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[54] **METHOD OF PROVIDING METAL SLABS FROM A METAL PRODUCTION FACILITY**

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[51] **Int. Cl.**..... **B23k 19/00**, B23p 17/00

[58] **Field of Search**..... 29/527.5, 527.6, 29/527.7, DIG. 32, DIG. 5; 164/76

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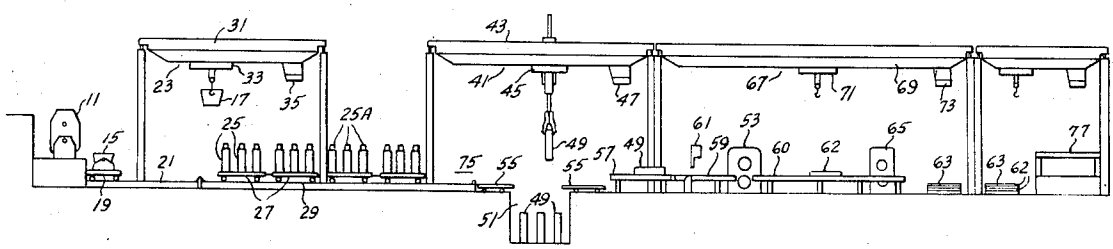
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[57] **ABSTRACT**

Expeditious delivery of plates and slabs from a metal slab producing facility is obtained by teeming a series of ingots to substantially the same height from a molten steel supply, determining a number of already ordered tailored slabs which can be made from each respective ingot leaving over an amount of metal within a predetermined range sufficient to form a single usable stock slab from each ingot for inventory, rolling said tailored slabs into plates for immediate delivery and placing said stock slab in inventory either as a stock slab or stock plate for subsequent delivery on an order for such stock slab or plate.

