Jan. 30, 1962 A. M. MURPHY ETAL 3,019,144

EXTRUSION HEAT TREATING SYSTEM

Original Filed March 17, 1959 2 Sheets-Sheet 1

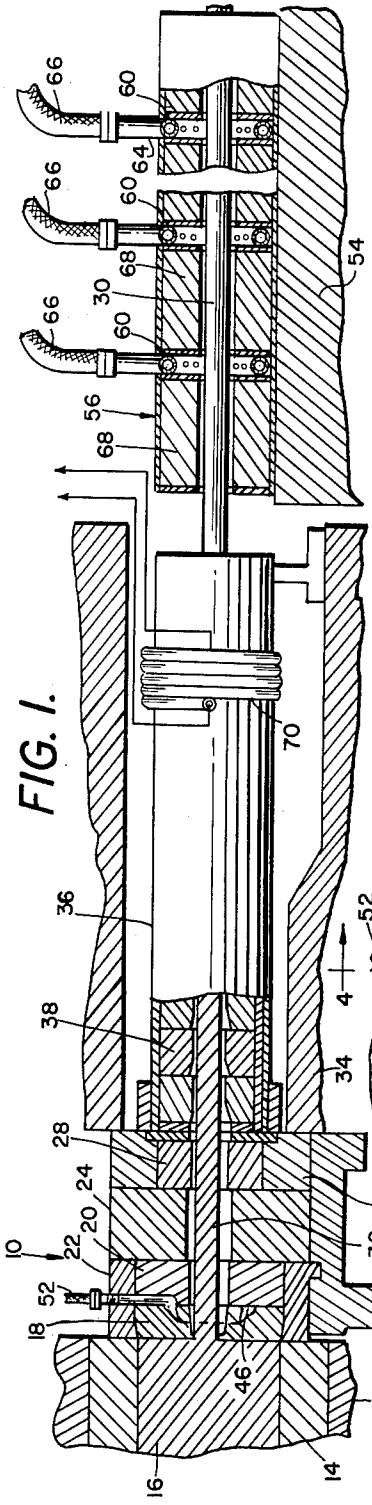


FIG. 1.

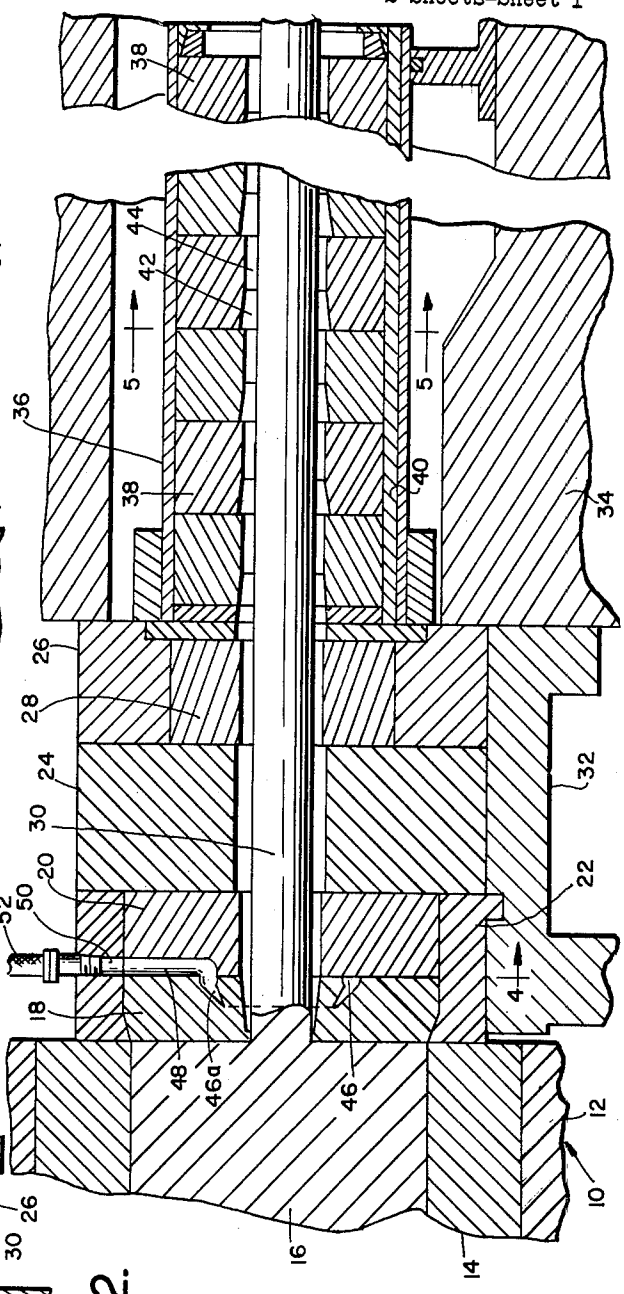


FIG. 2.

