EUROPEAN PATENT SPECIFICATION

APPARATUS AND METHOD FOR AUTOMATICALLY COMPENSATING FOR LATERAL RUNOUT

GERÄT UND METHODE ZUR AUTOMATISCHEN KOMPENSATION VON LATERALEN RUNDLAUFFEHLERN

APPAREIL ET PROCEDE DESTINE A COMPENSER AUTOMATIQUEMENT LE ROULIS LATERAL

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Description

[0001] This invention relates to an improved on-car brake lathe apparatus. More specifically, this invention relates to an apparatus and method for automatically compensating for the lateral runout of a lathe apparatus with respect to a vehicle hub. The invention further includes a novel runout measurement and control system that describes the runout of a disc brake assembly and directs a corrective signal to an automated control system for adjustment in order to effectively compensate of lateral runout. The novel runout apparatus and method may also be advantageously utilized in other practical applications in order to align two concentrically attached rotating shafts.

[0002] A brake system is one of the primary safety features in every road vehicle. The ability to quickly decelerate and bring a vehicle to a controlled stop is always critical to the safety of the vehicle occupants and those in the immediate vicinity. In this, a vehicle braking system is designed and manufactured to exacting specifications and rigorous inspection.

[0003] One of the main components of a brake system are the disc brake assemblies typically mounted on the front wheels of most passenger vehicles. Generally, the disc brake assemblies include a caliper (cooperating with a brake hydraulic system), brake pads, a hub, and a rotor. The caliper supports and positions a pair of brake pads on opposing sides of a brake rotor. In a hub-less brake rotor (i.e. when the rotor and hub are separate components), the rotor is secured to the vehicle hub, via a rotor hat, with a series of bolts for rotation with the hub about a vehicle spindle axis. When a vehicle driver depresses a brake pedal thereby activating the hydraulic system, the brake pads are forced together and toward the rotor to grip the friction surfaces of the rotor.

[0004] Disc brake assemblies must be maintained to manufacturers specifications throughout the life of the vehicle in order to assure optimum performance and maximum safety. However, several problems have plagued the automotive industry since the inception of disc brakes.

[0005] A significant problem in brake systems is usually referred to as "lateral runout." Generally, lateral runout is the side-to-side movement of the friction surfaces of the rotor as it rotates with the vehicle hub about a spindle axis. Referring to Figure 1, for example, there is shown a rotor having friction surfaces on its lateral sides. A rotor is mounted on a vehicle hub for rotation about the horizontal spindle axis X. In an optimum rotor configuration, the rotor is mounted to rotate in a plane Y that is precisely perpendicular to the spindle axis X. Generally, good braking performance is dependant upon the rotor friction surfaces being perpendicular to the spindle's axis of rotation X and parallel to one another ("parallelism"). In the optimum configuration, the opposing brake pads will contact the friction surfaces of the rotor at perfect 90 degree angles and will exert equal pressure on the rotor as it rotates. More typically, however, the disc brake assembly will produce at least a degree of lateral runout that deviates from the ideal configuration. For example, a rotor will often rotate in a canted plane Y and about an axis X which is a few thousandths of an inch out of axial alignment with the spindle (shown in exaggerated fashion in Figure 1). In this rotor configuration, the brake pads, which are perpendicular to the spindle axis X, will not contact the friction surfaces of the rotor along a constant pressure plane.

[0006] The lateral runout of a rotor is the lateral distance that the rotor deviates from the ideal plane of rotation Y during a rotation cycle of the rotor. A certain amount of lateral runout is inherently present in the hub and rotor assembly. This lateral runout often results from defects in individual components. For example, rotor friction surface runout results when the rotor friction surfaces are not perpendicular to the rotor's own axis of rotation, rotor hat runout results when the hat connection contains deviations that produce an offset center mount, and stacked runout results when the runouts of the components are added or "stacked" with each other. An excessive amount of lateral runout in a component or in the assembly (i.e. stacked runout) will generally result in brake noise, pedal pulsation, and a significant reduction in overall brake system efficiency. Moreover, brake pad wear is uneven and accelerated with the presence of lateral runout. Typically, manufacturers specify a maximum lateral runout for the friction surfaces, rotor hat, and hub that is acceptable for safe and reliable operation.

[0007] After extended use, a brake rotor must be resurfaced in order to bring the brake assembly within manufacturers specifications. This resurfacing is typically accomplished through a grinding or cutting operation. Several prior art brake lathes have been used to resurface brake rotors. These prior art lathes can be categorized into three general classes: (1) bench mounted lathes; (2) on-car caliper-mounted lathes; and (3) on-car hub mounted lathes. As discussed below, the on-car hub mounted lathes have proven to be the most reliable and accurate rotor refinishing lathes in the industry.

[0008] Bench mounted lathes, for example, that disclosed in United States Patent No. 3,540,165 to Lanham, are inefficient and do not have rotor matching capabilities. In order to resurface a rotor on a bench mounted lathe, the operator is first required to completely remove the rotor from the hub assembly. The operator then mounts the rotor on the bench lathe using a series of cones or adapters. After the cutting operation, the operator remounts the rotor on the vehicle spindle. Even if the rotor is mounted to the lathe in a perfectly centered and runout free manner, runout between the rotor and hub is not accounted for in the bench lathe resurfacing operation. In addition, bench lathes are susceptible to bent shafts which introduce runout into a machined rotor. This runout is then carried back to the brake assem-
bly where it may be added with hub runout to produced a stacked runout effect.

[0009] Similarly, caliper-mounted lathes, for example, that disclosed in United States Patent No. 4,388,846 to Kopecko et al., have had limited success in compensating for lateral runout, but require time consuming manual operations. During a rotor refinishing procedure, the brake caliper must first be removed in order to expose the rotor and hub. Once removed, the caliper mounting bracket is freed and can be used to mount an on-car caliper-mount lathe. The caliper-mount lathes are wholly unacceptable for many reasons including the lack of a "rigid loop" connection between the driving motor and cutting tool and the inability to assure a perpendicular relationship between the cutting tools and the rotor. Moreover, the caliper-mount lathes do not have any reliable means for measuring and correcting lateral runout. Typically and in much the same manner as described below with reference to the hub mounted lathes, a dial indicator is utilized in determining the total amount of lateral runout in the disc assembly. This measurement technique is problematic in terms of time, accuracy and ability of automechanics to comfortably use the equipment.

[0010] On-car hub mounted lathes, for example, that disclosed in United States Patent No. 4,226,146 to Ekman, assigned to the assignee of the instant application, and incorporated by reference into the disclosure herein, have proven to be the most accurate and efficient means for resurfacing the rotor. Also, the Ekman system is operator specific. That is, the operator experience, the procedure time for even the most skilled operators, has practical limitations.

[0011] Referring now to Figure 2, there is shown an Ekman type on-car disc brake lathe 10 for mounting to the hub of a vehicle 14. The lathe 10 includes a body 16, driving motor 18, adapter 20, and cutting assembly 22. The lathe is also provided with a stand and anti-rotation post (not shown), either of which can be used to counter the rotation of the lathe during a resurfacing operation. After the brake caliper is removed, the adapter 20 is secured to the hub of the vehicle 14 by using the wheel lug nuts. The lathe body 16 is then mounted to the adapter 20.

[0012] At this point in the prior art procedure, the operator must determine the total amount of lateral runout and make an adjustment. Specifically, the operator first mounts a dial indicator 26 to the cutting head 22 using a knob 28. The dial indicator 26 is positioned to contact the vehicle 14 at one of its distal ends as shown in Figure 2. Once the gauge 26 is properly positioned, the operator is required to take the following steps in order to measure and compensate for lateral runout:

1. The operator mates the lathe to the rotor using the adapter and procedure outlined above.
2. The operator activates the lathe motor 18 which causes the adapter 20, and thereby the brake assembly hub and rotor, to rotate. The total lateral runout of the assembly will be reflected by corresponding lateral movement in the lathe body.

3. The lateral movement of the lathe body is then quantified by using the gauge 26. Specifically, the operator observes the dial indicator to determine the high and low deflection points and the corresponding location of these points on the lathe.

4. Upon identifying the highest deflection of the dial indicator, the operator "bumps" the motor and stops the rotation at the point of the identified highest deflection.

5. The operator then makes an adjustment to compensate for runout of the assembly. This is accomplished by careful turning of the adjustment screws 24. Specifically, there are four adjustment screws and the correct screw(s) must be turned depending on the location of the high point. The affect of turning the screws is to adjust the orientation of the lathe body with respect to the adapter 20 (and therefore the rotor and hub) to mechanically compensate for the runout of the assembly. The operator adjusts the screws until the highest deflection point is reduced by half as determined by reference to the dial indicator 26.