6 Claims, 3 Drawing Figures



2 Sheets-Sheet 1

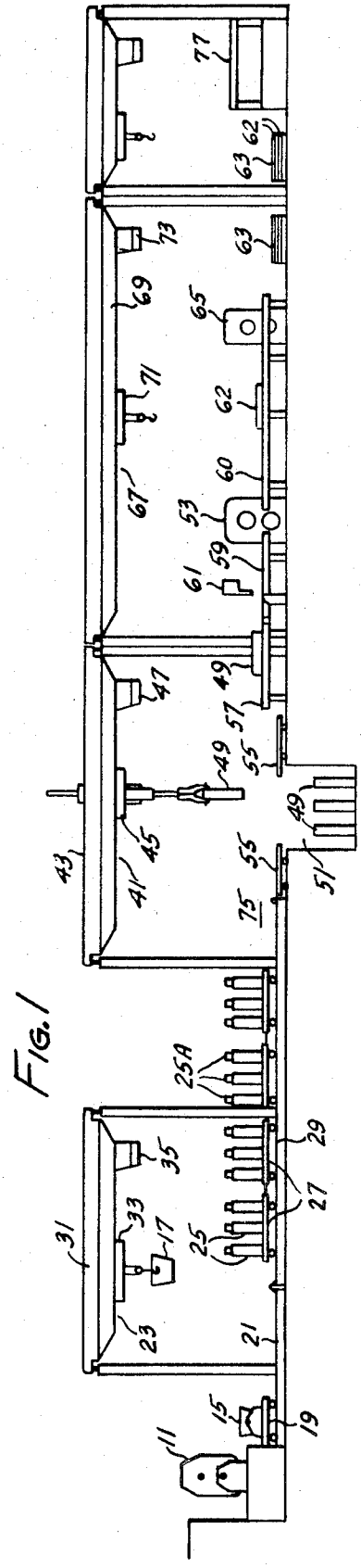


FIG. 1

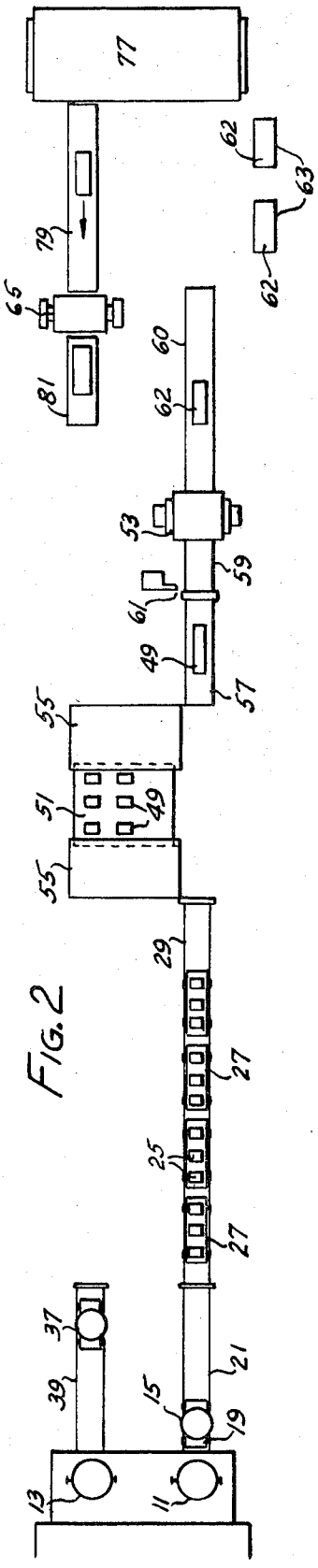


FIG. 2

FIG. 3

SEMI-KILLED
30"x66"x79" INGOT MOLD
INGOT WEIGHT-36,750 lbs.
TOTAL AVAILABLE PRODUCT WEIGHT-31,300 lbs.
160" PLATE MILL
COMPENSATING PROVIDING TABLE

PLATE GAUGE		CONTINUOUS FCE. SLAB WEIGHT RANGE	USABLE TAILORED SLAB WEIGHT RANGE	SLAB SECTION	LENGTH FACTOR
MIN.	MAX.	59" 117"		THICK. WIDTH	"/LB.
.1875	- .499	4575 - 7775	23400 - 26600	4 1/2 x 61	.0128
.500	- .624	5100 - 10100	22660 - 24700	5 x 61	.0116
.625	- .749	5600 - 11125	21600 - 24200	5 1/2 x 61	.0105
.750	- 1.00	6100 - 12125	20600 - 23700	6 x 61	.0096
1.01	- 1.50	6625 - 13125	19600 - 23200	6 1/2 x 61	.0089
1.51	- 1.75	7125 - 14150	18500 - 22700	7 x 61	.0083
1.76	- 2.00	7650 - 15150	17500 - 22200	7 1/2 x 61	.0077
2.0" MAX.		8150 - 16175	16500 - 21700	8 x 61	.0072
2.5" MAX.		8650 - 17200	15500 - 21200	8 1/2 x 61	.0069
3.0" MAX.		9175 - 18200	14500 - 20600	9 x 61	.0064
3.5" MAX.		9675 - 19200	13500 - 20100	9 1/2 x 61	.0061
4.0" MAX.		10200 - 20200	12500 - 19600	10 x 61	.0058
5.0" MAX.		11225 - 22250	10400 - 18600	11 x 61	.0052
6.0" MAX.		12225 - 24275	8400 - 17600	12 x 61	.0048

METHOD OF PROVIDING METAL SLABS FROM A METAL PRODUCTION FACILITY

BACKGROUND OF THE DISCLOSURE

The present disclosure relates to the production of plates from ingots and more particularly to a more efficient method for the production of slabs and plates from ingots whereby additional production and greater customer satisfaction are attained.

Slabs are heavy flat sections rough rolled by a slabbing mill directly from an ingot, sometimes by way of an intermediate stage. A plate on the other hand is a heavy flat section rolled on a plate mill from a slab. A plate is thus one product produced from slabs. It has been the custom in the stell and related industries to produce two broad types of slabs and plates. One of these broad types is the so-called tailored slab which is subsequently made into a tailored plate. A tailored slab or plate is nothing more than a slab or plate made especially to a customer's special order. Since many customers require only one or at most several plates at a time, each of which is more often than not required to be of special dimensions, a very large proportion of a plate mill's output is quite often devoted to tailored plates which require tailored slabs as starting stock.

In addition to tailored or special order plates most plate mills also produce a certain percentage of so-called stock plates. These are plates having more or less standard dimensions which are ordered frequently enough to warrant maintaining a inventory of sorts containing plates of these dimensions held for immediate delivery. Many of the stock slabs and plates which are produced are in reality metal sections accidentally left over after the production of tailored slabs or are, in other words, tailored slabs which did not meet specifications, usually because they were smaller than required.

It has been the general, and, in fact, almost the univeral, custom in the steel industry to attempt to match orders for tailored slabs as the orders are received and attempt to make as many tailored slabs from the metal contained in one ingot as possible. Since the sizes of plates and slabs on order at any one time do not necessarily add up to the aggregate metal contained in any one ingot or aggregation of similar sized ingots, it is necessary, in order to make such slabs, to provide a series of ingots made in various sized ingot molds and poured during teeming to different heights of metal within the ingot molds. Teeming to different heights is difficult to accomplish and often requires that the hot tops on the molds be set to various heights, itself a difficult procedure. The various sizes of molds and various pouring heights have resulted in the customary production of a large number of different sized ingots which must be kept track of through succeeding reheating steps and the like and provided with different soaking times, etc., before they are ready to be rolled and sheared into slabs.

