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(54) Process for continuously annealing of a cold rolled steel strip.

(57) The present invention involves a concept of combining the following:

using instead of a direct fired furnace a radiation heating furnace, thereby preventing the formation of an appreciable oxide layer during the stages for heating to and holding within the requisite annealing temperature range;

cooling the annealed steel strip by a cooling medium consisting of a mixture of gas and liquid, and;

removing the oxide film formed during the cooling stage, by means of pickling at the final step.

In the present invention it is possible to eliminate the surface-quality problems caused by conventional processes and simultaneously to omit the reheating for overaging of the steel strip.

EP 0 032 583 A1

PROCESS FOR CONTINUOUSLY ANNEALING OF A COLD ROLLED STEEL STRIP

FIELD OF THE INVENTION

The present invention relates to a process for continuously annealing a cold rolled steel strip. More particularly, the present invention relates to a process for continuously annealing a cold rolled steel strip, which process is capable of completing the annealing operation within a short time and, also, capable of obtaining a cold rolled steel strip having an excellent workability, especially formability, and an excellent surface quality, at a low cost.

BACKGROUND OF THE INVENTION

It is known that a cold rolled steel strip having a deep drawing quality can be produced by tightly or loosely coiling a cold rolled steel strip and, then, by annealing it batchwise in a box type annealing furnace. This type of method needs several days to complete the entire process thereof and, therefore, is extremely inefficient. In order to avoid the above-mentioned disadvantage, various attempts have been made to continuously carry out the annealing process, and some of the attempts have been practically used in steel industry.

The continuous annealing method can exhibit an extremely high efficiency in comparison with the conventional batch type annealing method. However, it is strongly desired to increase the efficiency of the continuous annealing method to such an extent that the continuous annealing operation is completed within a few minutes.

In order to accelerate the continuous annealing operation, it has been attempted to rapidly heat the steel strip by using a direct fired furnace or to rapidly cool the heated steel strip with water or gas in the primary stage of the cooling operation. However, both rapid heating operation and rapid cooling operation in the above-mentioned processes cause an oxide layer to be formed on the peripheral surface of the steel strip. Therefore, it is necessary to eliminate the oxide layer from the annealed steel strip. Examples of the accelerated continuous annealing processes are as follows.

(1) Japanese Patent Application Laying-open (Kokai) No. 52-14431 (1977) discloses an annealing process in which a steel strip is rapidly heated to a predetermined temperature in a direct fired furnace and, then, rapidly cooled with water, reheated, overaged and, finally, subjected to a pickling operation to remove an oxide layer formed on the peripheral surface of the steel strip.

(2) Japanese Patent Application Laying-open (Kokai) No. 53-17518 (1978) discloses a process wherein a steel strip is rapidly heated to a predetermined temperature and maintained at the temperature in the direct fired furnace, rapidly cooled with water and, reheated, overaged while the oxide layer on the peripheral surface thereof is removed by reducting it.

Especially, in the above-mentioned process (1), the heating and cooling operations result in the formation of a considerably large thickness of the oxide layer, and this large thickness causes the time necessary for completing the elimination of the oxide layer to be undesirably long. In addition, the sheet surface is coarsened due to the pickling for removing the oxide layer.

In the above-mentioned process (2), the elimination of the oxide layer from the steel strip is carried out during the reheating overaging operation at a relatively low temperature. Therefore, in order to effectively attain the elimination of the oxide layer, the reducing operation should be carried out by using a strictly controlled reducing atmosphere having a special concentration of hydrogen and dew point. Also, in the processes (1) and (2), in order to overage the steel strip after the rapid cooling, it is necessary to reheat the steel strip to an overaging temperature thereof.

