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(11) **EP 1 108 478 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.06.2001 Bulletin 2001/25

(51) Int Cl.7: **B05D 1/00**, B05B 13/00,
B05C 9/08

(21) Application number: **00309235.0**

(22) Date of filing: **20.10.2000**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**
Designated Extension States:
AL LT LV MK RO SI

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(30) Priority: **14.12.1999 US 460761**

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(54) **Method and apparatus for painting automobile components**

(57) An apparatus 10 for painting automobile components. Apparatus 10 includes a preliminary washing station 12, an adhesion promoter or primer coating station 14, a base coating station 16, a clear coating station 18, and an oven 20. Stations 12, 14, 16 and 18 each include several of independently operable and adjacent cells 64-70, 26, 34, and 42. Each conveyor assembly 22 traverses a respective and unique one of each of the independently operable painting cells 64-70, 26, 34, and 42.

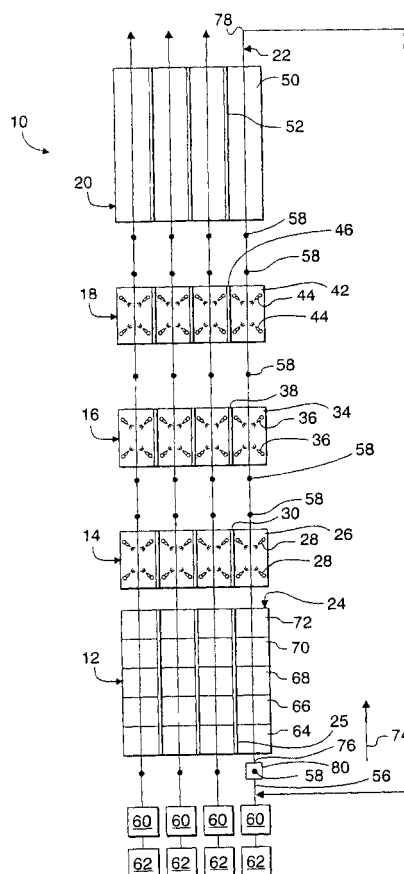


Fig. 1

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Description

(1) FIELD OF THE INVENTION

[0001] This invention relates to a method and an apparatus for painting vehicle components and more particularly, to a method and an apparatus which allows a variety of vehicle components to be simultaneously and/or independently painted and which further allows a variety of different types and colors of paint to be simultaneously, selectively, and/or independently applied to the vehicle components.

(2) BACKGROUND OF THE INVENTION

[0002] Vehicle interior and exterior components, such as bodies, fascias, bumpers, grilles, spoilers, mirrors, door handles, instrument panels, door trim panels, and body side and interior moldings are typically painted in an "assembly line" or "serial" type manner in which each component is placed and/or positioned upon a selectively movable conveyor, or other type of automated device, and made to sequentially traverse or move through a series of "stations" or "booths". The stations and/or booths cooperate to cause each component to be painted according to a certain singular painting process.

[0003] Many of these stations or booths generally include several manual (e.g., hand-held "spray guns") and/or automated (e.g., computer and/or robotic controlled) paint applicators which are typically arranged in a pair of opposed rows. Each of the components typically and sequentially move between each of the respective pairs of applicator rows in each of the stations or booths. The applicators, within each of the stations or booths, cooperatively coat each of the respectively received components with paint or other substances and/or materials, in accordance with a stored program or a manual spray pattern. Typically, each station or booth includes about ten to about sixteen applicators, arranged in two equal and opposed rows. Hence, each of the rows typically contains about five to eight applicators.

[0004] While many different types of vehicle component paint processes exist, each station or booth usually and generally performs a unique portion or a "stage" of whatever component painting process is being employed. Particularly, as the components travel through each station or booth they are subject to various parts and/or portions of the overall painting process. Typically, the conveyor travels at a speed of about twenty feet per minute and conventional painting systems have an average output or "through-put" of about four properly painted vehicle components per minute. While these prior vehicle component painting systems adequately paint vehicle components, they suffer from several drawbacks.

