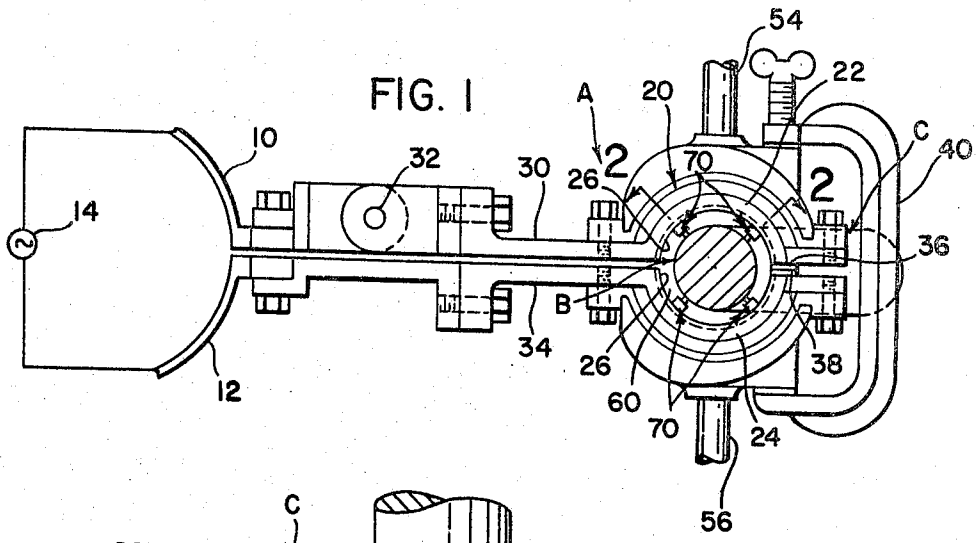
July 18, 1967 W. J. McDANELS 3,331,938

CONDUCTOR WITH AN ADJUSTABLE WORKPIECE CENTERING ARRANGEMENT

Filed March 2, 1965

FIG. 1



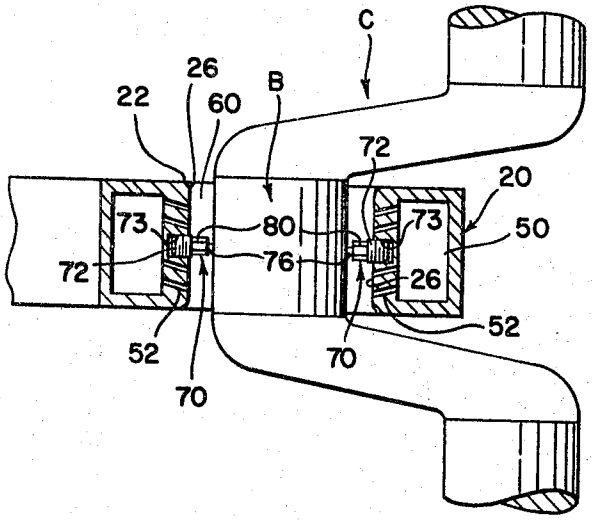


FIG. 2

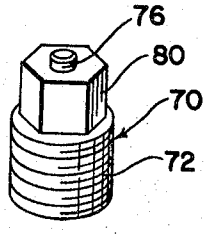


FIG. 4

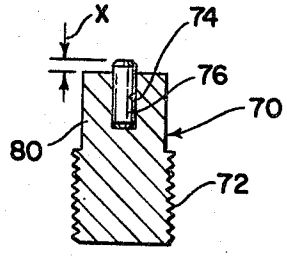


FIG. 3

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CONDUCTOR WITH AN ADJUSTABLE WORKPIECE CENTERING ARRANGEMENT

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This invention pertains to the art of induction heating and more particularly to a device for centering a workpiece within the inner passage of an inductor used in an induction heating apparatus.

The invention is particularly applicable for use with a circular inductor for hardening the crank pins of a crankshaft and it will be described with particular reference thereto; however, it will be appreciated that the invention has much broader applications and may be adapted for use with other inductors, such as an inductor for hardening cams on cam shafts or bearing surfaces on drive shafts.

When surface hardening the crank pin of a crankshaft, an inductor is usually positioned around the crank pin with the pin located within the central or inner passage of the inductor. The inductor is then energized by a high frequency power source while the crank pin is either held stationary or rotated. The inner passage of the inductor has a diameter greater than the outer diameter of the crank pin; therefore, an air gap, is provided between the pin surface and the energized inductor. Heretofore the crank pin was centered within the passage by a plurality of locating pins extending from the inductor toward the pin. These locating pins are usually formed from a refractory material and they have a short extended length because the optimum air gap between the crank pin and the inductor is relatively small.

