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(54) Cold rolling mill for thin foil and strip

(57) A rolling mill has a roll stand 1 in a plane 2-2 of a building 37, a wind-off reel 6 arranged in a plane 5-5 above the plane 2-2, and a winding-up roll 8 for the rolled strip 9 standing on a plane 7-7.

Two working rolls 12, 13 and two backing rolls 16, 17 are arranged horizontally in the roll stand 1.

Screw-down forces F are applied horizontally to the ends of the backing rolls 16, 17 and bending forces are applied horizontally and vertically to the ends of the working rolls 12, 13. Rolled strip 9 runs in the vertical direction through the rolling gap 18 between the working rolls 12, 13.

Feed boxes 23 arranged over the rolls ensure optimum lubrication and cooling of the rolls by laminar application of a film of oil to the rolls. Such cooling of the rolls provides optimum regulation of strip flatness.

Fig. 1

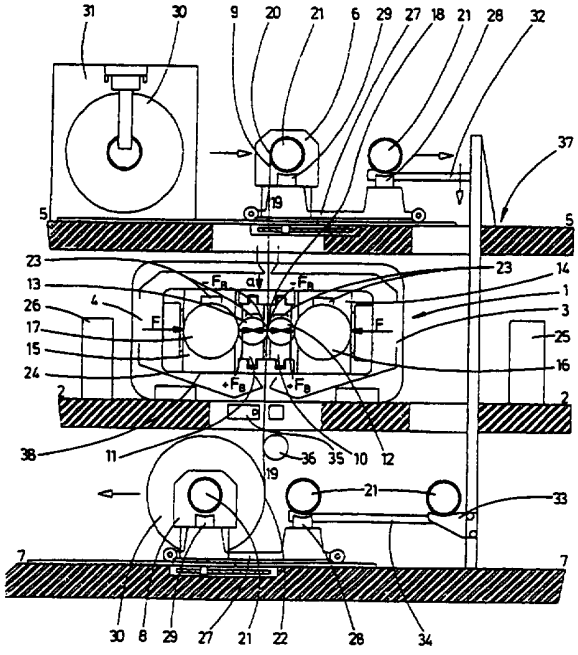

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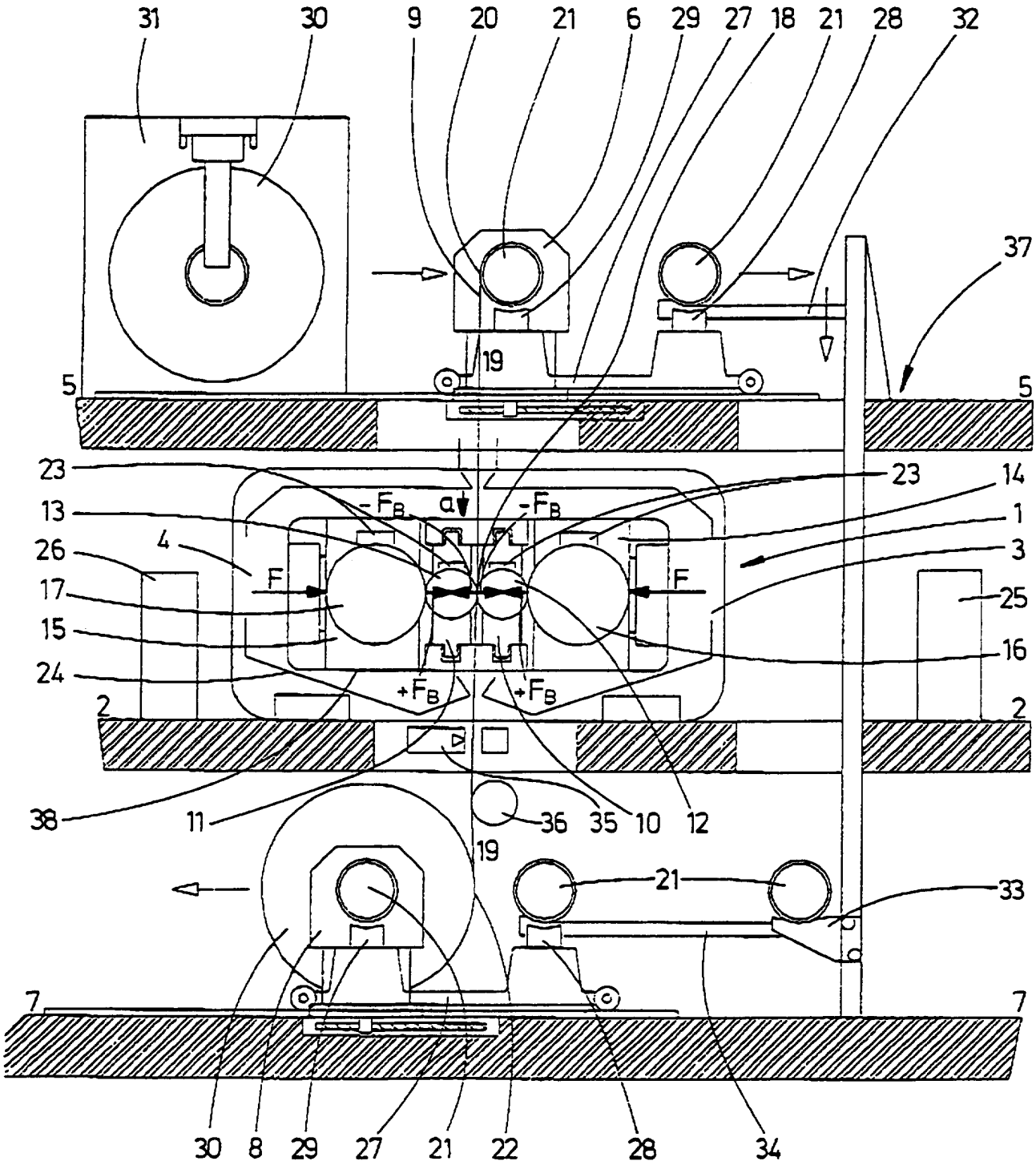
Fig. 1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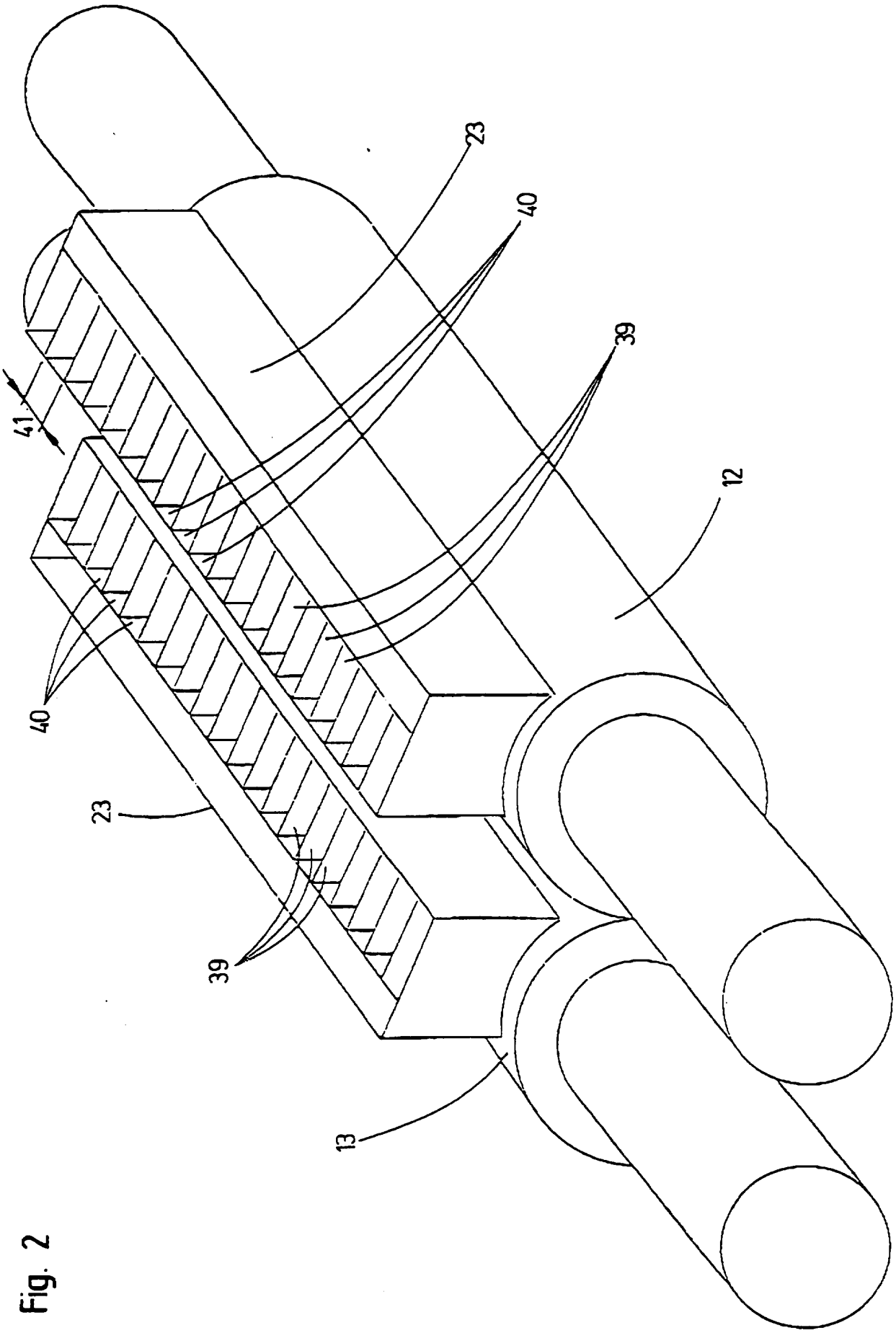

