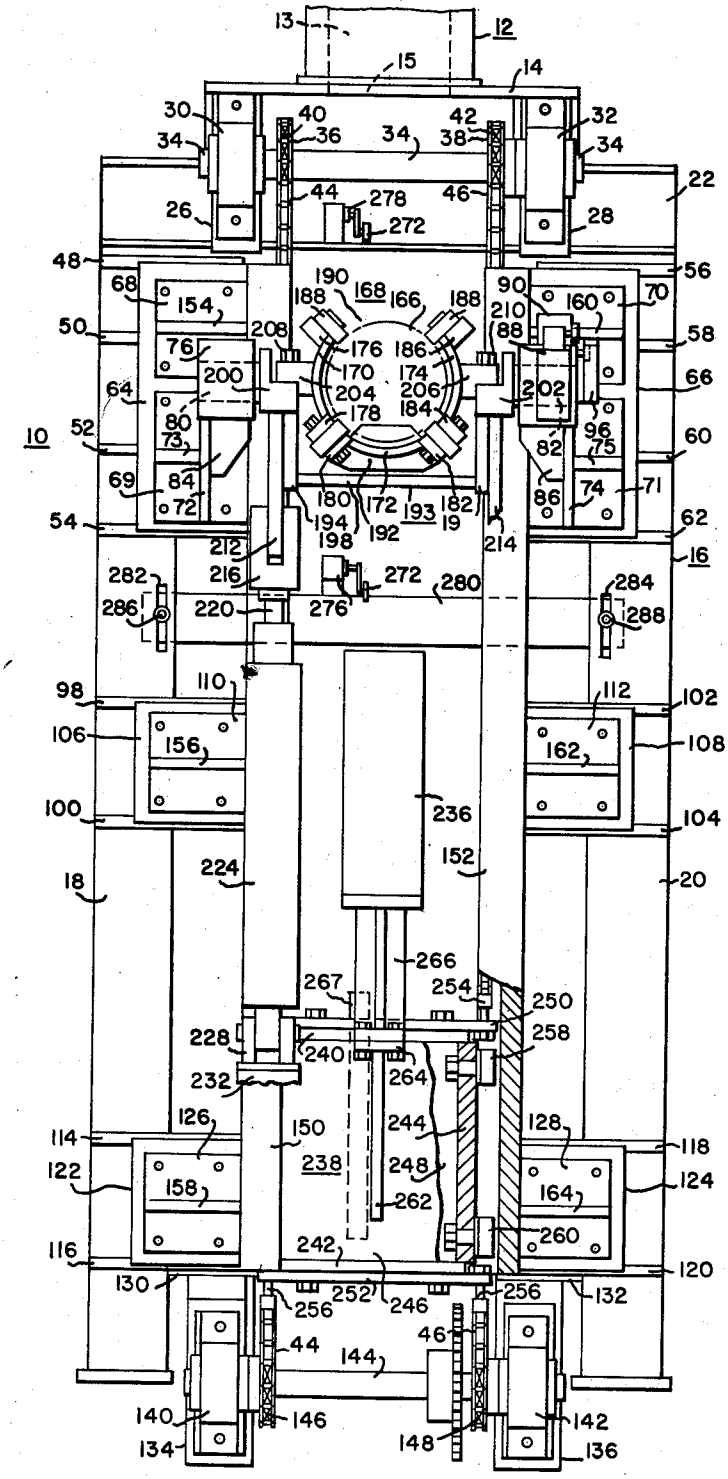
Feb. 18, 1964 R. D. ECKEL ETAL 3,121,779

