Dec. 1, 1970 H. G. BAUMANN ET AL 3,543,555

FORM CHANGING DEVICE FOR CONTINUOUS CASTING

Filed Jan. 18, 1968 2 Sheets-Sheet 1

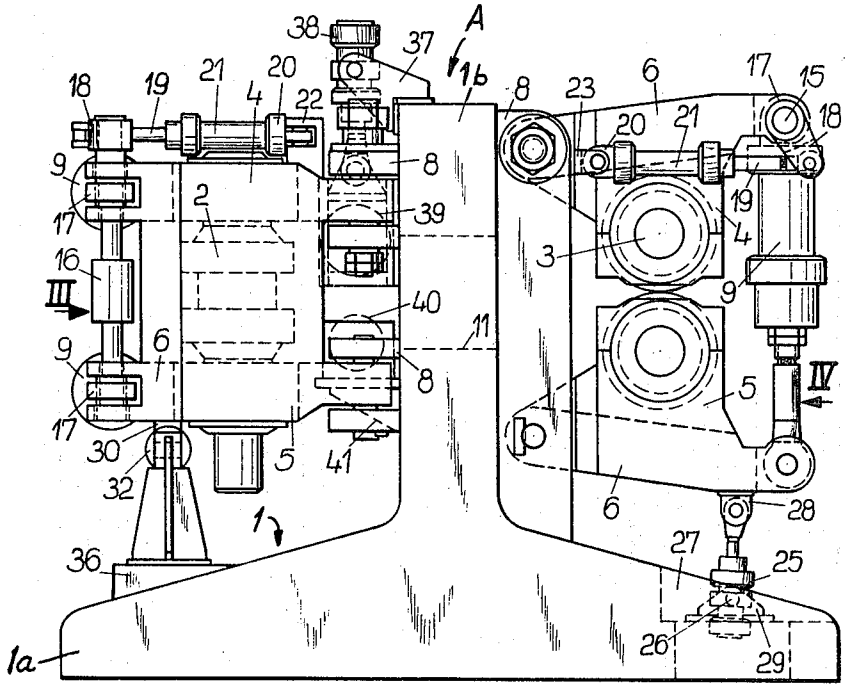


Fig.1

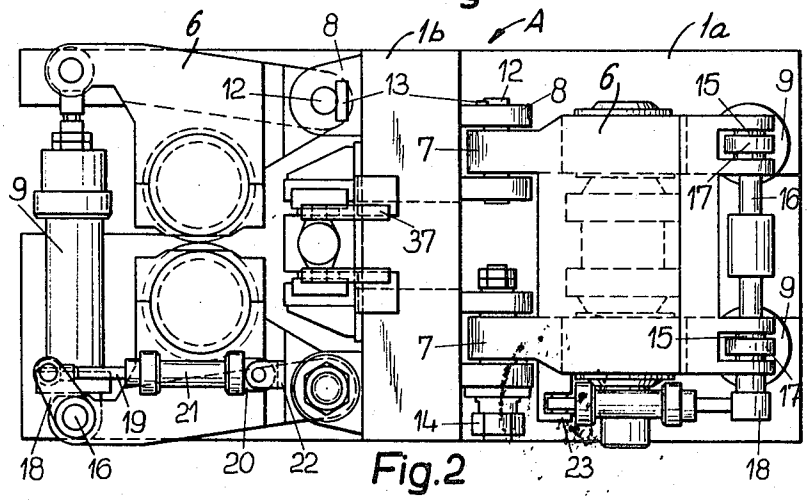


Fig.2

Inventors
HANS G. BAUMANN
GERHARDT K. KOMMA
BY
McGlew & Toren
ATTORNEYS

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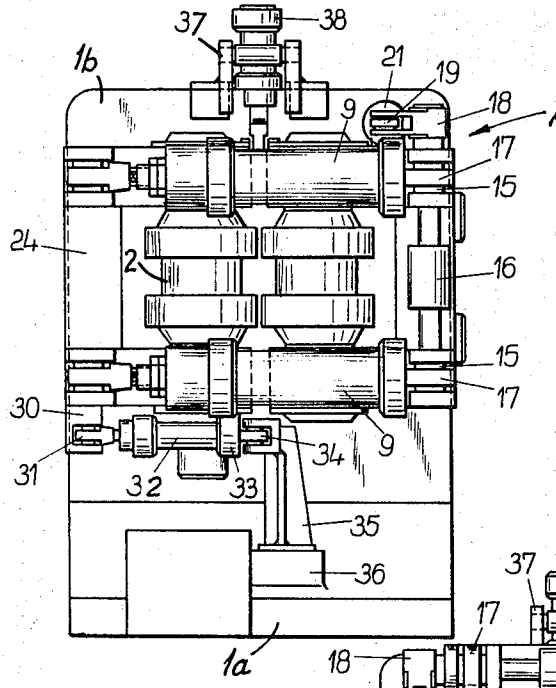


Fig. 3

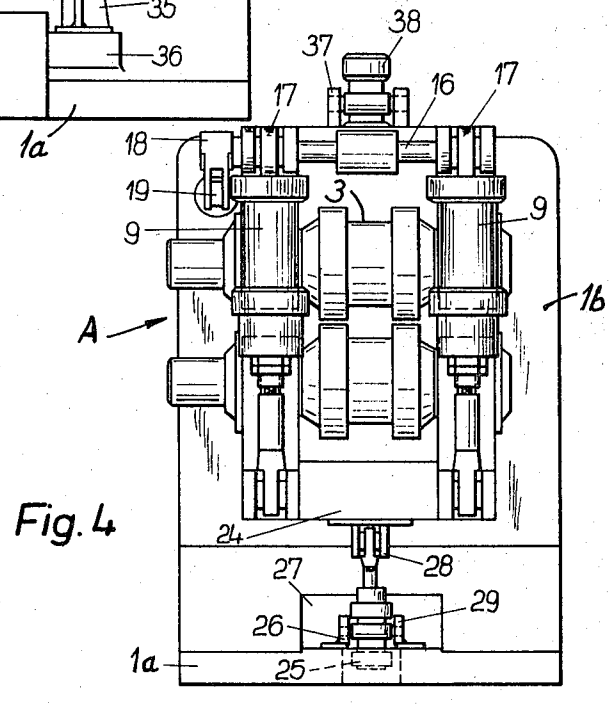


Fig. 4

Inventors
HANS G. BAUMANN
GERHARDT K. KOMMA

BY
McClew & Toren
ATTORNEYS

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FORM CHANGING DEVICE FOR CONTINUOUS CASTING

Hans G. Baumann and Gerhard K. Komma, Duisburg, Germany, assignors to Demag Aktiengeseilschaft, Duisburg, Germany

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U.S. Cl. 72—224 21 Claims

ABSTRACT OF THE DISCLOSURE

A form changing device for castings in a continuous casting operation is formed of a rigid frame for suporting form changing rolls. In a preferred embodiment, the frame has an inverted T-shaped configuration with its upright web having an opening for the passage of the casting from a pair of vertically arranged rolls supported on one side of the web to a pair of horizontally arranged rolls on the other side. Support arms are articulated to and extend outwardly from the web and each form changing roll is supported by a pair of spaced support arms. Adjustable means are secured to the outer ends of the support arms for varying the spacing between cooperating rolls. Cross members are provided between the adjusting means to supply additional rigidity to the device. One of the cross members may be a shaft provided with cams for affording a fine adjustment of the spacing between cooperating form changing rolls. A bearing means including an adjustably movable member, such as a piston cylinder and arm, permits the pivotal movement of the combination of the support arms, adjusting members, and cross members relative to the web of the frame. An adjustable holddown device is provided on the web of the frame for properly positioning the casting in its passage between the horizontal and vertical rolls.