All of these various steps and requirements have each resulted in multiple possibilities for error during the production of slabs and the care required to eliminate such errors has necessarily resulted in additional time requirements for production and unforeseen delays. The additional time for production and, in particular, the unforeseen delays has frequently resulted in customer dissatisfaction and complaints and loss of material.

Previous industry practice after an order for a tailored plate has been received has basically involved the following steps:

a. calculating the weight of metal required to make the final tailored plate,

b. adjusting the calculated amount of metal for the amount of scrap metal customarily lost between the slab and the plate stage,

c. determining the amount of metal required to make several selected tailored slabs for which there are orders, including the tailored slab necessary to make the particular tailored plate in question. This amount of metal will be juggled as necessary by adding several slab orders together in various combinations to obtain a total metal requirement approximately equivalent to one normal sized ingot weight,

d. an amount of excess metal is added to this ingot weight which by experience has been found to be usually more than sufficient to allow for wastage and miscalculations in making and converting the ingot into slabs,

e. the amount of metal which is to be contained within the particular ingot is determined,

f. an ingot mold size and a pour, or teeming, height is selected appropriate to the particular determined amount of metal required for the ingot,

g. the ingot is teemed into the selected ingot mold to the particular pour height, and

h. the ingot is then followed in sequence with other ingots through the soaking pits to make sure that the particular ingot receives the correct soaking time based upon its thickness and composition before being transported to the slabbing mill for rolling into tailored slabs which are subsequently rolled in turn into tailored plates.

It will be seen from the foregoing enumeration of the usual steps of the prior practices that there are a large number of places where the operation can go astray. For example, since the ingot sizes and teeming heights are varied it is quite easy for the ingot mold to become mixed or lost and poured to incorrect heights. It is also very difficult at times to determine at exactly what height the molten metal in an ingot mold is at any given time as the ingot is being teemed and very frequent errors in teeming to a particular height occur. If too much metal is teemed into the ingot mold there is a complete waste not only of the additional metal which was added to the calculation of the metal required for the slabs in the ingot to allow for normal wastage and for mistakes on the low side in pouring but also a wastage of the additional overteemed metal. Since the overteemed or overpoured ingot is seldom large enough to produce a block of excess metal large enough to make an additional slab having usable dimensions, this additional metal is normally good for nothing but scrap for the open hearth or basic oxygen furnaces. Since, however, open hearths are in general slowly being phased out of operation and basic oxygen furnaces are not well adapted for the melting of large amounts of scrap metal, the production of excess scrap from a hot metal shop is not only wasteful and inefficient but can present a considerable problem in disposal.

On the other hand if an ingot is underpoured, or underteemed, by an amount more than the excess amount of metal which has been allowed in the scheduling calculations for wastage and errors in pouring, the ingot

will not be large enough to provide sufficient metal to produce all of the slabs assigned to that particular ingot. Since plate heats and teeming operations are usually scheduled, a substantial period in advance and plate heats are often not made regularly in the typical hot metal shop, a missed heat or slab may frequently result in several weeks delay in fulfilling an order. If a 20,000 pound ingot is aimed for it is not at all unusual in the average shop to end up with an 18,000, 19,000 or 21,000 pound ingot.

In the event that the missed slab was to be a large slab the excess metal left over which is insufficient to produce the missed tailored slab may still be sufficient to make a stock slab for application against future orders for stock slabs or plates. Most stock slabs, in fact, customarily derive from such underteemed ingots. If the amount of metal left over is insufficient to make a stock slab, however, this remaining metal will be good for nothing but scrap. In either event, whether a stock slab can be made from the left over metal or not, there is a delay, and very often a serious delay, in filling the order for the missed tailored slab. In addition to the time required to discover the error, the rescheduling time and the additional production time may add two to three weeks or even more to the fulfillment of a customer's order. Statistically, in at least one shop, three out of every 50 ingots, or 6 per cent of the ingots poured, may not contain enough metal to obtain all the expected slabs from the respective ingots and statistically the record with respect to subsequent attempts to correctly pour an ingot to produce the same missed slab may be come even worse since on the second try about one out of every three teeming operations also misses. It is not unusual, furthermore, for a pour to be missed three or even four times in a row. All this is conducive to considerable delay in fulfilling an order and is, needless to say, hardly conducive to consistent customer satisfaction.

