Aug. 25, 1959 P. W. KLOOZ 2,901,583

FORGING APPARATUS AND STOCK WARMING MEANS THEREFOR

Filed Aug. 17, 1956 2 Sheets-Sheet 1

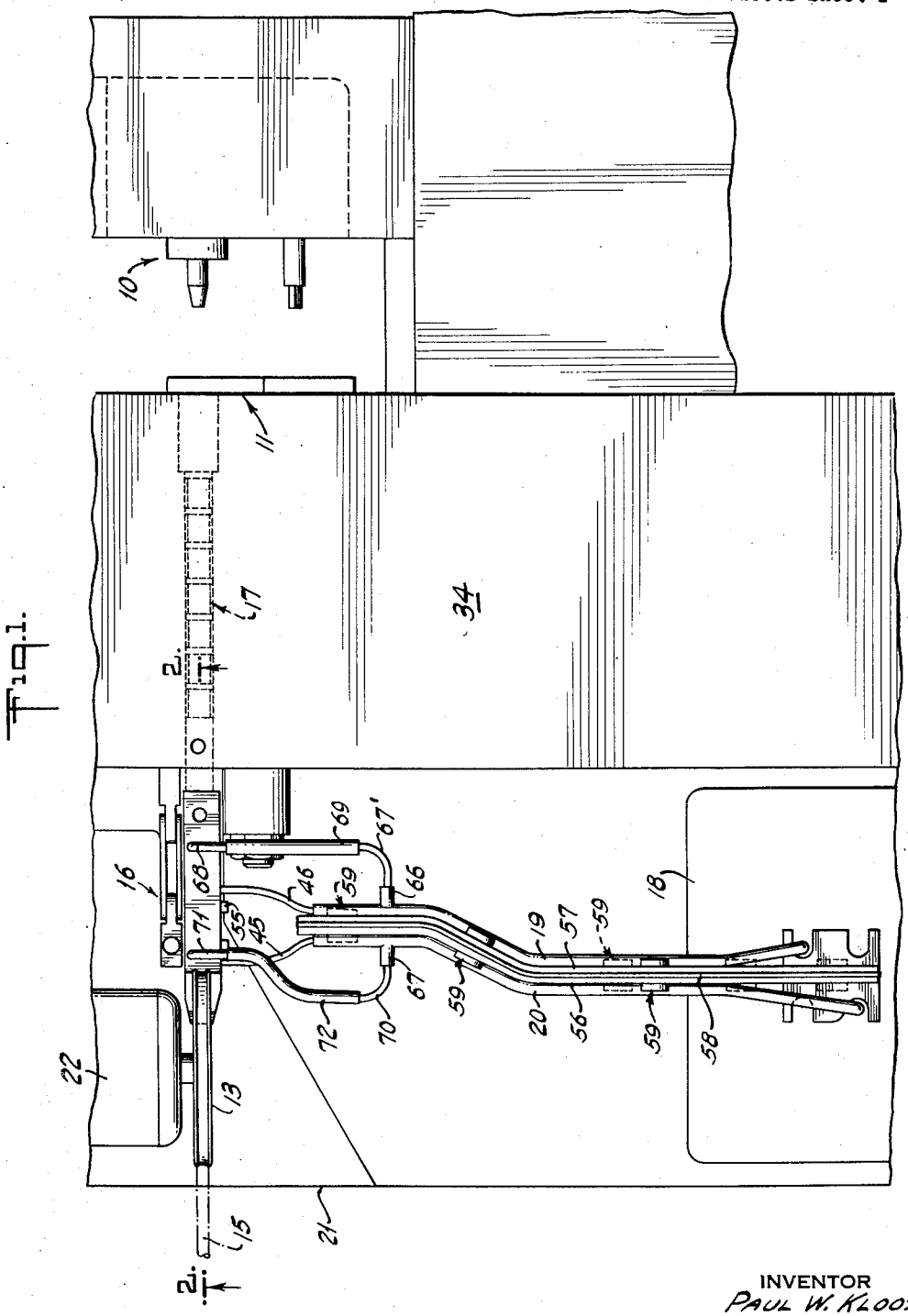


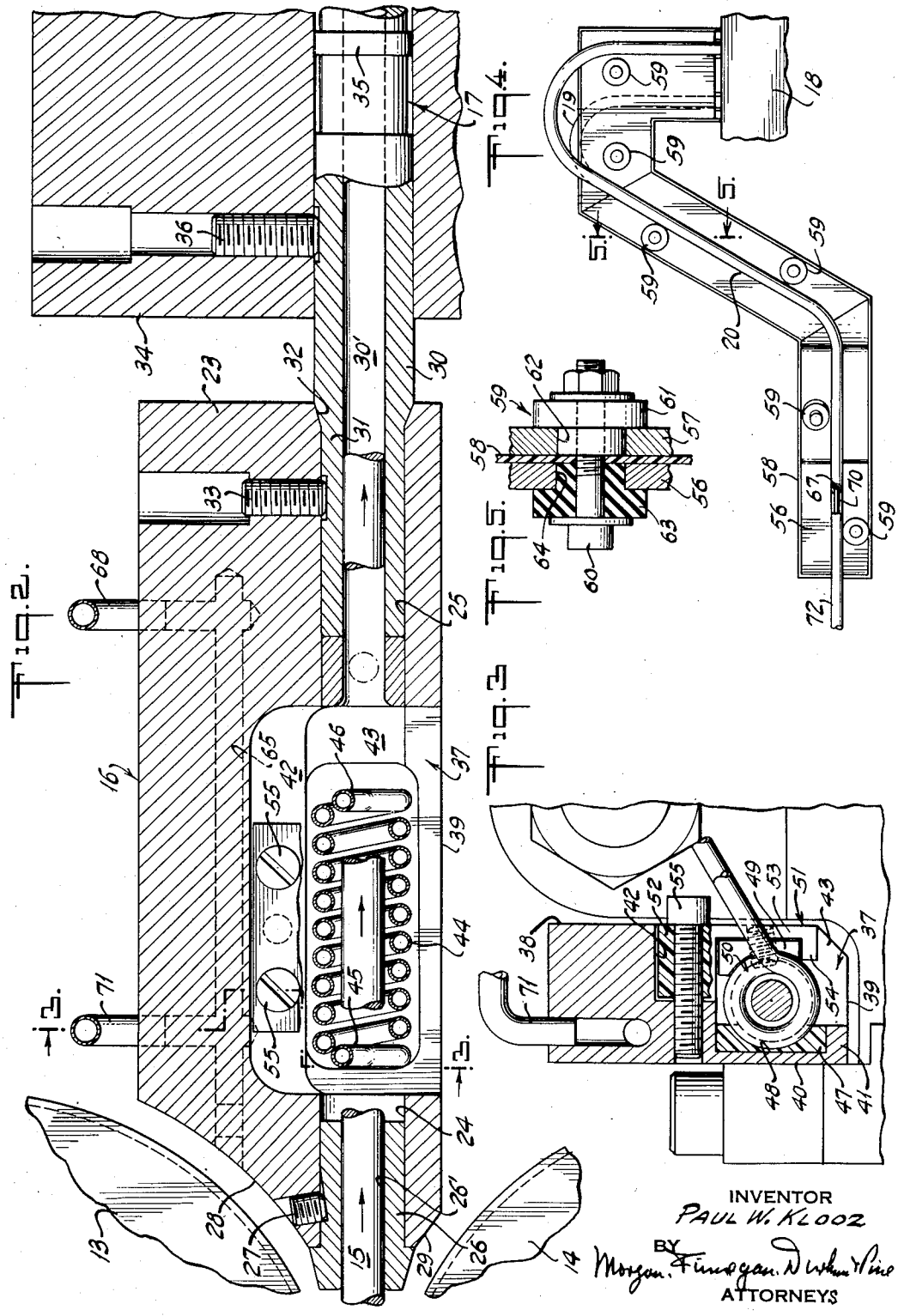
Fig. 1.

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2,901,583

FORGING APPARATUS AND STOCK WARMING MEANS THEREFOR

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9 Claims. (Cl. 219—10.49)

This invention relates to metal forming and more specifically to an improved method and apparatus for heat treating metal wire and rod stock immediately prior to the forming operations.

