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(54) IMPROVEMENTS RELATING TO HEATING OF BILLETS

(71) We, INDUCTOTHERM EUROPE LIMITED, of The Furlong, Berry Hill, Droitwich, in the County of Worcester, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to heating of billets of, for example, steel preparatory to subsequent treatment, e.g. blanking and/or forging or rolling of the billets.

Where billets are to be cut into blanks for forging, it is conventional practice with billets of the order of several inches in diameter or transverse dimensions to saw the billets into blanks at ambient temperatures, but this is a time-consuming process. It is also conventional practice to crop the billet into blanks by a cropping mechanism or shear comprising a blade or blades which may be actuated to sever the billet with a shearing action. However, depending upon the nature of the billet material, its hardness and also dimensions, cropping is not always feasible, and it is sometimes found that a particular standard billet can be cropped successfully when the ambient temperature is high but leads to the cropping blades shattering when an attempt is made to perform the same operation at low ambient temperatures.

One object of the present invention is to provide an improved method of cropping billets which can be carried out, under a wider range of conditions, and apparatus for carrying out the method.

In accordance with one aspect of the present invention we provide a method of cropping billets comprising the steps of making electrical connections at or adjacent opposite ends of a billet, heating the billet to an elevated temperature by electrical resistance heating using the billet as the resistance, disconnecting the said connections, and effecting cropping by a shear blade or

blades.

Whilst it is within the scope of this invention to raise the billet temperature to a temperature of the order of 50° to 100°C. It is preferred to effect further elevation, typically to within the range of 500° to 600°C.

Where the blanks produced by cropping the billet are to be forged, the heat engendered for the cropping purpose may be employed as a first increment towards billet heating required for the forging step, in which event the blanks may be delivered to a supplementary heater which could be of any desired kind, but conveniently may also be electrical resistance heating means operating in similar fashion to the pre-cropping heater means, and which serve to raise the temperature to the forging temperature which may typically be of the order of 1250°C.

However it is envisaged that the billet may be raised to the forging temperature by electrical resistance heating prior to cropping; this would depend upon the time cycle of the forging apparatus and general economics, and possibly also upon the number of blanks to be produced from any one billet.

According to a second aspect of the invention we provide apparatus when used in the cropping of metal billets comprising electrical resistance heating means adapted for connection to opposite ends of the billet, a cropping mechanism and means for conveying heated billets from the heating means to the cropping mechanism.

A further object of the invention is to provide improved apparatus for heating billets.

According to a further aspect of the invention we provide electrical resistance heating apparatus for heating billets, comprising a billet-supporting structure, first and second electrode means spaced apart longitudinally of the billet-supporting structure and first and second electrical conductors respectively connected to said first and

second electrode means and connected or connectible to different phase or opposite polarity outputs of a source of electrical power, said electrode means being movable relative to one another to vary the spacing therebetween and at least one of the conductors being jointed to permit extension and retraction thereof in response to variation of the spacing between said electrode means.

In practice, billets are produced in lengths ranging from 8 feet to about 20 feet and such a range of billet lengths may be accommodated in the apparatus according to the last-mentioned aspect of the invention by appropriate design thereof.

Conveniently, each electrode means comprises a pair of electrode members disposed one on each side of the location occupied by a billet in use, the electrode members being movable towards and away from one another to respectively grip a billet, supported by said structure, therebetween and release the same after heating has been terminated.

Each electrode member may be carried by a fluid-pressure-operable device for movement towards and away from the associated member.

Conveniently, the supply of electrical power to the electrode means is governed by a timer or a thermally-responsive device responsive, in use, to the temperature of a billet being heated. Where a timer is utilised to terminate the supply of electrical power the interval it is set to time in order to heat a billet within a desired temperature range may be determined empirically for billets of different lengths and materials.

One of the electrode means may be fixed and the other movable relative thereto longitudinally of the billet-supporting structure. Such movement may be achieved by mounting said other electrode means on a carriage guided on a track and providing means for moving the carriage along the track.

In a preferred embodiment, said other electrode means is connected or connectible to the power source by an assembly of electrically-conductive bars which are so jointed that at least some of the bars fold with respect to one another during movement of said other electrode means.

The billet-supporting structure conveniently comprises two or more longitudinally spaced supports which have vertically-displaceable billet-receiving mouths.

The apparatus may further comprise a conveyor, preferably a roller conveyor, for transporting a heated billet from said supporting structure and away from said electrode means for subsequent treatment such as cropping or rolling of the billet.

The invention will now be described with reference to the accompanying drawings in which:—

Figure 1 is a longitudinal view of electrical

resistance heating apparatus;

Figure 2 is a sectional view taken in the direction 2-2 Figure 1; and

Figure 3 is a sectional view taken in the direction 3-3 in Figure 1.

