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(54) **PROCESSING DEVICE FOR SHAVINGS AND METHOD FOR PROCESSING SHAVINGS**

(57) A method for processing shavings and a processing device for shavings that comprises a filling unit arranged to receive the shavings, and a conveyor comprising at least one of a screw conveyor, a belt conveyor and a vibratory chute. The at least one conveyor conveys or transports the shavings from one unit of the processing device to another. The device further comprises a magnetic unit arranged to separate ferrous components from the shavings, a washer unit comprising at least two vibratory bowl feeders, a dryer, and a collector unit for collecting the cleaned shavings. The washer unit is arranged to separate the shavings. The one of the at least two vibratory bowl feeders is operated with a solvent and the other of the at least two vibratory bowl feeders is operated with water. The dryer is arranged to dry the separated shavings.

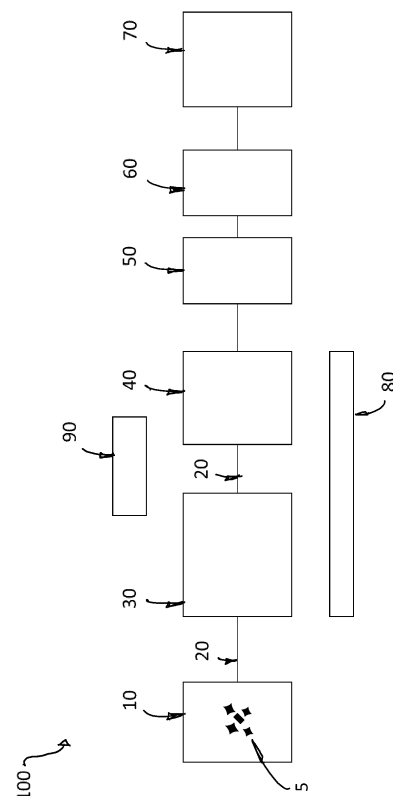


Fig. 1

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Description

Cross-Reference to related Applications

[0001] This application claims benefit of and priority of the Luxembourg application LU505288, filed on 16 October 2023. The entire disclosure of the Luxembourg application LU505288 is hereby incorporated by reference.

Field of the Invention

[0002] The present document relates generally to the handling of thin or filamentary material and more particularly to a processing device for shavings and a method for processing shavings.

Background of the invention

[0003] In known systems for cleaning metal shavings, solvents such as perchloroethylene, modified alcohols or non-chlorinated hydrocarbons are used, which are carcinogenic, toxic, hazardous to water, flammable and can only be used with a high level of effort in terms of occupational safety. In addition, the use of these substances requires special and cost-intensive safety measurements for the handling during procurement, operation, and disposal. Furthermore, perchloroethylene runs the risk of being largely "banned" by regulatory measures.

[0004] Newer systems, such as multi-chamber immersion systems or continuous spraying systems, use sustainable water-based substances and are produced and marketed by various manufacturers. In multi-chamber immersion systems, the shavings to be cleaned are moved through the washing and drying process in baskets. In the case of crushed metal shavings, the debris or rubble in the baskets creates diffusion paths that make it extremely difficult for the solvent to reach the shavings surface, dissolve the contamination and transport the contamination out of the debris. The same physical phenomena occur during the subsequent rinsing and drying process. In continuous spraying systems, the parts to be cleaned are fixed in devices provided for this purpose, some of which are specially made, and then moved through the washing, rinsing and drying process. This is technically very challenging or even not possible with particles the size of broken shavings.

[0005] Current washer units of shavings on the market are designed for substantially large shavings, like the size of a pack of cigarettes, or half the volume of a pack of cigarettes. Processing the shavings with these washer units is not efficient, as the shavings cannot be rinsed off and cannot be dried properly. They are indeed not passing the process individually, i.e., as one single shaving, but the shavings are passing the process as encaged and as a bundle of shavings.

[0006] CN 103 056 125 A discloses a method for cleaning waste metal scraps generated during machin-

ing. The method mainly includes a feeding procedure, a cleaning procedure, a centrifugal separating procedure, a drying procedure, a distilling procedure, and a rectifying procedure. An organic solvent is used which absorbs engine oil from the waste metal scraps.

[0007] DE 10 2019 002 751 A1 discloses an apparatus for the treatment of a surface of one or more objects, in particular cleaning, and method of operating such an apparatus. Here, a process medium, in particular a detergent and/or a cleaning agent, is used, of which the temperature must lie within a certain working range in order to ensure satisfactory functioning of the surface treatment apparatus.

[0008] Cleaning trials with metal shavings in these systems have shown that often the cleaning and subsequent drying of the shavings is not satisfactory if certain process parameters are not met.

[0009] US 4 108 644 A discloses a method for manufacturing of reactive metals or alloys having properties equal to or better than metals or alloys manufactured from prime raw materials, utilizing revert materials obtained from the fabrication of such metals or alloys into finished parts as the principal raw material.

[0010] US 4 063 564 A discloses that in the cleaning and coating of relatively small articles of either simple or complex shape, numerous problems are encountered since small articles are difficult or expensive to handle on an individual basis. US 4 063 564 A provides a system and apparatus for treating articles of variable size and shape utilizing vibrating feeder bowls into which fluids are introduced for treating the articles simultaneously with their automatic advancement. A particular system is disclosed for treating aluminum nails by continuous advancement through a succession of feeder bowls at which the nails are subject to cleaning, washing, coating and rinsing.

[0011] "Vibratory finishing: Versatile, effective, and reliable" discloses that vibratory finishing is an important component of a group of industrial processes referred to as mass finishing or mass media finishing. Mass finishing is a term used to describe a group of abrasive industrial processes by which large lots of parts et components made from metal or other materials can be economically processed in bulk to achieve one or several of a variety of surface effects.

[0012] The objective of the present invention is to provide a processing device for impure shavings and a sustainable and more environmentally friendly method for processing the impure shavings that avoids the use of hazardous and toxic solvents and ensures a high degree of cleaning and drying results.

