

Nov. 15, 1966

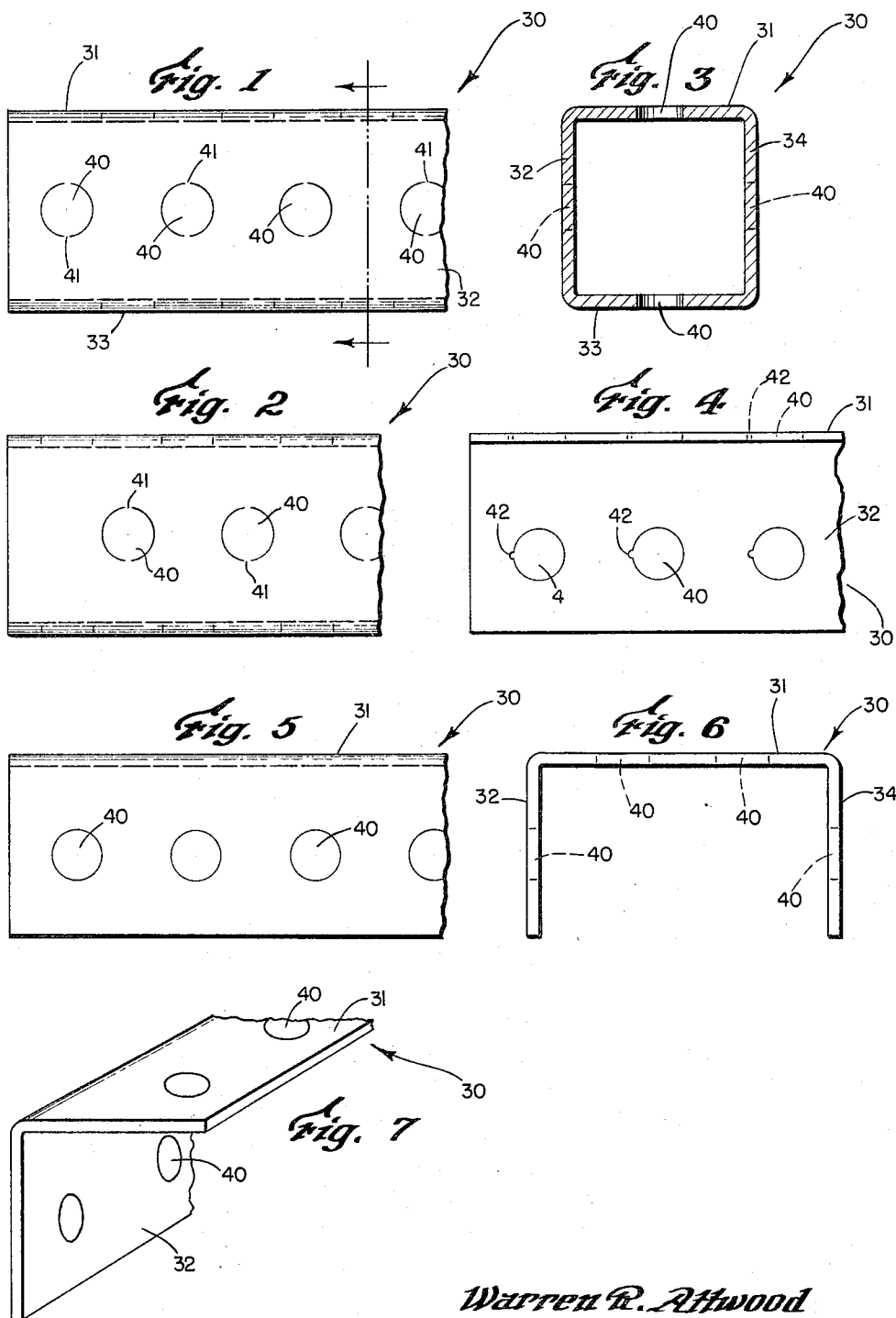
W. R. ATTWOOD

3,284,971

STRUCTURAL ELEMENTS FOR METAL FRAMING SYSTEMS

Filed Aug. 11, 1959

4 Sheets-Sheet 1



Warren R. Attwood
Inventor
by Porter, Custick and Russell
Attorneys

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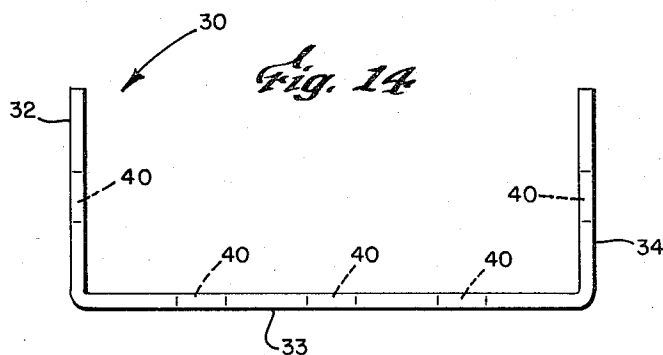
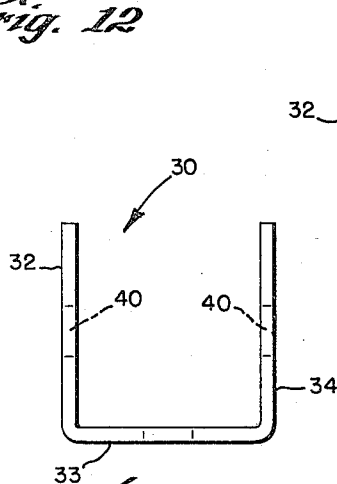
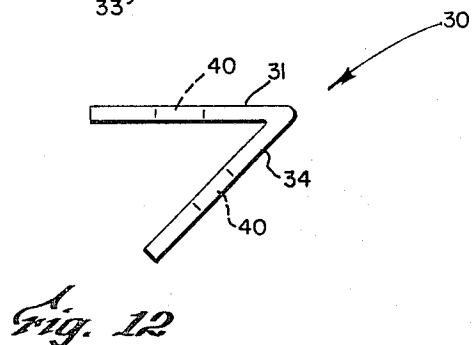
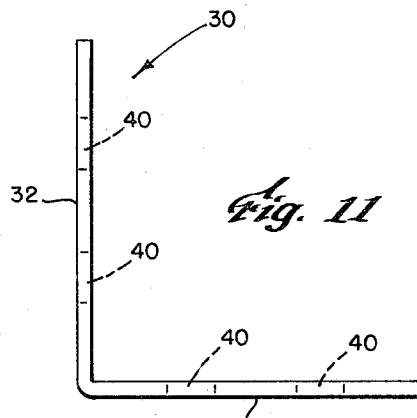
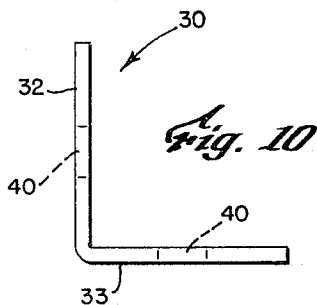
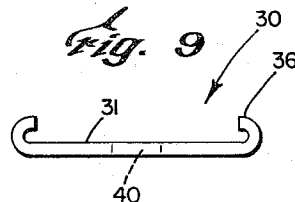
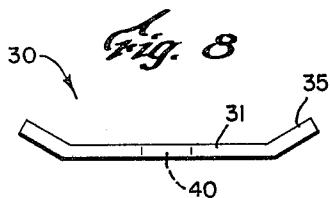
W. R. ATTWOOD

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Warren R. Attwood
Inventor
by Porter, Chittick + Russell
Attorneys