6. The operator activates the lathe motor 18 and observes the dial indicator 26 to again identify the highest deflection of the dial. If the maximum lateral movement of the lathe body, as measured by the needle deflection, is acceptable (i.e. typically less than 3/1000) then mechanical compensation is complete and the lathe turning operation can commence. Otherwise, further measurement and adjustment will be necessary by repeating steps (1) to (6).

[0013] The cutting operation is then performed by adjusting the tool holder 22 and cutting tools 23, and setting the proper cutting depth.

[0014] Although the hub mounted on-car brake lathe was a considerable advance in the disc brake lathe industry, its structure and corresponding procedure for compensating for lateral runout of the disc brake assembly has practical limitations.

[0015] First, as readily apparent, upon observation of steps (1)-(6) above, the Ekman procedure requires a significant amount of time to determine and adjust for lateral runout of the brake assembly. Although the specific amount of time necessary will vary based upon operator experience, the procedure time for even the most trained and experience is significant and can substantially increase the cost associated with rotor refinishing to the vehicle owner and the shop. Second, the prior art system and procedure requires the shop owner and technicians to undergo extensive education and operator training in order to assure that proper mechanical compensation for lateral runout is accomplished. Moreover, the Ekman system is operator specific. That is, the accuracy and success of measurement and adjustment of lateral runout will vary from operator to operator.
In general, the prior art systems and procedures are problematic with respect to accuracy in the measuring and adjusting of lateral runout. The prior art systems require an operator to locate a high reading for lateral runout by viewing the gauge 26; often, the operator is required to "bump" the motor to relocate the high point once it has been identified. Moreover, even if the operator correctly locates and/or relocates the high point of lateral runout, human errors are often introduced during the adjustment process. For example, selecting the correct screw or screws 24 and applying the precise amount of torque necessary for adjustment is often difficult and imprecise.

The difficulties and limitations suggested in the preceding are not intended to be exhaustive, but rather are among many which demonstrate that although significant attention has been devoted to disc brake lathes, such systems will admit to worthwhile improvement.

US-A-5615589 discloses a runout compensator to assist in machining brake rotors that have been removed from a vehicle. A technician manually adjusts the runout compensator to achieve proper alignment.

It is therefore a general object of the invention to provide a novel on-car disc brake lathe system which will obviate or minimize difficulties of the type previously described, and another general object is to provide a novel runout measurement and control system for an on-car disc brake lathe that accurately detects and quantifies the runout of a lathe apparatus with respect to a vehicle hub assembly.

It is yet another general object of the invention to provide a novel automated alignment apparatus for an on-car disc brake lathe that adjusts the axial alignment of the lathe in accordance with information produced by a runout sensing and control system.

It is a specific object of the invention to provide a novel runout measurement and control system for an on-car disc brake lathe that directs a corrective signal to an automated control system for adjustment.

It is a specific object of the invention to provide a novel on-car disc brake lathe apparatus which eliminates the need for manual adjustment by an operator in order to compensate for lateral runout.

It is another specific object of the invention to provide a novel on-car disc brake lathe apparatus system which will accurately and consistently measure and adjust for runout.

It is still another specific object of the invention to provide a novel on-car disc brake lathe apparatus which will significantly reduce the time required for a complete brake disc lathing operation.

It is still yet another specific object of the invention to provide a runout measurement and control system for an on-car disc brake lathe having a processing unit for accurate and reliable data evaluation.

It is another specific object of the invention to provide a runout measurement and control system for an on-car disc brake lathe that advises an operator or directs an electrically controlled system to perform an axial alignment of the lathe and vehicle hub.

It is still another specific object of the invention to provide an automated alignment device for an on-car disc brake lathe that accurately adjusts the relative angle between the vehicle hub's axis of rotation and the lathe's drive shaft.

It is yet another specific object of the invention to provide an automated alignment apparatus for an on-car disc brake lathe that, when used with a suitable control system, will reduce the total lateral runout of the lathe with respect to the vehicle hub assembly to within acceptable manufacturing specifications.

It is a further specific object of the invention to provide an automated alignment apparatus for an on-car disc brake lathe that is simple, accurate, capable of computer control, and low in cost.

It is another specific object of the invention to provide a runout measurement and control system for an on-car disc brake lathe that senses rotational accelerations while rejecting linear accelerations in any of the three dimensional axes.

It is another specific object of the invention to provide a runout measurement and control system for an on-car disc brake lathe that senses rotational that it is a one piece mechanism mounted securely to the lathe and not subject to operator error during setup.

**SUMMARY OF THE INVENTION**

According to a first aspect of the present invention, an on-vehicle disk brake system comprises a lathe body with a driving motor; a cutting head operably attached to the lathe body; a drive shaft; and an alignment system which comprises:

- a sensor operable to produce a signal indicative of movement of the lathe body with respect to the vehicle brake assembly;
- an input adaptor attached to the drive shaft to rotate with the drive shaft;
- a hub adaptor configured to be attached, in use, to a hub of a vehicle and to rotate with the drive shaft; and
- an adjustment mechanism coupled to the input adaptor and the hub adaptor for adjusting alignment of the lathe body and the cutting head relative to an axis of rotation of the hub;

characterised in that an electronic controller responds to the sensor so as provide a control signal to cause the adjustment mechanism to automatically adjust axial alignment of the input adaptor with respect to an axis of rotation of the hub adaptor, whereby any movement of the lathe body is reduced, and in that the adjustment...
mechanism comprises at least one stop disc coupled to the input adaptor and operable to selectively follow the rotation of the drive shaft or to rotate relative to the draft shaft in response to said control signal, and at least one adjustment component associated with the stop disc and operable to rotate in response to the relative rotation of the stop disc, whereby the axial alignment of the input adaptor relative to the hub adaptor varies with respect to the rotational orientation of the adjustment component.

[0033] According to a second aspect of the present invention, a method of resurfacing a disk grace comprises:

- providing an on-vehicle brake lathe system having a lathe body with a drive motor; a cutting head operably attached to the lathe body, and a rotatable drive shaft securing the on-vehicle brake lathe system to the vehicle;
- initiating rotation of the brake disc;
- producing a signal indicative of movement of the lathe body relative to the vehicle brake assembly as the drive shaft rotates; and
- using the signal, as the drive shaft rotates, to automatically adjust the orientation of the lathe body relative to the vehicle brake assembly so as to reduce any such movement, thereby maintaining alignment of the lathe body relative to the vehicle brake assembly, including adjusting the orientation of the lathe body relative to the vehicle brake assembly in a first direction; and if the adjustment in the first direction reduces movement of the lathe body, continuing to adjust the orientation of the lathe body relative to the vehicle brake assembly in the first direction until the adjustment increases movement of the lathe body, and after adjusting the orientation in the first direction which increases movement of the lathe body, adjusting the orientation of the lathe body relative to the vehicle brake assembly in a second direction; and if, the adjustment in the second direction reduces movement of the lathe body, continuing to adjust the orientation of the lathe body relative to the vehicle brake assembly in the second direction, until the adjustment improves the alignment of the lathe body.

**DRAWINGS**

[0034] Other objects and advantages of the present invention will become apparent from the following detailed description of the invention, taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a graphical representation of a lateral runout phenomenon.

FIGURE 2 is a plan view showing an on-car disc brake lathe and depicting a prior art procedure for measuring, and compensating for lateral runout of a disc brake assembly.

FIGURE 3 is a perspective view showing an on-car disc brake lathe mounted on the hub of a vehicle in preparation for a disc resurfacing operation in accordance with the present invention.

FIGURE 4 is a partially sectional schematic view of a disc brake lathe with an automatic alignment apparatus of the first preferred embodiment of the present invention mounted on the hub of a vehicle.

FIGURES 5a and 5b are cross-sectional and front views, respectively, of the automatic alignment apparatus of the first preferred embodiment of the present invention.

FIGURES 6 and 9 are cross-sectional views of the adjustment disc assemblies of the automatic alignment apparatus of the first preferred embodiment of the present invention.

FIGURES 7a and 7b are front cross-sectional views of one of the adjustment disc assemblies of the automatic alignment apparatus of the first preferred embodiment of the present invention.

FIGURES 8 and 9 are cross-sectional views of the adjustment disc assemblies of the automatic alignment apparatus of the first preferred embodiment of the present invention.

FIGURES 10a and 10b are cross-sectional and side views, respectively, of the automatic alignment apparatus of the second preferred embodiment of the present invention.

FIGURE 10c is a front and cross-sectional views of an adjustment disc of the automatic alignment apparatus of the second preferred embodiment of the present invention.

FIGURE 10d is a front and cross-sectional views of a slant disc of the automatic alignment apparatus of a pivot ring of the second preferred embodiment of the present invention.

FIGURES 11a and 11b are schematic representations of the compensation vector and compensation alignment angle of the automatic alignment apparatus of the second preferred embodiment of the present invention.

FIGURE 12 is a cross-sectional view of the automatic alignment apparatus of the third preferred embodiment of the present invention.