In the fabrication of metal parts such as screws, bolts, rivets, pins and the like, steel or other alloy in the form of wire or rod is fed to forming apparatus frequently referred to as a header. The wire or rod is severed into predetermined lengths and the header forges each severed length of rod or wire to provide an article of a desired shape and configuration. In the case of a bolt or screw, the articles would be provided with an elongated shank and an enlarged head of the desired outer contour which may include slots or depressions. The heading operation according to known processes is performed in several stages and with cold forging processes it has been necessary to perform the heading operation in three or more steps with the partially formed blanks being annealed between each step to relieve stresses and strains and soften the material for the next operation. Annealing of the blanks between forging operations has also been found necessary in order to prevent fracturing of the material and obtain even reasonable life from the forging dies.

In some cases a so-called progressive method of forging or heading is employed which provides for the completion of heading operation in as many as four or five gradual steps. This procedure however not only involves considerable added expense in the provision of the relatively large member of dies and punches and a relatively complicated machine for automatically performing many heading operations, but the rate of production is low and the quality of the resultant product is below acceptable standards.

It has been found that with the present invention the difficulties encountered with prior methods of forging articles from metal rod and wire are substantially completely overcome with the result that high quality articles can be fabricated at a more rapid rate and at the same time the life of the dies as compared with prior methods is greatly extended.

Another object of the invention resides in the provision of an improved method and apparatus for treating the metal rod and wire stock immediately prior to the heading operation and at the same time accurately coordinating the treatment with the characteristics of the heading operation so that the severed piece being formed by the header will attain an optimum forming temperature. This is accomplished through the coordination of the temperature changes in the metal blanks during the heading operation with the heat imparted to the rod or wire just prior to the heading operation in such a manner that the temperature attained by the formed blank during the heading operation will be maintained within a range that will prevent fracturing or rupturing of the metal. At the same time the blank is maintained in a warmed state that will enable the heading or forming to be accomplished in materially fewer steps than has heretofore been required. In most cases it has been found that a so-called two-blow header for performing the heading operation in two steps can be used to produce high quality metal articles and at the same time provide long die life and a higher rate of production.

Another object of the invention resides in the provision of novel and improved warming or heating means for wire and rod stock that will provide a substantially fool-proof and dependable device for maintaining the temperature attained by the blank during the heading operation within predetermined limits.

A still further object of the invention resides in a novel and improved method for heat treating wire and rod stock preparatory to the forging of articles therefrom.

A still further object of the invention resides in improved heating apparatus for rod stock having means for selectively heating discrete portions of the stock particularly in instances wherein the stock is provided with an intermittent feed. It has been found that by producing predetermined temperature gradients in the stock and coordinating these gradients with the lengths of stock to be severed for the forming operation it is possible to provide accurate control over the resultant maximum temperature attained by the metal during the actual heading operation. In this way the heading operation can be performed more quickly and easily and at materially reduced costs.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the steps, construction, combination of elements, process and arrangement of parts which will be exemplified in the construction and process hereafter set forth and the scope of the application of which will be indicated in the appended claims.

In the drawings:

Fig. 1 is a fragmentary and partially diagrammatic plan view of heading or forging apparatus embodying the invention;

Fig. 2 is a cross sectional view of the warming apparatus of Fig. 1 taken along the line 2—2 thereof;

Fig. 3 is a cross sectional view taken along the line 3—3 of Fig. 2;

Fig. 4 is a side view of the conductors and the supporting means therefor supplying an electrical energy to the heating means and taken in the direction of the arrow 4 of Fig. 1;

Fig. 5 is a cross sectional view of Fig. 4 taken along the line 5—5 thereof.

This application constitutes a continuation in part of U.S. patent application, Serial No. 515,709 filed June 15, 1955 entitled Method and Apparatus for Cold Forging.

