We, CIBA-GEIGY AG

of Klybeckstrasse 141, Basle, Switzerland

hereby apply for the grant of a Patent for an invention entitled

"PROCESS FOR SEPARATING SO₂ FROM A CURRENT OF GAS,
WITH PRODUCTION OF SULPHURIC ACID BY THE NITRIC
OXIDE PROCESS"

which is described in the accompanying complete specification.
This application is a Convention Application and is based on the
application numbered 3000/75

for a patent or similar protection made in Switzerland

on 10th March, 1975

Our address for service is:

Care: SPRUSON & FERGUSON
PATENT ATTORNEYS
ESSO HOUSE, 127 KENT STREET
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AUSTRALIA.

Dated this TWENTY-SIXTH day of FEBRUARY, 1976

CIBA-GEIGY AG

By: E. McLance

Signature of Applicant
Registered Patent Attorney

To: The Commissioner of Patents
DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT OR PATENT OF ADDITION

In support of the Convention Application made by CIBA-GEIGY AG for a patent for an invention entitled:

"Process for separating SO₂ from a current of gas, with production of sulphuric acid by the nitric oxide process"

We, André Höhn and Arnold Seiler of CIBA-GEIGY AG, Klybeckstrasse 141, Basle, Switzerland
do solemnly and sincerely declare as follows:

1. We are authorised by the applicant for the patent to make this declaration on its behalf.

2. The basic application(s) as defined by Section 141 on the Act was were made in Switzerland on the 10th day of March 1975 by CIBA-GEIGY AG, 4002 Basle, Switzerland.

3. Volker Fattinger, Im Lee 39, 4144 Arlesheim, Switzerland,
is are the actual inventor(s) of the invention and the facts upon which the applicant is entitled to make the application are as follows:

The applicant is the assignee of the said Volker Fattinger.

4. The basic application(s) referred to in paragraph 2 of this Declaration was were the first application(s) made in a Convention country in respect of the invention the subject of the application.

DECLARED at Basle, Switzerland, this 5th day of February 1976 by CIBA-GEIGY AG

To: The Commissioner of Patents
CLAIM 1. A process for separating \( \text{SO}_2 \) from a moist current of gas containing up to about 6% by volume of the same, with attendant production of sulfuric acid by the nitrogen oxide process in a system of reaction zones, which system is adapted for the production of a strong sulfuric acid having a \( \text{H}_2\text{SO}_4 \)-content of above 70%, by weight, in which system the current of \( \text{SO}_2 \)-containing gas is caused to flow, successively

a) through an acid denitration zone;

b) through an \( \text{SO}_2 \)-processing zone which contains at least one packed tower and in which said current having a nitrogen oxides concentration of at least about 1% by volume, is brought into intimate contact with dilute sulfuric acid having a concentration of less than 70% \( \text{H}_2\text{SO}_4 \) and being substantially free from nitrose, flowing in a cycle through the latter zone; said pressure on said gas current being sufficiently low to avoid an increase of the nitrose content in said acid cycle;
c) through a nitrogen oxides-absorption zone; all of the nitrose-containing acid exiting from said absorption zone being indirectly heated to a temperature above 60°C and then introduced directly into said denitration zone by-passing said SO₂-processing zone characterized in that said process further comprises the steps of

α) removing a portion of the said dilute sulfuric acid, substantially free from nitrose, from said SO₂-processing zone and bringing the said removed portion into contact with the moist current of said SO₂-containing gas in a pretreatment drying zone upstream of said denitration zone in said system;

β) reintroducing a portion of the acid formed in (α) more diluted by moisture from said gas and free from nitrose into the dilute sulfuric acid circulating through the SO₂-processing zone, and

γ) at least when the water-content of the more diluted acid exiting from the pretreatment drying zone increases to the extent that the H₂SO₄-content of the denitrated sulfuric acid leaving the denitration zone drops substantially below 70% by weight of H₂SO₄, removing a portion of the dilute sulfuric acid from said cycle and conveying the last-mentioned portion through an acid-dehydration zone, wherein the last-mentioned portion of dilute sulfuric acid is heated to evaporate water therefrom, and then returning the resulting more concentrated acid to said cycle.
Name of Applicant: CIBA-GEIGY AG

Address of Applicant: Klybeckstrasse 141, Basle, Switzerland

Actual Inventor: VOLKER FATTINGER


Complete Specification for the invention entitled:

"PROCESS FOR SEPARATING SO₂ FROM A CURRENT OF GAS,
WITH PRODUCTION OF SULPHURIC ACID BY THE NITRIC OXIDE PROCESS"

The following statement is a full description of this invention, including the best method of performing it known to me/us:
The invention relates to a process for separating SO₂ from a current of gas, with production of sulphuric acid by the nitric oxide process in a tower system, in which the SO₂-containing gas is introduced into a denitration zone, and, after passing through the latter at a nitric oxide concentration of at least 1% by volume in the gas phase, onward into an SO₂-processing zone comprising at least one packed tower, in which it is brought into intimate contact with sulphuric acid containing less than 70% by weight of H₂SO₄ (dilute acid), the acid which is then used to absorb the nitrogen oxides in the towers downstream from the SO₂-processing zone having a concentration of between 70 and 85% by weight, preferably 74 to 80% by weight, of H₂SO₄ (absorption acid) and containing nitrose.

Such a process is already known, as emerges from the following description of the development and current state of the art in the field of separating SO₂ from waste gases and converting the separated-off SO₂ into sulphuric acid.

As in the known nitric oxide/sulphuric acid process, three process steps can be distinguished in the process of the invention, namely: (1) denitration, (2) SO₂-processing and (3) nitric oxide absorption. For the processing of SO₂, an acid of less than 70% strength is used, in the process according to the invention, in at least one tower; it is referred to as dilute acid. In the old literature, the term "chamber acid" corresponds to this term. The old term "Glover tower" corresponds to the term "denitration tower" and the old term "Gay-Lussac tower" is replaced by...
"absorption tower". During denitration, there occurs necessarily some working up of SO₂ with formation of sulphuric acid.

In the description of the present invention, all towers of a system which discharge gas containing more gaseous nitric oxide than is contained in the feed gas of the tower are taken to belong to the denitration zone. So-called "production" towers of a Petersen tower plant, which comply with this condition, are thus regarded, in accordance with the definition (also in the patent claims) as belonging to the denitration zone. Whether the acid discharged from a tower contains nitrose or is free from nitrose is not employed herein as a criterion for applying the term "denitration tower" thereto.

