June 26, 1962 N. R. ABBERLY 3,040,849

FIELDWELDABLE BUILT-UP HOLLOW STRUCTURAL STEEL LENGTH

Filed Oct. 10, 1960

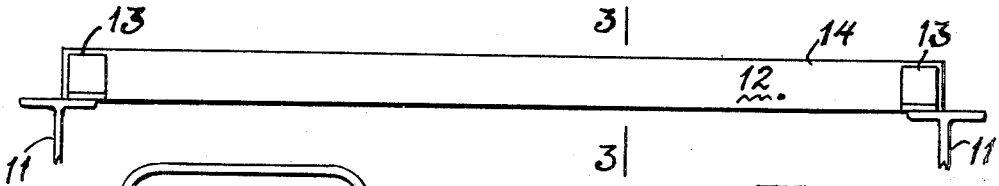


Fig. 1

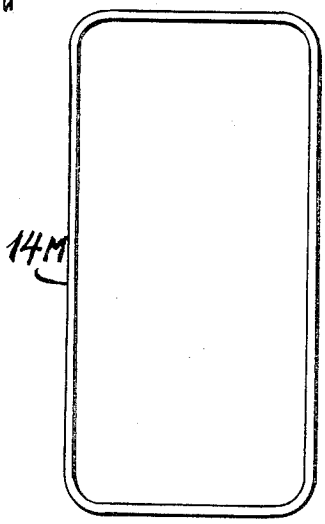


Fig. 2

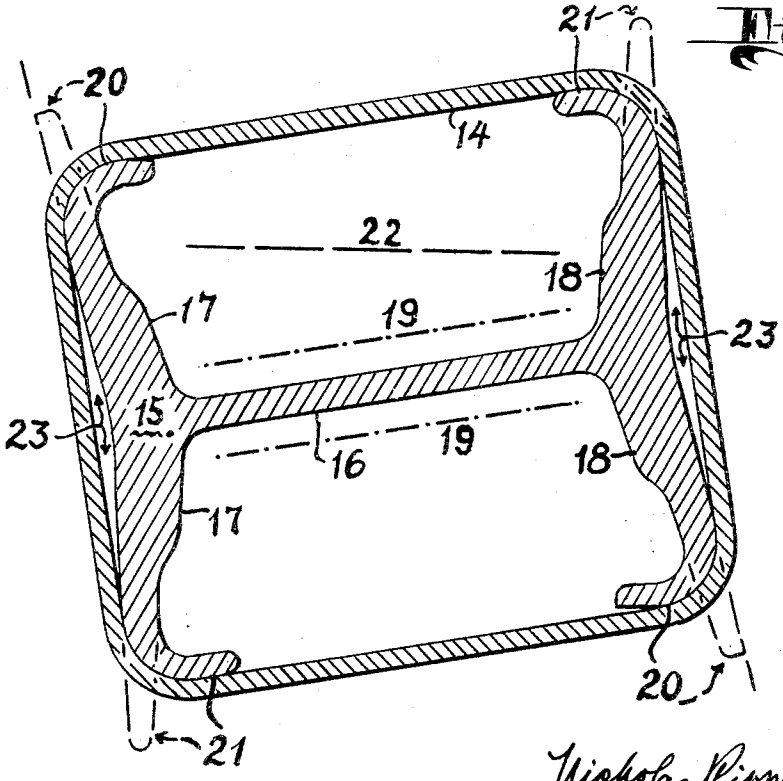


Fig. 3

INVENTOR

Nicholas Rippon Abberly

United States Patent Office 3,040,849 Patented June 26, 1962

3,040,849

FIELDWELDABLE BUILT-UP HOLLOW STRUCTURAL STEEL LENGTH

Nicholas Rippen Abberly, 4018 Worth St., Dallas 10, Tex.

Filed Oct. 10, 1960, Ser. No. 61,783
4 Claims. (Cl. 189—37)

This invention relates to steel lengths that contributorily constitute all types and sizes of structures, both earth-anchored and movable, particularly the skeletons of tier structures, as well as relating to lengths that do not form a part of an inclusive structure, namely, poles. Excepting where qualified, the comprehensive expression, general lengths, including therefore poles as well, has been adopted herein.

The application of the invention is limited to lengths designed for affixment in the field by welding; fieldwelding is of course not associable with full heat treatment, for which a furnace large enough to house the inclusive structure is used.

A salient ultimate aim consists in providing general lengths, respecting every contemplated ratio of length to weight or transverse dimensions, or of weight thereto, with a structure-derived degree of strength that exceeds that attained in all comparable other general lengths. The expression, structure-derived, refers to the fact that, so far as concerns invention aspects, the augmentation in strength derives from geometric and affixing and not from metallurgic innovations.

