United States Patent

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[54] **DWELLING ASSEMBLY LINE AND METHOD**
20 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **29/430,** 29/200
[51] **Int. Cl.** **B23p 19/00**
[50] **Field of Search** ..... 29/430, 200 (J), 200 (A), 200 (P), 429

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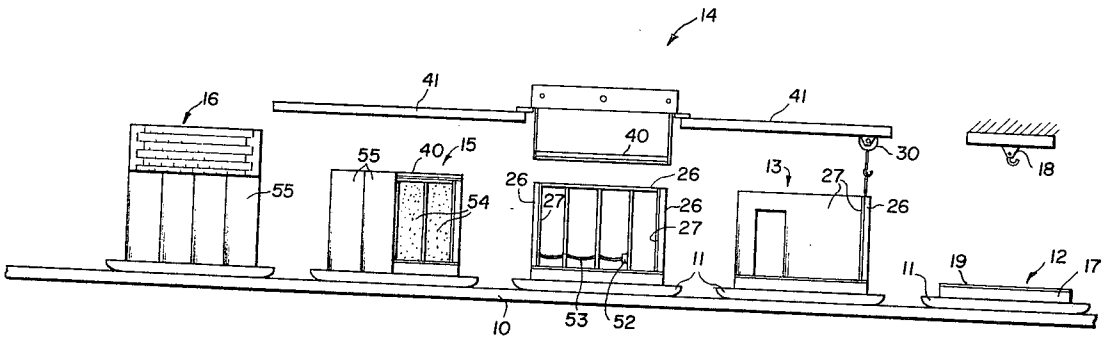
ABSTRACT: A dwelling is assembled by: building a floor joist framework upside down; installing service fixtures in the floor joist framework and fastening a subfloor to it; framing and covering walls with interior covering; erecting the interior-covered walls on the floor; building a ceiling on a jig above the dwelling; inverting the ceiling jig and lowering the ceiling onto the walls; securing service fixtures to the exposed stud and joist frameworks; trimming, covering, and roofing the dwelling; installing lifting hardware, and transporting the dwelling to its site.



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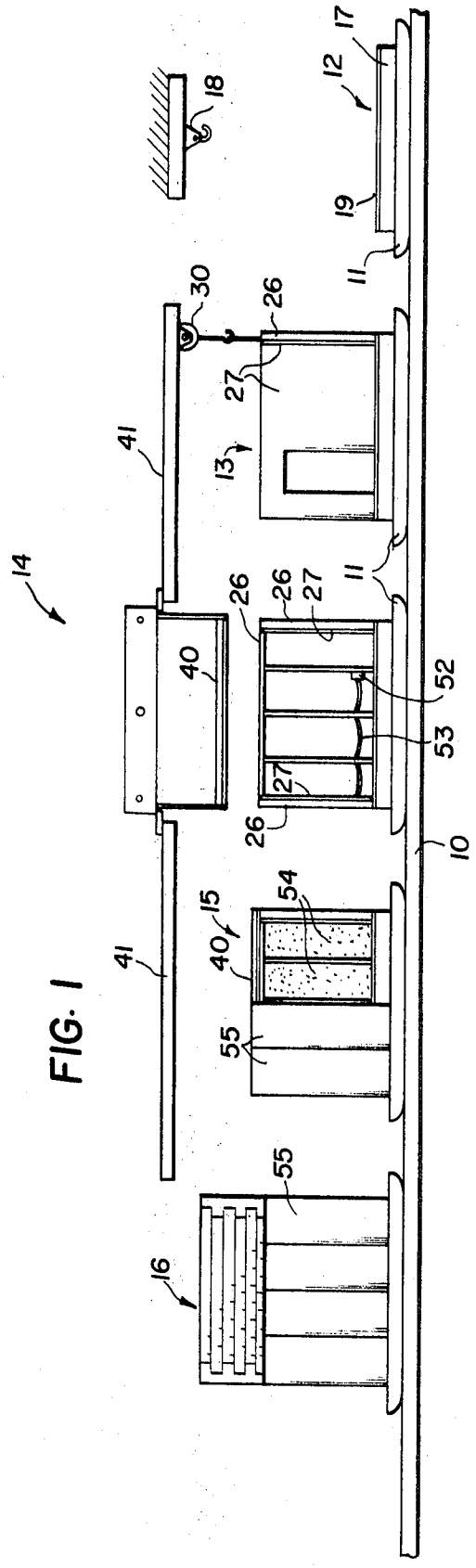