As part of the endeavours to keep the atmosphere clean, the separation of SO₂ from currents of waste gas is a pressing problem. Diverse endeavours are being made to recover the SO₂, separated from the waste gases, in a utilisable form, for example as sulphur or sulphuric acid. However, at low SO₂ concentrations, cost of recovering sulphuric acid is very high. The sulphuric acid contact process requires extensive gas purification in order to avoid excessively rapid poisoning of the catalyst, and this purification makes it necessary to cool the gases. Warming the gases to the start temperature of the catalyst, and drying the gas before it reaches the catalyst, entails high costs. For this reason attempts have been made to bring about the formation of sulphuric acid at a lower temperature by using active charcoal or by means of catalytic-
cally active dissolved metal salts (for example manganese). However, the processes which result are relatively expensive and complicated if pure acid containing more than 40% of H₂SO₄ is to be produced.

The nitric oxide process for the manufacture of sulphuric acid is over 100 years old. The process is described, for example, in the following books: Winnacker-Küchler, Chemische Technologie (Chemical Technology), volume II, Carl Hanser-Verlag, Munich, 1970, page 38 et seq.; Ullmann's Enzyklopaedie der Technischen Chemie, volume 15, page 432 et seq. The second literature reference employs the term "nitrose process".

The limits of the known nitric oxide process result from the water balance of the plant, because, in the production of sulphuric acid, water is also necessarily absorbed from the gas. The reason for the importance of the water balance is that in order to be able to store the sulphuric acid obtained in iron tanks, the acid should, if possible, contain more than 65% by weight of H₂SO₄, that is to say it must not be diluted too much.

If a gas contains more water vapour than is consumed in producing an acid of a concentration sufficient for nitric oxide absorption, this fact interferes with the operation of a nitric oxide/sulphuric acid process. A further disadvantage of known processes is that the reaction chambers must have a large volume.

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Thus, when processing moist gases with an SO$_2$ content of less than 6 \% by volume at temperatures below 60°C, the known nitric oxide/sulphuric acid processes only afford a daily production of limited amounts of sufficiently concentrated sulphuric acid per m$^3$ of reaction space. When processing gases containing 4 to 6 \% by volume of SO$_2$, modern Petersen tower installations produce less than 150 kg of a sulphuric acid containing 78\% by weight of H$_2$SO$_4$ (Glover acid) per m$^3$ of packed space per day. Only with more concentrated gases are higher space-time yields achieved.

Waste gases having the above low concentration of SO$_2$ are produced, for example, in plants in the metallurgical industry. Flue gases of power stations which burn oil or coal contain a few grams, for example 2 to 4 g, of SO$_2$/Nm$^3$ (1 Nm$^3$ = 1 m$^3$ at 1 atmosphere and 0°C). When applying known enrichment processes, for example the process according to U.S. Patent 3,721,066, to gases of such low SO$_2$ content, the regeneration of the solid or liquid sorption agents yields gases which contain varying amounts of SO$_2$, at concentrations which are frequently only a few percent by volume, and which have a relatively high water content.

A "relatively high" water content is to be regarded here as a water content which exceeds 50\% of the weight of SO$_2$ which the gas contains per m$^3$, that is to say, for example, a water content of more than 50 g of H$_2$O/m$^3$ if 100 g of SO$_2$/m$^3$ are present.

The decomposition of waste sulphuric acid also
produces waste gases with relatively low $\text{SO}_2$-content (for example from 50 to 150 g/m$^3$) because a substantial proportion of the oxygen is consumed by the fuel in the decomposition oven.

It is furthermore known, in Petersen tower installations, to place, upstream from the towers of the nitric oxide absorption zone which follows the $\text{SO}_2$ processing zone, a tower which is trickle-fed with dilute acid. In accordance with the $\text{SO}_2$-processing taking place in this tower, formation of NO is expected, and it was therefore regarded as necessary to ensure a sufficient sojourn time of the gases therein before they enter the absorption zone, so that NO is converted into NO$_2$. For this reason, a special regeneration chamber was interposed in Petersen tower installations if, in the said dilute acid production tower in the $\text{SO}_2$-processing zone, it is necessary to work up not only gases containing small remnants of $\text{SO}_2$ but also gases containing a few percent by volume of $\text{SO}_2$ (for example 2 to 5% by volume).

It is also known that in tower systems a high proportion of the reaction space required is attributable to the absorption system for the nitric oxides (Gay-Lussac towers). It can be seen from the initially mentioned literature reference in Ullmann, page 435, 18th line from the bottom, et seq., that it is considered advantageous that small amounts of $\text{SO}_2$ should pass into the absorption system. In contrast thereto it was however already recognised that the absorption system can be made substantially smaller if practically
complete working up of $SO_2$ is ensured before the gases enter the first tower of the absorption zone. A further known prerequisite for reducing the space required for nitric oxide absorption is accurate regulating of the total system, so that the NO:NO$_2$ ratio in the gases entering the absorption is an optimum.

Furthermore, German Patent 1,031,292 (Petersen) points out that it is advisable to keep the feed acid of a production tower, which, as mentioned above, is to be considered part of the denitration zone because, in it, nitric oxides are released into the stream of gas, at a temperature of 50 to 60°. As is further stated in this German Petersen Patent, this production tower is trickle-fed in a circulation system shared with the first Gay-Lussac tower (nitric oxide absorption zone). The exit temperature of the acid from the Gay-Lussac tower accordingly corresponds to the feed temperature of the acid to the denitration tower.

However, as already mentioned, a space-time yield of at most 150 kg of 78% strength sulphuric acid per cubic metre per day is achieved with such known measures. This space-time yield is also not improved if, in order to be able better to expel the nitrose fumes from the acid, the trickle acid charged with nitrose is kept at a temperature of 50 to 60°, or if, as is also already known, attempts are made to raise the acid entry temperature of a denitration tower by mixing a part of the hot acid discharged from the same tower, or
from another denitration tower, with the feed acid. This process entails a reduction in the nitrose content of the feed acid, which has a most unfavourable effect since the reaction space needed remains undeniably large.