FIGURES 13a and 13b are front views of the input and output adaptor assemblies and a front view of the drive arm assembly, respectively, of the automatic alignment apparatus of the third preferred embodiment of the present invention.

FIGURE 14 is a front view of the starwheel stop mechanism of the of the automatic alignment apparatus of the third preferred embodiment of the present invention.

FIGURES 15a-g is a timing diagram of the star-
wheel stop operation of the automatic alignment apparatus of the third preferred embodiment of the present invention.

[0036] Referring to Figure 4, the subject invention is now described with reference to Figures 4 through 9. Referring to Figure 4, there is shown a lathe 48 having an automatic alignment mechanism 50, the lathe housing or body 52, hub adaptor 54, and drawbar assembly 56. The drawbar assembly includes a drawbar 58 that extends through the body 52 and alignment mechanism 50 and is operably connected to the adaptor 54 by a threaded connection (as shown) or the like. A calibrate knob 60 is tightened during the automated alignment sequence of the lathe and after alignment is complete, a run knob 62 is tightened for the cutting operation. Spring 64 is a bellows washer that provides a loading force on bar 58 which in turn runs through the components of the lathe.

[0037] Referring to Figure 5a there is shown a cross-sectional view of the auto alignment coupling 50 of the preferred embodiment. An input adaptor 66 is operably attached to a rotating drive shaft of the lathe machine (shown in phantom in Figure 4). Shaft 68 is attached to the input adaptor 66 such that the adaptor 66 mounting face is perpendicular to the shaft 68 axis so that shaft 68 runs true with the lathe machine axis.

[0038] Two slant or adjustment disc assemblies 86 and 88 are provided to be interposed between the input adaptor 66 and an alignment drive disc 70 which is attached to the shaft 68 and caused to rotate with it by a key 72 and set screw 74. A pivot plate 76 is operably attached to an output adaptor 78 and mounted to the shaft 68 by spherical bearing 80 so that the pivot plate 76 can pivot in relation to shaft 68 while being constrained from radial movement.

[0039] A pin 82, inserted into pivot plate 76, fits into a slot 84 at the periphery of the drive disc 70 and causes the pivot plate 76 to be rotationally coupled to the shaft 68 and input the adaptor 66. As such, when the input adaptor 66 is mounted on the lathe machine's drive shaft and the output adaptor 78 is mounted on the automobile brake disc adaptor 54, the lathe machine output rotation will cause the automobile brake disc adaptor to rotate, in turn causing the brake disc to rotate.

[0040] The slant or adjustment disc assemblies 86 and 88, which are mirrors of each other, are placed between the input adaptor 66 and the output adaptor 78 as shown. The axial force produced by the axially mounted drawbar 58, that mounts the output adaptor 78 to the automobile brake disc hub, causes the output adaptor 78 to be forced against slant disc assembly 88 and to assume an angle to the shaft 68 that depends upon the relative rotational positions of the slant disc 90 and 92.

[0041] Referring to Figure 6, adjustment disc assemblies 90 and 92 are shown in parallel and in positions of maximum angular runout. Control of the relative position of the slant discs 90 and 92 is accomplished while the lathe machine output shaft is driving the automobile brake disc hub. Specifically, by stopping the rotation of stop disc 94 or 96, its associated slant disc is caused to rotate in relation to the other slant disc, thus producing a change in angle of the output of the adjustment disc assemblies 86 and 88, causing the angle of the output
adaptor 78 to change in response. This causes a change in the angular alignment of the lathe machine axis and the automobile brake disc axis.

[0042] As shown in Figures 5a and 5b, the stop discs 94 and 96 are selectively stopped by powering a respective electromagnetic catch 98 and 100. The catches are controlled by an microprocessor system that operates in conjunction with a runout measurement and control mechanism described in more detail below. The lathe machine output shaft rotates at a speed that is too fast (for example, 123.14 RPM) to allow stop and release of a stop disc and associated slant disc for adjustment. As such, the rotation speed of the adjustment components is slowed by using a gear train contained in each of the slant disc assemblies. The gear train will extend the time permitted for adjustments in a given 1/2 revolution of the shaft 68 (i.e. the time it takes stop pin 114 to stop the relative rotation of the slant discs in 1/2 revolution for maximum angular runout adjustment). For example, the time will extend at 123.14 RPM shaft rotation from .243 seconds for 1/2 revolution of the shaft 68 to 3.297 seconds thereby permitting easy and complete adjustment of the slant disc assemblies 86 and 88.

[0043] Referring to Figures 6 and 7a, the preferred gearing mechanism comprises a gear 102 containing 88 teeth, and gear 102 is coupled with key 104 to rotate with shaft 68. Gear 106 contains 38 teeth and is mounted on a pivot 108 formed on stop disc 94. Thus, when stop disc 94 is stopped by the electromagnetic catch 98, gear 106 rotates at a much faster rate than shaft 68. For example, if shaft 68 rotates at 123.14 RPM, gear 106 rotates at 285.166 RPM. A gear 110, also mounted on pivot 108, is provided with 36 teeth and is pinned to gear 106 to rotate therewith. Gear 110 is coupled to a gear 112 that is provided with, for example, 90 teeth. As such, gear 112 rotates at 114.06 RPM, or .926X the rotational speed of shaft 11, rotating backwards in relation to shaft 68 and slant disc 92. Because slant disc 90 is pinned to gear 112, it also moves backwards in relation to shaft 68 thereby adjusting the relative position of the slant discs 90 and 92. The gear arrangement and stop discs of the present invention permits the adjustment of the slant disc assemblies, and therefore, the alignment of the lathe drive axis and the hub axis, without the need for a separate motor or power source. It is to be understood that the identified gear ratios and rotation speeds are practical examples and are not intended to limit the scope of the invention hereof. When the stop disc 94 is released, it and slant disc 90, in its new position, again rotates at the rate of the shaft 68.

[0044] A stop pin 114 secured to slant disc 92 stops the relative rotation of the slant discs at 1/2 revolution, with stop disc 94 being parallel with stop disc 96 at one extreme to maximum angular runout at the other extreme. Specifically, by stopping the rotation of both stop discs 94 and 96, adjustment disc 90 and 92 remain fixed in relation to each other. Stopping the rotation of stop disc 94 alone until stop pin 114 couples to slant disc 90 causes stop disc 96, and thus output adaptor 78, to assume the maximum angular runout position.

[0045] Referring to Figure 8, the adjustment disc assemblies 86 and 88 and associated adjustment discs 90 and 92 are rotated in relation to each other so that the "slant" or wedge on respective interfaces complement each other and the input surface of the assembly is parallel with the output surface. This is accomplished by stopping the stop disc 94 until the pin 114 couples with the slant disc 90. Thus the output adaptor 78 "runs true" to the input rotation axis. The angle of the interface of the two slant discs has been exaggerated in the figures for clarity. The angle could be of a dimension that depends on the application of the lathe, but could be in the order of 0.323 degrees. It is noted that because the input adaptor 66 is solidly mounted to the shaft 68 and its face is perpendicular to the axis of rotation, the adaptor 66 serves as a positioning reference to the slant disc assembly 86. Referring to Figure 9, the slant disc assemblies 86 and 88 with the discs are rotated in relation to each other by stopping the stop disc 96 until the pin 114 couples to the slant disc 90. In this position, the slant angle on the two slant discs add to each other causing the output surface of the assembly and the output adaptor 78 to display maximum angular runout with the input rotation axis.

[0046] With the novel alignment adjustment system of the present invention, the runout caused by a misalignment between the vehicle's hub axis and the axis of the lathe can be corrected without the time consuming and inaccurate manual methods of the prior art. With the novel system, additional adjustment motors are not necessary and accurate and automated realignment is possible when the novel alignment system is operated in conjunction with a measurement and control system of the type described below.

[0047] A second preferred embodiment incorporates the fundamental features of those disclosed with respect to the first embodiment, but permits adjustment with only one slant disc and the output pivots in one selectable axis only when driven by the slant disc. In the first preferred embodiment, the compensation vector (explained in more detail with reference to Figures 11a and 11b) necessary to adjust the angle of the output adaptor 78 could potentially require adjustment of two slant discs. The fixed pivoting axis of the second preferred embodiment eliminates this problem, requiring only one adjustment, potentially reducing the time required for shaft alignment.

[0048] Referring to Figure 10a, there is shown a cross-sectional view of the automatic alignment coupling or mechanism 120 that occupies the same position of the mechanism 50 of the first embodiment shown in Figure 4. Input adaptor 122 attaches to the rotating shaft of the lathe machine. Shaft 124 is attached to the input adaptor 122 such that the adaptor 122 mounting face is perpendicular to the shaft 124 so that shaft 124 runs true with the lathe machine axis. A second shaft 126 is
placed over the shaft 124 and the rotated position of the second shaft 126 relative to shaft 124 is controlled by the stop disc assembly 128. The stop disc assembly 128 contains a gear train and operates similarly to the stop disc assemblies 86 and 88 of the first preferred embodiment. However, in this case, instead of driving a slant disc when the stop disc 130 is stopped by an electromagnetic catch, the second shaft 126 is driven and moves backwards relative to the shaft 124. Rotary movement of the shaft 126 also controls the rotary position of a pivot ring assembly 132 which is firmly attached to the second shaft 126. An output adaptor 134 is mounted on the shaft 124, held in place by a clamp ring 136, and caused to rotate with the shaft 124 by a drive disc 138.

