June 20, 1961 R. L. COLBY, JR 2,989,154

BUILDING CONSTRUCTION

Filed March 17, 1955 3 Sheets-Sheet 1

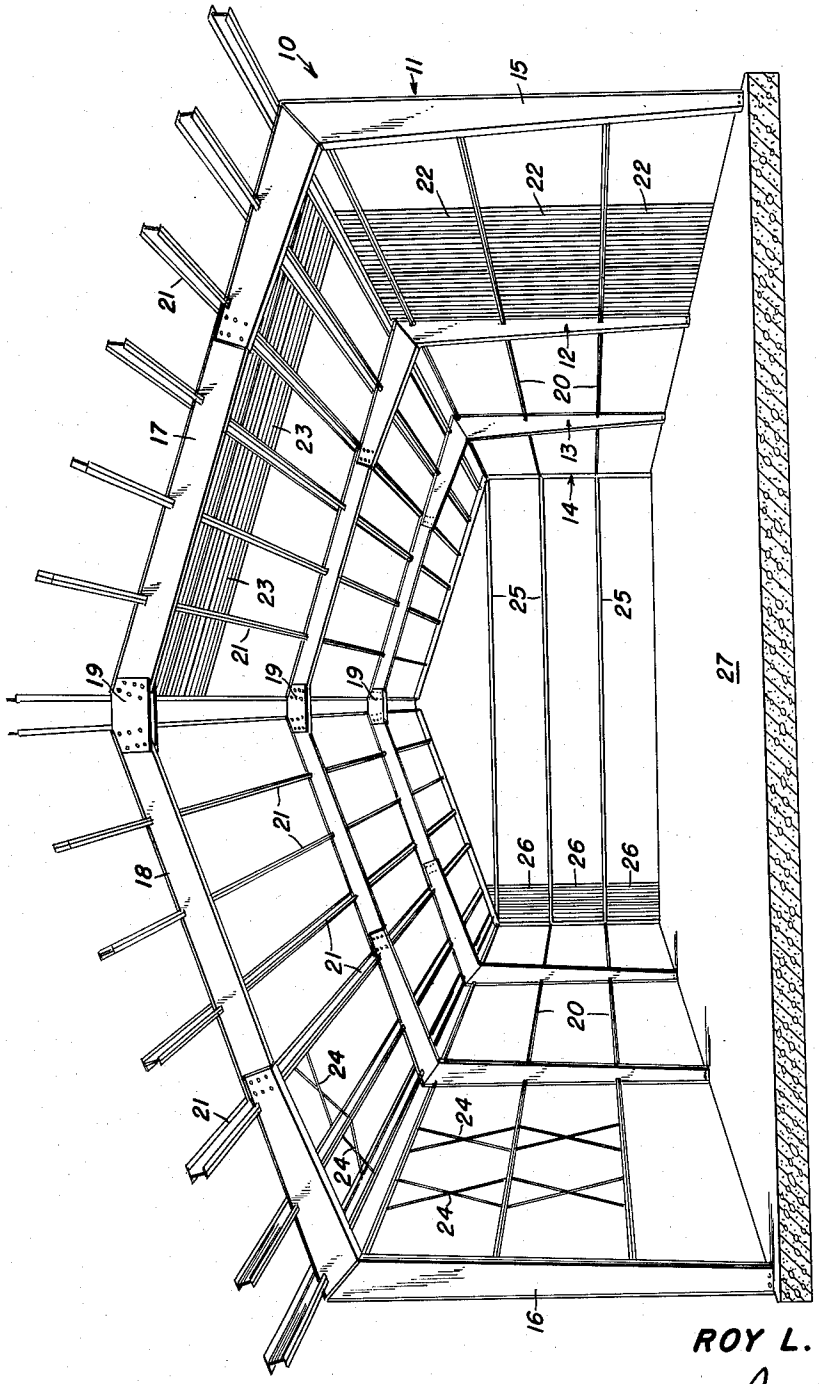


FIG. 1

INVENTOR

ROY L. COLBY, JR.

