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(54) FLAME CUTTING MEANS FOR DIVIDING A SLAB LONGITUDINALLY

(71) We, THYSSEN AKTIENGESELLSCHAFT, a Company organised according to the laws of the Federal Republic of Germany of 4100 Duisburg, Federal Republic of Germany, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to apparatus for dividing a slab longitudinally.

In conjunction with steel continuous casting plants it is proposed in the Japanese laid-open specification 50-128 628 to divide the strand longitudinally by flame cutting directly subsequent to the roller apron and then to divide the strand transversely. In the case of this proposal the strand is divided longitudinally when hot and then divided transversely. This construction does not guarantee an exact longitudinal division with desired proportion for various reasons. One is that it is problematic to alter the division proportion during continuous casting when the strand is being continuously extracted. Moreover, exact straightening of the strand longitudinally is not guaranteed as the continuously extracted strand does not always assume exactly the same position. The specialists have therefore preferred to divide excessively wide slabs longitudinally when cold. A corresponding proposal is known from the publication "Concast News" 13 (1974, pages 6 and 7). The advantages of longitudinal division of cold slabs are regarded as being that less slag and fumes are produced on division and that the cycle time of longitudinal division is independent of the casting speed. The disadvantage of these known plants is that they need a substantial amount of space and often additionally need an intensive cooling plant in order to cool the slabs, which have been cut into lengths, quickly down to room temperature.

The object of the present invention is to provide apparatus for dividing a slab longitudinally which may provide a quick and exact longitudinal division at the same time being low in apparatus costs and having a simple construction.

According to the present invention there is provided apparatus for dividing a slab longitudinally, the apparatus including at least one longitudinal dividing device which has a slab bearing means, at least one flame cutting means, a cutting point opening located below the flame cutting means in the slab bearing means and displacement means which is located at at least one of the longitudinal sides of the slab bearing means and which is adapted to move the slab transversely.

The slab can thus be straightened laterally with the aid of the displacement means as well as be moved transversely with respect to the flame cutting means. Preferably, if the cutting point opening corresponding to a flame cutting means in the slab bearing means is fixed, that flame cutting means is constructed and arranged so as not to be shiftable in the transverse direction. Such an arrangement is particularly advantageous if the displacement means is in the form of a so-called "centering means" which "centres" and shifts the slab relative to the (fixed) cutting point opening in tranverse direction of the longitudinal dividing device. This "centering means" preferably includes an abutment surface at one longitudinal side of the slab bearing means and means at the other longitudinal side of the slab bearing means to push in use a slab lying on the slab bearing means against the abutment surface. The abutment surface is preferably movable in a transverse direction relative to the slab bearing means so that in use the position of the abutment surface determines the transverse position of a slab lying on the slab bearing means relative to the flame cutting means and the (fixed) cutting point opening such that the division proportion can be adjusted exactly. The slab can thus be shifted with the aid of the centering means. The centering means can thus be in abutting relationship with the longitudinal side of the slab, for example, it may be arranged vertically with respect to the broad side of the slab. The transverse movement of the centering means can be stopped after the slab has been centered. By "centered" it is meant placing a slab lying on the slab bearing means in a desired transverse position relative to the cutting torch(es). The cutting line need not correspond to a centre line on the slab, but is such to divide the slab into the desired portions, for example 2/5 and 3/5. The longitudinal dividing device need therefore have only a few parts which are mobile during operation. It can thus be guaranteed that the slabs can be divided longitudinally with the aid of this device in a desired division proportion and very accurately.

It is preferred that the cutting point opening is in the form of a gap which extends through the slab bearing means and leads to a channel for receiving the waste material. With this construction the waste material can be easily removed. It is particularly advantageous in this construction if the suction device for removing the fumes is attached to the channel. It has been found that besides the slag produced approximately 90% of the fumes produced arise below the slab and therefore by using the suction device almost all of the disturbing fumes can be removed. If the gap is not particularly large, there can be the advantage that only a small proportion of infiltrated air (false air) is also sucked off. It is thereby possible to deal with the problem of waste gas effectively even with relatively low suction performance of the suction device. This aim is realised in an even better way if—apart from the necessary cutting point opening—the channel can be closed for the most part in order to minimise the penetration of infiltrated air. Expedient solutions for this are explained below in connection with Figs. 3 and 4 of the accompanying drawings.

