

March 1, 1966

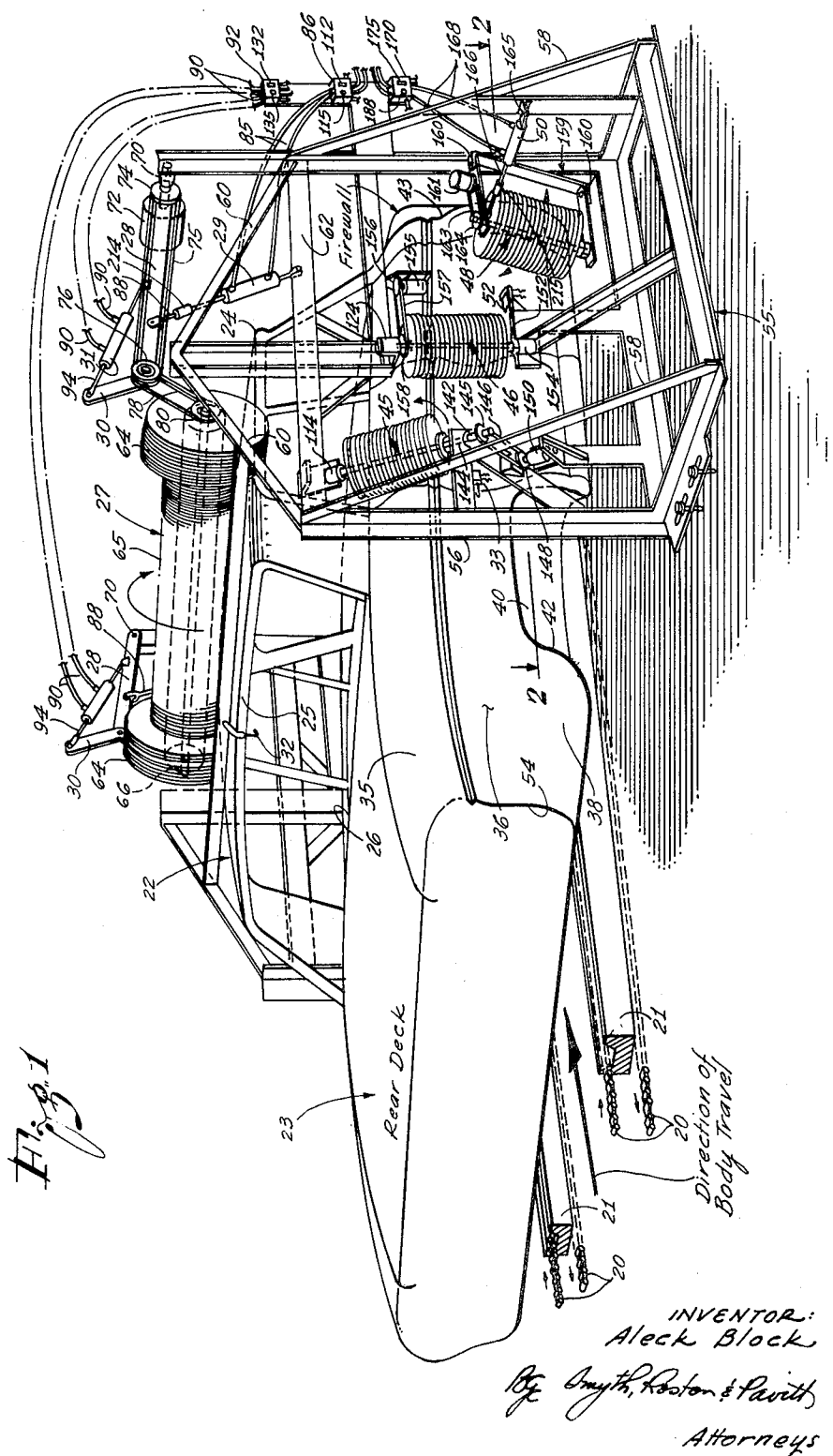
A. BLOCK

3,237,348

ABRASIVE APPARATUS

Filed July 25, 1962

4 Sheets-Sheet 1



March 1, 1966

A. BLOCK

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ABRASIVE APPARATUS

Filed July 25, 1962

4 Sheets-Sheet 2

Fig. 2

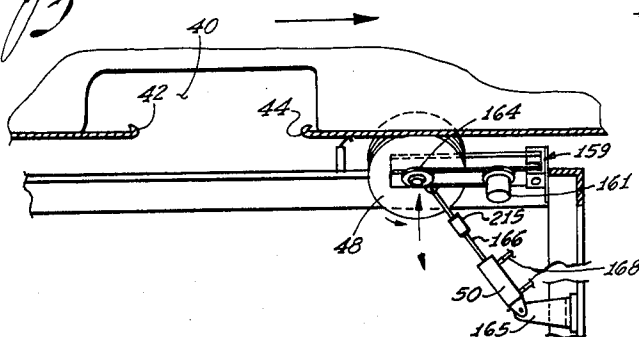


Fig. 14

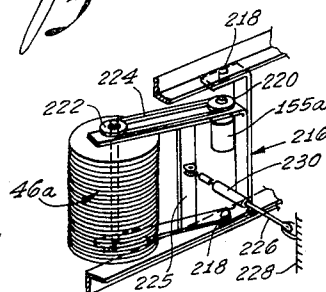


Fig. 3

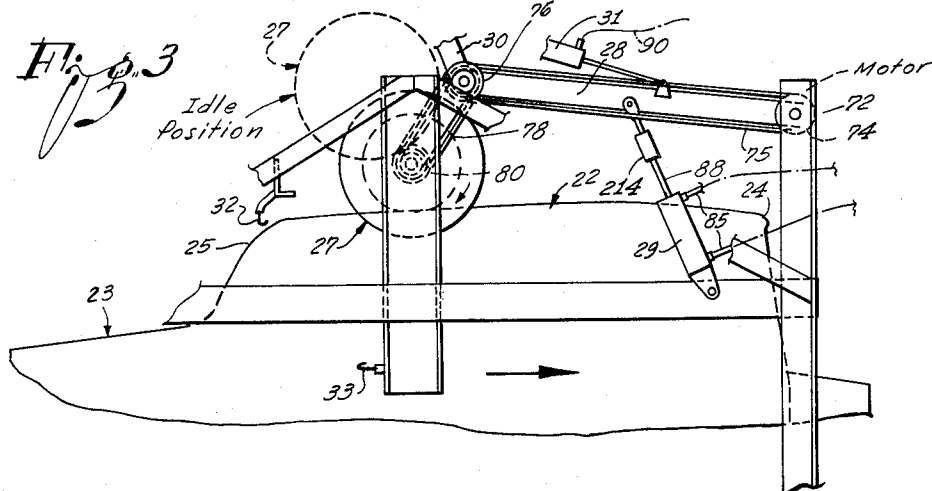


Fig. 4

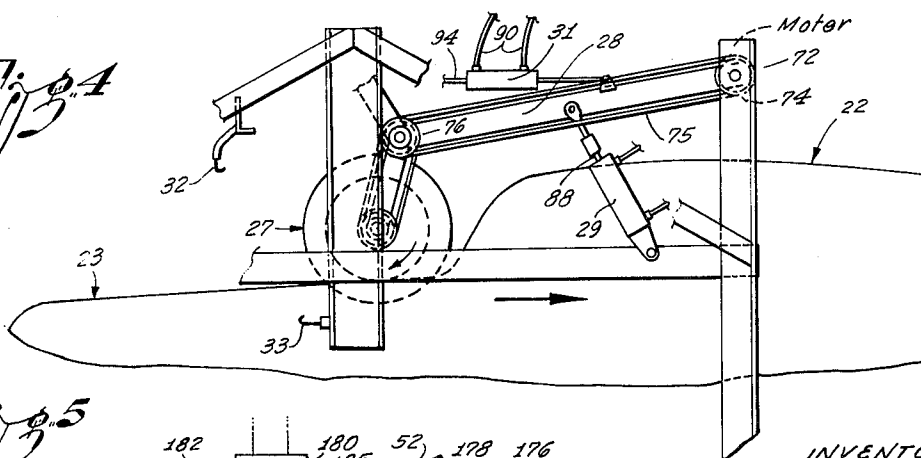
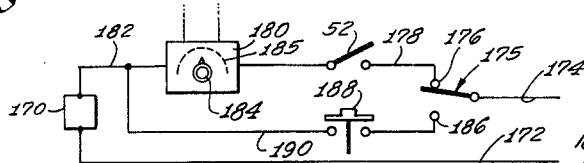


