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### 54 LUBRICANT COMPOSITION FOR HOT-ROLLING OF STEEL.

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**DATABASE WPIL, AN=86-217980, Derwent  
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**See also references of WO8912669**

**Inventor: SAKAKIBARA, Masayoshi  
Charmant coop 308,5539, Ohba,Fujisawa-shi  
Kanagawa 251 (JP)**

**Inventor: KAMIYASHIKI, Hiroshi  
2-5-56, Matsugaoka,Chigasaki-shi  
Kanagawa 253 (JP)**

**⑦ Representative: Kador & Partner  
Corneliusstrasse 15  
D-80469 München (DE)**

**Description**

## TECHNICAL FIELD

5 The present invention relates to a lubricating composition for hot-rolling steel. More particularly, the present invention relates to a lubricating composition by which a transfer of heat to a work roll from a material to be rolled is prevented and the effect of reducing the thermal crown of the work roll is attained by incorporating a specific heat-insulating agent into a base oil or base grease.

## 10 BACKGROUND ART

In the conventional hot-rolling method, only roll-cooling water is used for protecting a roll, but now a rolling oil is used for reducing the rolling load and decreasing wear of the roll, and an excellent effect is attached thereby.

15 The main object of the conventional lubricant for hot rolling is to reduce wear of a work roll and improve the roll surface, because the requirement for the quality of a rolled product is relatively moderate and the thermal crown of the work roll is not regarded as important. Nevertheless, recently, an increased of the quality of the product has been demanded, and the effect of reducing the thermal crown of the work roll, which has an direct adverse influence on the quality of the product, has become important.

20 EP-A-135,932 discloses a lubrication composition for metal forming, which comprises a condensed phosphoric acid; a sulfur- or chlorine-containing organic compound as extreme pressure additive; and a solid lubricant such as boron nitride as an additive when the mold temperature is 300 °C or higher.

US-A-4,107,058 discloses a composition containing a lithium soap grease and an insoluble phosphorus composition such a tricalcium phosphate.

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## DISCLOSURE OF THE INVENTION

The present invention relates to a lubricant composition for hot-rolling steel, which is characterized in that a heat-insulating agent is incorporated into a base oil or base grease. More specifically, it was found  
30 that if two specific kinds of heat-insulating agents, i.e., (A) an inorganic compound which is melted by an absorption of heat at a temperature lower than 1200 °C, and (B) an inorganic powder, selected from silicon dioxide or silicon nitride, or powder of amorphous carbon, which is not melted or decomposed at a temperature lower than 1200 °C and has a heat conductivity lower than 0.01 cal/cm.s. °C at room temperature and a friction coefficient smaller than 0.7, are incorporated in combination in specific amounts  
35 in the composition, and excellent heat-insulating effect can be attained and the thermal crown of a work roll can be effectively prevented. The present invention was completed based on this finding.

According to the present invention a lubricating composition for hot-rolling steel, which consists essentially of a base oil or base grease; a combination of heat-insulating agents (A) and (B), the heat-insulating agent (A) being an inorganic compound which is melted by an adsorption of heat at a  
40 temperature lower than 1200 °C, the heat-insulating agent (B) being an inorganic powder, selected from silicon dioxide or silicon nitride, or powder of amorphous carbon, which is not melted or decomposed at a temperature lower than 1200 °C and has a heat conductivity lower than 0.01 cal/cm. s. °C at room temperature and a friction coefficient smaller than 0.7; an extreme pressure additive and a solid lubricant, said combination of heat-insulating agents (A) and (B) being selected from the group consisting of a  
45 condensed phosphoric acid salt and silicon nitride; a condensed phosphoric acid salt and amorphous carbon; a condensed phosphoric acid salt and silicon dioxide; sodium chloride and silicon nitride; and sodium silicate and silicon nitride, said extreme pressure additive being selected from the group consisting of zinc dialkyldithiophosphate, tricresyl phosphate and sulfurized lard, said solid lubricant being selected from the group consisting of graphite, molybdenum disulfide, mica and MCA, said heat-insulating agents (A)  
50 and (B) being contained at a weight ratio of from 49/1 to 1/49 and in a total amount of 5 to 50% by weight of the composition.

When the components (A) and (B) are incorporated in combination, a highest effect can be attained due to the synergistic action of the two components.

In the above-mentioned lubricating composition for hot-rolling, by incorporating an extreme pressure  
55 additive and/or a solid lubricant together with the heat-insulating agents (A) and (B), the lubricating property of the base oil or grease can be further improved, and the lubricating property, heat-insulating property, storage stability, working property, and water washing resistance of the base grease can be further improved.

## BRIEF DESCRIPTION OF THE DRAWING

Fig. 1 is a diagram illustrating the method of measuring the contact heat transfer ratio between metals.

## 5 BEST MODE OF CARRYING OUT THE INVENTION

The surface temperature of a work roll is elevated to about 800 °C by contact with a material to be rolled. Most of the conventional lubricants for hot rolling comprise a mineral oil, an oiliness agent, an extreme pressure additive, and a solid lubricating agent, in combination, and although the lubricating  
10 property is taken into consideration, an insulation of heat (prevention of transfer of heat to the work roll from the material to be rolled) is not considered.

