

Sept. 22, 1925.

O. H. DE LAPOTTERIE

1,554,336

METAL ARTICLE

Filed April 17, 1920

5 Sheets-Sheet 1

FIG. 1

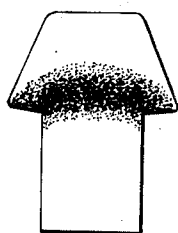


FIG. 2



FIG. 3

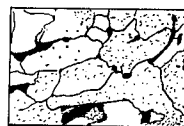


FIG. 4

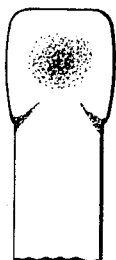


FIG. 5

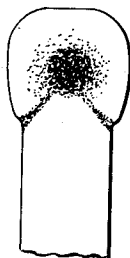


FIG. 6

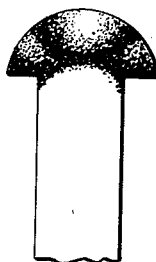


FIG. 7

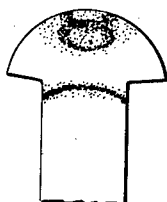


FIG. 8.

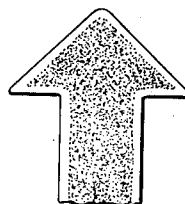
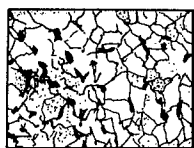


FIG. 9.

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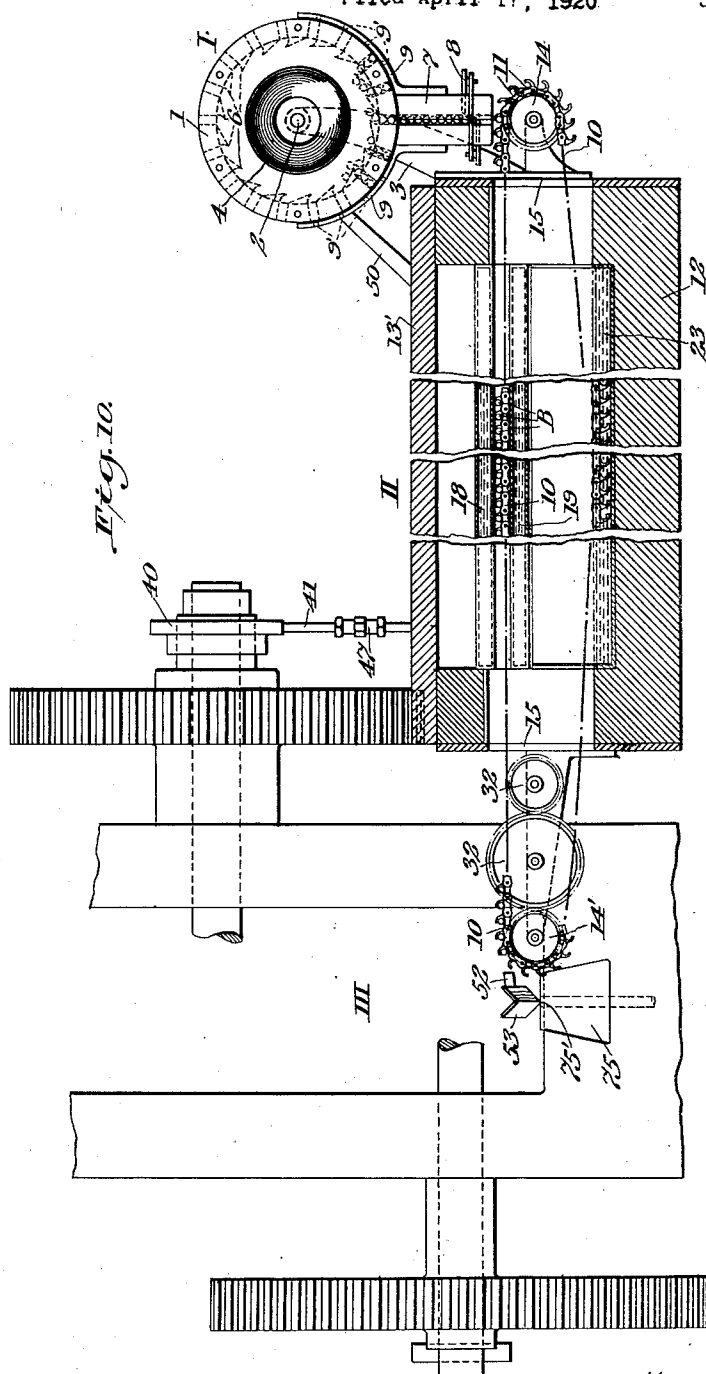
1,554,336

