Oct. 20, 1959 C. VOLKHAUSEN 2,909,088

MOUNTING FOR BACKING ROLLS

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FIG. 8

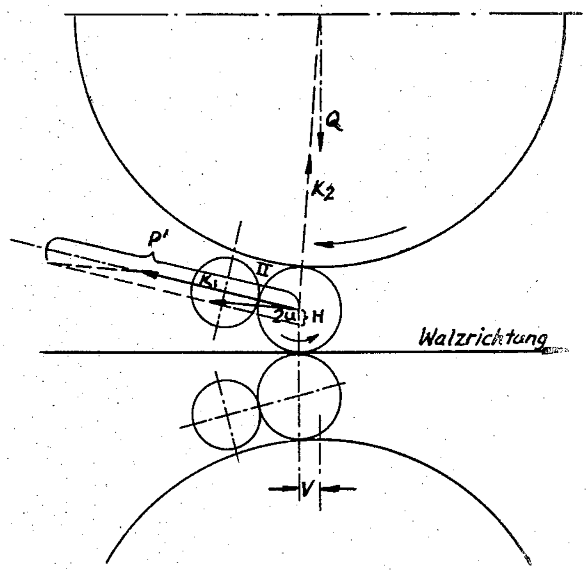

FIG. 9

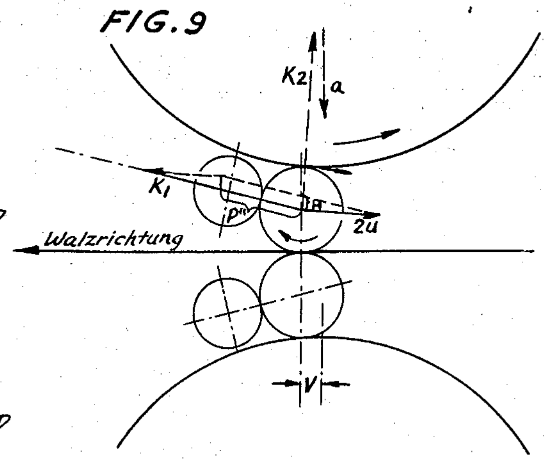

FIG. 1

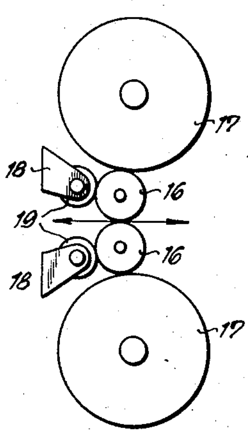

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FIG. 2

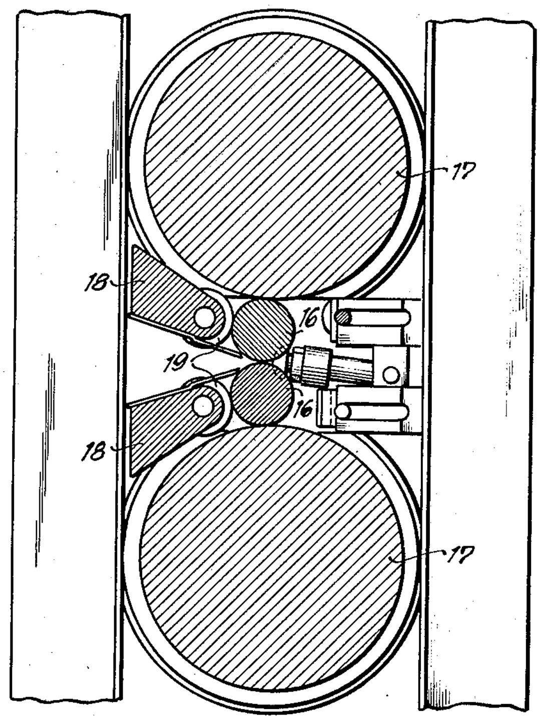

FIG. 5

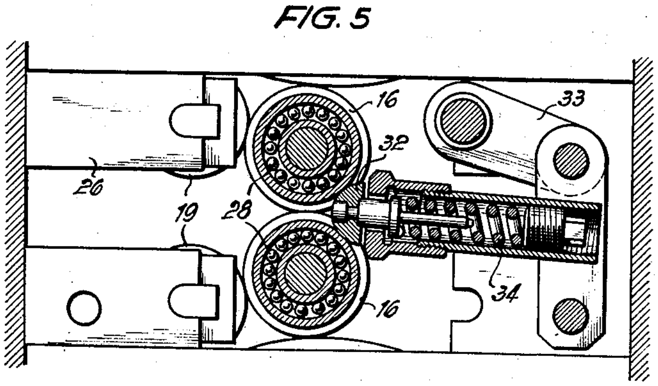

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FIG. 4

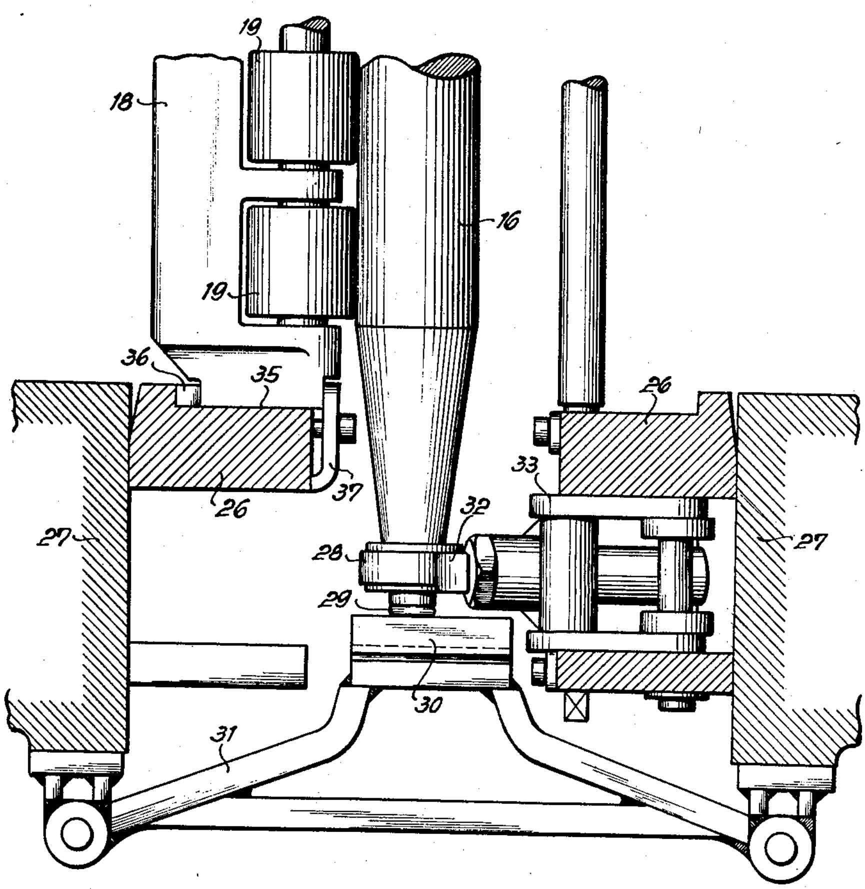