The salient possibilitating aim consists in providing, as part of each general length, an outside member or members, termed, shielding, constituted of relatively soft metal and which is at least limitedly fieldweldable, and an inside member or members, termed, coring, of relatively hard metal, there being between the shielding and the coring, airspace designed to obstruct the passage of outside welding heat from the shielding to the coring in an amount sufficient to damage the latter.

The term, coring, a coined one, designates, in a given said length, the single core or plurality of core elements. A coring is simple when, transversely regarded, it consists of a single core element. It is complex when, so regarded, it consists of a plurality of core elements. Such a plurality is not to be confused with a longitudinally disposed plurality of simple cores. The herein adopted symbols for them, derived from said expressions, are SC and CC.

The shielding is preferably of machinable metal in the sense that holes can be drilled in it in the field with portable tools mounting cobalt drills and not necessarily carbide drills (because of the difficulty of establishing a rigid relationship between the tool and the drilled object), altho carbide-tipped drills are alternatively employable, instead of the cobalt drills.

Admissible in all embodiments is every conceivable ratio between the long dimensions of the shielding and the coring, the differences merging into one another over an infinitely extended series of gradations and which therefore cannot be species determining factors. The coring constitutes, in every embodiment, at least an auxiliary strength member, and, in the herein selected exemplifying embodiment, the member which provides approximately ninety-five one-hundredths of the inclusive strength of the respective length. At the other extreme, where the shielding is the principal strength member, the coring consists of one or more abbreviated cores supplying needed extra strength at critical points along the length. One embodiment of the latter would be in a pole where the pole-long shielding must be accorded stiffening at the most highly stressed zone, adjacent the ground. And, where a pole consists of a succession of lengths because of being too high for an integral shield, one or more

abbreviated cores serve as the traditional inside liners at the juncture zones. In a simple beam of uniform or nearly uniform depth thruout, an abbreviated core can usefully serve in the middle zone. In a cantilever beam, the abbreviated core would of course be installed at the point of support for the beam. The shielding girths the coring in such a relationship thereto that they adjoin one another (transversely) discontinuously, which means that there is, transversely peripherally, a plurality of mutually separated air spaces and, alternating with them, a plurality of mutually separated pairs of contact-zone portions, the two in each said pair being respective portions of the coring and the shielding. In each contact zone they engage one another pressurally by the largest available respective areas in order to reduce the unit pressure value on the softer metal of the shielding, which of course is of particular importance where the hardness contrast between the shielding and the coring is considerable, and the advent of enormous hardness contrast is confidently predicted for embodiments of this invention in years to come. The role of the air spaces is the barring of the transmission of the greater part of the field welding-associated heat from the shielding to the coring, so that whatever heat does reach the coring is insufficient in quantity to deleteriously affect the coring grain structure. The aforegoing possibilitates the fabricating of structural steel lengths with fieldweldable shielding and where the coring is length-long, that exceed in strength every other currently known comparable structural steel length, because of the incorporation, into the coring, of steel of a hardness unprecedented in structures and which could never have been realistically contemplated for such use before the advent of this invention. Since ultimate strength in steels at least roughly parallels hardness, and, in the case of those which are heat treated, almost perfectly, hardness numbers are adopted for indicating relative strengths. The invention incorporating lengths, when they are not poles, are such components of inclusive structures as beams, chords of trusses and built-up beams, columns, struts and otherwise.

In my application for U.S.A. Letters Patent filed September 12, 1960, under the title, Built-Up Hollow Fieldweldable Structural Steel Length, Serial Number 55,501, six species of the invention are described, the species-creating concepts being the two kinds of coring, namely, simple and complex, and the three ways of tensioning the shielding sufficiently to preclude relative lengthwise sliding between the shielding and the coring, namely, expanded shielding where a filler is forced between the shielding and the coring, retracted shielding where threaded fasteners force a shielding-long portion thereof inwardly of the coring where there is lengthwise recessing thereof, and a third way where the shielding and the coring are interference-fitted to one another. The subject of the instant application for letters patent consists of a seventh and eighth species of the invention, respectively characterized by the coring being simple and complex, the shielding being of a kind that unites the characteristics of said expanded shielding and of said interference-fitted shielding and coring. Only the seventh species is described herein and illustrated in the accompanying drawing. Persons who are skilled in the art and who have studied this specification and that of said other application for Letters Patent cannot conceivably experience any difficulty is designing and/or fabricating, let alone envisaging, embodiments of the eighth species. The herein description teaches that the tensioning of the shielding in the seventh and the eighth species derives from the dimensional relationship between the coring and the shielding, wherein the expansion of the latter is effected without the presence of a filler, particle migration, which

characterizes every interference fit, being confined to the shielding for two reasons. One consists in the fact that the hardness of the coring considerably exceeds that of the shielding. The other consists in the preference of a coring thickness that exceeds the shielding thickness, whereby the by far greater contribution to the strength of the length is made by the coring, which, in the case of the illustrated embodiment, approximates, as a matter of fact, ninety-five one-hundredths, based on the assumption that the unit strength value of the coring metal is thrice that of the shielding metal, and the fact visible to the eyes of all that the mean thickness of the coring is thrice that of the shielding. Facile telescoping of the shielding and the coring is facilitated and the desirable degree of an interference fit is attained by heating and/or refrigerating preparatorily to the telescoping of the two members.