Fig. 2

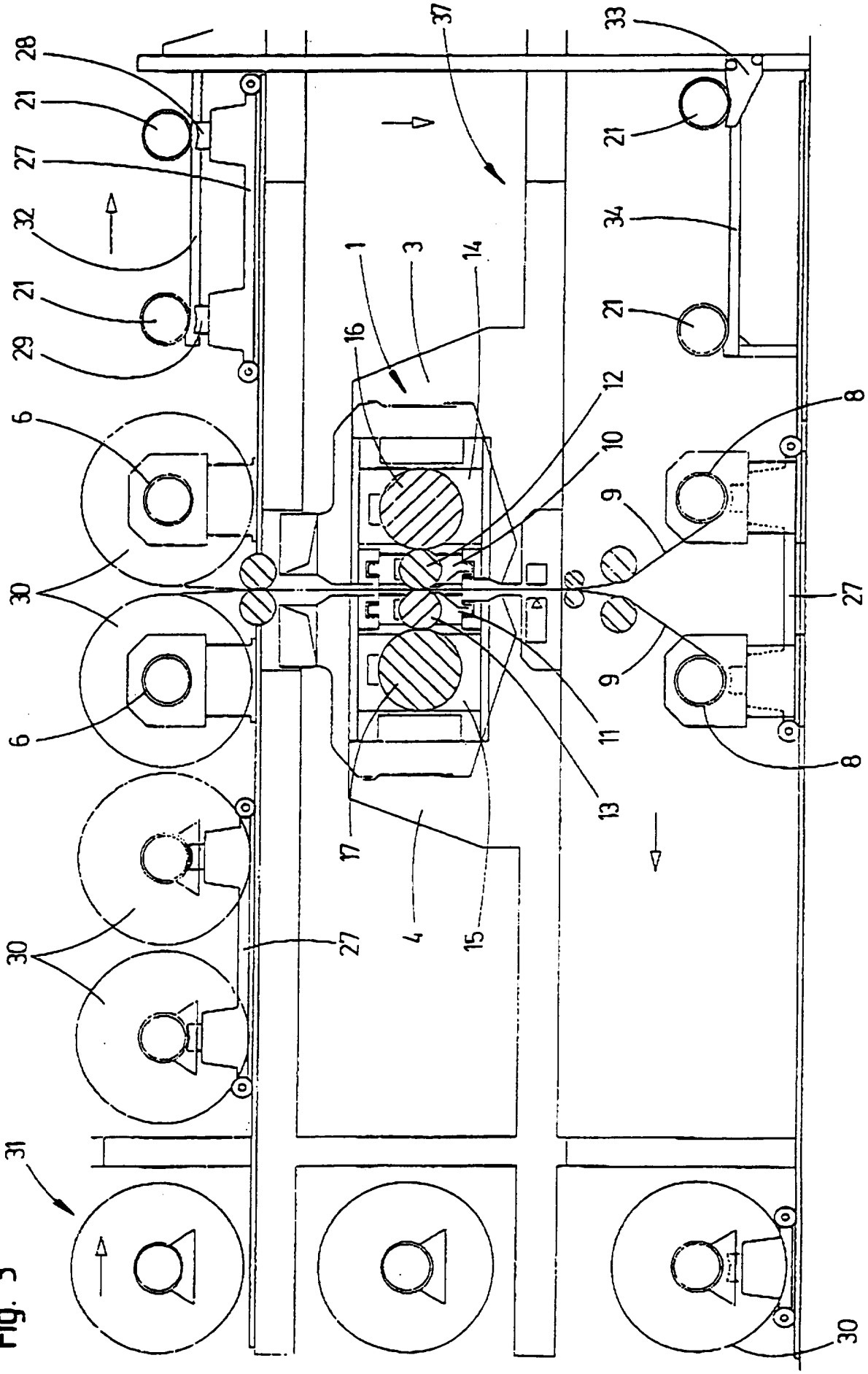
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Fig. 3

