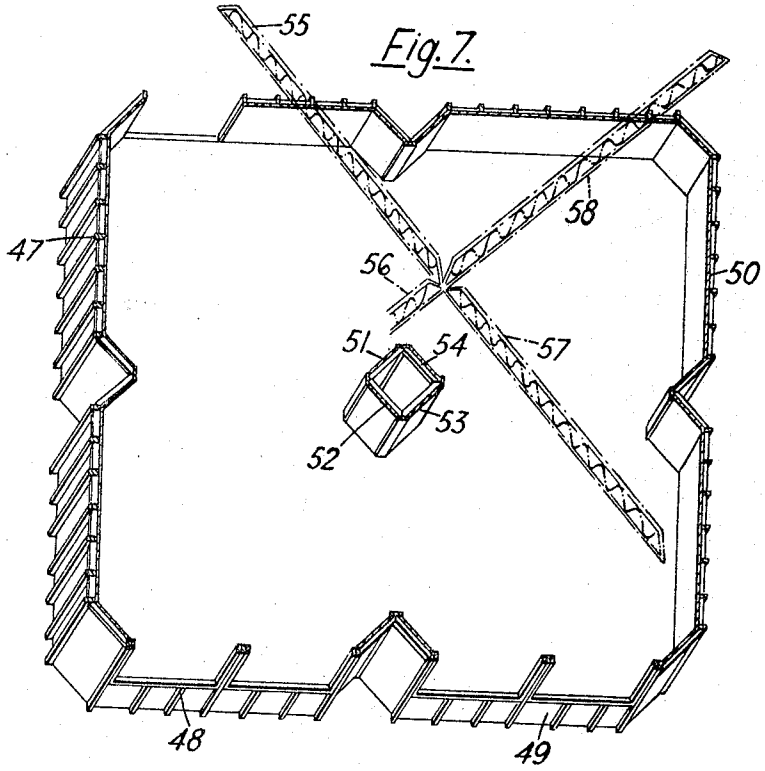


Fig. 7.



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PREASSEMBLED SUBENCLOSURES ASSEMBLED TO FORM BUILDING CONSTRUCTION

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Fig. 5.

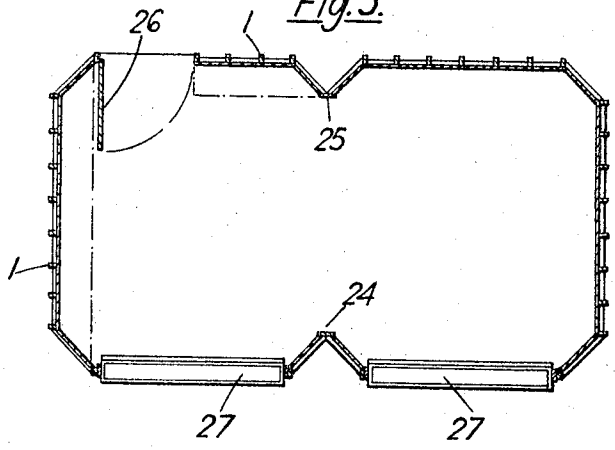

Fig. 6.