In addition to the overriding problem of missed heats due to insufficient metal in an ingot, the previous methods of operation have also been inconvenient due to the large number of ingot mold sizes which have been required in the past to be kept on hand and the necessity for keeping close track of each individual ingot as it is transferred from the teeming operation to the soaking pits and then to the slabbing mill.

A listing of the ingot mold sizes and pouring heights of the ingots ordered for the teeming of a single plate heat according to prior practice might appear somewhat as follows:

30 × 66	2/671/69	1/73	1/75	2/77	1/78
30 × 59	1/721/74	1/75			
31 × 53	1/651/59				
26 × 50	2/723/73				

This listing would indicate to an experienced teeming operator or steel procuror that eight ingot molds having the dimensions 30 × 66 inches and three ingot molds having the dimensions 30 × 59 inches must be obtained and prepared for teeming along with two other sizes of ingot molds to accommodate the teeming of a particular heat of steel. Two of the 30 × 66 inch ingot molds are indicated to be scheduled for teeming to a height of 67 inches, one to a height of 69 inches, one to a height of 73 inches and so forth through the substantial variety of pour heights listed. The height to which each ingot is to be poured is chalked onto the inside of each

ingot mold, itself a painstaking and difficult job, and when the ingot is teemed the hot metal is poured hopefully to the level of the chalk mark inside of the ingot. The marking of the desired pour heights within the ingots provides a fertile operation for mistakes, and, as may readily be imagined, the attempt to teem the hot molten metal to a chalk mark within the cavity of the ingot mold under typical shop conditions becomes an almost insurmountable task during which numerous mistakes are frequently made. If the ingot molds are to have hot tops placed upon them in order to provide better quality, and also more expensive, steel, the bottoms of the hot tops must be set down to the chalk mark within the ingot mold at the desired height of the resulting ingot and a second chalk mark is then made within the cavity in the hot top to indicate to the teeming crew the level to which the molten metal is to be poured within the hot top. The correct placement of hot tops is itself a ticklish and skilled operation in which many mistakes can occur and the subsequent teeming operation into the ingot molds with the hot tops is also a fertile source of possible mistakes. Not only can mistakes occur in marking the desired pour height on the inside of the ingots, furthermore, but even if the measurements are done correctly the actual internal volume may frequently vary at any given height among ingot molds of the same nominal dimensions.

Heats which are poured into non-uniform mold sizes or poured to non-uniform heights are frequently referred to as "drugstore heats." Each is in effect a special heat and must receive special treatment until it or its resulting ingot reaches the slabbing mill. It is frequently difficult, as explained above, to set up hot tops at correct heights, shuffling of molds is continually going on, some heats must be pulled out of sequence and held to allow a certain predetermined solidification time, with different sized molds having different hold times, and when the ingots are stripped and placed in the soaking pits the different sized ingots will require different soaking times. The ingots then have to be picked out in the soaking pits to allow soaking for the proper period. In a varied mix in the soaking pits the heating time is almost invariably based upon the size of the thickest ingot. This is a very inefficient procedure which, however, is customarily followed even where extremely varied mold sizes are used. All this shifting around and shuffling of ingots exposes the operation to a large change for error and, in fact, a large number of errors in treatment of the various ingots frequently occur throughout the normal operation, all or any of which may result in either a completely missed order or an unsatisfactory end product, neither of which events is conducive to customer satisfaction or good customer relations.

In a typical shop with which the applicant is familiar an average plate heat made in either an open hearth furnace or basic oxygen furnace and then teemed is on the average teemed into three different mold sizes and to eight different pouring heights. There are thus about 24 possible size variations in one average plate heat teeming operation to take into consideration. Some atypical heats, furthermore, have even more size variations. It will readily be seen that it quickly becomes a great problem to keep track of all these different sizes of ingots which may also have different compositions due to additions of the ingot molds or different physical

structures due to different holding and soaking treatments.

Occasionally in prior practice when there simply have been no orders on file to completely fill an ingot mold containing, or scheduled to contain, other tailored slabs a stock slab has been included in one or even two ingots in a given plate heat rather than risk filling the ingot only half full. This has been only an emergency procedure, however, and has not served to decrease the number of ingot sizes or pour heights. In practice the isolated stock slabs scheduled in this manner have actually been treated in the manner of tailored slabs even to the point usually of pouring the ingots in question to marked heights.