INDUCTION HEATING APPARATUS

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Fig.1

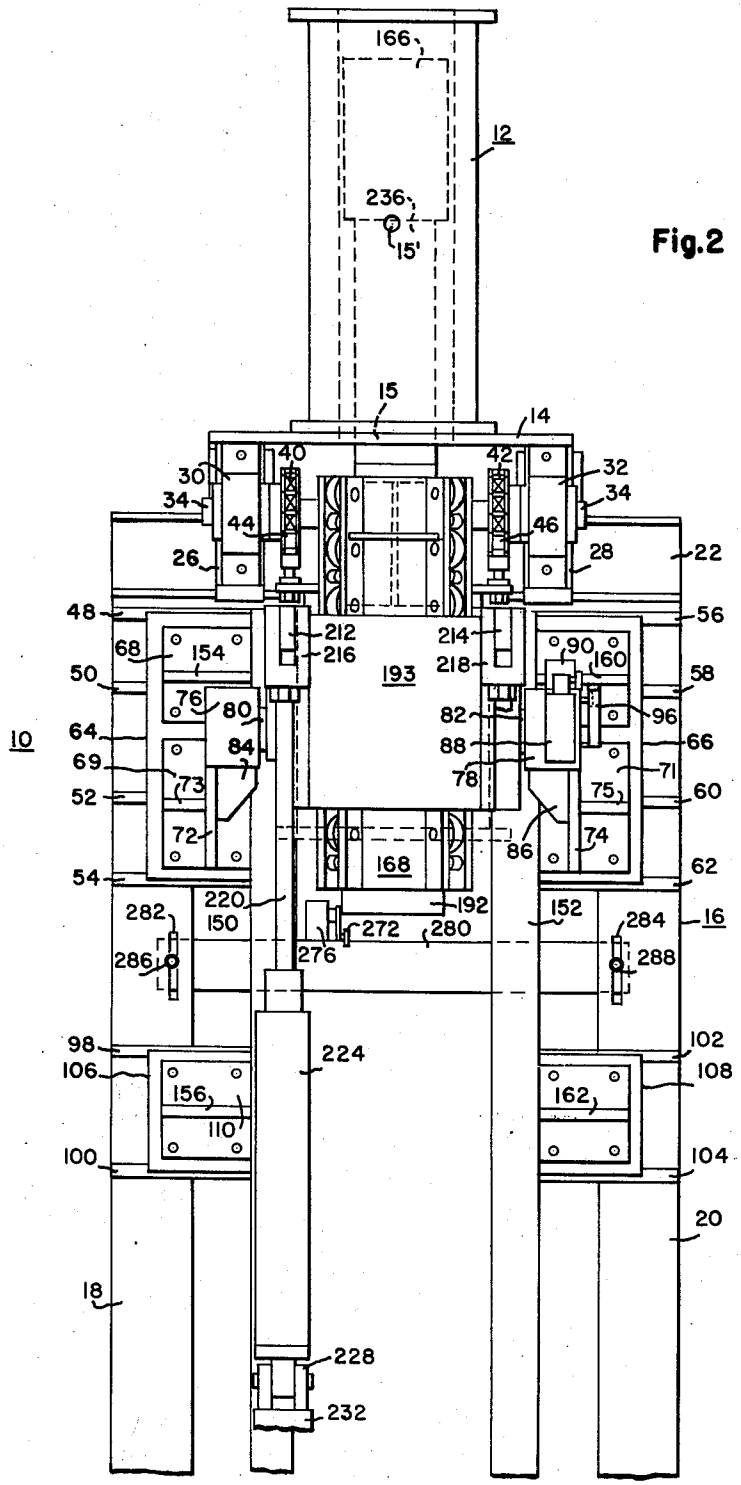


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INDUCTION HEATING APPARATUS

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Fig.2



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INDUCTION HEATING APPARATUS

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Fig.3

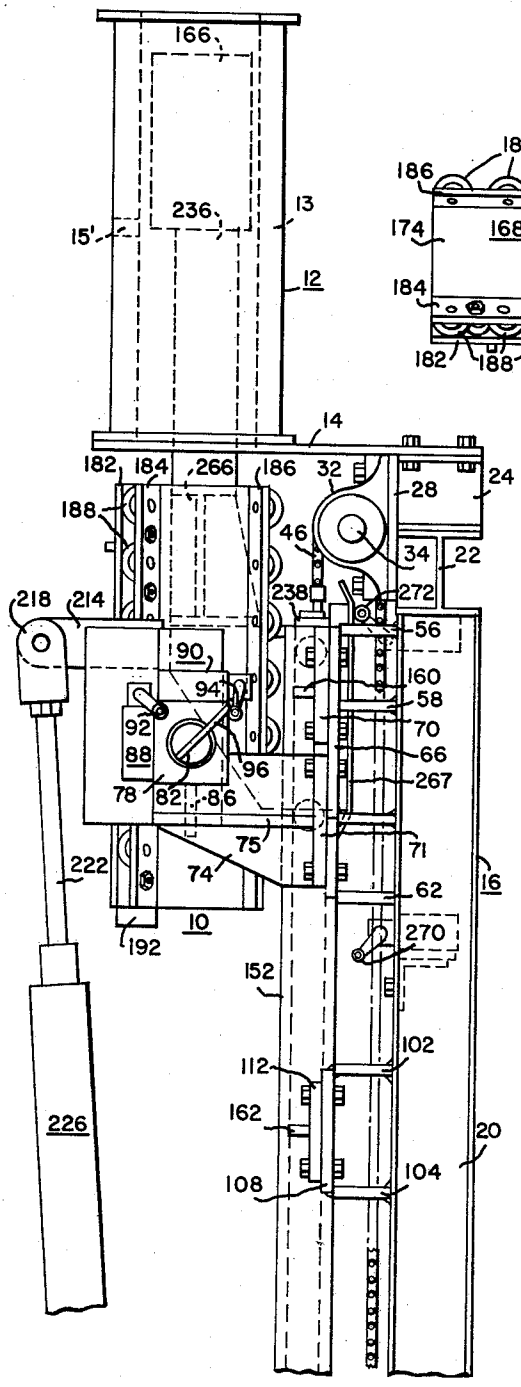
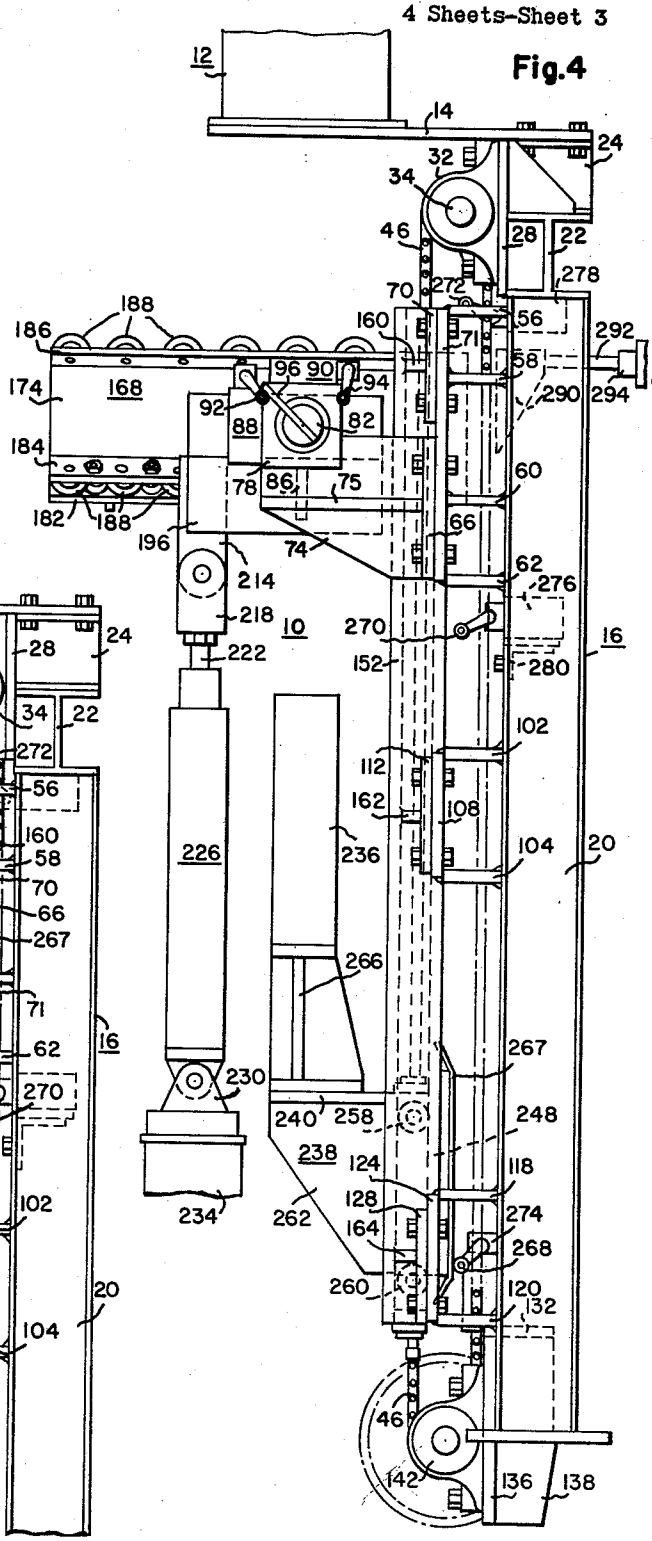


