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WELDED STEEL STRUCTURE

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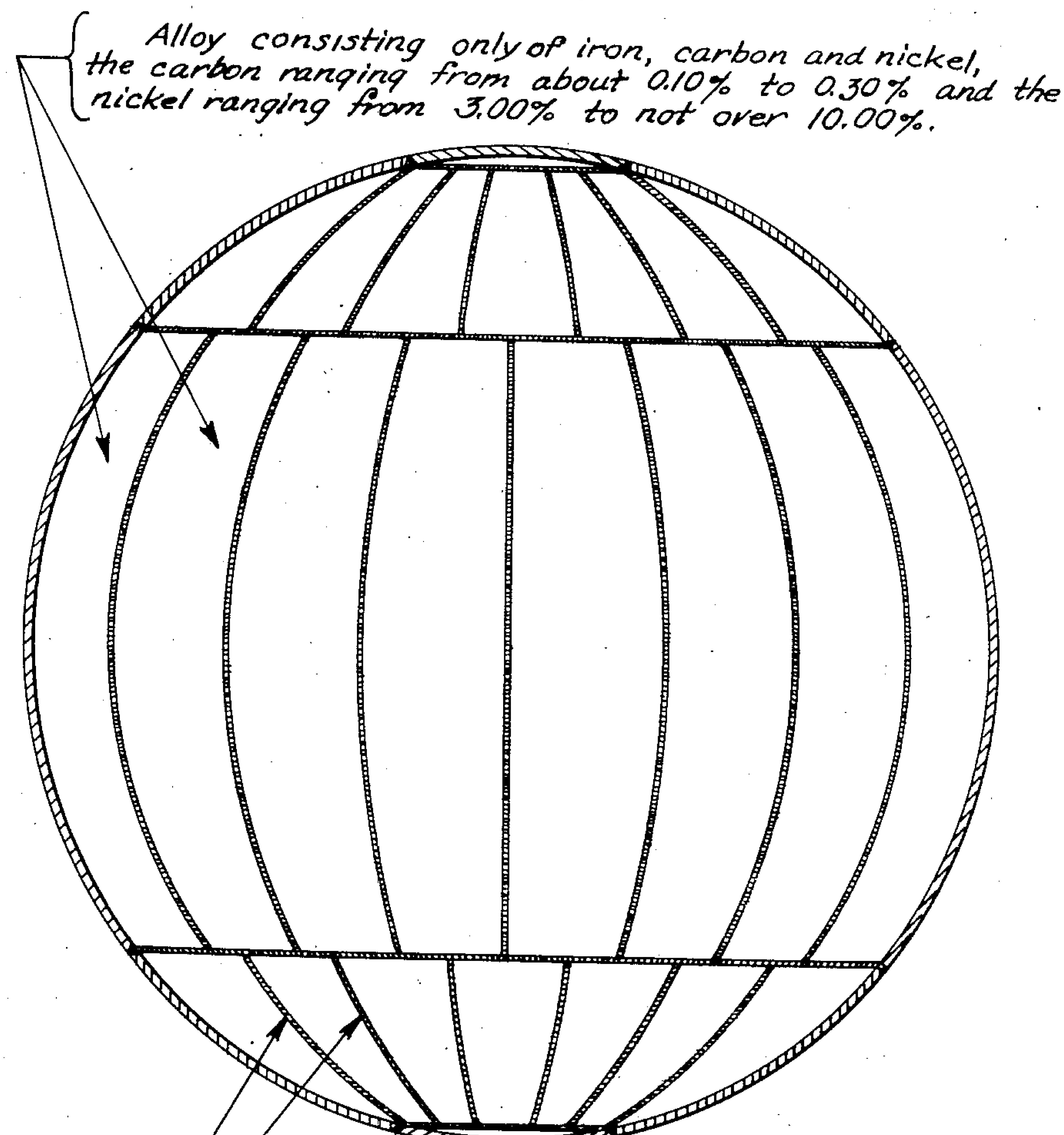