According to one embodiment the cutting torch and the cutting point opening are fixed in both transverse and longitudinal direction of the device, whereby the slab is pushed over the cutting point opening in the longitudinal direction for division longitudinally. The slab is thereby guided longitudinally by the stopped (secured) displacement means. In this construction the cutting point opening and the channel situated below it are restricted in the longitudinal direction of the device to a narrow space so that the slag produced in this space can be easily removed. It is preferred in this construction that a single cutting torch is used in order to guarantee a smooth cut edge without any faults.

According to another preferred embodiment the cutting point opening extends over substantially the entire length of the slab bearing means and two flame cutting means are present which are movable longitudinally in opposing directions. The combination of such a cutting point opening with a channel for receiving waste material which connects with the gap and which extends practically over the entire length of the longitudinal dividing device below the slab bearing means can provide an arrangement in which the slab can be divided quickly in the longitudinal direction, i.e. in almost half the time, whereby at the same time slag and fumes are removed simply. As an alternative to the channel provided over substantially the entire length of the longitudinal dividing device it is possible to provide a bucket, for example, which can be removed in the conceived gap direction, i.e. a much shorter slag collecting device, whereby the feed motion of the bucket must be coordinated with the feed motion of the cutting torch. The construction with the movable bucket can be used advantageously when the slab lies securely on the bearing means during the entire flame cutting process, i.e. the slab does not move excessively with respect to the torch during the flame cutting.

It has been observed that the formation of sabre-shaped longitudinal sides of the slab can be avoided by maintaining the surface temperature as high as possible during longitudinal division. Conversely, the present applicant has established that at slab temperatures of approximately 150°C to 250°C the slabs tend to distort outwardly in the form of a curved sabre extending outwardly from the flame out line so that further treatment of the divided sabre-shaped slabs is made more difficult. Longitudinal division at surface temperatures of over 300°C, preferably over 500°C, is preferred.

These desired high surface temperatures can be achieved by conveying slabs which have been cut in lengths from a continuously cast strand by transverse cutting directly to a longitudinal dividing device from the casting heat at surface temperatures of over 300°C.

Apparatus including a transverse cutting device, at least one transport means, and at least two longitudinal dividing devices arranged so that, in use, a slab cut-off from a continuously cast strand by the transverse cutting device is conveyed by the transport means selectively to the longitudinal dividing devices forms the subject of our co-pending parent application No. 6902/78 Serial No. 1 600 684. A common transport means is preferably provided as transport means supplying all the longitudinal dividing devices. A favourable arrangement as to space can thus be achieved if the common transport means is in the form of a transverse transport means.

In such an arrangement the longitudinal dividing devices are preferably provided in the proximity of or at the height of a runout roller table allocated to the strand. In particular the longitudinal dividing devices are conveniently arranged parallel to the runout roller table. Even at high casting speeds longitudinal division can thus be carried out in a very short time after the transverse cutting so that the slab need merely be conveyed to the respective free longiudinal dividing device by means of the transport means after transverse cutting. As the transverse cutting device, the run-out roller table, the transport means and the longitudinal dividing devices are arranged very close together, an entire plant may be space-saving and constructionally simple. Moreover the slab cut from the strand can be moved on without delay after transverse cutting and can be divided longitudinally practically without delay to guarantee the highest possible surface temperature.

The present invention is particularly suited for dividing steel slabs. It is also particularly suitable for dividing slabs of magnetic sheet materials with a silicon content of $>0.6\%$, preferably $>1.5\%$ Si.

A particular embodiment of the invention will now be described by way of example only with reference to the accompanying drawings, in which:—

Fig. 1 shows a top view onto an entire plant with several longitudinal dividing devices,

Fig. 2 shows a top view onto one of the longitudinal dividing devices,

Fig. 3 shows a longitudinal section through the longitudinal dividing device on line III-III of Fig. 2, and

Fig. 4 shows a cross-section through the longitudinal dividing device on line IV-IV of Fig. 2.