Fig.4



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INDUCTION HEATING APPARATUS

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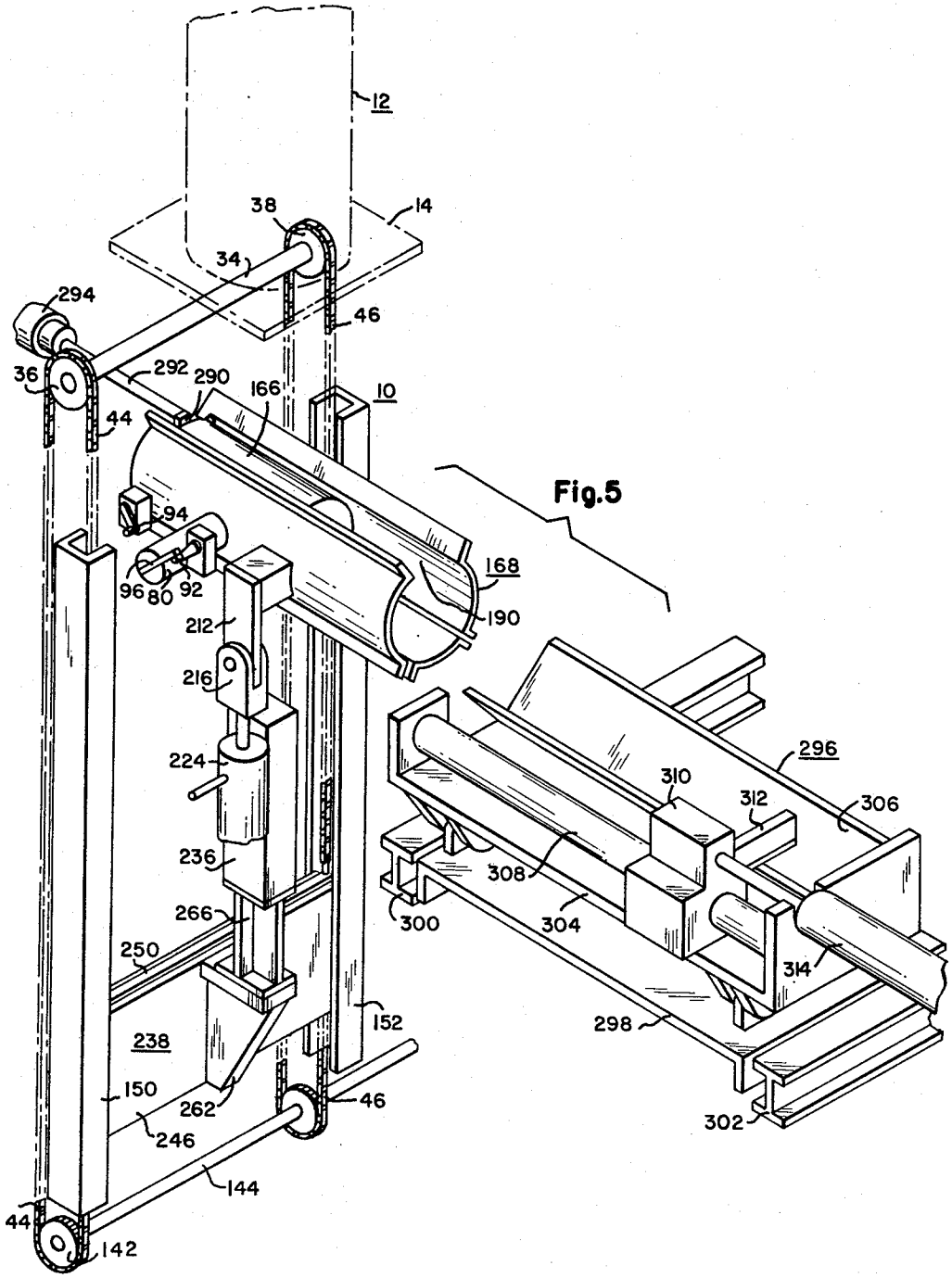