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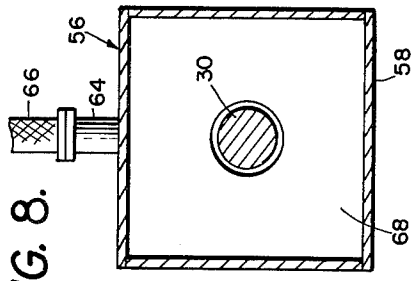


FIG. 8.

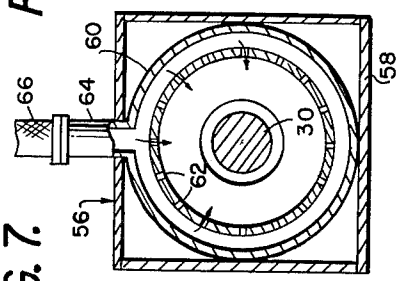


FIG. 7.

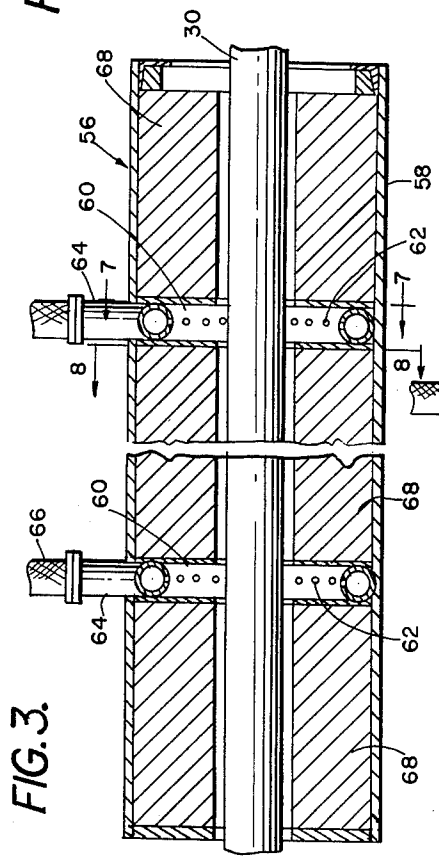


FIG. 3.

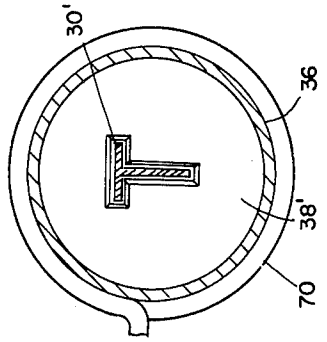


FIG. 6.

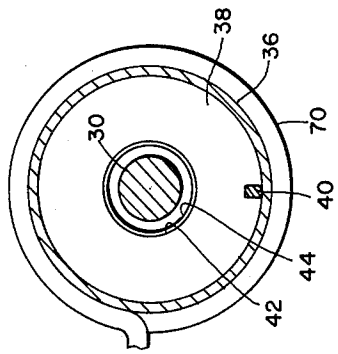


FIG. 5.

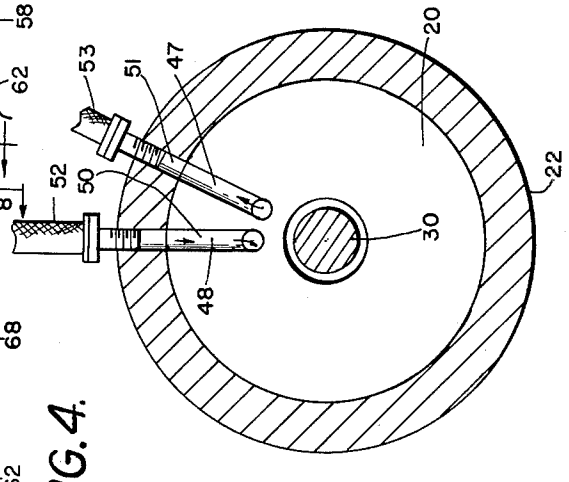


FIG. 4.