Japanese Unexamined Patent Publication No. 60-6211 teaches that a roll can be protected by adding a fine powder of an inorganic compound having a melting point lower than 1200 °C under atmospheric pressure, an average particle size smaller than 1 μm, and no corrosive action on iron and steel including  
15 cast iron and cast steel and other metals, and acting as a substance having a poor heat conductivity to a commercially available hot-rolling oil (liquid).

The base oil disclosed in this patent publication is a commercially available hot-rolling oil (liquid) and is different from the base grease used in the second embodiment of the present invention. Furthermore, the powder used in the invention of the above-mentioned patent publication is a powder of an inorganic  
20 compound which melts at a temperature lower than 1200 °C, and the heat transfer-preventing effect is drastically reduced after melting.

In the present invention an inorganic compound melting at a temperature lower than 1200 °C and an inorganic powder not melting or decomposing at a temperature lower than 1200 °C are used in combination,

The heat-insulating agent used in the present invention includes (A) an inorganic compound which is  
25 melted by an absorption of heat at a temperature lower than 1200 °C and (B) an inorganic powder which is not melted or decomposed at a temperature lower than 1200 °C, is stable against oxidation and has a heat conductivity lower than 0.01 cal/cm·s·°C at room temperature (20 °C) and a friction coefficient smaller than 0.7. The inorganic compound (A) which is melted by an absorption of heat at a temperature lower than 1200 °C is at least one of condensed phosphoric acid salts such as (KPO<sub>3</sub>)<sub>n</sub>, (NaPO<sub>3</sub>)<sub>n</sub> and K<sub>4</sub>P<sub>2</sub>O<sub>7</sub>,  
30 sodium silicate, chromic acid salts such as K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub><sup>-</sup>, and halides such as NaCl, KCl, KF, KBr and KI. Condensed phosphoric acid salts and sodium silicate, which have no corrosive action on a rolling mill or a material to be rolled, are especially preferable.

The inorganic powder (B), which is not melted or decomposed at a temperature lower than 1200 °C, is stable against oxidation and has a heat conductivity lower than 0.01 cal/cm·s·°C at room temperature and  
35 a friction coefficient smaller than 0.7, is at least one of silicon nitride, amorphous carbon, K<sub>3</sub>PO<sub>4</sub>, bentonite, SiO<sub>2</sub> and ZnO. The friction coefficient referred to herein is determined by the pin-on-disk method (a rod having a diameter of 3 mm and a flat top end is pressed under a load of 1 kgf against a disk having a diameter of 11 mm, and the disk is slid at a speed of 0.01 m/s).

A heat-insulating agent having an average particle size smaller than 50 μm can be used, but in view of  
40 the clearance between the roll and the material to be rolled, preferably the average particle size of the heat-insulating agent is smaller than 10 μm.

The reason why better results are obtained when the inorganic compound (A), which is melted by an absorption of heat at a temperature lower than 1200 °C and the inorganic powder which is not melted or decomposed at a temperature lower than 1200 °C and has a heat conductivity lower than 0.01 cal/cm·s·°C  
45 and a friction coefficient smaller than 0.7 are used in combination, has not been completely elucidated, but it is considered that the reason is probably as follows. At the rolling step, the temperature and pressure become high in a roll bite (higher than 600 °C and higher than 2000 kgf/cm<sup>2</sup>). At this point, the heat-insulating agent (A) is promptly melted by absorption of heat and prevents heat from being transferred to the work roll from the material to be rolled. It is known that the heat conductivity of a liquid is, in general,  
50 increased more than that of a powder. Accordingly, it is considered that the heat transfer-reducing effect of the heat-insulating agent (A) is abruptly decreased by melting. On the other hand, since the heat-insulating agent (B) is not melted or decomposed even under high-temperature and high-pressure conditions, the heat-insulating agent (B) is present in the form of a powder in the roll bite and prevents the work roll from falling in contact with the material to be rolled, and it is considered that since the powder per se has a  
55 lubricating property, a generation of heat by friction in the roll bite is reduced by the powder of the heat-insulating agent (B).

Namely, although the heat-insulating agent (A) has an excellent heat-insulating property, when the heat-insulating agent (A) is melted at a high temperature, the heat-insulating property is drastically reduced. On

the other hand, since the heat-insulating agent (B) is not melted or decomposed at a temperature lower than 1200 °C, the heat-insulating agent (B) has a heat-insulating property over a broad temperature range. Accordingly, if the heat-insulating agent (A) and the heat-insulating agent (B) are made present at a specific ratio, a lubricating agent having the excellent effects of both heat-insulating agents (A) and (B) can be obtained.

Preferably, the heat-insulating agent is added in an amount of 5 to 50% by weight, especially 10 to 40% by weight. If the amount of the heat-insulating agent is smaller than 5% by weight, the heat-insulating effect is too low, and if the amount of the heat-insulating agent is larger than 50% by weight, the viscosity of the lubricant becomes too high and the oil-supplying property is degraded. Preferably, the ratio of the heat-insulating agent (A) to the heat-insulating agent (B) is in the range of 49/1 to 1/49, especially 19/1 to 1/4. This is because, if the proportion of the heat-insulating agent (A) is reduced, the heat-insulating property is lowered by an absorption of heat in the roll bite, and if the proportion of the heat-insulating agent (B) is reduced, the heat-insulating property at high temperature is lowered.