The invention more specifically concerns the provision of improved method and apparatus for warming or heating metal wire and rod stock immediately prior to the severance of the stock into pieces of predetermined length to be forged by heading apparatus. The heating means is arranged and coordinated with the stock severing means and heading apparatus so that each piece or blank will attain a predetermined temperature upon severance and immediately prior to the heading operation. The control of the temperature in this way is accomplished by improved apparatus preferably embodying a high frequency heating coil spaced a distance from the heading apparatus governed by the length of the pieces to be severed and coordinated relative to the severing means so that the temperature of each length of stock just prior to severance will lie within predetermined limits. The control of the temperature is accomplished by an improved heating unit

and transfer means for guiding the heated rod to the heading apparatus.

Referring now to Fig. 1 there is illustrated diagrammatically a forming machine including the forming apparatus generally denoted by the numeral **10**, rod or wire cut off means **11**, a pair of feed rollers **13** and **14** for feeding a rod or wire **15** to the cutter **11** and forming apparatus **10**, heating means **16** disposed between the rollers **13** and **14** and the cutter **11** and means in the form of a quill **17** for guiding the heated rod from the heater **16** to the cutter **11**. The heating means **16** includes a coil preferably of copper tubing or the like energized by high frequency generating means **18** through a pair of insulated conductors **19** and **20**.

The forming apparatus **10** may be of any suitable construction, as for example, the apparatus shown in a prior patent to Purtell No. 2,236,733 issued in 1941.

In the illustrated embodiment of the invention the driving or feed rolls **13** and **14** are supported by the frame **21** and powered by suitable intermittent drive means **22**. The heating means **16** is disposed between the feed rolls **13** and **14** and the cutter **11** and is preferably coordinated with the cutter **11** so that heat is applied substantially uniformly to successive discrete portions of the stock **15** that ultimately form independent pieces or blanks upon severance by the cutter **11**. The stock **15** upon being heated is fed to the cutter **11** by the guide or quill **17** which shields the heated stock to restrict heat dissipation and is arranged with relatively narrow supporting surfaces to reduce the loss of heat through direct conduction to the machine frame.

The heating means **16** and the guiding means **17** are illustrated more clearly in Figs. 2 and 3 of the drawings. With reference to the heating means **16**, it includes an elongated housing **23** of generally rectangular configuration and has a pair of aligned openings **24** and **25** through which the stock **15** passes. The opening **24** includes a bushing or die **26** adapted to slidably accommodate the particular size of wire or rod being used to fabricate the finished articles. This die may be held within the opening **24** by a set screw **27** or other suitable means. In order to obtain a more dependable and reliable feed for the rod **15** the housing **23** is tapered as indicated at **28** and **29** to conform roughly with the radii of the feed rolls **13** and **14**. The outer end of the die **26** is also tapered so that the distance between the point of contact of the stock **15** with the feed rollers and the face of the die **26** can be maintained as short as possible.

The opening **25** in the housing **23** is arranged to accommodate an elongated bushing **30**, the latter having a section **31** of reduced diameter and a tapered portion **32** for reception by the housing **23** to limit the innermost position of bushing **30** with reference to the housing. The bushing **30** is held in the housing **23** by a set screw **33** or other suitable means. The central opening **30'** within the bushing **30** is aligned with the opening **26'** in the bushing **26** to avoid unnecessary deflection of the stock **15** in its passage through the housing **23**.

The quill or guide **17** is supported by the frame member **34** in any suitable manner and is provided with a plurality of outwardly extending circumferential ridges **35** by which it is mounted in poor thermal contact with frame **34** and quill **17** is provided with a smooth interior to accommodate the particular size of stock being fed to the header **10**. The quill **17** is preferably formed of a material having relatively low heat conductivity such as stainless steel or the like. In order to align accurately the opening **30'** of the bushing **30** with the opening in the quill **17** the frame **34** is arranged to receive the right hand end of the bushing **30** as illustrated in Fig. 2 and the bushing is locked in the frame member **34** by means of a set screw **36**.