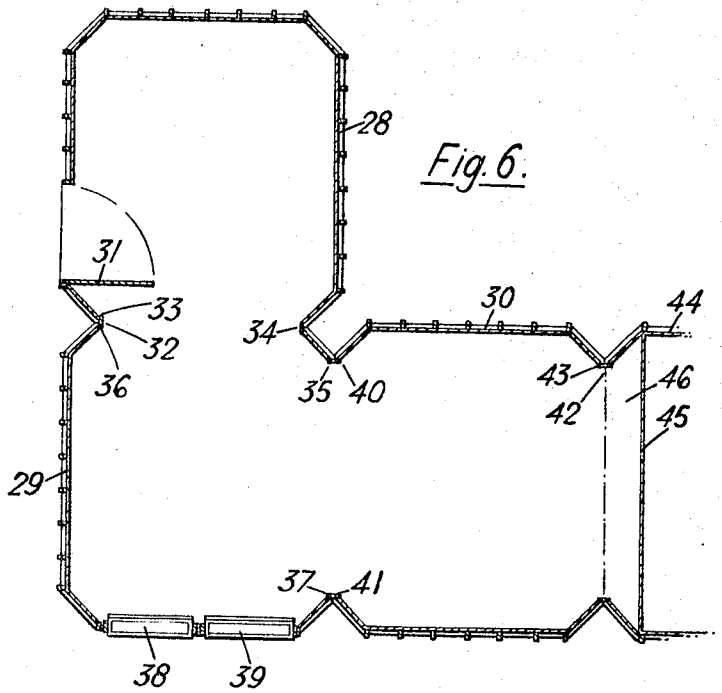

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Fig. 8.