[0049] A second stop disc assembly 130, containing a gear train, is mounted on the second shaft 126 and operates similar to stop discs 94 and 96 of the first preferred embodiment with the output of the gear train driving a single slant disc 140 detailed in Fig. 10c. When stop disc 130 is stopped, the slant disc 140 moves backward in relation to shaft 124. The axial force produced by an axially mounted drawbar 58, note again Figure 4, causes the output adaptor 134, through the pivot ring 132 to assume an angle to the shaft 124 depending upon the rotated position of slant disc 140.

[0050] Referring to Figure 10b, there is shown a cross-sectional view of automatic alignment mechanism rotated 90 degrees counterclockwise about the input axis of Figure 10a. The pivot ring 132 does not rest against the stop disc assembly 130 over its entire surface. Rather, there are 2 "bumps" diametrically placed on the face of the pivot ring 132 which rest against the stop disc assembly 130. This allows the slant disc 140 to transmit its angle to the pivot ring 132 but allows the pivot ring 132 to pivot on its fixed axis pins 142. Thus, once set, the compensation vector (explained in more detail with reference to Figures 11a and 11b) necessary for alignment does not change when the slant disc 140 varies the output compensation angle. Referring to Figure 10d, there is shown the pivot ring assembly 132 in more detail. Specifically, by making one of the "bumps" on the pivot ring 132 a certain amount larger than the other, the pivot ring 132 is made perpendicular to the shaft 124 at one extreme position of slant disc 140 and at maximum compensation angle at the other extreme. A 1/2 degree variance, for example, is provided between the bumps as shown in Figure 10d. Similarly, a 1/2 degree variance between the bumps on slant disc 140 is provided as shown in Figure 10c. Thus, when the slant disc 140 and the pivot ring 132 are placed against the disc 130 with the 1/2 degree face angles complementing each other, a 0 degree runout between the input to output adapters is achieved. On the other hand, when the discs are rotated 180 degrees relative to each other, the angles oppose each other and the runout input and output is 1 degree.

[0051] Referring now to Figures 11a and 11b, there is shown a schematic depicting the relationship between the compensation vector, compensation angle, and pivot axis contemplated by the alignment device of the present invention. Generally, two parameters are of importance when aligning the rotating shafts of the lathe and brake hub. The first parameter referred to as the "compensation vector" is defined by the a rotation position at which the lateral runout deflection of the brake lathe is the greatest. The second parameter referred to as the "compensation angle" is defined by the angle that the input adaptor and the output adaptor must assume in relation to each other in order to compensate for this lateral runout. In the second embodiment, the compensation vector and the compensation angle can be adjusted separately as shown in Fig. 10a.

[0052] However, in the first and third (described below) embodiments, the compensation vector is adjusted by "stopping" simultaneously the input disc and output disc. This does not affect the relative rotational positions of the discs and thus does not change the input to output angle. Rather, adjustment of the compensation vector only changes the rotational position where the disc's angle changing capability is effective. The compensation angle is adjusted by "stopping" the output disc only, which rotates it in relation to the input disc and thus changes the input to output angle.

[0053] Referring now to Figures 12 through 16 there is shown a third preferred embodiment of the present invention. The third preferred embodiment is similar to the first preferred embodiment differing in that the slant discs are separated from each other and from the input and output adapters by pin roller thrust bearings to allow free rotation of these elements under normal axial pressure; the rotational positioning of the slant discs relative to each other and to the input and output adapters is performed by actuating four "starwheels" which drive the slant discs through gear trains; and both forward and reverse positioning capability of the slant discs is provided which allows a considerable decrease in time to final alignment.

[0054] Referring to Figure 12, there is a cross-sectional drawing of an automatic alignment coupling or mechanism 144 that occupies the same position of the mechanism 50 of the first embodiment shown in Figure 4. An input adaptor 146 attaches to and is rotationally driven by the output shaft of the brake lathe. Adaptor 146 contains two "starwheels" 180 and 182 which drive gear trains which ultimately position an input slant disc 152, described in more detail with reference to Figure 13a. An adaptor cover 154 serves as a cover for the gearing and as a bearing surface which runs perpendicularly true to the shaft 156 which is attached to input adaptor 146.

[0055] Thrust bearing assembly 158, with its two race rings, are place between input slant disc 152 and the bearing surface of adaptor cover 154. This bearing assembly allows free rotation of the slant disc 152 relative to the input adaptor 146 and the attached shaft 156 while
automatic alignment mechanism is under axial pressure in normal operation. Output slant disc 160 is separated from slant disc 152 by a thrust bearing assembly 162 identical to thrust bearing assembly 158 to allow output slant disc 160 to freely rotate under axial pressure. A third thrust bearing assembly 164 is placed between output slant disc 160 and the output adaptor cover 166, again to allow free rotation of the output slant disc 160.

Output adaptor 168 contains the same "starwheel" and gearing assembly as does input adaptor 146. It differs in that it is free to move to an angle that varies as much as 1 degree, for example, from perpendicular to the shaft 156 axis. Output adaptor 158 is rotationally coupled to the shaft 156 by means of a drive arm 170 that is keyed to the shaft 156. Referring to Figure 13b, there is shown the input side of the output adaptor 168 without the starwheel and gears for clarity. The drive arm 170 is shown in place with key 172 coupling it to the shaft 156. A drive pin 174 is positioned in the output adaptor 168 and fits in the slot 176 of the drive arm 170 to cause the output adaptor 168 to rotate with the shaft 156 while allowing the output adaptor 168 to tip angularly in relation to the shaft 156.

Referring to Figure 12, a collar 178 serves as both a bearing surface for the inside diameter of output adaptor 168 and a shoulder to prevent the disassembly of the parts when the auto align mechanism is not operating under axial pressure. A wave washer 153 or the like is placed between input slant disc 152 and input adaptor 146 in order to provide some friction so that rotation of output slant disc 160 will not cause unwanted rotation of the input slant disc 152.

Referring to Figure 16, there is shown a novel alignment process flow diagram as specifically exemplified with reference to the third preferred embodiment. It is noted that any suitable measurement device could be used in conjunction with the alignment mechanism. Preferably, however, a novel sensing and measuring device of the present invention as described below is utilized to operate in conjunction with the novel alignment mechanisms described above. It is also noted that although the alignment process is shown and described in Figure 16 with reference to the third preferred embodiment, the general process algorithm is applicable to all embodiments of the present invention. Furthermore, the novel alignment apparatus and process may also be advantageously utilized in other practical applications in order to align two concentrically rotating shafts.

In general, the flow diagram of Figure 16 shows a sequence of "trial and error" adjustments wherein an adjustment is initially made by stopping a star wheel on one of the adapters and measuring the change in the runout or alignment. If the runout improved, an additional adjustment is ordered in the same direction. If the alignment worsens, an adjustment in the opposite direction is ordered. This process is repeated until the alignment is corrected to within specifications and the lathe shaft and hub axes are aligned. Two distinct periods of adjustment are employed in the present invention. A first cycle takes place wherein large adjustments are made in the orientation of slant discs 152 and 160 to more significantly change the alignment of the shaft and hub axes, and thereby correct runout. Once alignment reaches a predetermined low level, finer adjustments are made to correct runout to within specified tolerances.

Referring to Figure 14, the runout correction process begins with initialization of several variables. At step 302, the stop level of stop mechanism 194 is set to three actuations of the starwheels. This provides the large movements of slant discs 152 and 160 at the beginning of the adjustment cycle. Also at step 302, sev-
eral internal counts and limits are initialized including flag Z, flag D, and a try counter. Also, the initial specification value is supplied which represents an acceptable level of runout. Typically, this value is set to be in the order of 25x10⁻⁶m (.001 inch). The try counter operates when runout drops to a "Min" value. This counter causes the value of "Spec" to increase after the system tries to reach the present "Spec" runout value a programmed number of tries or cycles. This prevents the system from trying to forever reach a runout value that is impossible given the circumstances.