SUMMARY OF THE INVENTION

The present invention is directed to a form changing device for castings in a continuous casting operation and, more particularly, it is concerned with a form changing device containing a rigid frame construction for supporting adjustably positionable vertical and horizontal pairs of form changing rolls.

In a continuous casting operation, the exterior of the casting is worked immediately after it emerges from the casting press, this is done not only for metallurgical reasons, but also for other processing which must be performed on the casting. In particular, at this part of the operation, a change in the cross sectional form of the casting takes place in the range of the lowest point of the liquid pool within the casting and results in a stretching of the casting.

In continuous casting operations, when the rolling is performed with the casting still in a somewhat molten condition, a relatively low speed of travel of the casting is important. It is not possible to utilize the same devices in continuous casting operations as are used in conventional rolling mills. In rolling mill operations, high speeds are imparted to the material being formed and the energy of the quickly moving material is employed to advantage in providing it with the desired form. Compared to continuous casting operations, the forming at high speed in rolling mills provides a much simpler process.

In continuous casting, however, the situation is considerably more difficult because the rate of speed of the casting or strand is only a few meters per minute, and

further, consideration must be given to the vraied dimensions of the casting. For example, the greater the cross section of the continuous casting, the greater will be both its heat content and the length of its liquid pool at the point at which the casting is to be roll formed. Consequently, in continuous casting operations special demands are made on the form changing device in adapting to the varying dimensions of the casting as it travels at relativeiy low rates of speed, and further consideration must be given to the type of steel used in the casting.

Accordingly, the primary object of the present invention is to afford a form changing device which is rigidly yet adjustably supported for adapting to the various changes in the dimensions of the castings.

Another object of the invention is to provide form changing rolls which are easily replaceable.

A further object of the invention is to utilize alternating horizontal and veritcal pairs of rolls for forming the castings.

Still, another object of the invention is to afford adjusting means for the rolls for adapting to the various temperature difference which exists within the continuous casting as compared to the temperature conditions at the shell or outer surface of the casting.

Moreover, another object of the invention is to provide an adjusting device for the rolls which affords both a coarse and a fine adjustment of the spacing between the rolls.

Yet, another object of the invention is to provide means for rigidly supporting the form changing rolls yet permitting adjustable movement of the rolls relative to the frame.

A further object of the invention is to provide a compact arrangement of the rolls and their supporting members whereby a multiple number of the form changing devices can be positioned within a relatively small space.

Therefore, the present invention is directed to a form changing device incorporating a frame or support member on which the deforming rolls can be easily replaced and in which the frame is rigid and resistant to bending forces. A structural member having an inverted T-shaped cross section with a passage through its upright web for the casting is considered particularly adaptable for positioning and supporting the deforming rolls on opposite sides of its web. During continuous casting operations, because of the high deforming forces which are exerted against the casting as it travels at a low rate of speed, the construction of the frame is especially suitable for adjusting to the changing cross sections of the castings.

In a preferred form of the invention, a pair of vertically arranged deforming rolls are positioned on one side of the upright web portion of the frame while a horizontally arranged pair of deforming rolls are positioned on the opposite side of the web. The pairs of rolls are aligned with one another for passing a casting therebetween through the opening in the web. The construction of the device permits the rolls to be held securely in place and at the same time to be adjustable as required due to the varying cross sectional dimensions of the castings.

Another important feature of the invention is the manner in which the vertically and horizontally arranged rolls are movably, yet rigidly, positioned on the frame. Support arms are articulated or pivotally secured to the frame at one end and are attached to adjusting members, for example, at their other ends. The support arms are constructed to afford easy removal and replacement of the deforming rolls. Further, the time required for making a changeover of the rolls is reduced, and because of the interchaneability of the horizontally and vertically arranged rolls, a relatively small stock pile of rolls is required for form changing operations. Moreover, in the de-

forming operation, since the forces applied by the rolls are directed perpendicularly to one another on opposite sides of the web of the frame a simple construction of the frame is afforded. Additionally, because of its simple and compact construction, the frame is accessible from all sides and it is possible to arrange a number of similar devices in side-by-side relationship for use in multiple continuous casting operations.