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FIG. 3

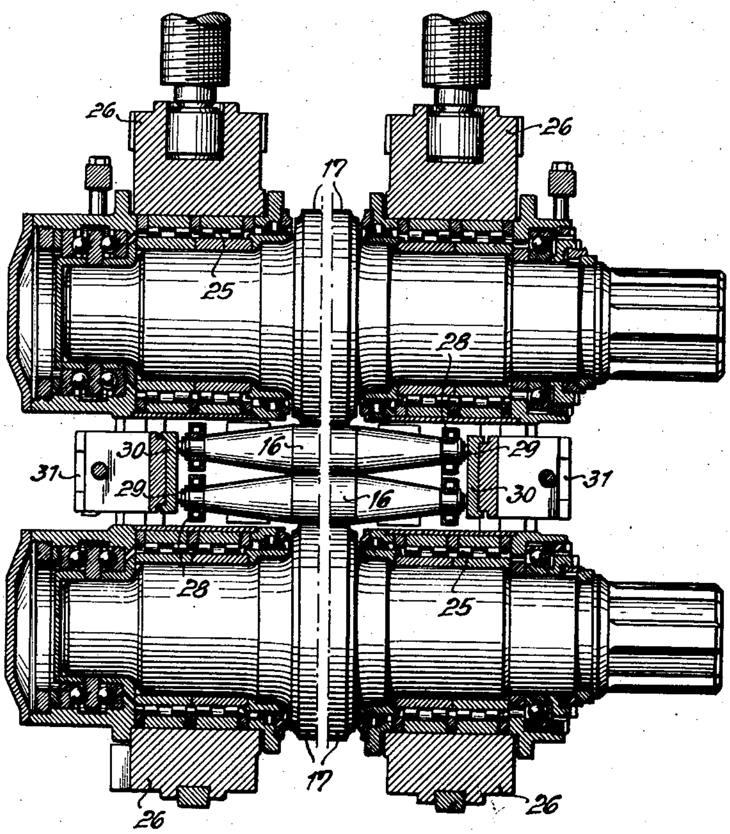

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FIG. 6

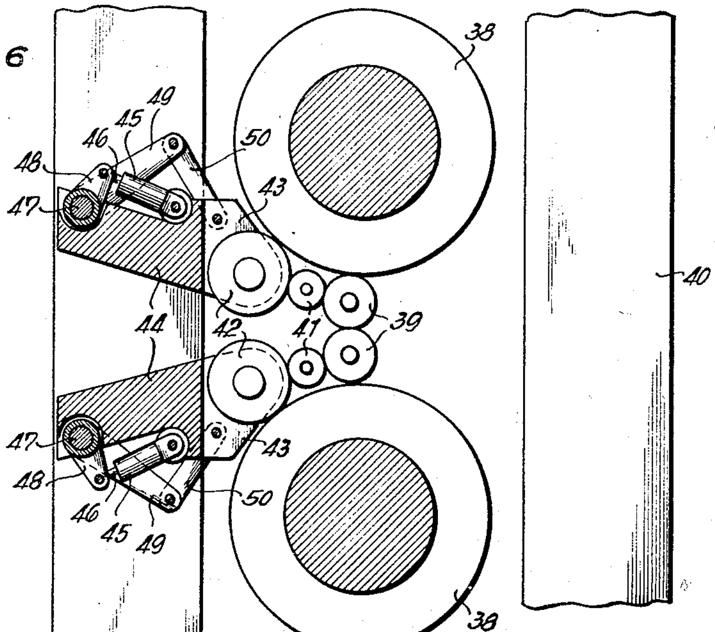
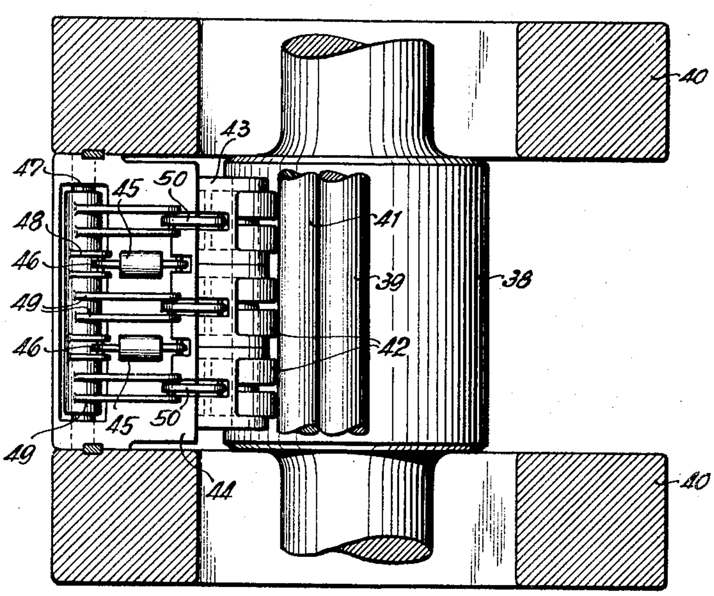


FIG. 7



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MOUNTING FOR BACKING ROLLS

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Application January 19, 1954, Serial No. 404,872

Claims priority, application Germany January 21, 1953

2 Claims. (Cl. 80—38)

In constructing rolling mills efforts have been made to reduce the diameter of the working rolls as far as possible consistent with ensuring sufficient gripping power of the working rolls for the rolling operation and to provide for adequate removal of heat from the working rolls. This is desirous because with working rolls of small diameter the contact surfaces between rolls and rolled material are small and consequently only a relatively small rolling pressure is necessary.