Referring again to the heating means **16** and more specifically the housing **23**, the latter is provided with a recess **37** disposed between and in effect intercepting the openings **24** and **25**. The recess **37** is formed in both the front and bottom walls **38** and **39** respectively of the block or housing **23** and extends beyond the openings **24** and **25** to leave a narrow downwardly extending rear wall portion **40** and a narrow bottom flange **41** originally constituting part of the bottom wall **39**. The upper portion **42** of the recess **37** is somewhat shallower than the lower portion **43**. As will be shown, the recessed part **43** is arranged to accommodate the heating element while the recessed part **42** accommodates means for holding the heating element within the recess **43**.

While the actual heating means may take any desired form, in the illustrated embodiment of the invention, it is in the form of a helical tube **44** with the ends **45** and **46** being connected with the hollow conductors **20** and **19**, respectively. Although the coil is illustrated in an uncoated form, it may include a coating of a relatively rigid heat resistant, electrically insulating material such as a ceramic coating, to afford additional mechanical and electrical protection. The D.-C. resistance of the coil **44** is substantially zero and it is fed by high frequency energy. Accordingly the number and diameter of the turns forming the coil must be accurately coordinated with the frequency of the generator **18** so that the coil, with the stock **15** extending therethrough, will present the desired inductance to the generator **18** in order that the generator may impart power to the coil.

It is preferable to coordinate the position of the coil **44** with reference to the cutter **11** so that a predetermined temperature can be produced within the rod **15**. For this purpose the recess **43** is made slightly longer than the coil **44** so that the latter can be moved longitudinally thereof. An improved support adjustably holds the coil within the recess and in alignment with the openings in the bushing **26** and **30**. Through an improved arrangement of elements, the coil support affords air cooling for the coil, reduces heat conduction to the housing **23** and facilitates removal of the coil from the housing or block **23** for repair or replacement.

The inner coil support is in the form of an elongated plate **47** of heat resistant insulating material that rests firmly against the back wall **40** of the recess **43** and is held in place by the lip or flange **41**. The exposed side of the plate **47** is provided with a cylindrical concave recess **48** for receiving the inner side of the coil **44**. A second plate **49** of insulating material also has a cylindrical concave recess **50** for engaging the outside of the coil **44** as illustrated in Fig. 3. The two plates **47** and **49** together with the coil **44** supported therebetween are held in the recess by an outer bracket member generally denoted by the numeral **51**. The upper portion **52** of this bracket member, also formed of insulating material, is generally rectangular in section and is adapted to be received within the recess part **42**. The lower portion of the bracket member **51** is in the form of a depending skirt **53** having an inwardly formed flange **54** on the bottom thereof to engage and hold the plate **49**. The bracket member **51** is secured to the housing **23** by a pair of cap screws **55** extending through the bracket part **52** and threadably received in cooperating openings in the housing **23**. With this arrangement the coil **44** can be displaced longitudinally within the recess **43** and the cylindrical concave recesses in the plates **47** and **49** will hold all of the turns of the coil **44** in precise alignment with the openings in the bushings **26** and **30**. Moreover by supporting the coil in this way an air space is provided above and below the coil so that the coil is not only rigidly supported at all times but maximum ventilation is provided for cooling. In supporting the coil **44** within the recess **43** it is desirable to provide, in addition to the required electrical insulation, heat insulation to prevent the direct conduction of heat into the housing or block **23**. While any suitable insulating material may be utilized for this purpose, it is preferable to form the plates **47** and **49** together with the bracket member **51**

of a rigid insulating material comprising asbestos and a suitable binder. A material of this character is presently manufactured under the trade name "Transite."

The supporting means for the conductors **19** and **20**, connecting the high frequency generator **18** with the coil **44**, is shown in Figs. 4 and 5. This supporting means is in the form of a pair of plates **56** and **57** separated by a layer of insulating material **58** of Transite or the like. The conductor **20** is welded or otherwise suitably secured to the plate **56** while the conductor **19** is similarly attached to the plate **57**. The plates **56** and **57** together with the intervening insulating material **58** are secured one to the other by means of a plurality of connectors generally denoted by the numeral **59**. Each connector includes a central bolt **60**, a centering washer **61** for engaging a cooperating opening **62** in the plate **57** and a second centering washer **63** for engaging the cooperating opening **64** in the plate **56**. The insulating material **58** is drilled to receive the bolt **60** which secures the assembly together. With the foregoing arrangement the plates **56** and **57** are electrically coupled to the conductors **19** and **20** and are insulated one from the other. Thus the plates form a condenser in parallel with the coil and form part of the resonant circuit which includes the heating coil.