Fig. 5



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Fig. 6

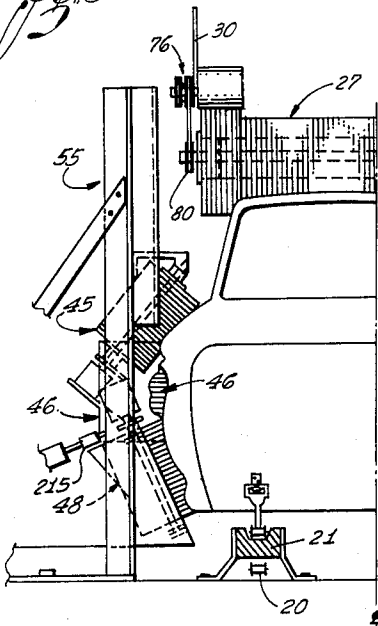


Fig. 7

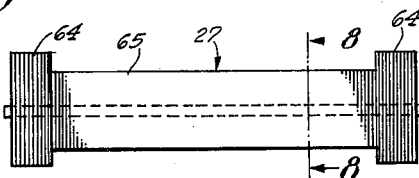


Fig. 8

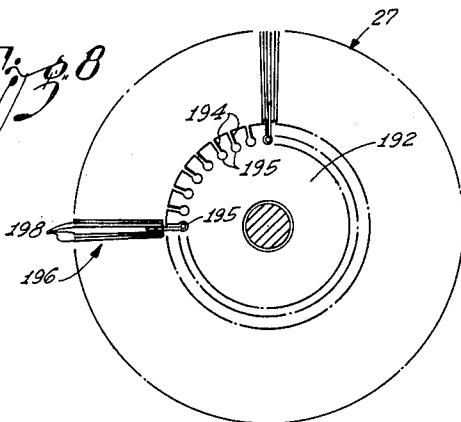


Fig. 9

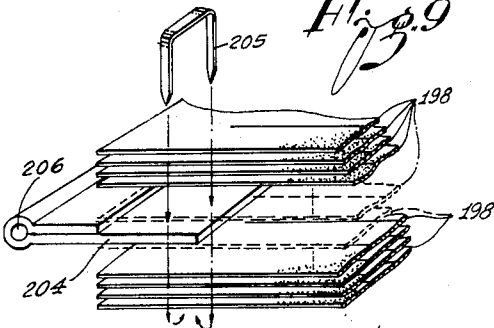


Fig. 10

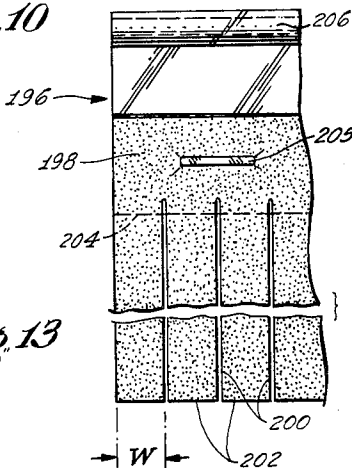


Fig. 11



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Fig. 12

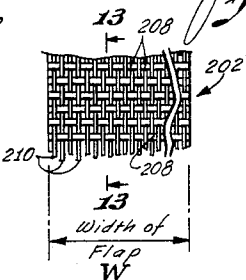
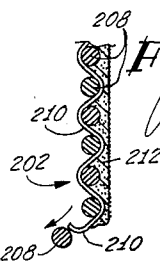


Fig. 13



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ABRASIVE APPARATUS

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20 Claims. (Cl. 51-74)

This invention relates to an apparatus for abrasively treating the surfaces of a series of vehicle bodies such as automobile bodies as they progress along an assembly line.

In the processing of the surface of an automobile body, it is desirable for a number of reasons to sand the bare metal before painting. In the first place, a lead constituent of the sheet metal alloy usually comes to the surface in the form of minute exudations in the course of the sheet-rolling operation and these surface impurities must be removed because they prevent adhesion of paint to the metal. In the second place, the bare metal has numerous superficial scratches and nicks that are readily removed by relatively light sanding. In the third place there are inevitably deeper scratches and dents which must be corrected by special treatment prior to the painting operation but the bare metal is so dull that these defects are difficult to detect. Preliminary sanding of the bare metal polishes the metal to highlight these deeper defects for easy detection. Number 80 grit abrasive has been found to be highly satisfactory for this purpose.

After the prime coat is applied a second sanding operation is desirable. In this second operation, the prime coat is wet-sanded in preparation for the final color coats.

Heretofore both of these sanding operations have been performed by hand in a slow and costly manner. The object of the present invention is to provide an apparatus to carry out the sanding operations mechanically and automatically as the automobile bodies are conveyed along the assembly line.

A basic requirement for carrying out this object is the provision for some kind of abrasive means to conform to the contour of an automobile body. This requirement involves two problems, first, to provide an abrasive means which will conform to a given cross sectional configuration of complex curvature and second, to provide such an abrasive means that is capable of following changes in cross section as the automobile body progresses past the abrasive means.

It has been found that both of these problems may be solved by using a flap-type abrasive drum having numerous radially extending flexible abrasive fingers or narrow leaves coated with abrasive particles for processing surfaces by both rubbing action and slapping action. Where an automobile surface is relatively flat and approximately parallel to the axis of such an abrasive drum, the abrasive fingers slap flat against the surface. A surface that is at substantial spacing from the drum axis is processed solely by the tip portions of the abrasive fingers but closer surfaces are processed by more extensive portions of the abrasive fingers. Where the automobile surface is inclined laterally at a steep angle relative to the drum axis the abrasive fingers accommodate themselves to the configuration by making edgewise impact with the inclined surface.

Such an abrasive drum may be constructed to conform to a complex cross sectional configuration of an automobile by varying the lengths of the abrasive fingers or leaves in accord with the distances from the drum axis of the portions of the automobile surface that correspond to the fingers. Thus to process a longitudinal portion of an automobile surface that is spaced relatively far from the drum axis or is inclined over a range of radial distances,

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the corresponding longitudinal segment of the drum is provided with relatively long abrasive fingers. The abrasive drum readily follows the longitudinal contour of an automobile body because with the radial abrasive fingers long enough to reach a surface of maximum distance from the drum axis the drum readily yields radially inward to process a surface of minimum distance from the drum axis.