[0065] An initial evaluation of the runout is made at step 303 and this quantity is stored a R-pres, representative of a base value of the runout. Step 304 provides for a comparison of the measured runout with a runout measurement that conforms to specification, usually on the order of .001 inches as noted above. If the runout is less than 25x10⁻⁶m (.001 inches), the runout is determined to fall within specified tolerances ("Spec") and no further compensation is required as is indicated in step 310. At step 306, the value of R-pres is copied into the memory location of R-last. Next, if R-pres does not exceed a predetermined level "Min" (step 307), the stop mechanism 196 is set to stop one tooth of the starwheel 180 or 182 per revolution as indicated in step 308. At step 309, the try count is incremented and at step 310 the try count is evaluated such that if the try count is at a limit, the runout "Spec" limit is raised (step 311) and the try count is reset to 0 (step 312). The higher "Spec" limit usually consist of a value that is still acceptable but less preferred than the original "Spec" limit (e.g. 25x10⁻⁶m (.001 inch). For example, 75x10⁻⁶m (.003 inch higher) "Spec" is acceptable.

[0066] At step 313, the flag Z is tested to determine if starwheel actuation has run in both directions. That is, whether both output 180 (forward) and 182 (reverse) starwheel have been activated. At step 10, if the Z flag has not been toggled twice, then the program proceeds to step 315 to determine the state of flag D and if the Z flag has been toggled has been toggled twice, then step 314 toggles flag D. If D equals 0, then the output only starwheel is actuated changing the "compensation angle" of the system. If D equals 1, both the output and input starwheels are actuated to change the "compensation vector" of the system.

[0067] At step 318, the system waits for one of two revolutions of the lathe (depending on whether the accelerometer is operating in mode 1 or mode 2 as described below) before proceeding in order to allow transients introduced by the last starwheel adjustment to dissipate. At step 319, the runout is again measured. In step 320, if runout is less than Spec (e.g. 25 or 75x10⁻⁶m (.001 or .003 inches) the system progresses to step 305 and the runout adjustment is complete. At step 321, the runout from the present measurement, R-pres, is compared to the runout from the last measurement, R-tast. If R-pers is less than R-tast, the system progresses to step 306 where R-pres is copied into R-last and the process continues through another iteration and the same starwheel previously actuated is again actuated. If, on the other hand, R-pres is greater than R-tast, the system progresses to step 322 where flag Z is toggled to its opposite state. Control is then passed back to step 306 where in turn the other starwheel of the starwheel pair is actuated to cause rotation of the adjustment disc in an opposite direction.

[0068] In this manner, the system employs a trial and error approach to reducing runout. As long as the runout continues to decrease, additional actuations of the same starwheel occur. However, if runout worsens, the opposite starwheel is actuated to begin to correct the runout. If this forward and reverse cycle does not improve the runout, the compensation vector is adjusted by moving both of the input and output adjustment discs. A microprocessor and suitable circuitry controls the operation of the present invention as described below with reference to Figure 23.

[0069] The alignment adjustment system of the present invention is a substantial improvement over prior art devices and techniques. Once the appropriate sensor and measuring system is properly secured (for example, one of the novel systems disclosed below), the automatic alignment system provides for mechanical compensation of the total lateral runout present in the disc brake assembly. Specifically, the alignment system adjusts the alignment of the brake lathe component with respect to a vehicle hub in order to compensate for lateral runout. This, in turn, ensures that the cutting head 36 is placed perpendicular to the rotation axis of the hub 44.

Lateral Runout Measurement and Control System

[0070] The apparatus and method for runout compensation disclosed above serves to align the lathe and rotor axes under the direction of an angular runout sensing and control mechanism of the present invention. However, it is to be understood that the runout sensing and control mechanism described herein may be used with any suitable sensor that is responsive to angular acceleration or variations in the distance between the cutting tool end of the lathe body and the auto under consideration. In the present invention, the runout sensor preferable takes the form of an electronic accelerometer. The novel measurement and control system may also be advantageously utilized in other practical applications in order to align two concentrically attached rotating shafts.

[0071] Referring to Figures 17 and 18, there is shown a brake lathe assembly, coupled through an auto align mechanism of the type shown and described above to a wheel axle. The lathe tools are shown at the end of the brake assembly mechanism arm, arranged to move from the center of the brake disc toward the outside while the drive motor causes the wheel and brake disc to rotate as described above. The solid lines show the
mechanism position when the wheel axis and the lathe axis are in alignment. Under these conditions the lathe tools cut the disc surfaces smoothly.

[0072] However, where runout is present, the lathe will rotate back and forth when in use. The dotted lines show the wobbling of the lathe mechanism when the wheel axis and the lathe axis are misaligned (in the drawing the runout is greatly exaggerated). Obviously, with the lathe mechanism and tools wobbling the brake disc lateral runout is cut into the rotor and such operation is not acceptable. Note that at the “X” point the mechanism changes its position not only linearly but also in a rotational sense perpendicular to the drive axis. That is, the angle of the mechanism changes cyclically as the wheel is rotated.

[0073] It is at this point that the sensing devices of the runout sensing and control mechanism of the present invention are preferably placed in order optimize measurement sensitivity. Preferably, the sensing devices are additionally positioned such that the internal rotor axis (as described below) is perpendicular to the lathe drive axis.

[0074] Referring to Figure 18, there is another misalignment mode which can occur when the wheel axis and the lathe axis are in misalignment. This is off-center misalignment. With this, the motion of the lathe mechanism contains only linear components while no angular runout occurs, therefore no rotational motion perpendicular to the drive axis occurs. This runout motion does not detract significantly from the smooth cutting of the brake disc surface and can be allowed. For this reason, it is an objective that the sensing device of the present invention sense only the rotation components impressed upon its housing while rejecting all linear motions.

[0075] A variety of different sensing configurations can be used as a part of the runout sensing and control mechanism of the present invention. Generally, there are two operating modes employed in utilizing the rotary accelerometer as a runout detector. In a first mode the natural frequency of resonant motion of the rotor-transducer is configured (as explained below) to be about 1.5 times the frequency of lathe rotation. In this mode configuration, the accelerometer achieves the most rapid following of the changes in runout and therefore, often the most rapid alignment due to damping inherent in the frequency differential. However, the runout sensitivity of the system is less than 1/2 that of mode two. In mode two, the natural frequency of resonant motion of the rotor-transducer is configured to be below the frequency of lathe rotation. This provides the most sensitivity to runout and helps to suppress harmonics in the runout motion which can cause alignment uncertainty. However, this mode configuration is slower in following changes in runout which may slow alignment as compared to mode configuration one. In any event, the natural frequency of resonant motion should never be placed at the frequency of lathe rotation because operating in resonance with the lathe results in an unnatural buildup of rotor-transducer motion which doesn't allow the accelerometer output to immediately follow the runout magnitude, seriously slowing the alignment process.

[0076] Independent of the operation mode, several considerations are relevant in implementing each of the embodiments of the inventive accelerometer. First, the accelerometer rotor should be completely balanced in order to insure measurement of rotational accelerations, while rejecting linear accelerations. Second, the rotation of the rotor should be physically limited such that rotation only occurs within the sensitive area of the transducer. Finally, the natural frequency of resonant motion of the rotor-transducer should be configured to operate in either mode 1 or 2 as already discussed above. In this regard, the natural frequency depends on several variable including mass of the rotor, diameter of the rotor, and characteristics of a spring element (e.g. music wire).

[0077] The accelerometer embodiment using a piezo-electric element as a sensor (described below) is best suited to operating where the natural frequency of resonant motion is about 1.5 times the frequency of lathe rotation because some force is required to bend the element tending to cause a high spring rate: The other transducer schemes described below are non-contact devices and the spring rate can be dictated by spring selection. In this regard, these embodiments are well suited to either mode one or mode two operation.

[0078] In a first embodiment as shown in Figure 19 there is a rotary accelerometer sensor 210. Sensor 210 comprises a housing 212 that encloses a rotor 214 mounted for rotation on bearings 216 and 218. The rotor 214 is carefully balanced so that all accelerations except rotational cause no rotation of the rotor 214. Rotation of the rotor 214 is sensed by a piezo electric element 220 which is mounted between the housing 212 and the rotor 214 and is bent by any rotation of the rotor 214 producing a voltage proportional to the magnitude of bending. Rotation of the rotor 214 is limited to protect the piezo electric element 220 by piezo element mount 220 in the slot 222 in the rotor 214.

[0079] The piezo disc 220 and the rotor 214 operate as a spring and mass system having a natural frequency of resonant motion as generally described above. In this spring/mass system, the rotor constitutes the mass and the piezo disc 220 constitutes the spring. In this embodiment, the system operates in mode one such that the rotor mass and diameter and the piezo spring quality is adjusted to obtain a frequency in the order of 1.5 times the frequency of lathe rotation. It is of further importance that the rotor 11 be suitably damped in order to minimize the settling time. This can be achieved by filling the housing 10 with a viscous fluid and sealing the housing with a cover. Alternatively, damping can be provided by using a clinging viscous material in the bearings 12 and 13. Other damping techniques are considered to be within the scope of the invention. A resultant signal, whose amplitude is proportional to the magnitude of the
angular runout, is then directed to a control system as described below with reference to Figure 23.