FIG. 1

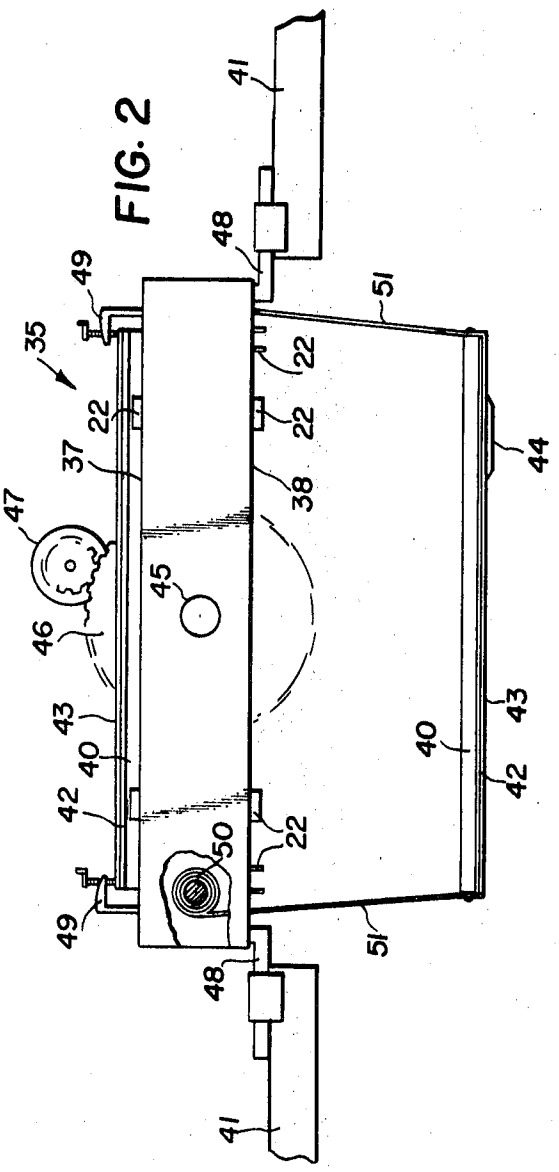

FIG. 2

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FIG. 3

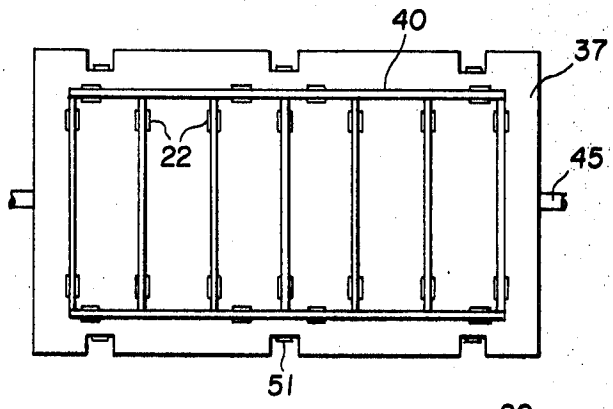
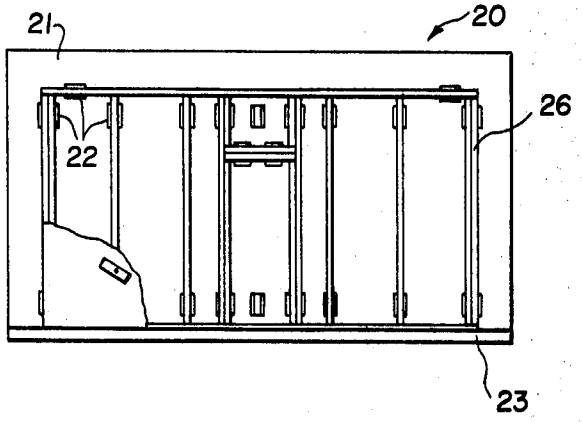