When the electrolytic cleaning is omitted in the processing line of the cold rolled steel strip including the direct fired furnace, iron powder, which is adhered on the surface of the cold rolled steel strip and remains on the steel strip conveyed into the direct fired furnace, is oxidized in this furnace. When the quantity of so oxidized iron powder is large, the oxide layer is partly peeled off from the sheet surface as the steel travels through a direct fired holding furnace. The peeled oxide layer is picked up by and firmly bonded around the hearth rollers of the holding furnace due to sintering phenomenon thereof, which causes generation of flaws on the high-temperature steel strips conveyed by the hearth rollers.

As is well known, the combustion air ratio is adopted as a parameter of the combustion condition in the direct fired furnace. The oxidation tendency of the sheet surface is dependent upon the combustion air ratio.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a continuously annealing process of a cold rolled steel strip, capable of eliminating the problems of a surface-quality caused by conventional processes.

It is another object of the present invention to provide a continuously annealing process of a cold rolled steel strip, capable of eliminating the surface-quality problems caused by conventional processes and simultaneously omitting the reheating step for overaging of the steel strip.

The present invention involves a concept of combining the following:

using instead of a direct fired furnace a radiation heating furnace, thereby preventing the formation of an appreciable oxide layer during the stages for heating to and holding within the requisite annealing temperature range;

cooling the annealed steel strip by a cooling medium consisting of a mixture of gas and liquid, and;

removing the oxide film formed during the cooling stage, by means of pickling at the final step.

In accordance with the objects of the present invention, there is provided a process, comprising the steps of:

introducing a cold rolled steel strip into at least one radiation-heating furnace, in which the steel strip is heated to a temperature range of from the recrystallization temperature to the Ac_3 point of said steel strip and held within said temperature range over a period of at least 10 seconds;

cooling said steel strip by a cooling medium consisting of a mixture of gas and liquid, and;

pickling said steel strip.

In accordance with the objects of the present invention, there is provided a process, comprising the steps of:

introducing a cold rolled steel strip into at least one radiation-heating furnace, in which the steel strip is heated within a temperature range of from the recrystallization temperature to the Ac_3 point of the steel strip and held within said temperature range over a period of at least 10 seconds;

cooling the steel strip by using a cooling medium consisting of a mixture of gas and liquid over a primary-cooling temperature range of from 600°C at the lowest to a temperature near to an overaging treatment temperature;

overaging the primary cooled steel strip;

secondary-cooling said overaged steel strip, and;

pickling the secondarily cooled steel strip.

DETAILED DESCRIPTION OF THE INVETNION

The process without the overaging step of the present invention can be applied to cold-rolled non-aging low carbon steel strips, for example, cold-rolled, extremely low carbon aluminum killed steel strips, and cold-rolled non- or retarded-aging extremely low carbon steel strips containing a small amount of Ti, Nb, V or B, which are capable of forming carbonitrides. In other words, the process of the present invention can be applied to various cold-rolled low carbon steel strips which include the usual type of cold-rolled low carbon steel strips having a drawing quality and a deep drawing quality, for example, bodies of automobiles, high tensile strength cold-rolled low carbon steel strips and other types of cold-rolled low carbon steel strips suitable for various surface-treating processes, for example, metal plating and coating processes. Since, there is no necessity of overaging in the non- or retarded-aging steels, the steel strips are directly pickled after cooling, so as to remove the oxide layer.

In the process with the overaging step of the present invention, the primary cooling operation is followed by an overaging operation. In the cases of usual cold rolled low carbon steel strips having an aging property, the overaging operation is usually applied to them. In this case, the cooling operation must be terminated when the temperature of the steel strip reaches a level near an overaging temperature of the steel strip, the cooled steel strip may be overaged and, then, the overaged steel strip may be additionally cooled to a desired temperature.

The present invention is hereinafter explained in detail in the sequence of the production steps.

Steel is processed in a conventional manner until the cold rolling step. Before applying the processes of the present invention, the peripheral surface of the cold-rolled steel strip may be cleaned to remove grease or rolling oil therefrom by a conventional surface-cleaning method. Otherwise, the process of the present invention may be applied to the cold rolled steel strip without surface-cleaning it.