[0005] It is relatively difficult to quickly or dynamically change the type or color of the paint, or the automated

paint spray pattern, in these conventional painting systems. For example, each time that a new color or type of paint is to be used, the applicators and the associated devices and/or equipment (e.g., the paint supply hoses which communicate paint to the applicators), must be fully cleaned or "flushed" in order to substantially prevent the undesired mixing of different types and/or colors of paint. This "flushing" is very time consuming, relatively costly, and requires the use of additional and relatively toxic flushing solvents. Such flushing also undesirably interrupts the entire painting process since the paint system cannot be used as it is flushed. Similarly, the paint system cannot be used as the computer and/or robotic applicators are modified to paint a new type of component requiring a different paint or spray pattern.

[0006] In order to increase painting efficiency and to reduce the amount of required flushing or spray pattern changes, relatively large sets or groups of components are typically painted (e.g., each set or group containing substantially identical components), thereby requiring large paint inventories and undesirably increasing component inventory and storage costs.

[0007] Moreover, since these prior paint systems utilize only a single conveyor operating in a sequential and serial manner, "substantially" any malfunction or "fault" in any of the painting components will typically cause the entire system or painting production line to "shut down" until that problem or malfunction is corrected. These prior vehicle component painting systems are therefore not substantially "fault tolerant" (e.g., operable even if parts of the system fail). Additionally, preventative or "scheduled" maintenance also causes the entire sequential and/or serial system to be inoperative. Accordingly, much of the preventative type maintenance, which is required to be performed upon these prior paint systems, is not done or is done well after it was due to be done.

[0008] There is therefore a need for a method and an apparatus for painting vehicle components which overcomes at least some of the various and previously delineated drawbacks of the prior systems; which utilizes multiple independently operable conveyors; which selectively allows different colors and/or types of paint to be simultaneously and independently utilized; which allows different types of vehicle components to be independently and simultaneously painted; which allows different components of different colors to be substantially, simultaneously, and independently produced; which continues to operate even after a fault or malfunction occurs within part of the assembly; and which allows portions of the painting system to be maintained and/or repaired without requiring the entire system to cease operation and/or become inoperative.

SUMMARY OF THE INVENTION

[0009] It is a first object of the invention to provide a method and an apparatus for selectively painting vehicle

components which overcome at least some of the previously delineated drawbacks of prior painting systems.

[0010] It is a second object of the invention to provide a method and an apparatus which allow vehicle components to be selectively painted in a parallel fashion.

[0011] It is a third object of the invention to provide a method and an apparatus which include multiple and independently operable stations and booths which are used to selectively paint multiple types of vehicle components.

[0012] It is a fourth object of the invention to provide a method and an apparatus for painting vehicle components and which allows vehicle components of a variety of colors to be selectively, substantially, simultaneously, and independently produced.

[0013] It is a fifth object of the present invention to provide a method and an apparatus or system for painting vehicle components which allow portions of the apparatus or system to be maintained, adjusted, and/or repaired while simultaneously allowing vehicle components to be selectively painted.

[0014] According to a first aspect of the present invention, an apparatus for selectively painting vehicle components is provided. The apparatus includes a first and a second group of stations which respectively cooperate to paint vehicle components. The apparatus further includes a first conveyor which receives a first vehicle component and which selectively transports the first vehicle component through the first group of stations; and a second conveyor which receives a second vehicle component and which selectively transports the second vehicle component through the second group of stations, thereby allowing the first and second vehicle components to be substantially and simultaneously painted.

[0015] According to a second aspect of the present invention, a method to paint vehicle components is provided. The method includes the steps of providing at least one painting booth having several independently operable painting cells; providing several independently operable conveyor assemblies, each of the conveyor assemblies traversing a unique one of the painting cells; removably attaching at least one of the automobile components to a unique one of the conveyor assemblies; and selectively moving the at least one of the automobile components through one of the independently operable painting cells, thereby causing the at least one automobile component to be painted.

[0016] These and other objects, aspects, features, and advantages of the present invention will become apparent from a consideration of the following specification and the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Figure 1 is a block diagram of a vehicle component painting assembly which is made in accordance with the teachings of the preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

[0018] Referring now to Figure 1, there is shown a vehicle component painting assembly 10 which is made in accordance with the teachings of the preferred embodiment of the invention. As shown, system 10 includes a preliminary or initial washing booth or station 12, an adhesion promoter or primer coating booth or station 14, a base coating booth or station 16, a clear coating booth or station 18, a paint drying or "setting" station or oven 20 and four independently operable and substantially identical conveyor assemblies 22 which traverse stations or booths 12, 14, 16, 18, and 20. It should be realized that each station or booth 12-20 is independently operated with respect to the other stations or booths 12-20 and that while four such conveyor assemblies 22 are shown, different numbers of conveyor assemblies 22 may be selectively used by system 10. Moreover, it should be realized that while one type of painting process is described and illustrated within Figure 1, the invention is equally applicable to other types of dissimilar painting processes, thereby requiring different types and/or numbers of stations or booths 12-20.