BY James J. Chambers

ATTORNEY

June 20, 1961 R. L. COLBY, JR 2,989,154

BUILDING CONSTRUCTION

Filed March 17, 1955 3 Sheets-Sheet 2

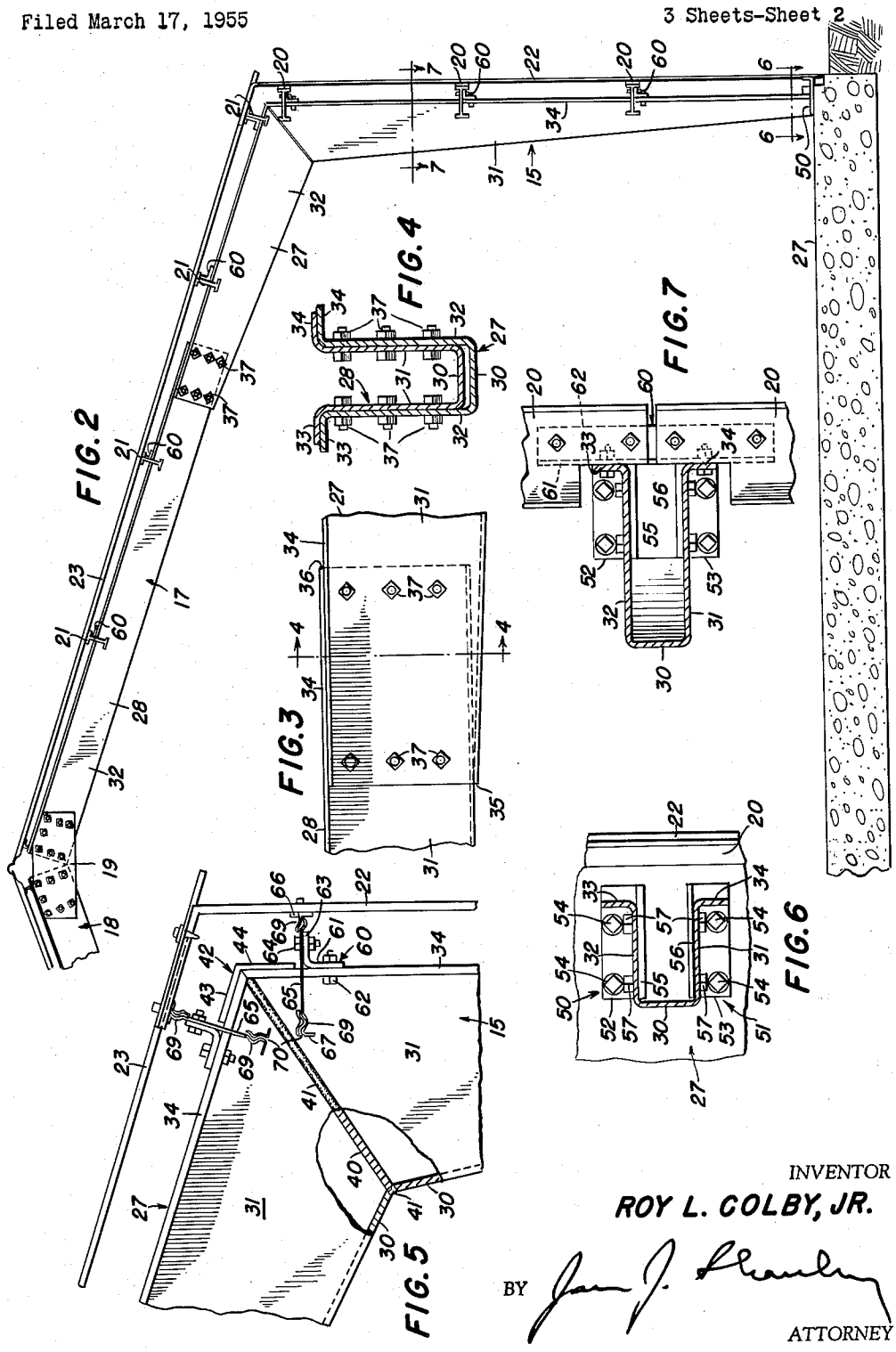


FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

INVENTOR

ROY L. COLBY, JR.

