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Automatic cleaning system and method for removing debris from dies

Abstract

An automatic system (10) and method for cleaning grease and debris from a die (12), such as a die (12) which stamps or trims aluminum or steel sheets used to form exterior vehicle body panels and thus should be free of dents and scratches, is provided. The system (10) includes multiple stations (22) and die handling arms (18), (20) or a conveyor (28) for moving the die (12) between the multiple stations (22). One of the stations (22) includes a spraying device (26) for cleaning and rinsing the die (12). Another one of the stations (22) includes an air blower (24) for removing loose debris from the die (10) and also for drying the die (10) after the washing step.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This U.S. National Stage Patent Application claims the benefit of PCT International Patent Application Serial No. PCT/US2022/013480 filed Jan. 24, 2022 entitled “AUTOMATIC CLEANING SYSTEM AND METHOD FOR REMOVING DEBRIS FROM DIES” which claims the benefit of and priority to U.S. Provisional Patent Application Ser. No. 63/141,114, filed Jan. 25, 2021, titled “Automatic Cleaning System For Removing Debris From Dies,” the entire [disclosure] disclosures of which are hereby incorporated by reference in their entirety.

BACKGROUND
1. Technical Field
(1) The invention relates to a system and method for cleaning dies used to trim, stamp, or otherwise

form metal components, for example exterior vehicle body panels formed of aluminum or steel.
2. Related Art
(2) Exterior vehicle body panels are typically formed by stamping, trimming, or otherwise cutting a metal sheet in a die. Slivers, or other small scraps of metal, typically come off the sheet during the cutting process and then accumulate on the die. The slivers, if left on the die, create scratches or dents on the panels formed during subsequent cutting steps, which are not acceptable for many types of vehicle components. For example, example exterior vehicle body panels must have a smooth appearance and be free of dents and scratches. Additional processing steps, and thus additional time and costs, are required to remove any scratches or dents on such components.
(3) To avoid scratches and dents, grease is typically applied to the die to collect the slivers and other debris. However, the die must be cleaned frequently to remove the grease containing the slivers and other debris which cause the stretches and dents. The current die washing process is labor and time intensive. The sliver filled grease is difficult to remove, and the die is very large and heavy. For example, the die, including an upper die half and lower die half, can have a total weight ranging from 70,000 to 95,000 pounds.
SUMMARY
(4) One aspect of the invention provides an automatic system for efficiently cleaning a die. The system includes an air blower for blowing air onto the die, a spraying device for spraying liquid onto the die, and a human machine interface for activating the air blower and the spraying device.
(5) Another aspect of the disclosure provides an automatic method for efficiently cleaning a die. The method includes activating an air blower and a spraying device using a human machine interface, blowing air onto the die with the activated air blower, and spraying liquid onto the die with the activated spraying device.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The drawings described herein are for illustrative purposes only of selected embodiments and are not intended to limit the scope of the present disclosure. The inventive concepts associated with the present disclosure will be more readily understood by reference to the following description in combination with the accompanying drawings wherein:
(2) FIG. **1** illustrates an example die, including an upper die half and a lower die half, which can be cleaned by the system and method of the present invention;
(3) FIG. **2** is a plan view of a system for cleaning the die according to a first example embodiment, wherein the system includes material handling arms;
(4) FIGS. **3** and **4** illustrate a process for cleaning the die using the system of the first example embodiment; and
(5) FIGS. **5-12** illustrate a system and process for cleaning the die according to a second example embodiment, wherein the system includes a conveyor.
DESCRIPTION OF EXAMPLE EMBODIMENTS
(6) Example embodiments will now be described more fully with reference to the accompanying drawings. However, the example embodiments are only provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail.

(7) One aspect of the invention provides an automatic system **10** for cleaning grease filled with metal slivers and other debris from a die **12**. An example of the die **12** is shown in FIG. **1** and includes an upper die half **14** and a lower die half **16**. The type of die **12** typically cleaned by the system **10** according to the invention is a die **12** which stamps, trims, or otherwise cuts metal. For example, the die **12** can be the type used to cut aluminum or steel sheets which form exterior vehicle body panels and thus should be free of dents and scratches which are oftentimes formed due to slivers on the die **12**. However, various other die designs can be cleaned by the system **10** of the present invention. The die **12** can be formed of steel or another material, typically a metal material.

(8) As indicated above, grease is typically applied to the die **12** prior to any cutting step to collect the slivers and other debris generated during the cutting step. However, another more environmentally friendly substance could be used to collect the slivers and debris instead of the grease. The grease and debris must be frequently washed and removed from the die **12**, to prevent the debris from creating dents and scratches on the metal sheets or other parts which are formed and/or cut in the die **12**.