Brief description of the invention

[0013] The above objective is solved by a processing device for shavings that comprises a filling unit arranged to receive the shavings, and a conveyor comprising at least one of a screw conveyor, a belt conveyor and a

vibratory chute. The at least one conveyer conveys or transports the shavings from one unit of the processing device to another. The device further comprises a magnetic unit arranged to separate ferrous components from the shavings, a washer unit comprising at least two vibratory bowl feeders, a dryer, and a collector unit for collecting the cleaned shavings. The washer unit is arranged to separate the shavings. The one of the at least two vibratory bowl feeders is operated with a solvent and the other of the at least two vibratory bowl feeders is operated with water. The dryer is arranged to dry the separated shavings.

[0014] The washer unit further enables a substantially easy and proper rinsing and/or a drying of the shavings.

[0015] With the processing device, the shavings can be effectively and individually cleaned and dried in a resource-saving and space-saving process.

[0016] The above objective is solved by a processing device for shavings. The processing device comprises a filling unit arranged to receive the shavings, and at least two conveyors of different types. The at least two conveyors comprise at least one of a screw conveyor, a belt conveyor and a vibratory chute. The at least two conveyors are arranged in such a way that the shavings can be processed from the filling unit to the collecting unit and in therebetween. The processing device further comprises a washer unit comprising at least two vibratory bowl feeders. The processing device further comprises a dryer, a magnetic unit arranged to separate ferrous components from the shavings, and a collector unit for collecting the cleaned shavings. The washer unit is arranged to separate the shavings. One of the at least two vibratory bowl feeders is operated with a solvent and the other of the at least two vibratory bowl feeders is operated with water. The dryer is arranged to dry the separated shavings.

[0017] With the processing device, the shavings can be effectively and individually cleaned and dried in a resource-saving and space-saving process.

[0018] In one aspect, the at least two conveyors of different types are a screw conveyor and a vibratory chute.

[0019] In one aspect, the solvent is water-based, and the water is demineralised water.

[0020] With the water-based solvent and the demineralised water, a sustainable and more environmentally friendly cleaning of the shavings can be ensured. Also, a high level of occupational safety and additional safety measures are not required for these substances, which reduces investment and operating costs.

[0021] In another aspect, the processing device further comprises a sampling unit for automatically extracting samples.

[0022] With the sampling unit, automatic quality assurance of the cleaned shavings can be ensured without stopping the process or introducing impurities into the system.

[0023] In another aspect, the processing device further

comprises a third vibratory bowl feeder which is operated with demineralised water.

[0024] The third vibratory bowl feeder enables a further cleaning stage when heavily contaminated shavings need to be cleaned. With the demineralised water, the system remains sustainable and more environmentally friendly.

[0025] In one aspect, the washer unit in the processing device comprises the third vibratory bowl feeder and/or the dryer.

[0026] The term "adjacent" might refer to the terms "next to", "contiguous to", and "close to".

[0027] In another aspect, the processing device further comprises a process water treatment unit provided adjacent to the washer unit and the dryer.

[0028] In one aspect, the process water treatment unit is connected to the washer unit and/or to the dryer.

[0029] The dryer enables to dry the shavings and to remove individual particles of the shavings, such as dust.

[0030] In one aspect, the water is demineralised water.

[0031] During operation, the water-based solvent and the demineralised water mix as process water. The process water is collected in the processing device and treated by the process water treatment unit. Thus, it is possible to separate the process water and recycle the solvent and the demineralised water.

[0032] In another aspect, the processing device further comprises an extraction unit provided adjacent to at least one of the at least one conveyor, the washer unit, and the collector unit.

[0033] In one aspect, the extraction unit is connected to the at least one of the at least one conveyor, the washer unit, and the collector unit.

[0034] In one aspect, the extraction unit is connected to the collector unit.

[0035] With the extraction unit the dust caused by the conveying of the shavings can be collected. Thus, the pollution of the environment around the processing device can be reduced resulting in a higher workplace safety and lower environmental contamination.

[0036] The above objective is further solved by a washer unit comprising the first vibratory bowl feeder operated with a solvent and the second vibratory bowl feeder operated with water.

[0037] The washer unit allows the shavings to be effectively and individually cleaned in a resource-saving and space-saving process.

[0038] Operating the first vibratory bowl feeder with the solvent enables to remove most of the impurities arranged on the plurality of shavings. Operating the second vibratory bowl feeder with water after the operating of the first vibratory bowl feeder with the solvent enables to wash, i.e., remove, rinse off, wash off, the remaining impurities, such as residual dust and dirt, that might be present on the plurality of shavings, and further enables to rinse off the solvent.

[0039] In one aspect, the washer unit further comprises the third vibratory bowl feeder operated with water, an-

d/or the dryer.

[0040] With the third vibratory bowl feeder and/or the dryer, a higher degree of contamination of the shavings can be removed more effectively in a resource-saving and space-saving process and the shavings can be dried individually.

[0041] Conducting subsequent washings of the plurality of shavings with water in the second vibratory bowl feeder, followed by demineralised water in the third vibratory bowl feeder, enables removing mechanically substantially all of the impurities on the plurality of shavings. This subsequent washings with water further enables to wash off the solvent originating from the operation of the first vibratory bowl feeder.

[0042] In one aspect, the washer unit comprises a fourth vibratory bowl feeder that might be designed as a dryer. The fourth vibratory bowl feeder might be arranged downstream of the third vibratory bowl feeder. The fourth vibratory bowl feeder might comprise heating plates. The fourth vibratory bowl feeder might work with a system not air-based, as some shavings might be volatile, and so might be ejected from the processing device.

[0043] The above objective is further solved by a method for processing shavings, whereby the method comprises receiving a plurality of shavings in a filling unit; separating ferrous components from the plurality of shavings; conveying the plurality of shavings by a conveyor to a washer unit, wherein the washer unit comprising at least a first and a second vibratory bowl feeder; separating and washing the plurality of shavings in the first vibratory bowl feeder using a solvent; separating and rinsing the plurality of shavings in the second vibratory bowl feeder using water; conveying the plurality of shavings to a dryer; drying the separated plurality of shavings in the dryer; and conveying the plurality of shavings to a collector unit.

[0044] The method enables the separation of the plurality of shavings resulting in the accessibility of the solvent and the water to the individual shavings and the subsequent drying capability in the dryer. Thus, the shavings can be effectively and individually cleaned and dried in a resource-saving, sustainable and environmentally friendly process.