A further problem arises in that the slapping action of the flexible leaves directly against an edge of a sheet metal object abrades the edge too severely and in addition causes the abrasive leaves to wear excessively. Thus if the travel of the periphery of the abrasive drum in contact with an automobile body is contrary to the direction of conveyance of the body, the drum adversely affects the leading edges of the sheet metal and, on the other hand, if the direction of rotation of the drum is in the same direction as the travel of the automobile body, the drum adversely affects the trailing edges. This problem of what may be termed "edge-on abrasion" is met in the present invention by retracting the abrasive drum to an ineffective position when such a vulnerable edge reaches the drum. Thus, where the sides of an automobile body are cut away for the wheels, leading and trailing sheet metal edges are exposed and the abrasive drum is retracted in the region of whichever of these two edges is vulnerable by virtue of the direction of rotation of the abrasive drum.

The top of a passenger automobile body also has leading and trailing sheet metal edges, the leading edge being at the forward window opening in which the windshield is to be mounted and the trailing edge being at the rear opening where the rear window is to be installed. An overhead abrasive drum for processing the upper surface of an automobile body must be retractible to an uppermost idle position clearing the car tops and must be movable between a first operating position for processing the car tops and a second lower position for processing the rear decks or trunk portions of the car. The movement of the overhead abrasive drum into its two operating positions must be timed and controlled to avoid slapping action against leading edges for reasons heretofore discussed.

An abrasive drum at the side of the assembly line in alignment with the wheel openings of the successive automobile bodies must also extend and retract. In this instance the retraction is to avoid excessive abrasion at either a leading edge or a trailing edge of the wheel opening according to the direction of rotation of the abrasive drum.

For complete automation in the operation of such extensible and retractible drums, some type of detecting means must be provided to sense the passing surfaces of the successive automobile bodies for synchronized extension and retraction of the drums. Certain difficulties arise, however, if an attempt is made to place such a sensing means in the same region as the drum that it controls. The invention teaches that these difficulties may be avoided by placing the sensing means in advance of the corresponding abrasive drum and by providing an adjustable timer to delay the response of the abrasive drum to the sensing means. With the automobile body traveling at a constant speed along the assembly line, it is a simple matter to adjust the timer to synchronize the advance and retraction of the associated abrasive drum with the movement of the bodies. An overriding manual control is available for use when necessary.

The invention also teaches that in processing the side surfaces of the automobile bodies, advantage may be taken of the fact that the two sides of an automobile body are symmetrical. The side surfaces are processed at two different stations spaced longitudinally along the assembly line. At one station the right hand side of a car body is sanded under the control of sensing means that

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contacts the left hand side of the car body. At the second station the arrangement is reversed, the left hand side of the car being sanded under the control of sensing means that contacts the right hand side of the car. In addition, the invention teaches that the overhead abrasive drum which processes the upper surfaces of the car may be controlled by a pair of sensing means, one contacting the top surface of the car, the other contacting a side surface of the car just below the level of the hood.

A further problem arises in that in the operation of a flap-type abrasive drum for this purpose, it has been found that the abrasive particles become worn and dislodged at the tip portions of the flexible fingers where the slapping action occurs. For this reason, a flap-type abrasive drum loses efficiency after a period of use, because bare flap tips instead of abrasively coated flap tips act on a surface that is under process. Efficiency may be restored by severing the worn tips of the abrasive fingers to expose fresh abrasive in the outer end regions of the fingers where the slapping action occurs, but, unfortunately, it is not feasible to take time out frequently for this purpose on an assembly line.

The invention meets this last problem by providing for automatic progressive disintegration of the tips of the leaves of the abrasive drum as the tips progressively lose their effectiveness. Usually a flap-type abrasive drum with fabric leaves is employed in which the warp of the fabric extends longitudinally of the leaves, i.e. radially of the drum. An important feature of the present invention is the discovery that if the warp is oriented laterally of the leaves, i.e. parallel with the drum axis, the warp threads fall away successively at the tips of the leaves as the abrasive becomes exhausted. The adhesive material that bonds the abrasive particles to the fabric also bonds together the threads of the fabric, but when the abrasive particles disappear at the tip portions of the leaves to expose the adhesive, the adhesive is soon disrupted to permit the exposed fabric to unravel. The heavy transverse warp threads fall away in succession and the corresponding tip portions of the weft threads soon disintegrate so that the slapping action is continuously shifted radially inward to fresh abrasive tip areas of the leaves.

The invention further provides compensation for the progressive shortening of the abrasive leaves and the consequent reduction in the effective radius of the abrasive drum. For this purpose means is provided to shift the axis of the abrasive drum periodically towards the passing automobile bodies as required. For those drums that extend and retract automatically, the range of extension and retraction is shifted to compensate for the progressive shortening of the abrasive leaves.

The features and advantages of the invention may be understood from the following detailed description and the accompanying drawings.

In the drawings, which are to be regarded as merely illustrative:

FIG. 1 is a perspective view of an automobile body on an assembly line passing a processing station where a selected embodiment of the invention is in operation;

FIG. 2 is a fragmentary horizontal sectional view along the line 2—2 of FIG. 1 showing a retractible drum that functions on the level of the wheel opening in the side of an automobile body;

FIG. 3 is a fragmentary side elevational view of an overhead abrasive drum and associated control mechanism for processing the upper surfaces of the automobile bodies, the abrasive drum being shown in position for abrading the surface of the car top;

FIG. 4 is a similar view with the abrasive drum lowered to process one of the fore and aft decks of the car;

FIG. 5 is a wiring diagram of a control system to cause an abrasive drum to extend and retract automatically in response to a sensing means;

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FIG. 6 is a fragmentary end elevation of an automobile body at the processing station;

FIG. 7 is a side elevation of the overhead abrasive drum that is employed to process the upper surfaces of the car;

FIG. 8 is a transverse sectional view of the overhead drum taken as indicated by the line 8—8 of FIG. 7;

FIG. 9 is a fragmentary perspective view showing the manner in which a disposable assembly of the abrasive fabric flaps is fabricated for use replaceably on the drum shown in FIGS. 7 and 8;

FIG. 10 is a fragmentary plan view of the completed assembly of abrasive flaps;

FIG. 11 is a plan view of a fragment of the back of a fabric abrasive flap of the conventional type with the warp extending longitudinally of the flap;

FIG. 12 is a similar view of the back of an abrasive flap of fabric fabricated in accord with the present invention with the warp extending transversely of the flap;

FIG. 13 is a greatly enlarged cross section along the line 13—13 of FIG. 12 showing how the fabric abrasive flap of the present invention progressively disintegrates at its tip by releasing successive warp threads;

FIG. 14 is a fragmentary perspective view showing how an abrasive drum normally rotating on a fixed axis may be constructed for periodic manual adjustment to compensate for the progressive shortening of the abrasive flaps of the drum;

FIG. 15 is a wiring diagram of an automatic control system for the overhead abrasive drum;

FIG. 16 is a series of four diagrams showing how a car body progresses past two sensing means comprising normally open switches shown in the wiring diagram in FIG. 15;

FIG. 17 is a diagrammatic plan view showing how abrasive drums on one side of a conveyor line may be controlled by sensing means on the other side of the conveyor line;

FIG. 18 is a diagrammatic fragmentary elevational view showing how a flap-type abrasive drum may be made in segments to process a laterally curved surface such as the shoulder of an automobile top; and

FIG. 19 is a similar view showing how a flap-type abrasive drum may be constructed in segments to follow a surface having a more complex curved profile.

General arrangement

As shown in FIG. 1, successive automobile bodies without fenders and windshields and with the hoods and front fenders missing are moved along a conveyor line at a constant rate by means of a pair of conveyor chains 20 and cooperating conveyor rails 21. The upper surfaces of each of the automobile bodies that are to be abrasively processed include the surface of the usual top portion 22 of the body and, at a lower level, the surface of the rear deck or trunk portion 23. The top portion 22 of the automobile body has a leading edge 24, i.e. an edge that is forward with respect to the direction of conveyance of the body and has a second trailing edge 25. The rear deck portion 23 has a leading edge 26.