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METAL ARTICLE

Filed April 17, 1920

5 Sheets-Sheet 2



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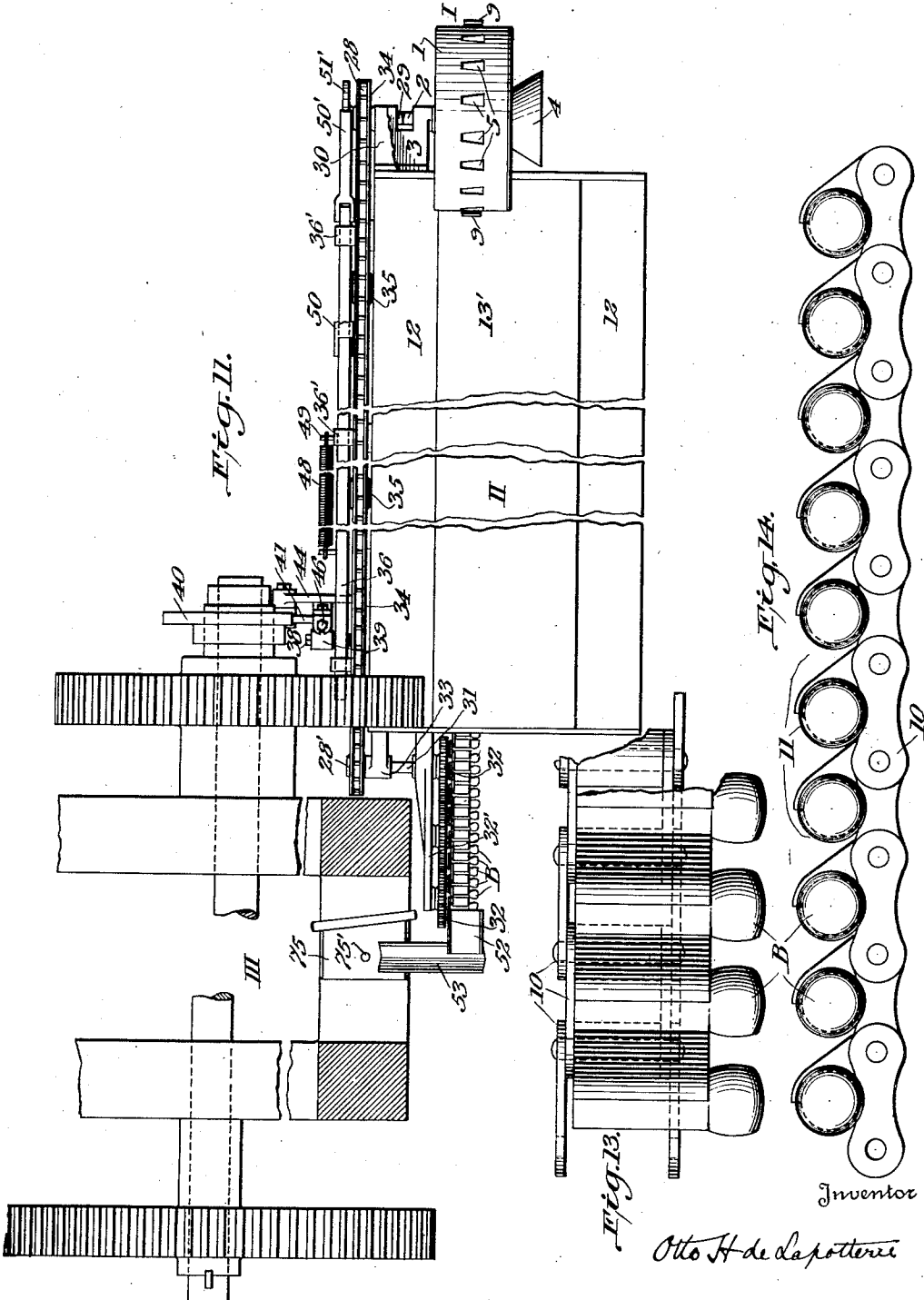
Sept. 22, 1925.

