Nov. 14, 1967 L. F. McNITT ET AL 3,352,724

HEAT TREATMENT OF STRUCTURAL SECTIONS

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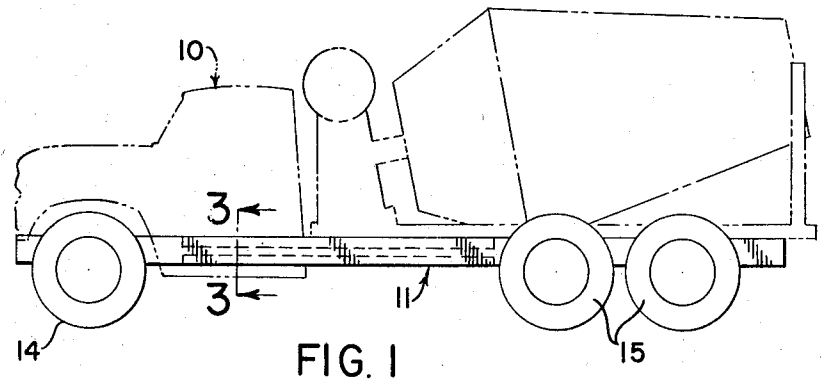


FIG. 1

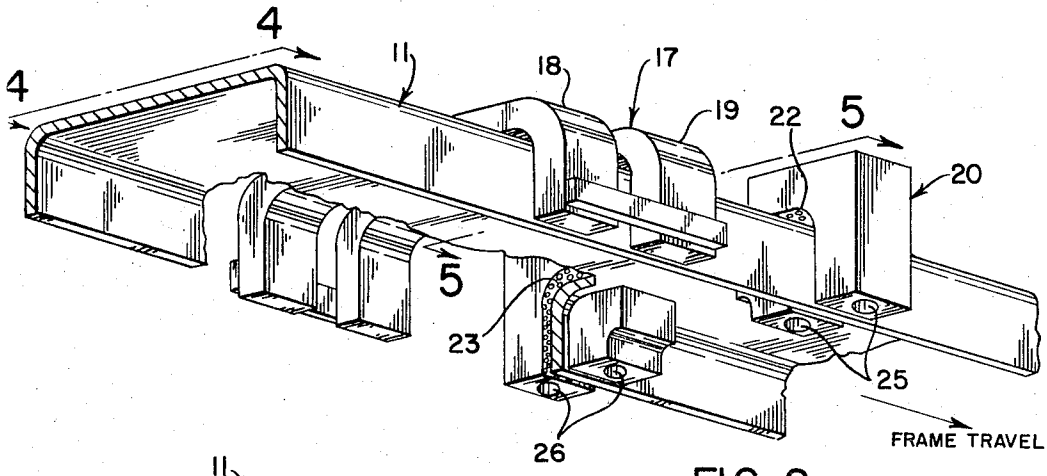


FIG. 2

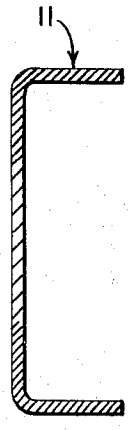


FIG. 3

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HEAT TREATMENT OF STRUCTURAL SECTIONS

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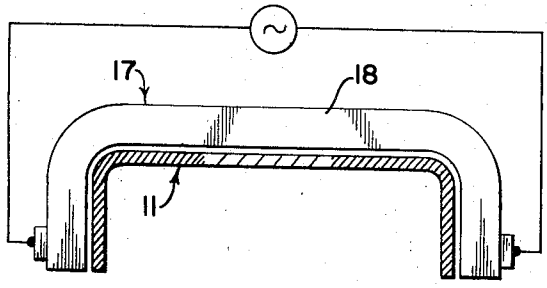
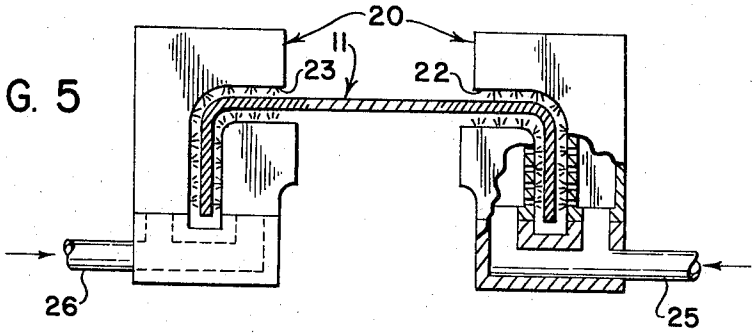