[0045] The above objective is further solved by a method for processing shavings, The method comprises receiving a plurality of shavings in a filling unit, conveying the plurality of shavings by a conveyor to a washer unit. The washer unit comprises at least a first vibratory bowl feeder and a second vibratory bowl feeder. The method further comprises separating and washing the plurality of shavings in the first vibratory bowl feeder using a solvent. The method further comprises separating and rinsing the plurality of shavings in the second vibratory bowl feeder using water. The method further comprises conveying the plurality of shavings individually to a dryer. The method further comprises drying the separated plurality of shavings in the dryer. The method further comprises separating ferrous components from the plurality of shav-

ings, and conveying the plurality of shavings individually to a collector unit.

[0046] In one aspect, the steps of the method are conducted in the order.

5 **[0047]** The term "conducted in the order" means that the step of receiving is followed by the step of separating. The step of separating is followed by the step of conveying. The step of separating is followed by the step of separating and washing in the first vibratory bowl feeder.
10 The step of separating and washing the plurality of shavings in the first vibratory bowl feeder is followed by the step of separating and rinsing the plurality of shavings in the second vibratory bowl feeder. The step of separating and rinsing the plurality of shavings in the second vibratory bowl feed is followed by the step of conveying. The step of conveying is followed by the step of drying. The step of drying is followed by the step of conveying.

[0048] In one aspect, the method further comprises the step of automatically extracting samples of the plurality of shavings by a sampling unit.

20 **[0049]** With this step, the automatic quality assurance of the cleaned shavings can be ensured without stopping or influencing the process or introducing impurities into the system.

25 **[0050]** In another aspect, the method further comprises the step of separating and rinsing the plurality of shavings in a third vibratory bowl feeder using water.

[0051] With this a further cleaning step is introduced for cleaning impure shavings, wherein the system remains sustainable and more environmentally friendly due to the use of water.

[0052] In another aspect, the method further comprises the step of collecting and treating process water by a process water treatment unit.

35 **[0053]** With this it is possible to separate the process water and recycle the solvent and the demineralised water and recycle back to the process.

[0054] In another aspect, the method further comprises the step of extracting dust or particles in the air by the extraction unit caused by the conveying of the shavings.

[0055] With the extraction of the dust and particles in the air caused by the conveying of the shavings, the pollution of the environment around the processing device can be reduced resulting in a higher workplace safety and lower environmental contamination.

[0056] The above objective is further solved by a method for processing shavings.

50 **[0057]** In a first step of the method, the plurality of shavings is received in the filling unit.

[0058] In one aspect the plurality of shavings includes impurities or contaminants from an upstream metalworking process and have essentially the same size.

[0059] In a second step of the method, the plurality of shavings is conveyed by the at least one conveyor to the washer unit.

[0060] In the washer unit, in a third step of the method, the plurality of shavings is fed to the first vibratory bowl

feeder. In the first vibratory bowl feeder, the plurality of shavings is separated and washed by the solvent. In the third step of the method, the plurality of shavings is freed from the contamination or impurities by the solvent. The washed plurality of shavings exits the first vibratory bowl feeder at the outlet of the first vibratory bowl feeder and is fed to the bowl of the second vibratory bowl feeder.

[0061] In one aspect the feeding to the bowl of the second vibratory bowl feeder is conducted directly or by the at least one conveyor.

[0062] In a fourth step of the method, the plurality of shavings is separated and rinsed with the water in the second vibratory bowl feeder. In the fourth step of the method, the plurality of shavings is freed from the solvent and last contaminations or impurities by the water. The plurality of shavings exits the second vibratory feeder individually or separated at the outlet.

[0063] In one aspect, following the fourth step of the method, the plurality of shavings is separated and rinsed with water in a third vibratory bowl feeder. In this aspect, the rinsed plurality of shavings is fed directly or by the at least one conveyor from the outlet of the second vibratory bowl feeder to the bowl of the third vibratory bowl feeder.

[0064] In one aspect, the conveyor includes a vibratory chute. In this aspect, the plurality of shavings exits the third vibratory feeder individually or separated at the outlet.

[0065] In a fifth step of the method, the separated plurality of shavings is conveyed to the dryer.

[0066] In a sixth step of the method, the separated plurality of shavings are dried in the dryer.

[0067] In one aspect, the method further comprises conveying the separated plurality of shavings from the dryer to the magnetic unit.

[0068] In a seventh step of the method, ferrous components are separated from the separated plurality of shavings by the magnetic unit. Cleaned, dried, and separated plurality of shavings are obtained.

[0069] In one aspect, the seventh step of the method is followed by a step of extraction comprising automatically extracting samples of the plurality of shavings by the sampling unit.

[0070] In an eighth step of the method, the cleaned, dried, and separated plurality of shavings is conveyed to the collector unit. The fully loaded packing unit is exchanged for an empty packing unit if the packing unit of the collector unit is filled with the plurality of shavings.

[0071] In one aspect, the method further comprises a processed water treating step comprising collecting and/or extracting the processed water by the process water treatment unit.

[0072] In one aspect, the method further an air treating step comprising collecting and/or extracting dust and/or particles in the air caused by the conveying or transport of the shavings through the processing device by the extraction unit.

[0073] In one aspect, the processed water treating step treating step and the air treating step are carried out in

parallel to at least one of the second step of the method to the eighth step of the method.

Brief description of the drawings

[0074] A more complete understanding of the invention and many of the advantages associated therewith may be readily obtained by reference to the following detailed description in conjunction with the enclosed figures.

Fig. 1 is a schematic illustration of a processing device.

Fig. 2 is a schematic illustration of a first example of a washer unit of the processing device.

Fig. 2A is a schematic illustration of a second example of a washer unit of the processing device.

Fig. 3 is a schematic illustration of a vibratory bowl feeder of the processing device.

Fig. 4 illustrates a flowchart of a method for processing shavings by the processing unit.