The surfaces of the top portion 22 and the deck portion 23 may be abrasively processed by a single transverse overhead abrasive drum, generally designated 27, which is of the flap type. The overhead drum 27 is carried by a pair of arms 28 that are swung in unison to move the abrasive drum between a first upper operating position shown in solid lines in FIGS. 1 and 3 for processing the top portions 22 of the bodies and a second lower operating position shown in FIG. 4 for processing the trunk portions or rear decks 23. The two arms 28 are operated in synchronism by a pair of corresponding power cylinders 29.

The overhead abrasive drum 27 is mounted on the two overhead arms 28 by pivoted bell cranks 30 which may be rocked by corresponding power cylinders 31 to

lift the abrasive drum to an upper idle position that is shown in dotted lines in FIG. 3. The power cylinders 29 that control the overhead arms 28 and the power cylinders 31 for controlling the bell cranks 30 are controlled by two suitable sensing means 32 and 33 best shown in FIGS. 3 and 4. The sensing means 32 is an overhead feeler positioned in advance of the overhead abrasive drum 27, the feeler functioning as a normally open switch and being flexed upward by contact with the top portions 22 of the successive automobile bodies. The second sensing means 33 is a lower feeler positioned on one side of the conveyor line and functions as a normally open switch for operation by contact with the side of each automobile body at a level just below the top of the rear trunk portion 23.

The side surfaces on each side of each car body include an upper inwardly inclined curved side surface 35 in the region of the tops of the fenders. Below the side surface 35 is a nearly vertical side surface 36 and below the nearly vertical side surface is a lower outwardly inclined side surface 38 which is interrupted by a wheel opening 40. The rear edge 42 of the wheel opening 40 is what may be termed a leading edge since it faces in the direction of conveyor movement. For the same reason the forwardly facing edge 43 at the front end of the car is what may be termed a leading edge. On the other hand, the forward edge 44 of the wheel opening is a trailing edge.

On each side of the conveyor path, an inwardly inclined flap-type drum 45 processes the upper side surfaces 35 of the successive cars, a substantially vertical abrasive drum 46 processes the side surfaces 36 of the successive cars and a lower outwardly inclined abrasive drum 48 of the same type processes the lower side surfaces 38.

Preferably all of the seven abrasive drums rotate counter to the direction of conveyance of the automobile bodies, i.e. their peripheral portions in contact with the successive automobile bodies travel rearwardly with respect to the direction of movement of the bodies. As heretofore explained, when a flap-type abrasive drum traverses a sheet metal object longitudinally thereof from end to end, the drum has an unduly severe abrasive effect on either the leading edge or the trailing edge of the sheet metal object depending upon the direction of rotation of the drum. In this instance since all of the drums rotate counter to the direction of conveyance of the automobile bodies, it is the leading edges that are vulnerable.

In the absence of an automobile body at the processing station, as in FIGS. 16-A, the overhead feeler 32 and the lower side feeler 33 are unrestrained and therefore the overhead abrasive drum 27 is at its uppermost idle position shown in dotted lines in FIG. 3. The overhead drum stays at its uppermost idle position if only the upper feeler 32 is actuated as in FIGS. 16-B. When an automobile body reaches the position at the processing station indicated in FIGS. 16-C so that both the overhead feeler 32 and the lower side feeler 33 are deflected, the overhead abrasive drum 27 drops from its idle position to its first upper operating position shown in solid lines in FIGS. 1 and 3 for processing the top of the car. The lowering of the drum to its effective position is delayed, however, to avoid excessive abrasion of the leading edge 24 of the top portion. When the automobile body advances to the point indicated in FIG. 16-D to release the overhead feeler 32 while still deflecting the lower side feeler 33, the overhead abrasive drum 27 is lowered automatically to its lower operating position shown in solid lines in FIG. 4 for processing the upper surface of the trunk portion 23. Here again, however, the downward movement of the abrasive drum is delayed to avoid excessive abrasion of the leading edge 26 of the rear deck 23. As the car body subsequently leaves the processing station, the lower feeler 33 is released to cause the overhead abrasive drum 27 to return to its normal uppermost idle position.

To prevent excessive abrasion of the leading edges 42 and 43 associated with the lower side surfaces 38 of the automobile bodies, the lower abrasive drum 48 is movable between a retracted position away from the path of conveyance of the automobile bodies and an advanced position for abrasive contact with the bodies. In the construction shown in FIG. 1 the lower abrasive drum 48 is extended and retracted by means of a power cylinder 50 under the control of a sensing means or feeler 52 which is a normally open switch responsive to contact with the sheet metal edges of the car bodies.

In the absence of an automobile body at the processing station, the lower abrasive drum 48 is retracted from the path of conveyance. When the leading edge 43 of an approaching automobile body deflects the feeler 52, the lower abrasive drum 48 responds by swinging to its advanced or effective position to process the lower outwardly inclined side surface 38 of the automobile body. When the trailing edge 44 of the wheel opening 40 reaches the feeler 52 to release the feeler, the lower abrasive drum 48 responds by retracting laterally away from the car to its ineffective position. When the leading edge 42 of the wheel opening 40 again deflects the feeler 52, the lower abrasive drum 48 again responds to take its effective position and remains in its effective position until the trailing edge 54 of the car body passes to release the feeler 52.

It is to be noted that each side feeler 52 is positioned in advance of the corresponding lower abrasive drum 48 with respect to the approach of the successive automobile bodies. As will be explained, suitable time delay means is effective to delay the response of the abrasive drums 48 to the corresponding feelers 52, the delay period being the period of the travel of an automobile body from the region of the feeler to the region of the abrasive drum.

To avoid undesirable excessive abrading action by the lower abrasive drum 48 on the leading edges 42 and 43 of the successive car bodies, an additional delay is provided in the responsiveness of the lower abrasive drums 48 so that the lower abrasive drums are not advanced to their effective positions against the car bodies until the leading edges travel far enough to be immune from the abrading action. Thus the response of a lower abrasive drum 48 to the signals from the corresponding feeler 52 is delayed to compensate for the advanced position of the feeler relative to the abrasive drum, and is additionally delayed to permit the leading edges 42 and 43 to travel somewhat beyond the axis of rotation of the abrasive drum. This delayed action on the part of the lower abrasive drum 48 may leave a small margin adjacent the leading edge 42 and another small margin near the leading edge 43 to be subsequently abraded by hand. It is also to be noted that the delayed action results in the lower abrasive drum 48 remaining in its advanced effective position as the two trailing edges 44 and 54 of an automobile body move past the abrasive drum but these edges are not excessively abraded by the drum because the direction of rotation of the drum is counter to the direction of conveyance of the automobile body.

Structural details

The working parts of the apparatus are supported by a framework which straddles the path of travel of the automobile bodies along the conveyor line. The framework on each side of the conveyor line includes a rectangular angle iron base, generally designated 55 and a pair of posts 56 reinforced by diagonal braces 58, the upper ends of the two posts being interconnected by a truss comprising two truss members 60 and a chord member 62.

As shown in FIGS. 1 and 7, the overhead abrasive roller 27 has two opposite relatively short end portions or segments 64 of relatively large diameter and a long intermediate portion or segment 65 of lesser diameter. These three portions provide a brush configuration that

is capable of following the curved upper surface of the top portion 22 of an automobile body as well as the curved upper surface of the rear deck portion 23.