For a clear understanding of the relationship of the tensioning of the shielding in the seventh and eighth species to that in the first six species, refer to the accompanying drawing in which—

FIGURE 1 is a side elevation view of a simple-beam embodiment.

FIGURE 2 is a schematic depiction of a certain cross-section of a beam.

FIGURE 3 is an enlarged cross-sectional view taken in plane 3—3 in FIGURE 1.

Refer to FIGURES 1 and 3. The two WF (wide-flange shape) girders **11** are shown fragmentarily. Supported by their top flanges is said beam embodiment **12**. It can be envisaged as a complete beam or as the top chord of a roof truss or of an open-web-type floor joist, like any one of those described in said other patent application.

Welded to the side walls at the two ends of the respective shielding are two pairs of flanking angles **13**, which in turn are to be tackwelded to the girder top flanges. Beam **12** consists in the main of the coring **15** and the shielding **14** of relatively soft steel, possibly as strong or nearly as strong as the boron-type less-than-one-percent-nickel steel, "T–1," but in any case fieldweldable without pre- or post-heat, at least limitedly, namely, by depositing a plurality of beads. The Brinell carbide-ball hardness number of the coring is at least one hundred higher than that of the shielding. The coring, being integral, is of the simple type, a modified WF shape hotrolled by the diagonal method but terminating, before the bending of the free margins of the flanges, at what would be ordinarily termed, the last intermediate pass. The web is indicated by **16**. When compared with the dimensions of the flange main portions and lesser portions (said free margins), those of the web are depicted schematically in that, in a WF with flanges like **17** and **18**, both the depth and the web thickness would be usually twice or more those in the view. The aforegoing is occasioned by the need of ample space for a clear view of the flange portions which, respecting the flanges themselves, have forms, dimensions and mutual relationships like those in many recommended embodiments of this invention. As an example of said larger dimensions, the dot-and-dash line **19** represents the web thickness when doubled. The mean thickness of each said main portion considerably exceeds that of the respective said lesser portion or free margin, the free margins being indicated by **20** and **20** and by **21** and **21**, with solid and dotted leadlines respectively indicating the before-bending and the post-bending state.

Dashline **22** indicates the horizontality of the axes of the rolling facility rolls being used for the hotrolling of this WF by the diagonal method, in this case, with an obliquity measuring ten degrees, which may be more and may be less. The two respective mean planes of the two "halves" of each said flange define an outside obtuse angle. In consequence thereof there are constituted the air spaces **23**, each separating a respective said coring main portion and a thereadjacent therealong shielding portion. The dotted lines **20**, **20**, and **21**, **21**, represent the rolled state of the free margins at said final intermediate pass. The bent state can alternatively be referred to with the expression, hooked state. It is effected rollingly with vertical rolls or slidingly with fixed dogs or, with the participation of a manipulator that rotates the WF into a position where the web is vertical, rollingly with horizontal rolls. With reference to each side of the web, the inside or concave surfaces of each two hooked free margins respectively of two flange "halves" confront one another. Characteristic of the diagonal method of rolling WF shapes are the relatively sharp edges **23** of margins **20**, **20**. To be noted is the more extreme bending that margins **20**, **20** are subjected to. This is to remove them out of contact with the shielding because otherwise the relatively soft metal of the shielding would be gradually penetrated and weakened by the relatively hard metal of the coring. Because the "edges" of margins **21**, **21** are rounded ones, the bending thereof is to a degree sufficient to preclude protruding into the shielding and no more. The shielding-parallel relationship of margins **21**, **21** can be seen in FIGURE 3. In view of the aforegoing, which is economically effected, the otherwise "breaking" of the relatively sharp edges is unnecessary and would involve added expense without reason.

The shielding and the coring are interference-fitted to one another by refrigerating the coring and heating the shielding, or, and preferably because of less expense, either heating the shielding or refrigerating the coring. The need of a filler for expanding the shielding, like the one in FIGURE 2 of said other patent application and especially in the therein more comparable embodiment, the subject of FIGURE 11, is dispensed with. An important advantage of the instant embodiment over the latter consists in a cross-sectional form constituted, if the rounded corners be ignored, rectangularly. Such a cross-section lends itself always to the simplest and most facilely effected affixment. The salient advantage however consists in the drastic reduction in assembling-labor cost made possible by the present invention.