BY

ATTORNEY

June 20, 1961 R. L. COLBY, JR 2,989,154

BUILDING CONSTRUCTION

Filed March 17, 1955 3 Sheets-Sheet 3

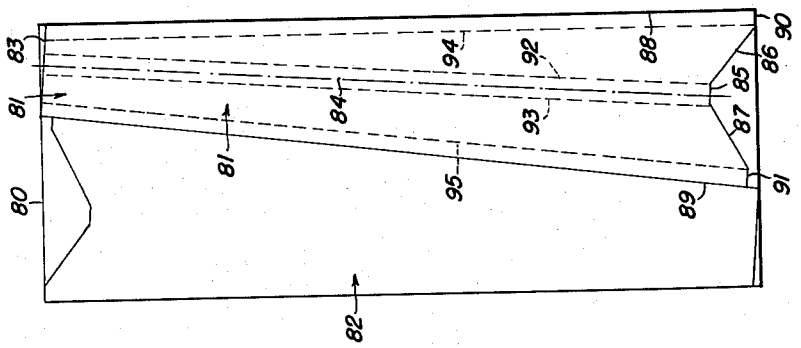


FIG. 13

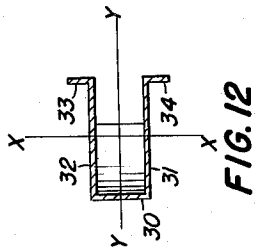


FIG. 12

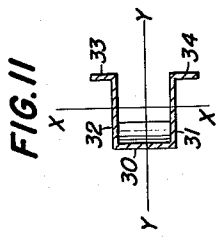


FIG. 11

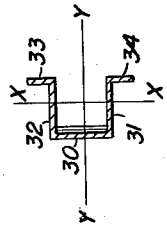


FIG. 10

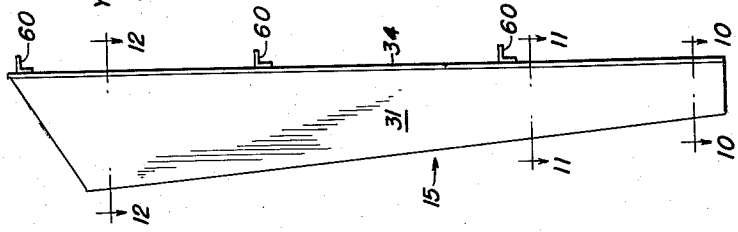


FIG. 9

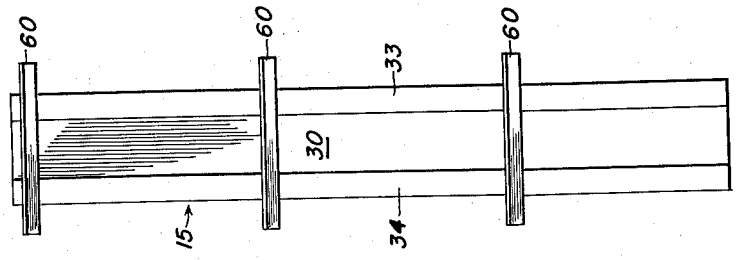


FIG. 8

INVENTOR

ROY L. COLBY, JR.

BY James J. Chandler

ATTORNEY

United States Patent Office 2,989,154 Patented June 20, 1961

2,989,154

BUILDING CONSTRUCTION

Roy L. Colby, Jr., Dearborn, Mich., assignor to National Steel Corporation, a corporation of Delaware

Filed Mar. 17, 1955, Ser. No. 494,936

2 Claims. (Cl. 189—1)

This invention relates to building constructions and more particularly to building constructions including rigid portal frames.

Rigid frame buildings provided by the prior art include a plurality of rigid portal frames spaced from each other longitudinally of the building and extending transversely of the building from side wall to side wall. The rigid portal frames include a pair of upstanding side members each positioned at one side of the building, and a pair of inclined roof members each having one end joined to the upper end of one of the side members at the haunch of the frame, with the other ends of the roof members being joined together at the ridge of the frame. Girts and purlins are secured to the side members and roof members, respectively, for supporting the siding and roofing of the building. Inasmuch as the maximum bending moment stresses occur at each haunch of the frames, and since the bending moment stresses gradually decrease in a direction away from each haunch, it has been the practice to utilize tapered members in the construction of rigid portal frames to present members having varying beam strength characteristics according to the varying bending moment stresses and thus effect a material saving in the amount of metal required.

Prior to the present invention tapered members for rigid portal frames were generally of I-shaped cross section. These members have been formed by welding elongated plates into an I-shaped section in which the web portion is provided with the desired taper. The members have also been formed by cutting the web portion of a hot rolled I-shaped member diagonally from end to end, and then by welding the web portions together in reversed relationship. Construction of rigid portal frames including members of I-shaped cross-section formed in this manner inherently requires time consuming and expensive fabrication operations. Also, building constructions including rigid portal frames of this type require external braces and/or composite members of relatively heavy construction as compared to the beam strength required, in order to provide frames of adequate stability against buckling or twisting in a direction longitudinally of the building construction.

It is therefore an object of the present invention to provide a novel building construction including rigid portal frames.

Another object is to provide a novel rigid portal frame.

Another object is to provide a novel rigid portal frame possessing relatively high inherent stability against buckling out of the plane of the frame.

Still another object of the present invention is to provide a novel rigid portal frame including tapered members possessing varying beam strength characteristics which may be fabricated from a single piece of sheet metal by a cold forming process.

Still another object is to provide a rigid portal frame of the above type is which the tapered members possess relatively high stability against buckling out of the plane of the frame.

Still another object is to provide a novel rigid portal frame of the foregoing character in which the varying cross sections of the tapered members are relatively

proportioned so that the major axes of the sections at the ends of the members are in graduating relationship.

A still further object of the present invention is to provide a novel building construction including a plurality of rigid portal frames lying in parallel planes spaced longitudinally of the building construction, in which the rigid portal frames are stabilized against buckling longitudinally of the building without the use of external braces.

A still further object is to provide a novel building construction of the above character, in which the stability of the rigid portal frames is obtained without employing composite members having beam strengths substantially in excess of the beam strength required to carry the design loading of the building construction.