Nov. 15, 1966

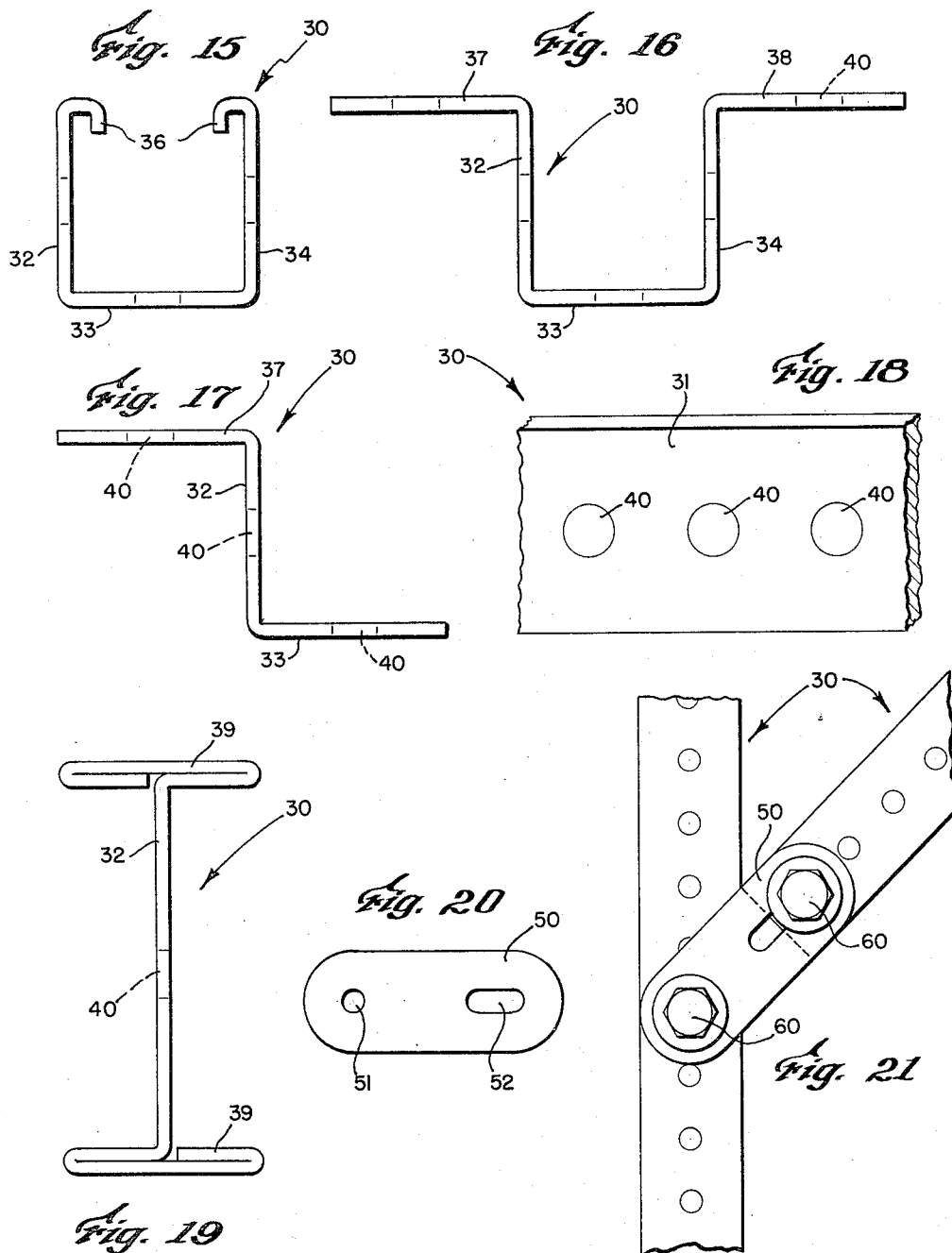
W. R. ATTWOOD

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Warren R. Attwood
Inventor
by Porter, Christie & Russell
Attorneys

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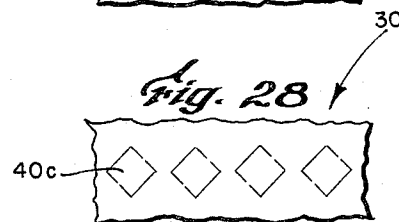