FIGURE 2 schematically sets forth a more acceptable width-to-depth ratio (the web being of course, in all cases, upright). Together with optimal thickness ratios between the shielding and the coring, the FIGURE 2 ratio works for an optimal radius of gyration and moment of inertia.

The usual coarse tolerances, respecting both the shielding tube and the hotrolled WF, are quite acecptable because the degree of stretching of the shielding is not important if the tautness thereof have a magnitude sufficing for considerable frictional engagement between the two elements, with relative sliding therefore precluded, even tho the stretching of the shielding spell a considerable attenuating and therefore weakening thereof. The explanation of the latter resides in the fact that, with respect to the seventh and eighth species of the invention, which is basically set forth in said other patent application, all embodiments contemplate the by-far-greater contribution to strength of the respective length being made by the coring.

Refer to FIGURE 2. The character, 14M, indicates the shielding which would replace the shielding **14** in FIGURE 2 for a more scientifically proportioned beam. It does not at all follow that the space between the web and the web-parallel portions of the shielding are more effective in obstructing the passing of heat from the shielding to the coring in proportion to the respective greater distance thereof over that of the spaces **23**. The latter are adequate and the former are very much greater than effective obstruction of the passing of welding heat to the coring calls for.

This economically producible WF does not lend itself to a tapering form, when discussing column embodiments. However, such a tapering form is possible by according, to the lengthwise extending middle zone of the web extra thickness and subjecting the WF, when heated to a plastic

state, to a simultaneous flattening and widening of the web, differentially from the anchoring (earth-affixed) zone to the top end of the column (pole). The progressive differentiation in thickness would be effected with a device mounting two pairs of rollers with respective axes at a fixed distance from one another, in a frame, one pair of rollers working on the web translationally along the web centroid, the other pair engaging a reaction rail opposed to the web centroid but at a slightly oblique angle thereto.

A recommended embodiment, in the case of massive bridge girders and the like, would consist of a pair of said beams, each with a depth-to-width ratio double even that in FIGURE 2. The two beams are spacedly held to one another by an intervening roof or floor frame or both, supplemented or not by bulkhead frames between the mutually confronting respective side walls of the two beams. Outdoors embodiments are limited best to beams large enough for personnel walking thru them inside, having the responsibility for rust inspection and repainting, as long as the problem of preventing, at truly low cost, inside rusting of hollow steel members, continues to baffle all concerned with steel structures.

I claim:

1. A built-up hollow structural length including a coring of relatively hard metal and a shielding of relatively soft metal, transversely discontinuously adjoiningly girthing at least a part of the coring in a relationship characterized by a plurality of transversely successive air spaces and, alternating with them, a plurality of transversely successive pairs of contact-zone portions intervening between the coring and the shielding, the two portions in each pair being respective integral portions thereof, in mutual pressural engagement, the coring consisting in the main of a modified WF wherein, in the case of each flange, the two mean planes respective to the flange "halves" form with one another an obtuse angle; whereby an air space separates them from the thereadjacent portion of the shielding, the thickness of the greater part of each "half" exceeding that of the free margin thereof, the two said free margins, respective to each flange, being hooked, whereby the two inside concave surfaces thereof confront one another, the coring and the shielding being mutually interference-fitted.

2. A built-up hollow structural length including a coring of relatively hard steel and a shielding of relatively soft steel, transversely discontinuously adjoiningly girthing at least a part of the coring in a relationship characterized by a plurality of transversely successive air spaces and, alternating with them, a plurality of transversely successive pairs of contact-zone portions intervening between the coring and the shielding, the two portions in each pair being respective integral portions thereof, in mutual pressural engagement, the coring consisting in the main of a modified WF wherein, in the case of each flange, the two mean planes respective to the flange "halves" form with one another an obtuse angle, whereby an air space separates them from the thereadjacent portion of the shielding, the thickness of the greater part of each "half" exceeding that of the free margin thereof, the two said free margins, respective to each flange, being hooked, whereby the two inside concave surfaces thereof confront one another, the coring and the shielding being mutually interference-fitted.

3. A length as described in claim 1, the Brinell carbide-ball hardness number of the coring exceeding that of the shielding by at least one hundred.

4. A length as described in claim 2, the Brinell carbide-ball hardness number for the coring exceeding that for the shielding by at least one hundred.

References Cited in the file of this patent

UNITED STATES PATENTS

2,095,719	Sinclair	Oct. 12, 1937
2,293,426	Coberly	Aug. 18, 1942
2,960,114	Hinde	Nov. 15, 1960

FOREIGN PATENTS

142,996	Germany	July 30, 1903
22,568	Great Britain	of 1913