In the drawings, in which similar reference characters denote similar elements throughout the several views:

FIG. 1 is an isometric view showing the interior of a building construction embodying the principles of the present invention;

FIG. 2 is a view in side elevation of a portion of a rigid portal frame included in the building construction shown in FIG. 1 and constructed in accordance with the principles of the present invention;

FIG. 3 is an enlarged fragmentary view of a construction detail of the rigid portal frame shown in FIG. 2;

FIG. 4 is a view in section taken along the line 4—4 of FIG. 3;

FIG. 5 is an enlarged fragmentary view of the haunch construction of the rigid frame shown in FIG. 2;

FIG. 6 is a view in section taken along the line 6—6 of FIG. 2;

FIG. 7 is a view in section taken along the line 7—7 of FIG. 2;

FIG. 8 is a diagrammatic outside end view of a side member of a rigid portal frame constructed in accordance with the present invention;

FIG. 9 is a diagrammatic side elevational view of the side member shown in FIG. 8;

FIG. 10 is a view in section taken along the line 10—10 of FIG. 9;

FIG. 11 is a view in section taken along the line 11—11 of FIG. 9;

FIG. 12 is a view in section taken along the line 12—12 of FIG. 9, and

FIG. 13 is a diagrammatic illustration of a phase of fabrication of portions of a rigid portal frame according to the present invention.

With reference more particularly to FIG. 1 of the drawings, a building construction 10 is shown therein including a plurality of rigid portal frames 11, 12, 13 and 14 extending transversely of the building from side wall to side wall and lying in vertical longitudinally spaced planes. Each rigid portal frame includes a pair of upstanding side members 15 and 16 and a pair of inclined roof members 17 and 18. The inner ends of the roof members are connected together by means of a gusset plate 19 at the ridge of the frame, and their outer ends are joined to the upper ends of the side members 15 and 16, respectively. The angular relationship between the longitudinal axes of respectively connected side members and roof members define an internal obtuse angle establishing the desired slope to the roof of the building. The side members 15 and 16 of the rigid portal frames support vertically spaced horizontal girts 20 which extend longitudinally of the building between the side members, while the roof members 17 and 18 of the rigid portal frames support parallel, transversely spaced purlins 21 extending longitudinally throughout the length of the building. The girts and the purlins support suitable siding material 22 and roofing material 23 secured thereto; the siding and roofing material may comprise corru-

gated galvanized metal sheets, for example. Suitable braces **24** may be positioned between adjacent girts and purlins to stabilize the girts and purlins intermediate the rigid portal frames. The ends of the building may be closed by any suitable structure, such as by means of a plurality of horizontal vertically spaced girts **25** extending transversely of the building construction between the side members of the end rigid portal frame, and suitable siding material **26** supported thereon. Doorways and windows may be located in the side walls between the rigid portal frames and in the end walls, as desired. The building floor **27** may comprise the upper surface of a concrete slab which may also constitute the foundation for the building construction. The building construction may be of any desired length by merely increasing the number of rigid portal frames and by providing girts and purlins for connecting the rigid portal frames in the manner described above.

Construction of the rigid portal frames is illustrated more clearly in FIG. 2 of the drawings. Inasmuch as the rigid portal frames are similar, and since the side member and the roof member on each side of the ridge of the frames are similarly constructed and positioned in reverse relationship, it will suffice to describe in detail only the roof member and the side member forming one half of a rigid portal frame. As shown, the upstanding side member **15** is of unitary construction while the roof member **17** is a composite structural member including sub-members **28** and **29** joined together in axial relationship to form a continuous member. The side member **15** and the sub-members **28** and **29** are each fabricated from a single piece of light gauge sheet metal by a cold forming process and are of "hat-shape" cross section, as shown in FIGS. 4, 6 and 7. Structure members of "hat-shape" cross section include an inner or closed web portion **30**, a pair of side web portions **31** and **32** extending from the edges of the inner web portion outwardly from one of its sides, and a pair of flange portions **33** and **34** joined to the free edges of the side web portions and extending outwardly therefrom in spaced relation with respect to the inner web portion. The "hat-shape" sections shown in the drawings include parallel side web portions **31** and **32** perpendicular to the plane of the inner web portion **30**, and coplanar flange portions **33** and **34** parallel to the plane of the inner web portion. It is to be expressly understood that the inner web portion **30** may lie in a plane curved transversely of the side web portions and the side web portions may be flared outwardly without forming a structural member not encompassed by the term "hat-shape."