Fig. 1 shows that part of a twin strand slab continuous casting plant which is arranged after the roller apron guiding of the twin strand slab (not shown), each with a transverse cutting device 1 and a connecting run-out roller table 2. The run-out roller tables 2 are connected selectively with one of four longitudinal dividing devices 5 by means of a joint transverse transport means 4. The connection between the run-out roller tables 2 and the transverse transport means 4 is provided by a transfer 3. The slabs produced after transverse cutting can be moved off from the run-out roller tables 2 individually by the transfer 3 and conveyed to the transverse transport means 4. In the illustrated example a transport car which can be moved on rails is provided as the transverse transport means. The four longitudinal dividing devices 5 are parallel and adjacent to one another at about the height of the section of the run-out roller tables 2 which extend behind the transverse cutting devices 1 of the continuous casting plant. This offset construction method of longitudinal dividing devices 5 and run-out roller tables 2 provides a compact arrangement, whereby a quick transporting of the slabs to and possibly also off the longitudinal dividing devices 5 can be attained with only one common transverse transport means.

As Figs. 2 to 4 show, each longitudinal dividing device 5 has a slab bearing means 50 provided by a plurality of bearing elements 55 arranged one behind the other, and at least one flame cutting means 10. The slab bearing means 50 includes a gap which provides a cutting point opening 51 below the flame cutting means 10. The gap-type cutting point opening 51 extends practically over the entire length of the longitudinal dividing device and is arranged, looking at it in transverse direction, approximately in the middle of the longitudinal dividing device. A transversely shiftable centering means 20 is positioned on one longitudinal side of the longitudinal dividing device 5. A pressing device 25 is provided as an abutment on the other longitudinal side of the slab.

Fig. 2 and Fig. 3 show that the longitudinal dividing device 5 has six rollers 53 arranged one behind the other for transporting the slab on and off said longitudinal dividing device 5, the feed motion of the slab being restricted at the front side by a fixed stop 54. The individually actuated rollers 53, which are cooled inside, are swung away forwards and downwards in a way known per se after the slab has been transported (see dotted position of rollers in Fig. 3). When the rollers 53 have been swung away the slab rests on the plurality of bearing elements 55 forming the slab bearing means 50. Each individual bearing element 55 is divided in the middle in longitudinal direction by the gap-type cutting point opening 51. The width of the cutting point opening 51 amounts at least to about 100 mm in the transverse direction of the longitudinal dividing device 5. According to Figs. 2 and 3 a total of six bearing elements 55 arranged one behind the other are provided.

The flame cutting means 10 is situated above the bearing elements 55. The flame cutting means is composed of two torch cars 13 and 14 equipped with cutting torches 15 and 16 respectively. Each torch car 13,14 runs on the same parallel rails 11, 12 and is individually actuated. During the flame cutting the torch cars are moved towards each other with a feed motion corresponding to the flame cutting speed. The cutting torches 15,16 are positioned in the middle of the car and are assembled so securely on the torch car 13,14 in the transverse direction of the longitudinal dividing device 5 that they move towards each other during the flame cutting on a straight line, the so-called flame cutting line. This flame cutting line overlies the cutting point opening 51 positioned underneath it.

In order to set the desired width into which the slab resting on the slab bearing means 50 is to be divided longitudinally, the centering means 20 is provided on one side of the bearing means 50. The centering means 20 is composed of a ruler-type beam 21 which is armed with rollers 22 and runs parallel to the longitudinal axis of the longitudinal dividing device 5. With the assistance of a worm gear 24 actuated by motor 23 the beam 21 can be pushed transversely to the longitudinal axis of the longitudinal dividing device 5 and then brought to a fixed position. In the shown preferred embodiment pressing devices 25 are provided on the other longitudinal side of the slab bearing means 50. Each pressing device 25 is composed of a rotatable lever 26 which is fastened to the floor of the longitudinal dividing device 5 and which can be operated by a hydraulic cylinder 27. After the desired widths into which the slab is to be divided longitudinally have been set with the assistance of the centering means 20, the slab is pressed by means of the pressing device 25 against the beam 21 which serves as an abutment. Exact centering of the slab is thereby guaranteed.

