

A. M. CRAIG.

PROCESS FOR TREATING METALS AND ALLOYS OF METALS.

APPLICATION FILED NOV. 21, 1916.

1,243,714.

Patented Oct. 23, 1917.

3 SHEETS—SHEET 1.

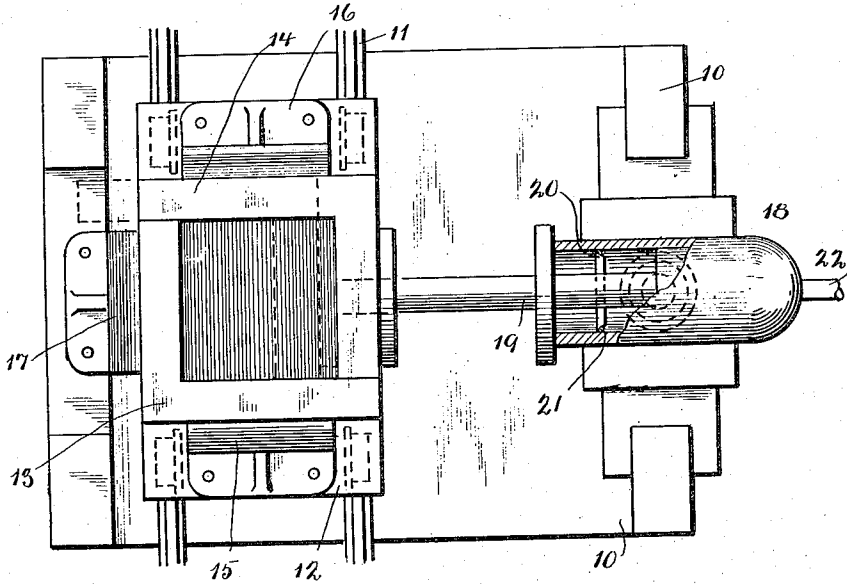


Fig. 1.

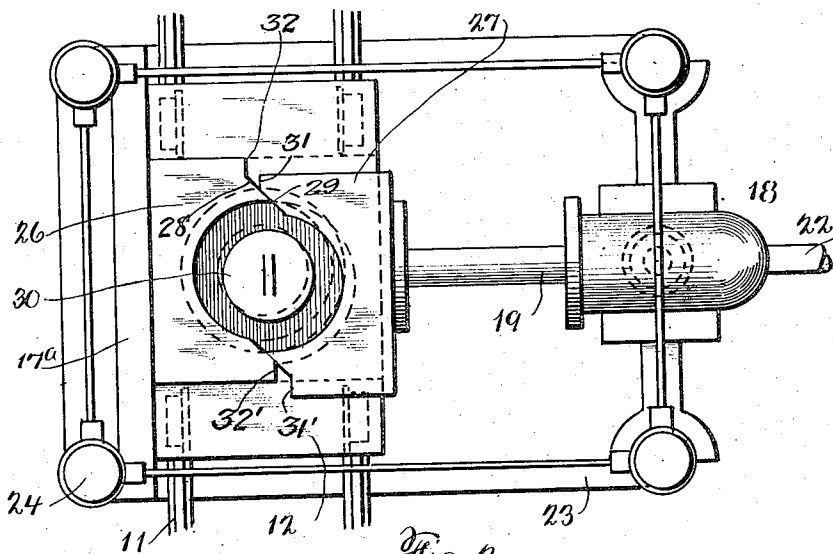


Fig. 2.

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By his Attorney  
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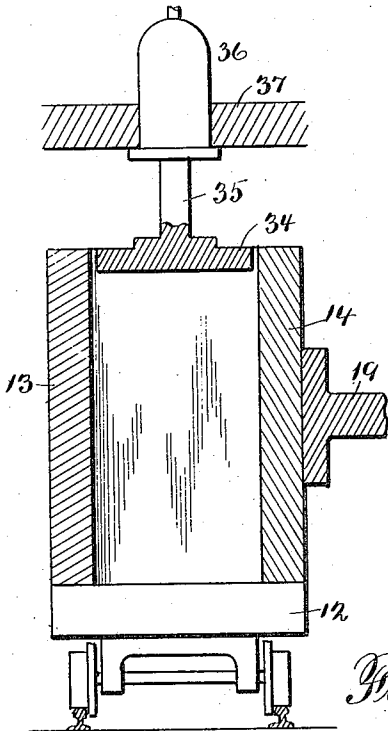


Fig. 3.