O. H. DE LAPOTTERIE
METAL ARTICLE

1,554,336

Filed April 17, 1920

5 Sheets-Sheet 3



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Sept. 22, 1925

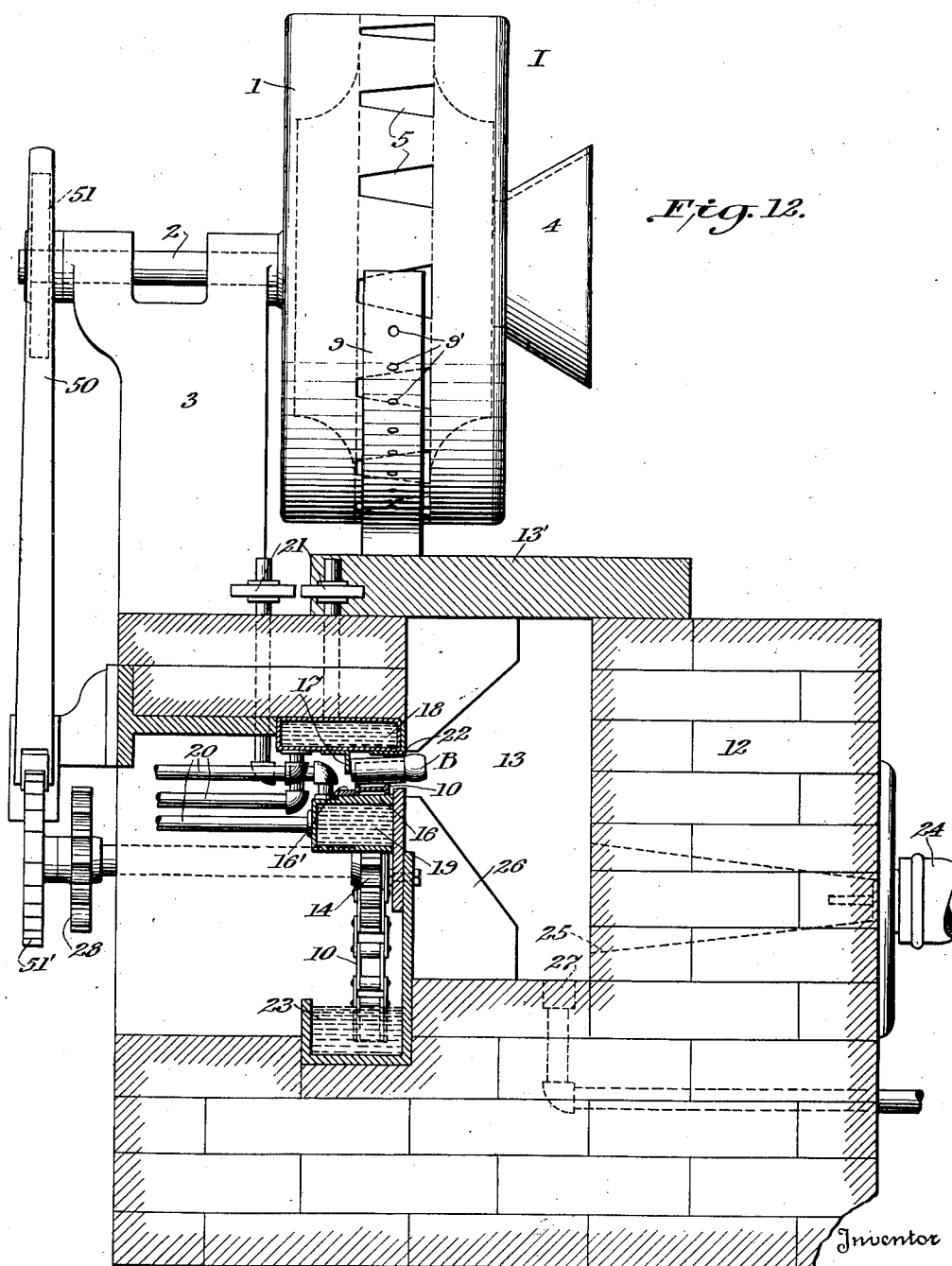
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1,554,336