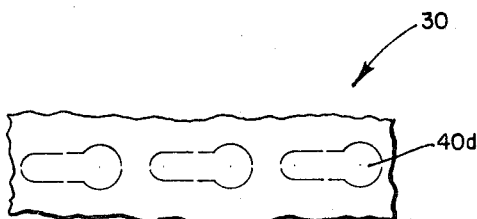
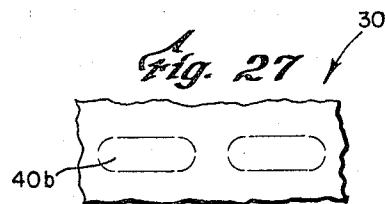
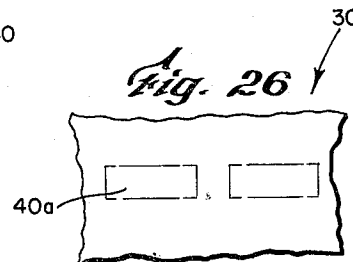
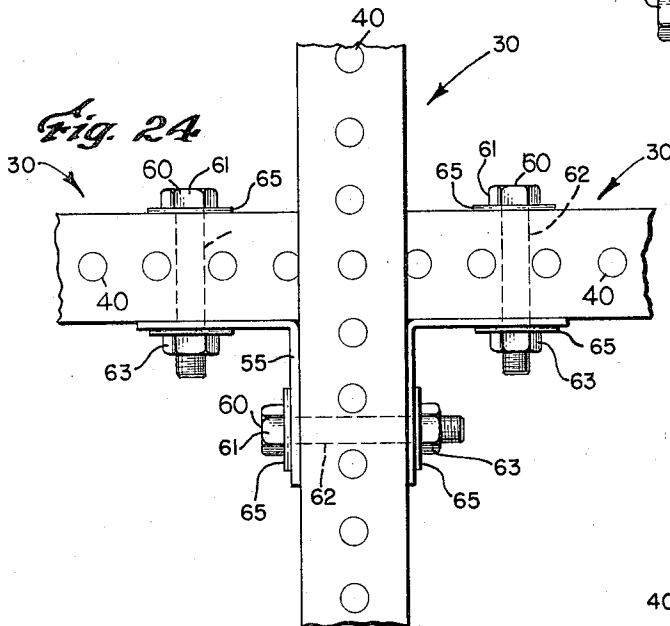
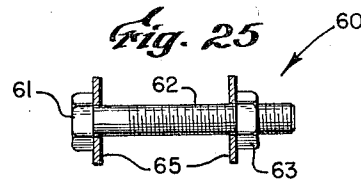
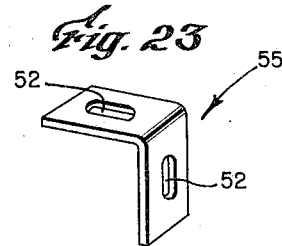
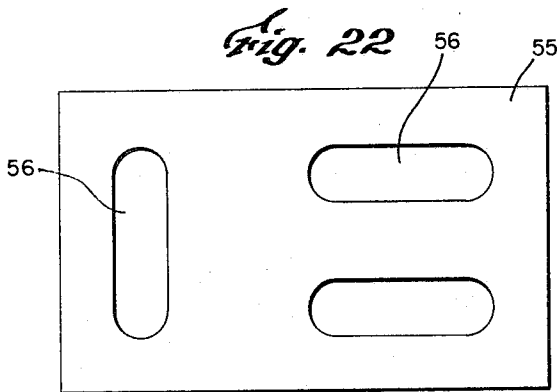
W. R. ATTWOOD