An inductor, as defined above, is a relatively expensive item; therefore, when only a few crank pins of a given diameter are to be hardened, it is not practical to provide a special inductor having the proper sized workpiece passage to produce an optimum air gap between the crank pin and the inductor. Consequently, it has become common practice, when hardening only a few crank pins, to select an existing inductor having an inner passage with a diameter as close as possible to the diameter which results in the optimum air gap. Quite often, the passage was substantially larger than the crank pin which resulted in an air gap substantially larger than the optimum air gap. Although this increased air gap does decrease the efficiency of the heating installation, this factor is not substantial, when compared with the high cost of a special inductor.

Difficulties have been experienced when using an inductor having a passageway substantially greater in diameter than the external diameter of the crank pins being hardened.

To center the crank pin within the inductor passage, when the diameter of the inductor passage is substantially larger than the diameter of the crank pin, the refractory locating or centering pins must have a substantial extended length. These pins are formed from a heat resistant, refractory material, such as lava or diamonite, which is a brittle material. Consequently, when the brittle centering pins extended a considerable distance inward within the passage, the pins often were fractured or broken. If a broken pin was not noticed, the crank pin was not centered within the inductor and a defective hardening pattern was formed on the crank pin. On the other hand, if the broken pin was noticed, the inductor had to be repaired. This required a substantial amount of labor and down time for the hardening apparatus.

Heretofore, there has been no solution to this problem and the trade has generally accepted the increased maintenance and time losses in hardening crank pins when no standard or special inductor was available.

These and other disadvantages of the prior arrangement for locating a crank pin or other workpiece within the central passage of an inductor are overcome by the present invention which is directed toward an improved construction for the centering pins which construction results in a substantial reduction in centering pin breakage.

In accordance with the present invention there is provided an improvement in an inductor as described above which improvement comprises constructing the workpiece centering device for the inductor from a plurality of elongated members having a bore at one end thereof, a refractory element mounted within the bore and extending only a slight distance outward from the member, means for mounting the members at circumferentially spaced points on the inner wall of the inductor passage with the members extending radially inward of the inductor passage and means for adjusting the radial position of the members in the passage to adjust the radial position of the refractory elements without changing the actual distance the refractory elements extend from the members.

By constructing the centering device for an inductor as defined above, the refractory pins or elements extend only a slight distance from their supports, irrespective of the air gap between the workpiece and the inner wall of the inductor. This substantially reduces the possibility of pin breakage during use of the inductor for hardening crank pins and similar workpieces.

The primary object of the present invention is the provision of an improved device for centering a workpiece within the passage of an inductor which device is less subject to fracture than previous centering devices, especially when the air gap between the workpiece and inductor is relatively large.

Another object of the present invention is the provision of an improved device for centering a workpiece within the passage of an inductor which device includes a plurality of members adjustably mounted within the inductor and a refractory element, having a short extended length, mounted on each of the members so that the extended lengths of the refractory elements do not change when adjusting the centering device for changes in the size of the air gap between the workpiece and the inductor.

These and other objects and advantages will become apparent from the following description used to illustrate the preferred embodiment of the invention as read in connection with the accompanying drawing in which:

FIGURE 1 is a side elevational view illustrating, somewhat schematically, the preferred embodiment of the present invention;

FIGURE 2 is an enlarged, partial cross-sectional view taken generally along line 2—2 of FIGURE 1;

FIGURE 3 is a cross-sectional view illustrating details of the preferred embodiment of the present invention; and,

FIGURE 4 is a pictorial view showing the embodiment of the invention illustrated in FIGURES 1–3.

Referring now to the drawing wherein the showings are for the purpose of illustrating a preferred embodiment of the invention only and not for the purpose of limiting same, FIGURE 1 shows an induction heating apparatus A adapted to inductively harden the bearing or crank pin B of a crankshaft C. Apparatus A includes an inductor **20** which is electrically connected, by power leads **10, 12**, across the output of a high frequency power source, schematically represented as generator **14**. Inductor **20** is separated into an upper semi-circular, inductor segment