Fig.5

United States Patent Office 3,121,779 Patented Feb. 18, 1964

3,121,779

INDUCTION HEATING APPARATUS

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Filed Oct. 10, 1961, Ser. No. 144,177
5 Claims. (Cl. 219—10.67)

This invention relates to induction heating apparatus and, in particular, to induction heating apparatus for developing a substantially uniform temperature in extrusion billets.

Many different types and designs of induction heating equipment have been known and used in the prior art for effecting the heating of billets and ingots. The known equipment however has not proven to be satisfactory for developing a uniform temperature in billets of ferrous-base metals and alloys, that is, metals and alloys having one or more of nickel, iron and cobalt as the base thereof and other metals such as the refractory base metals which are designed to be hot extruded in glass lubricated dies or otherwise.

An object of this invention is to provide an induction heating apparatus for effecting a substantially uniform heating of metal billets.

Another object of this invention is to provide, in an induction heating apparatus for extrusion billets, for effecting an efficient loading of the billet in an induction coil and to impart a predetermined oscillating motion to the billet in said coil to effect a substantially uniform heating thereof.

Other objects of this invention will become apparent from the following description when taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a front elevational view with parts broken away of an induction heating apparatus embodying features of this invention illustrating the loading position;

FIGURE 2 is a view in elevation of a portion of the apparatus of FIG. 1 illustrating the loaded position;

FIG. 3 is a view in side elevation of the apparatus of FIG. 2;

FIG. 4 is a view in side elevation of the apparatus of FIG. 1; and

FIG. 5 is a schematic isometric perspective view of certain of the components of the apparatus of, and in the same position as, that of FIGS. 1 and 4.

Referring to FIGS. 1–4 of the drawings, this invention is illustrated by reference to an induction heating apparatus 10 comprising a vertically disposed induction coil 12 having a cylindrical work receiving opening 13 therethrough, the coil 12 being carried on a platform 14 which is mounted on the upper end of a vertically extending supporting frame 16 formed of spaced vertical columns 18 and 20 and a suitable cross or horizontal I beam 22 secured together, the vertical columns 18 and 20 being disposed to be secured to a suitable supporting structure (not shown). The platform 14 has a circular opening 15 therein in alignment with the opening 13 of the coil 12 and is secured to a pair of spaced I beam sections 24 (see FIG. 4) which are carried on and secured to the upper surface of the cross beam 22. Vertical plates 26 and 28 (see FIG. 1) are secured to the ends of the spaced I beams sections 24 and across the flanges of the cross beam 22 to form supports for bearing pillow blocks 30 and 32, respectively, in which a horizontal shaft 34 is mounted for rotation. A pair of ratchet wheels 36 and 38, having teeth 40 and 42, respectively, are mounted on the shaft 34 for engaging chain drives 44 and 46, respectively, as will be referred to hereinafter.

Adacent the upper ends of columns 18 and 20, a plurality of outwardly extending horizontal plate members 48—50—52—54 and 56—58—60—62, respectively, are disposed and secured thereto in spaced relation as by welding for providing supporting bases for receiving base plates 64 and 66, respectively, which are secured thereto as by welding. Mounted on the spaced base plates 64 and 66 are supporting members 68—69 and 70—71, respectively, which have their bases bolted to such base plates, each of the supporting members 69 and 71 carrying an outwardly extending flange member 72—73 and 74—75 disposed to support bearing pillow blocks 76 and 78, respectively, for receiving the ends of shafts 80 and 82, respectively. The mounting of the pillow blocks 76 and 78 is reinforced as by means of the flange plates 84 and 86, respectively, being welded to the respective plates 84 and 86 and notched portions of the sides of the associated supporting flange members 72 and 74. A pair of micro switch housings 88 and 90 are also carried on two adjacent surfaces of the pillow block 78 with the actuating roller members 92 and 94 of such switches disposed to be selectively engaged by an actuating arm 96 carried on the end of the shaft 82 as will be referred to hereinafter.

Intermediate the ends of vertical columns 18 and 20 a pair of outwardly extending horizontal plate members 98—100 and 102—104, respectively, are disposed and secured thereto in spaced relation as by welding for supporting base plates 106 and 108, respectively, on which are mounted supporting and reinforcing members 110 and 112, respectively. A similar pair of plate members 114—116 and 118—120 are disposed on and secured to columns 18 and 20, respectively, adjacent the lower ends thereof for supporting base plates 122 and 124, respectively, which carry supporting members 126 and 128, respectively.