The overhead abrasive drum 27 is mounted by suitable bearings on a transverse shaft 66 which is fixedly mounted on the ends of the previously mentioned bell cranks 30. The two main arms 28 that carry the bell cranks 30 are pivotally mounted on corresponding spindles 70 to swing between upper positions for placing the abrasive drum 27 at a level to process the automobile top portions 22 and lower positions to place the abrasive drum at a level for processing the surface of the rear deck portions 23 of the automobile bodies. For actuation of the overhead abrasive drum 27, a motor 72 drives a pulley 74 on one of the spindles 70 and the pulley is connected by a belt 75 to a dual pulley 76 on the pivot of one of the bell cranks 30. The dual pulley 76 is connected by a belt 78 with a pulley 80 on the end of the abrasive drum.

The two power cylinders 29, which may be actuated by compressed air, are connected by hoses 85 with a four-way solenoid valve 86 in a suitable housing, the valve being operable in opposite respects to cause opposite operations of the power cylinders. Each power cylinder 29 is mounted by pivotal means on the corresponding chord member 62 of the frame structure and a piston rod 88 extending from the power cylinder is pivotally connected to the corresponding overhead arm 28. The four-way solenoid valve 86 is biased to take one of its limit positions when it is de-energized, the four-way solenoid taking its opposite position when energized.

In the same manner the two power cylinders 31 that control the bell cranks 30 are connected by hoses 90 with a four-way solenoid valve 92 which is operable in opposite respects to cause opposite operations of the power cylinders. Each power cylinder 31 is mounted by pivotal means on the corresponding overhead arm 28 and a piston rod 94 extending from the power cylinder is pivotally connected to the corresponding bell crank 30. Here again the four-way solenoid valve 92 is of the solenoid type, the valve being biased to take one of its limit positions when it is de-energized.

As heretofore stated, the two feelers 32 and 33 function as normally open switches which close in response to contact with an automobile body. When the four-way solenoid valve 86 for the two power cylinders 29 is de-energized, the two piston rods 88 of the power cylinders are extended to the maximum to hold the two overhead arms 28 at elevated positions for processing the top portion 22 of an automobile body, and when the four-way solenoid valve 92 for the power cylinders 31 is de-energized the piston rods 94 are at maximum extension to hold the overhead abrasive drum 27 in an operating position. It is apparent, then, that the overhead abrasive drum 27 is placed in its uppermost idle position by de-energization of the four-way solenoid valve 86 and energization of the four-way valve 92. If the four-way solenoid valve 92 is then de-energized the power cylinders 31 will actuate the bell cranks 30 to lower the overhead abrasive drum 27 to its first operating position for processing the top portion 22 of an automobile body. If the four-way solenoid valve 86 is then energized while the four-way solenoid valve 92 remains de-energized, the two power cylinders 29 will operate to lower the two overhead arms 28 to place the overhead abrasive drum 27 at its lower operating position for sanding the upper surface of the trunk or rear deck 23 of an automobile body.

FIG. 15 shows a wiring diagram for functionally relating the two feelers 32 and 33 with the two four-way solenoid valves 86 and 92. In the diagram the normally open feeler switch 32 is connected to one lead 95 from a suitable E.M.F. source and is connected through the coil of a normally closed relay 96 with a second lead 98 from the opposite side of the E.M.F. source. One side of

the normally open feeler switch 33 is connected to the lead 95 and the other side is connected by a wire 160 with one side of a normally open arm 102 of the relay 96. The relay arm 102 closes against a contact 104 which is connected by a wire 105 to a timer 106 that is adjustable by a manually operable knob 108. The second side of the timer 106 is connected to a stationary contact 110 of a single-pole double-throw switch having a switch arm 112.

When the switch arm 112 is positioned against the contact 110, as shown in FIG. 15 for automatic action, it connects the timer 106 with the four-way solenoid valve 86, the second side of the solenoid valve being connected to the lead 98. When the switch arm 112 is in its alternate position against a second stationary contact 114, the four-way solenoid valve 86 is connected to a manual control switch 115, the second side of the manual switch being connected to the lead 95 by a wire 116. For actuation of the timer 106, one of its sides is connected to the wire 116 and the other side is connected by a wire 118 with the lead 98.

The wire 100 associated with the feeler switch 33 is connected to the lead 98 through the coil of a normally closed relay 120 having an arm 122. The relay arm 122 is connected to the lead 95 by a wire 124 and cooperates with a contact 125 that is connected to one side of a second timer 126 that is equipped with an adjustment knob 128. The second side of the timer 126 is connected to one contact 130 of a single-pole double-throw switch having a switch arm 132. In FIG. 15 the switch arm 132 lies against the contact 130 to connect the timer 126 to one side of the four-way solenoid valve 92, the second side of the solenoid valve being connected to the lead 98. At its alternate position the switch arm 132 lies against a second contact 134 to connect the four-way solenoid valve 92 to a manual control switch 135 which is connected to the lead 95 by a wire 136. For actuation of the timer 126 one of its sides is connected to the wire 136 and the other side is connected by a wire 138 to the lead 98.

If the feeler switch 33 is open regardless of the position of the feeler switch 32, as in FIGS. 16-A and 16-B, the overhead abrasive drum 27 is retracted to its upper idle position because the four-way solenoid valve 92 is energized through the normally closed relay arm 122 to retract the piston rods 94 that operate the bell cranks 30 and because the four-way solenoid valve 86 is de-energized with the power cylinders 29 holding the overhead arms 28 at their upper positions.

If both of the feeler switches 32 and 33 are closed as in FIG. 16-C, the relay arm 122 opens to de-energize the four-way solenoid valve 92 to lower the bell cranks 30 to place the overhead abrasive drum 27 in its first upper operating position for processing the top portion 22 of an automobile body, the four-way solenoid valve 86 being cut off by the relay 96 to keep the two overhead arms 28 at their upper positions.

When the feeler switch 32 opens while the feeler switch 33 remains closed as in FIG. 16-D, the de-energization of the relay 96 closes a circuit to the four-way solenoid valve 86 through the feeler switch 33 and the timer 106 to cause the two power cylinders 29 to lower the two overhead arms 28 to place the overhead abrasive drum 27 at its second lower operating position for processing the surface of the rear deck or trunk portion 23 of an automobile body. The four-way solenoid valve 92 remains de-energized because the relay 120 remains energized through the closed feeler switch 33.

The function of the timer 126 is to delay the operation of the four-way solenoid valve 92 for lowering the overhead abrasive drum 27 from its idle position to its first upper operating position to avoid excessive abrasion of the leading edge 24 of the top portion 22 of the automobile body. The function of the timer 106 is to delay the operation of the four-way solenoid valve 86 to delay the lowering of the overhead abrasive drum 27 from its

first upper operating position to its second lower operating position to avoid excessive abrasion of the leading edge 26 of the rear deck or trunk portion 23 of the automobile body. Since the conveyor chains 20 are driven at a constant rate, it is a simple matter to adjust the two timers 106 and 126 for the precise time delays that are required.

If it is desirable at any time to operate the four-way solenoid valve 86 by manual control, the switch arm 112 is shifted to its alternate position for control of the four-way solenoid valve by the manual switch 115. In like manner the switch arm 132 may be moved to its alternate position for control of the four-way solenoid valve 92 by the manual switch 135. As indicated in FIG. 1, the two switches 112 and 132 may be toggle switches on the housings of the respective four-way solenoid valves 86 and 92 and the manual switches 115 and 135 may be normally open push button switches on the two housings respectively.

On each side of the assembly line each of the inwardly inclined abrasive drums 45 is mounted on an inwardly inclined shaft 142 that is journaled in bearings 144. A pulley 145 on the shaft 142 is connected by a belt 146 with a drive pulley 148 that is actuated by a suitable motor 150.