Cold-rolling mill for thin and foil strip

In conventional rolling mills for thin and foil strip according to DE 3 525 038 C2, which are equipped with at least one roll stand with vertically disposed backing and working rolls as well as at least one wind-off reel and at least one winding-up reel, the screw-down forces for creating the rolling force and the bending forces for compensating for roll bending and for regulating the rolling gap are introduced to the roll journals in the vertical direction and the strip runs in the horizontal direction through the rolling gap between the working rolls.

On account of the vertical arrangement of the backing and working rolls in a roll stand with two roll standards equipped with a closed frame for absorbing the screw-down forces, the working conditions are not at all favourable for rolling thin and foil strip.

In the conventional thin and foil strip rolling mills with closed roll standards the abutment surfaces of the roll bearing parts are not always well defined. Because of the necessary fitting play, the roll inserts tilt when the rolling moment is applied and there are unequal frictional moments when closing up the rolls. The regulation of the screw-down forces and bending forces as well as balancing of the rolls is very involved, because of the asymmetrical forces and bending conditions, which result with the lower and upper working and backing rolls of a roll stand, on account of the self-weight of the rolls. The unequal thermal stresses of the roll stand arising from the rolling oil running down from the upper to the lower rolls and the rising heat result in asymmetries in the thermal balance of the stand, which have to be taken into account as interfering values in the regulation of the screw-down forces and the bending forces.

The non-uniform thermal stresses in the upper and lower sides of the rolled strip have a disadvantageous effect on the surface quality of the strip. Drawing off the start of the strip from the wind-off reel and threading the strip, especially a

double strip or a strip to be pack rolled, into the rolling gap and transporting the strip from the rolling gap to the winding-up reel, by means of mechanical or pneumatic conveyor means such as guide rollers and air tables, is very involved. Moreover, winding doubled foils away from one another with the usual rolling mill arrangement can only be effected with great difficulty. The fitting and removal of the coils and the empty strip spools at the wind-off and winding-up reels can only be done in several operating steps which take a lot of time and effort. The poor accessibility of the roll stands, the oil catch pans, the strip thickness measuring apparatus and the strip flatness measuring rollers lead to substantial difficulties in cleaning the rolling plant from strip residues and servicing the various plant parts and measuring apparatus. The measurement of the strip thickness, which must be effected in the strip running direction as close after the rolling gap as possible, requires suitable positioning of the strip thickness measuring apparatus with expensive devices behind the rolling gap. The quality of the upper and lower side of the rolled strip is affected by the necessary strip guide rollers, as well as by the different thermal stresses. Moreover, limits are imposed on displacement of the backing and/or working rolls in correspondence with the current strip width by the guiding in the window between the standards.