In the process of the present invention, radiation heating means, such as a radiant-tube heating and other appropriate heating means, are employed for heating the steel strip to a temperature within the range of from the recrystallization temperature to the Ac_3 point of the steel strip and also for holding the steel strip within the temperature range of from the recrystallization temperature to the Ac_3 point over a period of at least 10 seconds, preferably from 10 to 60 seconds. Although a radiation heating furnace is well known the present invention is characterized as compared with the prior arts in the combination use of the radiation heating furnace for heating steel strip to and holding it within the requisite annealing temperature range, cooling the steel strip by a cooling medium consisting of a mixture of gas and liquid, a pickling removal of the oxide layer formed by the cooling and overaging without reheating, if overaging is necessary.

The holding temperature depends on the composition and the other properties of the steel strip, as well as the objective properties of the final product. The holding temperature is not always constant but may be varied in the direction of the holding zone so as to adapt the heat cycle for recrystallization and growth of crystal grains.

In the processes of the present invention, the heating rate is lower than that of the direct fired heating, but the surface deterioration due to the direct contact of flame with the sheet surface is prevented. As a result, the pickling time in the final step is shortened as compared with that of steel strips heated in the direct fired furnace, and also a surface quality problem involved in the pickling is mitigated. When a non-oxidizing or reducing atmosphere inert to the steel is employed for the furnace atmosphere and is maintained during the heating and holding zones, the oxidation of the sheet surface in these zones is prevented. As a result, the pickling at the final step is carried out at an extent sufficient to remove only a thin oxide layer formed at this cooling step or the primary cooling step. The fact that no oxide layer is formed during the heating step advantageously leads to the prevention of the oxide pick up on the hearth rollers. The reducting atmosphere preferably comprises a mixture of 4% by volume or more of hydrogen gas, with the balance consisting of nitrogen gas, and preferably exhibits a dew point of 10°C or less.

The steel strip, which is subjected to the holding in a radiation heating furnace, is then rapidly cooled at a cooling rate from 10 to 300°C/second which is preferable from the view points of the metallurgical properties of the annealed steel strip. In the process without the overaging step of the present invention, the steel strip may be directly rapid-cooled from the holding temperature, or may be slow-cooled from the holding temperature to a temperature of preferably 600°C at the lowest and then rapid-cooled, if necessary. In the process with the overaging step of the present invention, the rapid cooling must start at a temperature between the above holding temperature and 600°C from the view points of shortening the overaging time period.

Although the steel strip can be rapidly cooled by immersing it into water, e.g. boiled water, the spraying of a cooling medium consisting of a mixture of gas and liquid hereinafter referred to as a gas-liquid cooling medium not only realizes the rapid cooling but also provides such advantages as, good shape of the cooled steel strip, and easiness in controlling the cooling rate. The term "gas-liquid cooling medium" herein is preferably a fluid which is produced through such a process that a high speed gas stream and a liquid stream of a predetermined pressure are injected from their respective nozzles as jet streams and these streams are then mixed with each other by intersecting with each other so that the liquid (e.g., water) reduces itself to fine particles mixed in the gas in the form of a mist, or in a form almost equivalent to spray.

The liquid is preferably water and the gas is usually selected from inert gases, such as nitrogen gas, and mixtures of nitrogen and hydrogen. In a preferable example, the gas-liquid cooling medium consists of a mixture of nitrogen gas with water. One of the advantages of the gas-liquid cooling medium is to control the cooling rate in the range of 10 to 300°C/second in such a manner as to control the temeprature near to the overaging temperature and then to overage without reheating. That is, when the present invention is applied to a cold-rolled low carbon steel strip having an aging property, the primary cooling operation can be advantageously terminated when the temperature of the steel strip reaches a level near the overaging temperature of the steel strip, the cooled steel strip is overaged and, then, additionally cooled to a desired temperature.