Referring to FIGS. 1 and 4, horizontal plate members 130 and 132 are also secured to the under side of plate members 116 and 120, respectively, and downwardly extending base plates 134 and 136, respectively, are secured as by welding to the members 130 and 132, respectively. Each of the base plates 134 and 136 is reinforced by a flange rib member 138 which is secured as by welding to the back of each of the base plates 134 and 136 and the under side of the horizontal plate members 130 and 132, respectively. The base plates 134 and 136 thus provide supports on which bearing pillow blocks 140 and 142, respectively, are mounted for receiving a drive shaft 144 and on which a pair of spaced ratchet wheels 146 and 148 are mounted with the teeth thereof in engagement with the endless chain drives 44 and 46, respectively. The shaft 144 extends outwardly from the assembly as shown in FIG. 5 and is disposed to be mechanically connected to a reversible drive motor (not shown) to actuate the chain drives 44 and 46.

In order to guard the chain drives 44 and 46, a pair of U-shaped channel guard members 150 and 152, respectively, are positioned on their sides to receive the front strand of such chain drives and are seated as shown in FIGS. 1–4 on the horizontal plate members 48—50—52—54—98—100—114—116 and 56—58—60—62—102—104—118—120, respectively, which are mounted in spaced relation on the columns 18 and 20, respectively, the guards 150 and 152 being preferably welded to such horizontal plate members. The guard members 150 and 152 also seat against the base plates 64—106—122 and 66—108—124, respectively, it being noted that the supporting members 68—110—126 and 70—112—128, respectively, mounted thereon are provided with flange members 154—156—158 and 160—162—164, respectively, which are seated against the side of guard members

150 and 152, respectively, and are preferably welded thereto to aid in the support thereof.

In order to support and position a billet 166 in position for entry into or discharge from the induction coil 12, a billet receiving housing 168 having shafts 80 and 82 secured to the sides thereof adjacent one end thereof is mounted with the ends of the shafts 80 and 82 disposed for pivotal movement in the bearing pillow blocks 76 and 78, respectively. The housing 168 is formed of three curved sections 170, 172 and 174 having outwardly extending flanges 176–178, 180–182 and 184–186, respectively, at the outer edges thereof and which are disposed to be connected, as by bolts through the adjacent flanges into circular shape with spaced rollers 188 disposed to be carried between the adjacent flanges as well as on the outer flanges of the assembly. When thus assembled, the housing 168 comprises about three-fourths of a cylinder with an open or slotted portion 190 extending lengthwise thereof in the upper side when the housing is in the horizontal position as shown in FIGS. 1 and 5. The back edge of the lower section 172 as viewed in FIG. 1 carries a lip or flange 192 which projects inwardly of the housing 168 to serve as a stop when the billet 166 is received in the housing and as a support for the billet when the housing 168 is pivotally rotated to the vertical position as will be referred to hereinafter.

In order to support the housing 168 and to effect a pivotal movement thereof, the housing 168 is carried in a U-shaped frame 193 comprising side plates 194 and 196 and a bottom plate 198 which are welded together with L-shaped blocks 200 and 202 secured as by welding to the upper edges of the side plates 194 and 196, respectively. Stud blocks 204 and 206 are welded to the sides of sections 170 and 174, respectively, of the housing 168 and terminate in a step shoulder to seat on the blocks 200 and 202, respectively, and are removably secured thereto as by means of stud bolts 208 and 210, respectively. Depending arms 212 and 214 are secured to the side plates 194 and 196, respectively, and to the blocks 200 and 202, respectively, and extend downwardly therefrom a short distance as viewed in FIGS. 1 and 4 to seat in yoke members 216 and 218, respectively, the lower ends of arms 212 and 214 being pivotally connected in such yoke members. The yoke members 216 and 218 are mechanically connected to the ends of piston arms 220 and 222, respectively of hydraulic piston assemblies 224 and 226, respectively, the lower ends of which are pivotally secured to clevises 228 and 230, respectively, mounted on suitable fixed supports 232 and 234, respectively. It will be appreciated that only the piston assembly 224 is shown in FIGS. 1, 2 and 5 in the interest of clarity, the piston assembly 226 being shown in FIGS. 3 and 4. It will also be appreciated that where the mass of the housing 168 and billet contained therein permits, only the assembly of the depending arm 212, yoke member 216, piston assembly 224 and support 232 need be employed, the omission of the arm 214, yoke member 218, piston assembly 226 and support 234 thus simplifying the construction.

As illustrated in FIGS. 1 and 4, a vertically disposed ceramic stool or pedestal 236 is disposed to be in alignment with the billet receiving housing 168 when the housing is in the vertical position and with the work receiving opening in the induction coil 12. In order to actuate the stool 236 to effect a vertical movement thereof, the stool is connected to and disposed to be moved in response to movement of the endless chain drives 44 and 46. Thus a frame member 238 formed of upper and lower spaced cross bars 240 and 242, respectively, and spaced side bars 244 (only one of which is shown in FIG. 1) and a front and rear face plate 246 and 248, respectively, are welded together and the welded assembly is secured between an upper and lower connecting arm 250 and 252, respectively. The arms 250 and 252 extend beyond the side bars 244 and are connected as by