However, in order to prevent bending of the working rolls as a result of the rolling pressure, the working rolls have to be suitably supported or backed. As support for the working rolls, for instance separate supporting rolls of suitable diameter are used, of which the axes are in the same plane as the axes of the working rolls. In these rolling mills, so long as the working rolls are driven their diameter cannot be reduced indefinitely, in view of the torque to be transmitted, more especially since the working rolls have to be made thicker than the articulated spindles driving them. These rolling mills are usually quite serviceable for rolling thick material, and are much used. But it is desirable to reduce the diameter of the rolls still further, more especially for the cold rolling of thin hard strips. In order to comply with this requirement, direct driving of the working rolls was abandoned and instead the supporting rolls were driven, and the supporting rolls in turn drove the working rolls by friction. But the frictional forces acting on the periphery of the working rolls cause large transverse forces to be exerted on the working rolls; said transverse forces being directed approximately perpendicularly to the plane containing the axes of the supporting rolls and oppositely to the rolling direction. These forces greatly exceed those that occur during rolling with driven working rolls, even when a forward tension is exerted. These forces can of course be taken up by strong bearings at the ends of the working rolls but bending can be kept within tolerable limits only if the working rolls are relatively short, and then only if the diameter of the working rolls is made such as not adequately to comply with the practical requirements in the rolling of thin hard strips.

Admittedly, it has already been proposed in a four-high stand, of which the working rolls are offset out of the plane containing the axes of the supporting rolls, so that the working rolls bear, in a direction perpendicular to this plane, against the supporting rolls that only the supporting rolls should be driven in certain cases. This proposal was not put into practice and did not become well-known to those skilled in the art. Moreover, this proposal has the disadvantage that the position of the working rolls is not fixed. With this arrangement differences in the forward or back tension, which cannot be avoided, cause change in the position of the working rolls and therefore changes in the dimensions of the rolled material.

On the other hand, a multi-roll stand for rolling strips is known which has two working rolls driven in the normal manner and two non-driven supporting rolls, and of which the working rolls are supported, perpendicularly to the plane containing the axes of the supporting rolls, over the whole of their body length or over a part thereof, in one direction by reason of the fact that the working rolls are offset out of this plane, and in the other direction by supporting beams provided with backing rollers. The supporting beams and their backing rollers take up the small rolling pressure components arising from the off-centre position of the working rolls, and prevent bending of the working rolls by the forward tension. Although this rolling mill was much used, its intrinsic disadvantage was observed, which is that also in this rolling mill a free choice of the diameter of the working rolls is not possible since in this case too the working rolls are directly driven and therefore their diameter has to be at least sufficient for the torque that has to be imparted to them. The lateral support of the working rolls over their body length or a part thereof on one side, by the fact that the working rolls are offset out of the plane containing the axes of the supporting rolls and on the other side by backing rollers mounted in a supporting beam rigid against bending, which support was found advantageous in this rolling mill, was obviously regarded as unsuitable for supporting working rolls driven indirectly by frictional connection with driven supporting rolls, owing to the great lateral forces which are produced by the indirect drive of the working rolls by the frictional connection with the driven supporting rolls and which greatly exceed the lateral forces that arise in the case of directly driven working rolls.

In the further course of development of rolling mills for the cold rolling of thin hard strips, more especially those that are also wide, rolling mills with two thin working rolls and a single supporting roll associated with each, i.e. four-high rolling mills, were abandoned. A return was made to rolling mills of the kind in which each working roll has associated with it two supporting rolls of equal size, which together with the working roll are arranged in Y-formation relatively to one another. But when each working roll is supported by two supporting rolls the diameter of the working roll cannot be made as small as may be desired, or if working rolls of small diameter are used the supporting rolls cannot be made thick enough to keep their bending within tolerable limits. For this reason additional supporting rolls were associated with the two supporting rolls, and finally still further supporting rolls or backing rollers were associated, with the additional supporting rolls. Thus, constructions are known in which ten or more supporting rolls or backing rollers are associated with the working rolls (Sendzimir rolling mill). Such rolling mills are expensive to build. A further important disadvantage is that re-grinding of the rolls is impossible, or possible only within narrow limits, on account of the change in the distances between the axes which is associated with it.

The object of the present invention is to avoid the expense of constructing rolling mills with twelve or more rolls and at the same time to provide a rolling mill which permits entirely free choice of the diameter and length of the working roll.