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4 Sheets-Sheet 4



Warren R. Attwood
Inventor
by Porter, Cliftlick + Russell
Attorneys

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3,284,971 STRUCTURAL ELEMENTS FOR METAL FRAMING SYSTEMS

Warren R. Attwood, 42005 North Drive, Wayne, Mich.
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7 Claims. (Cl. 52-100)

This invention relates to an adjustable metal framing system, and more particularly to structural elements comprising such system. This application is a continuation in part of my application Serial No. 806,969, filed April 16, 1959 which in turn was a continuation of my original application Serial No. 317,128, filed October 27, 1952, for Structural Material.

Adjustable bolted metal framing systems came into use during World War II. The first adjustable bolted metal framing system was that made by Unistrut Corporation of Wayne, Michigan, sold under the trademark Unistrut and now widely sold throughout the United States and in many foreign countries. The Unistrut metal framing system is shown and described in the patent to Charles W. Attwood No 2,345,650, granted April 4, 1944 for Skeletonized Structure. The Unistrut metal framing system is characterized by a channel-shaped metal structural member having inturned edges, a threaded clamping nut adjustably movable longitudinally inside the channel-shaped member and having parallel grooves to receive the inturned edges of the channel member, and a threaded bolt to bring and hold the inturned edges of the channel member into engagement with the grooves of the clamping nut as the threaded bolt is tightened. With these basic elements a large number of fittings have been designed for special uses, of which some 2500 different kinds are maintained in stock and some 10,000 have been designed with working drawings and engineering specifications and are available on order. The great virtue and advantage of the Unistrut metal framing system is that the only tools required to put it together are a hacksaw and a wrench, both now generally powered. The drilling, bolting, riveting or welding of the structural parts formerly used in metal framing systems are completely eliminated. Even more important, the great amount of engineering layout, design and planning, prior to shop fabrication, to determine where the parts should be drilled for bolting or riveting, is eliminated. The use of the Unistrut adjustable metal framing system has thus made great savings in labor and material, in costs of engineering and installation and has provided complete adjustability, with the ability of being disassembled and reassembled for use in other locations. The Unistrut adjustable metal framing system has been phenomenally successful and has created a new industry since World War II. The established advantages and great commercial success of the Unistrut adjustable metal framing system has encouraged competitors to design other bolted metal framing systems, in general using different types of clamping nuts, or other adjustable clamping means, and particularly competitors have sought to design more efficient or less expensive adjustable metal framing systems. But thus far these efforts have been unsuccessful.

Despite the phenomenal commercial success of the Unistrut metal framing system, so far superior to the older types of metal framing which had to be engineered or custom built at great expense from the particular job, the Unistrut system still has had its limiting factors or disadvantages. One principal limiting factor has been that the fittings, and panels as used for partitioning or walls, could only be attached to the open channel side of the channel member, and to permit fittings to be attached to other sides, one, two, three or four channel members or

other complicated fittings had to be welded together to make multiple section structural members. This made Unistrut expensive to use, particularly in partitions, building structures, and in supporting frames for equipment. Another limiting factor is that the channel passage is obstructed by the clamping nut and connecting fittings and this frequently makes it impossible to make full use of the interior of the channel to carry pipes, cables, conduits, wires and the like for the support of electrical and mechanical equipment, without adding an additional Unistrut channel. In addition the great number of fittings and connections required to make a flexible and versatile metal framing system, requiring an inventory of some 2500 different fittings to be kept in stock with some 10,000 more special fittings designed with working drawings and engineering specifications, to be manufactured on order has greatly increased the cost of doing business in adjustable metal framing systems. But thus far efforts to solve these problems and to make an improved metal framing system superior to Unistrut have not been successful.