The invention is therefore intended, above all, to solve the problem of improving the process described at the outset so that when processing gases containing up to about 6% by volume of SO₂, the space-time yield, calculated as 78% strength sulphuric acid, is increased substantially, preferably to more than twice what has hitherto been attainable, and at the same time, preferably, to reduce the large volume, hitherto necessary in most cases, of reaction chambers, and to achieve these improvements substantially independently of the water content of the feed gases.

These objects are attained in a process for separating SO₂ from a moist current of gas containing up to about 6% by volume of the same, with attendant production of sulfuric acid by the nitrogen oxide process in a system of reaction zones, which system is adapted for the production of a strong sulfuric acid having a H₂SO₄⁻ content of above 70%, by weight, in which system the current of SO₂-containing gas is caused to flow, successively

a) through an acid denitration zone;

b) through an SO₂-processing zone which contains at least one packed tower and in which said current having a nitrogen oxides concentration of at least about 1% by volume, is brought into intimate contact with dilute sulfuric acid having a concentration of less than 70% H₂SO₄ and being substantially free from nitrose, flowing in a cycle through the latter zone; said pressure on said gas current being sufficiently low to
avoid an increase of the nitrose content in said acid cycle;

c) through a nitrogen oxides-absorption zone; all
of the nitrose-containing sulfuric acid exiting from said
absorption zone being indirectly heated to a temperature above
60° C and then introduced directly into said denitration zone
by-passing said SO₂-processing zone

characterized in that
said process further comprises the steps of

a) removing a portion of the said dilute sulfuric
acid, substantially free from nitrose, from said SO₂-processing
zone and bringing the said removed portion into contact with
the moist current of said SO₂-containing gas in a pretreatment
drying zone upstream of said denitration zone in said system;

b) reintroducing a portion of the acid formed in (a)
more diluted by moisture from said gas and free from nitrose
into the dilute sulfuric acid circulating through the SO₂-processing zone, and

c) at least when the water-content of the more
diluted acid exiting from the pretreatment drying zone increases
to the extent that the H₂SO₄-content of the denitrated sulfuric
acid leaving the denitration zone drops substantially below
70% by weight of H₂SO₄, removing a portion of the dilute
sulfuric acid from said cycle and conveying the last-mentioned
portion through an acid-dehydration zone, wherein the last
mentioned portion of dilute sulfuric acid is heated to evaporate
water therefrom, and then returning the resulting more
concentrated acid to said cycle.

Preferably the sojourn time of the SO₂- and nitric
oxides-containing gas between leaving the denitration zone and
entering the first tower of the nitric oxide absorption zone,
while passing through the SO$_2$-processing zone therebetween and being irrigated with dilute acid therein, is held to less than 30 seconds when the gas entering the denitration zone contains at least 5% by volume of SO$_2$ and at least 10% by volume of O$_2$, and limiting the aforesaid sojourn time, when the SO$_2$ content at the last-mentioned entry is less than 5% by volume, to a maximum period determined by the equation

$$Z_{\text{max}} = \frac{1,500}{[\text{SO}_2] \cdot [\text{O}_2]}$$

in which formula $Z_{\text{max}}$ is the sojourn time in seconds, SO$_2$ 10 denotes the SO$_2$ content in the gas entering the denitration zone, in % volume, and [O$_2$] denotes the oxygen content in the same entry gas, in % by volume.
denitration zone and entering the first tower of the nitric oxide absorption zone is, at concentrations of at least 5% by volume of SO\textsubscript{2} and at least 10% by volume of O\textsubscript{2} in the gas entering the denitration zone, less than 30 seconds while at lower SO\textsubscript{2} contents or lower O\textsubscript{2} contents in the said entry gas the upper limit of the sojourn time is calculated from the equation

\[ Z_{\text{max}} = \frac{1500}{[\text{SO}_2][\text{O}_2]} \]

in which formula \( Z_{\text{max}} \) is the sojourn time in seconds, \([\text{SO}_2]\) denotes the SO\textsubscript{2} content in the gas entering the denitration zone, in % by volume, and \([\text{O}_2]\) denotes the oxygen content in the same entry gas, again in % by volume.

The tower system in which the process according to the invention is carried out can be fed with SO\textsubscript{2}-containing gas which consists of waste gases of known type, especially flue gases or roasting off-gases, such as arise on combustion of fuels of low sulphur content or on roasting of ores containing sulphur, for example when producing copper, or as arise from other industrial processes, especially also from processes of pre-concentration of waste gases to increase the sulphur content therein, and which usually contain between 0.4 and 4% of sulphur, preferably from 1 to 3% of sulphur, in the form of SO\textsubscript{2}, that is to say insufficient SO\textsubscript{2} for use in the contact process.

In the waste gas to be treated in accordance with the process of the invention, i.e. in the gas as it enters the denitration zone, the SO\textsubscript{2} content should preferably not be less than 0.2 % by volume.
In the process according to the invention, the towers of the \( \text{SO}_2 \)-processing zone work with a concentration of gaseous nitrogen oxides above 1% by volume if the gas entering this zone contains less than 2% by volume of \( \text{SO}_2 \); whilst if the entry gases have a higher \( \text{SO}_2 \) content the nitric oxide concentration in the gas phase should be more than 2% by volume.

It is now possible to work up gases having an \( \text{SO}_2 \) content of the order of less than 2% by volume, preferably of 1 to 2% by volume, and having a water vapour content corresponding to a saturation temperature higher than 35°C (36 g/m\(^3\) of \( \text{H}_2\text{O} \)), using a nitric oxide concentration of less than 0.2% by volume, to obtain a sulphuric acid of more than 75% strength by weight, by bringing the moist \( \text{SO}_2 \) gases into contact with dilute acid in a drying tower upstream of the denitration zone, whereby a part of their water vapour content is removed from the gases, and water from the entry gases is utilised for sulphuric acid formation by exchange between acid from the drying tower and the dilute acid production tower, without this portion of the water passing into the denitration zone by a gas path.

To achieve sufficient denitration it is necessary to heat the acid which is to be charged into the denitration tower to above 60°C.

According to the invention this is achieved, in contrast to the method of warming described further above, by heating the nitrose-containing acid which is intended for the denitration tower upstream from the first tower, trickle-fed with dilute
acid, of the \( \text{SO}_2 \) processing zone, to above \( 60^\circ \text{C} \) by indirect heat exchange before the acid comes into contact with the gas stream.