means of upper and lower studs 254 and 256, respectively, to and as a part of the endless chain drives 44 and 46. In order to guide the frame 238 for free movement relative to the guard members 150 and 152 in which one strand of the endless chains 44 and 46, respectively, are mounted, a pair of roller members 258 and 260 are mounted on each of the side bars 244 and are disposed to ride in the guard channels. The roller members 258 and 260 are slightly smaller than the channel formed in the guard members so that binding does not occur. An outwardly extending flange plate 262 is secured to the face plate 246 of the frame member 238 and carries a supporting plate 264 at the upper end thereof. A supporting base 266 to which the stool 236 is secured is disposed to be removably connected to the supporting plate 264 whereby different sized stools may be readily installed in the assembly. It is to be noted that the supporting face plate 264 is of a width to pass longitudinally through the slotted portion of the housing 168 when the housing is positioned in the vertical position and that the ceramic stool 236 is of a size to pass by the stop 192 into the interior of the housing 168 to seat against the end of the billet 166 and support the billet during movement thereof into and out of the induction coil 12 as will be referred to hereinafter.

Again referring to FIG. 4, it is seen that the rear face plate 248 of the frame member 238 has a sliding contact member 267 secured thereto disposed in alignment with the roller contact members 268, 270 and 272 of spaced micro switch members 274, 276 and 278, respectively. The micro switch 274 is utilized to control the lower limit of movement of the frame member 238 and consequently the lower positioning of the stool 236, whereas, the micro switches 276 and 278 are utilized to control a vertical oscillating movement of the frame member 238 and consequently the vertical oscillating movement of the billet 166 when the billet is positioned within the confines of the induction coil 12 as will be explained more fully hereinafter.

In order to establish the limits of the oscillating movement of the billet 166 in the induction coil 12, the micro switch 278 is mounted on the horizontal I beam 22 in a fixed position to limit the upper movement of the frame member 238 and the billet 166 whereas the micro switch 276 is mounted on an adjustable cross bar 280 which is disposed (see FIGS. 1–4) with its ends releasably secured to vertical columns 18 and 20. Thus vertical slots 282 and 284 are provided in columns 18 and 20, respectively, to receive stud bolts 286 and 288, respectively, which extend through the slots into the ends of the cross bar 280 and which can be released for vertical adjustment of the cross bar 280 relative to such slots. The control systems actuated by the different micro switches for controlling the operation of the reversible motor (not shown) for effecting the operation of the drive chains 44 and 46 and the operation of the hydraulic rams 224 and 226 are not illustrated as they form no part of the present invention and different control systems may be used.

In order to eject the billet 166 from the housing 168 when the housing is in the horizontal position, a discharge pusher plate 290 (see FIGS. 4 and 5) carried by an arm 292 and disposed to be actuated by a suitable hydraulic piston assembly 294 is positioned to be actuated into seating engagement with the end of the billet 166 to move the billet over the rollers 188 and out of the housing. The pusher plate 290 is positioned relative to the horizontally disposed housing 168 so as to pass over the stop member 192 and pass through the slotted portion of the housing 168 while ejecting the billet and as the pusher plate is retracted from the housing.

Any suitable means may be employed for supplying the billet to and receiving the billet from the horizontally positioned housing 168. Thus, as illustrated in FIG. 5, a loading and unloading trough assembly 296 is illustrated disposed adjacent the end of the housing 168. The as-

sembly 296 comprises a base member 298 having rollers (not shown) carried on the ends thereof disposed to ride in rails or tracks 300 and 302 formed from I beams and a carriage 304 mounted on the base member. The carriage 304 carries a trough member 306 of a size to accommodate the billet 166 and a guide member 308 adjacent the trough, the guide member 308 carrying a slidable pusher member 310 having a pusher arm 312 which is disposed to be seated against the end of the billet to move the billet from the trough 306 into the horizontally positioned housing 168. The pusher member 310 is mechanically connected to a hydraulic piston assembly 314 which is disposed to be operated to move the pusher member 310 lengthwise of the guide member 308 to eject the billet and to retract the guide member 308 so that the billet can be received in the trough 306. After the billet is ejected from the housing 168, the carriage 304 may be moved lengthwise on the rails 300 and 302 to a position free of the frame 16 where the billet may be discharged from the trough 306 to be further processed.

The operation 10 will next be described. Assuming that the billet receiving housing 168 is in the horizontal position illustrated in FIGS. 1, 4 and 5 for receiving a billet 166, a billet which has been preheated to a predetermined temperature is supplied to the trough 306 and the carriage 304 is moved to the loading position shown in FIG. 5. The hydraulic mechanism 314 is then actuated so that the arm 312 seats against the end of the preheated billet 166 and moves the billet lengthwise of the trough 306 into the housing 168 where it rides on the rollers 188 and seats against the stop 192. It will be appreciated that the housing 168 may be actuated by a manual control of the hydraulic mechanisms 224 and 226 to move between the horizontal and the vertical positions although usually all of the operations to be described will be controlled by suitable automatic control systems (not shown). Thus, micro switches 88 and 90 have their contact members 92 and 94 disposed on the housing to be selectively engaged by the arm 96 depending upon whether the housing 186 is in the horizontal or the vertical position, respectively, the micro switches being disposed to be connected to suitable relays for establishing control circuits where the operation is to be controlled automatically. In this description the function of the micro switches 88 and 90 will not be described for it will be assumed that a manual control is utilized for effecting the operation necessary for positioning the housing 168 in the horizontal or vertical positions.