I have sought to devise a metal framing system which would be an improvement over the present Unistrut system, having all the advantages of the Unistrut system but providing additional advantages, and particularly in overcoming the limitations of the Unistrut system above mentioned. With this purpose in view I have now succeeded in devising such a metal framing system, and disclose it herein. The principal structural element of my new metal framing system is no longer confined to a channel or U-shaped member, but includes several basic shapes. Thus the structural element may be a single flat side, preferably reinforced, an angle member with two flat sides disposed at an angle to each other, a channel or U-shaped member of three sides, a tubular shaped member of four sides, and square or rectangular in cross-section, an I-shaped member; a Z-shaped member of three sides, and the like, as shown in the accompanying drawings. Polygonal structural members, such as hexagonal and octagonal in cross-section are regarded as within the scope of the present invention. It will be plain that many combinations of structural members can be made from these basic structural shapes, as set forth in more detail below.

Briefly, my invention consists in punching out of the several structural members which comprise my metal framing system, a row or series of rows of so-called "knock-outs," which are the slugs formed when the hole is partially punched out of the structural member, and the slug or "knock-out" is then replaced, filling its hole again, leaving the strength of the structural member practically unimpaired. Then in use, when a metal framing system is being assembled, a slug or knock-out is punched out at a particular point where a fitting is to be attached, a bolt or other attaching means is inserted through the hole thus provided, and the appropriate fitting is secured to the bolt, by a nut, for instance, or the structural members may be bolted directly to one another.

The series of knock-outs in a row are not limited to one uniform size or shape and may be intermittent and not continuous. But preferably the knock-outs are uniformly spaced and arranged in some sort of repetitive pattern, for practical manufacturing and assembling operations. In a four-sided tubular structural member, for instance the knock-outs on opposite sides should preferably coincide; but the knock-outs on adjacent sides may be staggered with respect to each other, so that connecting bolts will not interfere with each other.

In addition, the centers of the knock-outs are preferably arranged exactly one inch apart from each other or with similar uniform spacing, thus providing a ready means of measurement merely by counting the knock-outs in a row. Similarly knock-outs at regular spacings such

as every 3rd, 6th or 12th knock-out, may be identified with some distinctive mark to facilitate measurement in installing the metal framing.

In this application I show the knock-outs connected to the structural member with two webs or attaching portions, or with one connecting web, as may be desired. But the knock-outs may be completely severed, leaving no connecting web, if desired, as I also show herein. The degree of penetration of the structural member by the punch required to completely sever the knock-out is a function of the hardness of the steel in the structural member. Ordinarily, depending on the relative hardness of the steel used, the punch penetrates the structural member from approximately one-third to two-thirds of its thickness. Then the slug or knock-out is pushed, or otherwise pressed back approximately into its original position and then replaced so that the structural member presents a substantially smooth surface again.

In my application I also show fittings adapted to be used with my structural members which include a flat bar or strip having a circular opening and also an elongated slot and a flat plate with elongated slots in three positions, for adjustability of attaching members. An angle fitting and a bolt are also shown, for connecting structural members.

It will be seen from the following description and accompanying drawings that my adjustable metal framing system herein disclosed permits infinite adjustment for the connecting members, with a multiplicity of potential bolt locations without undue weakening of the structural members themselves.

Other objects and advantages will be apparent from the following description and accompanying drawings, in which:

FIG. 1 is a view in front elevation of a piece of a structural member in square tubular form;

FIG. 2 is a view in front elevation of the same piece, but showing a face at 90° from that of FIG. 1;

FIG. 3 is a view in cross-section of the piece shown in FIG. 1;

FIG. 4 is a view in front elevation of a piece of structural member in angle form showing one connecting web for the knock-outs;

FIG. 5 is a front elevation of a structural member in U-shaped form.

FIG. 6 is a vertical cross-section of the structural member shown in FIG. 5;

FIG. 7 is a perspective view of a structural member in angle form;

FIG. 8 is a view in cross-section of a structural member having one flat side with angled flanges;

FIG. 9 is a view in cross-section of a structural member having one flat side with reversely bent flanges;

FIG. 10 is a view in cross-section of a piece of structural member in right angle form such as shown in FIG. 7;

FIG. 11 is a view in cross-section of a larger form of right angle structural members with two rows of knock-outs in each side or face.

FIG. 12 is a view in cross-section of a structural member in angle form with the two sides at an acute angle to each other;

FIG. 13 is a view in cross-section of a U-shaped channel member with single rows of knock-outs on their flat sides;

FIG. 14 is a view in cross-section of a U-shaped channel member with three rows of knock-outs in the center web.