The overaging operation is carried out for the purpose of precipitating carbon in the steel matrix which has been super-saturated with a solid solution carbon. The overaging operation is preferably carried out in a temperature range of from 300 to 550°C, more preferably, from 350 to 450°C, for 3 minutes or less, more preferably 2 minutes or less. It is not always necessary that the steel strip be maintained at a constant temperature throughout the overaging operation. That is, the overaging temperature in an initial stage of the overaging operation may be higher than that in a final stage of the overaging operation. The temperature profile from the entry to withdrawal ends of the overaging equipment may be gradual or may decrease stepwise.

When the gas-liquid cooling medium contains water, the peripheral surface portion of the steel strip cannot be prevented from oxidation. That is, the resultant layer of oxides causes the appearance of the steel strip surface to be unsatisfactory, and the surface property of the steel strip to be unsuitable to the surface treatments. Therefore, it is necessary to eliminate the layer of oxides from the peripheral surface of the steel strip.

The elimination of the oxide layer is effected by any conventional pickling methods effective for eliminating various oxides. For example, the oxide layer can be removed by treating the peripheral surface of the steel strip with, for example, an acid aqueous solution of an inorganic acid, such as hydrochloric acid, sulfuric acid or phosphoric acid, or of an organic acid, such as formic acid or oxalic acid. The treatment may be effected by immersing the steel strip in an acid aqueous solution, by spraying the acid aqueous solution onto a peripheral surface of the steel strip, or by subjecting the steel strip to an electrolytic pickling with an acid aqueous solution.

In the processes of the present invention, the oxide layer formed in the cooling and, optionally, overaging operations, is very thin. Therefore, the oxide layer can be readily eliminated by the above-mentioned methods. After the pickling operation is completed, the pickled steel strip is linsed with water. However, since the peripheral surface of the acid-cleaned steel strip is reactive to oxygen and easily rusts, it is preferable that the linsed steel strip be neutralized with a diluted alkali aqueous solution. This neutralization is effective for preventing rust and discoloration of the peripheral surface of the steel strip.

Usually, the cold rolled steel strip, for example, to be used for producing an automobile body, is coated before the working process. In this case, the surface of steel strip is treated with zinc phosphate. The quality of the zinc phosphate film formed on the surface of the steel strip can be improved by applying the following treatment to the steel strip after the pickling operation.

That is, as a surface pre-treatment an aqueous suspension containing water-insoluble phosphate, for example, $Zn_3(PO_4)_2$, is sprayed onto the surface of the pickled steel strip, or a thin film of Ni, Zn or Mn is flash-coated on the pickled steel strip surface by means of electroplating. Thereafter, as a pre-coating operation the surface of steel strip is treated with the zinc phosphate. The above-mentioned surface pre-treatment is effective for promoting the formation of crystal nuclei of the zinc phosphate and for providing a dense film of the zinc phosphate. Therefore, the above-mentioned surface pre-treatment is very effective for enhancing the bonding strength of the zinc phosphate layer to the coating layer and for increasing the resistance of the coating layer to corrosion.

The process of the present invention can exhibit the following advantages.

(1) By utilizing the cooling operation with a mixture of a gas and a liquid, the cooling rate of the steel strip can be easily controlled. For example, the steel strip can be easily cooled to a temperature near to the overaging temperature of the steel strip. Therefore, the overaging operation can be directly applied to the cooled steel strip without heating the cooled steel strip to the overaging temperature. A reheating step for overaging treatment is not necessary, if such treatment is required for having an aging property.

(2) Since no appreciable oxide layer is formed in the heating and holding stages, the oxide layer to be removed by the pickling is merely that formed at the cooling step, especially the primary cooling step. The pickling operation can therefore be simplified.

(3) It is possible to prevent the oxide adhesion on the hearth rollers.

(4) Surface quality of the final product is excellent.

The following specific examples are presented for the purpose of clarifying the present invention. However, it should be understood that these examples are intended only to illustrate the present invention and are not intended to limit the scope of the present invention in any way.