Detailed description of the invention

[0075] Fig. 1 is a schematic illustration of a processing device 100 for shavings 5. Shavings 5 are thin, elongated pieces or fragments, strips or chips that are typically generated when metal is machined or worked upon using cutting tools such as lathes, milling machines, or drills, wherein the shavings 5 are contaminated or impurified by cooling substances as in a non-limiting example cutting fluids, water-soluble or synthetic coolants, and cutting oils. Metal shavings 5 can be produced in various shapes, including curly or helical forms, depending on the machining process and the type of metal being worked with. In this application, the term shavings 5 refer to a plurality of metal or metal-alloy shavings 5 which were contaminated during metal processing by the cooling substance, and wherein the shavings 5 have been crushed to ensure uniform size and easier handling.

[0076] The processing device 100 comprises a filling unit 10, at least one conveyor 20, a washer unit 30, a dryer 40, a magnetic unit 50, and a collector unit 70. The filling unit 10 serves as a storage container for the impure shavings 5 to be processed. In one example, the filling unit 10 might be configured as a hopper. The at least one conveyor 20 conveys or transports the shavings 5 or the plurality of shavings 5 from one unit of the processing device 100 to another. The at least one conveyor 20 might be configured in a non-limiting example as one of a screw conveyor, a belt conveyor, and a vibratory chute. In a further non-limiting example, the processing device 100 comprises at least two conveyors 20 of different types, such as a screw conveyor and a vibratory chute, wherein the conveyors 20 are arranged in such a way that the

shavings 5 can be processed from the filling unit 10 to the collecting unit 70 and in therebetween.

[0077] The dryer 40 is configured to dry the shavings 5 by applying thermal energy and/or airflow. In a non-limiting example, at least one dryer 40 is positioned in the washer unit 30, as illustrated in Fig. 2A. If the at least one dryer 40 is positioned in the washer unit 30, the at least one dryer 40 might be configured as vibratory bowl feeder with heating elements, such as in a non-limiting example heating plates. In another non-limiting example, the at least one dryer 40 is positioned after the washer unit 30. In another non-limiting example, the dryer 40 is configured as vibratory bowl feeder.

[0078] The magnetic unit 50 separates ferrous components from the shavings 5, in particular from the cleaned and dried shavings 5. The collector unit 70 is provided such that the cleaned, dried, and separated shavings 5 are collected in a packing unit (not shown). The dryer 40, the magnetic unit 50, and the collector unit 70 are well known from the prior art and will therefore not be described in detail for the sake of brevity.

[0079] The processing device 100 further comprises a sampling unit 60, a process water treatment unit 80 and an extraction unit 90. The sampling unit 60 automatically collects or extracts samples of the shavings 5 from the processing device 100, without the need for manual intervention. The sampling unit 60 is designed to extract representative samples for analysis, quality control, monitoring, or testing purposes. The sampling unit 60 uses sampling methods that include in a non-limiting example grab sampling, composite sampling, time-based sampling, or event-based sampling.

[0080] The shavings 5 which are contaminated by cooling substances enter the washer unit 30, where the shavings 5 are treated with a solvent 38 and a water 39, and the dryer 40, wherein the liquids are mixed and result in a process water in the processing device 100. Thus, the process water comprises the contamination or impurities from the shavings 5, the solvent 38 and the water 39. The process water is collected and treated by the process water treatment unit 80 which comprises an upstream cascaded settling tank (not shown) and optionally a vacuum distillation (not shown). The process water treatment unit 80 is provided adjacent to the washer unit 30 and the dryer 40 and used for the separation and removal of suspended solids from the process water as well as to separate different fractions of the process water based on their boiling points.

[0081] The extraction unit 90 is provided adjacent to at least one of the at least one conveyor 20, the washer unit 30, the dryer 40, and the collector unit 70. The extraction unit 90 collects or extracts dust or particles in the air, which are caused by the conveying or transport of the shavings 5 through the processing device 100. The extraction unit 90 might be in a non-limiting example one of a blower with a filter, baghouse filters, cyclone filters, electrostatic precipitators, scrubbers, activated carbon filters, or wet dust collectors.

[0082] The extraction unit 90, the cascaded settling tank and the vacuum distillation are well known from the prior art and will therefore not be described in detail for the sake of brevity.

[0083] Fig. 2 illustrates a first example of the washer unit 30 of the processing device 100. The washer unit 30 comprises at least two vibratory bowl feeders 32, 34 connected in series. The first vibratory bowl feeder 32 is operated with the solvent 38. The second vibratory bowl feeder 34 is operated with the water 39. The solvent 38 might be a water-based solvent being non-toxic, non-hazardous and safe. Non-limiting examples of a water-based solvent are hydrochloric acid, ammonia as aqueous solution, acetic acid, sodium hydroxide, sodium chloride, and ethanol. The water 39 might be a demineralised water or deionized water, thus being free from dissolved minerals, salts, and other ions. In one example, the washer unit 30 might comprise a third vibratory bowl feeder 36. The third vibratory bowl feeder 36 is operated with demineralised water. The third vibratory bowl feeder 36 facilitates an additional cleaning stage when the shavings 5 are heavily contaminated. In a further non-limiting example, the washer unit 30 might comprise more than three vibratory bowl feeders connected in series.

[0084] From and to the washer unit 30 the shavings 5 are conveyed or transported by the at least one conveyor 20. Within the washer unit 30 or between the vibratory bowl feeders 32, 34, 36 the shavings 5 are conveyed by a conveyor (not shown), in a non-limiting example a vibratory chute.

[0085] Fig. 2A illustrates a second example of the washer unit 30 of Fig. 2 with the dryer 40. In this example, the shavings 5 are conveyed through the washer unit 30 from one of the vibratory bowl feeders 32, 34, 36 to another of the vibratory bowl feeders 32, 34, 36 to the dryer 40. The cleaned shavings 5 leave the washer unit 30 in a dried state.

[0086] Fig. 3 is a schematic illustration of the first vibratory bowl feeder 32, which also illustrates the second and third vibratory bowl feeder 34, 36. However, in a non-limiting example, the first, second and third vibratory bowl feeders 32, 34, 36 might distinguish from each other.