FIG. 15 is a view in cross-section of a U-shaped channel member similar to FIG. 13 having inturned edges;

FIG. 16 is a view in cross-section of a U-shaped structural member having side wall flanges;

FIG. 17 is a view in cross-section of a Z-shaped structural member having two angle sides;

FIG. 18 is a plan view of a structural member having one flat side;

FIG. 19 is a view in cross-section of a structural member in I-shaped form;

FIG. 20 is a plan view of a connecting fitting;

FIG. 21 is a front elevation of a structural member with connecting fitting attached;

FIG. 22 is a plan view of another form of connecting fitting;

FIG. 23 is a perspective view of an angle fitting;

FIG. 24 is a front elevation illustrating the use of the structural elements in a framing system;

FIG. 25 is a front elevation of a bolt and nut suitable for use with the structural members; and

FIGS. 26 to 29 inclusive are front elevations of structural members showing alternative shapes of knock-outs.

As shown in the drawings the present invention resides in elongated metal structural members having one or more flat sides, and having one or more rows of spaced knockouts formed and retained therein, which knock-outs are removable to provide holes for the adjustable attachment of connecting fittings.

In FIGS. 1, 2 and 3 the elongated sheet metal member comprises a polygonal tubular member 30, square or rectangular in cross-section, and having flat sides 31, 32, 33 and 34, as best shown in FIG. 3. The sheet metal member is produced by forming rolls acting upon a suitable strip of sheet metal and the meeting edges are welded, or seam rolled, as desired. Before the forming operation, however, the strip of sheet metal is subjected to a punch press or roller die operation, whereby a multiplicity of so-called knock-outs 40 or slugs are formed when a hole is partially punched out of the structural member, and the slug or knock-out is then replaced, filling its hole again, and leaving the strength of the structural member practically unimpaired. In FIGS. 1 and 2 I have shown the knock-outs connected to the structural member with two webs 41 or attaching portions at the top and bottom of the knock-out, and in FIG. 4 with one web or attaching portion 42 at the side. In FIG. 5 the knock-out 40 is shown completely severed, leaving no connecting web. To completely sever the knock-out the sheet metal member must be substantially penetrated by the punch, and as stated above the degree of penetration of the structural member is a function of the hardness of the steel forming the structural member. With a hard steel the punch normally will penetrate the structural member approximately one-third of its thickness, and with a softer steel will penetrate the structural member to approximately two-thirds of its thickness. The slug or knock-out 40 is then pressed back into place in a suitable manner, as by pressing rolls, to present a substantially smooth surface on the flat sides of the structural member 30. To restore or retain the original strength of the structural member after the knock-outs are severed, and are then pressed back into place, it is important that the knock-outs closely contact the sides of the hole which is formed in the structural member by punching out a knock-out. The closer the fit of the knock-out in its hole, and hence its contact with the sides of the hole, the more the original compressive strength of the structural member is retained or restored.

Preferably the knock-outs are uniformly spaced and arranged in some sort of repetitive pattern, for practical manufacturing and assembling operations. In a four sided tubular structural member, as shown more particularly in FIG. 3, the knock-outs 40 on opposite sides 31 and 33 preferably coincide; but as shown in FIGS. 1, 2 and 24 the knock-outs on adjacent sides may be staggered with respect to each other, so the connecting bolts passing through to opposite sides will not interfere with each others. In addition the center points of the knock-outs are preferably but not necessarily exactly one inch apart from each other, thus providing a ready means of measuring in determining the precise slug to be knocked out for attaching and fitting. For the same reason knock-outs at regular intervals such as every third, sixth or twelfth

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knock-out may be identified with its number or some distinctive mark to facilitate measurement in installing the metal framing.

As stated above in FIGS. 1, 2 and 3 show the structural member 30 in a four-sided square or rectangular tubular shape. I have also stated above that the four-sided tubular member can be made hexagonal with six sides and octagonal with eight sides if desired, and so on until the angled opposite sides are increased and disappear into a true circle, without departing from my invention. In FIGS. 4 to 19 inclusive I have shown other shapes in which the basic structural member 30 may be provided with knock-outs 40 formed therein, but I do not restrict myself to the specific shapes shown of the structural member 30. For simplicity and clarity I have designated the four sides of the four-sided tubular structural member as 31 for the top side, 32 for the left side, 33 for the bottom side and 34 for the right hand side, as shown in FIG. 3. I adopt similar corresponding numbering for the sides of the structural members 30 as they are shown in FIGS. 4 to 19 inclusive, but it will be understood that the other structural members 30 are turned or positioned in any suitable manner in use, and any side may be top or bottom, left or right, as may be desired.

In FIG. 4, therefore, I show a structural member 30 in angle form comprising the sides 31 and 32 and which same angle form is shown in perspective in FIG. 7. The knock-outs 40, however, in FIGS. 4 and 7 differ in that the knock-out 40 in FIG. 4 has a side connecting web 42, and the knockouts 40 in FIG. 7 are completely severed and have no connecting webs.

In FIGS. 5 and 6 the structural member 30 is a U-shaped member having sides 31, 32 and 34.