As the base oil that can be used in the present invention, there can be mentioned medium and heavy mineral oils such as spindle oil, machine oil, dynamo oil, motor oil, cylinder oil and bright stock, animal and vegetable oils such as beef tallow, lard, sperm oil, palm oil, coconuts oil, linseed oil, rice bran oil and soybean oil, synthetic oils such as esters of fatty acids having 8 to 22 carbon atoms with monohydric or polyhydric alcohols,  $\alpha$ -olefins, polybutene, silicone oils and fluorine oils, and mixtures of these oils.

As the base grease that can be used in the present invention, there can be mentioned lithium soap grease, calcium soap grease, sodium soap grease, aluminum soap grease, calcium complex grease, polyurea grease and organo-clay grease. Lithium soap grease, calcium complex grease, polyurea grease and organo-clay grease, which have an excellent heat resistance, are preferable.

As the solid lubricant that can be used in the present invention, there can be mentioned inorganic solid lubricants such as graphite (natural graphite and artificial graphite), molybdenum disulfide, mica (natural mica and artificial mica), fluorinated graphite, boron nitride, soft metals (such as gold, silver and copper) and talc, and organic solid lubricants such as PTFE (polytetrafluoroethylene), MCA (melamine/cyanuric acid adduct) and phthalocyanine. Graphite (natural graphite and artificial graphite), mica (natural mica and artificial mica), boron nitride and talc, which have an excellent heat resistance and oxidation stability at a high temperature and have no substantial influence on a material to be rolled, are preferably. Preferably the amount added of the solid lubricant is 0 to 40% by weight, especially 5 to 15% by weight. If the amount added of the solid lubricant exceeds 40% by weight, the viscosity of the lubricant becomes too high and the oil-supplying property is reduced.

As the extreme pressure additive that can be used in the present invention there can be mentioned sulfur compounds, phosphorus compounds, chlorine compounds and organic metal compounds. Preferably the amount added of the extreme pressure additive is 0 to 20% by weight, especially 0.5 to 10% by weight. If the amount added of the extreme pressure additive exceeds 20% by weight, undesired side effects such as an appearance of a corrosive action and reduction of the stability of the micell structure of the grease occur.

The present invention will now be described in detail with reference to the following examples and comparative examples.

#### Examples 1 through 16 and Comparative Examples 1 through 11

A base oil, a base grease, a heat-insulating agent, an extreme pressure additive, and a solid lubricant were mixed at a mixing ratio shown in Table 1, whereby lubricating agents of Examples 1 through 16 and Comparative Examples 1 through 11 were prepared. With respect to each of the so-obtained compositions, the performances were evaluated according to the test methods described below. The results are shown in Table 1.

#### A) Lubricating Property Test by Hot Lubricating Property Tester Model E-12

According to the principle of the hot lubricating property tester Model E-12, both ends of a test piece were fixed and the test piece induction-heated gripped between rolls while supplying an oil to the test piece, and a slip lubrication effected. The friction coefficient and seizure resistance of each lubricant were examined to evaluate the lubricating property.

Friction coefficient  $\mu = T/R \cdot W$  in which T represents a shaft torque, R represents a roll radius, and W represents a load. The outlines of the tester and the test conditions are as follows.

- a) Type: lubricity tester of two-high type for slip lubricating

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- b) Roll dimension: 124 mm (diameter) x 80 mm (length)
- c) Roll material: high chromium roll (Hs = 70 - 75)
- d) Test piece material: SS-41 [20 mm (height) x 20 mm (width) x 580 mm (length)]
- e) Test piece temperature: 400 °C, 600 °C and 800 °C (automatically adjusted)
- 5 f) Revolution: 200 rpm
- g) Rolling load: 500 to 3000 kgf (the load is increased by 500 kgf at every time)
- h) Method of supplying lubricant: applying

### B) Rust Prevention Test

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- a) The test piece used at the test (A) was cut to a size of 20 mm x 20 mm x 100 mm.
- b) The test piece prepared at a) above has hung under the eaves and allowed to stand for 2 weeks, and the state of rusting was checked.
- o: no rusting
- 15 x: extreme rusting

### C) Water Washing Resistance Test

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- a) A defatted and weighed steel sheet (SPCC-SD 100 mm x 100 mm x 0.8 mm) was uniformly coated with  $30 \pm 3$  mg of the lubricant.
- b) The steel sheet prepared at a) above was washed with water under the following conditions, and the weight was measured after the water washing and the residual oil ratio is determined.
- a) Nozzle model number: 1/4 KBF 0865
- b) Extrusion rate: 6.4 l/min (extrusion pressure = 2.0 kgf/cm<sup>2</sup>)
- 25 c) Water washing time: 5 seconds (water temperature = 25 °C)
- d) Distance between steel sheet and nozzle: 200 mm