METAL ARTICLE

Filed April 17, 1920

5 Sheets-Sheet 4



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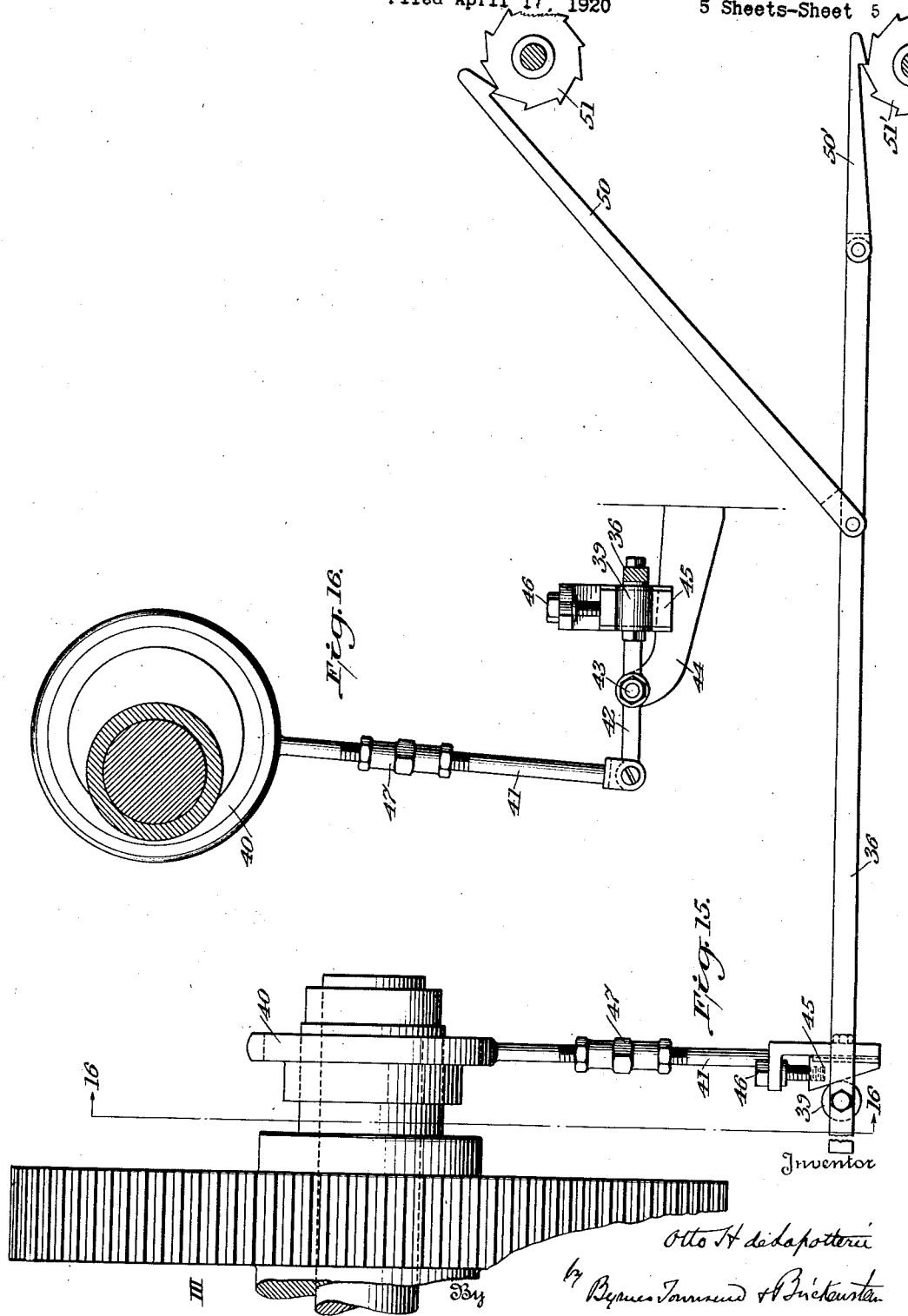
O. H. DE LAPOTTERIE

1,554,336

METAL ARTICLE

Filed April 17, 1920

5 Sheets-Sheet 5



Patented Sept. 22, 1925.

1,554,336

UNITED STATES PATENT OFFICE.

OTTO H. DE LAPOTTERIE, OF KENT, OHIO, ASSIGNOR TO ROY H. SMITH, OF KENT, OHIO.

METAL ARTICLE.

Application filed April 17, 1920. Serial No. 374,603.

To all whom it may concern:

Be it known that I, OTTO H. DE LAPOTTERIE, a citizen of the United States, residing at Kent, in the county of Portage and State of Ohio, have invented certain new and useful Improvements in Metal Articles, of which the following is a specification.

This invention relates to making headed ferrous metal articles from blanks whose heads only are heated to a forging temperature.

The invention has for one purpose, the development of a new article of manufacture, i. e. a headed ferrous metal article having a smooth accurately finished shank of predetermined shape and gauge, such as results from cold-drawing or forging, the head of the article being free from detrimental crystal formations or other defects which tend to cause snapping off of the heads of such articles.

The invention also comprises a method for forming articles of the kind above referred to, which method comprises accurately drawing or forging stock intended for the headed articles to the predetermined diameter desired for the shank of such an article; severing from such stock cold a blank and enlarging the head by forging; then carrying the thus formed blanks through a heating zone in such a manner that the partly formed head or enlarged portion protrudes into such zone; the shank portions of such blanks being refrigerated or kept cool while the head portion travels through the heating zone; so regulating the time and speed of travel of the partially headed blanks through said heated zone to certainly eliminate any detrimental crystal formation due to the cold forging of the head portion; and then forming the head by hot forging.

While it is primarily the object of the invention to make by the combination of cold drawing and hot forging, ferrous metal articles such as push rod pins, knuckle pins, clevis pins, yoke pins, and numerous similar headed articles which because of accuracy required or because the metal does not lend itself to cold forging without detrimental results, are now turned from full diameter stock, I do not wish to be understood as limiting myself to such articles; as it is self-evident that any headed ferrous metal article; whether of finished shape or to be further treated, comes within the limit

of my invention. Nor is my invention limited to articles of iron or steel, as it may be applicable to other metals having like properties.

I have discovered that the cold forging to form the heads of articles of the kind described if carried to the extent of producing a finished head produces or tends to produce a zone of distortion or crushing strain in such head, together with the formation of a crystalline structure particularly in the top portion of the head and along the plane or zone at which the head joins the shank.