<u>Examples 1, 2 and 3 and Comparative Examples 1, 2 and 3</u>

In these examples, 0.8 mm thick cold rolled steel strips were processed under the conditions given in Table 1. The oxide film thickness in the comparative examples 1 and 2 was determined by preliminary experiments, in which the steel strips were heated under the same condition as in these examples by a direct fired furnace followed by a rapid cooling by means of blowing nitrogen gas on the strips in the next zone. Samples were cut from the strips and pickled in a 5% hydrochloric acid aqueous solution. The weight decrease of samples due to pickling was reduced to the thickness of the oxide layer of FeO.

Table 1

Continuous Annealing Condition

Example Nos.	Steel Grade	Heating Condition	An oxide layer thickness at withdrawal end of a direct fired furnace	Holding Condition	Primary Cooling Condition	Overaging Condition	Secondary Cooling Condition	Pickling Condition	Neutralizing Condition	Appearance of Finished Steel Strip
Example 1	Extremly Low-carbon Al-killed steel (C=0.0018%)	Heating at an average heating rate of 10°C/second in a radiant-tube furnace with an N_2 atmosphere	-	850°C for 20 seconds within an atmosphere of 5% H_2	Cooling down below 90°C at an average cooling rate of 200°C/second by a gas-liquid mixture of N_2 and water	None	None	Immersing into 2% HCℓ at 80°C for 2 seconds	Immersing into 1% NaOH at 30°C for 1 second	Excellent
Example 2	ditto	Heating at an average heating rate of 10°C/second in a radiant-tube furnace with an N_2-2% H_2 mixture atmosphere	-	850°C for 20 seconds within an atmosphere of 5% H_2	ditto	None	None	ditto	ditto	Excellent
Example 3	ditto	Heating at an average heating rate of 10°C/second in a radiant-tube furnace with an N_2 atmosphere	-	850°C for 20 seconds within an H_2 atmosphere	ditto	None	None	ditto	ditto	Excellent

to be continued.

Table 1

Continuous Annealing Condition

continued.

Example Nos.	Steel Grade	Heating Condition	An oxide layer thickness at withdrawal end of a direct fired furnace	Holding Condition	Primary Cooling Condition	Overaging Condition	Secondary Cooling Condition	Pickling Condition	Neutralizing Condition	Appearance of Finished Steel Strip
Comparative Example 1	Low-carbon capped steel (C=0.07%)	Heating at an average heating rate of 30°C/second in a direct fired furnace. The combustion air ratio of the furnace being 0.95.	1200 Å	730°C for 20 seconds in the direct fired furnace having a combustion air ratio 0.95.	Cooling down to 400°C at an average cooling rate of 200°C/second by a gas-liquid mixture of N_2 and water	400°C for 90 seconds in an N_2 atmosphere	Immersing into water	ditto	ditto	Inferior (Temper color remains)
Comparative Example 2	Extremely Low-carbon Aℓ-killed steel (C=C.0018%)	ditto	1200 Å	ditto	Cooling down below 90°C at an average cooling rate of 200°C/second by a gas-liquid cooling medium of N_2 and water	None	None	ditto	ditto	Inferior (Temper color remains)
Comparative Example 3	Low-Carbon Capped Steel (C=0.07%)	Heating at an average heating rate of 10°C/second in a radiant-tube furnace with an N_2-5% H_2 mixture atmosphere	-	730°C for 100 seconds within an atmosphere of concentration of 5% H_2	Cooling down to 400°C at an average cooling rate of 20°C/second in a gas-liquid mixture of N_2 and 4% H_2	400°C for 200 seconds within an atmosphere of a concentration of 4% H_2	Immersing into Water	None	None	Excellent

Examples 4, 5 and 6 and Control Examples 4, 5 and 6

The 0.8 mm thick cold rolled steel strips were processed under the conditions given in Table 2. The oxide layer thickness was determined by the same procedure as described above.