The invention is based on the object of developing a rolling mill construction as a two-roll, four-roll and multi-roll stand, especially a four-roll stand for thin and foil strip, which avoids the disadvantages of conventional thin and foil strip rolling mills set out above.

This object is met according to the invention by a cold-rolling mill for thin and foil strip, with at least one multi-roll stand, at least one wind-off reel and at least one winding-up reel for the rolled strip, and characterized by a horizontal arrangement of the rolls, horizontal application of the screw-down forces and the bending forces to the ends of the rolls, a vertical passage of the rolled strip through the rolling gap between the working rolls, and an arrangement of the multi-roll stand or the multi-roll stands, the wind-off reel and the winding-up reel in planes of a

building or framework which lie one above the other.

Such a rolling mill construction is distinguished from conventional rolling mills by the advantages set out below:

The threading of the rolled strip into the rolling gap is effected under gravity, if required with air-assistance and/or assisted by guide metal plates, without manipulating the strip. The threading operation is substantially simplified by the use of gravity, especially when doubling foil strip. When rolling a doubled foil strip, the vertical strip guiding results in another advantage, that the contact surfaces of the two strips can be sprayed with a release medium very simply, before the two foil strips run into the rolling gap from two wind-off reels. In addition, winding up separately from one another, parting and trimming of doubled foil is possible without any problem, using two winding-up reel units. Weight balancing of the upper roll is not necessary. The screwing down and bending of the working and backing rolls, which are rotatably mounted in like-formed mounting parts in the two roll standards or pedestals of a roll stand, which are formed symmetrically relative to the vertical strip running plane or pass-line, are effected with screw-down and bending forces which are applied by position-regulated screw-down and bending cylinders. Through hydrostatic support of the roll mounting parts of the horizontally arranged rolls on a horizontal guide surface, clearly defined bearing surfaces result and there is minimum friction, whereby the "stick-slip effect" caused by thermal expansion of the rolls is avoided, which effect occurs in particular in the long coil running times with foil rolling mills. The problem of compensating for the roll wear which arise with conventional rolling mills is avoided, since the rolls are always adjusted to the stand centre or the vertical running plane of the strip. By position regulation of the wind-off and winding-up reels to the current setting of the wind-off point of the strip running off the wind-off spool and the run-in point of the strip running on to the winding-up spool in line with the vertical strip running plane, the strip can run from coil to coil through the rolling gap without being guided by deviating and tensioning rollers, so that it becomes possible to affect the quality of the strip surfaces,

especially of thin and foil strip, through the length of contact of the strip with the working rolls. The fact that the thermal loading of the rolls and correspondingly of the whole strip surface is uniformly large has a favourable effect on the surface quality, especially of foil strip. The regulation of the speed of the wind-off and winding-up rolls in dependence on the constantly altering roll diameter is simpler than in conventional cold strip, thin strip and foil rolling mills. Supplying the wind-off reel with a coil and taking away the empty spool from the wind-off reel as well as supplying the winding-up reel with an empty spool and taking away the coil from the winding-up reel can each take place in one working operation. With installation of the horizontally extending roll stand above the floor, the rolling oil which runs off can be caught more simply in an oil pan arranged under the roll stand above the floor, compared with the conventional rolling mills with installation of the oil pan below the floor, and the reservoir for fresh oil as well as the feed container for receiving the rolling oil from the catch pan can also be arranged above the floor. The roll cooling and lubricating device with feed boxes open to the roll surface, arranged directly above the rolls, for zoned or overall flooding of the rolls over the roll width with a rolling oil or rolling oil emulsion facilitates optimum cooling and lubrication of the rolls. In the case when strip flatness regulation is required, the flatness measuring roller ensures error-free, zoned measurement of the strip tension over the strip width, on account of the constant angle of contact of the rolled strip, which is facilitated by the vertical strip guidance. The strip thickness measurement can be effected with a readily accessible measuring apparatus near to the rolling gap on the strip in-feed and/or out-feed side of the roll stand. Because of the good accessibility of all parts of the plant, there are no difficulties in servicing the roll stand and in cleaning the rolling mill of strip tinsel and strip residues, which can be vacuumed up from the floor, as is needed when the strip tears, to remove the danger of fire. The horizontal arrangement of the rolls in the roll standards or pedestals of a roll stand erected in the plane of the floor facilitates individual disassembly of any roll for repair and servicing purposes, as well as during a needed roll exchange.