Residual oil or grease ratio (%) = [(amount of residual oil or grease)/(amount coated of oil or grease)] x 100

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### D) Measurement of Contact Heat Transfer Ratio between Metals

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- a) Material of test piece: WT-60 [25 mm (diameter) x 50 mm (length)]
- b) Temperature: 780 °C (high-temperature material), 22 to 30 °C (low-temperature material)
- c) Thermocouple: CA (0.5 mm) sheath (attachment position = 1.5 mm, 3.0 mm)
- d) Heat-insulating material: kao wool
- e) Compressive force: 500 kgf/cm<sup>2</sup>
- f) Method of filling sample and thickness:

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As shown in Fig. 1, a high-temperature material 3 was pressed against a low-temperature material 2 coated with a sample 1, and the contact interface temperature of each sample and the heat flow flux were reckoned backward from the change of the temperatures of both materials with a lapse of time after the contact. The cooling law of Newton was applied in an extended manner to determine the heat transfer coefficient between the metals. The obtained coefficient was compared with the coefficient obtained when the sample is not coated, and the heat transfer ratio determined.

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Note, in Fig. 1, reference numeral 4 represents a heat-insulating material and reference numeral 5 represents a thermocouple.

### E) Roll Wearing Quantity Ratio in Actual Rolling Mill

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Eight air spray nozzles (20 ml/min•nozzle) were attached to a work roll on the inlet side of F5 stand (6-stand mill), and about 300 metric tons of an ordinary material rolled by using nickel grain rolls. The wear quantity was measured and compared with the wear quantity observed when an oiling agent now available was used.

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Table 1-1

	Example 1	Example 2	Example 3	Example 4	Example 5
Base Oil	mineral oil (ISO VG 430)	85	85	85	85
	synthetic oil (hydrocarbon type)	85			
Base Grease	lithium soap grease (mineral oil type)				
	lithium soap grease (synthetic oil type)				
	polyurea grease (mineral oil type)				
	calcium complex grease (mineral oil type)				
Heat-Insulating Agent	melting type (A)	10	10	10	10
	(B)				
	$(KPO_3)_n$				
	$Na_2SiO_4$				
	NaCl				
	non-melting type (B)	5	5	5	5
	silicon nitride				
	amorphous carbon		5		
	silicon dioxide				5

Table 1-1 (Continued)

	Example 1	Example 2	Example 3	Example 4	Example 5
Extreme Pressure Additive					
zinc dialkyl dithiophosphate					
tricresyl phosphate					
sulfurized lard					
Solid Lubricant					
graphite (artificial)					
mica (natural)					
boron nitride					
MCA					
Consistency Number (JIS K 2220)	-	-	-	-	-
E-12 Model Hot Lubricating Performance Test					
400°C load resistance (kgf)	2000	2000	2000	2000	2000
μ under above load	0.18	0.18	0.18	0.18	0.18
600°C load resistance (kgf)	1000	1000	1000	1000	1000
μ under above load	0.18	0.18	0.18	0.18	0.18
800°C load resistance (kgf)	500	500	500	500	500
μ under above load	0.18	0.18	0.18	0.18	0.18

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Table 1-1 (Continued)

	Example 1	Example 2	Example 3	Example 4	Example 5
Rust Prevention Test	0	0	0	0	0
Water Washing Resistance Test (residual oil or grease ratio; %)	45	46	45	44	46
Contact Heat Transfer Ratio between Metals	0.7 - 0.8	0.7 - 0.8	0.7 - 0.8	0.7 - 0.8	0.7 - 0.8
Roll Wearing Ratio in Actual Rolling Mill	0.8 - 0.9	0.8 - 0.9	0.8 - 0.9	0.8 - 0.9	0.8 - 0.9

Table 1-2

	Example 6	Example 7	Example 8	Example 9	Comparative Example 1
Base Oil	85	82	80	77	
mineral oil (ISO VG 430)					
synthetic oil (hydrocarbon type)					
Base Grease					90
lithium soap grease (mineral oil type)					
lithium soap grease (synthetic oil type)					
polyurea grease (mineral oil type)					
calcium complex grease (mineral oil type)					
Heat-Insulating Agent		10	10	10	10
melting type (A)					
$(KPO_3)_n$					
$Na_2SiO_4$					
NaCl	10				
non-melting type (B)					
silicon nitride	5	5	5	5	
amorphous carbon					
silicon dioxide					

Table 1-2 (Continued)

	Example 6	Example 7	Example 8	Example 9	Comparative Example 1
Extreme Pressure Additive		3		3	
zinc dialkyl dithiophosphate					
tricresyl phosphate					
sulfurized lard					
Solid Lubricant			5	5	
graphite (artificial)					
mica (natural)					
boron nitride					
MCA					
Consistency Number (JIS K 2220)	-	-	-	-	1
E-12 Model Hot Lubricating Performance Test					
400°C load resistance (kgf)	2000	2500	2500	3000	2000
μ under above load	0.18	0.17	0.17	0.15	0.18
600°C load resistance (kgf)	1000	1500	2000	2000	1000
μ under above load	0.18	0.16	0.16	0.15	0.18
800°C load resistance (kgf)	500	1000	1000	1500	500
μ under above load	0.18	0.16	0.18	0.16	0.18