Referring now to the drawings, an electrical resistance heating apparatus includes a frame structure comprising end columns 10 and 12 between which extends a centrally-disposed I-beam 14 constituting a track as hereinafter explained. A roller conveyor 16 is disposed directly below the track 14, the rollers 16a of which are of V-section for receiving billets 25 as shown in Figure 2. Between certain adjacent pairs of rollers 16a, there are disposed lifting rams 18 which may be pneumatically or hydraulically-operable. Two lifting rams are shown in Figure 1 but three or more may be utilised. The piston stem of each ram 18 mounts a billet-supporting member 20 which has a V-shaped mouth for this purpose as will be apparent from Figure 2.

The end columns 10 and 12 are in the illustrated embodiment spaced apart to a sufficient extent to allow billets to be fed transversely of their length, for example by a walking beam mechanism (not shown), between the columns and discharged onto the conveyor 16. When the rams 18 are retracted, the supporting members 20 thereof are disposed below the upper surfaces of the rollers 16a (as seen in Figure 2) so as to be clear of the billet 25.

When the rams are extended, either under manual or automatic control, the members 20 move vertically in unison and lift the billet to the position indicated by reference numeral 25a in Figure 2 and maintain it in that position until retracted.

Each end column 10, 12 comprises a pair of spaced uprights connected by a cross beam. The uprights of end column 10 each mount a pair of electrode devices 22 consisting of jaw members 24 carried on piston rods 26 which are slidable in cylinders 28. The devices 22 may be hydraulically or pneumatically-operable and are arranged so that the jaw members 24 clamp a billet, supported in the position 25a, therebetween when the rods 26 are extended. The billet is released when the rods 26 are retracted.

A second pair of electrode devices 32 similar to the devices 22 is supported by a main carriage 38 and are also operable to clamp a billet therebetween when the latter is located in position 25a. The main carriage 38 is provided with wheels guided and supported by the track 14 and is coupled to the piston rod 42 of a hydraulically or pneumatically-operable ram 44, the cylinder 46 of which is supported from the underside of the track and in fixed relation thereto. Extension and retraction of the ram 44 serves to move the main carriage 38 respectively away from and towards the end column 10 so that the

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spacing between the electrode devices 22 and 32 may be varied.

Electrical power of one polarity is supplied from a suitable transformer (not shown) adjacent the end column 10 to the electrode devices 22 by a first pair of laminated electrically-conductive bus bar assemblies 50 (one only of which is seen in the drawings). Electrical power of the opposite polarity is supplied to the devices 32 by laminated, electrically-conductive bus bar assemblies 52 consisting of first sections 54 which are fixed, second sections 56, which are directly electrically-connected one to each jaw member 34 of the devices 32, and intermediate sections 58 and 60 which are jointed one to each section 54 and 56 and together. The sections 58 and 60 form knuckles one in each bus bar assembly 52 whereby the latter may be extended or retracted in response to movement of the electrode devices 32 with the main carriage 38. An additional wheeled carriage or carriages, such as that indicated by reference numeral 62 in Figure 1, may be provided to support the sections 54 and 56 adjacent their jointed connections with the sections 58 and 60.

The joints between the sections 54, 58, 60 and 56 are designed so as to provide good electrical continuity whilst permitting folding of the sections 58 and 60 relative to one another during extension and retraction of the assemblies 52. A suitable joint (not shown) comprises a headed pin passing through aligned apertures in the adjacent sections and Bellville washers located one on each side of the connected sections and stressed by a nut engaging with a threaded end portion of the pin, the extent of stressing being sufficient to urge adjacent faces of adjacent sections into good electrical contact with one another without providing excessive resistance to relative movement between the sections so connected. It will be appreciated that provision of suitable electrical insulation will be necessary to isolate the devices 22 and 32 from one another and the remainder of the apparatus.

Operation of the apparatus will now be described. A billet to be heated is transferred to the roller conveyor which is operated to feed the billet towards the column 10 until one end of the billet engages a stop (not shown) which is positioned to locate that end of the billet in predetermined relation to the devices 22. Upon engagement of the billet with the stop, the conveyor is disabled and the lift rams 18 are operated to raise the billet to the position 25a. If the billet is the same length as the billet previously heated, then the devices 32 will be located adjacent the other end of the billet. If however, the billet is, for example, longer than the previously heated billet, re-positioning of the devices 32 will be necessary and this is achieved by

manually-controlled extension of the ram 44 until the devices 32 are adjacent said other end of the billet.

Once the devices are correctly positioned, pressurised fluid is admitted to the cylinders 28 and 38a of the devices 22 and 32 respectively so that the billet is clamped at each end by the respective jaw members 24 and 34. Electrical power is then supplied to the jaw members 24 and 34 from the transformer to pass electrical current through the billet to heat the same.