Finally the novel rolling mill is distinguished from rolling mills according to the state of the art by the substantial price advantage arising from the saving of various plant parts made possible by the novel rolling concept.

A cold strip rolling mill is known from US 2 237 794 for rolling hot-rolled strip material with a starting thickness of 9.5 to 12.7 millimetres to a final thickness of up to 0.254 millimetres. The rolling mill consists of a plurality of roll units encapsulated in a housing, with horizontally arranged working rolls, wherein the roll units are arranged in two vertical rows, of which one is traversed by the rolled strip with a downwardly directed rolling direction and of which the other is traversed by the rolled strip with an upwardly directed rolling direction. The teaching according to the invention, to use a rolling mill with horizontally arranged working rolls for rolling thin and foil strip with a final thickness of 0.200 to 0.600 millimetres and to use the cooling of the working and backing rolls made possible by the horizontal roll arrangement, through laminar application of a cooling and lubricating oil to the rolls, as an optimal adjusting value for the strip flatness regulation, is not anticipated by this state of the art.

The invention is now explained with reference to schematic drawings, in which:

Figure 1 shows a rolling mill for rolling thin and foil strip,

Figure 2 shows a roll cooling device in perspective view and

Figure 3 shows a rolling mill for double rolling of thin and foil strip.

The main plant parts of the fine and foil strip rolling mill shown in Figure 1 are a four-roll roll stand 1 set up in the plane 2-2- of a building 37, with two roll standards or pedestals 3, 4, a wind-off reel 6 fitted in an upper plane 5-5 above the plane 2-2 of the building 37 and a winding-up reel 8 for the rolled strip 9 standing on a lower plane 7-7 below the plane 2-2.

The two working rolls 12, 13 rotatably mounted in the mounting parts 10, 11 and the backing rolls 16, 17 rotatably mounted in the mounting parts 14, 15 are arranged horizontally in the rolling mill 1 and the mounting parts 14, 15 of the

backing rolls 16, 17 are buttressed in the roll standards or against the pedestals 3, 4.

The screw-down forces F are introduced horizontally into the roll ends of the backing rolls 16, 17 and the bending forces F_B are introduced horizontally into the roll ends of the working rolls 12, 13, and the rolled strip 9 runs in the vertical direction a through the rolling gap 18 between the working rolls 12, 13.

In order to reduce the frictional forces when screwing down the rolls, the mounting parts 10, 11 of the working rolls 12, 13 and the mounting parts 14, 15 of the backing rolls 16, 17 are supported hydrostatically on a horizontal guide 38.

The four-roll stand 1 is equipped with pressure cylinders, not shown, for bending the working rolls 12, 13 on the one hand in the strip running direction a, in order to stretch the rolled strip in its width, in order thereby to avoid formation of folds and on the other hand in the horizontal direction to counteract lack of flatness of the rolled strip 9.

The working rolls 12, 13 and the backing rolls 16, 17 are axially movable to match the strip width. This is made possible by the variable arrangement of the horizontal guideway 38.

