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F. N. DARMARA

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PROCESS OF INDUCTIVELY HEATING PLIERS

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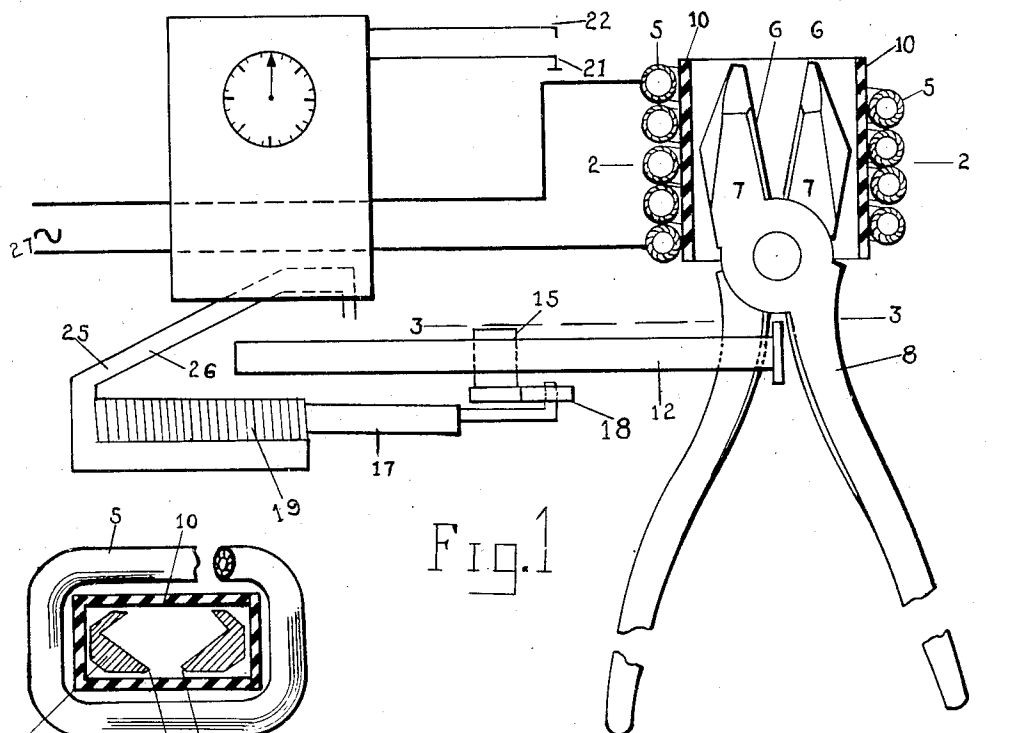


Fig. 1

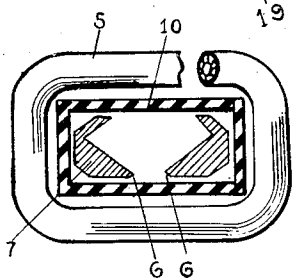


Fig. 2

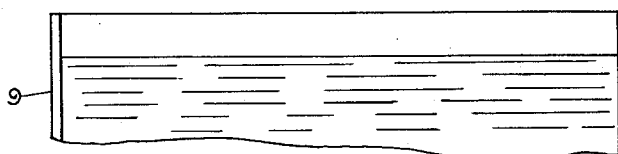
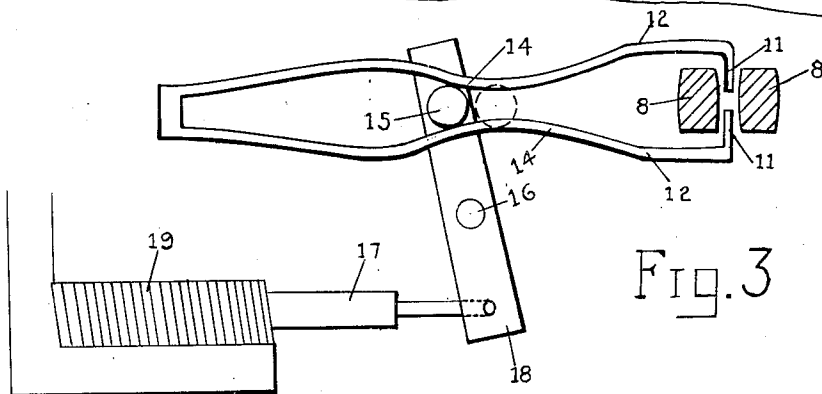


Fig. 3



INVENTOR.