Table 2

Continuous Annealing Condition

Example Nos.	Steel Grade	Heating Condition	An oxide layer thickness at withdrawal end of a drect fired furnace	Holding Condition	Primary Cooling Condition	Overaging Condition	secondary Cooling Condition	Pickling Condition	Neutralizing Condition	Appearance of Finished Steel Strip
Example 4	Low-carbon capped steel (C=0.07%)	Heating at an average heating rate of 10°C/second in a radiant-tube furnace with an N_2 atmosphere	-	730°C for 20 seconds within an atmosphere of 5% H_2	Cooling down to 400°C at an average cooling rate of 200°C/second by a gas-liquid mixture of N_2 and water	400°C for 90 seconds within an N_2 atmosphere	Immersing into water	Immersing into 2% HCℓ at 80°C for 2 seconds	Immersing into 1% NaOH at 30°C for 1 second	Excellent
Example 5	ditto	Heating at an average heating rate of 10°C/second in a radiant-tube furnace with an N_2-2% H_2 mixture atmosphere	-	730°C for 20 seconds within an atmosphere of 5% H_2	ditto	ditto	ditto	ditto	ditto	Excellent
Example 6	ditto	Heating at an average heating rate of 10°C/second in a radiant-tube furnace with an N_2 atomsphere	-	730°C for 20 seconds within an N_2 atmosphere	ditto	ditto	ditto	ditto	ditto	Excellent

to be continued.

Table 2

Continuous Annealing Condition

continued.

Example Nos.	Steel Grade	Heating Condition	An oxide layer thickness at withdrawal end of a drect fired furnace	Holding Condition	Primary Cooling Condition	Overaging Condition	secondary Cooling Condition	Pickling Condition	Neutralizing Condition	Appearance of Finished Steel Strip
Comparative Example 4	Low-carbon capped steel (C=0.07%)	Heating at an average heating rate of 30°C/second in a direct fired furnace. The combustion air ratio of the furnace being 0.95	1200 Å	730°C for 20 seconds in the direct fired furnace having a combustion air ratio of 0.95	Cooling down to 400°C at an average cooling rate of 200°C/second by a gas-liquid mixture of N_2 and water	400°C for 90 seconds within an N_2 atmosphere	ditto	ditto	ditto	Inferior (Temper color remains)
Comparative Example 5	ditto	ditto	1200 Å	ditto	ditto	400°C for 90 seconds within an atmosphere of a concentration of 4% H_2	ditto	none	none	Inferior (Temper color remains)
Comparative Example 6	ditto	Heating at an average heating rate of 10°C/second in a radiant-tube furnace with an N_2-5% mixture atmosphere	-	730°C for 100 seconds within an N_2-5% H_2 atmosphere	Cooling down to 400°C at an average cooling rate of 20°C/second by a gas-liquid mixture of N_2 and 5% H_2.	400°C for 200 seconds within an atmosphere of concentration of 4% H_2	ditto	none	none	Excellent

CLAIMS

1. A process for continuously annealing a cold rolled steel strip, comprising the steps of:

introducing a cold rolled steel strip into at least one radiation heating furnace, in which said steel strip is heated to a temperature within the range of from the recrystallization temperature to the Ac_3 point of said steel strip and held within said temperature range over a period of at least 10 seconds;

cooling said steel strip by a cooling medium consisting of a mixture of gas and liquid, and;

pickling said steel strip.

2. A process for continuously annealing a cold rolled steel strip, comprising the steps of:

introducing a cold rolled steel strip into at least one radiation heating furnace, in which said steel strip is heated to a temperature within the range of from the recrystallization temperature to the Ac_3 point of said steel strip and held at said temperature range over a period of at least 10 seconds;

cooling said steel strip by a cooling medium consisting of a mixture of gas and liquid over a primary-cooling temperature range of from 600°C at the lowest to a temperature near to an overaging treatment temperature;

overaging said primary cooled steel strip;

secondary-cooling said overaged steel strip, and;

pickling said secondary cooled steel strip.