With the billet 166 seated in the housing 168, the hydraulic mechanisms 244 and 226 are actuated to drive their pistons upwardly to effect a rotation of the housing 168 about the shafts 80 and 82 until the housing 168 is in a vertical position aligned with the opening 13 in the induction coil 12. In this position the billet 166 is seated against the stop 192. With the housing 168 in the vertical position described, the drive motor (not shown) is energized to effect a rotation of the shaft 144 to drive the ratchet wheels 142 and 146 in a direction to drive the chain drives 44 and 46 to move the ceramic stool 236 vertically to a position where it engages the lower end of the vertically disposed billet 166 within the housing 168 so as to pick up the billet 166 and carry it vertically into the induction coil 12. As the stool 236 moves the billet 166 into the confines of induction coil 12, it is seen that the sliding contact member 267 carried on the support for the ceramic stool 236, passes over contact member 270 of the micro switch 276 and as the stool continues to be raised, engages the contact member 272 of the micro switch 278. The micro switch 278 is connected in a control circuit (not shown) to reverse the direction of operation of the drive motor for the shaft 144, it being noted that such micro switch 278 is positioned so as to limit the upward movement of the billet 166 in the coil 12. This limit of movement is usually about three inches from the upper end of the induction coil 12.

When the motor drive (not shown) is reversed, the direction of movement of the chain drives 44 and 46 is reversed to lower the billet 166 in the induction coil 12 a predetermined distance depending upon the location of the micro switch 276, the positioning of which has been described hereinbefore as being adjustable. Thus, as a sliding contact member 267 moves downwardly to a position where it engages the contact member 270 of microswitch 276, the stroke of movement of the billet 166 in the coil 12 is determined since the micro switch 276 is connected to again reverse the direction of the motor drive (not shown) to again effect an upward movement of the billet 166 in the coil 12. The positioning of the micro switch 276 depends upon the length of the billet 166 which is to be heated in the induction coil 12. The vertical oscillation thus imparted to the billet 166 in the coil 12 is continued until it has been determined that the temperature of the billet 166 has been raised to a predetermined temperature usually in the neighborhood of 2300° F. Such determination of temperature can be readily determined by scanning the sides of the billet 166 through the sight opening 15' as by means of a radiation pyrometer (not shown). When the temperature has thus been increased to the predetermined temperature desired in the billet 166, a suitable cutout (not shown) may be energized to deenergize the control effected by the micro switch 276 so that the motor drive (not shown) is continued in a direction to drive the stool 236 downwardly to remove the billet 166 from the coil 12 and lower the billet into the vertical housing 168 to a position where the end of the heated billet again seats on the stop 192. The downward stroke of the stool 236 is continued, however, until the sliding contact member 267 engages the contact member 268 of micro switch 274 to establish a circuit to stop the operation of the motor drive (not shown) whereby the stool 236 is clear of the housing 168.

The hydraulic rams 224 and 226 are then actuated to retract their piston rods and thereby effect a pivotal movement of the housing 168 from the vertical position to the horizontal position shown in FIGS. 1, 4 and 5. With the carriage 304 positioned so that the trough 306 is in alignment with the housing 168, the hydraulic mechanism 294 is actuated to drive the pusher plate 290 forwardly to seat against the end of the billet 166 and drive the billet from the housing 168 into the trough 306 after which the pusher plate 290 is retracted from the housing 168. The carriage 304 may then be moved to a position where the billet may be discharged from the trough 306 away from the apparatus 10 for further processing.

The apparatus of this invention makes it possible to effect a substantially uniform heating of a billet in an induction coil without encountering "banding." It will be appreciated that the configurations of the windings of any induction coil determines the distribution of magnetic flux inside the coil and that the heating of the billet in the coil 12 is a function of the magnetic flux. If the vertical oscillation of the billet 166 within the coil 12 as previously described was not utilized but instead the billet was maintained stationary within the coil, it would be found that the temperature of the billet would vary axially throughout the length of the billet depending upon the axial variation of the flux of the coil. This temperature banding effect would be detrimental since, in particular where billets of different sizes are used, the temperature lengthwise of the billet would no longer be even. However, by providing for the vertical oscillation of the billet within the coil 12, it is seen that each portion of the billet is subjected to the flux density through the length of the coil thereby eliminating the detrimental effects of the peaks and valleys of flux densities inherently encountered in any induction coil.

With the apparatus of this invention it is possible to utilize the same induction coil 12 for developing pre-

determined temperatures in billets which vary in length from eight to twenty-six inches. In practice it has been found it is desirable to oscillate the billet in the induction coil at a speed of from twenty to thirty-six inches per minute in developing the uniform temperatures desired.

It will be appreciated that in order to utilize the apparatus with billets having different diameters it may be necessary to employ different sized housings **168** depending upon the diameter of the billet. For this reason, the housing **168** is releasably mounted in its supporting frame and different housings **168** can be readily substituted in the apparatus simply by releasing the stud screws **208** and **210** to permit the removal of a given housing and the substitution therefor of a different housing which is then secured by the stud screws **208** and **210** in an operative position.

Further, by using the guards **150** and **152**, the support for the stool **236** is maintained at all times in a substantially constant plane so as to align the stool **236** with the opening in the vertically disposed housing **168** and the opening in the induction coil **12** so that a vertically aligned movement can always be obtained.