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3,019,144

EXTRUSION HEAT TREATING SYSTEM

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Continuation of application Ser. No. 799,979, Mar. 17, 1959. This application Mar. 23, 1961, Ser. No. 99,009
8 Claims. (Cl. 148—12.7)

This invention relates to method and apparatus for solution heat treating heat-treatable aluminum alloys while such alloys are being extruded. More especially, this invention relates to apparatus and method for simultaneously extruding and heat treating an aluminum alloy to obtain T–4 temper without the necessity of a separate solution heat treating operation to bring it to that temper after the extrusion has been removed from the extrusion press.

It has long been the practice to heat treat extrusions of heat-treatable aluminum alloys by a process known as solution heat treatment, to reach T–4 temper. Such treatment involves heating the extrusion to a temperature at which solution and diffusion of the heat-treatable alloying constituents takes place and produces, as nearly as practicable, a homogeneous solid solution. The alloy then is quenched (i.e., rapidly cooled) in order to prevent the hardening constituents from precipitating substantially from solid solution during the cooling period. Slow cooling, on the other hand, would permit these constituents to precipitate to a greater extent, so that the alloy would be in a partially annealed condition unsuitable for subsequent precipitation heat treatment. Solution heat treatment, including the quench, is a necessary preliminary to subsequent precipitation heat treatment to T–6 temper, to increase the mechanical properties of the alloy.

T–4 temper is defined as "solution heat treated and naturally aged to a substantially stable condition." Such natural aging may take one or two days, but the extrusion can be precipitation heat treated to T–6 temper at any stage of natural aging to stable T–4 temper. For the purposes of this application, therefore, "T–4 temper" refers to the solution heat treated condition after quenching, regardless of subsequent natural aging.

One conventional method of solution heat treatment of heat-treatable aluminum alloys is carried out by operations separate from the forming operations, i.e., after the extrusion operation has been completed. The extrusions are removed from the press, heated to solution heat treatment temperature in a molten salt bath or in an air furnace, and, after being heated for the required time at such temperature for solution of the soluble constituents to take place, are removed and immediately quenched. Such separate heat treatment operations require expensive equipment and add to operating costs. Separate heat treating operations also necessitate additional handling of the extrusions which increases the possibility of marring them, and the heat treatment frequently causes surface staining of the metal which can be removed only by a further operation. Furthermore, reheating to high temperatures promotes additional grain recrystallization and growth, which adversely affects the mechanical strength.

A second conventional method of solution heat treating an extrusion is to extrude it completely at about a solution heat treatment temperature, and then cut off the extrusion and immediately quench it in a tank of water adjacent the run out table. However, the product of this

method suffers the disadvantage that its temper is apt to differ from one end to the other, because the leading end of the extrusion would necessarily have time to cool to a lower temperature than the trailing end, by the time the whole length of the extrusion is quenched simultaneously. Consequently, at least part of the extrusion may miss the desired T–4 temper, and hence fail to develop the desired increased strength when subjected to precipitation heat treatment. Furthermore, the hot extrusion warps and twists excessively while quenching in horizontal position in the water tank. Such warping and twisting is partially controlled in the first-mentioned conventional method, by hanging the extrusions vertically during the solution heat treatment.

A third conventional method of solution heat treating an extrusion is to lead it through a water trough built into the run-out table, so that the extrusion can be quenched continuously as it comes from the press. This may overcome the uneven temper objection of the second method, except at the relatively long terminal end of the extrusion which has not reached the water at the end of the press stroke. However, this third method is only practicable for relatively small and simple shapes which can be moved readily along a sinuous path, and the problem of warping and twisting is severe. This difficulty is complicated by the fact that the angle at which the extrusion enters the water has a strong influence on the twist effect of uneven cooling across the cross-section of the extrusion as it enters the water. Consequently, this method is difficult to operate and has only limited application.

It is, therefore, an object of this invention to provide method and apparatus for simultaneously extruding and heat treating a heat-treatable aluminum alloy to produce an extrusion that has a temper equivalent to that obtained by separate solution heat treating operations, while at the same time avoiding substantial warping and twisting of the extrusion.

It is a further object of this invention to provide method and apparatus for simultaneously extruding and heat treating an aluminum alloy that not only provides the extrusion with a T–4 temper, but also with a smooth and relatively unstained surface.

Other objects and advantages of the invention will become apparent from the following description and accompanying drawings in which:

FIGURE 1 is a fragmentary longitudinal sectional view of apparatus embodying this invention.