Falish N. Darmara

BY Martin & Rendell

ATTORNEYS.

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PROCESS OF INDUCTIVELY HEATING
PLIERSFalih N. Darmara, Utica, N. Y., assignor to Utica
Drop Forge & Tool Corporation, Whitestown,
N. Y., a corporation of New York

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2 Claims. (Cl. 219—13)

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My present invention relates to a process of heating the cutting edges and external surfaces of hand tools.

One purpose of my invention is to provide a new and improved process of heating the opposed cutting edges of cutting pliers and other related hand tools and the external skin of the working portions of such hand tools and further to so heat by induced electric current such a hand tool at any stage of manufacture.

The most desirable sort of hardening procedure is one which hardens the surface of the working portions of the tool without such hardness penetrating all the way through the tool. When the hardness goes all the way through, the tool is brittle. When it goes only part way through, the soft tough center prevents the tool cracking in use. The cutting edges in hand tools being always opposed and close together are difficult to harden without hardening all the metal surrounding them. By my process only the opposed cutting edges and the external skin of the working portion of the tool are hardened; thus giving the ideal condition.

Referring first to the process and its metallurgical aspects, it will be seen that the heating is by means of high frequency electric currents passing through a coil 5 of one or of several turns properly and accurately positioned surrounding the opposed cutting edges 6 and working end or head 7 of the tool 8. The high frequency current from source 27 generates by electro-magnetic induction heating currents in the steel of the tool to be hardened. Because the frequency of oscillation of the current is high (of the order of 10,000 to several million cycles per second) these currents are generated principally in the skin of the metal. The tool with the cutting edges 6 opposed and opened slightly, so that the opposed edges do not touch to convey leakage currents from one to the other which would cause sparking and pitting of the edges, is positioned within the coil; the current is turned on for a predetermined short time, of the order of a few seconds, after which the tool with the skin and cutting edges heated above the Curie point is allowed to drop into a quench tank 9 of oil, water, brine, or other medium, as is suitable for the particular steel being hardened.

A close predetermined time and power cycle must be worked out for each size of tool and grade of steel used. Some steels are shallow hardening in which cases less power and a longer time can be used, limited mainly by the speed by which

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heat is conducted from the skin into the inner body of the tool. In deep hardening steels, short time and high powers are essential to prevent a too deep penetration of the hardness which leaves too little soft, tough metal at the center of the metal mass and results in breakage of the tools in use. In extreme high frequencies and high powers applied for short times, external quenching may be unimportant since the heat absorbing power of the cold steel at the center of the metal mass is sufficient in many types of steel to quench the shallowly heated surface.

Fig. 1 is a vertical sectional view through an inductance coil in which is positioned a pair of pliers with the rest of the view more or less diagrammatic and showing a machine embodying my invention and illustrating my process.

Fig. 2 is a horizontal view of the parts seen immediately on line 2—2 of Fig. 1.

Fig. 3 is a horizontal sectional view on line 3—3 of Fig. 1.

The drawings herein are merely illustrative of my machine and of my process and the specific description is not to be taken as limiting my invention in either of its aspects, but only to give definiteness to what is a workable form of my process.

The machine includes a coil 5 composed conveniently of several loops of copper tubing. This coil is connected to a source 27 of high frequency alternating current commonly of the order of from 10,000 to several million cycles per second. Preferably as shown most plainly in Fig. 2 the coil is generally rectangular in horizontal cross section so as to let the head or working end 7 of the tool be as closely surrounded as practicable by said coil, although there is therebetween a box-like open-ended insulator 10 placed within the coil not as insulating the head of the tool from the electric action of the coil but as a protection to prevent the coil being abraded or damaged by the head of the tool and to prevent any direct electrical contact of the tool with the coil. The hand tool 8 is placed in position with the head of the tool within the coil. In the machine as here illustrated the head of the tool is placed into the coil from below as that is a convenient and practical way of positioning the head of the tool within the coil and particularly allows for a ready and quick release of the tool from its position within the coil seeing that under most conditions the tool remains in the coil only a matter of a few seconds, say three and one-half seconds for a medium size of common pliers with steel such as S. A. E. 1080. As-

suming then that the head of the tool is to be placed into the coil from below, although it will be obvious that that is merely a matter of physical construction of the machine and other equivalent arrangements may be used, the pliers will preferably be held in the relative position shown in Fig. 1 by the following described releasable holding device:

Near the coil 5 there is provided a releasable holding device which in one position as shown in Fig. 3 is adapted to hold the hand tool 8 with its head 7 in proper position in the coil 5. When the tool head is to be placed into the coil from below a convenient form of this releasable holding device is such as shown in Figs. 1 and 3 wherein the suitably supported pair of movable arms 12 have their opposed inturned ends 11 engage the hand tool just below the central pivoted parts thereof. On the opposing inner surfaces of the arms 12 are provided inwardly curved cam faces 14 against the more remote sides of which (relative to the hand tool) impinges a rounding boss 15 projecting from a suitable pivoted lever 16 so that when the solenoid 19 moves the outer end 18 of the lever 16 to the left as the device is here arranged, the boss 15 engages the cam surfaces 14 and moves them apart and thereby in an obvious manner separates the inturned ends 11 and thus the releasable holding device is moved to non-supporting position and the tool is allowed to drop into the quenching tank 20. Obviously other forms of a releasable tool holding device can be provided without departing from the claims herein.

Commonly I provide my machine with some sort of a timing apparatus. The apparatus suggested in Fig. 1 is an electrically operating timer although other forms of timer may be obviously used. The timer illustrated is brought into operation by the starting button 21 being depressed into contact with the contact piece 22. Promptly thereupon the circuit through the alternating current source to the high frequency generator is completed so as to bring the alternating high frequency current into action upon the coil 5. After the lapse of the predetermined time and usually only a matter of a few seconds the timer operates to disconnect the source of power and at the same time the current is closed through the wires 25 and 26 leading to the solenoid 19. As already suggested this is of such form that on the solenoid being energized its movable core 17 will be drawn to the left and as already mentioned will move the prongs of the holding device and particularly its inturned ends 11 away from each other and thus allow the then unsupported tool to drop into the quenching tank 9.

I believe that I am the first to harden the opposed cutting edges of jointed hand tools and the thin exterior surface or casing of the head of such tools by induced electric current after the members of the jointed tool have been assembled. As the cutting edges of a jointed hand tool, for example a pair of pliers, are located closely opposed and close to the center of the head, it has been difficult if not impossible with ordinary methods of hardening, to harden the cutting edges and a thin outer layer after the parts are assembled without hardening too much of the mass of the head, but with my process I am enabled to easily and regularly accomplish this result because the heating currents that are induced in the head of the tool are limited to a determinable relatively shallow layer or casing along the external surface of the tool. By prop-

erly positioning the head of the pliers within the inductance coil and by properly proportioning the time of heating according to the high frequency and power of the inductance coil and considering the metallurgical and chemical character of the steel of the plier and the size of the tool, I am able to effect a heating of the carefully spaced cutting edges and of the desired depth of the casing of the head of an assembled plier so as to secure the proper hardening of the cutting edges and of the casing without disturbing the soft tough character of the mass of the tool head within the shallow outer hardening casing.

Another advantage of my process used on assembled jointed tools is that by my process the two cutting edges are hardened alike so that neither edge will spoil the other or be spoiled by it.

My invention as described herein is shown as concerned only with the heating and quenching of the tools. It is recognized that nearly all steels hardened by such operations are excessively hard and accordingly too brittle and this has to be corrected by a drawing or tempering operation which consists of reheating the article say from 300° F. to 600° F. and allowing it to cool. No apparatus for such drawing or tempering is shown. That used by me is common to this art.

Furthermore, in thus heat treating two joined cutting members they must be correctly located in the coil and relative to each other so that each member will get its proper amount of heat and will not be shadowed by the other member. Particularly it will be noted that the tool is placed in the coil with the cutting edges of the tool separated part way so that no induced current will pass from one cutting edge to the other, as, if that happened, the edges would be burned or pitted so that they would be defective and useless.

Again, it may be stated that the tool should be placed in the coil so that both members are in the same position relative to the coil so that they will each receive the same effective induced current or heating effect as each other. I have found that the preferred and most desirable pattern of heat treatment is to have the head of the tool so placed in the coil that the longitudinal axis of the tool will be not only parallel with but preferably coinciding with the longitudinal axis of the coil. This position of the plier in the coil is shown in Fig. 1 and accomplishes the desirable purposes mentioned in this and the next preceding paragraph.