SUMMARY OF THE DISCLOSURE

The aforesaid difficulties encountered in prior slab and plate producing operations have now been largely obviated by the hereinafter described method of operation according to the present invention. The present applicant has discovered that the efficiency and reliability of a slab and plate producing operation can be greatly increased if instead of attempting to make as many tailored slabs as possible from each ingot, each ingot is instead programmed to make one or more tailored slabs plus a single stock slab from each ingot. Since usable stock slabs can vary in weight between fairly wide ranges in the usual operation it has been found that it is fiarly easy to produce a usable stock slab in any given ingot even though the production of a tailored slab is quite difficult. The stock slabs produced from each ingot are sent to inventory until an order for such slabs is received. While the inventory of stock slabs thus tends to become larger than under standard operating procedures it is found that the inventory soon reaches an efficient operating plateau where the input and output from inventory is stabilized. At the same time the number of sizes and in particular the number of pouring heights for ingots are greatly reduced with considerable consequent increase in efficiency. In addition, and most importantly, a customer order for a tailored slab or plate is, in the production method of the invention, almost never, if ever, missed. This, of course, leads to very considerably advanced customer satisfaction.

In accordance with the disclosure the size of customarily usable stock slabs in the production operation is predetermined for the particular operation. Each ingot mold in a single teeming operation for a plate heat is filled then to substantially the same predetermined level relative to the ingot mold structure — preferably full, or to the top — and the ingots after solidification and any intermediate treatment such as soaking are rolled into at least one special order slab from each ingot plus one stock slab within the predetermined ranges of usable stock slabs. The tailored slab or slabs are then rolled to tailored plates of the required dimensions and the stock slab is either stored in inventory for a period dependent upon demand for such stock size or may be rolled only after a brief interval into a stock plate for either storage or immediate application to a stock order.

A typical listing of the ingot mold sizes and the pouring heights of the ingots in an average plate heat teemed in accordance with the present invention would be similar to the following:

30 × 66 18/79

In some instances several different sized ingot molds may be used. Except in rare instances, however, all the ingot molds will be teemed to the same level or to comparable levels such as, for instance, full or to the top of the mold.

The disclosure has the following among its more notable advantages over prior practice. Operation in accordance with the disclosure:

a. eliminates the loss of a tailored slab due to underpouring or underteeming of an ingot,

b. eliminates the loss of a tailored slab due to cut backs of an ingot for quality reasons (for instance to eliminate piping or porosity in the top of the ingot),

c. improves dramatically the probability of producing slabs ordered by a customer on time and thus greatly increases customer satisfaction,

d. results in yield improvement, or material savings, since all sound steel possible is ultimately used,

e. obviates the need for varied hot top settings and pour heights on open topped molds,

f. eliminates losses due to interchange of ingots having varied pour heights,

g. eliminates losses due to accidental interchange or mixing of ingots during soaking pit charging and drawing (placement and removal of ingots in soaking pit), and

h. eliminates losses resulting from the so-called rolling of heavy sections or the rolling of ingots having more usable metal than necessary to produce the tailored slabs assigned to them.

Probably the greatest single advantage of the new method of operation is, of course, the increase in customer satisfaction which the new method produces by practically eliminating missed orders.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic overall elevation of a slab and plate producing operation.

FIG. 2 is a schematic plan view of FIG. 1.

FIG. 3 is a typical table for facilitating determination of the number of slabs obtainable from a single ingot.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIGS. 1 and 2 a pair of hot metal converters 11 and 13, which may for example be basic oxygen type furnaces, are arranged to tap molten steel into a pair of teeming ladles 15 and 17. Teeming ladle 15 is shown supported upon a ladle car 19 positioned on tracks 21 in position to receive hot metal from the converter 11 during tapping. Teeming ladle 17 is shown supported from a crane 23 approaching position for teeming into a series of ingot molds 25 supported upon buggies 27 running on tracks 29. As shown the ingots 25 may have hot tops 25A. A craneman can control the location of the span 31 and carriage 33 of crane 23 from cab 35 of the crane 23 to faciliate the teeming operation. A second ladle car 37 for ladle 17 is shown in FIG. 2 supported upon tracks 39. After the ingots of a plate heat derived from the converters 11 or 13 have solidified the ingot molds 25 are stipped from the ingot by a crane 41 having a span 43, carriage 45 and cab 47 and each stripped ingot 49 is placed in a soaking pit 51 where it is heated to a uniform temperature suitable for breaking down the ingot and rolling it in a slabbing mill 53.