It is well-known that the maximum bending moment stresses occur at the eaves or haunches of rigid portal frames, and that the magnitude of the bending moment stresses in the side member **15** gradually decrease from the haunch to a minimum value at the base of the member, while the magnitude of the bending moment stresses in the roof member **17** gradually decrease from the maximum bending moment at the haunch in a direction toward the ridge of the frame. In order to reduce the amount of metal required, the side member **15** and the roof member **17** are constructed to possess beam strength which varies longitudinally of the members in accordance with the varying bending moment stresses in the members. The side member **15** and the roof member **17** are constructed to possess a varying beam strength characteristic by forming the members to include tapered side web portions **31** and **32**. The side webs of the members are of maximum width to provide "hat-shape" sections of maximum depth at the haunch of the frame which presents the greatest resisting bending moment of the frame. As shown in the drawings, the width of the side web members gradually decrease in a direction away from the haunch in such a manner to provide sufficient resisting bending moments throughout the length of the members. The bending moments on the roof member **17** drop to a relatively low value at an appreciable distance displaced from the haunch and the remaining portion of the roof member may possess uniform beam strength. For this reason a composite roof member is provided including the sub-member **27** of varying cross section and the sub-member **28** of uniform cross section. As shown in FIGS. 3 and 4, the sub-members are connected in axial relationship by proportioning the spacing of the side web portions of the sub-member **28** to lie in contiguous relation with the inside surfaces of respective side web portions of the sub-member **27**, and by positioning the sub-members in telescopic relation with the end **35** of the sub-portion **27** extending in a direction towards the ridge of the frame beyond the edge **36** of the sub-member **28**. The depth of the sub-member **28** is properly proportioned so that its flange portions are in parallel contiguous relation with the outer surfaces of the flange portions of the sub-member **27** throughout the overlapping region of the sub-members, and the sub-members are rigidly joined together by bolts **37**, for example, passing through and securing together adjacent side web portions.

The side member **15** and the sub-member **27** are integrally joined together at the haunch of the frame in a manner disclosed and claimed in copending application Serial No. 499,377, filed April 5, 1955, for Composite Structure. As described in the copending application and as shown in FIG. 5, the adjacent ends of the members **15** and **27** lie in spaced parallel planes perpendicular to respective side web portions and inclined at an acute angle with respect to their longitudinal axes. The members at their adjacent ends are of corresponding cross section and are positioned in complementary relationship. A metal plate or diaphragm **40**, of a thickness at least equal to the space between the planes of the adjacent ends of the members, is positioned within the space defined by the side web portions and the inner web portions of the members in a plane parallel to and equally distanced from the planes of the adjacent ends of the members. The plate **40** is shaped to fit snugly within the space with its edges in contiguous contact with the inside marginal edges of corresponding side web portions and the inner web portions of the members. The open groove defined by the spaced adjacent edges of the side web portions and the inner web portions of the members and by the edges of the plate member **40** is filled with a full penetration butt weld **41**. The butt weld integrally joins the adjacent edges of the members and of the plate member **40**. The plate member **40** functions as a structural element increasing the strength of the joint between the members as well as a back-up plate permitting formation of the joint by an efficient full penetration butt weld.

According to the above-mentioned copending application, the joint between the members **15** and **27** also includes an angle member **42** having flange portions **43** and **44** inclined with respect to each other at an angle corresponding to the angular relationship between the longitudinal axes of the members. An edge of the plate **40**, opposite its edge joined to the inner web portions, is welded to the inside surface of the angle member **42** along the line of intersection of the flange portions **43** and **44**. The angle member **42** is of sufficient length to overlie the flange portions of the members and bridge the space therebetween, and the length of the plate **40** is proportioned to position the flange portions **43** and **44** in parallel contiguous relation with the outside surfaces of flange portions **33** and **34** of the members in the region of their adjacent ends. The flange portions **43** and **44** are joined to the flange portions of the members, by welds for example, and the angle member **42** functions as a back-up member to allow the adjacent edges of the flange portions of the members to be joined by a full penetration butt weld.

For a purpose that will appear more fully below, the side member **15** and the roof member **17** are relatively positioned with their inner web portions and their flange portions lying in planes perpendicular to the plane of the rigid portal frame. Also, the members are relatively positioned with their flange portions defining the outer perimeter planes of the frame, and with their side web portions extending from respective flange portions inwardly of the frame and there merging into the inner web portions. The base of the side members **15** of each of the rigid portal frames is secured to the foundation **27** in a manner illustrated in FIG. 6 of the drawings. As shown, a pair of right angle brackets **50** and **51**, including horizontal flange portions **52**, **53**, and vertical flange portions **55**, **56**, respectively are spatially secured to the foundation by means of bolts **54**. The angle members are positioned to space the vertical flange portions the proper distance so that they lie in contiguous parallel relation with the inside surfaces of adjacent side web portions **31** and **32** at the base or end of the side member **15**. Adjacent side web portions and vertical flange portions are rigidly secured together by means of bolts **57**. The manner in which the girts **20** and the purlins **21** are secured to the side member **15** and the roof member **17**, respectively, is illustrated in FIGS. 5 and 7. As shown, a right angle bracket member **60** is secured to the members **15** and **17** on the outside surfaces of their flange portions **33** and **34** at the required position of the girts **20** and the purlins **21**. In particular, each angle member **60** includes a vertical flange portion **61** lying in parallel contiguous relation with the outside surfaces of flange portions **33** and **34** to which it is connected by bolts **62**, for example. Each angle member **60** also includes a horizontally disposed flange portion **63** projecting outwardly from the plane of the flange portions of the members. The girts **20** and the purlins **21** may be similar members preferably of I-shape cross section. As seen in FIG. 5, the girts and purlins include a web portion **65** and the flange portion **66** and **67**. The girts and purlins are positioned on respective horizontal flange portions **63** with their web portions **65** in parallel contiguous relation therewith and to which they are secured by means of bolts **64**. As shown more clearly in FIG. 7, the girts and purlins are of a length determined by the spacing of the rigid portal frames, and their connected ends are notched inwardly at **68** so that the web portions of the girts and the purlins are connected to the angle members **60** along a longitudinal line spaced a greater distance from the inside flange **67** than from the outside flange **66** to which the side or roof is attached. This arrangement reduces the moment between the angle members **60** and the side walls or the roof, and provides a more stable structure.