In FIG. 18 the structural member 30 comprises a single, flat side 31 with knock-outs 40. As such a single flat sided structural member is particularly vulnerable to twisting forces, I prefer to strengthen it by adding angled flanges 35 as shown in FIG. 8, or reversely bent flanges 36 as shown in FIG. 9. Other forms of strengthening means such as strengthening ribs formed in the flat sided structural member 30 may also be provided.

FIG. 10 shows an angle form of structural member 30, similar to FIG. 7 with two sides 32 and 33 and single rows of knock-outs 40 in the sides thereof.

FIG. 11 shows a structural member in angle form, similar to FIG. 10, but larger, and again comprises sides 32 and 33, but with two parallel rows of knock-outs 40 in the two sides.

FIG. 12 shows the structural member 30 in angle form, but with the two sides 31 and 34 arranged at an acute angle. Again a single row of knock-outs 40 is provided in each of the sides, and it will be understood that the member 30 may be bent at an obtuse angle as well.

FIG. 13 again shows a structural member 30 in the form of a U-shaped channel member comprising the three sides 32, 33 and 34, with a single row of knock-outs 40 in each of the sides.

FIG. 14 is similar to FIG. 13 in showing a structural member 30 of U-shaped channel form, with the three sides 32, 33 and 34. But in this form of channel structural member the central web or side 33 of the channel member has three parallel rows of knock-outs 40 provided therein.

FIG. 15 shows a structural member 30 of U-shaped channel form, similar to FIG. 13, comprising sides 32, 33 and 34, but with turned edges 36 at the open side of the channel member.

FIG. 16 again shows another form of structural member 30, in the form of a U-shaped channel member comprising the sides 32, 33 and 34, but with the two vertical sides 32 and 34 provided with outwardly extending flanged sides 37 and 38 respectively. Each of the sides 32, 33, 34, 37 and 38 is provided with a single row of knock-outs 40, as shown in FIG. 16.

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FIG. 17 shows another form of structural member 30 in Z-shaped form comprising the sides 37, 32 and 33, again with single rows of knock-outs 40 provided therein.

It will be understood of course that the angular relationship between the two sides comprising the structural member 30, in all cases where it is shown as a right angle, may be at an acute angle or obtuse angle, as may be desired.

FIG. 19 shows a structural member 30 in an I-shaped form, which comprises the vertical side 32 with a single row of knock-outs 40 provided therein and with reversely bent flanges 39, provided at right angles to the central side 32.

FIG. 20 shows a flat sided form of connecting fitting 50, comprising a short bar or strap and which is provided with a circular opening 51 and an elongated slot 52 at the other end.

In FIG. 21 the fitting 50 is shown in use, serving to attach by means of bolts 60 to an upright structural member 30, which may be of four-sided tubular form, as shown in FIG. 3, a channel form as shown in FIG. 13, or a single flat sided form as shown in FIG. 18, or the like, to a diagonal truss, comprising a second structural member 30 of similar suitable form.

FIG. 22 shows a second form of connecting fitting comprising a flat metal plate 55, shown in enlarged dimensions therein, and having elongated slots 56 provided therein with one pair of slots 56 in parallel relation at one end of the plate and a third slot 56 at right angles thereto at the other end of the plate 55.

FIG. 23 shows a third form of connecting fitting, similar to the fitting 50 in FIG. 20, except that it is bent transversely approximately at its mid-section, to provide angled ends, in turn provided with elongated slots 52 similar to a slot 52 provided in the fitting 50.

FIG. 25 shows a standard form of threaded bolt 60 which may be used for connecting the structural members and fittings together in making up the metal framing system disclosed herein. As any suitable form of bolt may be used, it suffices to say that the bolt should be slightly smaller in diameter than the knock-outs 40, to fit a hole left when the knock-out is removed. A suitable bolt 60 as shown in FIG. 25 comprises a head 61, a threaded shank 62 and a threaded nut 63. Suitable washers 65 are optional. It will be understood that a stud or rivet (not shown) can be used in place of the bolt 60, and that structural members 30 may be bolted together directly without the use of intermediate connecting fittings.

It will be understood that a suitable form of lock washer (not shown herein) may be provided for locking or tightly binding the structural members and connecting fittings together, if desired.

FIG. 24 (in addition to FIG. 21) shows a typical installation illustrating the use of the structural members. The connecting fittings are bolted together in a typical metal framing installation. Thus in FIG. 24 structural members 30, of desired cross-sectional shape, such as the four sided tubular member as shown in FIG. 3, or a U-shaped channel member as shown in FIG. 13 are shown in connected relation. An upright structural member 30 has two horizontal structural members 30 attached to it by means of angle fittings 55 and three bolts 60 with their nuts 63. It will be understood that in attaching the bolts 60, the knock-out located at the desired position is pushed out in any suitable manner and the shank 62 of the bolt 60 inserted in the hole left by the removed knock-out 40. FIG. 24 also shows how the staggered relation of the knock-outs 40 on adjacent sides of the structural members 30 permits bolts to be inserted in adjacent knock-outs without interfering with each other. It will be seen that the shank 62 shown in dotted lines of the bolt 60 pass between the adjoining knock-outs of the adjacent sides of the structural members 30.