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Table 1-2 (Continued)

	Example 6	Example 7	Example 8	Example 9	Comparative Example 1
Rust Prevention Test	x	0	0	0	0
Water Washing Resistance Test (residual oil or grease ratio; %)	46	47	60	60	80
Contact Heat Transfer Ratio between Metals	0.7 - 0.8	0.7 - 0.8	0.7 - 0.8	0.7 - 0.8	0.7 - 0.8
Roll Wearing Ratio in Actual Rolling Mill	0.8 - 0.9	0.5 - 0.6	0.6 - 0.7	0.5 - 0.6	0.8 - 0.9

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Table 1-3

	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5
Base Oil	mineral oil (ISO VG 430)			
	synthetic oil (hydrocarbon type)			
Base Grease	lithium soap grease (mineral oil type)	87	87	87
	lithium soap grease (synthetic oil type)			
	polyurea grease (mineral oil type)			
	calcium complex grease (mineral oil type)			
Heat-Insulating Agent	melting type (A)			
	(KPO) <sub>3n</sub>	10	10	10
	Na <sub>2</sub> SiO <sub>4</sub>			
	NaCl			
	non-melting type (B)			
	silicon nitride	10		
	amorphous carbon			
	silicon dioxide			

Table 1-3 (Continued)

	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5
Extreme Pressure Additive		3		
zinc dialkyl dithiophosphate				
tricresyl phosphate		3		
sulfurized lard				3
Solid Lubricant				
graphite (artificial)				
mica (natural)				
boron nitride				
MCA				
Consistency Number (JIS K 2220)	1	1	1	1
E-12 Model Hot Lubricating Performance Test				
400°C load resistance (kgf)	2000	3000	3000	3000
μ under above load	0.18	0.14	0.14	0.14
600°C load resistance (kgf)	1000	2000	2000	2000
μ under above load	0.18	0.17	0.17	0.17
800°C load resistance (kgf)	500	1500	1500	1500
μ under above load	0.18	0.17	0.16	0.16

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Table 1-3 (Continued)

	Comparative Example 2	Comparative Example 10	Comparative Example 3	Comparative Example 4	Comparative Example 5
Rust Prevention Test	0	0	0	0	0
Water Washing Resistance Test (residual oil or grease ratio; %)	80	85	81	81	81
Contact Heat Transfer Ratio between Metals	0.7 - 0.8	0.6 - 0.7	0.7 - 0.8	0.7 - 0.8	0.7 - 0.8
Roll Wearing Ratio in Actual Rolling Mill	0.6 - 0.9	0.7 - 0.8	0.7 - 0.8	0.7 - 0.8	0.7 - 0.8

Table 1-4

	Comparative Example	Comparative Example
	6	11
Base Oil	mineral oil (ISO VG 430)	
	synthetic oil (hydrocarbon type)	
Base Grease	lithium soap grease (mineral oil type)	77
	lithium soap grease (synthetic oil type)	
	polyurea grease (mineral oil type)	
	calcium complex grease (mineral oil type)	
Heat-Insulating Agent	melting type (A)	10
	(KPO <sub>3</sub> ) <sub>n</sub>	
	Na <sub>2</sub> SiO <sub>4</sub>	
	NaCl	
	non-melting type (B)	10
	silicon nitride	
	amorphous carbon	
	silicon dioxide	

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Table 1-4 (Continued)

	Comparative Example	Comparative Example
Extreme Pressure Additive	zinc dialkyl dithiophosphate	11
	tricresyl phosphate	6
	sulfurized lard	
Solid Lubricant	graphite (artificial)	
	mica (natural)	
	boron nitride	
	MCA	5
Consistency Number (JIS K 2220)		1
E-12 Model Hot Lubricating Performance Test	400°C load resistance (kgf)	3000
	μ under above load	0.18
	600°C load resistance (kgf)	3000
	μ under above load	0.15
	800°C load resistance (kgf)	2000
	μ under above load	0.17

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Table 1-4 (Continued)

	Comparative Example 6	Comparative Example 11
Rust Prevention Test	0	0
Water Washing Resistance Test (residual oil or grease ratio; %)	86	86
Contact Heat Transfer Ratio between Metals	0.7 - 0.8	0.6 - 0.7
Roll Wearing Ratio in Actual Rolling Mill	0.7 - 0.8	0.5 - 0.6

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Table 1-5

	Example 12	Example 13	Example 14	Example 15	Example 16
Base Oil	mineral oil (ISO VG 430)				
	synthetic oil (hydrocarbon type)				
Base Grease	lithium soap grease (mineral oil type)	47			
	lithium soap grease (synthetic oil type)		72		
	polyurea grease (mineral oil type)			72	
	calcium complex grease (mineral oil type)				72
Heat-Insulating Agent	melting type (A)	10	25	10	10
	(A)	$KPO_3 \cdot n$	$Na_2SiO_4$		
		NaCl			
	non-melting type (B)	10	10	5	5
		silicon nitride			
		amorphous carbon			
		silicon dioxide			