(9) The system **10** used to clean the grease and debris from the die **12** according to a first example embodiment is shown in FIGS. **2**-**4**. The system **10** includes upper and lower die handling arms **18**, **20** for lifting, lowering, and conveying the upper die half **14** and lower die half **16** to multiple stations **22** used in the cleaning process. A crane operator can use a human machine interface on a panel to quickly turn on the system **10** and activate the die handling arms **18**, **20**. The system **10** can be controlled by the operator using the human machine interface. Once the system is active or turned on, the system **10** and method can run automatically. According to the first example embodiment, the system **10** includes a first station **22***a*, second station **22***b*, third station **22***c*, and fourth station **22***d*. The first station **22***a* is for loading and unloading of the die **12**. The second station **22***b* is for polishing the die **12**. The third station **22***c* includes an air blower **24** for blowing off loose debris prior to washing the die **12** and also drying the die **12** after washing. The fourth station **22***d* is includes a spraying device **26** for washing the die **12** with a cleaning solution and water.

(10) FIG. **3** illustrates the cleaning of the upper die half **14** according to the first example embodiment. The upper die half **14** begins at the first station **22***a* and the die handling arms **18**, **20** move the upper die half **14** to the third station **22***c* to blow out the loose slivers. Next, the die handling arms **18**, **20** move the upper die half **14** to the fourth station **22***d* to degrease, wash the upper die half **14** with a cleaning solution, and then rinse the upper die half **14** with water. An anti-rust spray can also be applied to the upper die half **14**, if desired. According to this embodiment, the air blower **24** and the spraying device **26** are located below the upper die half **14**. This arrangement is beneficial as it allows the debris and used cleaning solution and water to collect below the upper die half **14** for convenient removal. After rinsing at the fourth station **22***d*, the upper die half **14** is conveyed back to the third station **22***c* for drying by the air blower **24**. After drying, the upper die half **14** is conveyed to the second station **22***b* and inverted. At the second station **22***b*, the upper die half **14** is inspected to confirm the debris is removed and polished. Finally, grease is re-applied to the upper die half **14** in preparation for future forming, stamping, trimming, and/or other cutting steps.

(11) FIG. **4** illustrates the cleaning of the lower die half **16** according to the first example embodiment. After the upper die half **14** is processed, the handling arms **18**, **20** move the lower die half **16** from the first station **22***a* to the third station **22***c* and rotate the lower die half **16** 180 degrees. At the third station **22***c*, the air blower **24** blows the loose slivers and debris off the lower die half **16**. Next, the die handling arms **18**, **20** move the lower die half **16** to the fourth station **22***d* to degrease, wash the lower die half **16** with a cleaning solution, and then rinse the lower die half **16** with water. An anti-rust spray can also be applied to the lower die half **16** by the spraying device **26** if desired. According to this embodiment, the air blower **24** and the spraying device **26** are

located below the lower die half **16**. This arrangement is beneficial as it allows the debris and used cleaning solution and water to collect below the lower die half **16** for convenient removal. After rinsing at the fourth station **22***d*, the lower die half **16** is conveyed back to the third station **22***c* for drying by the air blower **24**. After drying, the lower die half **16** is conveyed to the first station **22***a* and inverted. At the first station **22***a*, the lower die half **16** is inspected to confirm the debris has been removed and polished. Grease is re-applied to the lower die half **16** in preparation for future forming, stamping, trimming, and/or other cutting steps. Finally, the upper die half **14** is conveyed from the second station **22***b* back to the first station **22***a* and placed on the lower die half **16**.

(12) The system **10** used to clean the grease and debris from the die **12** according to a second example embodiment is shown in FIGS. **5-8**. This system **10** can also run automatically; it can be activated and controlled by a single operator using the human machine interface. The system **10** includes a conveyor **28** for moving the upper die half **14** and lower die half **16** to multiple stations **22** used in the cleaning process. According to the second example embodiment, the system **10** includes a first station **22***a*, second station **22***b*, third station **22***c*, fourth station **22***d*, and a fifth station **22***e*. According to this embodiment, the upper die half **14** and the lower die half **16** can be processed simultaneously using multiple stations **22** at the same time.

(13) The first step of this second example embodiment is shown in FIG. **5**. During the first step, the upper and lower die halves **14**, **16** are loaded onto a platform at the first station **22***a*, for example by a crane. The crane then removes the upper die half **14** from the lower die half **16**, rotates the upper die half **14** 180 degrees, and places the upper die half **14** at the second station **22***b*.