In the present invention both a coarse and a fine adjustment is provided for the cooperating rolls. When operation of the form changing device is commenced, the coarse adjustment can be effected and any fine or precise adjustments can be made during operation to offset any of the changes in the dimensions of the casting as it travels throughout the device.

Another important feature of the invention is the provision of cross members extending in the direction of the axes of the rolls and interconnecting the ends of the support arms secured to the adjusting members. These cross members afford additional rigidity for the form changing device. Accordingly, with the support arms securely held in two directions by the adjusting members and the cross members there is no need of a special construction for the arms, and a greater rigidity is provided for the roll support arrangement.

With the provision of the cross members extending between the support arms and the adjusting members, the use of cams or similar devices in combination with the cross members furnishes a fine adjustment for the positioning of the rolls. During the form changing operation it often happens that a small bearing force is required, depending on the degree of deformation to be imparted, therefore, the main members of the adjusting arrangement for the rolls serve more as supports for the passage of the continuous casting and for absorbing the deformation forces. As compared to the adjustment afforded by the main adjusting members, though a smaller range of adjustment is provided by the cams, a greater degree of accuracy is available.

In the passage of the casting from one pair of rolls to the other, the proper alignment of the pairs of rolls can be achieved by an adjustable lifting member which supports the roll support arrangement. For example, a lifting device can be provided under the cross member of the support arrangement for the horizontally arranged rolls for properly positioning the rolls relative to the other pair. In this arrangement, it is a prerequisite that the direction of movement of the continuous casting takes place first through the horizontally arranged rolls and then through the vertically arranged pair.

While the construction of the frame and of the support arrangement for the rolls provides sufficient rigidity for the continuous passage of the casting between the two pairs of deforming rolls, the casting may be deflected in either the vertical or the horizontal direction during passage between the pairs of rolls. To prevent this possibility, a holddown roll is mounted on the frame member intermediate the horizontally and vertically arranged rolls. The holddown roll is adjustably actuated by a member, such as a hydraulically adjustable device, for properly positioning and applying force to the casting as it passes between the two pairs of rolls. In the inverted T-shaped frame, the holddown roll is located at the point where the casting passes through the frame and, thereby, provides additional rigidity for the form changing device.

Another valuable feature of the invention is the interchangeability of the horizontal and vertical rolls with their support arms and adjusting members. By means of cranes or similar lifting devices, repair work can be quickly carried on the form changing device without any appreciable loss of time. The exchangeability of the rolls and their adapting to different dimensions of the casting.

In the present invention, the adjusting members for the horizontally and vertically arranged rolls can be arranged to be actuated only in mutual dependence. In such an arrangement, if the horizontally arranged rolls are moved

apart then the vertically arranged rolls are also rearranged in a similar fashion. In positioning the horizontally and vertically arranged rolls, each pair is aligned with the center of the continuous casting by an adjusting cylinder or similar arrangement.

Due to the support arrangement, provided for the rolls by means of the support arms, the adjusting members and the cross members, in addition to affording mobility of adjustment, correction of any dislocation in the axial shifting of the roll can be accomplished.

As a result, the present invention provides not only for the metallurgical problems experienced in forming a casting but also takes care of various other problems experienced during the continuous casting operation.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there is illustrated and described a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 shows a side view of a form changing device for a continuous casting operation embodying the present invention;

FIG. 2 is a plan view of the device shown in FIG. 1;

FIG. 3 is an end view of the device shown in FIG. 1 taken in the direction of the arrow III; and