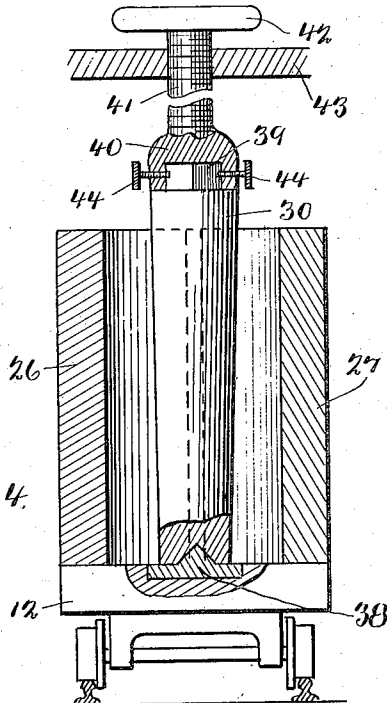


Fig. 4.

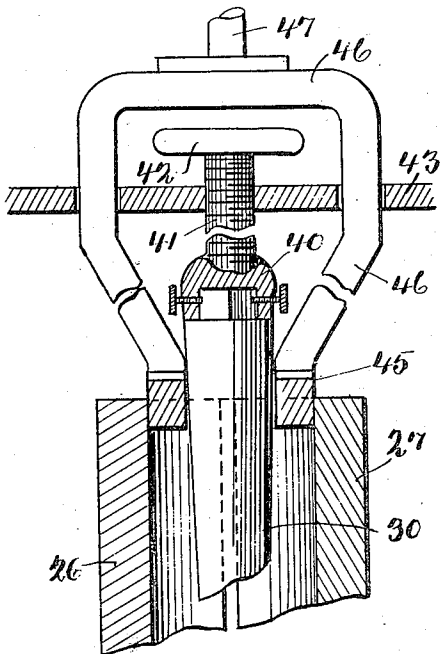


Fig. 5.

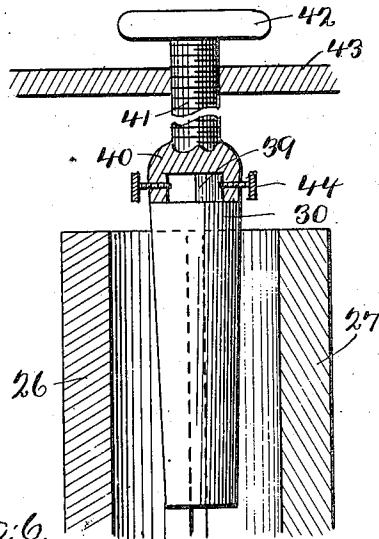


Fig. 6.

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3 SHEETS—SHEET 3.

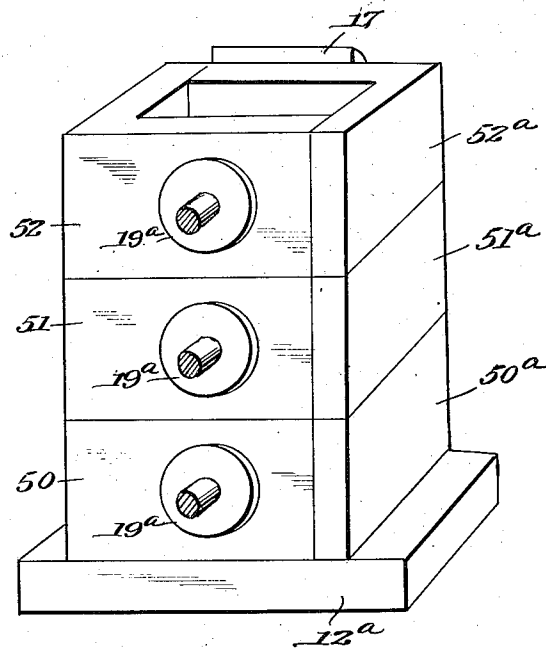


Fig. 7.

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# UNITED STATES PATENT OFFICE.

ALVIN M. CRAIG, OF NEW HAVEN, CONNECTICUT.

PROCESS FOR TREATING METALS AND ALLOYS OF METALS.

1,243,714.

Specification of Letters Patent.

Patented Oct. 23, 1917.

Application filed November 21, 1916. Serial No. 132,518.