It has been found that in order to control the precise temperature of the rod **15** and to insure the attainment of a predetermined temperature of each severed piece, it is important to prevent the accumulation of heat in the housing **23** and to transfer the heated wire or rod stock to the cutter **11** as rapidly as possible to minimize the loss of heat through radiation and conduction. For this purpose a suitable coolant is circulated through the conductors **19** and **20** to cool the coil **44** and a portion is diverted through a passage **65** in the housing **23**. Diversion of a part of the coolant is accomplished by the use of a pair of T-connectors **66** and **67** inserted in series with the conductors **19** and **20**. The T-connector **66** is connected to one end of the passage **65** by means of conduits **67'** and **68** and an intervening conduit **69** of insulating material. The T-connector **67** is similarly coupled to the other end of the passage **65** by conduits **70** and **71** and an intervening conduit **72** of insulating material. The circulation of the coolant through the passage **65** maintains the housing **23** at the desired temperature and with intermittent forward motion of the stock **15** in the direction of the arrows as shown in Fig. 2, little or no heat will be imparted to the stock before the actual heating operation. In this way a predetermined temperature can be maintained in the stock **15** as it passes through the bushing **30**. In order to effect the desired cooling of block **23**, it is preferable to form it of aluminum, copper or other suitable material having a relatively high rate of heat conduction.

In order to minimize the loss of heat in the rod or stock **15** after leaving the coil **44**, the quill **17** previously described is preferably formed of stainless steel or other similar material having relatively low heat conductivity. It is also desirable to provide supporting ridges **35** which may be integral with the quill **17** and formed of stainless steel or other metal having a relatively low heat conductivity. In addition the coil **44** is placed relatively close to the cutter **11** so that in the normal operation of the machine each successive portion of the stock **15** arrives at the cutter **11** within a few seconds, at most, after leaving the coil **44**.

With the invention as described above and with a two blow header **10**, the stock is preferably heated to a temperature of at least 150 to 200 degrees. This temperature is accurately controlled and the successive portions of the stock **16** will arrive at the cutter at approximately the same temperature. By reason of this relatively small amount of heat imparted to the stock **15**, the temperature of the severed blanks upon being worked by the header will rise to about 450 to 650 degrees Fahrenheit. It is preferable, however, to adjust the temperature imparted by coil **44** to the particular type of stock being worked so that the resultant temperature of the articles will be in the vicinity of 500 to 600 degrees, and not exceeding 650 degrees Fahrenheit. This temperature has been generally found to be most desirable when working steel and other similar alloys, though the preferred temperature range may vary for different alloys. The resultant temperature of the articles being formed directly depends upon the heat applied to the article immediately prior to the forming operation, and, after the elements of the machine have attained normal operating temperature, a temperature of 500 to 600 degrees in the finished articles will be automatically maintained. By controlling the temperature of the stock being formed in this way the material is maintained in a condition that will greatly facilitate forging by the headers with the result that exceedingly long die and punch life are obtained. At the same time critical temperatures of the stock are not exceeded and fractures or ruptures of the material are completely avoided.

In certain instances the entire heading or forming operation may be carried out in a single step. In this case it is desirable to preheat the stock **15** to a temperature of 250 to 400 degrees Fahrenheit depending on the nature of the heading operation. This temperature is adjusted to provide a resultant temperature in the forged article in the range of 500 to 600 degrees Fahrenheit as in the case with the two stage operation.

While only one embodiment of the invention has been illustrated and described, it is apparent that modifications, alterations and changes may be made without departing from the true scope and spirit thereof.