On each side of the assembly line each of the vertical abrasive rollers 46 is mounted on an upright shaft 152 that is journaled in a pair of bearings 154. A motor 155 for actuating each of the abrasive drums 46 actuates a drive pulley 156 which is connected by a belt 157 to a driven pulley 158 on the shaft 152.

Each of the extensible and contractible lower abrasive drums 48 on the opposite sides of the assembly line is inclined outwardly in accord with the inclination of the lower side surfaces 38 of the automobile bodies and is mounted between the two arms of an inclined yoke 159 that is swingable about an inclined axis on a pair of pivot supports 160. A motor 161 on the yoke is connected by a belt 163 with a driven pulley 164 that is unitary with the abrasive drum 48.

The previously mentioned power cylinder 50 that extends and retracts the drum 48 is mounted on a pivotal support 165 with a piston rod 166 extending from the power cylinder and pivotally connected to the yoke 159.

The opposite ends of each of the power cylinders 50 are connected by a pair of hoses 168 to a four-way valve 170 in a suitable housing, the four-way valve being operable in opposite respects to cause extension and retraction of the abrasive drum 48. The four-way valve 170 is of the same solenoid type as the previously described valves 86 and 92 and is controlled by the circuit shown in FIG. 5 which includes the previously mentioned normally open feeler switch 52.

In FIG. 5 one lead 172 from a suitable E.M.F. source is connected to one side of the four-way solenoid valve 170 and a second lead 174 from the opposite side of the source is connected to the switch arm of a single-pole, double-throw switch 175. At the position shown in FIG. 5 the arm of the switch 175 cooperates with a fixed contact 176 which is connected by a wire 178 to one side of the normally open feeler switch 52. The second side of the feeler switch 52 is connected to an adjustable timer 180 and the second side of the timer is connected by a wire 182 to the second side of the four-way solenoid valve 170. The timer is adjustable by means of a knob 184 which traverses an arcuate timing scale 185. The second fixed contact 186 of the switch 175 is connected to a normally open manual switch 188 which in turn is connected to the wire 182 by a wire 190. As indicated in FIG. 1 the switch 175 may be a toggle switch on the housing of the four-way solenoid valve 170 and the manual switch 188 may be a normally open push button switch on the side of the housing.

When the toggle switch 175 is in the position shown in FIG. 5, the apparatus set for automatic operation, the

position of the abrasive drum 48 is determined by the feeler switch 52 with a time delay introduced by the timer 180. When the feeler switch 52 is opened, the abrasive drum 48 is retracted laterally from the path of movement of the automobile bodies along the conveyor line. When the feeler switch 52 is closed by contact of the feeler with the lower side surface 38 of an automobile body, the abrasive drum 48 is shifted to its extended operating position for processing the side surface 38 but the timer 180 delays the movement of the abrasive drum to its effective position to compensate for the advanced position of the feeler switch 52 and further delays the movement to avoid excessive abrasion of the leading edge 43 of the front end of the car and the leading edge 42 at the wheel opening 40. Here again it is a simple matter to adjust the timer 180 for the precise time delay that is required. If it is desirable at any time to extend or retract the abrasive drum 48 by manual control, the toggle switch 175 is manipulated to connect the lead 174 with the push button switch 188.

All of the abrasive drums 27, 45, 46 and 48 are preferably of the construction shown in FIGS. 7 to 13. FIG. 7 is a side elevation of the overhead abrasive drum 27 and FIG. 8 is a transverse section of FIG. 7. As shown in FIG. 8 the abrasive drum has a hub structure 192 with a circumferential series of longitudinal peripheral slots 194, each slot having an enlargement 195 at its inner end which may be of circular cross-sectional configuration as indicated. Each of the peripheral slots 194 mounts a disposable abrasive assembly 196 comprising several sheets 198 of abrasive cloth which extend for the full length of the drum and have spaced slits 200 (FIG. 10) forming radially outward abrasive leaves or flaps 202. As indicated in FIG. 9, each abrasive assembly may be constructed by interposing a base member 204 between two stacks of the sheets 198 and then driving a series of high carbon steel staples 205 through the margins of the sheets and through the interposed base member. The base member may be made of sheet metal which is folded on itself and which is looped at the fold to form an enlargement 206 to fit into the enlargement 195 of a slot 194 of the hub structure.

It is not new to construct replaceable abrasive units in this general manner, but heretofore it has been the usual practice to cut the fabric sheets in such manner that the warp threads extend radially of the abrasive drums. Thus in FIG. 11, which illustrates the usual construction, the heavier warp threads 208 extend radially of the abrasive drum, i.e. longitudinally of the abrasive leaves or flaps 202. As heretofore stated, a feature of the present invention illustrated by FIG. 12 is that the warp threads 208 extend 90° from conventional practice, the warp threads extending transversely of the leaves or flaps 202 to lie parallel with the axis of rotation of the abrasive drum. FIG. 13 shows on an enlarged scale and in a somewhat exaggerated manner how the warp threads 208 and the intersecting weft threads 210 of an abrasive flap 202 are normally bonded together by the adhesive coating 212 that bonds abrasive particles to one face of the fabric. As the slapping action of the tips of the flaps erodes the abrasive coatings, the bonding of the transverse warp threads 208 is weakened to permit the warp threads to unravel and drop away successively in the manner indicated in FIG. 13. The end portions of the lighter weft threads 210 which are exposed by the departure of the successive warp threads rapidly wear away. Thus the end portions of the flaps 202 were the slapping abrasive action occurs disintegrate in accord with the rate of erosion of the abrasive coating so that the flaps progressively shorten for continually presenting slapping end portions that have fresh abrasive.

Any suitable provision may be made to compensate for the progressive shortening of the flaps with consequent reduction in the effective radius of the various abrasive

drums. For example, each of the two piston rods 88 that connect the power cylinders 29 to the overhead arms 68 for extending and retracting the abrasive overhead drum 27 may be made in two sections interconnected by an adjustment sleeve 214. The two piston rod sections are oppositely threaded into the sleeve 214 so that the sleeve may be manually rotated to decrease the effective lengths of the two piston rods 88 and thus shift the range of reciprocation of the abrasive drum downward to compensate for the progressive reduction of the effective radius of the abrasive drum. In like manner the piston rod 166 that is operatively associated with each of the lower abrasive drums 48 may be provided with a manually rotatable adjustment sleeve 215.

The normally stationary abrasive drums 45 and 46 may be made adjustable in the same general manner. For example, FIG. 14 shows how an abrasive drum 46a may be journaled in the two arms of a yoke 216 that is mounted on pivots 218. The motor 155a for driving the drum 46a is mounted on one of the arms of the yoke and is operatively connected to the abrasive drum by means of two sheaves 220 and 222 interconnected by a belt 224.

The two arms of the yoke 216 are interconnected by a cross bar 225 and an adjustment bar 226 is pivotally connected at one end to the cross bar and is pivotally connected at the other end to fixed structure 228. The adjustment bar 226 is made in two sections which have opposite threads engaged by a manually rotatable adjustment sleeve 230 having corresponding opposite threads. Thus periodic manual rotation of the adjustment sleeve 230 extends the effective length of the adjustment bar 226 to shift the abrasive drum 46a towards the conveyor line to compensate for the progressive reduction in the effective radius of the abrasive drum.

FIG. 17 indicates how the two opposite sides of the automobile bodies may be processed respectively at two different stations along the assembly line with the abrasive drums on one side of the assembly line controlled by corresponding feeler means on the opposite side of the assembly line.