Fig. 1

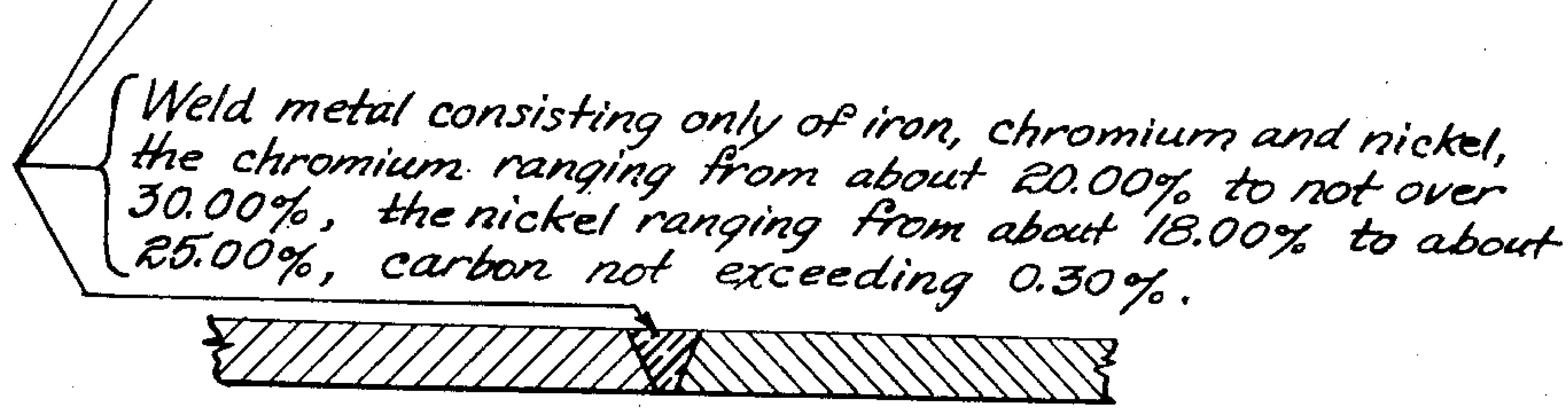

Fig. 2

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WELDED STEEL STRUCTURE

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2 Claims. (Cl. 220—1)

This invention relates to steel structures for use at low temperatures, some or all of the component parts of which are united by a welding operation.

It is well-known that ordinary welded steel structures are not satisfactory for use at low temperatures. Both the steel and the welds become embrittled to such an extent that the structures fail when subjected to load. These failures manifest themselves by cracking and rupturing of the steel or welds and are directly related to loss of ductility at the low temperatures involved.

It is generally accepted by engineers that a structural steel or part must have a Charpy impact value of at least 10 ft. lbs. before it can be used in engineering structures. Below that value the ductility is unsatisfactory. The usual grade of structure steel suitable for the production of electrically welded products has at ordinary temperatures an average Charpy impact value ranging from about 60 ft. lbs. at 100° F. to about 43 ft. lbs. at 0° F. Below 0° F. the impact value is erratic and tests show that at —50° F. Charpy impact values are obtained which vary within the rather broad range of 6–38 ft. lbs. At —100° F. ordinary structural steel has a Charpy impact value of about 2–3 ft. lbs. This signifies practically complete loss of ductility and such material is, therefore, unsuited for use in steel structures which are subjected to load. By usual or ordinary structural steel, I mean a steel which has a carbon content up to approximately 0.35% with the balance iron except for the usual contaminants in normal amounts.

It is also known that some materials are satisfactory for use in low temperature work in constructing load-bearng structures but that these are unduly expensive. Therefore, for large structures the cost becomes prohibitive and frequently also the use of such materials gives rise to other problems, particularly welding problems. The austenitic stainless steels containing about 18% chromium, about 8% nickel, with low carbon and the balance iron except for the usual contaminants in normal amounts are theoretically satisfactory for low temperature work but, practically, are not employed because of the inordinate expense and the difficulty in welding such material. Copper and aluminum are also capable of being employed at low temperatures without undue loss of ductility but they too are expensive and at the present time scarce. Even where it has been possible to employ metals or alloys which are themselves capable of retaining adequate ductility at low temperatures, it has not been possible to weld the same in such manner that the welds resist embrittlement at such temperatures. Therefore, engineers are still seeking a moderately priced material which can be employed at low temperatures and which can be welded in such manner that the welds are at least as substantially resistant to embrittlement as the base metals or alloys themselves. So far as I am aware, this problem has not heretofore been successfully solved and it is with the solution of this problem that my present invention is concerned.

One of the objects of my present invention, accordingly, is to produce welded structures in which both the base material and the welds are resistant to embrittlement even at temperatures as low as —260° F. and which at such temperatures have a Charpy impact value af 10 ft. lbs. or more.

Another object of my invention resides in producing welded structures which have a Charpy impact value of at least 10 ft. lbs. at temperatures as low as —260° F. and in which the composition of the base metal or alloy and the composition of the weld metal are predeterminedly correlated.

A futher object of my invention resides in producing welded structures composed of component parts of nickel-modified steel and weld metal of special composition and in which the minimum impact value of any portion of the welded structure ranges from about 18–20 ft. lbs. at about —260° F.

Other and further objects and advantages will either be pointed out in the following description or will be understood or appreciated by those versed in this subject.

The attached drawing forming part of this application illustrates a welded steel structure embodying this invention.

In the drawing:

Figure 1 is a sectional view of the inner shell of a welded steel storage tank embodying this invention and in this view, the width of the weld bands is exaggerated for the purpose of illustration.