What is claimed is:

1. Apparatus for warming wire and rod stock comprising an elongated cooled block of energy absorbing material including an opening extending therethrough for slidably receiving said stock, said block further including a central recess formed in one wall with a length less than said block, said recess intercepting a portion of the length of said opening, an induction heating coil within said recess formed of a plurality of spaced turns of an electrically conductive material, a plate of insulating material within said recess and having a shallow concavity therein for partially receiving one side of said coil, a second plate of insulating material having a concavity therein for at least partially receiving the opposing surface of said coil, and means for holding said plate of insulating material and said coil within said recess with the axis of the coil substantially coincident with the axis of said opening.

2. Apparatus according to claim 1 wherein said coil is coated with relatively rigid, heat-resistant, electrically-insulating material.

3. Apparatus for warming wire and rod stock comprising a generally rectangular cooled metal block having a longitudinal opening extending therethrough for slidably receiving the stock to be warmed, said block further including an elongated recess therein encompassing at least part of two adjoining surfaces of said block and intercepting an intermediate portion of said opening to form a pair of spaced aligned stock-guiding openings, a helical induction heating coil within said recess, an insulating plate of heat resistant material in said recess having a concavity in one surface thereof for at least partially receiving said heating coil, a second insulating plate of heat resistant material having a concavity on one side thereof for at least partially receiving the other side of said coil, and insulating means secured to said block and engaging at least one of said insulating plates for securing both plates and said coil within the recess with the axis of said coil in substantial alignment with the axis of the aligned openings.

4. Apparatus according to claim 3 wherein said metal block includes means for circulation of a coolant there-

through and stock guiding and aligning bushings are carried by said aligned openings extending from each end of said recess.

5. Apparatus according to claim 3 wherein said insulating plates and said insulating means are formed of a rigid electric and heat insulating material containing asbestos and a binder.

6. Apparatus for warming wire and rod stock comprising a generally rectangular metal block having a longitudinal opening extending therethrough for slidably receiving the stock to be warmed, said block further including an elongated recess therein encompassing at least part of two adjoining surfaces of said block and intercepting an intermediate portion of said opening to form a pair of aligned openings, a helical heating coil within said recess, an insulating plate of heat resistant material in said recess having a concavity in one surface thereof for at least partially receiving said heating coil, a second insulating plate of heat resistant material having a concavity on one side thereof for at least partially receiving the other side of said coil, insulating means secured to said block and engaging at least one of said insulating plates for securing both plates and said coil within the recess with the axis of said coil in substantial alignment with the axis of the aligned openings, an elongated tubular stock guide extending from said block and in the direction of the stock feed, said guide having a plurality of spaced narrow ribs and guide supporting means engaging said ribs.

7. In apparatus for warming wire and rod stock having spaced stock feeding and cutoff means, stock heating and guiding means between said feeding and cutoff means comprising induction heating means surrounding said stock, a shield at least partially surrounding said heating means restricting the flow of air about the last said means and formed of material absorbing electrical energy emitted by said heating means and heat radiation, means on said shield for removing heat generated therein to minimize heat radiation from said shield to said stock and stock guiding means surrounding said warmed stock and extending from said shield to said cutoff means, said stock guiding means being formed of a low heat conductivity material.

8. In apparatus for warming wire and rod stock having spaced stock feeding and cutoff means, said apparatus further including induction heating means surrounding said stock between the feeding and cutoff means, a shield of energy absorbing material about said heating means and including cooling means restricting radiation of heat from said shield to said stock, and second shielding means of low heat conductivity material between the first said shield and said cutoff means, said shielding means minimizing air circulation about said stock and heating means and reciprocal temperature influences of said apparatus and stock one on the other.

9. In apparatus for warming wire and rod stock having spaced stock feeding and cutoff means, stock heating and guiding means between said feeding and cutoff means comprising induction heating means surrounding said stock, a shield at least partially surrounding said heating means restricting the flow of air about the last said means and formed of material absorbing electrical energy emitted by said heating means and heat radiations, means on said shield for removing heat generated therein to minimize heat radiation from said shield to said stock and stock guiding means surrounding said warmed stock and extending from said shield to said cutoff means, said stock guiding means being formed of a low heat conductivity material and having an elongated, tubular configuration with a plurality of spaced ribs on the outer surface thereof, said ribs forming the support for said tubular member in said apparatus to limit the transfer of heat between said stock guiding means and said apparatus.

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