The discovery of this crystal formation of ferrous headed articles, I believe explains for the first time in the history of the art the heretofore unaccounted for reasons for the heads of such articles often snapping off in commercial practice.

These difficulties are entirely eliminated by my invention, which also relates to a suitable apparatus for carrying out the method above described.

The invention will be understood from the accompanying specification and drawings in which—

Figure 1 is a diagrammatic representation of the appearance of a polished and etched cross section of a cold headed ferrous article.

Fig. 2 is a rough representation of the appearance of the grain structure in the center of the distorted zone shown in Fig. 1, as shown by a microphotograph with a magnification of 150 diameters;

Fig. 3 is a similar representation of a microphotograph on the same scale showing the original grain structure of the blank before heading;

Figs. 4 and 5 illustrate the blank having its head portion enlarged by successive operations, to form a partial head;

Fig. 6 is another showing of the appearance, as photographed, of a polished and etched cross-section of a ferrous article, which has been headed by cold forging. The shaded portions indicate the zones of distortion strains;

Fig. 7 represents the appearance of an article, such as shown in Fig. 6, after it has been annealed or heat treated and allowed to cool. The shaded portions are an attempt to show the zones of crystal formation, which result from this treatment;

Fig. 8 is a representation of the appearance of a polished and etched cross section of a headed ferrous metal article made ac-

cording to my new method, the shank having been cold drawn or forged to the finished diameter and the head forged above 1300° F., the head being free from the dark zone of distortion shown in Fig. 1 and the weakening crystal formation, shown in Fig. 7;

Fig. 9 is an attempt to show the appearance of a microphotograph, magnified to 150 diameters, of the grain structure in the center of the head of the article shown in Fig. 8, just above the line where the hot forged head joins the cold shank, showing the grains to be free of the flattening or compression effect as shown in Fig. 2. The actual photograph shows the effect of hot forging readily recognizable to those skilled in the art;

Fig. 10 is an elevation of the apparatus which may be used, parts being shown in section;

Fig. 11 is a plan of Fig. 10; and

Fig. 12 is a vertical section;

Figs. 13 and 14 are fragmentary views, in plan and elevation respectively, of the blank carrier chain;

Fig. 15 is an elevational view on an enlarged scale of intermittent motion mechanism;

Fig. 16 is a section taken on line 16—16, Fig. 15.

The method of operation is as follows: Ferrous metal stock of suitable size, which is usually round rod or bar steel which does not lend itself to cold forging without developing detrimental defects is taken as finished on a hot rolling mill and cleaned by pickling in a hot dilute solution of sulphuric acid to remove the scale resulting from hot rolling.

It is then washed, limed, and baked in the usual manner to neutralize the acid action; after which, it is taken to a draw bench or block and drawn through dies to the finished size required for the shank of an article. The size of die, the speed of drawing and the size of stock, are regulated to condense the surface of the metal and cause a skin effect which better enables the article to withstand the wear and tear of service.

The stock after being drawn as above described is fed into one of the well known types of continuous automatic cold heading machines where it is cut and formed cold into blanks of desired length, and has the portion intended for the head of the article swelled or enlarged in a manner shown in Figs. 4 and 5, care being taken not to develop too great a zone of strain or distortion, as I have discovered that strains or distortion of such degree develop the dangerous lines of detrimental crystal demarcation shown in Fig. 6 and Fig. 7.

This enlarging to a limited degree by cold forging of the portion of a blank intended to be hot forged into the head of an article,

is, to the best of my knowledge and belief, original with me and forms an important part of the invention because: (1) the pressure necessary to enlarge the head portion of a blank accurately straightens the shank portion thereof by forcing it to the true bore of the holding or gripping die; (2) this enlarging of the portion of a blank by cold forging prior to hot heading, I have discovered is necessary to assure centering of hot forged heads on the relatively cold shanks of headed metal articles. Failure to so enlarge the head portions of the blanks prior to hot forging of heads thereon will result in products lacking commercial value as it will be found that more heads will be off than on center when this preliminary enlargement is not resorted to.

An important part of my invention is that the arrangement of the mechanism of the heading machine, the heating apparatus, and the automatic cut off of the hopper chute, hereinafter described, are all interdependently so designed, adjusted and timed that with a given temperature maintained in the heating zone through which the blanks are compelled to travel, a blank cannot travel therethrough and reach the heading machine with its enlarged head portion heated below a forging temperature, nor without eliminating the detrimental crystal formation.

Referring to the drawings, Figs. 10 to 16, I, generally designates a rotary automatic blank-feeding hopper which may advantageously consist of a drum 1 mounted on a shaft 2, carried on a suitable supporting structure 3. On the side opposite the shaft 2, the drum 1 is provided with a bell-mouth opening 4 for charging the hopper. The drum 1 is provided with radial tapering slots 5 of the length of the blanks and of a width at the narrow end slightly smaller than the orifice 75' of the stationary die 75 in the heading machine generally designated III, which is preferably of the solid die single blow type.