Fig. 2 is a fragmentary sectional view taken through a typical weld seam uniting adjacent parts of the structure of Fig. 1.

In carrying out my present invention I preferably employ as a base material, i. e., the material of the plates or other component parts or members which are to be welded into a desired structure, a steel having the following composition:

	Percent
Carbon	About 0.10 to 0.30
Manganese	About 0.30 to 0.50
Silicon	About 0.10 to 0.20
Nickel	About 3.0 to 4.0
Sulphur	Up to about 0.04
Phosphorus	Up to about 0.04
Iron	Balance

A nickel content of approximately 3½% is preferred but I have found that nickel may be satisfactorily employed within the range of about 0.5–10%.

This steel is cast in ingot molds in the conventional manner and is preferably deoxidized by the addition thereto of approximately .08% aluminum while the steel is still in the molten state. The ingots are reduced in the usual manner and rolled into plates, bars and other desired shapes, hereinafter designated as component structural parts. After rolling, the component structural parts should preferably be normalized at a temperature of about 1550° F.

After the fabrication of the component structural parts, they may be properly prepared for welding in known manner, as by cleaning, pickling sandblasting, polishing, or the like. I then preheat the component structural parts to a temperature ranging from about 170–350° F. While the entire parts can, if desired, be raised to preheating temperature, I have found that it is only essential that those areas of the parts be preheated which are adjacent the metal which is to be welded. The welding operation is carried out by means of the known electric arc process, using a covered metallic electrode which contains about 15–30% of chromium with the balance iron except for a percentage of nickel which may range from about 10–30%. By employing covered electrodes, atmospheric gases are excluded and better welds are thus secured. The use of covered electrodes is known in welding and is not per se deemed to be a part of the present invention. Uncovered electrodes may be employed with success but the best results are secured by using covered electrodes. In connection with the composition of the electrode, I have discovered that a metallic electrode containing approximately 25% chromium and approximately 20% nickel with the remainder iron gives optimum results, and this particular electrode composition is, therefore, deemed to be an important part of my present invention.

Welds made in accordance with the foregoing procedure are characterized by the fact that the base metal or material is not penetrated by the weld metal to a very great or deep extent. There is a definite alloying of the weld metal and the base metal or material such as is characterized, for example, by parts united by brazing. In practicing the present invention, I have been able to secure butt-welded joints in plates of the base material above specified having a Charpy impact value of about 18–20 ft. lbs. at a temperature of −260° F. The welded structure so produced is further characterized by the fact that such values are equaled or exceeded in the weld metal itself and in the fusion and heat-affected zones adjacent the welds. So far as I know, these results are unique and have not heretofore been even approximated.

Welded structures as above described and produced in accordance with the procedure set forth are especially adapted for use in low temperature containers, i. e., those for storing liquefied natural gas and other materials as typified by my copending applications Serial No. 426,012, filed January 8, 1942, and Serial No. 426,192, filed January 9, 1942. It is to be particularly noted, furthermore, that I employ welding compositions having 50% or more of iron while still obtaining welds that are fully satisfactory at low temperatures, even temperatures down to about −260° F. or less. This has both economic and structural advantages as will be appreciated.

An important feature of my new procedure resides in the preheating step in which connection areas of the component structural parts adjacent the metal to be united by the welding operation are raised to a temperature above the prevailing ambient temperature but not to a temperature high enough to bring about adverse changes in respect to ductility or grain size.

It is to be further understood that the present invention may be employed in connection with the use of a backing-up strip for the weld metal as illustrated in my aforesaid copending application, Serial No. 426,012.

The foregoing is to be understood as illustrative and not as restrictive and within the purview hereof I may resort to other and further additions, omissions, substitutions and modifications without departing from the invention, the scope of which is rather that defined by the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A welded steel structure which during normal use is subjected to load while at a temperature below −100° F., which is characterized by possessing a minimum Charpy impact value of at least 10 foot pounds at a temperature as low as about −260° F. and which is fabricated from component structural parts formed from alloy steel consisting only of iron, carbon and nickel, except for usual impurities in common amounts, the carbon content ranging from about 0.10% to 0.30%, and the nickel content ranging from 3.00% to not over 10.00%; said parts being united by weld metal consisting only of iron, chromium and nickel, except for usual impurities in common amounts; the chromium content of said weld metal ranging from about 20.00% to not over 30.00%, the nickel content ranging from about 18.00% to about 25.00% and the carbon content not exceeding 0.30%.

2. A tank for storing liquefied gas at a temperature in the neighborhood of −260° F. and which at such temperature has a ductility represented by a Charpy impact value of at least 10 foot pounds, said tank being fabricated from a plurality of butt welded alloy steel plates of the composition set forth in claim 1 and in which the weld metal uniting said plates is deposited weld metal and has the same composition as the weld metal set forth in claim 1.

JAMES O. JACKSON.