FIG. 4 is an end view of the device shown in FIG. 1 taken in the direction of the arrow IV.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the drawings, a form changing device A is shown for a continuous casting operation. The device A is formed by an inverted T-shaped frame **1** having a base **1***a* and a web **1***b* extending upwardly from the base section. On one side of the web **1***b* is a pair of vertically arranged deforming rolls **2** and on the opposite side is a pair of horizontally arranged deforming rolls **3**. Each of the rolls **2, 3** is positioned at its opposite ends within covered bearings **4, 5**. The bearings **4, 5** are part of the support arm **6** which, at their ends adjacent the web **1***b*, are pin-connected or articulated to bearing blocks **8** integrally attached to the web. The support arms **6** extend outwardly from the web and are secured at their outer ends to piston cylinder drive mechanisms **9**. Each of the rolls extends between a pair of support arms **6** and the piston mechanisms **9** are disposed perpendicularly to the axes of the rolls they support and they extend between the outer ends of two support arms providing bearing for different rolls. Though not shown in the drawings, the piston mechanism **9** may be interconnected by control means and may be actuated in mutual relationship. An opening **11** is provided through the web **1***b* of the frame for the passage of the casting between the oppositely disposed pairs of rolls **2, 3**.

The support arms may be easily removed from the frame by removing the pins **12** or the safety wedges **13** or a similar attaching means **14** which secures the ends **7** of the support arms **6** to the bearing blocks **8**.

In addition to the adjustment for the rolls provided by the piston cylinder drive mechanisms **9**, a further fine adjustment is accomplished by means of cams **15** located on cross shafts **16** extending between the movable ends of the piston drive mechanism **9**. For each pair of rolls, the cross shaft **16** extends in spaced parallel relationship with the axis of the roll disposed between the support arms attached to the movable ends of the piston drive mechanism **9**. The cams **15** are positioned on the cross shafts **16** and interengage the ends of the support arms **6** and the end bearing sections **17** of the piston drive mechanisms **9**. Accordingly, when the cross shaft **16** is ro-

tated, the position of the cams relative to the support arms is changed and a fine adjustment of the rolls supported by the support arms is achieved. In order to turn or rotate the cross shaft **16**, a lever is secured to one end of the shaft and to a drive rod **19** extending from the housing **20** of a piston drive mechanism **21**. As can be seen in FIG. 1, the piston drive mechanism **21** is pin connected to the bracket **22** formed on the support arm **6** for the vertically arranged rolls **2**. A similar bracket **23** is illustrated in FIG. 2 and is provided on the outer side of the support arm **6** for the horizontally arranged pair of rolls.

At the opposite ends of the piston drive mechanisms for the cross shaft **16** a cross beam **24** extends between the support arms **6** and is in parallel relationship with the axes of the rolls. The cross shaft **16**, and the piston drive mechanisms **9**, in combination with the support arms **6** and the web **1***b* provide a support structure which is capable of withstanding all of the forces which might be developed in the course of deforming a casting as it passes through the forming changing device A. As can be seen in FIG. 4, this overall frame construction is adjustably positionable for the horizontally arranged pair of rolls **3** by means of a piston drive **25**. The piston drive **25** as shown in both FIGS. 1 and 4 is pivotally secured to the base **1***a* of the frame **1** by means of a pin extending between the bearing brackets **29** located in the recess **27** in the base of the frame. At its upper end, the piston drive **25** is connected to the cross beam **24** by means of a pin connection through the bearing block **28**.

A somewhat similar arrangement is provided for the vertically arranged rolls **2** as shown in FIGS. 1 and 3 by a piston driven mechanism **32** having a piston arm **31** pivotally attached to a bearing block **30** secured to the cross beam **24** and also pivotally secured at the other end of its housing **33** to a bracket **34** on a stationary support block **35** attached to a lug **36** on the base **1***a* of the rigid frame **1**.