FIG. 4

FIG. 5



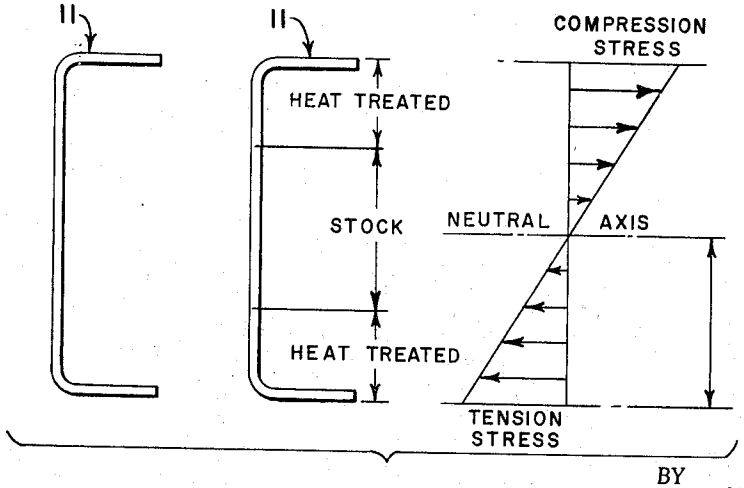


FIG. 6

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United States Patent Office 3,352,724 Patented Nov. 14, 1967

3,352,724 HEAT TREATMENT OF STRUCTURAL SECTIONS

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Filed June 14, 1965, Ser. No. 463,652
2 Claims. (Cl. 148—144)

This invention relates to heat treatment of structural sections and, more particularly, to selective heat treatment of areas of the sections that may be subjected to excessive bending type loads along their length; the treatment leaving the structural section without any significant distortion.

Structural shapes are generally symmetrical about longitudinal axes and may take the form of a channel, I beam, wide-flanged beams, or rolled sections. Each of these shapes can be advantageously subjected to the hereinafter described heat treatment and to only the areas or sections subjected to excessive loading of axial or column type and/or bending. The structural shapes are generally used in frames of trucks, as floor joists, roof supports, columns, and often where either axial or bending type loads are imposed. As an example, in the trucking industry, a channel shaped member is used in the frame for side rails as load supporting beams, as well as in trailer frames. Also, such members might be used for support of railroad cars requiring resistance to bending type loads.

The heat treatment method of this invention gives the sections used in the aforesaid example an increase in strength in substantial amounts in the treated areas without any further structural buildup that otherwise would be required. The proposed heat treatment is by means of induction heating apparatus, the electrodes designed to conform to the shape or form of the structure to be treated. By way of example, the method of this invention will be described in connection with a channel structure used in a frame of a truck, as in a cement carrier.

The method, in general, is one of selective heating, initially preparatory heating of the center and the outer flanges of a channel member, followed by high heat effecting hardening, then a water quench and a drawing or tempering of that portion of a channel which it is desired to improve over its basic physical strength characteristics. Temperatures used depend somewhat upon the quality of the structural steel and its thickness, however, all steels can benefit in an increase of strength. Steel utilized in frames for trucks usually is an alloyed material standardized type including those chemical elements which contribute to grain refinement and hardenability. Such steels are capable of being increased in hardenability and strength considerably, by about at least 100% or more over its basic hardness and strength, and without noticeable distortion when subjected to the herein described treatment. A substantial increase is particularly advantageous in truck frames for it provides greater additional strength and toughness in areas where most needed and without much increase in cost. The method of raising the impact strength of truck or trailer frame steels will be more thoroughly described in the following specification taken in connection with the accompanying drawings, where:

FIGURE 1 represents a form of truck and its supporting frame;

FIGURE 2 shows a section of the truck frame side member of FIGURE 1 and a form of induction heating device followed by a water cooling means;

FIGURE 3 is a cross section of the truck frame side member of FIGURE 1 taken across line 3—3;

FIGURE 4 is a sectional detail of FIGURE 2 along the line 4—4 thereof, showing the position of the induction heater unit relative the frame side member;

FIGURE 5 is a further sectional detail of FIGURE 2 along line 5—5 showing the following water quenching means; and

FIGURE 6 graphically represents the selective stress improvement, particularly in the highly stressed flange sections.

By way of example, there is shown in FIGURE 1 a standard cement mixer truck **10**, its superstructure being supported on a frame having side rails **11** in the form of channels. The truck frame itself is supported by wheels **14** in front and **15** in the rear. Generally, as assembled, the truck frame comprises two identical, equispaced, longitudinally extending channel members **11** each having a cross section as shown in FIGURE 3. A common dimension of a side channel member **11** is about 25 feet long, 9.5 inches deep with flange width of about 3 inches and having a thickness of about .250 inch. The side channel members **11** are interconnected by cross members (not shown) to provide for transverse rigidness as well as for further support of the truck's superstructure.

As seen in FIGURE 1, there is a substantial length of a side member **11** that is not directly supported, the length being that between the front and rear wheels. It is in this area where additional impact or bend resisting strength is needed. Advantageously, this additional strength can be achieved by selective heat treatment of the side rail **11**, particularly of the flange area of each side channel member **11**, leaving the web section unhardened for subsequent utilization during buildup, the drilling being done with ordinary tools. The method of selectively heat treating a channel member having the dimensions given herein contemplates full heat treatment of the flanges and adjacent area part way down the web only to a hardening value of from an initial hardness of from 60,000–80,000 p.s.i. to about 135,000–150,000 p.s.i. The heating and quenching in the process is done on a continuous basis and as rapidly as the desired temperatures in the material are reached. Generally, it was found that truck frame steels when subjected to temperatures of about 1650° F., then quenched and subsequently drawn and quenched would give a yield strength increase of from about 60,000–80,000 p.s.i. to about and more than 135,000 to about 150,000 p.s.i. This substantial improvement in strength is imposed only on the flanged or selected portions of the side member yet leaving the web soft, and the channel is, advantageously, not effected with any significant distortion. The treatment yields a highly strengthend and toughened side channel member at a slight additional cost.

One form of an induction heating electrode **17** (not a subject of this invention) may be as generally indicated in FIGURE 2 where the highest concentration of heat is had about the flanges of the channel **11** while the web section itself is subjected to considerably less heat. The induction unit or electrode **17** is formed of two sections **18** and **19**. The first section **18** initially preheats the entire channel **11**, the second section **19** follows up with substantially higher temperatures only about the flanged sections. More specifically, the electrode **17** is so advantageously devised that it preheats the web area of the channel member **11** initially by the prior electrode section **18** to about 400° to 600° F. and the flanges to about 900° F. then, also selectively, the following electrode **19** raises the temperature to about 1600–1700° F. to harden only the flanges and adjacent web portions. The low and high heating is followed by an immediate water quench **20**. After the quenching, the induction unit **17** again is passed over only the highly heated flange and web areas at a range to permit drawing temperatures of 800° F. to 1200° F.

This method yields a highly desirable increase in flange hardness and strength yet an insignificant distortion of the

channel. It gives the desired improvement in strength in a vulnerable area subject to impact yet leaving the web soft for working with standard tools. The timing and temperatures are relative to the thickness and the critical temperatures of the side members. With the temperatures of about between 1600° F. and 1700° F. being above a material's critical temperature, quenching must be rapid in order to obtain substantially complete transformation of the steel into a martensitic structure. Quantity, directness and pressure of the water quench can be readily determined to quickly yield the low temperatures required prior to drawing.