FIGURE 2 is an enlarged fragmentary view of a portion of FIGURE 1.

FIGURE 3 is an enlarged fragmentary view of another portion of FIGURE 1.

FIGURE 4 is a sectional view taken substantially on the line 4—4 of FIGURE 2.

FIGURE 5 is a sectional view taken substantially on the line 5—5 of FIGURE 2.

FIGURE 6 is a view corresponding to FIGURE 5 but illustrating a slightly modified form of apparatus.

FIGURE 7 is sectional view taken substantially on the line 7—7 of FIGURE 3.

FIGURE 8 is a sectional view taken substantially on line 8—8 of FIGURE 3.

The process embodying this invention has been practiced extensively, with excellent results, on heat-treatable aluminum alloys in which the major portion of alloying elements consist of magnesium and silicon, which are present principally in the form of the compound magnesium silicide. The most commonly used of these alloys

are 6061, 6062 and 6063. The percentage composition limits of these alloys are as follows:

	6061	6062	6063
Silicon	0.40–0.08	0.40–0.8	0.20–0.6
Iron	0.7 max.	0.7 max.	0.35 max.
Copper	0.15–0.40	0.15–0.40	0.10 max.
Manganese	0.15 max.	0.15 max.	0.10 max
Magnesium	0.8–1.2	0.8–1.2	0.45–0.9
Chromium	0.15–0.35	0.04–0.14	0.10
Zinc	0.25 max.	0.25 max.	0.10 max.
Titanium	0.15 max.	0.15 max.	0.10 max.
Others, each	0.05 max.	0.05 max.	0.05 max.
Others, total	0.15 max.	0.15 max.	0.15 max.
Balance	Al	Al	Al

Although the process will be described with reference to these specific alloys, it will be realized that it is applicable to other heat-treatable aluminum alloys, such as those in which the major alloying element is copper (2000 series), zinc (7000 series) and, in some cases, silicon (4000 series) with other elements (e.g., 4032).

The substantially continuous extruding and solution heat treatment process embodying this invention, when applied to 6061 aluminum alloy, has produced extrusions which, when aged, have met all the mechanical and surface requirements of 6061–T6 aluminum alloy. Equivalent results have been obtained in applying the process to 6062 and 6063 aluminum alloys.

The steps involved in the process are outlined as follows:

(1) Heating the aluminum alloy billet to be extruded to the selected solution heat treatment temperature and maintaining it at such temperature for a time sufficient for solution of the soluble constituents to occur, particularly the constituents (e.g., magnesium silicide) which give heat treating properties to the alloy. For 6061 and 6062 aluminum alloys this temperature is preferably about 960° F. to 980° F., but could be in the range of about 900° F. to 1050° F. For heat-treatable aluminum alloys generally, this range is about 800° F. to 1050° F.

(2) Quenching the billet with a coolant, preferably water, down to a practical extrusion temperature. For 6061 and 6062 aluminum alloys this temperature is preferably about 750° F. to about 850° F., and for heat-treatable aluminum alloys generally the range of extrusion temperatures is about 600° F. to 1000° F. This quenching step should not take place, however, until immediately prior to extruding the billet, because it is important to extrude before the soluble hardening constituents have time to precipitate out of solution to the reduced solution equilibrium at the extrusion temperature of the quenched billet. If the selected solution heat treatment temperature and extrusion temperature should coincide, such billet quenching is unnecessary.

(3) Extruding the billet through a die that is cooled by a forced flow or fluid, preferably air, but possibly water. The fluid employed to cool the die is allowed to escape, according to present preferred practice. However, it can be made to impinge directly on the exterior surfaces of the extrusion immediately following its emergence from the die, which may be helpful in controlling the degree of initial quenching of the extrusion. The cooling of the die reduces surface pick-up on the extrusion, thus improving surface smoothness, and also permits faster rates of extrusion for temperature control in connection with heat treating effects, and for increased production.

(4) Passing the still hot and somewhat plastic extrusion, substantially immediately on its emergence from the die, through a series of guide members, preferably in the form of carbon rings, that closely embrace and guide the moving extrusion in order to prevent any twisting or distortion until it cools sufficiently to remain substantially straight. Such tendency to twist or bend can result from the action of the particular die, and can be caused by uneven thermal contraction due to unequal thickness of different parts of the extrusion, or unequal cooling of different parts of the extrusion, or combinations of these factors, or other factors.

