April 24, 1951 G. C. RIEGEL ET AL 2,549,930

SELECTIVE TEMPERING BY INDUCTION MEANS

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Fig. 2.

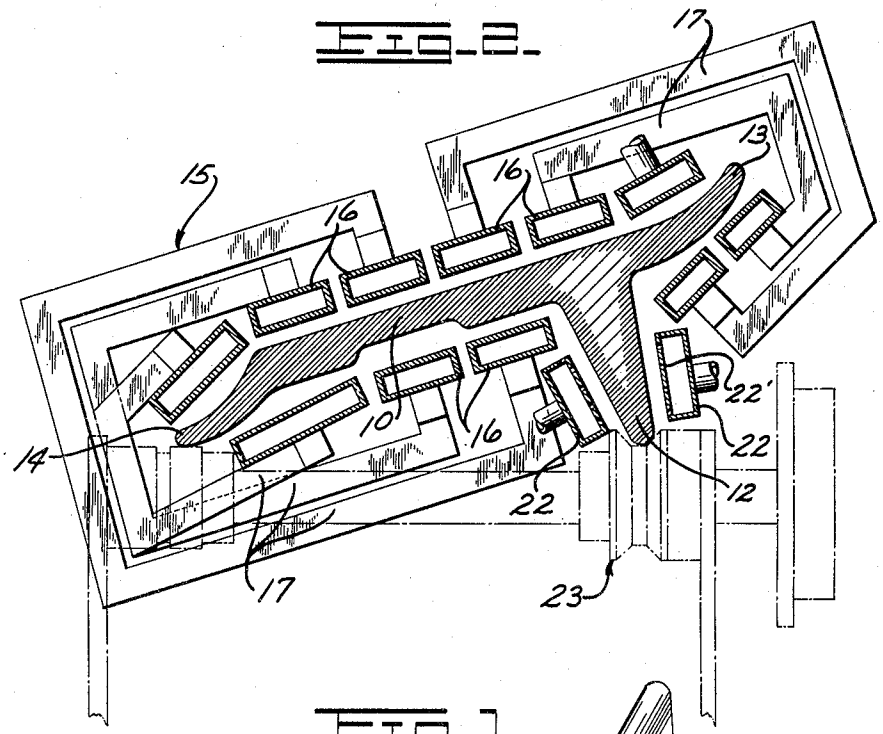
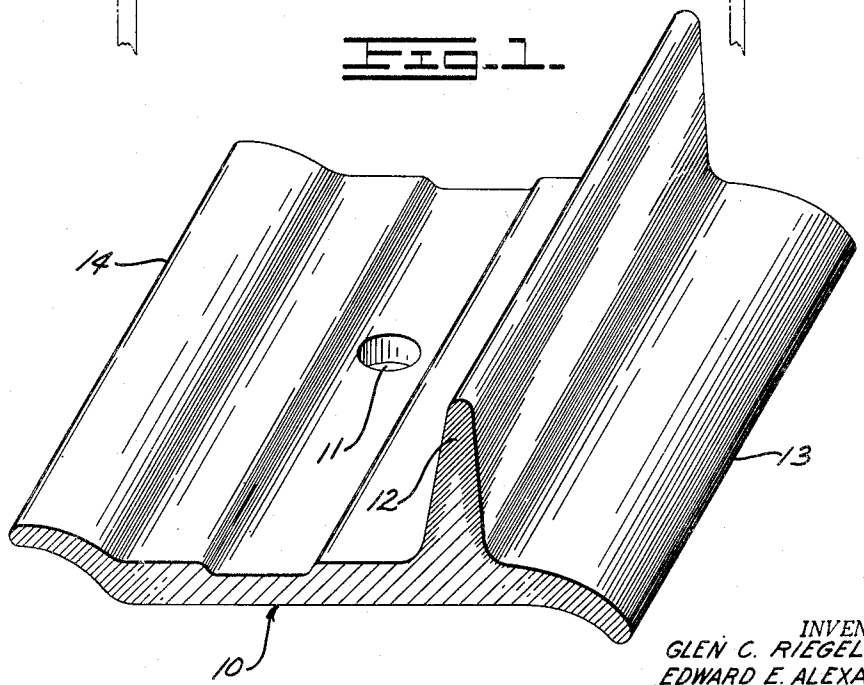


Fig. 1.