[0080] The sensing device of the present invention may also be configured with alternative transducing elements that provide a suitable control signal. For example, the inventive sensor may be sensing element comprising an accelerometer with a tuned coil oscillator. Referring to Figure 22, the spring component of this system comprises a wire (preferably music wire) 244 that is attached to the body 256 and rotor 246 as shown. The wire may be attached by any suitable means such as, for example, brackets as shown in Figure 22. As previously noted, the natural frequency of resonant motion of the rotor-transducer is dependant on the mass and diameter of the rotor and spring characteristics. When using a music wire 244 to control frequency a shown, the tension of the wire 244 and the wire 244 gage are manipulated to vary the frequency. For example, to achieve a natural frequency or resonant motion of the rotor-transducer that is below the frequency of lathe rotation, a gage in the range of approximately 9-10 thousandths is utilized and the wire tension is configured to be relatively loose. On the other hand, to achieve a natural frequency of resonant motion of the rotor-transducer that is about 1.5 times the frequency of lathe rotation, a gage in the range of approximately 16 thousandths is utilized and the wire tension is configured to be relatively tight.

[0081] A ferrite or the like disc 248 is placed in the periphery of the rotor 246 adjacent to a housing-mounted coil 250 which forms the -L- of an oscillator circuit 252. When the rotor 246 turns, the ferrite disc 248 moves in relation to the coil 250, causing a change in the inductance of the oscillator coil 250, thus a change in the frequency of oscillation. A discriminator 254 converts the change in frequency of oscillation to a varying DC voltage. This varying voltage reflects the rotation of the accelerometer housing 256. The signal is then forwarded to a control system as described below with reference to Figure 23.

[0082] As previously noted, it is important to configure the rotor such that it is balanced. In order to limit the rotation of the rotor such that rotation only occurs within the sensitive area of the transducer, a counterbore 245 is provided that cooperates with a pin 247 to limit rotor rotation as appropriate. Other limiting means are within the scope of the invention.

[0083] In an alternative embodiment the sensing device is an accelerometer with a magnet-hall effect transducer as shown in Figure 20. In this configuration, a leaf spring 222 has a spring rate which, in combination with the inertia of the rotor 224, provides a resonant frequency about 1.5 times the rotational rate of the brake lathe shaft (i.e. operation in mode one). Alternatively, the accelerometer of this embodiment could be configured to operate in mode one or two using a music wire as described above. A magnet 226 is placed in the periphery of the rotor 224. A Hall effect transducer 228 with a linear characteristic is placed in the housing 230 adjacent to the magnet 226 such that rotary motion of the rotor is reflected in the output voltage of the hall effect transducer 228. The magnitude of the AC voltage at the output of the hall effect transducer 228 is a reflection of the rotary motion of the accelerometer housing 230 that is attached to the lathe, preferably at the position identified with reference to Figures 17 and 18. The resulting signal is forwarded to a control system as described below with reference to Figure 23.

[0084] In yet another alternative embodiment, the sensing element comprises an accelerometer with an infrared generator. Referring to Figure 21 and 21a, there is shown a leaf spring 232 that preferably has a spring rate which, in combination with the inertia of a rotor 234, provides a resonant frequency about 1.5 times the rotational rate of the brake lathe shaft. Again, this accelerometer could alternatively be configured to operate in mode one or two using a music wire as described above. An infrared generator diode 236 is placed facing an infrared detector diode 238 on the housing 240 near the periphery of the rotor 234.

[0085] A shutter 242 is attached to the rotor 234 and projects between the IR generator 236 and IR detector 238 such that rotary motion of the rotor 234 varies the amount of radiant energy transferred, causing the voltage out of the IR detector 238 to reflect the magnitude of housing 240 rotation. Again, this measurement reflecting the runout of the disc coupling. The signal is forwarded to a control system as described below with reference to Figure 23.

[0086] The runout sensing and control mechanism of the present invention further comprises a control circuit which is now described with reference to Figure 23. Transducer 400 may be advantageously comprised of any of the several different types of sensors designed to evaluate the rotational acceleration of the lathe as set forth below. Because lateral runout manifests itself in varying rotational motion imparted to the lathe, any sensor arrangement capable of producing an accurate qualitative measure of rotational acceleration may be utilized. The preferred structured herein utilizes an inertial disc and piezo electric element as transducer 400, as described in greater detail below. The output of transducer 400 is fed to amplifier 402 and then to rectifier 404. Because runout produces a cyclical motion in the lathe, the signal produced by transducer 400 is sinusoidal in nature; however, at lower runout levels other wave forms could resonate. After amplification by amplifier 402 and rectification by full wave rectifier 403, the peak runout signal is used to control an integrator 404 that is reset at the lathe rotation cycle as indicated. The signal is then sent to a sample and hold circuit 407. A hall pickup timer 405 produces a synchronization signal as shown. The output is then transmitted to A/D converter 408 which samples the voltage level and produces a digital representation thereof. The output of A/D converter 408 is passed to both latch 410 and microprocessor 412.
The output of latch 410 is also provided to microprocessor 412. Latch 410 is a conventional sample and hold latch and is clocked just prior to the time A/D converter 408 presents a new sample. In this manner, both the current sample taken by A/D converter 408 and the last sample taken by A/D converter 408 are available to microprocessor 412. At the output of microprocessor 412 there is provided amplifiers 414 and 416 which are used to drive stop mechanism 196.

[0087] Taken in conjunction with the algorithm set forth in Figure 16, microprocessor 412 is thus provided with a stream of samples of the runout of the rotor under consideration, together with a sample representing the last historical value of the runout. In this manner, the microprocessor implements the trial and error approach described above with respect to Figure 16.

**SUMMARY OF MAJOR ADVANTAGES OF THE INVENTION**

[0088] After reading and understanding the foregoing detailed description of an inventive on-car brake lathe with automatic alignment system and process in accordance with preferred embodiments of the invention, it will be appreciated that several distinct advantages of the subject alignment system and process are obtained.

[0089] Without attempting to set forth all of the desirable features of the instant on-car disc brake lathe with automatic alignment system, at least some of the major advantages include providing an on-car disc brake lathe having an automated alignment assembly 50 that includes a pair of adjustment disc assemblies that are positioned between an input adaptor 66, 122, 146 and an output adaptor 78, 134, 168. Each of the adjustment disc assemblies includes an adjustment disc 90, 92, 140, 152, 160 and associated stop disc. An electromagnetic catch 98, 100 or the like is operably associated with each of the stop discs 94, 96 and operates in response to a control signal issued from a control system. When the rotation of one of the stop discs is stopped, rotational movement of the lathe drive shaft is transferred, through appropriate gearing, to a respective adjustment disc to change the relative position of the lathe drive axis and the vehicle hub axis.

[0090] In a preferred embodiment, the control algorithm and alignment process of the present comprises a series of "trial and error" adjustment inquiries in order to compensate for runout. As the lathe begins to rotate and the Hall signal provides a timing signal, and the runout level is evaluated and if within the "Spec" limit, normally .001", the alignment goes to the "Low-Ready to Cut" light and the program ends. If the runout is above the "Spec" limit, an actuation of the output forward starwheel is ordered. The runout is evaluated and if lower, added actuations of the same starwheel are ordered until an actuation causes the runout to increase. At this point, if the runout is still above the "Spec" limit, an actuation of the output reverse starwheel is ordered. If the runout is lower, further such actuations are ordered until an actuation causes the runout to increase. The previous two actions adjust the "compensation angle." At this point, if the runout is still above the "Spec" limit, an actuation of both the output and the input forward starwheels in tandem is ordered. This action adjusts the "compensation vector." The runout is evaluated and if lower, further actuations of the output and input forward starwheels in tandem are ordered until an actuation causes the runout to increase.

[0091] At this point, if the runout is still above the "Spec", an actuation of the output and input reverse starwheels in tandem is ordered. The runout is evaluated and if lower, further such actuations are ordered. If an actuation causes a runout increase, and if the runout is still above the "Spec" limit, the starwheel actuations revert to the output starwheels only mode again as described previously. This actuation sequence continues as above, trial and error, until the runout is reduced to the "Spec" limit, where the "Ready to Cut" light is illuminated and the program ceases.

[0092] A count is kept of the number of tries to reach the "Spec" runout level and when a preset number of tries is exceeded, the acceptance level is raised to about .003" and if the runout is within this level, a "Ready to Cut" light is illuminated and the program ceases. If this new higher runout level can not be reached after a preset number of tries, a "Out of Spec" light is illuminated and the program ceases. The operator is directed to check the lathe coupling to the brake disc hub and to check for bad wheel bearings, correct the problem and try the alignment cycle again. Depending on the level of runout, the system can be controlled such that 3 starwheel teeth are "caught" in each starwheel actuation for rapid adjustment or only 1 starwheel tooth is caught each actuation allowing fine adjustment of the runout level.