[0087] The vibratory bowl feeder comprises a base unit 306, dampers 307, a drive unit 304, spring elements 305, a bowl 301 with a pathway 302, and an outlet 303. The bowl 301 is typically a curved or conical-shaped container where the shavings 5 are evenly distributed within the bowl 301. The bowl 301 comprises the pathway 302 along its curved or conical-shape, where the pathway 302 has a track-shape or spiral-shape. The drive unit 304 and the spring elements 305 generate a vibration which is transmitted to the bowl 301, resulting in a series of rapid linear or circular movements or vibrations. These vibrations cause the plurality of shavings 5 to move from the bowl 301 along the pathway 302 to the outlet 303. As the shavings 5 move along the pathway 302, the combination of the vibration and the pathways design causes the plurality of shavings 5 to separate and align themselves.

The plurality of shavings 5 arrives the outlet 303 individually one by one.

[0088] In one example, the first vibratory bowl feeder 32 is configured to have substantially the same dimension than the second vibratory feeder 34 and/or the third vibratory bowl feeder 36.

[0089] In one example, the first vibratory bowl feeder 32 is configured to be twice as high as the second vibratory feeder 34 and the third vibratory bowl feeder 36. This enables an improved two-step washing with water in the second vibratory feeder 34 and the third vibratory bowl feeder 36 resulting an improved washing off of the solvent.

[0090] Fig. 4 illustrates a flowchart of a method for processing the shavings 5 by the processing unit 100.

[0091] In a first step S1 the plurality of shavings 5 is received in the filling unit 10. The plurality of shavings 5 includes impurities or contaminants from an, in a non-limiting example, upstream metalworking process, and have essentially the same size. In a second step S2 the plurality of shavings 5 is conveyed by the at least one conveyor 20 to the washer unit 30. In the washer unit 30, in a third step S3, the plurality of shavings 5 is fed to the first vibratory bowl feeder 32.

[0092] In the first vibratory bowl feeder 32 the shavings 5 move in a first direction from the bowl 301 along the pathway 302 to the outlet 303, while the solvent 38 flows in a second direction, contrary to the first direction, from the outlet 303 along the pathway 302 to the bowl 302. In the first vibratory bowl feeder 32 the plurality of shavings 5 is separated and washed by the solvent 38. In the third step S3 the plurality of shavings 5 is freed from the contamination or impurities by the solvent 38. The washed plurality of shavings 5 exits the first vibratory bowl feeder 32 at the outlet 303 and is fed to the bowl 302 of the second vibratory bowl feeder 34 directly or by the at least one conveyor 20, wherein in a non-limiting example the conveyor 20 includes a vibratory chute.

[0093] In a fourth step S4, the shavings 5 move in the first direction from the bowl 301 along the pathway 302 to the outlet 303, while the water 39 flows in the second direction from the outlet 303 along the pathway 302 to the bowl 302. In the second vibratory bowl feeder 34 the plurality of shavings 5 is separated and rinsed with the water 39. In the fourth step S4 the plurality of shavings 5 is freed from the solvent 38 and optionally last contaminations or impurities by the water 39. The plurality of shavings 5 exits the second vibratory feeder 34 individually or separated at the outlet 303. In an optional step S45, the plurality of shavings 5 is separated and rinsed with the water 39 in a third vibratory bowl feeder 36. In this case, the rinsed plurality of shavings 5 is fed directly or by the at least one conveyor 20 from the outlet 303 of the second vibratory bowl feeder 34 to the bowl 302 of the third vibratory bowl feeder 36, wherein in a non-limiting example the conveyor 20 includes a vibratory chute. In this case, the plurality of shavings 5 exits the third vibratory feeder 36 individually or separated at the outlet 303.

[0094] In a fifth step S5, the separated plurality of shavings 5 is conveyed to the dryer 40. In a sixth step S6 the separated plurality of shavings 5 are dried in the dryer 40. In a seventh step S7, ferrous components are separated from the separated plurality of shavings 5 by the magnetic unit 50. In an optional step S78, samples of the plurality of shavings 5 are automatically extracted by a sampling unit 60. In an eighth step S8, the cleaned, dried, and separated plurality of shavings 5 is conveyed to the collector unit 70. If the packing unit of the collector unit 70 is filled with the plurality of shavings 5, the fully loaded packing unit is exchanged for an empty packing unit.

[0095] In another step S10, the processed water is collected and treated by the process water treatment unit 80. In another step S11, dust or particles in the air, which are caused by the conveying or transport of the shavings 5 through the processing device 100 are collected or extracted by the extraction unit 90. The step S10 and step S11 are carried out in parallel at least to the steps S2 to S8.

[0096] With the method the separation of the plurality of shavings 5 and the resulting accessibility of the solvent 38 and the water 39 to the individual shaving and the subsequent drying capability in the dryer 40 are achieved.

[0097] In one example, the method comprises the step S1 of receiving the plurality of shavings 5 in the filling unit 10. The step S1 is followed by the step S2 of conveying the plurality of shavings 5 to the washer unit 30 comprising at least the first vibratory bowl feeder 32 and the second vibratory bowl feeder 34. The step S2 is followed by the step S3 of separating and washing the plurality of shavings 5 in the first vibratory bowl feeder 32 using the solvent. The step S3 is followed by the step S4 of separating and rinsing the plurality of shavings 5 in the second vibratory bowl feeder 34 using water. The step S4 is followed by the step S5 of conveying the plurality of shavings 5 to the dryer 40. The step S5 is followed by the step S6 of drying the separated plurality of shavings 5 in the dryer 40. The step S6 is followed by the step S7 of separating ferrous components from the plurality of shavings 5. The step S7 is followed by the step S8 of conveying the plurality of shavings to a collector unit.

Reference signs

[0098]

100	processing device
5	shavings
10	filling unit
20	conveyor
30	washer unit
32, 34, 36	vibratory bowl feeder
38	solvent
39	water
40	dryer

50 magnetic unit
 70 collector unit
 60 sampling unit
 80 process water treatment unit
 90 extraction unit

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one of the at least two vibratory bowl feeders (32, 34) is operated with a solvent (38) and the other of the at least two vibratory bowl feeders (32, 34) is operated with water (39), and wherein the dryer (40) is arranged to dry the separated shavings.