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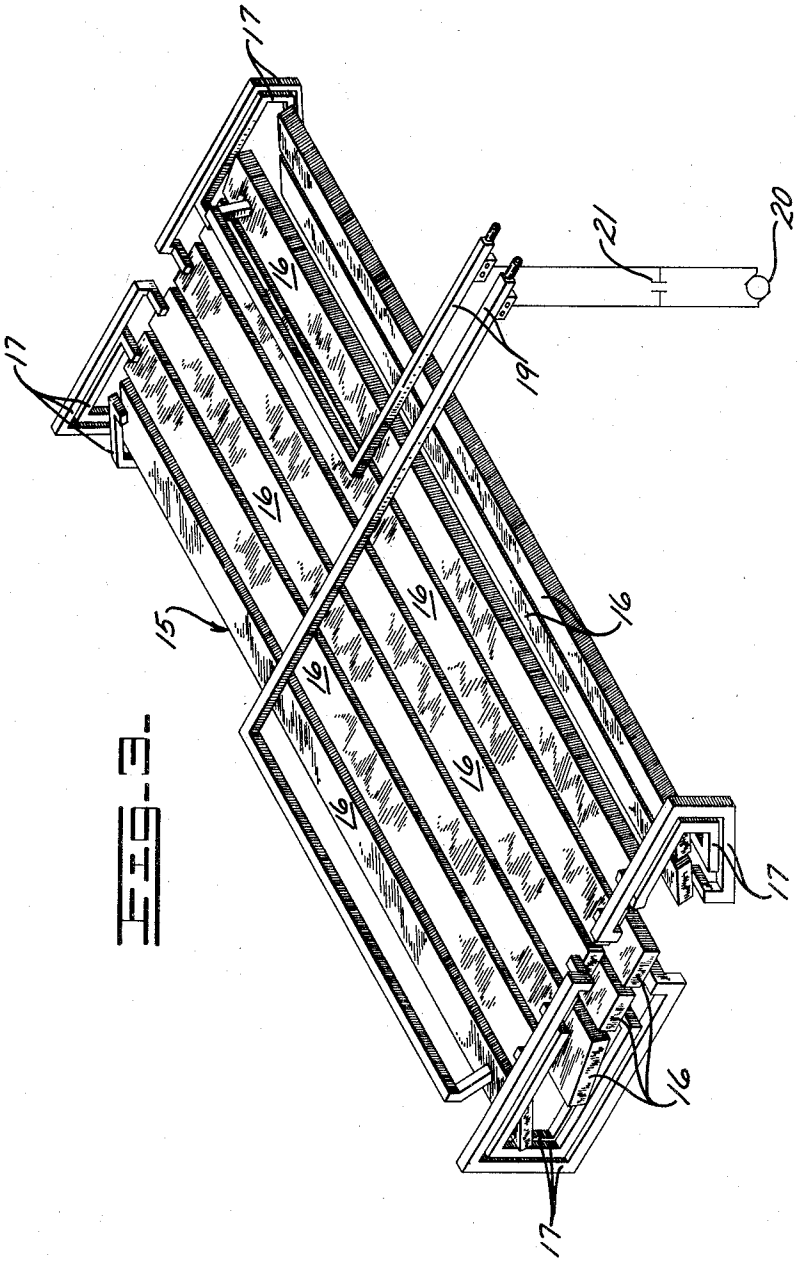

FIG. 3.

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SELECTIVE TEMPERING BY INDUCTION MEANS

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Application September 19, 1949, Serial No. 116,533

1 Claim. (Cl. 219—47)

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This invention relates to the heat treatment of ferrous articles in general and more particularly to apparatus for selectively tempering various parts of a single article to different degrees of hardness by induction means.

This invention is particularly adapted for use in the heat treatment of irregularly shaped articles having a uniform cross sectional shape in which it is desirable to vary the hardness of different parts of the article from a machinable hardness to the maximum possible hardness. For purposes of illustration the present invention is disclosed in its application to the selective tempering of a track shoe of the type commonly employed on a track type tractor. Such track shoes are subjected to particularly abusive service and it is desirable to provide a wide range of hardness in various areas of each shoe. It will be apparent from the following description that the invention is not limited to this particular type of article but is readily adaptable to other uses.

In the past, one method of hardening track shoes has been to heat the entire part uniformly to a predetermined temperature and then, during quenching, attempt to vary the cooling rate of certain parts of the shoe to obtain different degrees of hardness. When hardened in this manner, it is necessary to subject the track shoes to a drawing or tempering process to relieve internal stresses set up due to grain growth in the structure, unequal contraction, and also to reduce the overall hardness sufficiently to obtain a machinable hardness in areas in which machine operations are to be performed. Another method employed was to heat only those parts of the shoe in which hardening was desirable and then quench. However, track shoes hardened by this latter method have an undesirable band of very soft and therefore weak material separating the hardened areas from the unhardened areas. In addition, hardening by this method does not provide the grain refinement necessary to produce a part having desirable strength characteristics.

It is, therefore, an object of the present invention to provide apparatus for selective tempering of a hardened article having a uniform cross sectional shape. It is another object of this invention to provide apparatus for selective tempering of a hardened track shoe for a tractor or the like to produce a shoe having a grouser of substantially maximum hardness and with other parts of the shoe graduated in

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hardness as required for manufacturing and operating conditions.

Other objects and advantages of this invention will be made apparent in the following description in which reference is made to the accompanying drawings.