At the upper end of the **1***b*, a support bracket **37** is secured to the frame **1** and extends laterally from it in the direction of the vertically arranged rolls **2**. Pivotally attached to the bracket **37** is a piston drive mechanism **38** which adjustably secures a piston roll **39** at a point immediately adjacent the opening **11** through the web **1***b*. At the lower portion of the opening **11** through the frame, a support roll **40** is aligned below the holddown roll **39** and is attached by means of a bracket **41** to the frame. The holddown roll **39** is adjustably positionable relative to the roll **40** to properly position castings being fed through the opening **11** in the frame between the vertically and horizontally arranged rolls **2, 3**.

The rigid frame need not be designed as a rectangular cross section. Because of the location of the bearing blocks **8** for the support arms on either side of the web **1***b*, an additional reinforcement is provided against the twisting or bending action exerted on the frame due to the oppositely disposed stresses exerted by the horizontally and vertically arranged rolls **2** and **3**.

In operation, a casting is passed first between one pair of deforming rolls then through the opening **11** in the web **1** and finally through the other pair of rolls. As it passes through the frame the hold down roll **39** positions the casting against support roll **40** to prevent any displacement in the course of its passage between the oppositely disposed rolls. In commencing the passage of the casting between the rolls, the initial adjustment of the rolls can be accomplished by means of the piston drive mechanism **9**, and during the form changing operation any variations which occur in the casting can be taken care of by means of a fine adjustment using the cams **15** on the cross shafts **6**. In addition to the adjustment afforded by the piston drive mechanisms **9** and the fine adjustment achieved by means of the cams **15** and the piston drive mechanism **21**, the rolls as a complete unit with the frame can be adjusted using the piston drive mechanism **25** for the horizontally arranged rolls and the piston drive mechanism **32** for the vertically arranged rolls.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A form changing device for castings in a continuous casting operation comprising a rigid support frame, a plurality of support arms secured to and extending from said support frame, a pair of vertically positioned rolls arranged for the passage therebetween of a continuous casting in contacting relationship with said rolls, a first group of said support arms for supporting said vertically positioned rolls, a pair of horizontally positioned rolls arranged for the passage therebetween of a casting in contacting relationship with said rolls, a second group of said support arms for supporting said horizontally positioned rolls, the opening between said vertically positioned rolls is aligned with and spaced from the opening between said horizontally positioned rolls for passing a casting first between one of said pairs of vertically and horizontally positioned rolls and then between the other said pair, and means secured to said support arms at spaced positions from said frame for adjusting the spacing between cooperating rolls in said pairs of horizontally and vertically positioned rolls.

2. A form changing device for castings in a continuous casting operation comprising a rigid support frame, a plurality of support arms secured to and extending from said support frame, a pair of vertically positioned rolls arranged for the passage therebetween of a casting in contacting relationship with said rolls, a first group of said support arms for supporting said vertically positioned rolls, a pair of horizontally positioned rolls arranged for the passage therebetween of a casting in contacting relationship with said rolls, a second group of said support arms for supporting said horizontally positioned rolls, said vertically positioned rolls aligned with said horizontally positioned rolls for passing a casting therebetween, means secured to said support arms at spaced positions from said support frame for adjusting the spacing between cooperating rolls in said pairs of horizontally and vertically positioned rolls, and each of said support arms articulated at one end to said support frame and at the opposite end thereto to said means for spacing said cooperating rolls in said vertically and horizontally positioned pairs of rolls.

3. A form changing device, as set forth in claim **2**, wherein each of said rolls extend between a different pair of spaced support arms, and one pair of said support arms holding one of said rolls is movably displaceable relative to the other pair of support arms holding the other cooperating said roll in each of said pairs of vertically and horizontally arranged rolls for adjusting the spacing therebetween.

4. A form changing device, as set forth in claim **3**, wherein said means for adjusting the spacing between the cooperating rolls in each said pair of rolls comprises a pair of adjustably movable members for each pair of vertically and horizontally positioned rolls, each of said adjustably movable members attached at its opposite ends to one of said support arms each of which holds a different one of said rolls, whereby said movable members are arranged to be coordinated for similar movement for displacing said support arms holding the movable one of said rolls an equal distance relative to the other roll in said pair of rolls.