The interval of time for which electrical power is supplied may be pre-set by a timer in dependence upon the length of the billet and the nature of the material thereof. Alternatively, a thermally-responsive switch device may be employed to sense the temperature of the billet and disconnect the current supply upon attainment of a pre-selected temperature.

When the billet has been heated to the desired temperature, the power supply is switched off and the lift rams 18 are retracted to transfer the heated billet onto the roller conveyor 16. Thereafter, said stop is retracted and the billet is transferred to another treatment zone, to the left of end column 10 as viewed in Figure 1, by the conveyor.

Where the billet is to be cropped into blanks for subsequent forging, a cropping mechanism, which may be of known type, will be located at the next treatment zone. Billet-cropping mechanisms are well-known in the art and description thereof is unnecessary here. Before the blanks are passed to forging apparatus, they may be further heated by, for example, electrical resistance heating. However, it is contemplated that the billets may be heated to a sufficiently high temperature by the apparatus described and that further heating prior to forging is rendered unnecessary.

Where the billet is to be rolled subsequent to heating, the next treatment zone may be constituted by rolling apparatus.

As the billets being heated will usually be of lengths within the range between 8 feet and 20 feet, they will not act as pure resistances but will have significant reactance. Thus, for maximum efficiency, provision is made for power factor control of the power supplied to the electrodes in order to maintain the power factor as close to unity as possible.

WHAT WE CLAIM IS:—

1. A method of cropping billets comprising the steps of making electrical connections at or adjacent opposite ends of a billet, heating the billet to an elevated temperature by electrical resistance heating using the billet as the resistance, disconnecting the said connections, and effecting cropping by a shear blade or blades.

2. A method as claimed in Claim 1

spacing between the electrode devices 22 and 32 may be varied.

Electrical power of one polarity is supplied from a suitable transformer (not shown) adjacent the end column 10 to the electrode devices 22 by a first pair of laminated electrically-conductive bus bar assemblies 50 (one only of which is seen in the drawings). Electrical power of the opposite polarity is supplied to the devices 32 by laminated, electrically-conductive bus bar assemblies 52 consisting of first sections 54 which are fixed, second sections 56, which are directly electrically-connected one to each jaw member 34 of the devices 32, and intermediate sections 58 and 60 which are jointed one to each section 54 and 56 and together. The sections 58 and 60 form knuckles one in each bus bar assembly 52 whereby the latter may be extended or retracted in response to movement of the electrode devices 32 with the main carriage 38. An additional wheeled carriage or carriages, such as that indicated by reference numeral 62 in Figure 1, may be provided to support the sections 54 and 56 adjacent their jointed connections with the sections 58 and 60.

The joints between the sections 54, 58, 60 and 56 are designed so as to provide good electrical continuity whilst permitting folding of the sections 58 and 60 relative to one another during extension and retraction of the assemblies 52. A suitable joint (not shown) comprises a headed pin passing through aligned apertures in the adjacent sections and Bellville washers located one on each side of the connected sections and stressed by a nut engaging with a threaded end portion of the pin, the extent of stressing being sufficient to urge adjacent faces of adjacent sections into good electrical contact with one another without providing excessive resistance to relative movement between the sections so connected. It will be appreciated that provision of suitable electrical insulation will be necessary to isolate the devices 22 and 32 from one another and the remainder of the apparatus.

Operation of the apparatus will now be described. A billet to be heated is transferred to the roller conveyor which is operated to feed the billet towards the column 10 until one end of the billet engages a stop (not shown) which is positioned to locate that end of the billet in predetermined relation to the devices 22. Upon engagement of the billet with the stop, the conveyor is disabled and the lift rams 18 are operated to raise the billet to the position 25a. If the billet is the same length as the billet previously heated, then the devices 32 will be located adjacent the other end of the billet. If however, the billet is, for example, longer than the previously heated billet, re-positioning of the devices 32 will be necessary and this is achieved by

manually-controlled extension of the ram 44 until the devices 32 are adjacent said other end of the billet.

Once the devices are correctly positioned, pressurised fluid is admitted to the cylinders 28 and 38a of the devices 22 and 32 respectively so that the billet is clamped at each end by the respective jaw members 24 and 34. Electrical power is then supplied to the jaw members 24 and 34 from the transformer to pass electrical current through the billet to heat the same.

The interval of time for which electrical power is supplied may be pre-set by a timer in dependence upon the length of the billet and the nature of the material thereof. Alternatively, a thermally-responsive switch device may be employed to sense the temperature of the billet and disconnect the current supply upon attainment of a pre-selected temperature.

When the billet has been heated to the desired temperature, the power supply is switched off and the lift rams 18 are retracted to transfer the heated billet onto the roller conveyor 16. Thereafter, said stop is retracted and the billet is transferred to another treatment zone, to the left of end column 10 as viewed in Figure 1, by the conveyor.