The slots are made slightly smaller in diameter at the narrow end, than the orifice in the solid die 75 to make certain that the shank portion of any blank gauged or passed out of the hopper will enter the die with little effort. The slots are also made smaller at one end thereof so that blanks can only be passed out with their enlarged head portions placed to travel through the heating zone in the proper manner.

In the interior of the drum 1 slot guards 6 are provided which prevent a blank entering an outlet slot 5 endwise, a blank being able to enter slot 5 only when it lies substantially parallel to the axis of the drum in front of a slot with its enlarged end corresponding with the greater diameter of the slot.

Below the drum 1 is a hopper chute 7

through which the blanks may pass from the hopper to the blank carrier chain 10 to be subsequently described in detail. This hopper chute 7 is of such a height as to hold in reserve a sufficient number of blanks to assure time for blanks in the hopper entering the radial slots 5 and also allow time for slightly rounding of cut edges of the shank ends of the blanks by the tumbling action of the hopper to thereby prevent injury to the orifice of the solid die 75.

Adjacent the lower end of the chute 7 is provided an automatic blank cut-off 8 for regulating the flow of blanks to the carrier chain 10. This cut-off 8 may be operated by a simple lateral movement of sufficient extent to allow a blank to pass to the blank carrier chain at the proper time to fill successive pockets 11 of the chain. For the sake of simplicity no translating mechanism for operating the cut-off 8 has been shown, but it is obvious that the cut-off may be operatively connected by simple means to any part of the mechanism for progressively advancing the blanks from the chute 7 to and through the heading machine.

The lower half of the drum 1 is surrounded by a guard 9 for preventing the blanks from leaving the hopper at points other than through the chute 7. This guard has perforations 9' to permit dirt to leave the hopper. This guard is shown as connected to the chute, but it is obvious that it may be supported in any other suitable manner.

The blank carrier chain previously referred to forms part of a device for heating the blanks, such device being generally designated by the character II. The heating device consists principally of a furnace structure having a combustion chamber, a conveyor system including the blank carrier chain 10, means for intermittently advancing the chain and special arrangements whereby only the enlarged end or head portion of each blank is heated to forging temperature while the shank part is kept relatively cool, by which is meant that it is not heated sufficiently to cause any change of the grain structure resulting from cold-drawing or forging. The furnace, which may be of any suitable design, comprises preferably the usual masonry work 12 providing a centrally located combustion chamber 13 closed at the top by a removable tile 13'. The cast iron furnace fronts, with the customary stay bolts and bracing, may be of the usual design.

The endless blank carrier chain 10 is carried by sprocket wheels 14 and 14' supported on suitable framework at opposite ends of the furnace structure and passes through openings 15 in the furnace fronts over a guide shelf 16 extending substantially horizontally through the furnace

structure. As is clearly indicated in Fig. 12, the guiding surface of the shelf 16 is inclined so that the chain 10 and the blanks carried thereby are also inclined and have a tendency to move to the lower side. The width of the chain 10 is smaller than the length of the blanks B so that the blanks project beyond one side thereof. The width of the chain is so chosen that the projecting part of the blanks corresponds to the portion which it is intended to heat.

The shelf 16 is so located that the projecting or enlarged portions of the blanks extend into the combustion chamber 13 and are thereby exposed to the flame and gases of combustion while the remaining shank portion is protected. The inclination of the shelf 16 has the purpose to prevent the blanks from being thrown by jars and vibrations of the chain into the combustion chamber.

To keep the chain in a straight line and to that extent hold the projecting ends of the blanks in alignment, the shelf 16 has a limiting shoulder 16' at the lower part thereof. In order to be able to regulate the amount of projection of different blanks, a guide rail 17 is provided which may be adjusted in the direction of the length of the blanks. By means of the shoulder 16' and the guide rail 17 it is made possible to control the extent to which the blanks are to be heated and uniformity of heating is attained.

Above and below the shelf 16 and the chain 10 are supported on suitable framework, cooling tanks 18 and 19 respectively. These tanks extend toward the combustion chamber 13 sufficiently far to effect a cooling of so much of the blanks as it is intended to keep relatively cold. Water or other cooling medium may be circulated through tanks 18 and 19 by pipes 20. Safety applications, such as valves 21, may be resorted to to relieve the cooling system from any pressure which might result from negligence or other unforeseen circumstances.

It is advisable to make the tanks in sectional units and a continuous angle iron 22, running the full length of the furnace in such a manner as to support the side of the cooling tanks nearest the combustion chamber, is provided for the purpose of eliminating the joints resulting from dividing the cooling tank into small units, which joints might interfere with the satisfactory riding of blanks through the surface passage.