FIG. 4



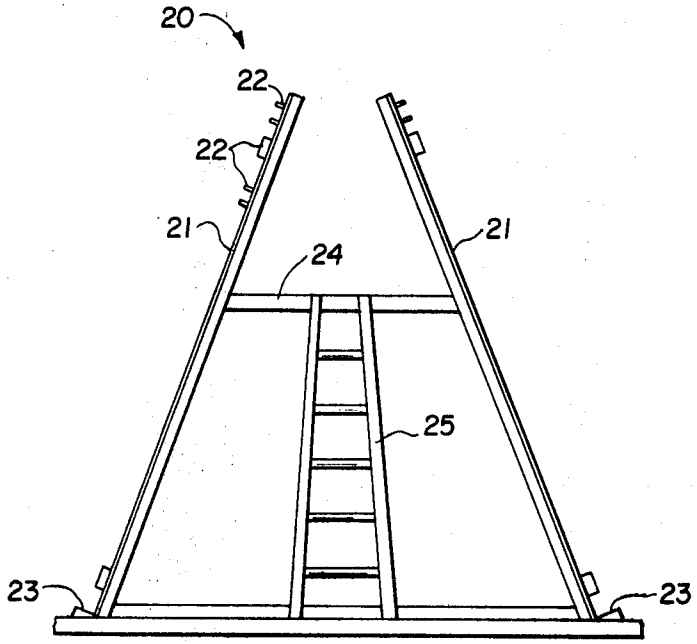


FIG. 5

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FIG. 6

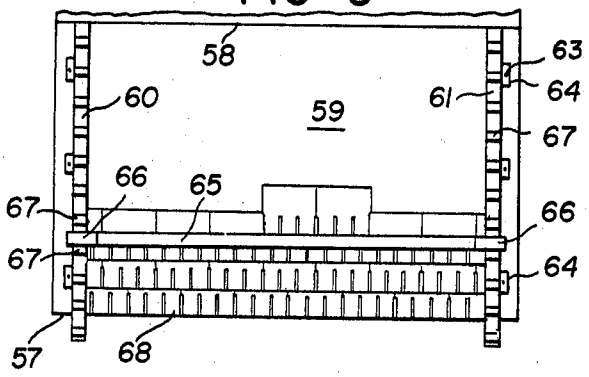
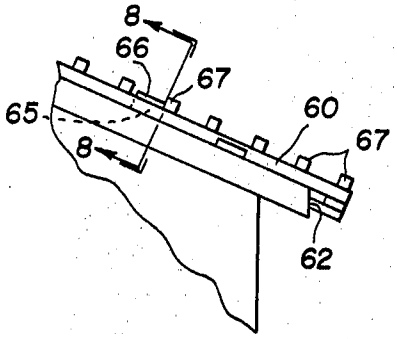


FIG. 7



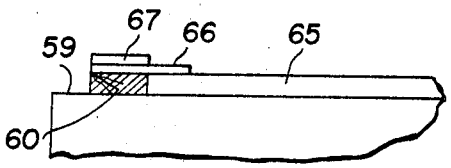


FIG. 8

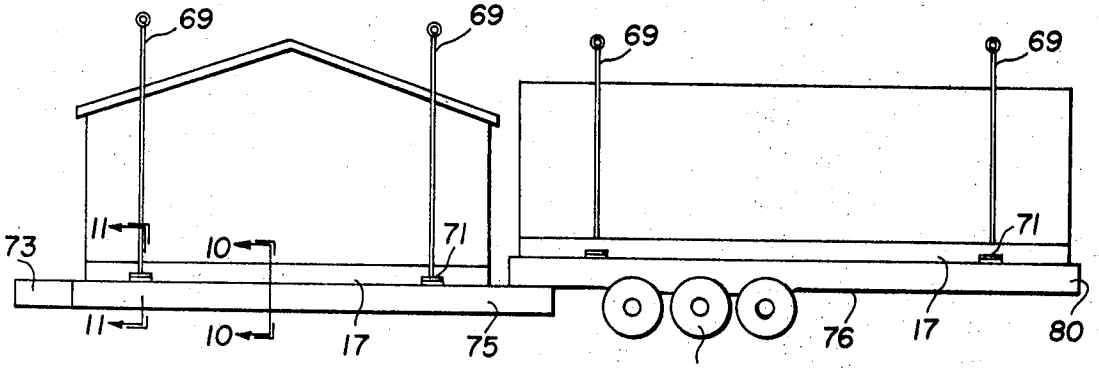


FIG. 9

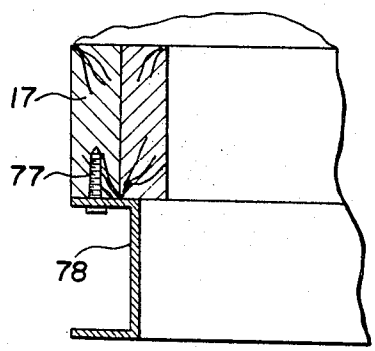


FIG. 10

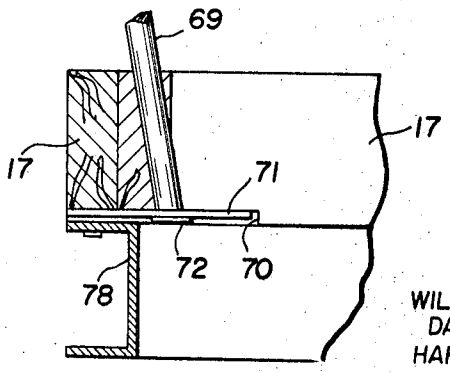


FIG. 11

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DWELLING ASSEMBLY LINE AND METHOD