[0019] In the preferred embodiment of the invention, each of the conveyors 22, by use of conventional carriers 58, selectively transports components 80 through unique portions of each of the stations or booths 12, 14, 16, 18, and 20. Hence, each conveyor assembly 22 respectively transports components 80 through a single and unique painting process. The four conveyor assemblies 22 therefore allow four independent painting processes to be accomplished in a substantially independent and simultaneous manner. While the following discussion illustrates and describes one overall type of painting process cooperatively performed by one independently operable portion of each station or booth 12-20 (e.g., each of the four independent painting processes are substantially identical), it should be realized that the discussion is equally applicable to the other independently operable portions of the booths or stations 12-20.

[0020] Washing station 12 comprises four independently operable, substantially identical, and conventional, vehicle component washing assemblies or compartments 24. As shown, a wall or divider 25 separates each adjacent assembly 24. Further, each assembly 24 receives vehicle components 80 from a unique one of the conveyor assemblies 22. As is further shown, each compartment or assembly 24 includes, in this non-limiting embodiment, five areas or portions 64 - 72 which correspond to and which perform different functions and/or washing "actions" which are required by the overall initial washing cycle or operation and which are more fully delineated below.

[0021] Particularly, a component 80 is initially received by portion 64 of a component receiving assembly 24 and, in portion 64, the received component 80 is se-

lectively sprayed with conventional and commercially available de-ionized water. The sprayed water is filtered, re-circulated, and re-used by system or apparatus 10. The conveyor 22 then causes the sprayed component 80 to enter portion 66 of the component receiving assembly 24. In portion 66, the received component 80 is placed into a conventional and commercially available chemical bath, including conventional and commercially available acidic and/or basic cleaning compounds. The conveyor 22 then transports component 80 to portion 68 of the component receiving assembly 24 where the component 80 is selectively rinsed with the re-circulated de-ionized water which was used within the portion 64. The conveyor 22 then transports the component 80 to the portion 70 of the component receiving assembly 24, where the component 80 is rinsed with conventional and commercially available de-ionized water which has not been previously re-circulated. The conveyor 22 then transports the component 80 to portion 72 of the component receiving assembly 24, where the component 80 is dried by the use of a commercially available and conventional hot air or gas blower.

[0022] It should be realized that each portion 64-72 of each initial washing compartment 24 operates independently. Further, while one washer station or booth 12 having four substantially identical and independently operable compartments 24 is shown, other types and numbers of washers may be used and other washers having different numbers of compartments 24 (and respective areas or portions 64-72) may be used by system 10.

[0023] After component 80 exits station 12, conveyor 22 causes the exiting component 80 to enter a unique one of the cells or portions 36 of priming station 14 where a primer coat of paint is applied to the component 80. The conveyor 22 then causes the "primed" component 80 to selectively enter a unique one of the cells or portions 34 of station 16 where a base coat of paint is applied. The conveyor 22 then causes the component 80 to enter a unique one of the cells of station 18 where a conventional "clear coat" type of finish material is applied to the component 80. Finally, the conveyor 22 causes the component 80 to enter a unique one of the ovens 50 of station 20 where the component 80 is dried and the applied material secured to the component 80. In this manner, stations or booths 12-20 cooperate to produce components 80 which are selectively painted according to a desired painting process. Stations 14-20 are further described below.

[0024] As shown, priming station or portion 14, in this non-limiting embodiment, includes four substantially identical and independently operating "parallel" or adjacent cells 26 which are each separated by a wall or divider 30. In one non-limiting embodiment, each wall or divider 30 comprises a conventional and commercially available "silhouette" divider or any other suitable divider for substantially preventing the transfer or exchange of paint between cells or portions 36.