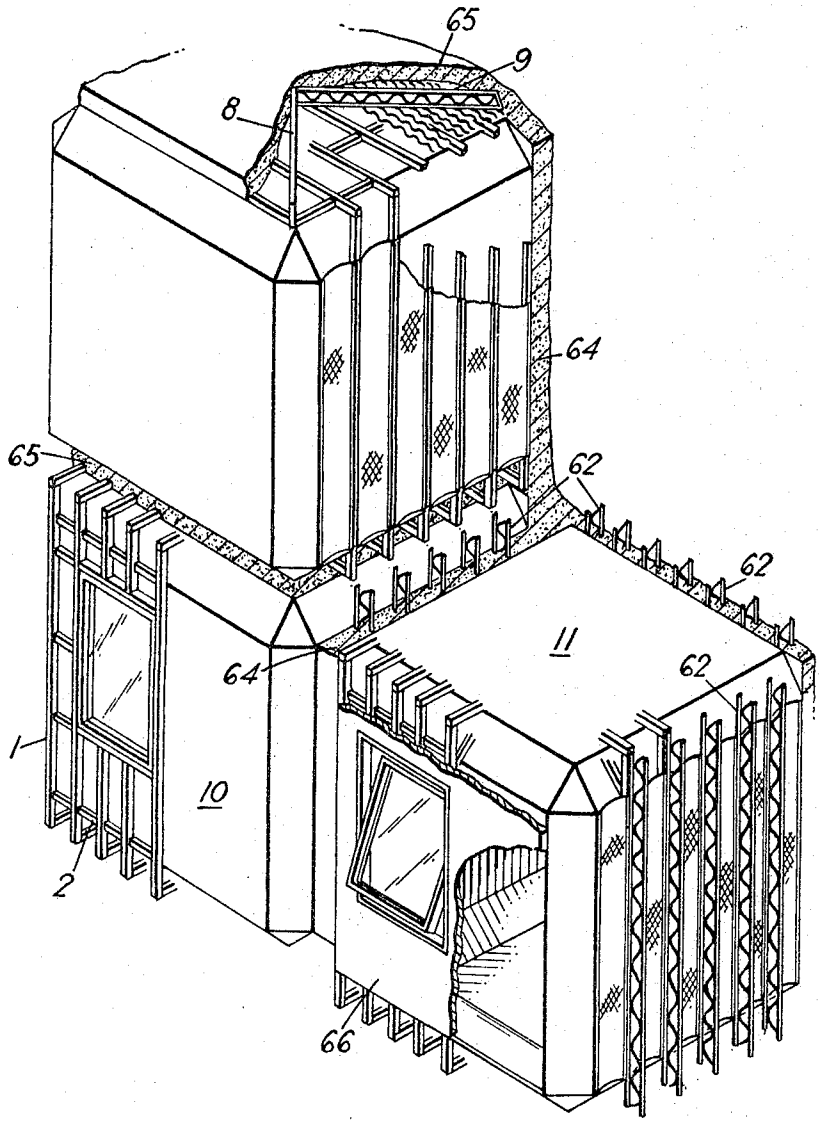

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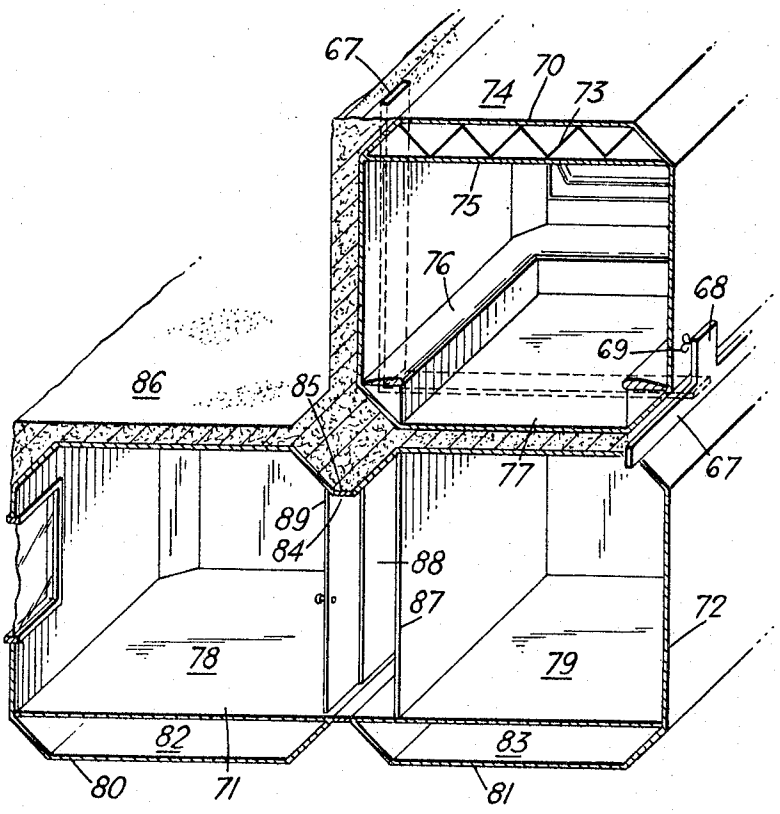
Fig. 9.



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PREASSEMBLED SUBENCLOSURES ASSEMBLED TO FORM BUILDING CONSTRUCTION

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Fig. 10.

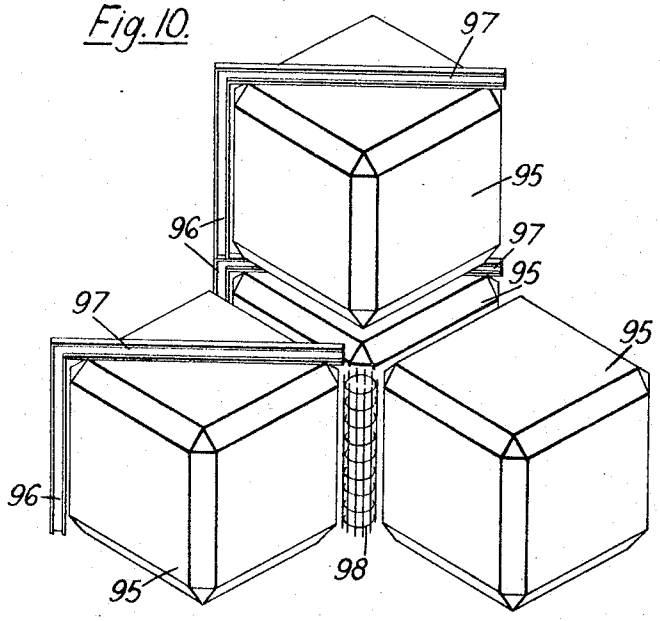
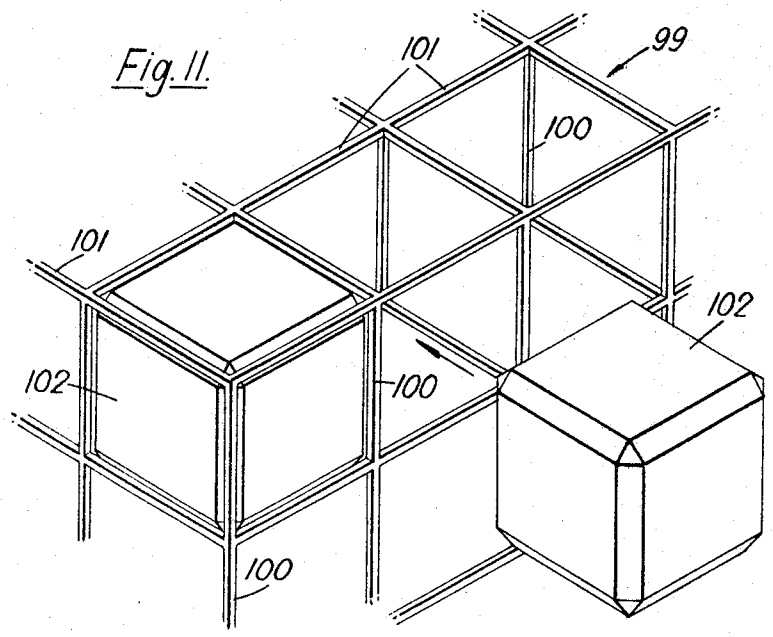