Table 1-5 (Continued)

	Example 12	Example 13	Example 14	Example 15	Example 16
Extreme Pressure Additive	zinc dialkyl dithiophosphate	3	3	3	3
	tricresyl phosphate				
	sulfurized lard				
Solid Lubricant	graphite (artificial)	5	10	10	10
	mica (natural)				
	boron nitride				
	MCA				
Consistency Number (JIS K 2220)	1	2	1	1	1
E-12 Model Hot Lubricating Performance Test	400°C load resistance (kgf)	3000	3000	3000	3000
	μ under above load	0.14	0.06	0.14	0.14
	600°C load resistance (kgf)	3000	3000	3000	3000
	μ under above load	0.15	0.08	0.15	0.15
	800°C load resistance (kgf)	2500	3000	2000	2500
	μ under above load	0.16	0.10	0.16	0.14

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Table 1-5 (Continued)

	Example	Example	Example	Example	Example
	12	13	14	15	16
Rust Prevention Test	0	0	0	0	0
Water Washing Resistance Test (residual oil or grease ratio; %)	87	93	87	89	87
Contact Heat Transfer Ratio between Metals	0.6 - 0.7	0.5 - 0.6	0.6 - 0.7	0.6 - 0.7	0.6 - 0.7
koll Wearing Ratio in Actual Rolling Mill	0.5 - 0.6	0.2 - 0.3	0.3 - 0.4	0.3 - 0.4	0.3 - 0.4

Table 1-6

	Comparative Example 7	Comparative Example 8	Comparative Example 9	Comparative Example 10
Base Oil	mineral oil (ISO VG 430)	90		
	synthetic oil (hydrocarbon type)			
Base Grease	lithium soap grease (mineral oil type)		87	72
	lithium soap grease (synthetic oil type)			
	polyurea grease (mineral oil type)	90		
	calcium complex grease (mineral oil type)			
Heat-Insulating Agent	melting type (A)	10	10	10
		$KPO_3$		
		$Na_2SiO_4$		
		NaCl		
	non-melting type (B)			
		silicon nitride		
		amorphous carbon		
		silicon dioxide		nickel powder 10 (note 1)

Table 1-6 (Continued)

	Comparative Example 7	Comparative Example 8	Comparative Example 9	Comparative Example 10
Extreme Pressure Additive			3	3
	zinc dialkyl dithiophosphate			
	tricresyl phosphate			
	sulfurized lard			
Solid Lubricant			10	5
	graphite (artificial)			
	mica (natural)			
	boron nitride			
	MCA			
Consistency Number (JIS K 2220)		-	-	-
E-12 Model Hot Lubricating Performance Test				
	400°C load resistance (kgf)	2500	1500	2500
	μ under above load	0.18	0.18	0.16
	600°C load resistance (kgf)	1500	500	1500
	μ under above load	0.17	0.17	0.16
	800°C load resistance (kgf)	1000	500 >	1000
	μ under above load	0.18	-	0.17
				0.17

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Table 1-6 (Continued)

	Comparative Example 7	Comparative Example 8	Comparative Example 9	Comparative Example 10
Rust Prevention Test	0	0	0	0
Water Washing Resistance Test (residual oil or grease ratio; %)	80	40	80	87
Contact Heat Transfer Ratio between Metals	0.7 - 0.8	0.9 - 1.0	0.9 - 1.0	0.8 - 0.9
Roll Wearing Ratio in Actual Rolling Mill	0.8 - 0.9	0.9 - 1.0	0.7 - 0.8	0.7 - 0.8

Note 1 heat conductivity = 0.22 cal/cm·s·°C  
melting point = 1455°C

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Table 1-7

	Compara- tive Example 11
Base Oil	mineral oil (ISO VG 430)
	synthetic oil (hydrocarbon type)
Base Grease	lithium soap grease (mineral oil type)
	lithium soap grease (synthetic oil type)
	polyurea grease (mineral oil type)
	calcium complex grease (mineral oil type)
Heat- Insulating Agent	melting type (A) $(KPO)_3n$
	$Na_2SiO_4$
	NaCl
	non-melting type (B)
	silicon nitride
	amorphous carbon
	silicon dioxide
	lubri- cating agent not added

Table 1-7 (Continued)

Compara- tive Example 11	
Extreme Pressure Additive	zinc dialkyl dithiophosphate
Solid Lubricant	tricresyl phosphate sulfurized lard graphite (artificial) mica (natural) boron nitride MCA
Consistency Number (JIS K 2220)	-
E-12 Model Hot Lubricating Performance Test	400°C load resistance (kgf) 500 > μ under above load - 600°C load resistance (kgf) 500 > μ under above load - 800°C load resistance (kgf) 500 > μ under above load -

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Table 1-7 (Continued)

	Compara- tive Example 11
Rust Prevention Test	0
Water Washing Resistance Test (residual oil or grease ratio; %)	-
Contact Heat Transfer Ratio between Metals	1
Roll Wearing Ratio in Actual Rolling Mill	1 <