3. A process according to claim 1 or 2, wherein the cooling rate by using said cooling medium is in the range of from 10 to 300°C/second.

4. A process according to claim 1 or 2, wherein the cooling by using said cooling medium is carried out by spraying the mixture of gas and liquid.

5. A process according to claim 4, wherein said liquid is water.

6. A process according to claim 4, wherein said gas

is inert gas.

7. A process according to claim 6, wherein said inert gas is nitrogen.

8. A process according to claim 4, wherein a high speed gas stream and a liquid stream of a predetermined pressure are injected from their respective nozzles as jet streams and these streams are then mixed with each other by being intersected with each other, thereby producing the sprayed cooling medium.

9. A process according to claim 1 or 2, wherein the holding time is from 10 to 60 seconds.

10. A process according to claim 1 or 2, wherein a non oxidizing atmosphere is maintained at the heating and holding zones of said at least one radiation-heating furnace.

11. A process according to claim 1 or 2, wherein a reducing atmosphere is maintained at the heating and holding zones of said at least one radiation-heating furnace.

12. A process according to claim 2, wherein said overaging operation is carried out in a temperature range of from 300 to 550°C for 3 minutes or less.

13. A process according to claim 12, wherein said overaging operation is carried out in a temperature range of from 350 to 450°C.

14. A process according to claim 1 or 2 wherein said pickling is carried out with an aqueous solution containing at least one acid selected from the group consisting of hydrochloric acid, sulfuric acid, phosphoric acid, formic acid and oxalic acid.

15. A process according to claim 1 or 2, wherein said pickling step includes neutralizing of the acid-cleaned steel strip.

16. A process according to claim 2, wherein an overaging temperature in an initial stage of the overaging operation is higher than that in a final stage of the overaging operation.

European Patent Office

EUROPEAN SEARCH REPORT

0032583

Application number

EP 80 10 8148.0

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	DE - B2 - 2 061 726 (NIPPON KOKAN) --	
A	DE - B2 - 2 133 411 (NIPPON KOKAN) --	
A	DE - B2 - 2 159 597 (NIPPON STEEL) --	
A	DE - B2 - 2 401 381 (NIPPON KOKAN) --	
A	Patents Abstracts of Japan Vol. 1, No. 4, 10 March 1977 page 46C76 & JP - A - 51 - 112413 --	
A	Patents Abstracts of Japan Vol. 1, No. 64, 22 June 1977 page 995C77 & JP - A - 52 - 28411 --	
A,D	Patents Abstracts of Japan Vol. 2, No. 59, 27 April 1978 page 431C78 & JP - A - 53 - 17518 --	
A	Patents Abstracts of Japan Vol. 3, No. 7, 24 January 1979 page 60C34 & JP - A - 53 - 130219 -- ./..	

CLASSIFICATION OF THE APPLICATION (Int. Cl.3)

C 21 D 9/52

TECHNICAL FIELDS SEARCHED (Int. Cl.3)

C 21 D 9/52

CATEGORY OF CITED DOCUMENTS

- X: particularly relevant
- A: technological background
- O: non-written disclosure
- P: intermediate document
- T: theory or principle underlying the invention
- E: conflicting application
- D: document cited in the application
- L: citation for other reasons
- &: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	29-04-1981	SUTOR

European Patent Office

EUROPEAN SEARCH REPORT

0032583

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.3)
A	Patents Abstracts of Japan Vol. 3, No. 7, 24 January 1979 page 160C34 & JP - A - 53 - 132418 --		
A,P	Patents Abstracts of Japan Vol. 4, No. 22, 23 February 1980 page 128C74 & JP - A - 54 - 162614 --		
A,P	Patents Abstracts of Japan Vol. 4, No. 38, 27 March 1980 page 50C4 & JP - A - 55 - 11155 ----		TECHNICAL FIELDS SEARCHED (Int. Cl.3)