Fig. 11.



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3,331,170

PREASSEMBLED SUBENCLOSURES ASSEMBLED TO FORM BUILDING CONSTRUCTION

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Claims priority, application Great Britain, Dec. 29, 1962, 33,194/62
3 Claims. (Cl. 52—236)

With modern building techniques, although it is possible to erect the shell of a building, such as a block of flats, in a comparatively short time, the total construction time is much longer because a large proportion of the total time taken to complete the building is consumed in finishing the building interally. This internal finishing consists in laying floors, fitting door frames and doors, applying plaster and other finishes and providing services such as water and electricity.

The proportion of the total construction time taken in internal fitting is particularly high in the construction of flats where the building is sub-divided internally into a large number of comparatively small rooms, and a number of internal fittings are necessary, for example built-in kitchen cabinets, sinks and also bathroom fittings.

The proportion of total construction time taken in internal finishing and the proportion of cost reflected in internal finishing are also particularly high in dwelling construction because it is usually carried out on site where the organization is at the mercy of the weather and also where the organisation is necessarily such that a multiplicity of trades, not only those concerned with internal finishing, are working on the job at the same time in a manner which is often only roughly co-ordinated.

According to this invention we construct a building by prefabricating a number of box-like units with their sides provided internally with finishes and fittings to form the floors, ceilings and walls of the rooms and other spaces within the building and the units are then fixed together in layers on site to form the building.

This method is especially applicable to flats and other multi-storey dwellings, but it can also be used with houses, particularly terrace houses in which there are only two or three floors. The units are also preferably provided with electrical wiring, plumbing, other services and also built-in furniture where this is required, before they are erected on site.

In this way all or nearly all the internal partitions in the buildings together with all finishes, fittings, services and built-in furniture can be produced in a factory by mass production techniques. The erection of the units on the site of the building is then comparatively simple matter which can take place very rapidly indeed. The fact that a large proportion of the construction of the building is carried out in a factory under factory conditions has a number of advantages. First of all, the developer of the building is able to plan and order ahead leaving only the actual erection to be carried at the time that the site becomes available. This enables the factories to plan ahead and large seasonal fluctuations in labour demands in the building industry can be avoided to a very considerable extent with a consequent saving in costs. Further, a large variety of different buildings can be constructed by the selection of different combinations of standard units. It is possible therefore to achieve variety while still achieving the savings of standardisation.

The units themselves may be wrapped up or otherwise protected as they are transported from the factory to the site for erection, but preferably the units themselves are made weatherproof and able, by themselves to stand up to the stresses imposed upon them during transport

and erection. For this purpose, where more than one unit is necessary to make a single room or other open space, the units are initially closed on all sides before erection and then at least some of the units have bulkheads which are removed after erection to open the spaces within two or more separate units into a single space.