45 Explanation of Reference Numerals in the Drawing

- 1: sample
- 2: low-temperature material
- 3: high-temperature material
- 50 4: heat-insulating material
- 5: thermocouple

**Claims**

- 55 1. A lubricating composition for hot-rolling steel, which consists essentially of a base oil or base grease; a combination of heat-insulating agents (A) and (B), the heat-insulating agent (A) being an inorganic compound which is melted by an adsorption of heat at a temperature lower than 1200 °C, the heat-insulating agent (B) being an inorganic powder, selected from silicon dioxide or silicon nitride, or

powder of amorphous carbon, which is not melted or decomposed at a temperature lower than 1200 °C and has a heat conductivity lower than 0.01 cal/cm. s. °C at room temperature and a friction coefficient smaller than 0.7; an extreme pressure additive and a solid lubricant, said combination of heat-insulating agents (A) and (B) being selected from the group consisting of a condensed phosphoric acid salt and silicon nitride; a condensed phosphoric acid salt and amorphous carbon; a condensed phosphoric acid salt and silicon dioxide; sodium chloride and silicon nitride; and sodium silicate and silicon nitride, said extreme pressure additive being selected from the group consisting of zinc dialkyldithiophosphate, tricresyl phosphate and sulfurized lard, said solid lubricant being selected from the group consisting of graphite, molybdenum disulfide, mica and MCA (melamine/cyanuric acid adduct), said heat-insulating agents (A) and (B) being contained at a weight ratio of from 49/1 to 1/49 and in a total amount of 5 to 50% by weight of the composition.

2. A lubricating composition for hot-rolling steel according to claim 1, wherein the base oil is a member selected from the group consisting of spindle oil, machine oil, dynamo oil, motor oil, cylinder oil, bright stock, beef tallow, lard, sperm oil, palm oil, coconut oil, linseed oil, rice bran oil, soybean oil, esters of fatty acids having 8 to 22 carbon atoms with monohydric and polyhydric alcohols,  $\alpha$ -olefins, polybutene, silicone oils and fluorine oils.
3. A lubricating composition for hot-rolling steel according to claim 1, wherein the base grease is a member selected from the group consisting of lithium soap grease, calcium soap grease, sodium soap grease, aluminum soap grease, calcium complex grease, polyurea grease and organo-clay grease.
4. A lubricating composition for hot-rolling steel according to claim 1, wherein the solid lubricant is a member selected from the group consisting of natural graphite, artificial graphite molybdenum disulfide, natural mica, artificial mica, boron nitride, soft metals, talc, polytetrafluoroethylene, melamine/cyanuric acid adducts and phthalocyanine.
5. A lubricating composition for hot-rolling steel according to claim 1, wherein the extreme pressure additive is a member selected from the group consisting of sulfur compounds, phosphorus compounds, chlorine compounds and organic metal compounds.

### Patentansprüche

1. Schmiermittelzusammensetzung zum Warmwalzen von Stahl, die im wesentlichen besteht aus: einem Basisöl oder Basisfett; einer Kombination von wärmedämmenden Mitteln (A) und (B), wobei das wärmedämmende Mittel (A) eine anorganische Verbindung ist, die durch Wärmeadsorption bei einer Temperatur von weniger als 1200 °C schmilzt, das wärmedämmende Mittel (B) ein anorganisches Pulver ist, das aus Siliciumdioxid oder Siliciumnitrid oder Pulver von amorphem Kohlenstoff ausgewählt ist, das bei einer Temperatur von weniger als 1200 °C nicht schmilzt oder zersetzt wird und ein Wärmeleitvermögen von weniger als 0,01 cal/cm·s·°C bei Raumtemperatur und einen Reibungskoeffizienten von weniger als 0,7 aufweist; einem EP-Additiv und einem festen Schmiermittel, wobei die Kombination aus wärmedämmenden Mitteln und (A) und (B) aus der Gruppe ausgewählt ist, die aus einem kondensierten Phosphorsäuresalz und Siliciumnitrid; einem kondensierten Phosphorsäuresalz und amorphem Kohlenstoff; einem kondensierten Phosphorsäuresalz und Siliciumdioxid; Natriumchlorid und Siliciumnitrid; und Natriumsilicat und Siliciumnitrid besteht; das EP-Additiv aus der Gruppe ausgewählt ist, die aus Zinkdialkyldithiophosphat, Tricresylphosphat und geschwefeltem Schmalz besteht, das feste Schmiermittel aus der Gruppe ausgewählt ist, die aus Graphit, Molybdändisulfid, Glimmer und MCA (Melamin/Cyanursäure-Addukt) besteht, und die wärmedämmenden Mittel (A) und (B) in einem Gewichtsverhältnis von 49/1 bis 1/49 und in einer Gesamtmenge von 5 bis 50 Gew.-% der Zusammensetzung enthalten sind.
2. Schmiermittelzusammensetzung zum Warmwalzen von Stahl nach Anspruch 1, wobei das Basisöl eine Verbindung ist, die aus der Gruppe ausgewählt ist, die aus Spindelöl, Maschinenöl, Dynamoöl, Motoröl, Zylinderöl, Brightstock, Rindertalg, Schmalz, Spermöl, Palmöl, Kokosnußöl, Leinsamenöl, Reisöl, Sojabohnenöl, Estern von Fettsäuren mit 8 bis 22 Kohlenstoffatomen mit einwertigen und mehrwertigen Alkoholen,  $\alpha$ -Olefinen, Polybuten, Siliconölen und Fluorölen besteht.