Soaking pit **51** has sliding doors **55** for ease of access in placing the ingots **49** within the pit. As shown in the FIGURES the shop is highly simplified and the same crane is used to place the ingots in the soaking pit **51**, remove the ingots from the soaking pit and transfer them to roller conveyors **57** from where the ingots **49** pass to the rolling tables **59** and **60** of the single pass reversing mill stand **53** which serves a dual function both as a blooming mill and a slabbing mill to break the ingots down into blooms and then roll them out into rough slabs. A suitable shear **62** may be positioned between the roller conveyor **57** and the rolling table **59** to serve to crop the head of the ingot initially and also, if desired, to shear the bloom into appropriate lengths prior to the rolling out of individual slabs. After the slabs **61** have been rolled they may be stored in inventory storage **63** or may be immediately passed to the single pass reversing plate mill stand **65** for processing into either tailored or stock plates. A crane **67** having a span **69**, a carriage **71** and a cab **73** may be used to handle the slabs and plates after rolling.

It will be understood that the production apparatus shown in FIGS. **1** and **2** is of only the most basic or essential kind necessary for the production of slabs and plates from a heat of steel. Only a minimum capital expenditure is necessary for the equipment shown. Much additional equipment will customarily be found in the average shop or plant for accomplishing the same purpose. For example the ingots are often transported from the soaking pits to the blooming mills by two separate cranes and an intermediate buggy system, there may be separate roughing or blooming mills and slabbing mills, each with multiple rolling stands, and the inventory storage area and plate mills will often be removed from the immediate vicinity of the slabbing mills. The teeming facilities are also customarily more sophisticated than shown. No attempt has been made to show the charging facilities for the converters in FIGS. **1** and **2** as the charging of the converters is not closely related to the instant invention. It will be understood also that the converters **11** and **13** shown in FIGS. **1** and **2** could be easily replaced by suitable open hearth facilities or other molten steel producing facilities.

In the practice of the invention it will have been previously determined what stock sizes of slabs are customarily usable. Such a determination can easily be made from a statistical survey of the historically most ordered stock slabs or plates within the production unit or in other similar production units. When a plate heat is to be made by the converter shop in one of the converters **11** or **13** a series of ingot molds **25** will be prepared for teeming. Preferably most of the ingot molds **25** will be of the same size and, with relatively rare exceptions, the hot tops **25A** on the ingots will be positioned at the same level upon the ingot mold.

Upon the making of the heat of steel, the steel will be tapped from one of the converters **11** and **13** into a ladle **15** or **17** and then teemed consecutively from the bottom of the ladle by the lifting of a stopper rod in the ladle into each of the ingot molds **25**. With rare exceptions the aim of the teeming crew will be to pour each ingot to the same height in each ingot mold **25**. Preferably the ingot molds **25** will be poured full. Since the pour height will be to the same point in the ingot molds **25** or hot tops **25A** in each case, this standardized pouring operation will be fairly easy to accomplish and there will be few errors made in pouring the steel to the correct height. The ingot molds will, after solidification of the molten metal within them, be moved to a stripping location **75** where the ingot molds are stripped from the ingots inside by the crane **41**. These ingots **49** are then picked up by the crane **41** and placed in the soaking pit for a thorough soaking. Since all of the ingots are very similar in size and substantially the same height the required soaking period for each ingot will be very similar to the soaking period for the other ingots. This uniform soaking period will considerably reduce the usual complications in attempting to provide a correct soaking period for a large number of varied sized ingots. After thorough soaking an ingot will be removed from the soaking pit **51** by crane **41** in the sequence in which the particular slabs are to be rolled and placed on the roller conveyor **57**. Since each ingot will have been teemed to substantially the same height the only variations between the ingots will be in the size of the ingot molds in which the ingots were made. Since the various sized ingot molds are fairly standard, they are soon learned and easily recognized by the operating personnel and the various sizes of the ingots deriving from the molds are also easily recognized. Few mistakes are thus made in removing the ingots **49** from the soaking pit and even if an ingot having the same size as the ingot desired is removed accidentally usually no harm is done in substituting this ingot for the particular one scheduled for production of a particular slab unless the analysis of the steel in the ingot should happen to be widely divergent from that of the desired ingot.

The ingot **49** is passed by the roller conveyor to the rolling table **59** after having had the piped end cropped back to eliminate the pipe and other porosity and the like by the shear **62**. The rolling tables **59** and **60** pass the ingot back and forth through the reversing mill stand **53** to break it down into a bloom and then continue to roll it out into a slab having the required width and gage. This slab is then sheared into one or several tailored slabs which hve been preassigned to it leaving over a single stock slab having the same gage and width as the tailored slabs and a length within customarily usable limits. Alternatively the ingot may be broken down into a bloom which may be sheared into one or several billets containing sufficient metal to be formed into tailored slabs plus one billet which contains sufficient metal to be formed into a usable stock slab after which the respective billets are further rolled into the respective slabs within the slabbing mill **53**. Since a stock slab may usually vary within wide limits it is fairly easy to make sure that there is a usable stock slab left over whereas it is quite difficult to attempt to obtain all tailored slabs from a single ingot.