The wind-off reel 6 and winding-up reel 8 are movable transverse to the strip running plane 19-19. By position regulation of the wind-off reel 6 and the winding-up reel 8, the run-out point 20 of the rolled strip 9 running off the spool 21 of the wind-off reel 6 and the run-in point 22 of the strip 9 running into the spool 21 of the winding-up reel 8 are constantly kept in line with the strip running plane 19-19.

The diameter of the coil 30 on the wind-off reel can be continuously derived from the vertical run-out of the rolled strip 9 from the wind-off reel 6 and the speed of rotation of the wind-off reel be regulated in dependence on the change of diameter of the coil.

The device for cooling, lubricating and heating the working rolls 12, 13 and the backing rolls 16, 17 consists of feed boxes 23 according to Figure 2 directly over the rolls and open to the roll surfaces, for zoned or overall flooding of the rolls 12, 13, 16, 17 over the roll width with a rolling oil or rolling oil emulsion. The feed

boxes 23 are divided by partitions 39 into chambers 40 with valve flaps, not shown, for flooding and closing the chambers. The movable partitions 39 of the feed boxes 23 facilitate adjusting the width 41 of the chambers 40 of the feed boxes 23 in accordance with the strip width and the cooling zone width in accordance with the strip flatness regulation.

The feed boxes 23 ensure optimum lubrication and cooling of the rolls 12, 13, 16, 17 by laminar application of a film of oil to the rolls. This results in maximum dwell time of the cooling oil film on the roll and thus in good reduction of the thermal gradient in the roll body. The partitioned division of the chambers of the feed boxes facilitates zoned cooling and lubrication of the rolls. Such a cooling of the rolls results in an optimum adjusting value for the strip flatness regulation.

Below the rolls 12, 13, 16, 17 there is a catch pan 24 for the rolling oil, which is integrated into the four-roll roll stand 1 lying in the plane 2-2. A reservoir 25 for fresh rolling oil and/or a feed container 26 for receiving the rolling oil from the catch pan 24 also lie in the plane 2-2.

The thin and foil strip rolling mill is equipped with a transport trolley 27 movable in the plane 5-5 of the wind-off reel 6, with two saddle pairs 28, 29 for transporting a coil 30 from a store 31 to the wind-off reel 6 and for taking away an empty spool 21 removed from the wind-off reel 6 to rails 32, via which the spool 21 is received by a vertical hoist 33, which transports the spools 21 to the plane 7-7 below the plane of the building, in which (7-7) a further transport trolley 27 with two saddle pairs 28, 29 can move. The empty spools 21 fed by the vertical hoist 33 are transferred on rails 34 to the transport trolley 27, which carries a spool 21 each time to the winding-up reel 8 and takes away a coil 30 received from the winding-up reel 8.

A strip thickness measuring apparatus 35 and a flatness measuring roller 36 are arranged below the oil pan 24, a short distance after the rolling gap 18.

The thin and foil strip rolling mill shown in Figure 3 for double rolling thin and foil strip 9 differs from the rolling mill according to Figure 1 for rolling single

thin and foil strip by provision of two wind-off reels 6 and two winding-up reels 8.

CLAIMS

1. A cold-rolling mill for thin and foil strip, with at least one multi-roll stand (four-roll stand 1), at least one wind-off reel (6) and at least one winding-up reel (8) for the rolled strip (9), and characterized by a horizontal arrangement of the rolls (12, 13; 16, 17), horizontal application of the screw-down forces (F) and the bending forces (F_B) to the ends of the rolls, a vertical passage (a) of the rolled strip (9) through the rolling gap (18) between the working rolls (12, 13), and an arrangement of the multi-roll stand (1) or the multi-roll stands, the wind-off reel (8) and the winding-up reel (8) in planes (2-2, 5-5, 7-7) of a building (37) or framework which lie one above the other.

2. A rolling mill according to claim 1, characterized by journalling the rolls (12, 13; 16, 17) in roll standards or pedestals (3, 4) which are integrated in an auxiliary or building structure.

3. A rolling mill according to claim 1 and 2, characterized by a hydrostatic support of the roll mounting parts (10, 11; 14, 15) on a horizontal guide (38).