3. Schmiermittelzusammensetzung zum Warmwalzen von Stahl nach Anspruch 1, wobei das Basisfett eine Verbindung ist, die aus der Gruppe ausgewählt ist, die aus Lithiumseifenfett, Calciumseifenfett, Natriumseifenfett, Aluminiumseifenfett, Calciumkomplexfett, Polyharnstofffett und Organopolysilicatifett besteht.

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4. Schmiermittelzusammensetzung zum Warmwalzen von Stahl nach Anspruch 1, wobei das feste Schmiermittel eine Verbindung ist, die aus der Gruppe ausgewählt ist, die aus natürlichem Graphit, künstlichem Graphit, Molybdändisulfid, natürlichem Glimmer, künstlichem Glimmer, Bornitrid, weichen Metallen, Talkum, Polytetrafluorethylen, Melamin/Cyanursäure-Addukten und Phthalocyanin besteht.

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5. Schmiermittelzusammensetzung zum Warmwalzen von Stahl nach Anspruch 1, wobei das EP-Additiv eine Verbindung ist, die aus der Gruppe ausgewählt ist, die aus Schwefelverbindungen, Phosphorverbindungen, Chlorverbindungen und Organometallverbindungen besteht.

### 15 Revendications

1. Composition lubrifiante pour le laminage à chaud de l'acier, consistant essentiellement en une huile de base ou une graisse de base; une combinaison d'agents isolants thermiques (A) et (B), l'agent isolant thermique (A) étant un composé inorganique que l'on fait fondre par adsorption de chaleur à une température inférieure à 1200 °C, l'agent isolant thermique (B) étant une poudre inorganique, choisie parmi le dioxyde de silicium ou le nitrure de silicium, ou une poudre de carbone amorphe, qui ne fond pas ni ne se décompose à une température inférieure à 1200 °C et a une conductivité thermique inférieure à 0,01 cal/cm.s. °C à la température ambiante et un coefficient de frottement inférieur à 0,7; un additif d'extrême pression et un lubrifiant solide, ladite combinaison d'agents isolants thermiques (A) et (B) étant choisie dans le groupe constitué par un sel d'acide phosphorique condensé et le nitrure de silicium; un sel d'acide phosphorique condensé et le carbone amorphe; un sel d'acide phosphorique condensé et le dioxyde de silicium; le chlorure de sodium et le nitrure de silicium; et le silicate de sodium et le nitrure de silicium, ledit additif d'extrême pression étant choisi dans le groupe constitué par le dialkyldithiophosphate de zinc, le phosphate de tricrésyle et la graisse sulfurée, ledit lubrifiant solide étant choisi dans le groupe constitué par le graphite, le disulfure de molybdène, le mica et le MCA (produit d'addition mélamine/acide cyanurique), lesdits agents thermiquement isolants (A) et (B) étant contenus en un rapport pondéral de 49/1 à 1/49 et en une quantité totale de 5 à 50% en poids de la composition.

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2. Composition lubrifiante pour le laminage à chaud de l'acier selon la revendication 1, dans laquelle l'huile de base est un membre choisi dans le groupe constitué par l'huile minérale pour broches, l'huile pour machine, l'huile de dynamo, l'huile moteur, l'huile pour cylindres, le bright stock, le suif de boeuf, le saindoux, l'huile de spermaceti, l'huile de palme, l'huile de coco, l'huile de lin, l'huile de son de riz, l'huile de soja, les esters d'acides gras ayant de 8 à 22 atomes de carbone avec les alcools monohydriques et polyhydriques, les  $\alpha$ -oléfines, le polybutène, les huiles de silicone et les huiles de fluor.

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3. Composition lubrifiante pour le laminage à chaud de l'acier selon la revendication 1, dans laquelle la graisse de base est un membre choisi dans le groupe constitué par la graisse de savon de lithium, la graisse de savon de calcium, la graisse de savon de sodium, la graisse de savon d'aluminium, la graisse de complexe de calcium, la graisse de polyurée et la graisse d'argile organique.

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4. Composition lubrifiante pour le laminage à chaud de l'acier selon la revendication 1, dans laquelle le lubrifiant solide est un membre choisi dans le groupe constitué par le graphite naturel, le graphite artificiel, le disulfure de molybdène, le mica naturel, le mica artificiel, le nitrure de bore, les métaux doux, le talc, le polytétrafluoroéthylène, les produits d'addition mélamine/acide cyanurique et la phtalocyanine.

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5. Composition lubrifiante pour le laminage à chaud de l'acier selon la revendication 1, dans laquelle l'additif d'extrême pression est un membre choisi dans le groupe constitué par les composés de soufre, les composés de phosphore, les composés de chlore et les composés organo-métalliques.

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Fig.1