At the first processing station of the assembly line indicated in FIG. 17, three abrasive drums 231, 232 and 233 are mounted at different levels on the left side of the assembly line for movement between retracted positions and operative positions under the control of three corresponding feelers 231a, 232a, and 233a, respectively, on the right hand side of the assembly line. The feelers sense the leading and trailing edges of the sheet metal on the right hand side of the assembly line and thus are able to control the abrasive drums accurately because the two sides of the automobile body are identical. No timer is required in the control circuit because the feelers may be adjusted longitudinally of the conveyor line to cause the abrasive drums to skip the leading edges of sheet metal that would otherwise be excessively abraded.

At the next processing station on the assembly line shown in FIG. 17 three abrasive drums 234, 235 and 236 mounted at different levels on the right side of the conveyor line are controlled in the same manner by corresponding feelers 234a, 235a and 236a, respectively, on the left side of the conveyor line. It is apparent that an overhead abrasive drum or drums may be used at either of the two stations for processing the upper surfaces of the top portions and rear deck portions of the car bodies.

FIG. 18 shows diagrammatically how an overhead abrasive drum 27a may be substituted for the previously described abrasive drum 27 to process the surfaces of the top portions of the car. In FIG. 18 two relatively narrow segments 246 and 248 forming a stepped configuration readily adapt themselves to the curved shoulder of the car top. The remaining portion 250 of the abrasive drum is of uniform diameter to follow the relatively slight changes in curvature of the central region of the car top.

FIG. 19 shows how an abrasive drum 252 may be con-

structed to follow the more complex configuration of a portion of a body 254 which is to be sanded. The profile of the body 254 forms a valley 255 with sloping side walls 256 and 258. The abrasive drum 252 is of stepped segmented configuration with two segments 260 and 262 of uniform diameter to process the body on opposite sides of the valley and with a central segment 264 of maximum diameter to process the bottom of the valley. Two segments 265 and 266 step up the diameter of the sanding drum to process the sloping side wall 256 of the valley and the two segments 268 and 270 step up the diameter of the sanding drum to process the side wall 258 of the valley.

My description in specific detail of the selected practices of the invention will suggest various changes, substitutions and other departures from my disclosure within the spirit and scope of the appended claims.

I claim:

1. In apparatus for polishing the surfaces of successive automobile bodies movable along an assembly line and defined by different longitudinal zones, the combination of:

support structure adjacent the assembly line;

a plurality of power driven abrasive drums to process the different zones longitudinally of said surfaces, each of said drums being shiftable between a retracted ineffective position and an operating position in contact with a different one of said zones and being rotatable in a particular direction to polish said body in an individual one of the zones and in the operative position of the drums;

sensing means disposed at a position advanced relative to a particular one of said drums in the direction of movement of the bodies to sense the movement of the bodies past the sensing means;

actuating means operatively coupled to said drums to shift said shiftable drums between their two positions, said actuating means being responsive to the operation of said sensing means to shift the drums to the operative position; and

means operatively coupled to said actuating means and to said sensing means to delay the response of said actuating means to said sensing means to compensate for the advanced position of the sensing means.

2. An apparatus as set forth in claim 1 wherein each of said drums by virtue of its particular direction of rotation tends to abrade excessively one of a leading edge and a trailing edge of each of said bodies in the individual zone engaged by the brush; and

wherein said delaying means delays the response of said actuating means to avoid excessive abrasion of said one edge.

3. In apparatus for polishing the surfaces of successive automobile bodies movable along an assembly line and defined by different longitudinal zones each having leading and trailing edges, the combination of:

a power driven flap-type abrasive drum adjacent a particular one of the different zones in the assembly line to abrade an individual one of longitudinal zones of each of said bodies, said drum being rotatable in a particular direction to process the particular zone except for the area adjacent to a particular one of said leading and trailing edges in said zone;

shifting means operatively coupled to each individual drum for obtaining a shift of the drum between a retracted inoperative position displaced from the bodies and an operative position in engagement with the bodies;

means disposed relative to said bodies to sense the arrival of said leading and trailing edges in the particular zone on each body movable along the assembly line; and

actuating means operatively coupled to said sensing means and to said shifting means to obtain a shift of said drum between the retracted ineffective position and the operative position for obtaining an abrading

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of the surface of the individual zone of each body by the drum, said actuating means being responsive to the operation of said sensing means to retract said drum when said particular edge in the particular zone of each body is in position relative to the drum for an abrasion of said one edge by said drum and to dispose the drum at its operative position at all other times when said individual zone of each body is in the region of said drum.

4. The combination set forth in claim 3 wherein said drum has radial flexible flaps with abrasive particles bonded thereto, said flaps being made of woven fabric having a warp and a woof with the warp of the fabric extending transversely of the flaps so that the warp successively unravels from the outer ends of the flaps and drops from the outer ends of the flaps for progressive shortening of the flaps as the abrasive particles disappear progressively from the outer ends of the flaps.

5. For use in apparatus for abrading the surfaces of successive automobile bodies movable along an assembly line and defined by different longitudinal zones, the combination of:

support structure adjacent the assembly line; and an abrasive drum mounted on said support structure in a position relative to said automobile bodies and rotatable on a particular axis to abrade an individual one of the longitudinal zones of the bodies, said drum having radial flaps with abrasive particles bonded thereto, said flaps being made of woven fabric having a warp and a woof with the warp of the fabric extending transversely of the flaps so that the warp successively unravels and drops from the outer ends of the flaps for progressive shortening of the flaps as the abrasive particles disappear progressively from the outer ends of the flaps, including means operatively coupled to said support structure and to said drum to shift the particular axis of said drum toward the assembly line to compensate for the progressive shortening of said flaps.

6. In apparatus for abrading the surfaces of successive automobile bodies movable along an assembly line and defined by different longitudinal zones and having edges defining said zones, the combination of:

support structure adjacent the assembly line; an abrasive drum mounted on said support structure in position relative to the bodies movable along the assembly line to abrade one of the different longitudinal zones of the bodies, said drum having radial flaps with abrasive particles bonded thereto, said flaps being made of woven fabric having a warp and a woof with the warp of the fabric extending transversely of the flaps so that the warp successively unravels and drops from the outer ends of the flaps for progressive shortening of the flaps as the abrasive particles disappear progressively from the outer ends of the flaps;

means operatively coupled to said drum to shift said drum through a range between an operating position engaging said bodies and a retracted position displaced from said bodies to avoid excessive abrasion of particular ones of the edges defining the individual longitudinal zone of the bodies;

means operatively coupled to said shifting means and responsive to the movement of the bodies along the assembly line to synchronize the shifting of said drum between the operating position and the retracted position in accordance with the movement of the bodies along the assembly line; and

means operatively coupled to said drum to obtain an adjustment in the position of said drum on said shifting means toward said assembly line to compensate for the progressive shortening of said flaps.

7. In apparatus for abrading a plurality of longitudinal zones of surfaces on each of successive automobile bodies sequentially movable along an assembly line having a plu-

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rality of longitudinally spaced stations, different ones of the zones having different elevations at the opposite sides of the movable bodies and a lower zone on each side of each body having a wheel opening defined by leading and trailing edges, the combination of:

a first plurality of abrasive drums at the different elevations on one side of the conveyor line to abrade the different longitudinal zones on said one side of each of said bodies, said drums including a first drum at a first one of the stations on the assembly line for the lower zone on said one side of each body;

a second plurality of abrasive drums at different elevations on the other side of the conveyor line to abrade different longitudinal zones on said other side of each of said bodies, said last mentioned plurality including a second drum at a second one of the stations on the assembly line for abrading the lower zone on said other side of each of said bodies, the second station being longitudinally spaced from said first station by a distance greater than the lengths of said bodies;

a first sensing means at said first station, on said one side of the assembly line to sense the arrival of the leading and trailing edges on said one side of each body;

first actuating means responsive to said first sensing means to retract said second drum when a particular one of said leading and trailing edges on said other side of each body is in the region of said second drum; second sensing means at said second station on said other side of the assembly line to sense the arrival of the leading and trailing edges on said other side of each of said bodies; and

second actuating means responsive to said second sensing means to retract said first drum when the particular one of said leading and trailing edges on said one side of the body is in the region of said first drum.