After the tailored slabs are made they may be heated in the continuous furnace **77** until they again reach the correct temperature for rolling and are then rolled into tailored plates within the reversing mill stand **65** through which the slab is passed by the rolling tables **79** and **81**. These plates are then shipped to the ordering customers. Since no tailored slabs will be missed by reason of not having sufficient hot metal in the ingot to make the slab, very few orders will be delayed beyond the promise date or shipped while only partially completed.

The one stock slab which has been left over from the formation of the required tailored slabs from each ingot will be sent to inventory for storage in well inventoried

piles 63 or the like until an order for such a slab or a corresponding plate is received, at which time these stock slabs 61 will be rolled into stock plates for shipment, or otherwise disposed of. As an alternative the stock slabs may be immediately rolled into stock plates for storage in inventory.

The key to the success of the method of production of the disclosure is the consistent production of one stock slab from each ingot together with as many additional tailored slabs as can be fitted into the ingot. Since a stock slab may vary fairly widely in the amount of metal contained in it so long as it has a reasonable shape it is not difficult to provide enough metal left over to make a suitable stock slab. In one typical production unit, for instance, analysis of historical customer orders has indicated that a usable stock plate may have weight between 3,000 and 35,000 pounds. The procurer, or person who schedules slabs, thus will in this plant merely initially determine how many tailored slabs within a certain general category and for which there are orders will fit into an ingot made in an ingot mold of given dimensions and poured to a standard height and still leave over approximately 10,000 to 25,000 pounds of metal. If the ingot is underpoured, or effectively underpoured due to severe cropping to remove defective metal or the like, there will still be almost always sufficient metal left over to make a usable stock slab and if the slab is overpoured it will be very very seldom that there is enough additional overpoured metal to form a stock ingot larger than the usable range of stock ingots. Thus, by scheduling a stock ingot from each ingot produced, the production procedure is not only simplified but a usable stock ingot is invariably made, leaving only unavoidable production waste as scrap. On the other hand, if it is attempted to make only tailored slabs from most ingots, as has been the previous practice and custom, and as would at first blush seem to be the most efficient production procedure (so long as no mistakes are made), not only is the production procedure greatly comlicated with an increasing probability of mistakes and unforeseen delays but often either one tailored slab is completely lost or there is very excessive scrap wastage from each of a significant percentage of the ingots produced.

While it will be understood that the determination of the number of tailored slabs which can be obtained from an ingot mold can be easily accomplished without outside aid by the procurer — particularly when a stock slab is to be obtained from each ingot — or by a suitable computer, it is sometimes advantageous for the procurer to have available a suitable table or the like to facilitate the calculating of the number of slabs available from any given sized ingot. Accordingly in FIG. 3 there is shown a suitable table made up to facilitate the task of the procurer in determining how many tailored slabs of various dimensions may be obtained from one ingot and still leave over sufficient metal to make a usable stock slab.

In FIG. 3 there is shown a table known as a compensating providing table. This particular table is for use in estimating the ingots for a 160 inch plate mill in a semi-killed ingot mold having nominal dimensions of 30 inches by 66 inches by 79 inches. The ingot weight from this particular sized ingot, when poured to a standard height, is 36,750 pounds and the total available product weight is approximately 31,300 pounds. This allows for the cropping of the ingot to remove piping and porosity and breakdown losses due to scaling and the like and other losses.

In the first column entitled "Plate Gauge," of the table, there are a number of ranges of gage. Assuming that the plate is to have a nominal gage or thickness of 0.55 inches it will be seen to fall within the range in the second column of 0.500 to 0.624 inches. Now let it be assumed that the procurer requires a slab weighing 8,000 pounds. This will be found in column 2 on the second line between the ranges 5,100 and 10,100 pounds. The procurer then knows that he is within the correct range. Assuming that a series of tailored slabs having the same weight are required, the 8,000 pounds is then added as many times as will fit in the adjacent range of 22,660 to 24,700 pounds under the heading in the third column "Usable Tailored Slab." In this case three times 8,000 pounds equals 24,000 pounds which is within the range of 22,660 to 24,700. Thus the procurer knows that he will require a slab section 5 inches by 61 inches from the fourth column entitled "Slab Section."