Claims

1. A processing device (100) for shavings (5) comprising:

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a filling unit (10) arranged to receive the shavings (5);
 at least one conveyor (20) comprising at least one of a screw conveyor, a belt conveyor and a vibratory chute;
 wherein the at least one conveyor (20) conveys or transports the shavings (5) from one unit of the processing device (100) to another;
 a washer unit (30) comprising at least two vibratory bowl feeders (32, 34);
 a dryer (40);
 a magnetic unit (50) arranged to separate ferrous components from the shavings; and
 a collector unit (70) for collecting the cleaned shavings; wherein
 the washer unit (30) is arranged to separate the shavings; wherein
 one of the at least two vibratory bowl feeders (32, 34) is operated with a solvent (38) and the other of the at least two vibratory bowl feeders (32, 34) is operated with water (39), and wherein
 the dryer (40) is arranged to dry the separated shavings.

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2. A processing device (100) for shavings (5) comprising:

a filling unit (10) arranged to receive the shavings (5);
 at least two conveyors (20) of different types, the at least two conveyors (20) comprising at least one of a screw conveyor, a belt conveyor and a vibratory chute, preferably a screw conveyor and a vibratory chute;
 wherein the at least two conveyors (20) are arranged in such a way that the shavings (5) can be processed from the filling unit (10) to the collecting unit (70) and in therebetween;
 a washer unit (30) comprising at least two vibratory bowl feeders (32, 34);
 a dryer (40);
 a magnetic unit (50) arranged to separate ferrous components from the shavings; and
 a collector unit (70) for collecting the cleaned shavings; wherein
 the washer unit (30) is arranged to separate the shavings; wherein

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3. The processing device (100) according to claim 1 or 2, wherein
 the solvent (38) is water-based and the water (39) is demineralised water.

4. The processing device (100) according to any one of the previous claims, further comprising
 a sampling unit (60) for automatically extracting samples.

5. The processing device (100) according to any one of the previous claims, further comprising
 a third vibratory bowl feeder (36) which is operated with demineralised water.

6. The processing device (100) according to any one of the previous claims, further comprising
 a process water treatment unit (80) provided adjacent to the washer unit (30) and the dryer (40).

7. The processing device (100) according to any one of the previous claims, further comprising
 an extraction unit (90) provided adjacent to at least one of the at least one conveyor (20), the washer unit (30), the dryer (40), and the collector unit (70).

8. The processing device (100) according to any one of the previous claims, wherein the washer unit (30) comprises the third vibratory bowl feeder (36) and/or the dryer (40).

9. A washer unit (30) comprising

a first vibratory bowl feeder (32) operated with a solvent (38); and
 a second vibratory bowl feeder (34) operated with water (39).

10. The washer unit (30) according to claim 9 further comprising a third vibratory bowl feeder (36) operated with water (39); and/or a dryer (40).

11. A method for processing shavings (5), the method comprising:

a. Receiving (S1) a plurality of shavings (5) in a filling unit (10);
 b. Conveying (S2) the plurality of shavings (5) by a conveyor (20) to a washer unit (30), the washer unit (30) comprising at least a first vibratory bowl feeder (32) and a second vibratory bowl feeder

- (34);
- c. Separating and washing (S3) the plurality of shavings (5) in the first vibratory bowl feeder (32) using a solvent (38);
- d. Separating and rinsing (S4) the plurality of shavings (5) in the second vibratory bowl feeder (34) using water (39); 5
- e. Conveying (S5) the plurality of shavings (5) individually to a dryer (40);
- f. Drying (S6) the separated plurality of shavings (5) in the dryer (40); 10
- g. Separating (S7) ferrous components from the plurality of shavings (5);
- h. Conveying (S8) the plurality of shavings (5) individually to a collector unit (70). 15
- 12.** The method of claim 11, further comprising:
- g1. Automatically extracting (S78) samples of the plurality of shavings (5) by a sampling unit (60). 20
- 13.** The method of any one of claims 11 or 12, further comprising:
- d1. Separating and rinsing (S45) the plurality of shavings (5) in a third vibratory bowl feeder (36) using demineralised water. 25
- 14.** The method of any one of claims 11 to 13, further comprising:
- i. Collecting and treating (S10) process water by a process water treatment unit (80). 30
- 15.** The method of any one of claims 11 to 14, further comprising:
- j. Extracting (S1 1) dust or particles in the air by the extraction unit (90) caused by the conveying of the shavings (5). 35