(5) Rapidly quenching the moving extrusion shortly after it emerges from the die, preferably with water sprays, down to a temperature at which it can be touched, i.e., substantially room temperature. During this quenching step, warping of the extrusion is prevented by the first set of guiding rings and by a second series of embracing and guiding carbon rings among the quenching sprays.

(6) Optionally, if the foregoing steps do not provide the desired temper, reheating the moving extrusion up to the solution heat treatment temperature range prior to quenching the same. Such reheating can be accomplished by a pass-through type of furnace interposed between the two series of carbon rings, but more desirably by electrical induction coils which surround the rearward end of the first series of rings.

As soon as the press has completed its stroke, the end of the extrusion near the die is detached from the die, in any convenient manner, and is immediately pulled through the above-described subsequent apparatus at approximately the extruding speed, in order to quench the trailing end of the extrusion in the same manner as the preceding portion. The extrusion is then capable of being conventionally precipitation heat treated to bring it to T–6 temper.

In carrying out the operation, the primary purpose and effect is to keep the heat-treatable alloying constituents in solution until the rapid quench of the extrusion as it is continuously coming from the die, while at the same time restraining the extrusion from warping and twisting, and guiding its movement along a straight path. The rapid quench prevents the said constituents from precipitating to any substantial extent and thus prepares them for subsequent artificial age hardening treatment to T–6 temper. Applying the quenching spray evenly all around the periphery of the extrusion helps to prevent warping and twisting. A special local spray may be used, however, to cause a desired local movement of the extrusion. While cooling the die is helpful it is not always essential.

While the foregoing are the material steps in the process, it will be realized that other factors affect the final physical properties of the extrusion. Such additional factors are the temperature of the cylinder of the extruding press, extrusion speed, volume of cooling fluid employed on the die, and the volume of water employed in the extrusion quenching step. These factors can be adjusted to provide the desired results, as will be understood by those skilled in the art.

The foregoing process when practiced with heat-treatable aluminum alloy produces extrusions that not only have T–4 temper properties, but also, after heat treating to T–6 temper, have higher mechanical properties than those of extrusions of identical alloy that are provided with a T–6 temper by conventional separate solution heat treatment operations after the extrusion is formed. This statement is substantiated by the following comparison of certain physical properties, based on numerous samples, of 6061–T6 alloy extrusions formed in accordance with this invention and by conventional extruding and separate solution heat treatment methods:

Fabrication Method	Tensile Strength (1,000 p.s.i.)			Yield Strength (1,000 p.s.i.)			Percent Elong. in 2″		
	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
Conventional	52.5	36.5	42.5	40.5	34.5	39.5	23.0	7.0	14.0
This Invention	55.0	38.0	45.0	51.0	35.0	43.0	20.0	8.0	14.0

Additionally, the foregoing process provides extrusions that have a smooth surface which is substantially free of the staining resulting from conventional, i.e., sepa-

rate, solution heat treating processes. Furthermore, it has been found that there is much less handling damage during manufacture with extrusions formed and heat treated in accordance with this invention. It also has been found that much heavier and thicker extrusions of 6063 aluminum alloys having a T–6 temper can be obtained with the desired strength properties by the process of this invention, on a reliable and economical basis. This is an improvement over conventional practice, which cannot guarantee strength in the case of like extrusions having thicknesses of over about one-half inch.

Referring now to the drawings there is shown apparatus for carrying out the foregoing process. Referring first to FIGURES 1 and 2 there is shown a section of the die end of a generally conventional aluminum extrusion press **10** having the usual cylinder **12** provided with a liner **14** which contains the aluminum alloy billet **16** being extruded. The end of the liner **14** is closed by the usual die **18** and die back-up piece **20** both carried in the usual die holder **22**. Backing the back-up piece **20** are the usual die block or bolster **24** and die arm plate **26**, the latter being provided with a carbon insert ring **28** having an interior configuration substantially the same as, but slightly larger than, the cross-sectional shape of the extrusion **30**. The die **18**, die back-up piece **20**, block **24**, and die arm plate **26** are carried in the usual die arm or tool holder **32** for interposition between the end of the liner **14** and the press platen **34**. In FIGURES 1 and 2 of the drawings the die **18** is shown as having a circular orifice to form an extrusion **30** in the shape of a cylindrical rod.