It will be especially noticed that while my process has hardened the desired thin outer casing and the cutting edges of the tool, it has left the core in its previous metallurgical and physical condition, or in other words its hardness has not been increased or decreased.

Therefore I can at will by previous treatment of the tool produce exactly the ultimate character in the core that I want by giving the whole tool that character and then rely upon my process to harden as desired only the thin casing and the cutting edges.

I am familiar with the fact that previously gears, cylinders and other cylindrical objects have been induction hardened. But I believe that my invention is the first to make use of the pronounced skin effect of high frequency currents to harden such unsymmetrical bodies as pliers with a thin casing and tough core.

I claim:

1. In the process of inductively hardening the

opposed cutting edges and the irregular outer surface of the head portions of a pair of pliers, said cutting edges facing each other and comprising an integral part of the inside of said head portions, respectively, said pliers comprising at least a first and a second member each having a pivotable body portion connected together by a metal-to-metal pivotal connection with each member including said head portion and the cutting edge thereon extending away from one side of the pivotal connection, said first member having the inner end of its cutting edge integrally terminating with the pivotable body portion thereof and the inner end of the cutting edge of the second member terminating next adjacent to the pivotable body portion of the first member and defining a space therebetween, said inner terminating end of the cutting edge and said pivotable body portion of the first member being movable relative to each other, said members being composed of metal hardenable by heating and quenching, the process of inductively heating the cutting edges and the outer surface of the head portions of the pliers which comprises the steps of positioning the head portions pivotably open to space the cutting edges from each other, providing a coil having an inner surface defining an aperture having a substantially rectangular cross-section which is nonconforming to the irregular shape of said pivotally spaced head portions, said aperture having a cross-sectional area amply large to receive the pivotally spaced head portions with an appreciable and irregular air gap between said head portions and said inner surface, said coil having an entrance end and a terminal end, inserting the movable head portions of the pliers in the aperture with the pivotal connection located near said entrance end and with the cutting edges of the head portions extending in substantially the same general direction as the axis of the coil, energizing said coil with high frequency current of at least 10,000 cycles per second to thereby establish high frequency magnetic lines of flux extending in the same general direction as the axis of the coil and to establish opposite magnetic poles at the ends of the coil having a distance between the poles greater than the length of the cutting edges, said lines of flux thereby establishing a heating current which flows about each head portion and the cutting edge thereon and in a plane substantially perpendicular to the cutting edge, maintaining said head portions in said magnetic field until the cutting edges and the outer surface of the head portions are heated to a hardening temperature, and then removing the head portions from the magnetic field.

2. In the process of inductively hardening the opposed cutting edges and the irregular outer surface of the head portions of a pair of pliers, said cutting edges facing each other and comprising an integral part of the inside of said head portions, respectively, said pliers comprising at least a first and a second member each having a pivotable body portion connected together by a metal-to-metal pivotal connection with each member including said head portion and the cutting edge thereon extending away from one side of the

pivotal connection, said first member having the inner end of its cutting edge integrally terminating with the pivotable body portion thereof and the inner end of the cutting edge of the second member terminating next adjacent to the pivotable body portion of the first member and defining a space therebetween, said inner terminating end of the cutting edge and said pivotable body portion of the first member being movable relative to each other, said members being composed of metal hardenable by heating and quenching the process of inductively heating the cutting edges and the outer surface of the head portions of the pliers which comprises the steps of positioning the head portions pivotably open to space the cutting edges from each other, providing a coil having an inner surface defining an aperture which is nonconforming to the irregular shape of said pivotally spaced head portions, said aperture having a cross-sectional area amply large to receive the pivotally spaced head portions with an appreciable and irregular air gap between said head portions and said inner surface, placing the movable head portions of the tool in the aperture of said coil with the pivotal connection located near one end of said coil and with the outer end of the cutting edges of the head portions extending in substantially the same direction as the axis of the coil, energizing said coil with high frequency current of at least 10,000 cycles per second to thereby establish high frequency magnetic lines of flux extending in the same general direction as the axis of the coil and to establish opposite magnetic poles at the ends of the coil having a distance between the poles greater than the length of the cutting edges, maintaining said head portions in said magnetic field until the cutting edges and the outer surface of the head portions are heated to a hardening temperature, and then removing the head portions from the magnetic field.

FALIH N. DARMARA.

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