In the drawings:

Fig. 1 is a sectional isometric view of a track shoe illustrating by variation in spacing of cross hatching the desired finished hardness pattern;

Fig. 2 is a transverse sectional view of a hardened track shoe and the induction apparatus for tempering selected parts of the shoe; and

Fig. 3 is an isometric view of the induction tempering apparatus.

Fig. 1 illustrates a part of a track shoe 10 of the kind commonly employed on a track-type tractor. The shoe is provided with a plurality of bolt holes, only one of which is illustrated at 11, to facilitate fastening of the shoe to an endless chain mechanism (not shown) adapted to be carried on suitable sprockets supporting and driving the tractor. The shoe is provided with an outstanding grouser 12 adapted to engage and penetrate the earth, and with arcuate leading and trailing edges 13 and 14 respectively. The leading and trailing edges are complementary in shape and are adapted to overlap and cooperate with the opposite edges of adjacent and similarly shaped track shoes (not shown) to provide a self cleaning action as the track chain moves around its driving sprocket.

Due to the abrasive environment in which track shoes operate and the severe impact loads encountered, it is particularly desirable that the grouser be provided with a hard wear resistant outer surface and have a relatively soft, ductile inner core as indicated by the hatching of the section in Fig. 1. It is also desirable that the leading and trailing edges be of an intermediate hardness to increase their resistance to bending and that the intermediate areas of the shoe be of a machinable hardness to permit the drilling of the bolt holes 11 after hardening. To obtain this desirable hardness pattern, the track shoe is first fully hardened by any suitable means, to a uniform depth as indicated in Fig. 2. This overall hardening of the surface of the shoe produces a more desirable grain structure as well as placing the outer surface in compression resulting in improved strength characteristics in the entire structure. After hardening, those areas in which it is desired to obtain a lesser hardness are tempered or drawn to the desired

hardness by passing the track shoe through an induction heating coil illustrated at 15.

The induction heating coil comprises a plurality of elongated rectangular conductors 16 spaced from each other and arranged in a pattern about the track shoe. The conductors are connected in series by end connectors 17 which extend toward the sides or laterally and outwardly leaving the ends of the induction coil open to permit the track shoe to pass therethrough in a path parallel to the longitudinal axes of the conductors. This arrangement of the conductors 16 and end connectors 17 is in effect the same as would be achieved by wrapping a coil longitudinally about the track shoe.

In Fig. 3, the induction heating coil 15 is illustrated as provided with a pair of hollow electrical leads 19 which are connected in a circuit including a high frequency alternating current generator 20 and suitable capacitors 21. The passage of a high frequency alternating current through each of the conductors creates a heat inducing field normal thereto in a well known manner. The amount of heat produced in a part passing through any one of these fields is proportional to the current density and to a lesser degree, the air gap between the part and the conductor. As all of the conductors are connected in series, the temperature and as a result the amount of tempering in various parts of the track shoe is controlled by providing conductors of various widths located at various distances from the surface of the shoe.

As is best illustrated in Fig. 2, the conductors adjacent the trailing edge of the track shoe are relatively wide. As a result, the temperature reached and the amount of tempering in this portion is less than that of the central part of the shoe which is adjacent narrower conductors. By permitting the leading edge of the track shoe to extend beyond the adjacent conductors, the resulting air gap is effective to control the amount of tempering in this area. As no tempering or reduction in hardness is desired in the grouser portion of the track shoe, it is permitted to extend downwardly out of the induced heating field.

This induction heating apparatus is particularly adapted to the needs of a continuously moving high production installation. The parts may be continuously passed through the induction field at a predetermined rate of speed by any conventional conveying mechanism such as the roller type conveyor indicated in phantom lines at 23 in Fig. 2. Cooling water may be circulated

through the hollow electrical leads, conductors, and end connectors to prevent overheating of the apparatus during continuous operation. By supporting the track shoe with the grouser portion extending downwardly out of the pattern of the conductors, tempering of the grouser by heat conducted from other parts of the shoe may be prevented by spraying a liquid coolant thereon which, due to its position, will not drain to other parts of the shoe. This may be accomplished by means of suitable manifolds indicated at 22 in Fig. 2 which may be provided with spaced apertures 22' for directing coolant against the grouser 12.

We claim:

An apparatus for selective induction heating for tempering of an article of uniform cross section that is generally flat with a lug-like portion extending outwardly from one side thereof which comprises a plurality of elongated conductors arranged in a parallel group forming a pattern substantially entirely embracing those portions of the cross section to be heated but permitting the lug-like portion to project downwardly outside of said pattern, means connecting all of said conductors in series without intersecting the pattern whereby the article may be passed through said group in the direction of its parallelism, and means disposed outside of said pattern but in the space between the ends of the conductors for directing a fluid coolant against the lug-like portion while the article is passing through the heat inducing field of the conductors.

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