Vertically below the tanks 18 and 19 and protected against the furnace heat is a tank 23 in which relatively cool water is maintained by circulation at a level which permits the lower or returning part of the blank carrier chain to sag through the water after its passage through the furnace to be thereby cooled.

The length of the combustion chamber depends upon the number of blanks it is desired to heat in a given time. If for instance 60 blanks should be desired per minute and it takes two minutes to heat a portion of a blank to the degree of heat necessary for forging it, then the length of the combustion chamber and the effective part of the blank carrier must be proportioned to accommodate 120 blanks.

As a source of heat is shown oil or gas burners 24 connected with the combustion chamber by flame passages 25. Fire-brick baffles 26 are so disposed in the combustion chamber 13 as to spread and guide the flames as they leave the oil burners 24 and to protect the cooling systems as much as possible against the heat. Blowers 27 may be used to direct blasts of air into the flames to support the combustion in the combustion chamber.

By the arrangement described, the enlarged end or head portions of the blanks B projecting into the combustion chamber are heated to the desired degree during their passage through the chamber, while the remaining portion of the blanks are kept relatively cool.

The sprocket wheels 14 and 14' of the carrier chain 10 are connected to sprocket wheels 28 and 28' of a second chain mechanism located outside the heating device. As indicated most clearly in Fig. 11, sprocket wheel 14 is directly connected to sprocket wheel 28 by a shaft 29 mounted in bearings 30 on a suitable support. Sprocket wheel 14' is connected to sprocket wheel 28' through a shaft 31 and intermediate gearing 32, the particular disposition and structural arrangement of parts not permitting a direct connection. However, as is obvious, the connection indicated may be varied in various ways and suiting particular requirements. The shaft 31 is mounted in a bearing 33 and the gear mechanism 32 on a bracket 32' which also serves as a support for the shaft 31.

The driving chain 34 on sprocket wheels 28 and 28' passes preferably over guide pulleys 35 to avoid jerks and jars which would be due to the intermittent motion and the alternate sagging and stretching of the chain.

In order to intermittently advance the chain mechanism and the blanks, the following mechanism has been resorted to:

A horizontal rod 36 is shiftably mounted in brackets 36' adjacent the driving chain 34. This rod carries a laterally projecting pin 38 on which a roller 39 is mounted. An eccentric 40 connected to the power drive of the machine in any suitable manner carries an eccentric rod 41. A lever 42 supported intermediate its ends by a pivot 43 on a bracket 44 is connected at one end

to the lower end of the eccentric rod 41 and carries at its free end a wedge 45 which may be adjusted by a bolt 46. A backing block of steel may be attached to the bracket 44 to reinforce the fulcrumed wedge lever 42. The eccentric rod may be lengthened or shortened by a nut 47.

By means of a spring 48 connected at one end to the rod or shaft 36 and at the other end to a stationary support 49 the shaft 36 is given a tendency to return in one direction and to force the roller 39 against the wedge 45. As the reciprocation motion of the eccentric rod 41 is transmitted through the lever 42 to the wedge 45, the wedge operates to reciprocate the roller 39 and with it the rod 36.

To the rod 36 are pivotally connected pawls 50 and 50' for engagement with ratchet wheels 51 and 51' respectively, the former being attached to shaft 2 of the hopper 1 and the latter to shaft 29 of the sprocket wheel 28.

The heated blanks are successively delivered from the furnace to a chute 52 and deposited thereby in a V-shaped set edge 53. Carrier fingers (not shown and not forming a part of this invention) mounted on the end of a transfer slide snap over the blank on their stroke toward the set edge, and in their stroke away from the set edge carry the blank, hot end up, underneath the reciprocating heading die and in position directly over the orifice 75' of the stationary solid die 75. As the heading die descends, the cold end of the blank is forced into the orifice of the die and carrier fingers return for another blank. The heading tool continues down and forms the head. The headed articles are knocked out of the orifice of the stationary heading die when the movable heading die has been moved out of its heading position and are carried away by suitable means. The timing of the apparatus may be such that a blank is placed in position on the set edge after the preceding blank has been carried to the heading die.

The movements of the mechanisms of the heading machine, of the heating apparatus, and of the automatic cut off of the hopper chutes, are interdependently so adjusted and timed as to produce a smooth continuous performance of the apparatus as a whole.

The operation of the apparatus will be readily understood. The blanks are delivered into the hopper or drum 1. There the blanks which during rotation of the drum happen to enter a radial slot at the time it is in alignment with the hopper chute are carried down into the hopper to await their turn to pass through the automatic cut off, 8, on to the blank carrier chain in proper position.