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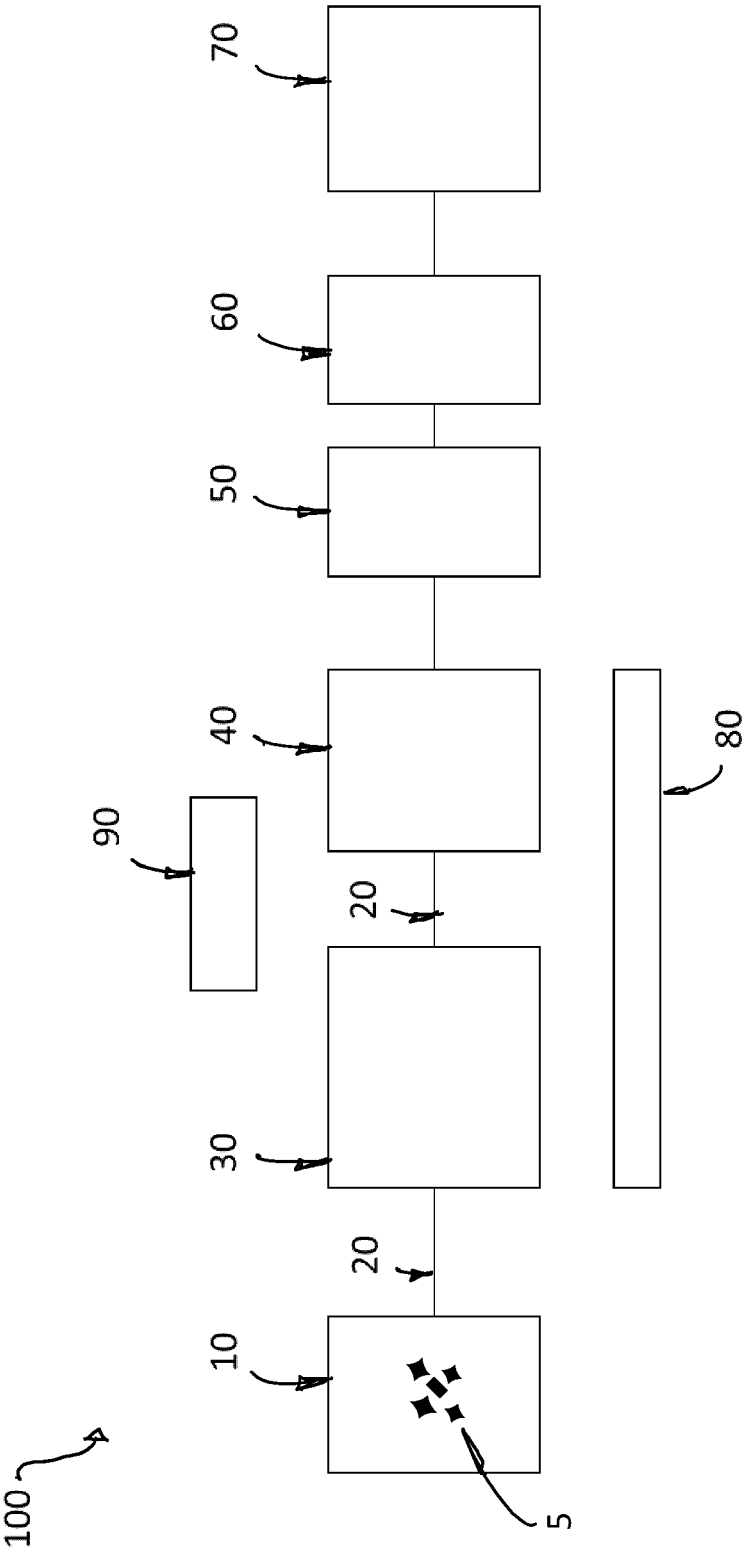