Preferably, the girts **20** and the purlins **21** comprise nailable steel structural members. As shown in FIG. 5, the web portion **65** of the girts and purlins is formed to include a sinuous nail receiving groove **69** adjacent each of its flanges **66** and **67**, and the flanges are provided with longitudinal slots **70** opening into the nail receiving grooves. With structural members of this type the siding **22** and the roofing **23** may be secured in parallel relation against the bearing surface of the outermost flanges **66** by means of nails driven through the siding or roofing into the associated nail receiving groove. The provision of nail receiving grooves associated with the intermost flanges **67** allows easy assembly of the inside walls and of the ceiling.

As mentioned above, it is an object of the present invention to provide a novel rigid portal frame that may be easily fabricated at relatively low cost as compared to the rigid portal frames provided by the prior art, and which possess when incorporated in a building construction the required stability against buckling out of its plane without necessitating external braces projecting into the interior of the building construction and without utilizing an amount of metal substantially in excess of the metal required to provide the beam strength necessary to carry the design loading of the building construction. The foregoing is accomplished by providing a rigid portal frame including a number of component members of "hat-shape" cross section fabricated from a single piece of light gauge sheet metal by a cold forming process, in which the critical component members of the rigid portal frame, mainly, those component members located at the haunch of the frame and subject to the maximum bending moment stresses, are of tapered construction to possess a varying beam strength characteristic in accordance with the varying bending moment stresses in the critical members. In order to provide a stable building structure it is necessary that the rigid portal frames possess sufficient beam strength to carry the design loads of the building structure and sufficient stability so that the rigid portal frames do not buckle out of their planes, mainly, in a direction longitudinally of the building construction. While these requirements are met in prior building constructions employing rigid portal frames, including I-shaped members, it has been necessary in such constructions to include external bracing to stabilize the frames and to utilize an amount of metal in the fabrication of the critical component members of the frame in excess of the metal required to provide the beam strength necessary to carry the bending moment stresses involved. It has been discovered that tapered members of "hat-shape" cross section include unobvious characteristics which lend to the solution of this problem. In addition, it has been discovered that certain characteristics of tapered members of "hat-shape" cross section materially aid in the design of rigid portal frames and allow the most efficient use of metal throughout a wide range of building sizes and loading requirements.

As mentioned above, in order to save metal and hence reduce the cost of manufacture, the critical members of the rigid portal frame, mainly the side member **15** and the sub-member **27** of the roof member **17**, are constructed to possess a varying beam strength characteristic in accordance with the bending moment stresses in the members. This is accomplished by tapering the side web portions of the members from the ends of the members of maximum depth, at the haunch of the frame, in a direction toward their other ends. It has been discovered that a member of "hat-shape" cross section, tapered in this manner posses unusual characteristics which are utilized when practicing the present invention to obtain the advantages described above. In order to provide a rigid portal frame having inherent stability against buckling out of its own plane, it is necessary that the axis of the section parallel to the plane of the frame comprise the major axis. As shown in FIG. 10, the section of the side member **15** adjacent its base is proportioned so that the axis *y*—*y*, the axis parallel to the plane of the frame, comprises the major axis of the section, and the frame is stable at that section. As the depth of the side web portions increase to provide additional beam strength in accordance with the increasing bending moment stresses, the stiffness about the axis *y*—*y* decreases while the stiffness about the axis *x*—*x* increases, until a point is reached in the region of the section line **11**—**11**, for example, where the axes *x*—*x* and *y*—*y* of the section are of equal stiffness. As the depth of the side web portions further increases, above the section line **11**—**11**, the axis *x*—*x* comprises the major axis of the section, as shown in FIG. 12 for example, and the member **15** above the section **11**—**11** is not stable against buckling out of its plane. However, since the rigid portal frames are structural elements in a building construction and are necessarily joined to the girts **20** and the purlins **21** at spaced points along their length, it is not necessary to design the rigid portal frames in such a manner as to provide complete inherent stability against buckling out of the plane of the frame. This is so since the girts and purlins act