Disposed within the platen **34** in alignment with the die **18** is a cylindrical canister **36** within which is stacked a series of carbon rings **38** each having an exterior longitudinal orienting groove fitting a longitudinal interior rib **40** in the canister. The interior configuration of each ring **38** is substantially the same as, but slightly larger than, the cross-sectional shape of the extrusion **30**, as best shown in FIGURE 5. Consequently, the carbon rings **38** rather closely surround and prevent deformation and warpage of the extrusion **30** passing through the canister **36**. It will be noted that the opening through each ring **38** has a forward section **42** that flares slightly toward the die **18** and tapers rearwardly toward a section **44** of substantially uniform cross-sectional configuration. Such flare eliminates any possibility of an extrusion-catching shoulder or step facing toward the die **18** between adjacent rings **38**. Hence, the extrusion **30** passes smoothly from ring **38** to ring **38** without obstruction, while being guided and restrained thereby against warping as it cools somewhat after emerging from the die **18**. The canister **36** is long enough so that by the time the extrusion **30** emerges therefrom, the latter, or at least its exterior layers, will have cooled sufficiently for the extrusion to become substantially self-supporting. FIGURE 6 illustrates the shape of a carbon ring **38'** adapted to guide an extrusion **30'** that is T-shaped in transverse section.

A groove **46** is formed in the face of the die **18** against the back-up piece **20**, and extends in almost a full circle around the central opening through the die. A portion **46***a* of groove **46** extends adjacent the surface of the die which bears against the extrusion as it is finally formed. A radially extending groove **48** in the adjacent face of back-up piece **20** connects one end of groove **46** with an opening **50** through die holder **22** to a supply line **52**, and a like radially extending groove **47** and opening **51** connect the other end of groove **46** with a discharge line **53**, so that a suitable cooling fluid (preferably air, but in some cases water) can be circulated through groove **46** to cool die **18** during the extruding operation. The supply of such cooling fluid may be controlled by a valve (not shown) to regulate the cooling of the die **18**. Because the openings through the back-up piece **20**, die block **24**, carbon insert **28** and rings **38** in the canister **36** are slightly larger in cross-section than that of the extrusion **30**, the cooling fluid passes outwardly through the canister between the interior surfaces of the carbon rings therein and the outer surface of the extrusion, to thus cool the latter.

Disposed on the run-out table **54** (FIGURE 1) of the press **10**, in alignment with and closely adjacent the outlet end of the canister **36**, is an inlet end of a quench canister **56**. The quench canister **56** comprises an elongated metal housing **58** having therein a plurality of longitudinally spaced spray rings **60** having spray orifices **62** to direct a cooling fluid onto the extrusion **30** as it passes through the rings **60**. The spray rings **60** are each provided with an inlet **64** which extends to the exterior of the canister **56** and to which may be secured a hose **66** for supplying water or other liquid coolant to the rings. The supply of water to the spray rings **60** may be controlled by valves (not shown) to regulate the quenching operation. Housed in the canister **56** and separating each pair of adjacent spray rings **60** is a carbon ring **68**, again shaped to rather closely conform, but with some clearance, to the exterior transverse configuration of the extrusion **30**. The purpose of these rings **68** is to prevent undue warping of the extrusion **30** as it is rapidly quenched by the water spray from the spray rings **60**. Any run-off water emerging from either or both ends of the quench canister **56** may be collected by an appropriate means (not shown).

In the event that the desired temper is not obtained competely by heating the billet **16** before extrusion into the solution heat treatment range and then extruding through the aforedescribed cooled die **18** and quench canister **56**, then in some instances the extrusion may be reheated to a desired solution heat treatment temperature immediately prior to entering the quench canister, so that upon being quenched in the latter the desired T–4 temper will be obtained. This reheating of the extrusion **30** may be accomplished by any appropriate type of pass-through furnace of gas fired or other type, interposed immediately between the canisters **36** and **56**. Preferably the reheating, if necessary, is accomplished by electrical induction coils or windings **70** surrounding the rearward end of the guiding canister **36** and connected to an appropriate source of electric power. By this means any desired reheating of the extrusion **30** may be accomplished without the necessity of extending the overall length of the apparatus by the interposition of a pass-through furnace between the two canisters **36** and **56**. However, where it is desirable to avoid solution heat treating and quenching before extrusion, the use of a longer pass-through furnace in place of coils **70** will permit solution heat treating after extrusion but immediately prior to the above-described rapid quenching to room temperature, in order to obtain T–4 temper and the capability of subsequent treatment to T–6 temper to obtain the desired age-hardened properties.