The internal wall surfaces and finishes together with their fittings may be detachably fitted within the units themselves so that the units can be redecorated or modified as the owner may require after the construction of the building.

The units may be fixed together in layers by first of all constructing a framework of columns and beams and then inserting the units into this framework so that they are supported side by side and in layers one above the other. Preferably, however, the units themselves are stacked together in layers and are then fixed to each other to form the building structure. So that the structure has sufficient strength, particularly in multi-storey buildings, to support the weight of the storeys above, the units themselves may incorporate sections of columns and beams which are connected together when the units are fixed to each other to form a structural framework knitting in with the units. As an alternative to this, the units may be fixed to each other with spaces between them and these spaces, both horizontal and vertical may then be filled with concrete which itself forms the weight supporting structure. The finished concrete structure is in the form of a three dimensional egg box with the units in the spaces between the crossing walls and the floors forming the box.

Especially when concrete is used to form the structure between the box-like units, the units are preferably made with double-skinned walls including studding with the internal wall finishes fixed to their inner faces and an outer skin fixed to their outer faces. The concrete is then placed between the outer skins of adjacent units so that there are air spaces between the concrete and the internal wall finishes. This avoids difficulties due to moisture from the concrete penetrating the wall finishes and damaging them during erection and it also assists in sound and thermal insulation between adjacent rooms or other spaces. Use may also be made of these spaces for the circulation of hot air for central heating purposes. When this is done, ducts are provided for supplying the hot air to these spaces and the spaces surrounding different units are separated from each other by divisions and the ducts have separate closures to allow the different spaces to be supplied with hot air as required.

To make it simple to fix the units together in different combinations, the units are preferably either all the same size and shape as each other and all the units are preferably rectangular. The units may have chamfered edges so that the spaces between adjacent units are increased in width at the adjacent edges of the units. When concrete is placed between the units, the thickness of the concrete filling is thus increased at the edges to form stiffening beams and columns. The units may be fixed to each other by clips which are fixed to the outside of the studding in the walls of the units these clips being themselves fixed together by members which are held by the clips on adjacent units. Each of these members may consist of a ladder comprising two flanges with connections between them and each clip then comprises a pair of side arms which embrace one of the flanges of the ladder. With this arrangement, there may be a number of clips arranged along the length of each stud in the studding and then the ladder is slid into position with its flanges sliding into the clips on two adjacent studs on different units.

Apart from the method of constructing buildings in

accordance with the invetnion, the units used in this method are also novel and form another aspect of the present invention. According to this, such a unit comprises a closed rectangular box having on its internal walls finishes and fittings to form the floor, walls and ceiling of a room or other space within a building and having fixed to its outside means for fixing the unit to other externally similar units in layers.

In many of the units, where rooms or other spaces are to be formed by more than a single unit, one side at least will be formed by a removable bulkhead. This bulkhead remains in place until the unit has been erected on site and the concrete, where this is used, has been placed.

Various examples of units and methods of using them to construct buildings in accordance with the invention will now be described with reference to the accompanying drawings, in which:

FIGURE 1 is a perspective view from above and from one corner, which is partly diagrammatic of one unit with parts broken away for clarity;

FIGURE 2 is a partly diagrammatic perspective view of another unit with one side wall removed to show the internal construction;

FIGURE 3 is a horizontal section to an enlarged scale showing the connection between two adjacent units;

FIGURE 4 is a diagrammatic perspective view showing a unit containing a staircase;

FIGURE 5 is a plan to a smaller scale illustrating the formation of a single room by two units fixed together side by side;

FIGURE 6 is a plan showing the formation of a single room with three units fixed together side by side;

FIGURE 7 is a partly diagrammatic sectional view showing the formation of a single room by four units fixed together with the tops removed to show the internal construction;

FIGURE 8 is a partly diagrammatic perspective view showing details of the construction of a building with three units fixed together and with concrete placed in-between them;

FIGURE 9 is a front perspective view of another three units fixed together with concrete between them and with their fronts removed to show internal details;

FIGURE 10 is a diagrammatic perspective view illustrating different units and the method of fixing them together; and,

FIGURE 11 is a diagrammatic perspective view illustrating yet another method of fixing the units together in layers.