THE IMPROVEMENT EFFECTED

Dwelling construction is relatively unprogressive and wastefully expensive in using outdoor, on-the-site, awkward and laborious methods. Prior art suggestions for factory-built dwellings generally imitate the old manual methods devised to fit the needs of slow construction exposed to weather. The outershell is built to keep the weather out then internal service fixtures, insulation, trim, flooring, etc. are built in. This requires many tasks to be done overhead or in awkward positions, requires considerable moving of materials about, and is generally wasteful of both labor and materials.

This invention departs from such old procedures and accomplishes dwelling assembly that is generally inside-out to facilitate service fixture installation, to allow each step of the construction to be done in the most comfortable and convenient working position for increased speed and reduced labor costs, and to take maximum advantage of construction jigs for holding work pieces during assembly. Most parts are precut and located for minimum movement; everything is done in the most convenient and efficient working positions; work-holding jigs eliminate measurement, plan-reading, error and the need for high labor skills; subassemblies are made adjacent their assembly regions for minimum transport; all operations are coordinated for a steady-flow assembly line; indoor construction takes advantage of uniform illumination, convenient power supplies for electric and pneumatic tools, glue dispensers fed by pipeline, and other conveniences not available in onsite construction; and the finished dwelling unit is ready for shipping to a construction site where it is merely positioned and connected to services.

One small plant with a single assembly line operating according to the invention for an 8-hour shift can produce two complete dwellings for four module units each of more than 1100 square feet, including three bedrooms, two and one-half baths, kitchen and living areas, and including central heating and air conditioning.

The objects of the invention include, without limitation, speed, economy, efficiency, reduced labor costs, high quality, uniform construction, minimum waste of materials, and the capacity to operate day or night in any weather.

SUMMARY OF THE INVENTION

The inventive assembly line and method includes: interfastening a floor joist framework to form a dwelling floor, inverting the floor joist framework and fastening a subfloor to it; using a jig to interfasten a wall stud framework; covering the wall stud framework with interior wall covering and erecting it on the floor; building a ceiling on a jig above the dwelling; inverting the ceiling jig and lowering the ceiling onto the walls; securing service fixtures to the stud framework outside the interior wall covering; and trimming, insulating, covering, and roofing the dwelling.

THE DRAWINGS

FIG. **1** is a partially schematic elevational view of an assembly line according to the invention;

FIG. **2** is a partially schematic elevation view of a ceiling assembly jig for the inventive assembly line;

FIG. **3** is a plan view of a jig surface of the jig of FIG. **2**;

FIG. **4** is an elevational view of a wall jig for the inventive assembly line;

FIG. **5** is an end elevation of the wall jig of FIG. **4**;

FIG. **6** is a plan view of a shingle jig for roofing dwelling modules made according to the invention;

FIG. **7** is a fragment of side elevation of the jig of FIG. **6**;

FIG. **8** is a fragment of an end elevation of the jig of FIG. **6**;

FIG. **9** is a side elevation of a trailer transport rig for carrying dwelling modules to a site;

FIG. **10** is a fragmentary cross section of the rig of FIG. **9** taken along the line **10–10** thereof; and

FIG. **11** is a fragmentary cross-sectional view of the rig of FIG. **9** taken along the line **11–11** thereof.

DETAILED DESCRIPTION

The illustrative assembly line shown in FIG. **1** includes a track **10** on which dwelling units roll on support members **11** from the floor end of the line to the finished end of the line. Cranes or hoists bring materials or subassemblies to the dwelling modules on track **10**, and each work region has pneumatic power lines for pneumatic nailers and staplers, glue dispensers fed by glue lines, and readily accessible electric power for tools and equipment. Completed units are preferably equipped with lifting hardware and are removed from the finished end of the line, transported to a building site, positioned with preferably several module units forming a single dwelling, and connected to service facilities to complete the construction. Parts of such a total assembly process are obvious and are not discussed. The inventive features of such an assembly are described below, and one particular way to practice them is explained.