[0093] In describing the invention, reference has been made to a preferred embodiment and illustrative advantages of the invention. Those skilled in the art, however, and familiar with the instant disclosure of the subject invention, may recognize additions, deletions, modifications, substitutions and other changes which fall within the scope of the subject invention, as defined by the claims.

**Claims**

1. An on-vehicle disc brake lathe system for resurfacing a brake disc of a vehicle brake assembly, the brake lathe system comprising a lathe body (34,52) with a driving motor (30); a cutting head (36) operably attached to the lathe body (34,52); a drive shaft (68,124); and an alignment system (50,120,144) which comprises:
a sensor (210,226,228;236;238;244;400) operable to produce a signal indicative of movement of the lathe body (34,52) with respect to the vehicle brake assembly;

an input adaptor (66,122,146) attached to the drive shaft (68,124) to rotate with the drive shaft;

a hub adaptor (40,54) configured to be attached, in use, to a hub (44) of a vehicle and to rotate with the drive shaft; and

an adjustment mechanism (50,120,144) coupled to the input adaptor (66,122,146) and the hub adaptor (40,54) for adjusting alignment of the lathe body and the cutting head (36) relative to an axis of rotation of the hub (44); characterised in that an electronic controller (412) responds to the sensor (210-400) so as provide a control signal to cause the adjustment mechanism to automatically adjust axial alignment of the input adaptor (66,122,146) with respect to an axis of rotation of the hub adaptor (40,54), whereby any movement of the lathe body (34,52) is reduced, and

in that the adjustment mechanism (50,120,144) comprises at least one stop disc (94,96,128,130) coupled to the input adaptor (66,122,146) and operable to selectively follow the rotation of the drive shaft (68,124) or to rotate relative to the drive shaft in response to said control signal, and

at least one adjustment component (90,92) shaped as a disc associated with the stop disc (94,96) and operable to rotate in response to the relative rotation of the stop disc, whereby the axial alignment of the input adaptor (66,122,146) relative to the hub adaptor (40,54) varies with respect to the rotational orientation of the adjustment component.

2. The system of claim 1, further comprising a draw bar (58) extending through the lathe body (52) and the input adaptor (66,122,146) and connected to the hub adaptor (40,54).

3. The system of claim 1 or 2, wherein the adjustment mechanism (50,120,144) is powered by rotation of the drive shaft (68,124).

4. The system of claim 1 or 2, wherein the adjustment mechanism (50,120,144) is powered by rotation of the input adaptor (66,122,146).

5. The system of any one of the preceding claims, wherein the adjustment mechanism (50,120,144) further comprises at least one stop mechanism (98,100) associated with the stop disc (94,96), the stop mechanism being operable to move between a first position in which the stop disc rotates relative to the drive shaft (68,124) and a second position in which the stop disc follows the rotation of the drive shaft, the stop mechanism moving between the first and second positions in response to said control signal.

6. The system of claim 5, wherein the stop mechanism (98,100) comprises an electromagnetic element and a catch member operable to move from the second position to the first position in response to said control signal.

7. The system of claim 5 or 6, wherein at least two stop discs (94,96) are rotatably secured to the input adaptor (66) such that the stop discs follow the rotation of the input adaptor when the stop mechanism (98,100) is in the second position and at least one of the stop discs (94,96) rotates relative to the input adaptor when the stop mechanism is in the first position.

8. The system of any of claims 1 to 4, wherein the adjustment mechanism (50,120,144) comprises a first adjustment component (90) associated with a first stop disc (94) and operable to rotate in response to the relative rotation of the first stop disc, and a second adjustment component (92) associated with a second stop disc (96) and operable to rotate in response to the relative rotation of the second stop disc (96); the axial alignment of the input adaptor (66) relative to the hub adaptor (40,54) varying with respect to the rotational orientations of the first and second adjustment components (90,92).

9. The system of claim 8, wherein the first and second adjustment components (90,92) comprise slant discs having opposed slanted surfaces in an abutting relationship.

10. The system of claim 8, further comprising a first gear train (102,106,110,112) operably associated with the first stop disc (94) and the first adjustment component; and a second gear train operably associated with the second stop disc (96) and the second adjustment component; each gear train following movement of the corresponding stop disc (94,96) so as to move the corresponding adjustment component (90,92).

11. The system of any of the preceding claims, wherein said stop disc (94,96,128,130) comprises a star-wheel having a plurality of protruding teeth.

12. The system of claim 11, wherein the, or a stop mechanism comprises an electromagnetic element (98,100) and a catch member operable to engage at least one of said teeth.
13. The system of any of claims 8 to 10, wherein the electronic controller (412) generates said control signal so as to time the actuation of a stop mechanism such that the catch member moves into the first position at a time appropriate to contact a specified one of the stop discs (94,96).

14. The system of any preceding claim, wherein the sensor (210-400) comprises an orientation sensor (210-400) operable to produce an orientation signal indicative of the rotational orientation of the input adaptor (122).

15. The system of claim 1, wherein the drive shaft (124) attached to the input adaptor (122) is a first drive shaft, and the system further includes a second drive shaft (1276) which can be driven backwards, relative to the first drive shaft (124), so as to adjust the orientation of an adjustment component (140), whereby only one adjustment component (140) is required in the adjustment mechanism (120).

16. The system of claim 1, wherein said stop disc (94,96;128,130) has an axis of rotation that is offset from an axis of rotation of the input adaptor (122).

17. A method of resurfacing a brake disc of a vehicle brake assembly, using the system according to any of claims 1-16, the method comprising:

- providing an on-vehicle brake lathe system having a lathe body (34,52) with a drive motor (30); a cutting head (36) operably attached to the lathe body, and a rotatable drive shaft (68,124) securing the on-vehicle brake lathe system to the vehicle;

- initiating rotation of the brake disc;

- producing a signal indicative of movement of the lathe body relative to the vehicle brake assembly as the drive shaft rotates; and

- using the signal, as the drive shaft rotates, to automatically adjust the orientation of the lathe body relative to the vehicle brake assembly so as to reduce any such movement, thereby maintaining alignment of the lathe body relative to the vehicle brake assembly, including adjusting the orientation of the lathe body (34,52) relative to the vehicle brake assembly in a first direction; and if the adjustment in the first direction reduces movement of the lathe body, continuing to adjust the orientation of the lathe body relative to the vehicle brake assembly in the first direction until the adjustment increases movement of the lathe body (34,52), adjusting the orientation of the lathe body relative to the vehicle brake assembly in a second direction; and if, the adjustment in the second direction reduces movement of the lathe body (34,52), continuing to adjust the orientation of the lathe body relative to the vehicle brake assembly in the second direction, until the adjustment improves the alignment of the lathe body.

18. The method of claim 17, wherein the step using said signal comprises axially aligning the drive shaft (68,124) with respect to an axis of rotation of the brake disc.

19. The method of claim 18, wherein the on-vehicle brake lathe system comprises an alignment system (50, 12, 144) including at least one adjustment disc (90,92) and the alignment system adjusts alignment of the lathe body (34,52) relative to the vehicle brake assembly; the drive shaft (68,124) being axially aligned with respect to the axis of rotation of the brake disc by changing the rotational orientation of the adjustment disc (90,92).

20. The method of claim 19, wherein the alignment system further includes at least one stop disc (94,96), and the rotational orientation of the adjustment disc (90,92) is adjusted by operating the stop disc (94,96) in a first state to follow the rotation of the drive shaft and in a second state to rotate relative to the rotation of the drive shaft.

21. The method of claim 20, wherein the stop disc (94,96) comprises a starwheel having protruding teeth and the alignment system further includes a toothed catch member operable to engage at least one tooth of the starwheel; the stop disc (94,96) being operated in said second state by actuating the toothed catch member to contact a tooth of the starwheel.