The unit shown in FIGURE 1 is substantially cubical with chamfered edges, being approximately 8 feet wide and 9 feet long in plan and 8 feet high in internal dimensions. The walls of the unit are formed by frames comprising vertical timber studs **1** with horizontal timber battens **2** between them. The vertical edges of the unit are chamfered as shown at **3** and horizontal timber battens **4** extend across these chamfers.

The top and bottom of the unit is formed with similar studding **6** with cross battens **7**. Spaced above the studding **6** and cross battens **7** in the top of the unit are two diagonally extending roof beams **8** and **9** which are shown partly cut away and form the structural members which support the layer of units above the layer in which the unit illustrated is placed. They may alternatively support the roof when the unit is placed in a top layer. To the inside faces of the studding **1** and **6** and the battens **2** and **7** is fixed panelling **10** and **11** and also flooring (not shown) which form the finished internal wall, floor, and ceiling surfaces of the room formed by the unit.

Sheets of metal mesh **12** and **13** are fixed to the outside of the studding **1** and **6**, respectively, so that there are air spaces between the mesh **12** and **13** and the adjacent panels **10** and **11**. Instead of metal mesh, strong sheets of hessian may in some circumstances be used.

In the particular unit illustrated in FIGURE 1, there is a window opening **14** fitted with an opening sash window **15**. This face of the unit is intended to form an external face of the completed building and in this instance is not covered with metal mesh. The face of the building may be finished with a separate exterior panelling. Where these panels are only intended to extend over the face of a single unit, they may be fitted in position in the prefabrication operation before the unit is erected in position, but where a single panel extends over the face of more than a single unit, the panels are fitted in position after erection of a number of units forming the face of the building.

The unit shown in FIGURE 1 is fitted with wheels **16** shown diagrammatically. These wheels may be provided solely for ease in moving the unit on the site, but alternatively they may be fitted temporarily for transporting the unit to the site by road or railway.

The unit shown in FIGURE 2 is constructed in a generally similar manner to the unit shown in FIGURE 1 with timber studding and cross battens **1, 6** and **7** as shown in FIGURE 1, but instead of the diagonally extending roof trusses **8** and **9**, there are a pair of roof trusses **17** and **18** extending directly across the centre section of the unit. There is again a window **19** in one side of the unit and in an adjacent side is a door **20**. The internal floor surface **21** is supported on diagonally braced timber beams **22** having bottom chord members **23** which perform a similar function to the bottom studs **6** shown in FIGURE 1.

The nearest side wall of the unit in FIGURE 2 is shown broken away to illustrate the internal details of the unit, but the right hand side of the unit, that is the side opposite the side having the window **19**, has an opening **24** surrounded by a frame **25**. During transport to the site and erection the opening **25** is closed by a removable bulkhead fixed to the surrounding frame **25** and the unit is fixed with a similar opening in another unit closely adjacent to it. This second opening also has a removable bulkhead and when erection is complete, both the bulkheads are removed so that the unit shown in FIGURE 2 and the adjacent unit together form a single room. Two such units fixed together side by side are illustrated diagrammatically in FIGURE 5 of the drawings where both units have openings **24** surrounded by frames **25** which are fixed to each other. One unit is provided with a door **26** and both units are provided with windows **27**.