5. A form changing device, as set forth in claim **4**, wherein said adjustably movable members are piston cylinders having a movable piston arm extending from one end thereof, each of said piston arms connected to one of said support arms.

6. A form changing device, as set forth in claim 5, wherein a cross shaft extends between and through the ends of the piston arms of said piston cylinder and the ends of said support arms secured to said piston cylinders and is disposed in parallel relationship to the axis of the movable one of said rolls extending between said support arms to which it is attached.

7. A form changing device, as set forth in claim 6, wherein cams are mounted on said cross shaft at the location of the junction of said cross shaft support arm and piston arm wherein by rotating said cross shaft said cams located thereon provide a fine adjustment in the positioning of the movable one of said rolls secured to the support arms connected to said cam.

8. A form changing device, as set forth in claim 7, wherein a lever is secured to said cross shaft, and means are attached to said lever for rotating said shaft.

9. A form changing device, as set forth in claim 8, wherein said means attached to said lever comprises a piston cylinder having a movable arm secured thereto for moving said lever and in turn rotating said shaft.

10. A form changing device, as set forth in claim 9, wherein said piston cylinder for moving said lever is attached to said support arm secured to said cross shaft.

11. A form changing device, as set forth in claim 6, wherein a cross beam is arranged at the opposite ends of said piston cylinders, from and in substantially parallel relationship with said cross shaft, said cross beam attached to said piston cylinders and to said support arms located at the ends of said piston cylinders opposite said cross shaft.

12. A form changing device, as set forth in claim 11, wherein an interconnected frame articulated to said support frame through said support arms is formed by said support arms, piston cylinders for adjustably positioning said support arms, cross shafts and cross beams for withstanding the various forces acting on a casting passing through the form changing device.

13. A form changing device, as set forth in claim 12, wherein an adjustable bearing assembly extends between said support frame and said cross beam for positioning said interconnected frame on said support frame.

14. A form changing device, as set forth in claim 13, wherein said adjustable bearing assembly comprises a bearing block attached to said support frame, a bearing block attached to said cross beam and a piston cylinder having a movable piston arm extending between and connected to said bearing blocks.

15. A form changing device, as set forth in claim 12, wherein said support frame comprises a base member and a web member integrally attached to and extending upwardly from said base member, said web member having an opening therethrough, said pair of vertically positioned rolls located on one side of said web member and said

pair of horizontally positioned rolls located on the opposite side of said web, said pairs of rolls aligned with the opening through said web for passing castings through the opening between said pairs of rolls.

16. A form changing device, as set forth in claim 15, wherein said support frame has an inverted T-shaped configuration.

17. A form changing device, as set forth in claim 15, wherein a holddown roll asembly is supported on said web and comprises a holddown roll located at the position of the opening through said web.

18. A form changing device, as set forth in claim 17, wherein said holddown roll assembly comprises a support member attached to and extending from one side of the upper end of said web, a piston cylinder having a movable piston arm secured to said support member and to said holddown roll.

19. A form changing device, as set forth in claim 18, wherein said holddown roll assembly comprises a support roll attached to said web adjacent the opening therethrough and aligned below and in spaced relationship with said holddown roll, the space between said holddown roll and said support roll being adjustable by means of said piston cylinder attached to said holddown roll for adapting the spacing between the holddown and support rolls to the various dimensions of the casting passing through said opening in said web between said pairs of rolls.

20. A form changing device, as set forth in claim 2, wherein brackets are secured to said support frame, means for pivotally connecting said support arms to said brackets whereby said means are easily removable from said support arm and bracket for removing said support arm and replacing said rolls.

21. A form changing device, as set forth in claim 1, wherein means are provided for removably securing said support elements to said support frame so that said support elements and said rolls which are supported thereby are interchangeable between the horizontally arranged and the vertically arranged positions.

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MILTON S. MEHR, Primary Examiner

U.S. Cl. X.R.

72—245; 164—282