[0025] Each cell 26 includes, in one non-limiting embodiment, four conventional, substantially identical, and commercially available robotic paint applicators or robots 28 which operate under stored program control and which are cooperatively adapted to selectively apply a "complete" and/or entire coat of conventional and commercially available primer or an "adhesion promoter" substance to the automotive components 80 passing through or selectively traversing each cell 26. Particularly, as shown, the robots 28 are arranged in two opposed and substantially equal rows. Each cell 26 (e.g., the robots 28 contained in each of the cells 26) operates independently of the other cells 26 (e.g., independently of the robots 28 contained in the other cells). Hence, the robots 28 within one of the cells 26 may be selectively and separately stopped, repaired, programmed, and/or adjusted without adversely affecting the operability of any of the other cells 26.

[0026] As shown, station 16 includes four substantially identical, independently operating "parallel" or adjacent cells 34. Each cell 34 is separated by a conventional wall or divider 38 and each cell 34 contains four robotic paint applicators or robots 36. In one non-limiting embodiment, station 16 is substantially identical to station 14 with the exception that robots 36 are designed and programmed to selectively apply a complete base coat of paint to automobile components 80 passing through each cell 34.

[0027] As shown, station 18 includes four substantially identical independently operating "parallel" or adjacent cells 42, each separated by a divider 46 and each containing four robots 44. Station 18 is, in one non-limiting embodiment, identical to stations 14, 16 and their respective components with the exception that robots 44 are designed and programmed to apply a complete conventional clear coating to the respective automobile components 80 which traverse or which pass through each cell 42. In other alternate embodiments robots 28, 36, and 44 are replaced with manually operated spray guns, or with a combination of robotic applicators and manually operated spray guns.

[0028] As shown, oven 20 is a convection oven having four adjacent and independently operable chambers or compartments 50. Each compartment or chamber 50 is separated by a substantially thermally resistant wall or divider 52. The walls/dividers 52 allow each of chambers 50 to selectively maintain a desired and independently programmable temperature.

[0029] Conveyors 22 are substantially identical, conventional, and commercially available "industrial grade" conveyors. Conveyors 22 each include a belt or "line" 56 upon which a plurality of substantially identical and equally spaced carriers 58 are attached. In one non-limiting embodiment, carriers 58 are separated by a distance of about four feet to about seven feet, although other spacings may be utilized. Particularly, carriers 58 are adapted to selectively attach, secure, and carry automobile components 80 by use of a mechanical or mag-

netic attachment apparatus (not shown). Belt 56 is driven by a conventional driver or motor 60. Moreover, motor or driver 60 is operated by use of a conventional external programmable type controller 62.

[0030] Each conveyor line 56 selectively traverses a unique one of the cells 26, 34, 42 in each station 14, 16, 18 and a unique one of compartments 50. Each controller 62 is adapted to selectively cause drivers 60 to move lines 56 in the direction of arrow 74 at a certain rate or speed, thereby causing carriers 58 to move from position 76 toward position 78 and to selectively traverse cells 26, 34 and 42 and compartments 50. After traversing stations 14, 16, 18 and oven 20, each line circles or revolves back to position 76.

[0031] In operation, automobile components 80 which are desired to be painted are attached to carriers 58. Drivers 60 are activated by way of controllers 62 and cause lines 56 to selectively move in the direction of arrow 74, thereby transporting carriers 58 from position 76 toward position 78. In the preferred embodiment of the invention, drivers 60 move carriers 58 at the rate of approximately 5-8 feet per minute. Particularly, each automobile component carrying carrier 58 traverses or passes through a unique one of the compartments 24 of the washing station 12; a unique one of cells 26 of priming station 14; a unique one of cells 34 of base coating station 16; and a unique one of cells 42 of clear coating station 18. As carriers 58 traverse each respective cell 26, 34, 42, the robotic paint applicators 28, 36 and 44 apply coatings in accordance with a predetermined, stored program. Particularly, the paint is applied according to the type, size, and shape of the component 80 desired to be painted and the color and type of the paint being used. It should be recognized that the independently operable adjacent cell groups 26, 34, 42, allow different types of components or colors to be painted simultaneously, and that vehicle component painting may be selectively accomplished in a parallel manner. For example and without limitation, system 10 may be used to substantially paint at least four different sets or types of components 80, with each cell of each station 12-20 being programmed to paint one particular type of component (e.g., each conveyor 22 transporting components 80 through a unique painting process utilizing a certain selected color and/or type of paint and having a spray pattern required by a unique type of component (e.g., body).