The invention is based on the four-high stand mentioned above, having working rolls which are driven not directly but by friction drive from the driven supporting rolls and are offset out of the plane containing the axes of the supporting rolls, so that the working rolls are supported against the supporting rolls, in a direction perpendicular to this plane, over their body length or a part thereof.

According to the invention, in a rolling mill of this kind the working rolls are supported, in one direction perpendicular to the plane containing the axes of the supporting rolls by reason of the fact that the working rolls are offset out of this plane, and in the opposite direction by backing rollers supported in bearings in a supporting beam rigid against bending.

It is to be briefly repeated that as a result of the indirect driving of the working rolls by frictional connection with the driven supporting rolls, the working rolls do not have to transmit any torque. Moreover, since the working rolls are supported, over their body length or a part thereof, in the direction of the rolling pressure and also in both directions perpendicular thereto, against bending and change of position, free choice of their diameter is possible; heretofore, if the working rolls were to be kept stationary such free choice was possible only in the case of mills having 12 or more rolls. It has already been proved in practice that the lateral support of the working rolls by means of backing rollers mounted in a supporting beam rigid against bending is possible even with the large lateral forces produced by frictional driving of the working rolls by the driven supporting rolls. But it is necessary to use back rollers supported in bearings in a supporting beam rigid against bending. It is not possible to use lateral support of the working rolls by means of sliding bearing brasses inserted in the supporting beams, although this particular kind of support appears particularly advantageous in the presence of the large lateral forces produced through frictional driving of the working rolls by the driven supporting rolls. With this known form of support the sliding friction between the working rolls and the sliding bearing brasses would consume a great deal of the torque imparted to the working rolls through friction with the driven supporting rolls. Moreover, fragments of the rolled material will inevitably get into the bearing gaps and damage the bearing surfaces and the surfaces of the rolls. Even the interposition of separate intermediate rolls between the working rolls and the sliding bearing brasses, does not lead to success, since as a result of the friction of the intermediate rolls in the sliding bearings these rolls cease to rotate in certain circumstances and then the working rolls and intermediate rolls slide on one another.

Since the backing rollers are supported on axles inserted in the supporting beams, obviously the bearings of the backing rollers and therefore the backing rollers themselves must be dimensioned according to the magnitude of the transverse forces that arise. To prevent the choice of the diameter of the working rolls from being dependent for instance on the diameter of the supporting rolls, a rolling mill according to the invention also may have a further non-driven roll between each working roll and its backing roller or rollers.

In the known multi-roll stands with lateral support of the working rolls by means of backing rollers arranged in supporting beams, the supporting beams are supported with respect to frame of the roll stand. Play and wear between the chocks and their grinding means in the frame prevent accurate paraxial alignment of the backing rollers, supporting rolls and working rolls relatively to one another.

Therefore, according to a further feature of the invention it is proposed to secure the supporting beams carrying the backing rollers to the chocks of the supporting rolls.

It is then of course possible to dispense with separate bearing means at the ends of the working rolls. But in order to prevent jumping of the working rolls when the material to be rolled is introduced, the working rolls may be mounted, outside their working region, in auxiliary bearings on which a pressure is exerted which keeps the working rolls in permanent contact with the supporting and backing means.

Additional and more specific objects will be apparent in the following description taken in connection with the accompanying drawings in which:

Figure 1 is a diagrammatic view illustrating the principle of the invention,

Figure 2 is a sectional view taken transversely of the rolls and further illustrating the arrangement of Figure 1,

Figure 3 is a view partly in section and partly in elevation and with the center sections of the rolls removed and with the section taken longitudinally of the rolls,

Figure 4 is a fragmentary view partly in transverse section and partly in elevation illustrating details of the backing rolls and the auxiliary bearings on the working rolls,

Figure 5 is a fragmentary end elevational view of the structure shown in Figure 4,

Figure 6 is a view similar to Figure 2 by illustrating a modified arrangement,

Figure 7 is a fragmentary view partly in plan and partly in transverse section of the arrangement of Figure 6, and

Figures 8 and 9 are diagrammatic views showing the interrelated forces acting on the working rolls in different directions of rotation, respectively.