It will be appreciated that a plurality of the apparatus **10** may be assembled in banks with the carriage **304** serving more than one of the apparatus **10** so that as a billet **166** is being heated in one induction coil **12** a heated billet can be removed from another housing **168** and a continuous supply of heated billets can be obtained for further processing such as in an extrusion operation. Where a plurality of the apparatus **10** are utilized, it will be appreciated that interlocking control systems are desirable and that the entire operation of such loading, heating and unloading can be effected automatically.

The apparatus of this invention makes it possible to heat billets to a uniform temperature in a minimum of time with the loading and unloading of the billets being effected efficiently by the apparatus disclosed. The apparatus described can be readily reproduced by anyone skilled in the art, as such apparatus is formed of standard components.

We claim:

1. In an induction heating apparatus including a vertically disposed induction coil having an opening therein adapted to accommodate a billet to be heated therein, the combination comprising, an open-ended loader pivotally mounted beneath said induction coil and disposed to be actuated between a billet receiving and discharging horizontal position and a vertical position where said loader is aligned with the opening in said induction coil, stop means carried at one end of said loader for receiving and maintaining the billet in said loader as said loader moves to the vertical position, billet support means disposed beneath said loader and in alignment therewith when said loader is in the vertical position, said support means being disposed to be moved into and out of supporting engagement with an end of the billet when said loader and billet contained therein are in the vertical position, actuating means disposed to be operated to effect vertical movement of said support means to engage and lift the billet from said loader into said induction coil and to lower the billet therefrom to seat against said stop means, and means disposed to control the vertical movement of said support means when the billet is within said induction coil to impart a predetermined vertical oscillation to the billet within said coil so that said coil can develop a substantially uniform heating of the billet.

2. In an induction heating apparatus including a vertically disposed induction coil having an opening therein adapted to accommodate a billet to be heated therein, the combination comprising, an open-ended loader pivotally mounted beneath said induction coil and disposed to be actuated between a billet receiving and discharging horizontal position and a vertical position where said loader is aligned with the opening in said induction coil, stop means carried at one end of said loader for receiving and maintaining the billet in said loader as said loader moves to the vertical position, billet support means disposed beneath said loader and in alignment therewith when said loader is in the vertical position, said support means being disposed to be moved into and out of supporting engagement with an end of the billet when said loader and billet contained therein are in the vertical position, actuating means disposed to be operated to effect vertical movement of said support means to engage and lift the billet from said loader into said induction coil and to lower the billet therefrom to seat against said stop means, means disposed to control the vertical movement of said support means when the billet is within said induction coil to impart a predetermined vertical oscillation to the billet within said coil so that said coil can develop a substantially uniform heating of the billet, and billet removing means disposed in alignment with the billet when said loader is in the discharge horizontal position, said billet removing means being disposed for movement to engage and move the billet from said loader.

3. In an induction heating apparatus including a vertically disposed induction coil having an opening therein adapted to accommodate a billet to be heated therein, the combination comprising, an open-ended loader pivotally mounted beneath said induction coil and disposed to be actuated between a billet receiving and discharging horizontal position and a vertical position in alignment with the opening of said induction coil, spaced roller means carried by said loader for receiving a billet to facilitate the loading and unloading thereof when the loader is in the horizontal position, stop means carried at one end of said loader for receiving and maintaining a billet therein as said loader moves to the vertical position, said loader having a soltted opening through the side thereof and extending throughout the length thereof, a billet support means disposed beneath said loader in alignment therewith when said loader is in the vertical position, said support means being disposed to be moved into and out of supporting engagement with an end of the billet when said loader and billet contained therein are in the vertical position, said support means also being aligned with said slotted opening and being disposed to be moved lengthwise thereof to vertically move the billet from said loader into said induction coil and return the billet to said loader, actuating means disposed to be operated to effect said vertical movement of said support means, and means disposed to control said vertical movement to impart a predetermined oscillation movement to the billet when positioned within said coil.

4. In an induction heating apparatus including a vertically disposed induction coil having an opening therein adapted to accommodate a billet to be heated therein, the combination comprising, an open-ended loader pivotally mounted beneath said induction coil and disposed to be actuated between a billet receiving and discharging horizontal position and a vertical position in alignment with the opening of said induction coil, spaced roller means carried by said loader for receiving a billet to facilitate the loading and unloading thereof when the loader is in the horizontal position, stop means carried at one end of said loader for receiving and maintaining a billet therein as said loader moves to the vertical position, said loader having a slotted opening through the side thereof and extending throughout the length thereof, a billet support means disposed beneath said loader in alignment therewith when said loader is in the vertical position, said support means being disposed to be moved into and out of supporting engagement with an end of the billet when said loader and billet contained therein are in the vertical position, said support means also being aligned with said slotted opening and being disposed to be moved lengthwise thereof to vertically move the billet from said loader into said induction coil and return the billet to said loader, actuating means disposed to be operated

to effect said vertical movement of said support means, means disposed to control said vertical movement to impart a predetermined oscillation movement to the billet when positioned within said coil, and billet removing means disposed in alignment with the billet when said loader is in said horizontal position, said removing means being disposed to be actuated to engage and move the billet from said loader.

5. The combination as set forth in claim 4 in which said billet removing means is disposed for horizontal movement in said slotted opening to engage and move the billet over said spaced roller means to eject the billet from said horizontally positioned loader.

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