(14) As shown in FIG. **6**, the second step of this example embodiment includes conveying the upper and lower die halves **14**, **16** using the conveyor **28** so that the upper die half **14** is located at the third station **22***c* and the lower die half **16** is located at the second station **22***b*. The third station **22***c* includes the air blower **24** for blowing off loose debris prior to washing the upper die half **14**. The system **10** includes roll up doors **30** around the third station **22***c* to keep debris within the third station **22***c* for easy removal. The roll up doors **30** can be formed of vinyl or steel. According to this embodiment, the air blower **24** can move horizontally along the length of the upper die half **14** to efficiently remove debris from the entire surface of the upper die half **14**. The air blower **24** can also move vertically toward and away from the upper die half **14**. Thus, the air blower **24** can accommodate dies **12** of various different sizes. The lower die half **16** remains idle at the second station **22***b* while the debris is removed from the upper die half **14** at the third station **22***c*.

(15) As shown in FIG. **7**, the third step includes conveying the upper die half **14** to the fourth station **22***d* and conveying the lower die half **16** to the third station **22***c*. During the third step, the debris is blow out of the lower die half **16** at the third station **22***c* while the upper die half **14** is washed at the fourth station **22***d*. The roll up doors **30** also surround the fourth station **22***d* to prevent waste water from escaping the fourth station **22***d*. According to this embodiment, the spraying device **26** can move horizontally along the length of the upper die half **14** to efficiently clean the entire surface of the upper die half **14**. The spraying device **26** can also move vertically toward and away from the upper die half **14**.

(16) As shown in FIG. **8**, the fourth step of this example embodiment includes conveying the upper die half **14** to the fifth station **22***e* while conveying the lower die half **16** to the fourth station **22***d*. The upper die half **14** remains idle at the fifth station **22***e* while the spraying device **26** cleans the lower die half **16** at the fourth station **22***d*.

(17) As shown in FIG. **9**, the fifth step includes conveying the lower die half **16** to the third station **22***c* while conveying the upper die half **14** to the fourth station **22***d*. The roll up doors **30** are raised and lowered when the die halves **14**, **16** travel in or out of the third station **22***c* and/or the fourth station **22***d*. The upper die half **14** remains idle at the fourth station **22***d* while the lower die half **16** is dried by the air blower **24**.

(18) The sixth step includes conveying the lower die half **16** to the second station **22***b* while conveying the upper die half **14** to the third station **22***c*, as shown in FIG. **10**. The lower die half **16**

remains idle at the second station **22***b* while the upper die half **14** is dried by the air blower **24**.
(19) The seventh step includes conveying the lower die half **16** to the first station **22***a* while conveying the upper die half **14** to the second station **22***b*, as shown in FIG. **11**. At the first station **22***a*, the lower die half **16** is inspected, polished, and repaired if needed. Grease is then re-applied to the lower die half **16** in preparation for future forming, stamping, trimming, and/or other cutting steps. While the lower die half **16** is being inspected, polished, repaired, and greased at the first station **22***a*, the upper die half **14** is inspected, polished, repaired, and greased at the second station **22***b*.
(20) As shown in FIG. **12**, the eighth step of this embodiment includes placing the upper die half **14** back on top of the lower die half **16**, and then removing the die **10** from the first station **22***a*. A crane can be used to move the upper die half **14** and remove the die **12**.
(21) The system **10** for cleaning the die **12** according to the example embodiments is able to reduce the time required to clean the grease filled slivers and debris from the die **10** by approximately 60%. According to conventional methods, it takes about 2.6 hours to clean the die **12**. The system **10** of the present disclosure, however, is capable of completing the entire cleaning process (loading, washing, inspecting, re-greasing, and unloading) in about an hour. The system **10** also requires about 50% less labor to clean the die **12**. Only a single crane operator is typically required to operate the system **10** according to embodiments.
(22) The design of the equipment used in the system **10**, including the air blower **24** and spraying device **26**, can vary. The system **10** variables can also vary.
(23) For example the air blower **24** can blow air to remove loose slivers and debris prior to the washing step, and also dry the die half **14** or **16** after the washing step. According to one embodiment, the air blower **24** blows the air at approximately 40,000 F.P.S. Electric or natural gas heat can be used to heat the air and also the water used in the spraying device **26**. The air blower **24** can be an Air Cannon and can provide the air in the form of an air knife or spiral. The air blower **24** typically moves linearly along the die half **14** or **16**. An intake could be placed in a pit below the die **12** to create a down draft in the system **10**. There should not be any standing water in pockets of the die half **14** or **16** after drying.
(24) The spraying device **26** typically sprays a degreaser onto the die half **14** or **16**. The type of degreaser, nozzle pattern (fan pattern, stream, or spiral), travel speed, volume required, distance from the die half, and soak time can be adjusted depending on the design of the die **12** and amount of grease. The spraying device **26** typically moves linearly along the die half **14** or **16** to apply the de-greaser.
(25) The spraying device **26** also typically sprays soap onto the die halves **14**, **16** for cleaning. The type of soap, quantity of water and soap, velocity, water temperature, nozzle pattern (fan patter, stream, or spiral), travel speed, and distance from the die half **14** or **16** can be adjusted.
(26) The parameters of the rinsing step to remove the soap and other debris can also be adjusted. The volume of water, water velocity, water temperature, nozzle pattern (fan patter, stream, or spiral), spray device travel speed, and spray device distance from the die half **14** or **16** can all be adjusted.
(27) The system **10** also includes waste management features in order to efficiently remove the used water and debris from the system **10**. For example, the system **10** can include a waste water evaporator, automatic tank clean-out, perimeter duct exhaust system, ultra-fine particle filtration, oil and grease skimmer, automatic pump shut down, low water safety shutdown, and an automatic water make-up to provide the water to the spraying device **26**.
(28) As indicated above, a significant advantage of the system **10** and method of the present invention is that it is automatic. The system **10** can be programmed and controlled using a human machine interface. The air blowing conducted by the air blower **24** and the washing cycle conducted by the spraying device **26** can be programmed to the most efficient parameters for the specific die **12** being cleaned. Thus, the parameters are adjusted appropriately for dies **12** of