The inventive assembly line includes a floor assembly region **12**, a wall assembly region **13**, a ceiling assembly region **14**, and several regions represented by regions **15** and **16** for installing service fixtures, insulation, trim, exterior siding, and roofing as desired. Each of these regions includes regions alongside track **10** in which subassemblies are made, materials are provided and tools are located and powered.

Floor joist assembly region **12** includes a jig (not shown) that has holders for proper location of floor joists for interfastening. The assembled floor joist framework **17** is of a known type having 2×12 planks nailed together. However, framework **17** is first assembled and fastened together upside down. Then service fixtures such as plumbing, electrical wiring, and heating and air conditioning ducts are installed and secured to framework **17** as desired. Such installation is inverted from the usual orientation and is conveniently made by workmen bending over framework **17**.

Then framework **17** is inverted by means of hoist **18** and set down right side up on timbers **11** on track **10**. A subfloor covering **19**, preferably of plywood, is fastened to the top of the framework **17**, preferably with both glue and nails to complete subfloor **17**. Floor covering such as linoleum or carpeting is laid over floor **17** whenever convenient during later assembly operations.

Meanwhile walls are framed in subassembly areas of wall assembly region **13**. For such purpose the wall jig **20** shown in FIGS. **4** and **5** is used. Surfaces **21** are sloped from the vertical to support stud members such as 2×4's or the like, and holders **22** are arranged on support surfaces **21** to receive and locate such stud members for interfastening. A ledge **23** supports the bottommost member of the wall framework, and precut stud members are placed in holders **22** as shown in FIG. **4** for interfastening to form framework **26**. Each holder **22** is a U-shaped bracket sized and positioned to receive the edge of a stud member and hold it in place for fastening.

Between support surfaces **21** is a gantry walkway **24** reached by a ladder **25** to support a workman in a comfortable position for nailing or fastening the uppermost portions of stud framework **26**. A man on walkway **24** with a pneumatic nailing machine can rapidly fasten the upper portions of framework **26** together. Another workman at the bottom of jig **20** can quickly secure the bottom portions of framework **26** together.

Each support surface **20** is preferably adapted for assembling a plurality of wall frameworks **26** by having holders **22** arranged in different positions for different frameworks. For such multiframework jigs, the stud position and corresponding holders on surfaces **21** are preferably painted different colors for each wall framework to be assembled on each support surface. Then workmen can quickly select precut stud members and place them on support surfaces **21** to cover all the regions painted a given color to make a given wall assembly. For walls of a different type, the workmen merely place stud members over different colored areas and holders.

After wall framework **26** is secured together, it is covered by an interior wall-covering material **27** of panelling or wallboard material having a finished interior surface. The stud members of framework **26** are covered with glue from a convenient dispenser, and covering material **27** is secured to the glued stud members until the glue sets. One way of doing this is with a few finishing nails **28** driven through cleats **29** into framework **26** and removed after the glue sets to leave only a few, almost unnoticeable, holes in covering **27**. This eliminates the usual nailing, countersinking of nails, patching over nailheads, and painting. Alternatively, covering material **27** can be clamped to framework **26** until the glue sets.

Covered wall framework **26** is moved by a travelling crane **30** to its proper position over the assembled floor **17** and nailed in place in erect position over floor **17**. Two of such erected walls are shown in wall assembly region **13** of FIG. **1**.

While floor **17** and walls **26** are being assembled, a ceiling is built on ceiling jig **35** best illustrated in FIG. **2**. A main body **36** of ceiling jig **35** has two support surfaces **37** and **38** each of which are provided with holders **22**, such as previously described for wall fixture **20**, for locating and holding the members of a ceiling joist framework **40**. Holders **22** and support surfaces **37** and **38** are painted in color coding for assembly of a plurality of different ceiling joist frameworks **40**, as desired.

Jig **35** is arranged just above the level of a second floor **41**, well above track **10** and above the tops of dwelling units passing along track **10**. Workmen standing on floor **41** find the upper support surface **37** is at a comfortable working height for laying down precut joist members of framework **40** in holders **22** and securing the framework **40** together.

Service fixtures such as vents or ducts **44** for heating or air conditioning units are then secured to framework **40**, and a subceiling **42**, preferably of plywood, is fastened to framework **40** by glue and nails. Then an interior ceiling material **43** is stapled to subceiling **42**.