The blank carrier chain 10 is intermittent-

ly moved so that a pocket 11 thereof is directly below the chute 7 when the chain is at rest and the cut off 8 is operated to release a blank at that very moment. The chain advances gradually through the combustion chamber 13 and the enlarged head ends of the blanks are exposed to the furnace flame and gases and are gradually heated to the desired forging temperature, while the shank portions are sufficiently cooled to present change of grain structure of the metal. The heated blanks are delivered by the chain, hot end up, to the V-shaped set edge 53 and then carried to the heading die.

By this method of heating the enlarged ends only of the blanks in the manner described, the objects of the invention as set forth at the beginning of the specification are fully attained. The heating is conducted under such conditions that the wasteful formation of scale is largely done away with. The operation is continuous since a steady stream of blanks is fed to the heading machine. All danger of sticking in the die is eliminated since the shank portion of the blank is cold and is able to withstand, without distortion, the strain due to the formation of the head, while these strains are negligible since the head portion of the blank must be at such a temperature that it will readily flow under the action of the die.

The apparatus disclosed for carrying out the objects of the invention is largely a diagrammatic representation of the idea on which the invention is based to explain the theory and principles thereof. It is understood that the objects and the desired result can be accomplished by apparatus of radically different nature.

By my invention there is produced an article having new and improved characteristics, the method of operation having the further advantage in that it permits increased production over the present methods of manufacture by a separation into separate operations of a series of operations which are now commonly grouped together in one machine. This separation permits the speeding up and highly specializing of these several operations, while at the same time relieving the machines themselves of strain and the forging tools of strain and wear because of the allotment of these separate operations, each to a machine particularly adapted to perform its particular function. By allotting to a cold heading machine only the work of partially enlarging the head and straightening the shank of the article and then completing the head by hot forging on a separate machine, preferably of the solid die type, each machine is enabled to do its work under the best conditions.

The enlargement of the head portions of the blank while the metal is practically cold

enables this head portion to be accurately formed with reference to the cold and already finished shank; and the fact that the shank is straight and already has a partially formed head enables the hot heading machine to do its work with accuracy, thus resulting in a perfected article having the described advantageous and improved physical properties.

I believe that I am the first to forge the portion intended for the head of an article of the kind described, by successive cold forging and hot forging.

In further explanation of Figs. 1 to 9, I desire to say that the representation, attempted in these figures, of the appearance of photographs, is not entirely satisfactory. I desire to emphasize that the cold-heading of the blank should not be carried to any material extent beyond the degree of enlargement shown in Fig. 5. As shown in Fig. 4, there begin to appear, zones of distortion which become enlarged and emphasized when the heading operation is carried further, as shown in Fig. 5. If the heading is completed by cold forging, these zones appear somewhat as shown in Fig. 6; and when a cold headed article, such as a rivet, is heat treated or annealed by heating up to about 1300° F. and permitted to cool naturally, there develop the weakening zones of crystal formation, shown in Fig. 7. As above pointed out, the heads of cold-forged articles such as rivets, even though annealed after formation, sometimes snap-off and this difficulty is overcome, since in the articles made by my method, there are no such zones of crystal formations nor zones of distortion strains.

I claim:

1. The method of forming the head of a headed metal article which consists in forging the portion intended for the head of such an article, partly cold and partly hot.

2. The method of making headed metal articles which consists in forging or drawing stock for blanks to the diameter intended for the shank of an article, enlarging the head portion of such blanks by cold forging, and hot forging the enlarged portion into a head of such an article.

3. The method of making headed metal articles which consists in drawing stock for blanks to the shape intended for the shank of a headed article, enlarging the head portion of such blanks by cold forging and hot forging the enlarged portion into a head of such an article at temperatures which will eliminate any deleterious crystal formation therein.

4. The method of making headed metal articles which consists in drawing stock for blanks to the shape intended for the shank of a headed article, enlarging the head portion of such blanks to a limited degree by

cold forging and hot forging the enlarged portion into a head at temperatures which will eliminate any deleterious crystal formation therein.

- 5 5. As an article of manufacture a headed ferrous metal article having a cold-drawn or forged finished shank, the head of which when tested by heating to 1200 degrees F. for one-half hour and permitted to cool undisturbed proves to be free of any deleterious crystal formation therein.

- 10 6. As an article of manufacture a headed ferrous metal article having a cold drawn or forged finished shank, the head of which
15 when tested by heating to 1200 degrees F. for one-half hour and permitted to cool undisturbed proves to be free of any deleterious crystal formation therein, the head

and neck of such article showing the characteristics resulting from heading blanks in solid dies, i. e. being free from grip marks of a sectional die. 20

7. As an article of manufacture a headed ferrous metal article having a cold formed shank and a hot forged head which when tested by heating to 1200 degrees F. and permitted to cool undisturbed proves, upon suitable etching to be free of crystal demarcation. 25

8. As an article of manufacture, a headed ferrous metal article having a smooth cold finished squarely severed shank and hot forged head free from crystal formation. 30

In testimony whereof, I affix my signature.

OTTO H. DE LAPOTTERIE.