FIGS. 26 to 29 inclusive show alternative shapes of knock-outs 40 which may be provided in the structural

members 30. In FIG. 26 knock-out 40a is rectangular in shape; in FIG. 27 the knock-outs 40b are oblong with rounded ends; in FIG. 28 the knock-outs 40c are square and arranged at a diagonal to the longitudinal axis of the structural member, and in FIG. 29 the knock-outs 40d are elongated slots in the shape of keyholes. It will be understood that the shape of the knock-outs used in any particular instance are optional and are not limited to those shown herein.

It will thus be seen that I have provided a metal framing system of great versatility and complete adjustability by providing adjustable attaching means which permits a wide variety of structural members to be used, with their inherent strength unimpaired, until the necessary knock-outs are removed for connecting fittings. The necessity of using U-shaped channel structural members as in FIG. 15 is entirely eliminated, the space in the channel when U-shaped channel members are used is entirely unobstructed and freed for additional uses, and the necessity of a vast number of connecting fittings for providing a flexible and versatile metal framing system is also eliminated by my metal framing system disclosed herein. It will thus be noted that with the metal framing system disclosed herein that any side of the structural member 30 can be used for the attachment of connecting fittings; whereas with the Unistrut channel member only the open side where the clamping nut is inserted, or only one-fourth of the surface of the Unistrut channel member is available for the attachment of fittings. As stated previously, in the Unistrut system 2, 3 or 4 channel members had to be welded together to make multiple sectional structural members, where fittings are desired to be attached on more than one open channel side of the channel member, as when Unistrut channel members are used for supporting partitioning or walls, for instance. Another important advantage of my present metal framing system is that when a U-shaped structural member, as shown in FIGS. 13, 14 or 15 is used to carry wires the knock-outs provide a ready-made hole for exiting the wires at a desired location, whereas with the Unistrut channel member to exit wires a separate hole has to be drilled for that purpose.

A further advantage of my metal framing system with the knock-outs pressed back into place to present a substantially smooth surface is the pleasing, unbroken appearance of the surfaces of the structural member 30, which can be painted or finished in any suitable manner, to present a clean and unbroken surface in the structural member. Further with the knock-outs severed but retained in original position the original strength of the structural member remains substantially unimpaired.

Naturally the shape and size of the structural member 30 selected for use in any particular installation or part of an installation, as shown in FIGS. 1 to 19 inclusive will depend on the purpose for which the framing system is to be used, and on the load the framing system is required to carry. But with the few sizes and shapes of structural members and connecting fittings here shown it is apparent that my framing system has great

flexibility and versatility and adaptability for a great many purposes and with a number of important advantages over any other metal framing system yet devised.

I claim:

1. In an elongated unitary load-supporting metal frame member for an adjustable metal framing construction, said frame member having one or more flat sides, a plurality of spaced removable knock-outs provided in at least one of said sides and forming a hole therein when removed, each of said knock-outs being completely severed from said member for at least the major portion of the common periphery of the knock-out and the associated hole, said knock-out being substantially coplanar with said side and the edge of said knock-out closely contacting the side of said hole whereby said frame member presents a substantially smooth surface and each said knock-out when retained contributes to the strength and rigidity of the frame member, said knock-outs when removed providing optional holes for the attachment of additional frame members to said frame member.
2. A frame member as claimed in claim 1 wherein said knock-outs are arranged in one or more longitudinal rows.
3. A frame member as claimed in claim 1 wherein said knock-outs are attached to said frame member by means of a connecting web.
4. A frame member as claimed in claim 1 wherein said knock-outs are completely severed from said frame member.
5. A frame member as claimed in claim 1 comprising two or more longitudinally connected angularly bent side elements.
6. A frame member as claimed in claim 5 wherein at least one of said elements is provided with one or more longitudinal rows of spaced knock-outs.
7. A frame member as claimed in claim 5 provided with at least three longitudinally connected side elements wherein at least two of said elements are parallel to each other, and wherein at least one such pair of parallel side elements are each provided with spaced knock-outs, the knock-outs on one side element of said pair being directly opposite corresponding knock-outs on the other side element of said pair.

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RICHARD W. COOKE, JR., *Primary Examiner*.

JACOB L. NACKENOFF, WILLIAM I. MUSHAKE,
JOEL REZNEK, *Examiners*.

R. C. DARR, C. L. PACE, *Assistant Examiners*.