Jig **35** is rotatable around shaft **45** by means of a gear **46** and a motor **47** for inverting the main body **36** of jig **35**. Latches **48** holding body **36** in the working position illustrated in FIG. **2**, are moved and motor **47** is driven to turn body **36** 180° to invert support surfaces **37** and **38**. Before doing this the assembled ceiling **40** is secured to jig **35** by clamps **49**; also dwelling units on track **10** are moved out from under jig **35** to give it a free sweep. After inversion a new ceiling can be built on the top surface of jig **35** while a completed ceiling awaits lowering from the bottom.

Recessed into the longitudinal edges of body **36** are a pair of windlasses **50** on which support straps **51** are wound. The ends of straps **51** are nailed to ceiling frame **40**, and when a walled dwelling is ready for a ceiling and positioned beneath jig **35**, clamps **49** are released and ceiling **40** is lowered by straps **51** under control of a motor (not shown). When ceiling **40** is properly positioned over a dwelling unit the ends of straps **51** are pried free and ceiling **40** is nailed in place on top of walls **26**.

Service fixtures such as electric outlet **52** and **53** are installed in the wall stud framework **26** from outside the dwelling unit as shown in FIG. **1**. This allows convenient working in the exposed exterior of the dwelling at a comfortable working height so that electric installation is fast and efficient. Other service fixtures such as plumbing, heating, and air conditioning ducts are installed in a similar fashion around the exterior of the dwelling or its subassemblies.

Then, insulation **54** and exterior siding material **55** are fastened on to the exterior of walls **26**. Interior subassemblies such as cabinets, cupboards, bathroom units, and staircases are made in regions alongside track **10** and installed in the dwelling units. Trim construction such as moldings, and door and window frames, are subassembled and installed.

Roofs are constructed over the uppermost modules of the inventive dwelling units, and materials handed down from second floor **41** are preferably used for roof construction. After supports and sloping roof surfaces are constructed, the roof is shingled with the aid of the shingling jig shown in FIGS. **6—8**.

Rails **60** and **61** are laid parallel with each other along the edges of roof **59** from the peak **58** to the bottom edge **57**. Abutment surfaces **62** extending below the bottom ends of rails **60** and **61** butt against the bottom edge **57** of roof **59** to locate rails **60** and **61** longitudinally, and the top ends of rails **60** and **61** extend to peak **58**. When rails **60** and **61** are accurately positioned, they are fastened to roof **59** by nails **63** through angle iron brackets **64** disposed along the outer edges or rails **60** and **61**.

A crosspiece **65** fits closely between rails **60** and **61** and rests on roof **59**. Extension pieces **66** are fastened to the top of each end of crosspiece **65** to reach over the top surfaces of rails **60** and **61**. Positioners **67** formed as blocks secured to the top surfaces of rails **60** and **61** are spaced apart by the exposed width of shingles **68** and are arranged in parallel and aligned sets on each rail **60** and **61**.

When extension pieces of crosspiece **65** are placed between the first pair of positioners **67** at the bottom ends of rails **60** and **61**, crosspiece **65** is positioned so that the lowermost row of shingles **68** can be butted against crosspiece **65** and secured to roof **59**. Then crosspiece **65** is moved upward on rails **60** and **61** to the next position between positioners **67** where it is correctly located for butting the second row of shingles **68** against crosspiece **65**. This process is repeated with each row of shingles **68** until roof **59** is shingled to its peak **58**.

The edges of roof **59** under jig rails **60** and **61** are not shingled until after the modules are positioned on the site and shingle splices or joints are made between adjacent roofs.

The jig of FIGS. **6—8** assures that the rows of shingles **68** are accurately parallel with peak **58** and accurately spaced so that the shingle rows of adjacent modules will line up accurately on the site for a neat appearance avoiding any jags or turns in the shingle joints between adjacent roofs. This is particularly important where several dwelling modules are placed side-by-side to form a common roof extending for many feet. In onsite construction such a roof would be built in place and its shingles aligned on long chalk lines. However, the inventive jig is faster and more accurate, and solves the problem of lining up the shingle rows of dwelling modules having roofs built in fairly short lengths that are later joined together.

In the final stages of construction of dwelling modules according to the invention, lifting hardware is secured to each module in preparation for its transport to a site. Preferably, long eyebolts **69** are used for the basic lifting rig, and bolts **69** extend through holes in floor joist framework **17** as best shown in FIGS. **9—11**. Recesses **70** are cut in the underside of floor joist framework **17** preferably before it is inverted to receive plates **71** fitting floor joist framework **17** and supporting the heads **72** of eyebolts **69**. Eyebolts **69** preferably extend above the tops of dwelling modules as illustrated, and such modules are lifted from above by cranes or lifts hooking onto eyebolts **69**.