Fig. 2 shows that the cutting point opening 51 is a narrow gap which extends practically over the whole of the length of the longitudinal dividing device 5. As the cross-section in Fig. 4 shows, the gap-type cutting point opening 51 feeds into a channel 28 which is open only to the top over the entire length of the longitudinal dividing device 5. The channel 28 has side walls 29 of heatproof sheets of metal. As Fig. 3 shows, these side walls 29 have recesses 31 which are formed according to the swing path of the rollers 53 (to the right in Fig. 3). When the rollers have been swung to the right, the recesses 31 for the rollers 53 are closed by shutter plates 32. The channel 28 is closed off to the bottom by a jigging conveyor 33 by which the slag produced during flame cutting is conveyed by a transport means 34 e.g. on a chute or in a bucket.

Fig. 4 shows that conduits 35 feed into the channel 28 at about the middle of the side walls 29. At their other end the conduits 35 are attached to a suction conduit 36, which runs parallel to the channel 28 and which feeds into a dedustng plaint 44 (see Fig. 1). The illustrated construction has the advantage that a good removal of slag by suction is guaranteed with relatively low activity. The shutter plates 32 contribute to this; they close the recesses 31 in the side walls 29 of the channel 28 during the flame cutting. Furthermore, the upper edge of the side walls 29 extends as far as possible, i.e. up to a distance of approximately 20 mm, up to the upper edge of the bearing elements 55, so that when the slab lies thereon only a small amount of infiltrated air can be sucked in. If a short slab is lying on the slab bearing means 50, the part of the cutting point opening 51 which is not covered by the slab is open at the top. As too much infiltrated air could be sucked in this case, there is the favourable possibility of closing the channel 28 corresponding to the length of the slab segment by segment from one or from both ends, so that only the part underneath the slab remains open.

To reduce the proportion of penetrating infiltrated air further it is preferred to drive towards or over the suction conduits 35 in coordination with the cutting. Only the suction conduits are open respectively and thereby functioning at the level at which the flame cutting devices are positioned.

The working of the device is as follows: The slab which in the illustrated embodiment is cut in lengths from the cast strand by means of the transverse dividing device 1 is transferred from the transfer 3 to the transverse transport means 4. The transverse transport means 4 in the form of a transport car is preferably armed with a roller table 9. The transport car 4 then moves with the slab to one of the four longitudinal dividing devices 5. When the roller table of the transport car 4 is switched on the slab is moved in the longitudinal direction onto the roller table 53 of the longitudinal dividing device 5 so that longitudinal division can begin. After longitudinal division has been completed the divided slabs are preferably collected by a second transport car 6 which is also armed with a roller table 8 and brought to a lifting truck 7 which singles out the divided slab sections. Division of the strand occurs while the metal is still hot, i.e. directly from the casting heat, so that the surface temperature in the longitudinal dividing devices is at least 300°C.

In the area of each longitudinal dividing device 5 the slab moves from the roller table 9 of the transport car 4, over the roller table of the longitudinal dividing device 5 until it rests against the stop 54. The rollers 53 are dropped and the recesses 31 are closed by the shutter plates 32. The slab now rests on the bearing means 50. The rollers 53 can still revolve when dropped in order to prevent the slag caking.

The slab is now brought into a cutting position by the centering means 20. For this purpose the slab is shifted transversely by means of the ruler-like beam 21 of the centering means 20 towards the middle of the longitudinal dividing device 5 until the distance between the flame cutting line and the beam 21 corresponds to desired dividing width (e.g. two-part slabs with dividing widths 2/5 and 3/5 of the excessively wide slab). The beam 21 is then secured in this position. The slab is then pressed by means of the pressing device 25 against the beam 21 which serves as an abutment. After this straightening process the beam 21 and the pressing device 25 can be moved back to their starting positions.

For the actual flame cutting process the torch cars 13,14 move towards each other with a predetermined feed motion. They meet at approximately the middle of the torch stretch. Before they reach the middle one of the torch cars 13 or 14 stops its course and moves back to the starting point whilst the other torch car completes the cutting. The slag produced falls freely into the channel 28 beneath the slab bearing means 50 and is transported to the bucket 34 by the jigging conveyor 33. The fumes are sucked through the suction conduits 35,36 up to the dedusting plant 44. It has been shown that about 90% of the fumes produced can be removed in this way. The fumes produced above the slab can be caught with the aid of a hood (not shown) and also conveyed to the dedusting plant by means of a conduit.