In order to enable the amount of water fed to the system to be kept as low as possible, the concentration of the acid in the denitration zone is regulated by adding dilute acid, in place of water, to the acid charged into the denitration tower.

In the case of gases containing more than 2\% by volume of \( \text{SO}_2 \), an upstream drying tower also offers advantages as regards the operation of the system, but is not absolutely essential. Heating to above \( 60^\circ \text{C} \) the nitrose-containing acid, which is passed into the denitration tower, which with regard to the direction of gas flow is upstream of the first tower, which is trickle-fed with dilute acid, permits a drastic reduction in the reaction space for \( \text{SO}_2 \)-processing if

a) bodies of packing having a total surface area of more than 90 \( \text{m}^2/\text{m}^3 \) are used in the dilute acid production tower or towers, and

b) the sojourn time of the gas between leaving the denitration zone and entering the first nitric oxide absorption tower, at 10 or more \% by volume oxygen content in the gas, is less than 30 seconds.

At lower oxygen contents, the upper limit of the sojourn time, \( Z_{\text{max}} \), for these gases containing more than 2\% by volume of \( \text{SO}_2 \) is calculated from the equation
\[ Z_{\text{max}} = \frac{30}{[O_2]^}\]  

wherein \([O_2]^\) denotes the oxygen content in % by volume in the gas on leaving the denitration zone.

Whilst hitherto, as already mentioned above, the sojourn time of the gases between the \(\text{SO}_2\)-processing zone and the nitric oxide absorption zone was extended, for example by interposing a regeneration tower between the two zones, a different approach was recognised to be successful in the process according to the invention, namely to shorten the sojourn time as much as possible between the denitration and the nitric oxide absorption, but, on the other hand, to use packings of sufficient surface area so that very intensive material exchange between gas and liquid is achieved.

Thus, according to the invention, at a lowered oxygen content, the increase in \(\text{NO}_2\) concentration is not brought about by using an empty chamber, as in the case of the Petersen process, but by increasing the reaction chamber which is charged with packings and trickle-fed with dilute acid. Therefore, in contrast to known systems, the process according to the invention avoids, as far as is at all possible, leaving any empty space, not filled with packings, intermediate the denitration and the nitric oxide absorption. It is only the combination of the several features of the invention which makes it possible to increase the efficiency of a tower system to the extent described, that is to say, to augment its yield, even when processing
gases containing less than 6% by volume of SO$_2$, to such a
degree that a daily production of 300 kg of 78% strength
sulphuric acid per m$^3$ of packed space, or even more, can be
achieved.

Preferably, the plant for carrying out the process according
to the invention is so designed, or the process is so con-
trolled, that the reaction space for the nitric oxide absorp-
tion is at least equal to, or preferably greater than, the
sum of the reaction spaces for denitration and SO$_2$-processing.
If this is not the case, nitrogen oxides required for carrying
out the process are lost because the nitric oxide absorption
depends primarily on the gas volume and not on the concentration
of the nitrogen oxides in the gas. By devising the reaction
spaces in the above-mentioned proportions, the total installation
can be kept substantially smaller than the known installations
for processes of the type initially described.

It is particularly advantageous to carry out the heat-
ing of the acid fed to the denitration tower by heat exchange
with the acid discharged from this tower. The temperature
can be regulated by partially by-passing the heat exchanger.
In the case of SO$_2$ gases containing less than 2% by volume of
SO$_2$ it is necessary to employ heat not originating from the
tower system. The additional amount of heat required is
astonishingly low, and steam or other heating media of a rela-
tively low temperature level can be utilised for the indirect
heating of the acid. In industrial plants, such heat energy
is frequently available in abundance from cooling processes.
The process according to the invention makes it possible to process gases entering the denitration tower which are at a temperature below 60°C. Entry gases at a temperature of less than 45°C can also still be processed to produce sulphuric acid even though they have an SO₂ content of only 1 to 1.5%.

Raising the temperature of the acid, before it enters the denitration tower, to above 80°C permits a further reduction of the reaction space required for the SO₂-processing. Suitable packings for the dilute acid production towers have proved to be packings according to U.S. Patent 2,867,425 or U.S. Patent 3,752,453 and especially those of the type described further below, the manufacture of which is simpler, because they have a large surface area coupled with a very low resistance to gas flow.

According to a further feature of the invention, the water balance of the system can be relieved by bringing the dilute acid into contact with the current of waste gas in a tower downstream from the last nitric oxide absorption tower, whereby this acid loses water and can be fed at a somewhat higher concentration to the dilute acid production tower or the denitration tower. The concentrating action of this additional downstream tower can be boosted considerably by heating the acid fed thereinto.

In order to effect this heating, hot acid from the tower system can be employed, as is in itself known for gases of higher SO₂ concentration.
It is also possible according to the invention, as an improvement of the state of the art described above, to regulate the NO:NO₂ ratio reliably by keeping the temperature of the acid entering the last denitration tower constant through regulation of the heat supply in the acid heater. The concentration of the acid discharged from the last denitration tower is at the same time kept constant by introducing dilute acid or water into the tower.

In order to regulate the NO:NO₂ ratio in the gas before it enters the nitric oxide absorption towers, the amount of nitrose-containing acid being fed to the denitration tower, is controlled. According to the invention, it is the variation in the amount of acid for the denitration which serves as the means of control in the tower system and not the addition of water, as is mostly customary in known tower systems. This control system employed in accordance with the invention makes it possible to automate the tower system.

A preferred mode of carrying out the process according to the invention in practice is now described in more detail in relation to the installation shown in the drawing:

In the latter, Fig. 1 shows the assembly of a plant for the treatment of SO₂-containing waste gas, for example in amounts of 500 Nm³/hour. In the drawing, the reference numbers 1 to 7 denote the towers of the nitric oxide/sulphuric acid plant; the reference numbers 8 to 12 denote heat exchangers for liquids, the reference numbers 13 to 16 denote vessels fo:
liquid, the reference numbers 131, 141, 151 and 161 denote acid pumps, the reference numbers 101, 201, 401, 501, 601 and 701 denote droplet-catching devices as described in Belgian Patent Specification 814,916 and in the corresponding German Offenlegungsschrift 2,324,520 and 605 denotes a gas scrubber as described in German Offenlegungsschrift 2,414,317.