The arrangement illustrated diagrammatically in Figure 1 relates to a multi-roll stand which includes working rolls **16** having their axes in a common vertical plane laterally offset from the vertical plane containing the axes of supporting rolls **17**. This arrangement is adapted for reversing operation. The transverse forces alternating in direction according to the change in the rolling direction and caused by the frictional driving of the working rolls **16** by the supporting rolls **17** are taken up in one direction by the backing rolls **17** themselves, by off-setting the working rolls out of the plane defined by the axes of the backing rolls **17**. The transverse forces in the other direction are taken up by supporting rolls **19** mounted in rigid support beams **18**.

The arrangement shown diagrammatically in Figure 1 is shown in detail in Figures 2 to 5.

The arrangement of Figure 1 is shown in detail in Figures 2 to 5 in which the working rolls are shown at **16** and the supporting rolls at **17**. The supporting rolls **17** are driven. The working rolls **16** bear against the supporting rolls **17** so as to be operatively connected with them by friction, and are driven by the supporting rolls. The frictional forces between the supporting rolls **17** and the working rolls **16**, the fact that the working rolls **16** are offset out of the plane containing the axes of the supporting rolls **17**, and the forward or back tension extended on the material being rolled, cause forces directed substantially perpendicularly to the plane containing the axes of the supporting rolls **17** to be extended on each working roll. The magnitude and direction of these transverse forces depends on the rolling pressure that arises, on the direction of rotation of the rolls and on the magnitude and direction of the forward or back tension extended. These conditions, and more especially the distance by which the working rolls **16** are offset out of the plane containing the axes of the supporting rolls, should always be made such that the sum of the transverse forces produces a force pressing the working rolls **16** against the backing rollers **19** supported in bearings in supporting beams **18** rigid against bending. The supporting rolls **17** are mounted, by means of bearings **25**, in chocks **26** which are themselves vertically displaceably guided in the roll housing **27**. The ends **35** of supporting beams **18** are also inserted in the chocks **26**. Wedge means **36** serve for adjusting and aligning the supporting beams. Also, clamping arm means **37** are provided which hold the supporting beams in the chocks **26**.

The working rolls **16** are provided at their ends with auxiliary bearings **28**, and with slightly rounded end surfaces **29**.

At both ends of the working rolls **16** bearing plates **30** bear against the end surfaces **29**, these bearing plates being mounted in a hinged holder **31**, and fixing the position of the working rolls **16** in an axial direction.

Pressure pieces **32** (Figures 4 and 5) act on the auxiliary bearings **28**. These pressure pieces **32** are subjected to the action of springs **34**, stressed by means of lever mechanism **33**. In this way the working rolls **16** are kept in permanent contact with the backing rolls **17** and the supporting rolls **19**.

In the embodiment described above the support of the working rolls in a horizontal direction is effected on one side by backing rollers supported in bearings in supporting beams rigid against bending, whereas on the other side the working rolls are supported against the supporting rolls themselves, the working rolls being arranged offset out of the plane containing the axes of the supporting rolls. It is easily possible to support the working rolls in a horizontal direction on both sides by means of backing rollers supported in bearings in supporting beams rigid against bending. Apart from the fact that such support must give rise to higher costs of construction, accessibility and ease of observation of the roll gap at both sides of the roll stand are impaired by the arrangement of backing rollers and supporting beams on both sides, and for this reason the kind of support described above with reference to the drawings must always be preferred.

In the embodiment shown in Figures 6 and 7 the working rolls are referred to by the numeral **39**. They are supported in a vertical direction against the backing rolls **38**, the latter being mounted in mounting pieces not shown in the drawings, and being guided and adjustable as regards height in the housing **40**. In the horizontal direction the working rolls **39** are supported at one side by the supporting rolls **38** through their axes being offset towards the opposite side out of the plane defined by the axes of the backing rolls **38**.

Towards the other side the working rolls **39** are supported against supporting rolls **42** through the medium of an intermediate roll **41** in each case. The supporting rolls **42** are mounted in bearing blocks **43**, these being supported in their turn movably in a vertical direction on supporting beams **44**.

Pistons **46** are also provided, acted upon by a pressure fluid, and guided in cylinders **45**, the force of which ensures frictional contact of the supporting rolls **42** against the backing rolls **38** through the medium of levers **48** and **49** fixed to shafts **47**, and through the medium of links **50** connected to the bearing blocks **43**. The shafts **47** are mounted rotatably in the supporting beams **44**, on which the cylinders **45** are likewise supported.