Three units **28, 29** and **30** may be fixed together as shown in FIGURE 6 to form a still larger open space within the building. In this instance, the unit **28** has a door **31** and a single opening **32** surrounded by a frame **33**. The unit **29** has two openings **34** and **35** surrounded by frames **36** and **37**, respectively. This unit also has two windows **38** and **39** arranged side by side. The unit **30** also has two openings but these are in opposite sides of the unit, one opening **40** being in register with the opening **35** and being surrounded by a frame **41**. The second opening **42** is surrounded by a frame **43** and leads to a further unit **44**. The unit **44** is provided with a partition **45** to enable a cupboard **46** to be formed, in the manner to be described later with reference to FIGURE 9, between the units **30** and **44**.

As shown in FIGURE 7, a single substantially rectangular room may be formed by four units **47, 48, 49** and **50** fixed together in a square. Each of these units has two adjacent walls and openings in the other two adjacent walls. The corners of the units **51, 52, 53** and **54** included between those sides of each unit which have openings, fit together and enclose a space between them which will form a column in the middle of the room. The tops of the units are supported by four diagonal beams **55, 56, 57**, and **58** which are indicated in outline in FIGURE 7. These beams span between the central column formed by the corners **51** to **54** and similar columns formed at

the four corners of the room. Alternatively, the corners **51** to **54** may be parts of the removable bulkhead and there is then an unobstructed space with no columns. There are then only two diagonal beams which span from corner to corner of the space.

The fixing of the units to each other side by side is best illustrated in FIGURES 3 and 8 of the drawings. As shown most clearly in FIGURE 3, the vertical studs **1** of two adjacent units have U-shaped clips **59** fixed to them through rubber pads **60**. These clips are arranged at intervals along the length of the studs **1**. The clips have inwardly bent tips **61** on their side arms. Between adjacent rows of clips **59** are connecting members in the form of ladders **62**. Each ladder **62** consists of two rolled steel T-sections **63** and **64** connected together by a wavy rod welded to either one of the sections **63** and **64** at each of its changes in direction. The ladders **62** are thus similar to fabricated steel beams sometimes used in buildings as floor supporting joists. The T-sections **63** and **64** have their outer arms which are not welded to the rod **65** embraced by the side arms of the clips **59**.

Between the studs **1** are the horizontal battens **2** and the cladding in the form of the metal mesh **12**. Extending across the inside faces of the studs **1** and fixed to the battens **2** are the internal wall panels **10**. There are therefore air spaces between the mesh sheets **12** and the wall panels **10**.

As is shown in FIGURE 8, the spaces between the mesh sheets **12** are filled, after a number of units have been placed side by side and stacked together, with concrete **64**. The concrete closely surrounds the ladders **62** which act as reinforcement. The buildings have a large number of walls formed by the concrete **64** which gives great strength to the finished building. Concrete **65** is also placed, as shown in FIGURE 8, between the different layers of units which are stacked one on top of the other. The concrete **65** which forms floor slabs is reinforced by the diagonally spanning beams **8** and **9** shown in FIGURES 1 and 8 of the drawings.

In FIGURE 8 the right hand lower unit is shown with a partly broken away external cladding panel **66** fitted to its front. Separate panels such as this may be fitted to the outsides of all those units which form the exposed faces on a building, but as an alternative to this, a single panel may be fitted in situ after the erection of the units and this panel extends over the faces of a number of units.

In FIGURE 9 three units are shown fixed together again with concrete interposed between them and this concrete is placed in a similar manner to that illustrated in FIGURES 3 and 8 of the drawings. The ladders **62** are not however shown for simplicity and clarity, but there are air spaces surrounding the units on all sides. Extending through these air spaces is ducting **67**. This ducting has a number of branches **68** leading from it with one branch leading into the space surrounding each separate unit. The spaces surrounding adjacent units are separated from each other by dividing partitions, which are not shown. Each of the branches **68** is provided with an outlet valve **69** which is operable by a control extending into the adjacent unit. By opening or closing these valves, heating air supplied through the ducting **67** can be discharged as required into the spaces surrounding the various units for central heating purposes. The heating is particularly effective because the internal walls of the unit are entirely surrounded by a jacket of hot air. Further ducting may be provided for conducting away the cooled air so that there is a continuous circulation of air through those spaces where it is required at any particular time.