8. A combination as set forth in claim 7 wherein each of said first and second sensing means is displaced longitudinally of the assembly line relative to the particular one of the first and second abrasive drums controlled by the sensing means to retract the particular drum when one of said edges is in the region of the particular drum to avoid excessive abrasion of said particular one of the leading and trailing edges.

9. A combination as set forth in claim 7 wherein each of said first and second drums has radial flexible flaps with abrasive particles bonded thereto, said flaps being made of woven fabric having a warp and a woof with the warp of the fabric extending transversely of the flaps so that the warp successively unravels and drops from the outer ends of the flaps for progressive shortening of the flaps as the abrasive particles disappear progressively from the outer ends of the flaps.

10. In apparatus for abrading the surfaces of vehicular bodies movable along a conveyor line, which bodies have top surfaces at an elevated level and have deck surfaces at a lower level, the combination of:

power actuated overhead abrasive drum means;

means mounting said overhead drum means for movement of the drum means between a first upper position for abrading the top surfaces of the bodies and a second lower position for abrading the deck surfaces of the bodies;

sensing means in the path of conveyance of the bodies and disposed relative to the bodies for sensing the change between the top surfaces and the deck surfaces of the bodies; and

actuating means responsive to said sensing means and operatively coupled to said mounting means to obtain a shift of said drum means by said mounting means between the first upper position and the second lower position, said actuating means being responsive to said sensing means to maintain the drum means at the upper position when said top surfaces are in the region of the drum means and to shift the

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drum means to the lower position when said deck surfaces are in the region of the drum means.

11. In the apparatus set forth in claim 10, the mounting means being also operative to move the drum means to a third position displaced from the top and deck surfaces of the bodies, and

means in the path of conveyance of the bodies and operatively coupled to the mounting means for obtaining a movement of the drum means by the mounting means between the first and third positions in synchronism with the movement of the bodies along the conveyor line to obtain a polishing of the top surfaces of the bodies by the drum means.

12. In apparatus for polishing the surfaces of vehicular bodies movable along a conveyor line, which bodies have top surfaces at an elevated level and have deck surfaces at a lower level and have side surfaces defining the top surfaces and the deck surfaces and extending below the deck surfaces, the combination of:

power actuated overhead abrasive drum means; means mounting said overhead drum means for movement of the drum means between a first upper position for abrading the top surfaces of the bodies and a second lower position for abrading the deck surfaces of the bodies and a third position above the first position and displaced from the top surfaces of the bodies;

first sensing means in the path of conveyance of the top surfaces of the bodies for actuation thereby to detect the presence of the top surfaces;

second sensing means in the path of conveyance of the side surfaces of the bodies below said deck surfaces for actuation thereby to detect the presence of said side surfaces; and

actuating means responsive to said first and second sensing means and operatively coupled to said mounting means to obtain a movement of said drum means between the first, second and third positions in accordance with the particular combinations in which the first and second sensing means are actuated at successive instants of time during the movement of the bodies along the conveyor line.

13. A combination as set forth in claim 12 wherein said sensing means is located at an advanced position relative to said drum means in the direction of movement of the bodies along the conveyor line; and

wherein means are included to delay the response of said actuating means to said first sensing means to compensate for the advanced position of the first sensing means.

14. A combination as set forth in claim 12 wherein the top and deck surfaces of the bodies are defined by leading edges and wherein the delay means are provided with a sufficient delay to delay the response of said actuating means until the movement of the leading edges of the top and deck surfaces of the bodies pass the drum means to avoid excessive abrasion of the leading edges of said top and deck surfaces.

15. In apparatus for polishing the surfaces of vehicular bodies movable along a conveyor line, which bodies have top surfaces at an elevated level and have deck surfaces at a lower level and have side surfaces defining the top and deck surfaces and extending below the deck surfaces, the combination of:

power driven overhead abrasive drum means having a retracted uppermost position displaced from the top and deck surfaces of the bodies, a first upper operating position below said retracted position for abrading said top surfaces and a second lower operating position for abrading the deck surfaces of the bodies; means operatively coupled to the drum means for obtaining a rotation of such drum means;

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a first sensing means in the path of conveyance of the bodies and disposed relative to the top surfaces of the bodies for actuation by such top surfaces to detect the presence of the top surfaces;

a second sensing means in the path of conveyance of the bodies and disposed relative to the side surfaces of the bodies for actuation by the side surfaces of the bodies to detect the presence of said side surfaces; and actuating means responsive to said first and second sensing means and operatively coupled to the drum means to position the drum means at said uppermost position when neither of said sensing means is actuated, to position the drum means at said first operating position when both of said sensing means are actuated and to position the drum means at said second lower operating position when only the second sensing means is actuated.

16. A combination as set forth in claim 15 wherein said first sensing means is located at an advanced position relative to said drum means; and

wherein means are included to delay the response of said actuating means to said first sensing means to compensate for the advanced position of the first sensing means.

17. A combination as set forth in claim 15 wherein means are included to delay the response of said actuating means to said first and second sensing means to avoid excessive abrasion of particular edges on the automobile bodies.

18. In apparatus for polishing the surfaces of vehicular bodies movable along a conveyor line, which bodies have side surfaces with a leading edge defining the front of the body and with a trailing edge defining the rear of the body and with first and second intermediate edges respectively defining the front and rear edges of a wheel opening,

power driven abrasive drum means having a retracted position displaced from the side surfaces of the bodies and having an operative position for providing an engagement between the drum means and the side surfaces of the bodies,

means operatively coupled to the drum means for obtaining a rotation of such drum means in a particular direction,

first sensing means in the path of conveyance of the bodies and disposed relative to the side surfaces of the bodies for actuation by such side surfaces to detect the presence of such side surfaces; and

means responsive to the actuation of the first sensing means and operatively coupled to the drum means to position the drum means in the operative position upon the movement past the drum means of the portion of the side surfaces of the bodies between the leading edges of the side surfaces and the first intermediate edges of the side surfaces and the portion of the side surfaces of the bodies between the second intermediate edges of the side surfaces and the trailing edges of the side surfaces and for producing a movement of the drum means to the retracted position in the portion of the side surfaces between the first and second intermediate edges of the side surfaces.

19. The combination set forth in claim 18 wherein the actuating means are provided with a delay in responding to the sensing means to prevent the drum means from engaging the side surfaces of the bodies at particular ones of the leading and trailing edges and the first and second intermediate edges of the side surfaces in accordance with the particular direction of rotation of the drum means to avoid excessive abrasion of such particular edges.

20. The combination set forth in claim 18 wherein the bodies are provided with top surfaces and with deck surfaces at a position below the top surfaces and wherein second sensing means are disposed relative to the bodies movable along the conveyor line to sense the top surfaces of the bodies and wherein second drum means are mov-

able between first positions displaced from the top surfaces and the deck surfaces of the bodies and are movable to second positions for engaging the top surfaces of the bodies and are movable to third positions for engaging the deck surfaces of the bodies and wherein second actuating means are responsive to the first and second sensing means to move the second drum means between the first, second and third positions during the movements of the bodies along the conveyor lines to provide a polishing action by the second drum means on the top surfaces and deck surfaces of the bodies.

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