*To all whom it may concern:*

Be it known that I, ALVIN M. CRAIG, a citizen of the United States, and a resident of New Haven, county of New Haven, State of Connecticut, have invented certain new and useful Improvements in Processes for Treating Metals and Alloys of Metals, of which the following is a full, clear, and exact description.

My invention relates to improvements in treating metals and alloys of metals while they are still both in a fluid and plastic state, and my process is particularly applicable to the treatment of steel while fluid and plastic.

By means of my process I am enabled to produce efficiently, quickly and directly at a minimum cost, a product partaking of all the qualities and characteristics of steel forgings. The product thus obtained is not only superior in quality, but it is produced at a minimum cost because many of the steps of the processes heretofore used in the manufacture of steel products are not necessary to the carrying out of my process.

My invention consists in applying an unyielding but incremental pressure to a confined body of metal which during this treatment, is first in a liquid and then in a plastic state, the result of which is the decremental reduction of horizontal cross sectional area of that body throughout its entire length. This invention is, therefore, radically and essentially different from the old plunger method of compressing metals either in a liquid or in a plastic state, which method results only in decreasing the length of the confined body without in any way decreasing its horizontal cross sectional area.

In the performance of my process, the confined body of fluid and plastic steel is subjected ultimately by increments to a very high pressure throughout the length thereof, resulting in a product of great toughness and tensile strength.

As a convenient means for carrying out my process I have provided a suitable apparatus illustrated in the accompanying drawings, and covered by application for Letters Patent of the United States No. 132,517, filed November 21, 1916, in which similar reference characters indicate similar parts in the several views.

Referring to the drawings:

Figure 1 is a plan view of an apparatus,

suitable for carrying out my process, for compressing a rectangular ingot.

Fig. 2 is a plan view of a modified form of apparatus for compressing an ingot into the form of a hollow cylinder.

Fig. 3 is a vertical sectional view showing a means for applying endwise pressure.

Fig. 4 is a sectional elevation showing a means for supporting a core in the space for confining the fluid and plastic metal.

Fig. 5 is a broken sectional elevation showing means for compressing the metal to be operated upon endwise around the core.

Fig. 6 is a vertical sectional elevation of a modified construction of Fig. 4.

Fig. 7 is a modified form of mold section used in the carrying out of my process upon masses of metal which are of relatively large cross sectional area and height.

In carrying out my process, I provide a sectional mold, the walls of which are formed by means of a plurality of complementary vertical sections, each of said sections being so constructed and arranged with respect to the other that either one or all of the vertical sections may be caused to move with respect to the other so that the confined space between the walls of the mold is reduced in horizontal cross section throughout the entire length of the mold.

A mold of simple construction is shown, and it is preferably either rectangular or circular in shape and consists of two parts. In the rectangular mold one member comprising two walls is held in a rigid position upon the flat base which forms the bottom of the mold. The other member comprising the remaining walls is constructed so as to slide upon the base and move freely upon and past the walls of the opposed member, so that the cross sectional area of the mold will be reduced when the movable member is moved upon the stationary member, but it will be understood of course that the two members may move with relation to each other with the same effect.

Referring more particularly to the construction shown in Fig. 1, the two complementary members 13 and 14 forming the walls of a rectangular mold, rest on end upon a plate forming the mold bottom. The walls of each member are respectively seated at right angles to the contiguous walls of the other member. When the member 14 is pushed toward the backing or abutment

17, it will slide freely upon the bottom plate, and the walls of the member 14 will slide freely upon the walls of the adjacent member 13 so that the pressure will be uniformly applied to a maximum degree upon the entire vertical surface of the material operated upon.

The vertical mold members 13 and 14 are held between guide supports 15 and 16 secured to the plate forming the mold bottom, and another support or guide 17 can be secured to the base to prevent the displacement of the mold and to resist the pressure from the hydraulic jack when operated in the carrying out of my process.

As a means for applying pressure to the movable walls of the mold, I may provide a hydraulic jack 18 securely held to the base of the structure. The piston rod 19 of the jack abuts with one wall of the vertical movable member 14 so that great pressure can be applied to the movable wall of the mold and thereby to the confined metal operated upon. The cylinder of the jack is preferably provided with a collar 20, behind which is a flap valve 21, so that the water in the cylinder will force the valve against the collar and prevent leakage around the piston rod 19. The valve shown is conventional simply, and any suitable valve can be used for the purpose. Water is admitted to the cylinder of the jack through the pipe 22. It will thus be seen that a regulated pressure can be applied by means of the jack to the charge in the mold and it is to be understood that this pressure can be made progressive or incremental in its intensity, the amount of pressure being controlled by the pump which supplies the jack in a manner well understood in this art.