22 and a lower semi-circular, inductor segment 24 which segments combine to define an inwardly facing, generally annular wall 26. In accordance with the illustrated embodiment of the invention, the segment 22 is mounted on the end of an arm 30 pivotally mounted at shaft 32. The lower segment 24 is secured onto a generally stationary arm 34. By providing outboard contacts 36, 38, the segments 22, 24 are electrically connected when the segment 22 is pivoted into its downwardmost position. In order to hold the segments 22, 24 in their operating position, as shown in FIGURE 1, there is provided a C-clamp 40 of generally conventional design. As so far described, the arm 30 is pivoted upwardly to receive the crank pin B. Thereafter, the arm 30 is pivoted downwardly and clamped in this downward position by clamp 40 to provide the generally annular inner wall 26 of the inductor 20. Each of the segments 22, 24 is provided with an internal quench passageway 50 which is communicated with a plurality of generally radially extending orifices 52 so that quenching fluid, such as water or oil, may be directed onto the crank pin B after the pin has been heated by the inductor 20. In accordance with common practice, quench inlets 54, 56 are communicated with the quench passageways 50 for supplying the passageways with quenching fluid.

The external diameter of the crank pin B is substantially less than the internal diameter of wall 26; therefore, there is provided an air gap 60 between the workpiece and the inductor. In order to provide a uniform air gap around the periphery of the workpiece, a plurality of centering devices 70, four of which are shown, are circumferentially spaced around wall 26 with the extended, radial length of the devices generally matching the desired width of air gap 60.

As so far described, the apparatus A does not differ from prior apparatus for inductively hardening the crank pins of a crankshaft. Heretofore, the centering devices have comprised pins or elements formed from refractory material, such as lava or diamonite. To adapt the inductor 20 for hardening a crank pin having a substantially lesser diameter than the crank pin for which the inductor was specifically constructed, it has heretofore been common practice to increase the length of the lava or diamonite pins. Since the refractory pins of the type adapted for use in an inductor have a relatively low physical strength, these pins often fractured when used with this increased extended length. This pin fracture resulted in an uneven air gap around the crank pin and required a substantial amount of down time. The present invention is directed toward improved centering devices to overcome this difficulty of the prior art.

In accordance with the invention, the centering devices 70 are formed from a metal, such as copper, and include a lower threaded base 72 adapted to be received within a threaded aperture 73 provided in the annular wall 26. Adjacent the upper portion of the centering devices 70, there are provided bores 74 which slidably receive refractory pins or elements 76. These pins or elements extend outwardly from the upper end of the centering device 70 a distance x which is preferably ⅛–⅜ inch in length. In accordance with the invention, the extended length of the refractory elements 76 does not vary as the air gap is changed within the inductor to accommodate crank pins of different sizes. The devices 70 are provided with intermediate portions 80 having a hexagonal cross-section or other means for receiving an appropriate wrench which is used to thread the centering devices 70 into apertures 73. By adjusting the position of bases 72 within apertures 73, the upper end of elements 76 is moved into the proper position within the inductor 20 to locate a crank pin centrally of the inductor, irrespective of the outer diameter of the crank pin. Consequently, an adjustment of the air gap of inductor 20 is accomplished by changing the radial position of devices 70 which does not increase the actual extended length of the brittle refractory elements 76. It has been found in practice that this arrangement provides a convenient adjustment for the air gap within the inductor without the resulting difficulty of fracturing the refractory pins or elements during use of the inductor with an enlarged air gap. This is a substantial benefit in the art of induction heating and substantially reduces the overall operating costs of inductor 20 when adapted for hardening crank pins and other cylindrical surfaces having outer diameters substantially less than the diameter for which the inductor is primarily designed.

The present invention has been described in connection with a preferred embodiment; however, it is appreciated that various modifications may be made in this embodiment without departing from the intended spirit and scope of the present invention as defined in the appended claims.

Having thus described my invention, I claim:

1. In an inductor for an induction heating apparatus, said inductor including a generally annular body having an inwardly facing wall defining a workpiece receiving passage and means on said wall and extending radially inward of said passage for defining the air gap of said inductor, the improvement comprising: said air gap defining means comprising a plurality of elongated members having a bore at one end thereof, a refractory element mounted within each of said bores and extending only a slight distance outward from said members, means for mounting said members at circumferentially spaced points on said wall with said elements extending radially inward of said passage and means for adjusting the radial position of said members in said passage to adjust the inward extending distance of said elements and, thus, the air gap of said inductor.

2. In an inductor for an induction heating apparatus, said inductor including a generally annular body having an inwardly facing wall defining a circular workpiece receiving passage and means on said wall and extending radially inward of said passage for defining the air gap of said inductor, the improvement comprising: said air gap defining means comprising a plurality of threaded apertures within said wall, a plurality of members each having a threaded base and an upper end, one of said members being threadably received within each of said apertures with said base within said aperture and with said upper end extending radially inward of said passage, and a refractory element mounted on the upper end of each of said members and extending outwardly therefrom.

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