4. A rolling mill according to any of claims 1 to 3, characterized by at least one four-roll roll stand (1) with two working rolls (12, 13) and two backing rolls (16, 17) and a device for bending the working rolls (12, 13) in the horizontal direction and in the vertical running direction (a) of the rolled strip (9).

5. A rolling mill according to any of claims 1 to 4, characterized in that the working (12, 13) and/or backing rolls (16, 17) can be shifted axially to match the strip width.

6. A rolling mill according to any of claims 1 to 5, characterized by a four-roll

stand (1) which is installed in the middle plane (2-2) of a building (37), a wind-off reel (6) arranged in an upper plane (5-5) above the middle plane (2-2) of the building (37) and a winding-up reel (8) for the rolled strip (9) standing on a lower plane (7-7) below the middle plane (2-2).

7. A rolling mill according to any of claims 1 to 6, characterized in that the wind-off (6) and winding-up roll (8) are movable transverse to the plane (19-19) in which the strip runs.

8. A rolling mill according to claim 7, characterized in that the wind-off (6) and winding-up reels (8) are provided with position regulation for continuous adjustment in line with the strip running plane (19-19) of the run-off point (20) of the strip (9) running off the spool (21) of the wind-off reel (6) and the run-in point (22) of the strip (9) running on to the spool (21).

9. A rolling mill according to any of claims 1 to 8, characterized by at least two wind-off reels (6) and two winding-up reels (8) for pack rolling, especially double rolling of thin and foil strip (9).

10. A rolling mill according to any of claims 1 to 9, characterized by devices for cooling, lubricating and heating the rolls (12, 13; 16,17), with feed boxes (23) arranged directly over the same and open to the roll surfaces for zoned or overall flooding of the rolls (12, 13; 16, 17) with rolling oil or rolling oil emulsion over the roll width.

11. A rolling mill according to claim 10, characterized by division of the feed boxes (23) by partitions (39) into chambers (40) with valve flaps for flooding and closing the chambers (40).

12. A rolling mill according to claim 10 and 11, characterized by adjustable partitions (39) for adjusting the width (41) of the chambers (40) of the feed boxes (23) in accordance with the strip width and the cooling zone width in the context of a strip flatness regulation.

13. A rolling mill according to any of claims 10 to 13, characterized by a catch pan (24) for rolling oil underneath the rolls (12, 13; 16, 17).

14. A rolling mill according to any of claims 10 to 13, characterized by the provision of a reservoir (25) for fresh rolling oil and/or a feed container (26) for reception of the rolling oil from the catch pan (24) in the plane (2-2) in which the roll stand (1) is set up.

15. A rolling mill according to any of claims 1 to 14, characterized by a transport trolley (27) movable in the plane (5-5) of the wind-off reel (6) or the wind-off reels (6) with at least two saddle pairs (28, 29) for transport of the coils (30) from a store (31), especially a high rack store to the wind-off reel (6) or wind-off reels (6) and for taking away the empty strip spools (21) from the wind-off reel (6) or the wind-off reels (6) to a vertical hoist (33) between the upper plane (5-5) of the wind-off reel (6) or the wind-off reels (6) and the lower plane of the winding-up reel (8) or winding-up reels (8), as well as a transport trolley (27) movable in the lower plane (7-7) with at least two saddle pairs (28, 29) for transporting the strip spools (21) from the hoist (33) to the winding-up reel (8) or winding-up reels (8) and to take the coils (30) away from the winding-up reel (8) or winding-up reels (8).

16. A rolling mill according to claim 15, characterized by rails (32, 34) for feeding empty strip spools (21) into the upper plane (5-5) from the transport trolley (27) to the vertical hoist (33) as well as to transport the strip spools (21) into the lower plane (7-7) from the hoist (33) to the transport trolley (27).

The Patent Office

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Claims searched: 1-16

Examiner: Vaughan Phillips
Date of search: 28 March 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B3M (MA, MB)

Int Cl (Ed.6): B21B

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
	NONE	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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