In the embodiment, in which the non-driven intermediate rolls **41** are arranged between the working rolls **39** and the backing rollers **42** which are supported in bearings **43** on supporting beams **44** rigid against bending, the backing rollers are placed further out, so that more space is available for accommodating them. This also enables the bearings **43** of the backing rollers **42** to be made as strong as is desirable in view of the large transverse forces due to the indirect drive of the working rolls. This construction also improves the accessibility of the roll gap, and observation of the rolling process is facilitated.

The interrelated forces acting on the rolls are shown in Figures 8 and 9.

Owing to the fact that the working rolls are placed some distance away from the plane containing the axes of the supporting rolls, which distance is to be made relatively large (about 5% or more of the supporting roll diameter) in the roll stand according to the present invention, the rolling pressure Q applied by the housing screw tends to force the working rolls out of the region between the supporting rolls, in the direction in which the working rolls are offset. Thus a component K_1 is extended on each working roll, which component acts towards the backing rollers associated with the working roll, whereas the other component K_2 acts towards the supporting roll associated with each working roll. The required torque on the working roll is applied as a peripheral force U by means of the frictional connection between the working roll and the supporting roll. The frictional force resulting from the rolling pressure component K_2 and the coefficient of friction between the working roll and the supporting roll is available for applying this peripheral force U. A lateral force twice as great as the peripheral force U acts on the working roll in a direction parallel to the peripheral force U.

If the rolls rotate in the directions shown in Figure 8 the lateral force 2U acts in substantially the same direction as the rolling pressure component K_1, but if they rotate in the directions shown in Figure 9 it acts substantially oppositely to the rolling pressure component K_1. Thus, for pressing the working roll against the backing rollers there is a force P′ approximately equal to K_1+2U if the rolls rotate in the directions shown in Figure 8, and a force P″ approximately equal to K_1-2U if the rolls rotate in the direction shown in Figure 9. Slight differences arise owing to the fact that the lateral force 2U is as a rule not exerted exactly along the line joining the centre of the working roll and the centre of the backing rollers, whereby a small component H arises, which acts in the direction of the rolling pressure if the rolls rotate in the direction shown in Figure 8, and oppositely to the rolling pressure if the rolls rotate in the direction shown in Figure 9.

If for instance with a rolling mill constructed in accordance with the invention, and provided with supporting rolls having a diameter of 1000 mm. and working rolls having a diameter of 160 mm., and in which the working rolls are offset 50 mm. out of the plane containing the axes of the supporting rolls, soft iron having a breadth of 800 mm. and a starting thickness of 3 mm. is rolled the following forces arise:

	Thickness reached in each pass						
	2.3	1.5	1.0	0.7	0.5	0.36	0.3
Rolling pressure (tons)	400	540	540	530	540	535	480
Static lateral force K_1 (tons)	34	46	46	46	45	45.5	41
Roll torque required (kilogramme-metres)	2,500	3,400	2,600	1,850	1,400	1,100	580
Peripheral force U (tons)	15.6	21.3	16.2	11.6	8.75	6.9	3.6
Dynamic lateral force 2U (tons)	31.2	42.6	32.4	23.2	17.5	13.8	7.2
Contact pressure of the working rolls against the supporting rolls for one direction of rotation of the rolls:							
According to Figure 8 P′ (tons)	65.2	86.6	78.4	69.2	62.5	58.3	48.2
According to Figure 9	2.8	3.4	13.6	22.8	27.5	31.7	33.8

As can be seen from the above table, contact of the working rolls against the backing rollers and, therefore, a stationary position of the working rollers is ensured. But in this example, rolling is not effected under forward tension. If forward tension is extended on the material being rolled, the forward tension will increase the force P″ pressing the working roll against the backing rollers if the rolls rotate in the directions shown in Figure 9. If the rolls rotate in the direction shown in Figure 8, the forward tension will of course act against the force P′ pressing the working roll against the backing rollers, but the contact pressure force P′ has a minimum value of 48.2 tons which is far greater than the forward tension that would in practice be employed, so that in this case also a stationary position of the working roll is ensured. Moreover, usually the forward tension is exerted simultaneously with braking of the incoming material to be rolled. A braking force that exceeds the forward tension and therefore acts on the working rolls might actually cause the working rolls to move away from the backing rollers, since if the rolls rotate in the directions shown in Figure 9 the backing force acts against the already relatively small force P″ pressing the working roll against the back rolls; whereas if the rolls rotate in the direction shown in Figure 8 the backing force assists the already large force P′ pressing the working roll against the backing rolls. Therefore, if the incoming material to be rolled is braked, the backing force could easily overcome the minimum contact pressure force P″ of 2.8 tons given in the numerical example. For this case, however, it is possible to make the distance of the working rolls from the plane containing the axes of the supporting rolls greater. If the distance were for instance made 60 mm. instead of 50 mm., while the other conditions were kept exactly the same as in the above numerical example, then with larger static lateral forces K_1 and the same roll torque required, the forces P′ and P″ pressing the working rolls against the backing rollers would be correspondingly greater. In accordance with the previous numerical example they would be as follows:

	Thickness reached in each pass						
	2.3	1.5	1.0	0.7	0.5	0.36	0.3
Static lateral force K_1 (tons)	40.8	55	55	55	54	54.5	49
Contact pressure of the working roll against the backing rolls for one direction of rotation of the rolls:							
According to Figure 8 P′ (tons)	72	97.6	87.4	78.2	71.5	68.3	56.2
According to Figure 9 P″ (tons)	9.6	12.4	22.6	31.8	36.5	40.7	41.8

Therefore, the force acting on the working rolls owing to braking of the incoming material to be rolled is opposed by a force P″ of at least 9.6 tons pressing the working roll against the backing rollers and this is sufficient to ensure the stationary position of the working roll. In the rolling of harder materials the force relationships become still more advantageous, since the rolls do not penetrate so deeply into hard materials and therefore the required torques and the peripheral forces that occur and act against the static lateral forces are not so great.

I claim:

1. In a rolling mill, the combination of a roll housing, chock means supported in said housing, a pair of driven backing rolls mounted in said chock means in mutually spaced, vertically aligned relation, a pair of freely rotatable working rolls, means supporting said working rolls in frictional engagement with the backing rolls so as to be driven thereby and with the axes of the working rolls lying in a common plane laterally offset from the vertical plane containing the axes of the backing rolls so that the working rolls are supported in one direction perpendicular to said last mentioned plane, and means for supporting said working rolls in the opposite direction comprising a plurality of axially spaced freely rotatable backing rollers having necks, several of said backing rollers engaging at least a portion of the working length of each working roll whose diameter is only a fraction of the diameter of the backing rolls on the side of the axis thereof opposite that engaging the associated backing roll, rigid bend resistant supporting beams extending parallel with said roll axis, each of said beams carrying bearings for rotatably supporting the necks of said backing rollers, a roller bearing surrounding each end of each working roll and freely displaceable therewith, common abutment means engaging the opposite ends of the working rolls to maintain the same in axial position and pressure applying means opposing the displacement of the working rolls, said means consisting of a yieldable biased wedge engaging between the peripheries of said roller bearings of the respective working rolls on the side of the axes thereof opposite said backing rollers to maintain the working rolls in permanent contact with the backing rolls and the backing rollers.

2. In a rolling mill, the combination of a roll housing, chock means supported in said housing, a pair of driven backing rolls mounted in said chock means in mutually spaced, vertically aligned relation, a pair of freely rotatable working rolls, means supporting said working rolls in frictional engagement with the backing rolls so as to be driven thereby and with the axes of the working rolls lying in a common plane laterally offset from the vertical plane containing the axes of the backing rolls so that the working rolls are supported in one direction perpendicularly to said last mentioned plane, and means for supporting said working rolls in the opposite direction comprising a plurality of axially spaced freely rotatable backing rollers having necks, several of said backing rollers engaging at least a portion of the working length of each working roll whose diameter is only a fraction of the diameter of the backing rolls on the side of the axis thereof opposite that engaging the associated backing roll, rigid bend resistant supporting beams extending parallel with said roll axis, each of said beams carrying bearings for rotatably supporting the necks of said backing rollers, a roller bearing surrounding each end of each working roll and freely displaceable therewith, common abutment means engaging the opposite ends of the working rolls to maintain the same in axial position and pressure applying means opposing the displacement of the working rolls and engaging the peripheries of said roller bearings of the respective working rolls on the side of the axes thereof opposite said backing rollers to maintain the working rolls in permanent contact with the backing rolls and the backing rollers.

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