The particular advantages of apparatus embodying the invention as described above are to be seen in that very quick longitudinal division can become possible at the highest possible slab temperature with a low cost in apparatus. Slabs which are narrower and in particular variable in width can be cut from excessively wide continuously cast strands. These cut slabs are particularly favourable as starting products for rolling mills with the desired sheet widths. In continuous casting the advantages of sequence casting can be used as quick and exact longitudinal division is possible with the present apparatus. By appropriate selection of the preferred features of the longitudinal dividing devices it may additionally be guaranteed that no problems arise due to slag or fumes as the fumes and working material losses produced can be removed at a low constructional cost without impairing the environment. Furthermore the longitudinally dividing slabs can be still so hot that the remaining heat in the slab can be utilised for the subsequent reheating up to rolling temperature since the use of the present invention permits the longitudinal division of continuously cast slabs when still hot, i.e. out of the production flow of the continuous casting plant, with a high degree of accuracy.

WHAT WE CLAIM IS:—

1. Apparatus for dividing a slag longitudinally, the apparatus including at least one longitudinal dividing device which has a slab bearing means, at least one flame cutting means, a cutting point opening located below the flame cutting means in the slab bearing means and displacement means which is located at at least one of the longitudinal sides of the slab bearing means and which is adapted to move the slab transversely.

2. Apparatus according to claim 1 wherein the displacement means includes an abutment surface at one longitudinal side of the slab bearing means and means at the other side of the slab bearing means to push in use a slab lying on the slab bearing means against the abutment surface.

3. Apparatus according to claim 2 wherein the abutment surface is movable in transverse direction relative to the slab bearing means so that in use the position of the abutment surface determines the transverse position of a slab lying on the slab bearing means relative to the flame cutting means.

4. Apparatus according to any one of claims 1 to 3, wherein the cutting point opening is in the form of a gap which extends through the slab bearing means and leads to a channel for receiving waste material.

5. Apparatus according to any one of claims 1 to 4 wherein the cutting point opening extends over substantially the entire length of the slab bearing means and two flame cutting means are present which are movable longitudinally in opposing directions.

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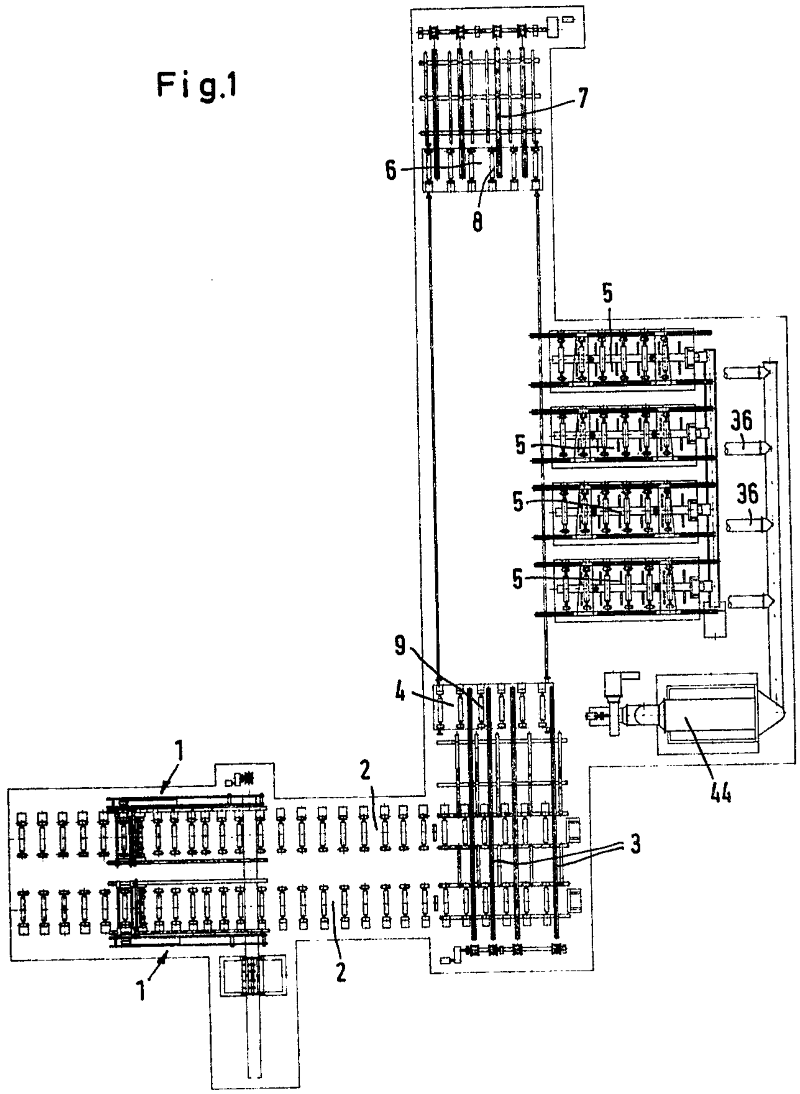
Fig.1