The trailer **80** shown in FIG. **9** is preferably used for transporting completed dwelling modules to a site. Trailer **80** has a hitch **73** at its forward end, a front frame **75** extending back to wheels **74** at the midsection and a rear frame **76** joined to the top of front frame **75** and extending over and beyond wheels **74**. Front and rear frames **75** and **76** are preferably formed of relatively light, structural metal materials.

As best shown in FIG. **10**, lag screws **77** are driven through the side beams **78** of frames **75** and **76** into the bottom of floor joist framework **17** at intervals of 3 feet or so along frames **75** and **76**, to hold floor joist framework **17** tightly against trailer frames **75** and **76**. Such interfastening stiffens and supports frames **75** and **76** which are braced by the strong and rigid construction of floor joist framework **17**. Such strengthening allows trailer **80** to be of lightweight construction and yet be sufficiently strong to carry heavy dwelling modules. This provides advantages such as only a few wheels **74** close together in the midsection of trailer **80** are required and a relatively long length of trailer and dwelling modules can be cantilevered behind wheels **74**; and the overall height of the loaded trailer is relatively low and the total weight of trailer **80**

and its dwelling modules is relatively small to meet licensing and highway requirements for vehicles. The prior art trailers for hauling heavy objects have always been strong enough to be the sole support of the cargo. Such a trailer for the inventive dwelling units would have to be the "low-boy"-type with a massive platform carried low between the hitch and a rear axle having many wheels. Such a trailer would far outweigh trailer **80** and could only haul one dwelling module. The front frame **76** forward of wheels **74** for supporting the taller, roofed modules is of comparable length to a "low-boy" trailer, but the light construction braced by the strength of the dwelling unit itself allows the additional dwelling module mounted above the wheels **74** on the cantilevered after frame **76**.

Persons wishing to practice the invention should remember that other embodiments and variations can be adapted to particular circumstances. Even though one point of view is necessarily chosen in describing and claiming the invention, this should not inhibit broader or related applications within the spirit of the invention. For example, different materials and fastening means can be used, and the inventive jigs and fabrication methods can be adapted to such variations; operations can proceed simultaneously or in different orders; and the movement of subassemblies can be varied.

We claim:

1. A dwelling factory assembly line comprising;

a. a floor assembly region including:

1. means for interfastening a floor joist framework in upside down position;
2. means for turning over said floor joist framework; and
3. means for fastening a subfloor to the top of said turned over floor joist framework to form a floor unit for said dwelling;

b. a wall assembly region including:

1. a wall jig having a surface sloped from the vertical for supporting a wall stud framework;
2. means for interfastening said supported stud framework;
3. means for fastening interior wall covering on said supported framework; and
4. means for erecting said covered wall framework on said floor unit;

c. a ceiling assembly region above said line including;

1. a ceiling jig for supporting a ceiling joist framework upside down;
2. means for interfastening said ceiling joist framework;
3. means for covering said ceiling joist framework with interior ceiling material to form a ceiling unit;
4. means for turning over said ceiling jig with said covered ceiling unit secured thereto; and
5. means for lowering said ceiling unit onto the tops of said wall frameworks;

d. means for securing service fixtures to said wall frameworks outside said interior wall covering; and

e. means for securing external covering to said dwelling.

2. The assembly line of claim **1** including a track and means for moving said dwelling along said track from said floor assembly region past said ceiling assembly region and toward a finishing region.

3. The assembly line of claim **1** including means at said floor assembly region for securing service fixtures to said floor joist framework before inversion thereof.

4. The assembly line of claim **1** including means at said ceiling assembly region for securing service fixtures to said ceiling joist framework before covering said ceiling joist framework with said interior ceiling material.

5. The assembly line of claim **1** wherein said wall jig includes a gantry walkway arranged behind said sloped surface and near the top of said sloped surface to support a workman in a comfortable position for fastening the upper portions of said stud framework.

6. The assembly line of claim **5** wherein a pair of said wall jig support surfaces are arranged on opposite sides of said gantry walkway.

7. The assembly line of claim **1** wherein said ceiling jig comprises two opposed jig surfaces arranged on a rotatable body, means for rotating said body about a horizontal axis to turn either of said jig surfaces uppermost, and means for latching said body in positions orienting either of said jig surfaces uppermost.