The invention is further illustrated in the following examples:

Example 1

A 6061 alloy billet, 8 inches in diameter and 22 inches long, is heated progressively over a period of about 5 minutes or more to a temperature of about 980° F., and then is submerged in a water bath to quench it to a temperature of about 810° F., as measured on the outside about 45 seconds after removal from the bath. The billet is then immediately put in an extrusion press having a cylinder temperature of about 800° F., and extruded through an L-shaped die slot to produce an extrusion having an L-shaped cross-section measuring 2 inches along one leg and 2 inches along the other leg, the two legs each being 0.100 inch thick. A canister containing a series of carbon blocks slotted to receive the extrusion, and 4 feet long, is mounted in the throat of the press close to the die to receive the emerging extrusion, and a

second canister 4 feet long is mounted in tandem and close to the first to receive the extrusion after it emerges from the first canister. The second canister has slotted carbin blocks like the first, but also has a series of water spray rings interspersed among the carbon blocks, to quench the extrusion rapidly to room temperature. The spray rings are also contoured to the shape of the extrusion to give uniform cooling to the extrusion. The first canister could also have such spray rings, but its principal function is to restrain the extrusion against bending and twisting as soon as possible after it emerges from the die. After the extrusion initially emerges from the die, the die is internally air cooled. After completion of the press stroke, the butt is sheared off next to the die, and the extrusion is drawn out through the die and canisters, with the quench sprays on, to complete the quench of the trailing end of the extrusion, so that the whole length of the extrusion is at T–4 temper. The extrusion is then stretched conventionally, cut to size, and, at any convenient later time, artificially aged for 6 hours at 350° F. (or other time and temperature suitable for precipitation heat treatment). The extrusion will then be at T–6 temper and have at least 38,000 p.s.i. tensile strength, 35,000 p.s.i. yield strength, and 10% elongation in 2 inches length, which meets strength and elongation standards published by the Aluminum Association (U.S.A.) for 6061–T6 extrusions.

Example 2

Example 1 is repeated with a wall thickness of 3/16 of an inch on both legs of the L-shaped extrusion, and the same results are obtained.

Example 3

Example 1 is repeated with a wall thickness of 5/8 of an inch on both legs of a 3 inch by 4 inch L-shaped extrusion, and the same results are obtained as stated in Example 1.

Example 4

Examples 1, 2 and 3 are repeated with 6062 alloy, with the same results, which meet the published standards of the Aluminum Association for 6062–T6 extrusions.

Example 5

6063 alloys can be put through the procedure of Examples 1 and 2 in order to obtain final T–6 properties which meet published standards of the Aluminum Association (at least 30,000 p.s.i. tensile strength and 25,000 yield strength in both cases, and 8% elongation in 2 inches in the case of the wall thickness of Example 1, and 10% elongation in 2 inches in the case of the wall thickness of Example 2). There are no equivalent published standards for Example 3, which refer to a wall thickness of over ½ inch, but Example 3 can nevertheless be repeated with 6063 alloy to meet the aforesaid standards for 6063 in Example 2, on a regular production basis. Moreover, it is feasible to substitute streams of air at room temperature, driven by fans, for the second canister and its water sprays, for quenching 6063 alloy extrusions to T–4 temper, if the wall thickness of the extrusion is not over about one inch. Water quenching is required for greater thicknesses. Such air quenching, though rapid compared to cooling in still air (which is not suitable for producing T–4 temper), is less rapid than water quenching, and hence the first canister alone is enough to restrain excessive warping and twisting. Such substitution of fanned air quenching, while suitable for 6063 alloy as stated above, would not be suitable for 6061 and 6062 alloys in Examples 1–4, for example, as the latter alloys require the rapid action of a water or like quench to attain the desired T–4 temper.

A rapid quench of the solution heat treated alloy to room temperature is the normal procedure, but for the purposes of this application "substantially room temperature" in this connection refers to any temperature at which the heat-treatable constituents are held in condition suitable for subsequent artificial age hardening to T–6 temper.

This application is a continuation of application Serial No. 799,979, filed March 17, 1959.

While the present preferred embodiments of the invention, and methods of practicing the same, have been illustrated and described, it will be recognized that the invention may be otherwise variously embodied and practiced within the scope of the following claims.

We claim:

1. Apparatus for continuously quenching an aluminum alloy extrusion as the latter is extruded to substantially final cross-sectional shape, comprising: an elongated open-ended canister; a plurality of longitudinally spaced spray rings disposed in said canister for passage of the extrusion therethrough, said rings having inwardly-facing spray orifices for directing sprays of a cooling fluid onto the moving extrusion; means for supplying a cooling fluid to said rings; and a plurality of carbon rings stacked in said canister and separating said spray rings, the interior configuration of said carbon rings being substantially the same as, but slightly larger than, the cross-sectional shape of the extrusion in order to closely guide the latter and prevent warpage thereof in its passage through said canister.