different designs. The system **10** can also be activated by a single operator pushing a button on the human machine interface. Thus, system **10** and method can successfully clean the dies **12** without the extensive labor and time required by comparative systems and methods used to clean such dies **12**.

(29) It should be appreciated that the foregoing description of the embodiments has been provided for purposes of illustration. In other words, the subject disclosure it is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varies in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of disclosure.

Claims

1. A system for cleaning a die, comprising: an air blower for blowing air onto the die, a spraying device for spraying liquid onto the die, a human machine interface for activating the air blower and the spraying device, a first station for loading and unloading the die, a second station for polishing or holding the die, a third station including the air blower, a fourth station including the spraying device, and doors surrounding the third station to prevent debris from escaping the third station, and doors surrounding the fourth station to prevent waste water from escaping the fourth station, the doors being capable of rolling up and down.
2. The system of claim 1 including a fifth station for holding the die.
3. The system of claim 1 including an upper handling arm and a lower handling arm for conveying the die to the stations, the upper and lower handling arms being activated by the human machine interface.
4. The system of claim 1 including a conveyor for conveying the die to the stations, the conveyor being activated by the human machine interface.
5. The system of claim 1 including a waste management system for removal of used water and debris.
6. The system of claim 1, wherein the air blower is movable horizontally and vertically to accommodate various sizes of dies, and the spraying device is movable horizontally and vertically to accommodate various sizes of dies.
7. The system of claim 1, wherein the system is capable of running automatically after being activated by the human machine interface.
8. The system of claim 1, wherein the die includes an upper die half and a lower die half, the system further comprising: an upper handling arm and a lower handling arm for conveying the upper die half and the lower die half to a plurality of stations, the upper and lower handling arms being activated by the human machine interface, and a waste management system for removal of used water and debris, and wherein the system is capable of running automatically after being activated by the human machine interface.
9. A system for cleaning a die, comprising: an air blower for blowing air onto the die, a spraying device for spraying liquid onto the die, a human machine interface for activating the air blower and the spraying device, wherein the die includes an upper die half and a lower die half, the air blower is movable horizontally and vertically to accommodate various sizes of dies, the spraying device is movable horizontally and vertically to accommodate various sizes of dies, the system further comprising: a conveyor for conveying the upper die half and the lower die half to a plurality of stations, the conveyor being activated by the human machine interface, the plurality of stations including a first station for loading and unloading the upper die half and the lower die half, a second station for holding and/or polishing the upper die half and the lower die half, a third station including the air blower for blowing loose debris off the upper die half and the lower die half prior

to washing and for drying the upper die half and the lower die half, a fourth station including the spraying device for washing the upper die half and the lower die half, and a fifth station for holding the upper die half and the lower die half, doors surrounding the third station to prevent debris from escaping the third station, the doors being capable of rolling up and down, doors surrounding the fourth station to prevent waste water from escaping the fourth station, the doors being capable of rolling up and down, a waste management system for removal of used water and debris, and wherein the system is capable of running automatically after being activated by the human machine interface.

10. The system of claim 1, wherein the plurality of stations are disposed consecutively in a straight line.

11. The system of claim 10, wherein the system includes die handling arms for moving the die from one of the stations to another one of the stations, and the human machine interface is disposed on a panel such that an operator can activate the die handling arms via the panel.

12. The system of claim 1, wherein the plurality of stations are disposed consecutively in a straight line, and the plurality of stations include a fifth station following the fourth station, wherein the fifth station is for holding the die.

13. The system of claim 12, wherein the system includes a conveyor for conveying the die from one of the stations to another one of the stations, and the human machine interface is disposed on a panel such that an operator can activate the conveyor via the panel.