It is obvious that the contour of the mold members may be changed indefinitely without modifying the generic invention, and to better illustrate this I have shown in Fig. 2 the application of the method to the casting of hollow cylinders, such as hollow projectiles or the like. In this view I have also shown a modified support for the apparatus, consisting of a base 23, having posts 24 erected thereon, which are connected to each other by tie rods. The mold shown, however, has opposed members 26 and 27 having inclined meeting parts 28 and 29 with abrupt meeting portions 31 and 32, 31' and 32', so that the mold members can slide freely together, and these members are compressed by a jack 18 as already specified, until the portions 31 and 31', 32 and 32' abut upon each other. The side guides for the mold members are not shown in this figure, and instead of the bracket 17, plates 17<sup>a</sup> are shown arranged behind the mold to resist the pressure of the hydraulic jack 18. A core 30 is suspended in the mold, and it will be noticed that when the mold is open, the

chamber of the mold is not circular in cross section, but when the pressure is applied, the charge is condensed until the mold assumes internally a cylindrical shape, thus imparting the desired shape to the charge and compressing it to the required amount.

Under certain conditions the lateral compression alone will be found sufficient, while at other times both lateral and vertical compression may be found desirable according to the purpose for which the particular mass of metal under treatment is designed to be used. An advantage of the lateral pressure while the metal is fluid, and of having the pressure precede the vertical pressure, if the latter is used, is that where the lateral pressure is applied while the metal is in a soft state the gases are forced upward freely from the charge, whereas with molds of the plunger type the gases are confined and tend to form small bubbles in certain parts of the metal.

I have illustrated, therefore, in Fig. 3, a means of compressing the charge vertically as well as laterally when a piston 34 is arranged in the upper part of the mold between the members 13 and 14, which piston is provided with a piston rod 35, which is operated by the hydraulic jack 36, the latter being carried by a suitable support 37. Thus pressure may be applied vertically on the charge either after or during the application of the lateral pressure.

In Fig. 4 I have shown a convenient means for supporting the core 30. As here shown, a socket in the bottom of the core fits over the centering pin 38 on the part 12 which constitutes the mold bottom, and at the top of the core 30 is squared as shown at 39, and enters a socket 40 connected with a screw 41 turned by means of the hand wheel 42, and mounted in a support 43. The core can be held firmly in the socket by the binding screws 44. When the core is to be raised, it can be done by turning the wheel 42 and screw 41, or the core can be removed in any other convenient manner.

In Fig. 5 is shown means for compressing the charge longitudinally around the core, this means comprising a ring 45 which enters the mold between the members 26 and 27, and a yoke 46 connects with the ring and straddles the core and its adjusting mechanism, the yoke connecting with the piston rod 47 of a suitable hydraulic jack.

In Fig. 6 I have shown means for suspending the core 30 so that the metal may flow beneath it, in which case the core is held as in Fig. 4 already described, with the exception that the core is not provided with the bottom connection.

In Fig. 7 I show the movable side portion of the mold constructed of superposed horizontal sections.

As a convenient means for facilitating the

transportation and handling of the compressed charge, I provide a portable base for the bottom of the mold, which preferably consists of the top 12 of a flat car, the car being mounted to run upon a track 11 supported upon a base frame 10, of sufficient strength to support the work and the necessary mechanism for carrying out my process.

10 In carrying out my method, I pour fluid metal into the confined space in the mold, then cause an unyielding but incremental pressure to be applied to the movable walls forming a portion of the side of the mold until the fluid metal has reached the required consistency and has been reduced by decrements to the required degree of cross sectional area.

When the mass of steel under treatment has a relatively large cross sectional area and height, instead of exerting pressure laterally as heretofore described, upon the entire surface of the mass, after the pouring operation has been completed, it is found desirable to first exert the pressure serially upon parts of the ascending column of metal as it is being poured, and then complete the operation by exerting equal lateral pressures upon the whole column of the metal. For this purpose I construct the movable side portion of the mold with superposed horizontal sections, as illustrated in Fig. 7.