as restraining means against buckling of the frames longitudinally of the building structure. For example, if side member **15** shown in FIG. 9 was only attached at its base to the foundation and at its upper end by a girt secured to the uppermost angle member **60**, it would be necessary to proportion the cross sections of the member **15** throughout its length to provide greater inherent stability against buckling out of its plane than would be required if additional girts were attached to the side member intermediate its base and haunch end at the location of the other members **60**, for example. The attachment of girts to the side member at spaced points longitudinally of the member reduces the length of the portions of the member subject to buckling outwardly of its plane, and hence less inherent stability of the member is required to obtain a stable rigid portal frame when incorporated in a building construction. The discovery that the major axis of the section shifts 90° as the depth of the section increases from its base end toward its haunch end, dictates the required location of the first restraining means, i.e., the location of the girts adjacent the base end of the member. The girt need not be located at the section where the major axis shifts, but may be secured to the member above that section since the restraining effect of the girts extends along the member on both sides of the point of connection. The phenomenon of the major axis displacement also aids in the design of the tapered members **15** and **27** to provide an optimum relationship between the beam strength characteristics of the members and the stability against buckling outwardly of the plane of the frame. This results from the fact that the section in which the major axis shifts from axis *y—y* to *x—x* may be located at any point along the length of the side member **15** by properly proportioning the geometry of the sections and the degree of taper of the side web portions. Thus it is possible, according to the principles of the present invention, to provide a side member **15**, as well as a roof sub-member **27**, which possesses the required varying beam strength characteristic in accordance with the varying bending moment stresses and which possesses the necessary stability to prevent buckling of the frame out of its plane when employed in the building construction throughout a wide range of building sizes and load requirements, with the use of a minimum amount of metal.

"Hat-shape" sections are unstable sections, and when a load is applied to a member of "hat-shape" cross section the side web portions **31** and **32** and the flange portions **33** and **34** spread outwardly with respect to the *y—y* axis. This spreading action increases the stiffness of the section about the *y—y* axis and increases the inherent stability of the rigid portal frame against buckling out of its plane, however, the spreading action also decreases the beam strength of the member. Inasmuch as the sections of side member **15** and the sub-member **27** are considered to be in their normal shape when the members are designed to establish the required beam strength and the necessary inherent stability, and since it would not be feasible to utilize the characteristics of the section, when deformed, for design purposes, the present invention provides means for stabilizing the "hat-shape" sections. The stabilizing means comprises the angle members **60** which are attached to the outer surfaces of the flange portions **33** and **34** to bridge the space between the flange portions at spaced points along the length of the members. The angle members **60** form a stable section at their point of attachment to the members and influence the stability of the section throughout an appreciable region on both sides of the angle members so as to prevent any material change in the beam strength of the members throughout any portion of their length. The flexibility of design provided by the present invention permits the section stabilizing means and the stability retaining means to be applied at identically spaced points along the length of the members, to thus allow the angle members **60** to stabilize the section and also to support the girts and purlins.

In addition to the foregoing, other characteristics of "hat-shape" members make it possible to provide a rigid portal frame possessing the required beam strength and inherent stability without necessitating the use of external braces or an excessive amount of metal. As shown in FIG. 12, for example, "hat-shape" sections possess a greater stiffness about the *y—y* axis due to the relatively high moment of inertia about this axis and about the polar axis *z—z*, the latter axis is perpendicular to the plane of the paper and passes through the point of intersection of the axes *x—x* and *y—y*. This results from the fact that the metal forming the side web portions **31** and **32** is displaced from the *y—y* and *z—z* axes. This characteristic of "hat-shape" sections should be compared to I-shape sections which possess relatively low moments of inertia about the *y—y* and *z—z* axes. Consequently, members of I-shape cross section, as employed in conventional rigid portal frames, would tend to rotate about the polar axis *z—z* requiring restraining means, such as external braces necessarily located interiorly of the building construction, in order to establish a stable structure. As mentioned above and as shown in the drawings, the "hat-shape" members forming the rigid potral frames are relatively positioned with the plane of the inner web portions **30** parallel to the longitudinal axis of the building construction and defining the inner perimeter of the frames. This type of construction presents a most pleasing internal appearance since only closed surfaces of the rigid portal frames are visible from within the building construction. The arrangement is made possible, in part, due to the relatively high moment of inertia about the *y—y* axis of the hat-shape sections. Thus, the restraining means and the section stabilizing means may take the form of elements of the side walls and roof of the building construction.