[0032] System 10 may also be used to paint four different sets or groups of components in different colors, with each adjacent cell corresponding to a different color. Adjacent cells may also be arranged by customer, by substrate type, by paint color or color family (e.g., light metallics), by paint type, by required oven temperature, by required painting speed, or by type of component (e.g., interior, exterior).

[0033] When the automotive components 80, attached to the carriers 58, reach point 78, the applied paint has been dried, and the components 80 are re-

moved and are ready for use in further assembly processes. Once the components 80 have been removed, the carriers 58 are revolved or returned by driver 60 where new components 80 are attached.

[0034] System 10 provides significant advantages over conventional painting systems of the prior art. Particularly, unlike prior painting systems, booths or stations 12, 14, 16, 18, or 20 each include a plurality of adjacent and independently operable and programmable cells 64-72, 26, 34, and 42. This arrangement allows system 10 to paint several different component types or models simultaneously and/or allows system 10 to utilize several different paint colors simultaneously. Furthermore, certain cell groupings can be assigned or "devoted" to certain paint colors or color families, thereby making color changes in system 10 less time consuming, less costly, and more efficient. Specifically, color changes can be made on a cell by cell basis, which requires only four robots or spray guns to be flushed and re-filled as opposed to the systems of the prior art which typically require sixteen applicators to be flushed per booth. This also allows the size of paint batches to be smaller thereby reducing inventory and inventory-related costs, and further allows component types and colors to be produced in smaller groups or sets, which provides for more close and flexible responses to changing consumer demands.

[0035] The independently operable "parallel" cell arrangement of system 10 also allows for the activation and deactivation of only certain cells. This allows system 10 to run at either full or partial capacity as customer demand increases and decreases, thereby offering improved efficiency. Importantly, the arrangement of system 10 allows maintenance and repairs to be performed on individual cells or conveyors while the balance of cells continue to function and produce, thus maximizing system "uptime" and efficiency.

[0036] Unlike prior systems, conveyors 22 of system 10 operate at a significantly slower speed or rate (e.g., 5-8 feet per minute). While the conveyor speed of system 10 is significantly slower than prior systems, a substantially identical output or "through-put" is achieved (e.g., 4 conveyor lines x 5 feet/minute x 1 carrier/5 feet = 4 carriers per minute for system 10, which is equal to 1 conveyor line x 20 feet/minute x 1 carrier/5 feet for a typical system of the prior art). Furthermore, the reduced speed of the components 80 through the painting stations allows robotic applicators to be timed more closely to the moving lines and allows manual hand sprayers additional time to spray the components 80 more precisely, thereby allowing paint delivery volume changes and spray pattern changes to be performed more precisely on the components 80 being painted.

[0037] It should be understood that Applicants' invention is not limited to the exact painting system 10 illustrated in Figure 1, but that various changes and/or modifications may be made without departing from the spirit and/or the scope of Applicants' invention. For example,

in other embodiments of Applicants' invention, rather than utilizing a single station having multiple adjacent cells, multiple adjacent stations are used (e.g., two adjacent stations each having two cells and a divider, or four adjacent stations each having one cell). Applicants' invention may also be modularly expanded by creating additional painting cells each having an associated conveyor. In one alternate embodiment, the number of robotic paint applicators per cell is dependent on the speed of driver 60 and the geometry and complexity of the components being painted. In other alternate embodiments, system 10 may include more or less cells per station or booth and/or more or less stations or booths.

Claims

1. An assembly which receives a plurality of vehicle components and which comprises a first portion which paints a first of said plurality of vehicle components according to a first painting process and a second portion which paints a second of said plurality of vehicle components according to a second painting process while said first of said plurality of vehicle components is being painted.
2. The painting assembly of claim 1 wherein said first portion paints said first of said plurality of vehicle components with a first color and wherein said second portion paints said second of said plurality of vehicle components with a second color.
3. The painting assembly of claim 1 wherein said first of said plurality of vehicle components and said second of said plurality of vehicle components are substantially and simultaneously painted.
4. The painting assembly of claim 1 wherein said first of said plurality of vehicle components is of a first type and wherein said second of said plurality of vehicle components is of a second type.
5. The assembly of claim 1 wherein said first portion includes at least one applicator and at least one oven.
6. The assembly of claim 5 wherein said second portion is substantially identical to said first portion.
7. The painting assembly of claim 1 wherein said first portion paints said first of said plurality of vehicle components with a first color and wherein said second portion paints said second of said plurality of vehicle components with said first color.
8. The painting assembly of claim 1 wherein said first of said plurality of vehicle components comprises a

body.