This mold it will be noticed has superposed sections 50, 51 and 52 moving upon complementary parts 50<sup>a</sup>, 51<sup>a</sup> and 52<sup>a</sup>, the whole mold being arranged opposite a backing 17 and the members 50, 51 and 52, sliding upon the base 12<sup>a</sup>, and moved by pistons 19<sup>a</sup>. When in pouring the column of metal has reached a distance slightly above the upper surface of the lower section 50 of the mold, lateral pressure is applied to the said section, and at the same time the pouring of the metal is continued until it reaches a point just above the upper surface of the section 51. Then lateral pressure is exerted upon the section 51 of the mold, and so on until the entire body of metal is poured and compressed. Then while the metal is still in a more or less plastic condition an unyielding incremental lateral pressure of equal intensity is applied to the entire mass as hereinabove described to complete the reduction of the cross sectional area thereof. The advantage of this is especially that if a large ingot is poured there is liability of the lower portion of the ingot becoming chilled before the mold is filled and before pressure can be applied, so that the compression afterward would not result in so homogeneous and nice a product as where the serial pressure is applied as described. In this latter case it will be seen that the pressure can be applied as the mold is filled so that the charge under compression

is all in substantially the same condition.

The product resulting from my process is one which avoids the great loss resulting from the cutting off of the piping of the ingots when the old processes are employed.

The illustrations serve merely to show a means for carrying out my improved method, but it is to be understood that this method is not dependent on the particular form of apparatus described. It is clear that the means shown and described permit the compression of the charge to any necessary or desired extent, and also the easy handling of the mold charge. I prefer to utilize hydraulic jacks as pressing means as they are the most convenient means for obtaining a powerful, unyielding and incremental pressure.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The step in the process of treating metals which consists in subjecting a charge of fluid metal to external incremental and unyielding lateral pressures, thereby decrementally reducing the cross sectional area thereof.

2. The step in the process of treating metals which consists in applying an external incremental pressure to a confined charge of fluid metal to increase its length and to decrementally reduce its cross sectional area.

3. The process of treating metals which consists in pouring a charge of fluid metal into a confined space, and applying incremental pressures to the sides of the charge before its outer parts are chilled or set to decrementally reduce the cross sectional area thereof.

4. The process of treating metals which consists in pouring a charge of fluid metal into a confined space, applying pressure to the sides of the charge while still in its fluid state thereby decrementally reducing the cross sectional area of the charge, then when the charge is in a plastic state, applying incremental pressure to decrementally reduce its cross sectional area.

5. The process of treating metals which consists in applying an incremental pressure laterally and externally to a confined body of fluid metal, to reduce the cross sectional area of the confined body, and applying pressure vertically to that body.

6. The process of treating metals which consists in pouring a charge of fluid metal into a cavity bounded by sectional walls, and applying incremental pressure to the walls while the charge is plastic to cause them to slide one upon the other to decrementally reduce the cross sectional area of the confined charge.

7. The process of treating metals which consists in subjecting a charge of metal while

in a plastic condition to substantially unyielding and incremental external pressures to decrementally reduce the cross sectional area of the charge.

5 8. The process of treating metals which consists in subjecting a poured charge of metal while in its plastic state to unyielding lateral pressure, thereby expelling the gases from the charge, then increasing said pressure in a ratio approximating the decreasing plasticity of the charge to reduce the cross sectional area of the charge.

10 9. The process of treating metals which consists in subjecting a poured charge of metal while in its plastic state to unyielding pressure, then increasing said pressure in a ratio approximating the decreasing plasticity of the charge, to reduce the cross sectional area of the charge.

15 10. The process of treating metals which consists in applying pressures serially to ascending sections of the poured column of fluid metal, then while the metal is still in a plastic state, applying an unyielding, incremental lateral pressure of equal intensity to the entire mass to complete the decremental reduction of the cross sectional area thereof.

20 11. The process of treating metals which consists in applying pressures serially to ascending sections of the poured column of fluid metal.

12. The process of treating metals which consists in applying pressures serially to ascending sections of a poured column of fluid metal, the pressures being serially applied in the same ratio as the charge is poured, whereby the charge at the initial pressure is always of substantially the same plasticity.

13. The process of treating metals which consists in applying lateral pressures serially to ascending sections of the poured column of fluid metal.

14. The process of treating metals which consists in applying lateral pressures serially to ascending sections of a poured column of fluid metal, the pressures being serially applied in the same ratio as the charge is poured, whereby the charge at the initial pressure is always of substantially the same plasticity.

15. The process of treating metals which consists in subjecting a charge of metal while soft to incremental lateral pressure, thereby decrementally reducing the cross sectional area thereof throughout its length, the said pressure being limited only by the resistance of the charge.

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Witnesses:

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M. G. O'DONNELL.