The manner the tapered members **15** and **27** of the rigid portal frames may be fabricated from a single piece of light gauge sheet metal is illustrated in FIG. 13 of the drawings. As shown, a rectangular piece **80** of light gauge sheet metal is cut to form a pair of blanks **81** and **82**, each of which may be cold formed into the side member of a frame. The small end of each blank is cut to present an end edge **83** perpendicular to the longitudinal axis **84** of the blank, and the large end is cut to provide a substantially V-shaped edge having a flat apex portion **85** perpendicular to the axis **84** and inclined portions **86** and **87** terminating in spaced relation from the outer edges **88** and **89** of the blank to provide narrow edge portions **90** and **91** perpendicular to the axis **84**. Opposite sides of the blank are then bent upwardly into parallel relation, along lines **92** and **93** parallel to the axis **84** and passing through the extremities of the portion **85**. The marginal edges of the blank may then be bent downwardly and outwardly along lines **94** and **95**, into parallel relation with the portion between the lines **92** and **93**, the lines **94** and **95** being parallel to the outer edges **88** and **89**, respectively. The portion between the lines **92** and **93** constitutes the inner web portion **30** of the "hat-shape" section, the tapered portions between the lines **92** and **94** and between the lines **93** and **95** constitute the side web portions **31** and **32**, and the portions between the outer edges **88** and **89** and the lines **94** and **95**, respectively, constitute the flange portions **33** and **34**. It is to be expressly understood that tapered members of "hat-shape" cross section of different lengths and sectional geometry and taper may be fabricated in this manner by merely selecting the appropriate size of the sheet **80**. Also, the required bends may be made in any desired order and not necessarily in the order described above.

There is thus provided by the present invention a novel building construction including a plurality of rigid portal frames in which the rigid portal frames possess the necessary stability against buckling longitudinally of the build-

ing construction, when employed therein, without necessitating the use of external bracing members which limit the usable internal volume of the building construction and disadvantageously affect its appearance, and without using an excessive amount of metal as compared to the metal required to provide rigid portal frames possessing the necessary beam strength in accordance with the design requirements of the building construction. The foregoing is accomplished by providing a rigid portal frame including composite members of "hat-shape" cross section in which the critical members of the frame, namely those members carrying the greatest bending moment stresses, are of tapered construction, the composite members being designed in such a manner so that the members may be fabricated from a single piece of light gauge sheet metal material by a cold forming process.

Although only one embodiment of the invention has been disclosed and described above, it is to be expressly understood that various changes and substitutions may be made therein without departing from the spirit of the invention as well understood by those skilled in the art. Reference therefore will be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. A rigid portal frame including a pair of spaced elongated side members and a pair of elongated roof members; means joining one end of one of the roof members to one end of the side members in the region of one haunch of the frame; means joining one end of the other of the roof members to one end of the other of the side members in the region of the other haunch of the frame, the longitudinal axes of the roof members being disposed at an obtuse angle relative to the longitudinal axes of respective side members; means joining the other ends of the roof members in the region of the ridge of the frame; the side members and the roof members each having in cross section a planar inner web portion, a pair of spaced parallel side web portions extending perpendicularly in the same direction from the inner web portion, and coplanar flange portions extending outwardly from the side web portions in spaced parallel relationship with the inner web portion with the side web portions of the side members being tapered in a direction away from their respective haunches to rotate the major axis of the section of the side members 90° at an intermediate point in the length of the side members; the longitudinal axes of the side and roof members lying in a common plane with their flange portions lying in planes perpendicular to the common plane, with the planes of the inner web portions of the side members and roof members defining the inner perimeter of the frame and the planes of the flange portions of the side and roof members defining the outer perimeter of the frame; and connecting members joined to and bridging the space between the coplanar flange portions of the side members positioned between the side member's respective haunch and intermediate point of rotation of the major axis.

2. A building construction including a plurality of rigid portal frames extending transversely of the building construction and positioned in longitudinally spaced vertical planes with each of the rigid portal frames including a pair of upstanding elongated side members located at the edges of the building construction and a pair of inclined roof members each having one end joined to the upper end of a side member in the region of a haunch of the building construction and joined to another roof member in the region of the ridge of the building construction with the longitudinal axes of the side members and the roof members lying in a common plane, the side and roof members of the portal frames having in cross section an inner web portion, a pair of spaced parallel side web portions extending in the same direction from the inner web portion, and flange portions extending outwardly from the side web portions in spaced relationship with the inner web portion, with the side web portions of the side members tapered in a direction away from their respective haunches to rotate the major axis of the section of the side members 90° at an intermediate point in the length of the side members, the side and roof members of the portal frames being positioned with the flange portions of the side and roof members lying in planes perpendicular to the common plane and with the planes of the inner web portions and flange portions of the side and roof members defining the inside and outside perimeters of the frame respectively; and vertically spaced longitudinal members joined to adjacent rigid portal frames, bridging the flange portions of respective side members, and positioned vertically along the side members between the haunch of the building and the intermediate point of rotation of the major axis of the section of the side member.

References Cited in the file of this patent

UNITED STATES PATENTS

1,992,054	Brown	Feb. 19, 1935
2,102,277	Murphy	Dec. 14, 1937
2,185,916	Groetschel et al.	Jan. 2, 1940
2,246,245	Eckart et al.	June 17, 1941
2,255,151	Clements	Sept. 9, 1941
2,263,214	Larkin et al.	Nov. 18, 1941
2,375,409	Glitsch	May 8, 1945
2,549,816	Johnson	Apr. 24, 1951
2,574,074	Vogel	Nov. 6, 1951
2,610,708	Shannon	Sept. 16, 1952

FOREIGN PATENTS

20,854	France	July 23, 1919
107,709	Sweden	June 22, 1943