2. Apparatus for producing a heat-treated extrusion having a predetermined cross-sectional shape from a heat-treatable aluminum alloy, comprising an extrusion press having a die to produce said shape; a series of carbon guide members mounted along the path of the extrusion emerging from the die, said members having openings therethrough which are aligned with the die and each other and conform closely to the shape of the extrusion, to cause the extrusion to move in a straight line and prevent it from warping as it passes through said carbon guide members; and means located between said carbon guide members and surrounding the extrusion for spraying water upon its surfaces as it passes between said guide members.

3. Apparatus for producing a heat-treated extrusion having a predetermined cross-sectional shape from a heat-treatable aluminum alloy, comprising: an extrusion press having a die to produce said shape; a series of carbon guide members mounted along the path of the extrusion emerging from the die, said members having openings therethrough which are aligned with the die and each other and conform closely to the shape of the extrusion, to cause the extrusion to move in a straight line and prevent it from warping as it passes through said guide members; and means located between said carbon guide members and surrounding the extrusion for spraying water upon its surfaces as it passes between said guide members; said water spray means and said guide members being enclosed in a surrounding canister to facilitate aligning the said openings with the die at the beginning of each extrusion operation.

4. Apparatus for producing a heat-treated extrusion having a predetermined cross-sectional shape from a heat-treatable aluminum alloy, comprising: an extrusion press having a die to produce said shape; a series of carbon guide members mounted along the path of the extrusion emerging from the die, said members having openings therethrough which are aligned with the die and each other and conform closely to the shape of the extrusion, to cause the extrusion to move in a straight line and prevent it from warping as it passes through said guide members; means located between said carbon guide members and surrounding the extrusion for spraying water upon its surfaces as it passes between said guide members; an additional series of like guide members mounted between the die and the first-mentioned guide members; and heating means adjacent said additional guide means for reheating the emerging extrusion prior to quenching it by said cooling spray means.

5. The method of producing a heat-treated extrusion having a predetermined cross-sectional shape from a heat-treatable aluminum alloy comprising the steps: heating an extrudable billet of heat-treatable aluminum alloy to solution heat treatment temperature; maintaining said solution heat treatment temperature for sufficient time to dissolve the soluble hardening constituents; extruding the billet through a die to produce an extrusion having said cross-sectional shape; maintaining the soluble hardening constituents of said alloy in solid solution subsequent to said extrusions; continuously quenching the extrusion while restraining the extrusion from warping; and precipitation hardening the quenched extrusion in substantially the size and shape in which it was extruded to increase the mechanical properties of the extrusion.

6. The method of producing a heat-treated extrusion having a predetermined cross-sectional shape from a heat-treatable aluminum alloy, comprising the steps: heating said alloy to solution heat treatment temperature; extruding the alloy in said cross-sectional shape; quenching rapidly and continuously the emerging extrusion, the alloy having heat-treatable constituents which immediately prior to such quenching are maintained substantially entirely in solution; continuously restraining the extrusion from warping and guiding it in a straight path as it is extruded and passes through the quenching stage; and precipitation hardening the extrusion in substantially the size and shape in which it was extruded to increase the mechanical properties of the extrusion.

7. The method of producing a heat-treated extrusion having a predetermined cross-sectional shape from a heat treatable aluminum alloy comprising the steps: heating said alloy to solution heat treatment temperature; extruding the alloy in said cross-sectional shape through a die; continuously reheating the moving extrusion to solution heat treatment temperature as it moves away from the die; and continuously quenching the reheated extrusion to substantially room temperature as it continues to move away from the die while restraining it against warping and twisting.

8. Apparatus for producing a heat-treated extrusion having a predetermined cross-sectional shape from a heat-treatable aluminum alloy comprising: an extrusion press having a die to produce said shape; means for guiding and restraining the emerging extrusion, said guide means having an interior configuration generally the same as and slightly larger than the cross-sectional shape of the extrusion; heating means for heating said alloy after extrusion to insure solution of the soluble constituents in said alloy prior to subsequent quenching; means for quenching said extrusion; and additional carbon guide members located on both sides of said quenching means, said additional carbon guide members having an interior configuration generally the same as and slightly larger than the cross-sectional shape of the extrusion.

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