Fig. 1

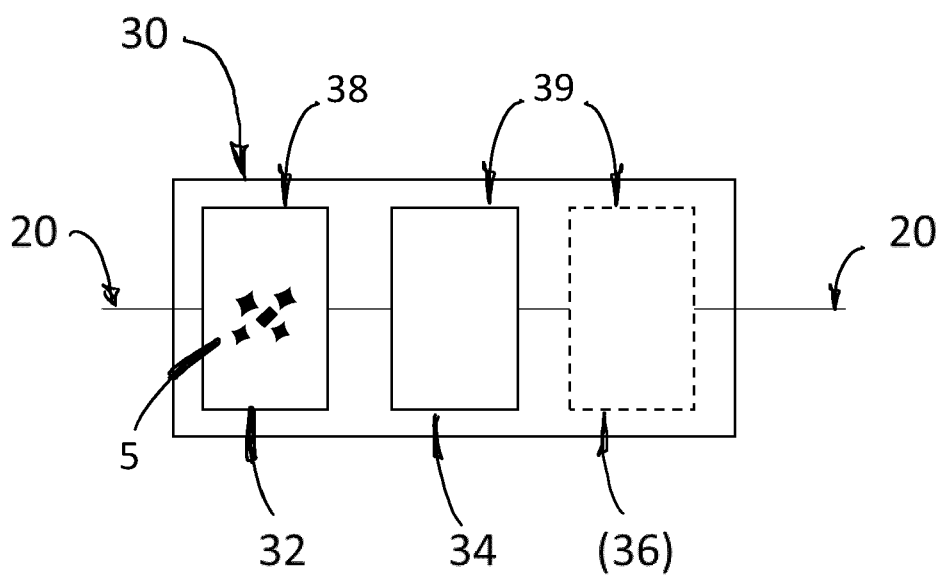


Fig. 2

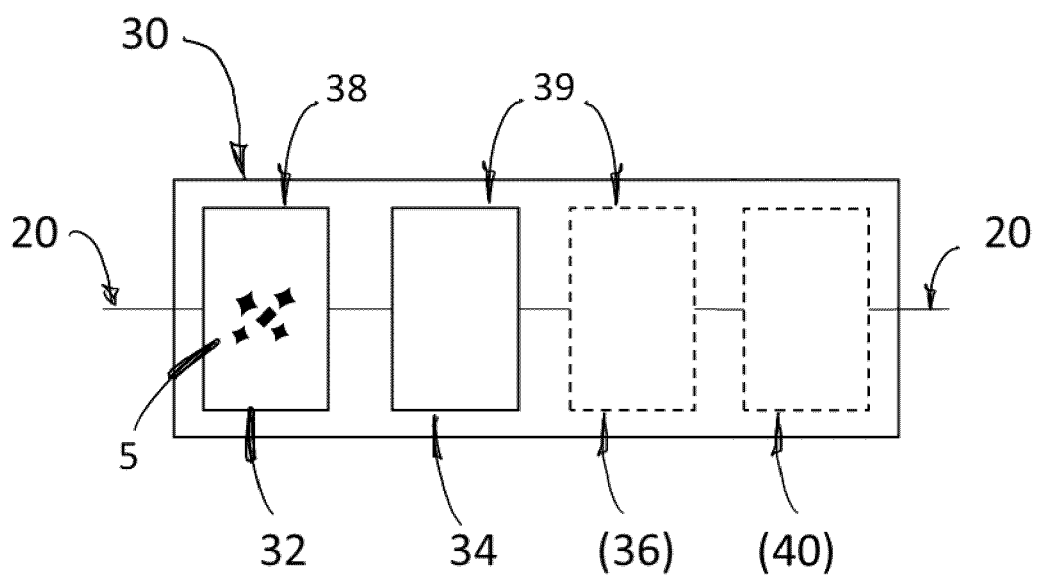


Fig. 2A

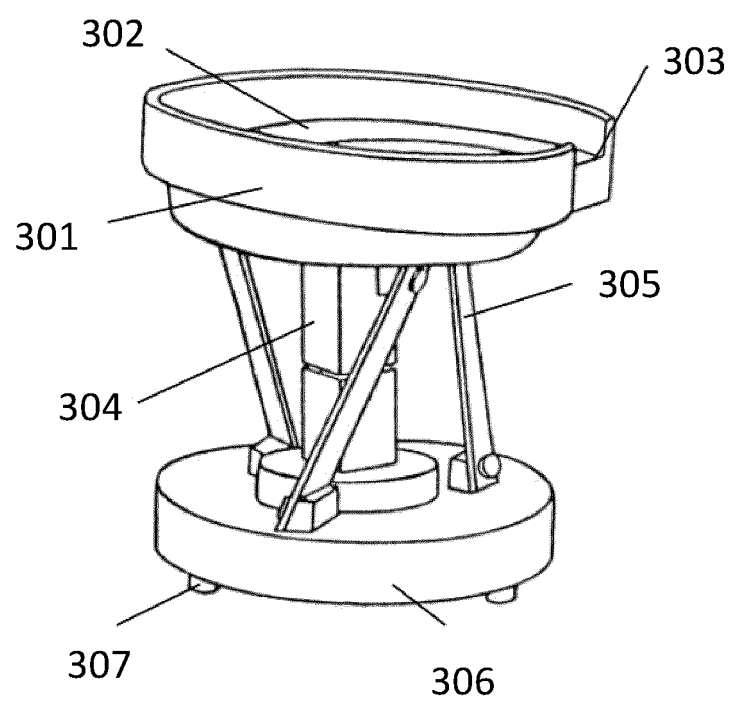


Fig. 3

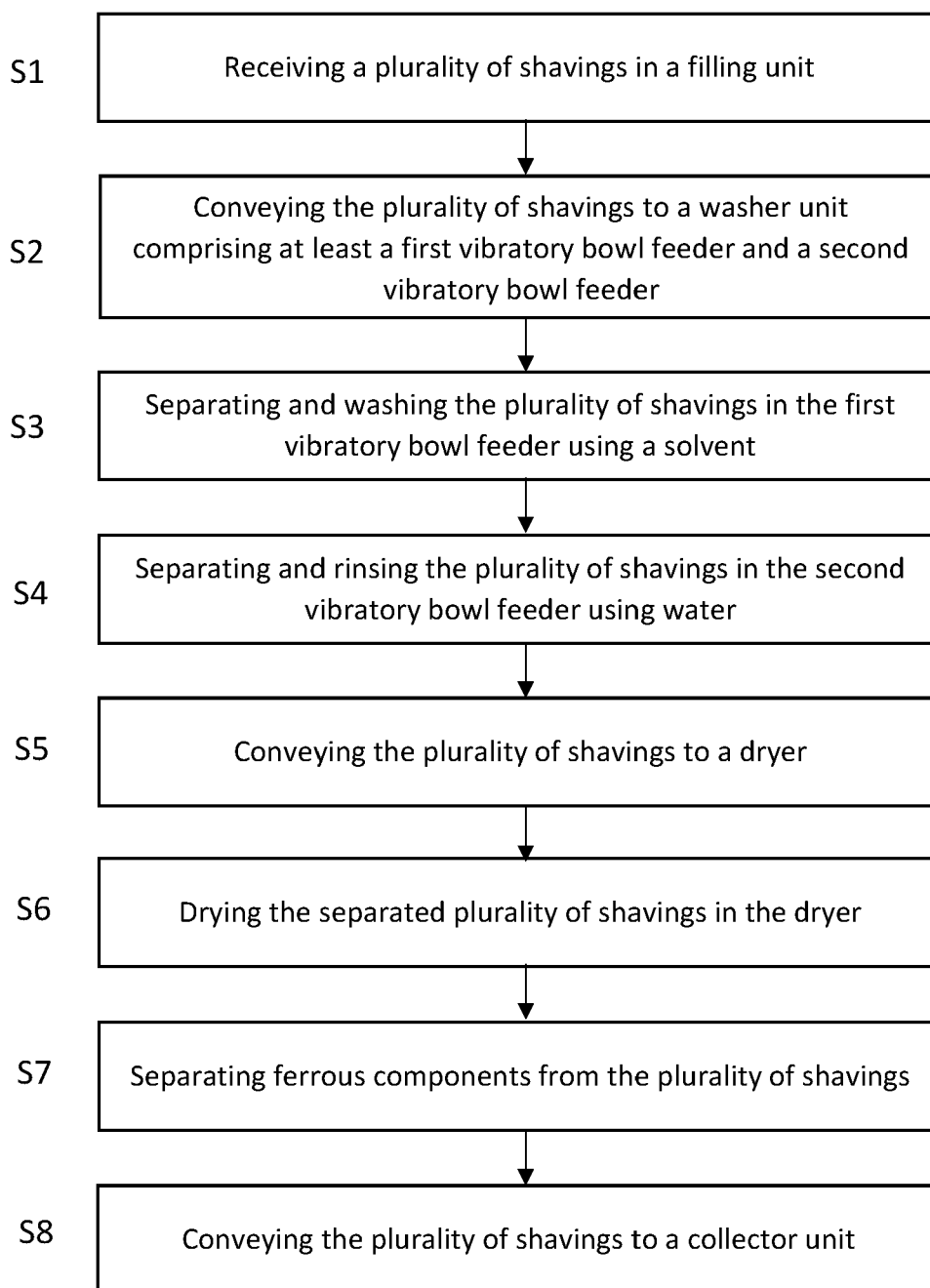


Fig. 4



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Application Number

EP 24 20 7022

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A	DAVIDSON ET AL: "Vibratory finishing: Versatile, effective, and reliable", METAL FINISHING : DEVOTED EXCLUSIVELY TO METALLIC SURFACE TREATMENTS, ELSEVIER, NEW YORK, NY, US, vol. 106, no. 5, 1 May 2008 (2008-05-01), pages 30-34, XP022834353, ISSN: 0026-0576, DOI: 10.1016/S0026-0576(08)80123-7 [retrieved on 2008-05-01] * page 31, column 2; figure 4 *	1-15	
A	WO 93/01898 A1 (EKOSPAN SRO [CS]) 4 February 1993 (1993-02-04) * the whole document *	1-15	TECHNICAL FIELDS SEARCHED (IPC) B65G C23G B07B B07C B03B B08B C22B
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		8 April 2025	Plontz, Nicolas
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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