9. A system for painting vehicle components, said system comprising:

at least one station having a plurality of independently operable painting cells, each of said painting cells having a plurality of paint applicators which selectively eject paint; and a plurality of conveyor assemblies, each of said plurality of conveyor assemblies traversing a unique one of said painting cells and selectively and cooperatively transporting at least one of said automobile components through each of said painting cells, thereby causing said paint to be selectively applied to said automobile components.

10. The system of claim 9 wherein said painting cells apply a primer coating to said automobile components.
The system of claim 9 wherein said painting cells apply a base coating to said automobile components.

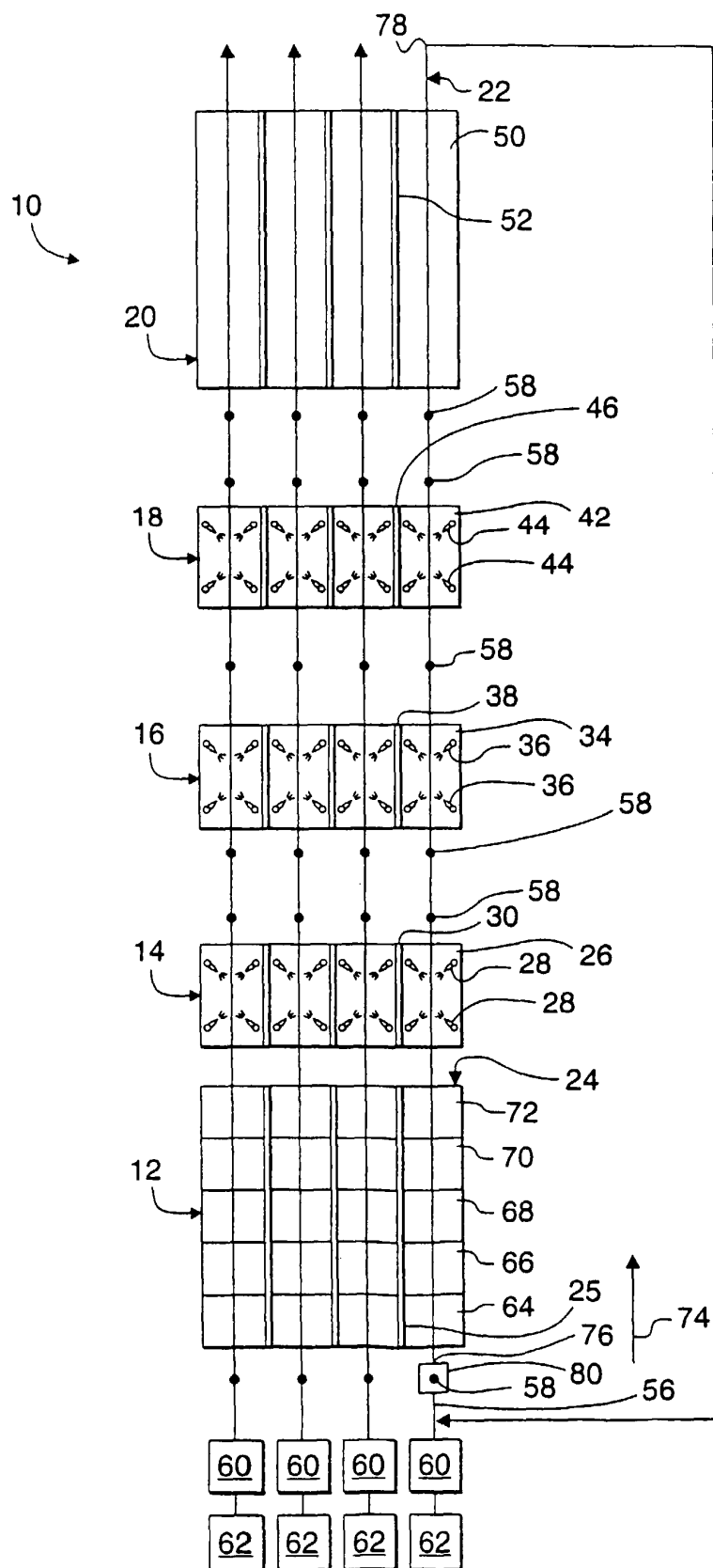


Fig. 1