For uniform treatment, it is desirable that the electrodes **18, 19** of the inductor **17** be spaced and maintained spaced at a most effective distance from the channel or rail surface being treated, in this example, the desirable distance being about from .1875 inch to .250 inch. This uniformity of spacing is shown in FIGURE 4. The highly heated flange sections of the channel **11** are desirably quickly chilled by the immediately following quench **20** comprising opposite inwardly perforated sections **22, 23** having a desirable number of outlets on the inner or channel side and conforming in shape to about the channel **11** sides. While the cooling is effected primarily on the sides of the channel or on the ends, the water quickly overflows over the entire cross section. The web section being originally heated to only about 400°–600° F. although water quenched is not structurally disturbed thus preventing subsequent distortion. The quench water is readily brought in to the quench head sections **22, 23** through external supply sources **25, 26.** Again, after the drawing of the flanges of the member **11** at a temperature of about 900° F.–1200° F., the side channel member is quenched. This was found to be necessary to control any tendency of the channel to longitudinal distortion.

As shown in FIGURE 6, the original channel or member **11** upon treatment by the methods described and as shown intermediately graphically assumes the greatest allowable stress increase in the flange area where required while the web area is hardly altered. The web area is thus left relatively soft and unhardened for easy drilling or punching out for necessary cross member support and other attachments while the load bearing flanges are considerably increased in their capacity to carry higher stresses.

EXAMPLE

By way of a specific example, a .25-inch-thick plate of steel known in the trade a Jalloy "S" with a molybdenum content of about .26% and having a yield strength of about 60,000 p.s.i. was cut and formed into a member shaped as a channel having 9.5 inches width (overall) with 3-inch flanges. The channel member was subjected to the described method, the inductor **17** element **18** initially preheating the channel member to about 400° F. in the web section and to about 900° F. about the flanges, and immediately thereafter element **19** raises only the flanged portions to about 1650° F. (3 inches in width and about 2 inches into the web). Immediately upon the high heating, the flange portions are quenched by a water spray at a pressure of about 8 p.s.i. The inductor **17** then again is passed over the channel flanges at about 900° F. in a drawing

operation followed by an immediate quenching. With the draw temperature being about 900° F., the yield strength was raised to at least about 130,000 p.s.i. It was found, however, when the draw temperature was further increased to about 1000° F., the yield strength was lowered somewhat to about 127,000 p.s.i. The elongation and distortion of the member remained within tolerable limits.

The method is advantageous in that it reduces costs where it is desired to increase the strength of steel members of common manufacture over special steels to offset higher loads; the treated members permit several load carrying capacities on the same wheel base; the dimensional stability is excellent, the web portion is left soft, thus simplifying the drilling of holes; a single type of steel can be kept in inventory from which variable strength frames can be built; fabricating equipment need not be extensive; more load can be carried for a given weight, etc.

What is claimed is:

1. The method of heat treating a low carbon steel channel form comprising, preheating the web area to a temperature of not lower than about 400° F. and the flange sections to about 900° F. unaffecting a molecular change therein, substantially immediately thereafter heating the flanged portions and desired area thereabout only to a temperature of from 1600–1700° F., substantially immediately applying a quench to cause hardening sufficient to form a martensitic structure in the said area, thereafter again applying heat at a temperature of about 900° F. to the said desired higher heated area to draw the temper of said flanges, and thereafter again quenching.

2. The method of treating a symmetrical longitudinally extending low carbon steel channel section of about .25-inch thickness and having at least a trace of molybdenum to effect a hardening of outer portions only leaving the in-between portion substantially unaffected comprising, preheating the entire cross-sectional area to a temperature of not lower than about 400° F. and not above about 900° F. unaffecting a molecular change therein, then substantially immediately thereafter highly heating the desired outer flange portions only leaving the web portion unaffected to temperatures of from 1600–1700° F., substantially immediately water quenching the heated portions to effect hardening sufficient to form a martensitic structure in the said area, thereafter again applying heat at a substantially lower temperature in the range of about 800–1200° F. to draw the temper of said outer portions, and thereafter again water quenching.

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