Where the billet is to be cropped into blanks for subsequent forging, a cropping mechanism, which may be of known type, will be located at the next treatment zone. Billet-cropping mechanisms are well-known in the art and description thereof is unnecessary here. Before the blanks are passed to forging apparatus, they may be further heated by, for example, electrical resistance heating. However, it is contemplated that the billets may be heated to a sufficiently high temperature by the apparatus described and that further heating prior to forging is rendered unnecessary.

Where the billet is to be rolled subsequent to heating, the next treatment zone may be constituted by rolling apparatus.

As the billets being heated will usually be of lengths within the range between 8 feet and 20 feet, they will not act as pure resistances but will have significant reactance. Thus, for maximum efficiency, provision is made for power factor control of the power supplied to the electrodes in order to maintain the power factor as close to unity as possible.

WHAT WE CLAIM IS:—

1. A method of cropping billets comprising the steps of making electrical connections at or adjacent opposite ends of a billet, heating the billet to an elevated temperature by electrical resistance heating using the billet as the resistance, disconnecting the said connections, and effecting cropping by a shear blade or blades.

2. A method as claimed in Claim 1



* C L M S *

wherein the billet is heated to a temperature within the range of 500° to 600°C.

3. A method as claimed in Claim 1 wherein the billet is heated for a predetermined interval of time.

4. Apparatus when used in the cropping of metal billets comprising electrical resistance heating means adapted for connection to opposite ends of the billet, a cropping mechanism and means for conveying heated billets from the heating means to the cropping mechanism.

5. Apparatus as claimed in Claim 4 including means for sensing the temperature of a heated billet and operable to terminate supply of electrical power to said heating means.

6. Apparatus as claimed in Claim 4 including pre-settable timing means operable to terminate supply of electrical power to said heating means after the elapse of a pre-selected time interval from commencement of heating.

7. Apparatus when used in the method of Claim 1 comprising a billet cropping mechanism and electrical resistance heating apparatus for heating billets, comprising a billet-supporting structure, first and second electrode means spaced apart longitudinally of the billet-supporting structure and first and second electrical conductors respectively connected to said first and second electrode means and connected or connectable to different phase or opposite polarity outputs of a source of electrical power, said electrode means being movable relative to one another to vary the spacing therebetween and at least one of the conductor means being jointed to permit extension and retraction thereof in response to variation of the spacing between said electrode means.

8. Apparatus according to Claim 7 including a conveyor extending between the resistance heating apparatus and said cropping mechanism for transferring heated billets from the resistance heating apparatus to said mechanism.

9. Electrical resistance heating apparatus for heating billets, comprising a billet-supporting structure, first and second electrode means spaced apart longitudinally of the billet-supporting structure and first and second electrical conductors respectively connected to said first and second electrode means and connected or connectable to different phase or opposite polarity outputs of a source of electrical power, said electrode means being movable relative to one another to vary the spacing therebetween and at least one of the conductors being jointed to permit extension and retraction thereof in response to variation of the spacing between said electrode means.

10. Apparatus according to Claim 9

wherein one of the electrode means is fixed and the other electrode means is movable relative thereto longitudinally of the billet-supporting structure.

11. Apparatus according to Claim 10 wherein said other electrode is mounted on a carriage guided on a track and means are provided for moving said carriage along the track towards and away from said one electrode.

12. Apparatus according to any one of Claims 9 to 11 wherein said billet-supporting structure includes a conveyor for positioning a billet supported thereby relative to one of said electrodes.

13. Apparatus according to Claim 12 including means for sensing movement of a billet by said conveyor into a predetermined position relative to said one electrode prior to heating and operable to disable the conveyor in response to such positioning of a billet.

14. Apparatus according to any one of Claims 9 to 13 wherein each electrode means comprises a pair of electrode members disposed one on each side of the location occupied by a billet in use, the electrode members being movable towards and away from one another to respectively grip a billet therebetween and release the same after heating has been terminated.

15. Apparatus according to any one of Claims 9 to 14 wherein the billet-supporting structure includes means for lifting a billet supported thereby to a level at which the electrode means are disposed.

16. Apparatus according to Claim 10 or any one of Claims 11 to 15 as appendant to Claim 10 wherein the electrical conductor or conductors connected to said other electrode means comprises an assembly of electrically-conductive bars which are so jointed that at least some of the bars fold with respect to one another during movement of said other electrode means.

17. Apparatus according to any one of Claims 9 to 17 wherein the supply of electrical power to said electrode means is governed by a timer or a thermally-responsive device which is arranged to sense, in use, the temperature of a billet being heated.

18. A method of cropping billets according to Claim 1, substantially as hereinbefore described.

19. Electrical resistance heating apparatus when used in the method of Claim 1, substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

20. Electrical resistance heating apparatus substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.



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