$SO_2$ gases are introduced into a drying tower 1 through an inlet pipe 102 at the abovementioned rate of 500 $Nm^3$/hour. Dilute acid from the tank 1 is charged into the drying tower 1 through a line 103. The acid leaves the tower, which contains packings, through a line 104 and flows back into the vessel 13. The pre-dried $SO_2$ gases pass through a gas line 202 into the denitration zone, which in the present installation consists of the denitration tower 2, in which the gases flow upwards through a packing. The tower 2 is fed, through a line 203, with nitrose-containing acid from the vessel 15, the amount of the acid being regulated by means of a valve 2031. The acid is warmed in the heat exchangers 8 and 9. Steam serves as the heat transfer medium for the heat exchanger 9. The denitrated acid leaves the tower 2 through a line 204 and is cooled in the heat exchangers 8 and 10 before it reaches the vessel 16. The sulphuric acid obtained as final product in the plant is taken off through a valve 2032 in an outlet branch of line 204 and is passed into a storage tank.

The heat exchanger 10 is fed with cooling water.

The exit gases from tower 2, which contain nitric
oxide, pass through a line 302 into the tower 3, that is to say the first tower of the SO$_2$-processing zone, which, in the plant shown, also includes the tower 4. The gases flow downwards through a packing, preferably of bodies of the type described further below. The tower 3 is fed through line 303 with dilute acid from the vessel 13, the acid being cooled in the heat exchanger 11. Water at $15^\circ$C is used as the coolant. Due to the reaction taking place in the tower 3, the acid warms up and is returned to vessel 13 through a line 304.

The gases leave the tower 3 at the bottom and pass through a line 402 into the second SO$_2$-processing tower 4, which is provided with the same type of packings as tower 3. The gas flow path in this tower 4 is upwards in counter-current to the acid which is introduced at the top of the tower 4 through a line 403. The acid passes from tower 4 into tower 3 through line 404, and from tower 3 back to vessel 13 through the line 304. The difference in temperature of the acid between entering and leaving the tower 4 is measured continuously; it is kept below 2 degrees Centigrade. This difference is a measure of the amount of SO$_2$ which enters the tower 4. If the difference is too great, the trickle feed to the tower 3 is increased so that more SO$_2$ is worked up in this tower.

No significant amount of nitric oxide is taken up by the dilute acid in the towers 3 and 4. The concentration of the nitrogen oxides in the gas remains unchanged but the NO$_2$ content increases at the expense of the NO content.
The SO₂-free gases which contain the nitrogen oxides in the volume ratio of NO:NO₂ = 1:1 pass through a line 502 into the first tower 5 of the nitric oxide absorption zone, which comprises the towers 5 and 6.

Tower 5 is trickle-fed through line 503 with sulphuric acid containing between 74% by weight and 80% by weight of H₂SO₄, and this acid absorbs nitrogen oxides. The acid leaves the tower 5 through a line 504 and passes into the vessel 15.

The exit gases of the tower 5 are drawn in by a fan 17 and forced through a line 602 into the tower 6, through which they flow upwards. Acid from the vessel 16 is fed into the tower 6 through a line 603. Vessel 16 receives nitrose-free acid from the tower 2 via the line 204 already referred to.

The acid issuing from the tower 6 passes through a line 604 into the tank 16. The gases leave the second nitric oxide absorption tower 6 through a line 702 and flow upwards through the acid dehydration tower 7 which is downstream from the nitric oxide absorption zone.

The tower 7 receives dilute acid from the tank 14, and this acid can be warmed indirectly by means of steam in the heat exchanger 12. A small degassing tower, which is not shown in the drawing, can additionally be fitted into a line 703, upstream from the heat exchanger 12. In this degassing tower, traces of nitrogen oxides can be flushed out of the acid with a small amount of air. The amount of air required is less than 20 Nm³/hour and can be introduced into the
plant upstream from the fan 17.

In the tower 7, the acid loses water and its temperature drops before the acid is returned to the tank 14 through a line 704.

A small amount of acid can be fed continuously into the vessel 13 through a valve 7041 in line 704. A liquid level-equalising line 133 is provided between the tanks 13 and 14.

The volume in the dilute acid circulation, which takes place via vessel 13, increases in accordance with the formation of sulphuric acid in the SO₂-processing towers 3 and 4. In accordance with the amount produced, dilute acid is passed into the top of the denitration tower 2 through a valve 1031 in a branch 105 of the line 103.

The reference numbers 4021, 5021, 6021, 7021 and 8021 denote transparent lengths of line in which the colour of the stream of gas can be observed.

Finally, the SO₂-free gases are led into the atmosphere through a line 705.

A metering device 18 serves to add water through line 104 to the dilute acid circulation. The supply of nitric acid to the system to form nitrose is not shown. Nitric acid is added at the top of the denitration tower 2 by means of a metering device and the level of nitrose in the system is kept at the desired magnitude.

The operation of the installation shown in Figure 1 of the drawing is further explained hereinafter, with the aid of a number of illustrative examples:
Example 1