As shown in FIGURE 9 the three units connected together, **70**, **71** and **72** differ in minor details from the units shown in the earlier figures of the drawings.

Instead of having the external roof beams **8** and **9**, or **17** and **18**, the unit **70** is fitted with internal roof beams **73** which are enclosed between the top of the unit **74** and a false ceiling **75**. This unit has a seat **76** around the two

internal walls shown and its floor **77** is at the bottom of the unit. On the other hand, the two units **71** and **72** have external roof beams similar to the beams **17** and **18**, but not shown, but their floors **78** and **79** are supported above the bottoms **80** and **81** of the units and this leaves spaces **82** and **83** in which electric wiring, plumbing and other services are fitted. When provided, these services are fitted in the units during the factory prefabrication of the units and they are arranged with connectors so that the services in adjacent units can be connected up as necessary when the units are erected.

Furthermore, the unit **72** is provided with an open side **84** which is surrounded by a frame **85** which prevents the concrete **86** entering it and spaced away from this open side is a partition **87**. The partition **87** forms the back of a cupboard **88** to which access is obtained through a door **89** in the side of the unit **71**. This arrangement enables a larger room to be formed by the whole of a single unit and for access to be provided from this unit to a cupboard formed in the adjacent unit which thus provides less room space.

All the units illustrated in FIGURES 1 to 3 and 5 to 9 of the drawings contain various living spaces, but, in the case of flats, in particular, the passages, landings and staircases are also formed in units. One such unit is illustrated in outline in FIGURE 4 and this shows a staircase having two flights **90** and **91** with a half landing **92** between them. In this case the top **93** of the unit is formed by a removable bulkhead and so also is the side **94**. The staircase **90**, **91** and **92** is prefabricated in the factory complete with tread finishes and hand-rails, although these are not shown in the drawing.

Three modified methods of fixing the units to each other and forming the building structure are illustrated in FIGURES 10 and 11 of the drawings. These are useful for multi-story buildings such as flats. As shown in FIGURE 10, each of the units **95**, which are illustrated diagrammatically, has fixed to it a column **96** at one corner, a cross beam **97** which extends diagonally across it, and a column **98** at the diagonally opposite corner. When the units are stacked one on top of the other as shown, each of the lengths of column **96** and **98** is fixed to the top of the length of column below. In FIGURE 10 the column **96** and the beam **97** are shown as rolled steel joists and the column **97** as reinforced concrete. In practice all three of these members are of the same material and all may be either steel sections or reinforced concrete. When the members are steel they are welded together or connected by rivetted gussets and when of concrete they are connected by cast in-situ concrete sections.

As shown in FIGURE 11, a building frame **99** is first formed with columns **100** and cross beams **101** to form a three dimensional grid. The pockets formed in this grid between the beams **101** and the columns **100** are arranged to fit the units **102** and the entire frame is first completed either from rolled steel sections or out of reinforced concrete and the units **102** are then fitted in position and later connected to each other. Only two units **102** are shown in FIGURE 11 but of course all the spaces formed in the grid are in fact filled with units.

We claim:

1. A building comprising a plurality of prefabricated box-like units stacked together in layers with spaces between them, each of said units including side walls comprising vertical studs horizontally spaced from each other, internal wall sheeting fixed to the inside of said studs, wall finishes and fittings on the inside of said sheeting, and a sole outer sheet made of flexible fluid-pervious fibrous textile material fixed to the outside of said studs and bowed toward but spaced from said sheeting, the space between the outer sheets of adjacent units being substantially filled with concrete and said internal wall sheeting, studs and outer sheets defining air spaces between said concrete and said internal wall sheeting.

2. A building as claimed in claim **1** in which said flex-

ible fluid-pervious sheeting is Hessian and said studs are timber.

3. A building as claimed in claim 1 in which the walls of adjacent units are connected by rigid spacing members.

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