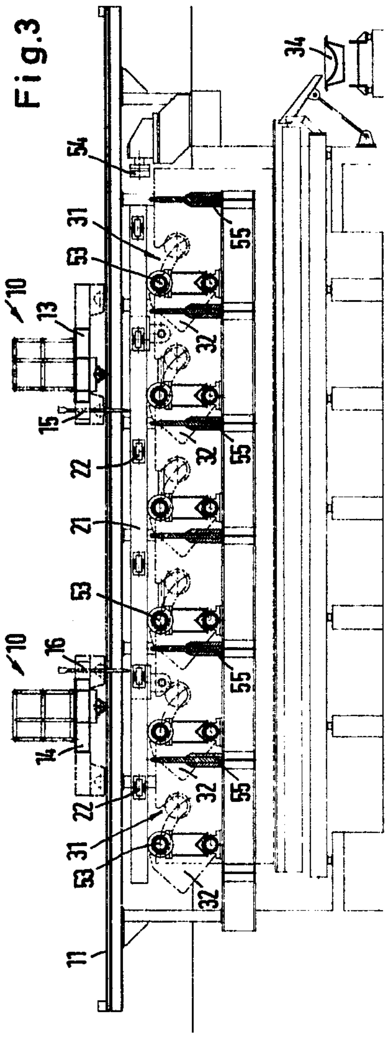

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Fig.3

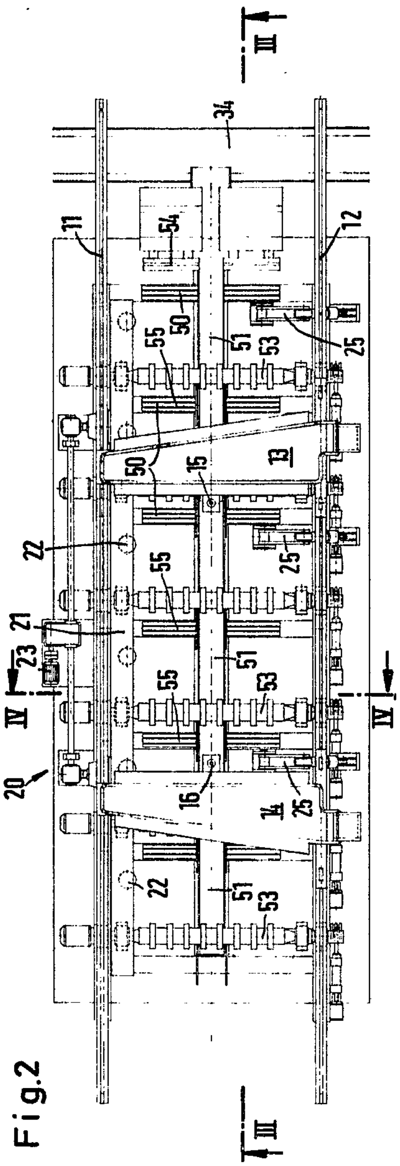
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Fig.2

1600685 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 3

Fig.4