Washed gases from a sulphide roasting process contain 1 to 1.5% by volume of \( \text{SO}_2 \) and about 0.05% by volume of nitrogen oxides. The gases are at a temperature of 35 - 40°C and are saturated with steam. Processing in an installation according to Figure 1 results in the following operating conditions:
<table>
<thead>
<tr>
<th>Operating condition</th>
<th>Unit</th>
<th>No. of the tower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of packed space</td>
<td>m³</td>
<td>1.2.3.4.5.6.7</td>
</tr>
<tr>
<td>Surface area of packing</td>
<td>m²</td>
<td>96.240.420.120.800.960.96</td>
</tr>
<tr>
<td>Trickle feed per hour</td>
<td>m³/m²</td>
<td>15.1.2.7.4.5.1.5.3</td>
</tr>
<tr>
<td>Gas entry temperature</td>
<td>°C</td>
<td>37.39.70.42.41.41.40</td>
</tr>
<tr>
<td>Gas exit temperature</td>
<td>°C</td>
<td>39.70.42.41.41.40.60</td>
</tr>
</tbody>
</table>
| Nitrose content of the acid discharged   | % by weight of HNO₃ | <0.05.<0.02.<0.02.3.0.3 |<-
<p>| Weight per litre of the acid discharged  | kg at 15°C | 1.47.1.69.1.48.1.48.1.68.1.69.1.54 |
| Temperature of the acid discharged       | °C         | 42.86.43.42.40.40.56 |</p>
<table>
<thead>
<tr>
<th>Operating condition</th>
<th>Unit</th>
<th>No. of the tower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of packed space</td>
<td>m³</td>
<td>1   2   3   4   5   6   7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.6  2.3  3   0.6  5   4   0.6</td>
</tr>
<tr>
<td>Surface area of packing</td>
<td>m²</td>
<td>1   2   3   4   5   6   7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>96   240  420  120  800  960  96</td>
</tr>
<tr>
<td>Trickle feed per hour</td>
<td>m³/m²</td>
<td>1   2   3   4   5   6   7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15   1.2  7   4   5   1.5  3</td>
</tr>
<tr>
<td>Gas entry temperature</td>
<td>°C</td>
<td>1   2   3   4   5   6   7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>37   39   70  42   41  41   40</td>
</tr>
<tr>
<td>Gas exit temperature</td>
<td>°C</td>
<td>1   2   3   4   5   6   7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39   70   42  41   41  40   60</td>
</tr>
<tr>
<td>Nitrose content of the acid discharged</td>
<td>% by weight of HNO₃</td>
<td>1   2   3   4   5   6   7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt;0.05 &lt;0.02 &lt;0.02 3   0.3</td>
</tr>
<tr>
<td>Weight per litre of the acid discharged</td>
<td>kg at 15°C</td>
<td>1   2   3   4   5   6   7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.47 1.69 1.48 1.48 1.68 1.69 1.54</td>
</tr>
<tr>
<td>Temperature of the acid discharged</td>
<td>°C</td>
<td>1   2   3   4   5   6   7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>42   86   43  42   40  40   56</td>
</tr>
</tbody>
</table>
The gas washing device 605 in the upper part of the
tower 6 shown in Figure 1 of the drawing, is not used in this
example. Tower 6 operates as a normal packed tower. Tower
2 is insulated against heat losses.

The heat energy supplied by means of steam is about
900 Kcal/kg of 100% strength H\textsubscript{2}SO\textsubscript{4}. Because of the content of
nitrogen oxides in the gases entering the installation, the manu-
facture of H\textsubscript{2}SO\textsubscript{4} does not consume any nitric acid. At the
exit of the denitration zone, the oxygen content is about 8% by volume and the nitric oxide content about 1.8% by volume.
The optimum entry temperature of the acid into tower 2 is 83\degree C.
A fan pressure of a total of 250 mm water column is required to
convey the gases through all seven towers.

The SO\textsubscript{2} content of the exit gases is less than 0.003% by volume.

**Example 2**

SO\textsubscript{2}-containing gases from a plant for splitting waste sul-
phuric acid are cooled in a purification installation and freed
from the hydrogen halide acids which they contain. The gases
are at a temperature of about 50\degree C and are saturated with
water vapour. The SO\textsubscript{2} content is 4 to 6% by volume and the O\textsubscript{2}
content is more than 10% by volume. Processing the gases in
an installation as shown in the drawing, but without tower 7
and without vessel 14, gives the following operating conditions:
<table>
<thead>
<tr>
<th>Operating condition</th>
<th>Unit</th>
<th>No. of the tower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of packed space</td>
<td>m³</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>Surface area of packing</td>
<td>m²</td>
<td>96 220 504 120 720 720</td>
</tr>
<tr>
<td>Trickle feed per hour</td>
<td>m³/m²</td>
<td>15 3 10 4 6 3</td>
</tr>
<tr>
<td>Gas entry temperature</td>
<td>ºC</td>
<td>50 49 78 53 46 44</td>
</tr>
<tr>
<td>Gas exit temperature</td>
<td>ºC</td>
<td>49 78 53 46 44 42</td>
</tr>
<tr>
<td>Nitrose content of the acid discharged</td>
<td>% by weight of HNO₃</td>
<td>- &lt;0.03 0.03 0.03 4.3 0.4</td>
</tr>
<tr>
<td>Weight per litre of the acid discharged</td>
<td>kg at 15ºC</td>
<td>1.47 1.72 1.49 1.49 1.71 1.72</td>
</tr>
<tr>
<td>Temperature of the acid discharged</td>
<td>ºC</td>
<td>51 112 57 44 44 43</td>
</tr>
<tr>
<td>Operating condition</td>
<td>Unit</td>
<td>No. of the tower</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>----------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Volume of packed space</td>
<td>$m^3$</td>
<td>0.6 1.5 2.1 0.6 3 3</td>
</tr>
<tr>
<td>Surface area of packing</td>
<td>$m^2$</td>
<td>96 220 504 120 720 720</td>
</tr>
<tr>
<td>Trickle feed per hour</td>
<td>$m^3/m^2$</td>
<td>15 3 10 4 6 3</td>
</tr>
<tr>
<td>Gas entry temperature</td>
<td>$^\circ C$</td>
<td>50 49 78 53 46 44</td>
</tr>
<tr>
<td>Gas exit temperature</td>
<td>$^\circ C$</td>
<td>49 78 53 46 44 42</td>
</tr>
<tr>
<td>Nitrose content of the acid</td>
<td>% by weight of $HNO_3$</td>
<td>- &lt;0.03 0.03 0.03 4.3 0.4</td>
</tr>
<tr>
<td>Weight per litre of the acid</td>
<td>kg at $15^\circ C$</td>
<td>1.47 1.72 1.49 1.49 1.71 1.72</td>
</tr>
<tr>
<td>Temperature of the acid</td>
<td>$^\circ C$</td>
<td>51 112 57 44 44 43</td>
</tr>
</tbody>
</table>
The nitric oxide concentration in the gas between denitration and nitric oxide absorption is 4.5 to 5.5% by volume. The temperature of the acid when entering tower 2 is 81°C. The acid produced has a concentration of 79% by weight and contains less than 0.01% by volume of nitrose, calculated as HNO₃ (100%). It is not necessary to supply heat during the operation. However, when starting up the plant, it is of advantage to bring the acid temperature in tower 2 rapidly to the optimum value, for which purpose an indirectly steam-heated heat exchanger is suitable. 0.6 kg of HNO₃ (100% strength) is consumed per 100 kg of H₂SO₄ (100% strength) when the gas scrubber 605 (Figure 1) is in operation. In that case, the gas resistance of the system consisting of 6 towers is 40 mbars. Without operating the gas scrubber in the upper part of the tower 6, the HNO₃ consumption is 1.1% by weight and the gas resistance is 24 mbars. The sojourn time of the gases between denitration and nitric oxide absorption is 19 seconds. The exit gases contain less than 0.003% by volume of SO₂.