If different weight tailored slabs are required from the same ingot the weights of the various slabs will be added together until they fall within the range of 22,600 to 24,700 pounds under the heading in the third column of "Usable Tailored Slab." If different sized slabs are required, for instance, a second slab having a gage of 0.80 inches, the procurer will read down in the table until he comes under the heading of "Plate Gauge" to the range of 0.750 to 1.00 inches. If the slab required is to be 9,000 pounds, it comes within the range of 6,100 to 12,125 pounds in the second column under "Continuous Furnace Slab Weight Range." This will then be added together with the 8,000 pounds of the first slab to give 17,000 pounds of slab weight. If an order for another slab having a required weight of 3,600 pounds to 6,700 pounds is available it may be added to the two initial slabs to give a range of 20,600 to 23,700 pounds under the heading "Usale Tailored Slab Weight Range." When he has completed the filling of the range under the heading "Usable Tailored Slab Weight Range" the procurer knows that he will have a usable stock slab left over having a weight between 6,100 and 12,125 pounds. It will be noted that the procurer may go immediately to the thickest gage slab to be produced from a given ingot and work out the procurement of the remainder of the slabs from this point. In the fifth column of the Table there is listed for convenience a so-called length factor, which, when multiplied with the weight of the slab, will give the length of the slab obtainable from the particular amount of metal in the slab. It will be understood that many similar tables can be readily made up to aid the procurer and normally he will have available a set of similar tables covering all possible combinations of slab sizes and weights.

It might seem that producing one stock slab from each ingot made would result in a rapid buildup of inventor and that the difficulties previously encountered in making the ingots would be merely transferred to keeping track of the inventory. This has not proved to be the case, however, as with a good inventory accounting system the inventory can be easily kept in a usable condition. Furthermore, it has been found that though inventory at first tends to build up with the institution of the new system of the invention it soon levels out onto a stable plateau. In one shop in which the pro-

duction system of the invention has been introduced the stock slabs produced now account for approximately 27 per cent of production whereas under the previous production system approximately 20 per cent of the slabs produced were stock slabs. This small increase in production of stock slabs does not provide any great problem in keeping track of the inventory and in fact provides a more varied inventory from which almost any given size of stock slab or plate can be obtained at short notice.

I claim:

1. A method of expeditiously providing plates from a production unit which includes pouring and rolling apparatus for pouring molten metal into ingot molds and subsequently rolling the ingots formed from solidification of the molten metal in the ingot molds into slabs and plates in which method the plates are rolled from slabs which are in turn rolled from ingots containing sufficient metal to make at least two slabs from each ingot according to the mass-volume principle comprising:

a. filling a series of ingot molds with molten metal to substantially the same predetermined level relative to the ingot mold structure,

b. allowing the metal in said ingot molds to solidify into metal ingots,

c. rolling at least one special order slab from each ingot having predetermined dimensions such that based upon the mass-volume principle there may additionally be rolled from the remaining metal left over from rolling said special order slabs a single stock slab having dimensions within a predetermined range of dimensions encompassing the slab sizes necessary to provide stock for rolling plates of the historically most requested dimensions in the production unit,

d. rolling the metal left over from step (c) of rolling said special order slabs from each ingot, into a single stock slab from each ingot,

e. rolling the said special order slabs produced in step (c) into special order plates for substantially immediate supply to the ordering customers, and

f. storing the said single stock slab from each ingot in inventory for later retrieval for subsequent rolling of additional products requiring for their production an amount of metal substantially the same as the amount of metal contained in each respective stock slab.

2. A method of providing plates from a production unit according to claim **1** wherein at least two special order slabs are rolled from substantially a majority of the ingots produced.

3. A method of providing plates from a production unit according to claim **2** wherein the single stock slabs from each ingot are substantially immediately rolled into plates.

4. A method of providing plates from a production unit according to claim **3** wherein the number of special order slabs of predetermined dimensions which can be rolled from each ingot leaving over a stock slab having dimensions within predetermined usable limits is determinable from a previous compilation of the number of tailored slabs of varying dimensions obtainable from ingots of varying dimensions with but a single stock slab left over.

5. A method of providing plates from a production unit according to claim **4** wherein the predetermined dimensions of the usable stock slabs is determined from a previous statistical compilation of the plates and slabs historically most frequently ordered from said production unit.

6. A method of providing plates from a production unit according to claim **1** wherein at least some of said stock slabs are rolled into stock plates before at least brief storage in inventory.

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