8. The assembly line of claim **1** including windlass strap means arranged on said ceiling jig for fastening to said ceiling to lower said ceiling from the bottom of said ceiling jig.

9. A dwelling assembly method comprising:

a. interfastening a floor joist framework in upside down position;
b. turning over said floor joist framework;
c. fastening a subfloor to the top of said turned-over floor joist framework to form a floor unit for said dwelling;
d. moving said floor unit to a wall assembly region;
e. interfastening stud frameworks for walls of said dwelling;
f. fastening interior wall covering on said wall stud frameworks;
g. securing said covered wall frameworks in erect positions on said floor unit;
h. interfastening a ceiling joist framework supported in upside down position on the surface of a ceiling jig above the top of said dwelling;
i. covering said ceiling joist framework with interior ceiling materials to form a ceiling unit;
j. turning over said ceiling jig with said covered ceiling unit secured thereto;
k. moving said dwelling under said ceiling jig;
l. lowering said ceiling unit onto said erected wall frameworks;
m. securing said ceiling unit to the top of said erected wall frameworks;
n. fastening services fixtures to said wall frameworks outside said interior wall covering; and
o. securing external covering to said dwelling.

10. The method of claim **9** including securing service fixtures to said floor joist framework before turning over said floor joist framework.

11. The method of claim **9** including securing service fixtures to said ceiling joist framework before covering said ceiling framework.

12. The method of claim **9** including gluing said interior wall covering to said wall stud framework.

13. The method of claim **9** including:

a. laying a pair of parallel rails to extend from the peak to the lower edge of the roof of said dwelling along the respective side edges of said roof, said rails having corresponding sets of positioners parallel with said peak and spaced apart by the width of the shingle rows for said roof;
b. arranging a crosspiece successively between said positioners;
c. butting a row of shingles against said crosspiece in each position of said crosspiece; and
d. securing each row of said shingles in place on said roof.

14. The method of claim **9** including securing lifting hardware to said floor joist framework and lifting said dwelling from overhead by said hardware for positioning said dwelling.

15. The method of claim **9** including positioning said dwelling on a relatively light-construction trailer for transport to a site, and fastening said floor joist framework of said dwelling to said trailer at a plurality of points to strengthen said trailer.

16. The method of claim **15** including turning a plurality of lag screws through the frame of said trailer into the bottom of said floor joist framework to fasten said dwelling to said trailer.

17. The method of claim **12** including using nails holding cleats against the interior surface of said wall covering and passing removably through said wall covering and into said framework to hold said wall covering in place until said glue sets.

18. A dwelling factory assembly line comprising:

a. a floor assembly region including:

1. means for interfastening a floor joist framework; and
2. means for fastening a subfloor to the top of said floor joist framework to form a floor unit;

b. a wall assembly region including:
1. a wall jig having a surface for supporting a wall stud framework;
2. means for interfastening said supported stud framework;
3. means for fastening interior wall covering on said supported framework; and
4. means for erecting said covered wall framework on said floor unit;

c. a ceiling assembly region including:
1. a ceiling jig for supporting a ceiling joist framework in inverted position;
2. means for interfastening said ceiling joist framework;
3. means for covering said ceiling joist framework with interior ceiling material to form a ceiling unit;
4. means for inverting said ceiling unit; and
5. means for positioning said ceiling unit on the tops of said wall frameworks;

d. means for securing service fixtures to said wall frameworks outside said interior wall covering; and

e. means for securing external covering to said wall frameworks.

19. A dwelling assembly method comprising:

a. interfastening a floor joist framework;

b. fastening a sub floor to the top of said floor joist framework to form a floor unit;

c. moving said floor unit to a wall assembly region;

d. interfastening stud frameworks for walls of said dwelling;

e. fastening interior wall covering on said wall stud frameworks;

f. securing said covered wall frameworks in erect positions on said floor unit;

g. interfastening a ceiling joist framework supported in inverted position on a surface of a ceiling jig;

h. covering said ceiling joist framework with interior ceiling materials to form a ceiling unit;

i. inverting said ceiling unit;

j. positioning said ceiling unit on said erected wall frameworks;

k. securing said ceiling unit to the tops of said erected wall frameworks;

l. fastening service fixtures to said wall frameworks outside said interior wall covering; and

m. securing external covering to said wall frameworks.

20. The dwelling assembly method of claim **9** including arranging said floor joist framework upside down on a plane surface for said interfastening so said subfloor lies substantially in a plane on said right side up floor joist framework.