The space-time yield is 310 kg of sulphuric acid, containing 78% by weight of H₂SO₄, per day per m³ of packed space of the tower system.

Comparative Example I

Processing the same SO₂-containing gases as in Examples 1 and 2, but in an installation without indirect heating of the nitrose-containing acid for the denitration tower, and without an upstream drying tower and a downstream acid dehydration tower proves to be impossible because the concentration of the acid for the nitric oxide
absorption falls below 74% by weight and the system loses its nitrogen oxides during operation within a few hours.

**Comparison Example II**

Processing the same SO\(_2\)-containing gases as in the preceding examples, but without heating the nitrose-containing acid for the denitration tower in a system according to Figure 1 is impossible because under these circumstances sufficiently denitrated acid cannot be produced.

If a production tower which is fed, in the manner of a PETERSL. tower plant, with acid from the first nitric oxide absorption tower (nitration tower), is inserted upstream from the first dilute acid production tower, the system can only be operated if the amount of gas being processed is reduced. The results of the above-mentioned intercalation of the production tower in the plant can be seen from the previously cited literature reference of Winnacker-Küchler, page 45, Figure 26a. In this case, the maximum nitric oxide concentration in the gas is about 2.8% by volume against 5.5% by volume in the process of the invention. In order to achieve the low nitric acid consumption of the process according to the invention, the gas throughput in the known process must be throttled so much that the space-time yield falls off to only 140 kg of sulphuric acid, containing 76% by weight of H\(_2\)SO\(_4\), per day per m\(^3\) of packed space of the tower system.
The packings employed in the dilute acid towers of the SO₂-processing zone are intended to produce as large a surface area as possible within the restricted volume of the tower.

Hitherto, packings in the form of wire-like structures, in particular, have proved especially effective for this purpose, since with such packings the ratio of the space occupied by, to the space actually filled with, the material of the packings is extremely high. One of the best hitherto known packings of this type is described in U.S. Patent No. 2,867,425. It consists of synthetic plastic material and is in the form of a spiral of which the beginning and the end are connected to one another. However, this known packing has the disadvantage that because of its complicated shape it can only be produced with relative difficulty and is correspondingly expensive.

This disadvantage is avoided with a packing which consists of small bars arranged substantially parallel to one another on a carrier.

In the text which follows, this packing is explained in more detail in relation to the illustrative embodiment shown in the drawing. In this:

Figure 2 shows a view at right angles to the small bars, and

Figure 3 shows the illustrative embodiment in a view parallel to the small bars.

As shown in the drawing, the packing consists of a plurality of parallel small bars 19 of circular cross-section,
which are arranged on a joint carrier 20. The carrier 20 is axially symmetrical relative to an axis parallel to the small bars 19. The small bars 19 are so arranged on the carrier and their lengths are so chosen, that the entire packing 21 occupies a space of approximately spherical shape. Of course, a different envelope, for example an ellipsoidal envelope, of the packing would also be possible.

The carrier 2 comprises three parallel rings 2a, 2b and 2c and a disc 2d. The three rings and the disc are held together by means of ribs 2e and in particular in such a way that they form an essentially conical basket. The result of this arrangement is that the interspaces between any two rings and two ribs do not become too small and thus do not offer a high resistance to flow. The largest ring 2a is provided on its outside with radial extensions 2f which each carry a small bar 1 at their ends.

Instead of a conical basket, a pyramidal basket can also serve as the carrier for the small bars. In that case, the parallel rings are replaced by polygons such as, for example, triangles, squares or hexagons. It is advantageous to provide at least two rings each with more than 3 small bars.

The packing described above can be manufactured very easily by injection moulding since the mould required for the purpose is itself relatively simple. The mould need only consist of two parts, with the parting surface being conical and coinciding with the outer envelope of the ribs 2e. The negative cavities corresponding to the rings and ribs are then,
respectively, simply annular grooves, or they are grooves running in the direction of the envelope lines of the two mould parting surfaces. Parallel bores in the two mould halves correspond to the small bars. The bores can be cylindrical or preferably conical, the latter for easier mould release.

In order that the packing described can perfectly fulfil the function intended for it, the distances between any two parallel small bars should not be less than about twice their diameter. Preferably, the distances are about three to ten times the diameter of the small bars. Furthermore, the meshes of the basket-like carrier, that is to say the inter-spaces each defined by two rings and two ribs, should also be as large as possible. If these conditions are fulfilled, the packing has no pronounced preferred directions in respect of resistance to flow, that is to say it is approximately equally effective in any desired position. Measurements in a gas scrubber installation have shown that, especially at higher flow speeds and lower concentrations of the materials to be removed by scrubbing, this preferred packing is superior, in respect of the degrees of absorption achievable therewith, to the known spiral packings, mentioned earlier, even when the latter are used under normal conditions.

The terms "nitrose acid" or "nitrose-containing acid" are used herein to designate a diluted sulfuric acid having a content of up to 85 weight percent H₂SO₄, in which acid nitro-sulsulfuric acid, (NO)HSO₄, and/or nitrogen trioxide (N₂O₃) are dissolved. Such acid is also referred to as "nitrated acid"
in some textbooks. "Nitrose" designates a mixture of nitrogen oxides the nitrogen-to-oxygen ratio of which corresponds to the formula $\text{N}_2\text{O}_3$. 
The claims defining the invention are as follows:

1. A process for separating \( \text{SO}_2 \) from a moist current of gas containing up to about 6% by volume of the same, with attendant production of sulfuric acid by the nitrogen oxide process in a system of reaction zones, which system is adapted for the production of a strong sulfuric acid having a \( \text{H}_2\text{SO}_4 \)-content of above 70%, by weight, in which system the current of \( \text{SO}_2 \)-containing gas is caused to flow, successively

   a) through an acid denitration zone;
   
   b) through an \( \text{SO}_2 \)-processing zone which contains at least one packed tower and in which said current having a nitrogen oxides concentration of at least about 1% by volume, is brought into intimate contact with dilute sulfuric acid having a concentration of less than 70% \( \text{H}_2\text{SO}_4 \) and being substantially free from nitroso, flowing in a cycle through the latter zone; said pressure on said gas current being sufficiently low to avoid an increase of the nitroso content in said acid cycle;
   
   c) through a nitrogen oxides-absorption zone; all of the nitroso-containing acid exiting from said absorption zone being indirectly heated to a temperature above 60°C and then introduced directly into said denitration zone by-passing said \( \text{SO}_2 \)-processing zone

   characterized in that

   said process further comprises the steps of

   a) removing a portion of the said dilute sulfuric acid, substantially free from nitroso, from said \( \text{SO}_2 \)-processing zone and bringing the said removed portion into contact with the moist current of said \( \text{SO}_2 \)-containing gas in a pretreatment drying zone upstream of said denitration zone in said system;

   b) reintroducing a portion of the acid formed in (a)
more diluted by moisture from said gas and free from nitrose into the dilute sulfuric acid circulating through the \( \text{SO}_2 \)-processing zone, and

\( \gamma \) at least when the water-content of the more diluted acid exiting from the pretreatment drying zone increases to the extent that the \( \text{H}_2\text{SO}_4 \)-content of the denitrated sulfuric acid leaving the denitration zone drops substantially below 70\% by weight of \( \text{H}_2\text{SO}_4 \), removing a portion of the dilute sulfuric acid from said cycle and conveying the last-mentioned portion through an acid-dehydration zone, wherein the last-mentioned portion of dilute sulfuric acid is heated to evaporate water therefrom, and then returning the resulting more concentrated acid to said cycle.

2. The process of claim 1, characterized in that the temperature imparted to the nitrose-containing acid prior to entering the denitration zone is above 80\°C.

3. The process of claim 1 or claim 2 characterized in that the current of gas through said denitration zone is brought counter currently into contact with nitrose-containing sulfuric acid having an \( \text{H}_2\text{SO}_4 \) concentration of above 70 and up to 85\% by weight, from said absorption zone.

4. The process of any one of claims 1 to 3 characterized in that another portion of dilute acid is indirectly heated before entering said acid-dehydrating zone.

5. The process of any one of claims 1 to 4 characterized in that the nitrose-containing acid fed to the denitration zone is heated upstream of the latter by indirect heat exchange with the denitrated acid discharged from the latter zone and is additionally indirectly heated to at least 60\°C.

6. The process of any one of claims 1 to 5 character-
ized in that dilute acid from said cycle thereof is introduced intermittently into said denitration zone in order to regulate the concentration of the acid in the latter zone.

7. The process of any one of claims 1 to 6 characterized in that the sojourn time of the SO₂- and nitric oxides-containing gas between leaving the denitration zone and entering the first tower of the nitric oxide absorption zone, while passing through the SO₂-processing zone therebetween and being irrigated with dilute acid therein, is held to less than 30 seconds when the gas entering the denitration zone contains at least 5% by volume of SO₂ and at least 10% by volume of O₂, and limiting the aforesaid sojourn time, when the SO₂ content at the last-mentioned entry is less than 5% by volume, to a maximum period determined by the equation

\[
Z_{\text{max}} = \frac{1,500}{[\text{SO}_2] \cdot [\text{O}_2]}
\]

in which formula \( Z_{\text{max}} \) is the sojourn time in seconds, \([\text{SO}_2]\) denotes the SO₂ content in the gas entering the denitration zone, in % volume, and \([\text{O}_2]\) denotes the oxygen content in the same entry gas, in % by volume.

8. The process of any one of claims 1 to 7 wherein, at a nitrogen oxides-concentration of at least 2% by volume and attendant an SO₂-concentration of at least 1% by volume, in the gas current entering the main sector of the SO₂-processing zone,

i) the latter zone comprises at least one tower filled with packing having a surface area of more than 90 m²/m³, and

ii) the upper limit of the sojourn time of the gas between leaving the denitration zone and entering the first
nitric oxide absorption tower, at less than 10% by volume oxygen content in the gas, is calculated from the equation

\[
Z_{\text{max}} = \frac{L_2}{[O_2]^n},
\]

\[n = \text{the oxygen content, in } \% \text{ by volume, in the gas on leaving the denitration zone.}\]

9. The process of claim 1, wherein at a nitrogen oxides-concentration of at least 2% by volume and an attendant SO$_2$-content of at least 1% by volume and a free oxygen content of at least 10% by volume in the gas current entering the main sector of the SO$_2$ processing zone,

i) the latter zone comprises at least one tower filled with packing having a surface area of more than 90 m$^2$/m$^3$, and

ii) the upper limit of the sojourn time of the gas between leaving the denitration zone and entering the nitric oxide absorption zone is below 30 seconds.

10. The process of claim 5, characterized in that the temperature of the nitrose-containing acid being introduced into said denitration zone is kept constant by correspondingly regulating said additional indirect heating.

11. The process of any one of claims 1 to 10 characterized in that H$_2$SO$_4$-concentration of the acid leaving said denitration zone is kept constant by introduction of dilute acid or water into said zone.

12. The process of claim 10 characterized in that the ratio of NO:NO$_2$ present in the gas current before entering said nitrogen oxides-absorption zone is regulated by varying the amount of nitrose-containing acid present at a given time in the
denitration zone.

13. The process of any one of claims 1 to 12, characterized in that the exit gas of said system is passed through said acid dehydration zone and conveys from said zone the water evaporated from said dilute sulfuric acid.

14. Process according to any one of claims 1 to 13, wherein the waste gas contains at least 0.2% by volume of SO$_2$ on entering the denitration zone.

15. Process according to any one of claims 1 to 14, characterized in that the reaction space for the nitric oxide absorption is at least as great as the sum of the reaction spaces for denitration and SO$_2$-processing.

16. Process according to any one of claims 1 to 15, characterized in that the gases entering the denitration zone are at a temperature below 60°C.

17. Process according to any one of claims 1 to 16, wherein the H$_2$SO$_4$-concentration of the acid which is brought into contact with the SO$_2$-containing waste gas in the pretreatment (drying) zone is inferior to that of the dilute acid circulating in the SO$_2$-processing zone.

18. A process for separating SO$_2$ from a moist current of gas containing up to about 6% by volume of the same, said process being substantially as hereinbefore described.

DATED this TWENTIETH day of SEPTEMBER 1979

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