22. The method of claim 17 further comprising resurfacing the brake disc using the cutting head (36).

23. The method of claim 17, wherein said signal is used by adjusting the orientation of the lathe body (34,52) relative to the vehicle brake assembly in a first direction and, if the adjustment in the first direction reduces movement of the lathe body, continuing to adjust the orientation of the lathe body (34,52) relative to the vehicle brake assembly in the first direction until alignment of the lathe body falls within a threshold amount or the adjustment worsens alignment of the lathe body.
Patentansprüche

1. Drehmaschinensystem für im Fahrzeug eingebaute Scheibenbremsen zum erneuten Plandrehen einer Bremsscheibe eines Fahrzeugbremsenaufbaus, wo- bei das Bremsen-Drehmaschinensystem einen Drehmaschinenkörper (34,52) mit einem Antriebsmotor (30); einen Schneidkopf (36), der betriebsfähig am Drehmaschinenkörper (34,52) angebracht ist; eine Antriebswelle (68,124); und ein Ausrich- tungssystem (50, 120,144) aufweist, das aufweist:

- einen Sensor (210,226,238;244;400), der betriebsfähig ist, um ein Signal zu erzeu- gen, das für die Bewegung des Drehmaschi- nenkörpers (34,52) bezüglich des Fahrzeug- bremsenaufbaus kennzeichnend ist;
- einen Eingangsadapter (66,122,146), der an der Antriebswelle (68,124) angebracht ist, um mit der Antriebswelle zu rotieren;
- einen Radnabenadapter (40,54), der gestaltet ist, um im Gebrauch an einer Radnabe (44) ei- nes Fahrzeugs angebracht zu werden und mit der Antriebswelle zu rotieren; und
- einen Einstellungsmechanismus (50,120,144), der mit dem Eingangsadapter (66,122,146) und dem Radnabenadapter (40,54) zur Einstel- lung der Ausrichtung des Drehmaschinenkör- pers und des Schneidkopfes (36) relativ zu ei- ner Rotationsachse der Radnabe (44) gekopp- pelt ist;

dadurch gekennzeichnet, daß eine elektronische Steuereinrichtung (412) auf den Sensor (210-400) reagiert, um ein Steuersignal bereitzustellen, um den Ein- stellungsmechanismus zu veranlassen, auto- matisch die axiale Ausrichtung des Eingangsadap- ters (66,122,146) bezüglich einer Rotationsach- se des Radnabenadapters (40,54) einzustellen, wodurch jede Bewegung des Drehmaschinenkör- pers (34,52) reduziert wird, und daß der Einstellungsmechanismus (50,120,144) mindestens eine Hemmscheibe (94,96,128,130) aufweist, die mit dem Eingangsadapter (66,122,146) gekoppelt und betriebsfähig ist, selektiv sich zwischen einer ersten Position, in der die Hemmscheibe relativ zur An- triebswelle (68,124) rotiert, und einer zweiten Position zu bewegen, in der die Hemmscheibe der Ro- tation der Antriebswelle folgt, wobei sich der Stop- mechanismus als Reaktion auf das Steuersignal zwischen den ersten und zweiten Positionen be- wegt.

2. System nach Anspruch 1, das ferner eine Zugstan- ge (58) aufweist, die sich durch den Drehmaschi- nenkörper (52) und den Eingangsadapter (66,122,146) erstreckt und mit dem Radnabenad- pter (40,54) verbunden ist.

3. System nach Anspruch 1 oder 2, wobei der Einstel- lungsmechanismus (50,120,144) durch die Rotati- on der Antriebswelle (68, 124) angetrieben wird.

4. System nach Anspruch 1 oder 2, wobei der Einstel- lungsmechanismus (50, 120, 144) durch die Rota- tion des Eingangsadapters (66,122,146) angetrie- ben wird.

5. System nach einem der vorhergehenden Ansprü- che, wobei der Einstellungsmechanismus (50,120,144) ferner mindestens einen Stopmecha- nismus (98,100) aufweist, der mit der Hemmschei- be (94,96) verbunden ist, wobei der Stopmechanis- mus betriebsfähig ist, sich zwischen einer ersten Position, in der die Hemmscheibe relativ zur An- triebswelle (68,124) rotiert, und einer zweiten Position zu bewegen, in der die Hemmscheibe der Ro- tation der Antriebswelle folgt, wobei sich der Stop- mechanismus als Reaktion auf das Steuersignal zwischen den ersten und zweiten Positionen be- wegt.

6. System nach Anspruch 5, wobei der Stopmecha- nismus (98,100) ein elektromagnetisches Element und ein Sperrklinkenglied aufweist, das betriebsfä- hig ist, sich als Reaktion auf das Steuersignal von der zweiten Position zur ersten Position zu bewe- gen.

7. System nach Anspruch 5 oder 6, wobei mindestens zwei Hemmscheiben (94,96) drehbar so am Ein- gangsadapter (66) befestigt sind, daß die Hemms- scheiben der Rotation des Eingangsadapters fol- gen, wenn sich der Stopmechanismus (98,100) in der zweiten Position befindet, und mindestens eine der Hemmscheiben (94,96) relativ zum Ein- gangsadapter rotiert, wenn sich der Stopmechanis- mus in der ersten Position befindet.

8. System nach einem der Ansprüche 1 bis 4, wobei der Einstellungsmechanismus (50, 120, 144) eine erste Einstellungskomponente (90), die mit einer ersten Hemmscheibe (94) verbunden und betriebsfähig ist, als Reaktion auf die Relativrotation der ersten Hemmscheibe zu rotieren, und eine zweite Einstellungskomponente (92) aufweist, die mit einer zweiten Hemmscheibe (96) verbunden ist und betriebsfähig ist, als Reaktion auf die Relativrotation der zweiten Hemmscheibe (96) zu rotieren; wobei die axiale Ausrichtung des Eingangsadap- ters (66) relativ zum Radnabenadapter (40,54) be- züglich der Rotationsorientierungen der ersten und
zweiten Einstellungskomponenten (90,92) variiert.

9. System nach Anspruch 8, wobei die ersten und zweiten Einstellungskomponenten (90,92) Neigungsscheiben aufweisen, die entgegengesetzt geneigte Oberflächen in einer aneinanderstoßenden Beziehung aufweisen.

10. System nach Anspruch 8, das ferner einen ersten Getriebezug (102,106,110,112), der betriebsfähig mit der ersten Hemmscheibe (94) und der ersten Einstellungskomponente verbunden ist; und einen zweiten Getriebezug aufweist, der betriebsfähig mit der zweiten Hemmscheibe (96) und der zweiten Einstellungskomponente verbunden ist; wobei jeder Getriebezug der Bewegung der entsprechenden Hemmscheibe (94,96) folgt, um die entsprechende Einstellungskomponente (90,92) zu bewegen.

11. System nach einem der vorhergehenden Ansprüche, wobei die Hemmscheibe (94,96,128,130) eine Arretierungsscheibe aufweist, die mehrere vorstehende Zähne aufweist.

12. System nach Anspruch 11, wobei der oder ein Stopmechanismus ein elektromagnetisches Element (98,100) und ein Sperrklinkenglied aufweist, das betriebsfähig ist, mit mindestens einem der Zähne in Eingriff zu treten.

13. System nach einem der Ansprüche 8 bis 10, wobei die elektronische Steuereinrichtung (412) das Steuersignal erzeugt, um die Betätigung eines Stopmechanismus zeitlich so zu steuern, daß sich das Sperrklinkenglied zu einer Zeit, die passend ist, in die erste Position bewegt.

14. System nach einem der vorhergehenden Ansprüche, wobei der Sensor (210-400) einen Orientierungssensor (210-400) aufweist, der betriebsfähig ist, ein Orientierungssignal zu erzeugen, das für die Rotationsorientierung des Eingangsadapters (122) kennzeichnend ist.

15. System nach Anspruch 1, wobei die Antriebswelle (124), die am Eingangsadapter (122) angebracht ist, eine erste Antriebswelle ist, und das System ferner eine zweite Antriebswelle (126) aufweist, die relativ zur ersten Antriebswelle (124) rückwärts angetrieben werden kann, um die Orientierung einer Einstellungskomponente (140) einzustellen, wodurch nur eine Einstellungskomponente (140) im Einstellungsmechanismus (120) benötigt wird.

16. System nach Anspruch 1, wobei die Hemmscheibe (94,96;128,130) eine Rotationsachse aufweist, die von einer Rotationsachse des Eingangsadapters (122) versetzt ist.

17. Verfahren zum erneuten Plandeuten einer Bremscheibe eines Fahrzeugbremsenaufbaus unter Verwendung des Systems nach einem der Ansprüche 1-16, wobei das Verfahren aufweist:

Bereitstellen eines Drehmaschinensystems für eine im Fahrzeug eingebaute Bremse, das eine Drehmaschinenkörpere (34,52) aufweist, mit einem Antriebsmotor (30); einem Schneidkopf (36), der betriebsfähig am Drehmaschinenkörper angebracht ist, und einer drehbaren Antriebswelle (68,124), die das Drehmaschinen- system für eine im Fahrzeug eingebaute Bremse am Fahrzeug befestigt;

Einleiten der Rotation der Brems scheibe;
Erzeugen eines Signals, das für die Bewegung des Drehmaschinens körpers relativ zum Fahrzeug bremsenaufbau kennzeichnend ist, wenn sich die Antriebswelle dreht; und Verwenden das Signals, wenn die Antriebswelle rotiert, um automatisch die Orientierung des Drehmaschinens körpers relativ zum Fahrzeugbremsenaufbau einzustellen, um irgendeine solche Bewegung zu reduzieren, wodurch die Ausrichtung des Drehmaschinens körpers relativ zum Fahrzeug bremsenaufbau aufrechterhalten wird, was die Einstellung der Orientierung des Dreh maschinens körpers (34,52) relativ zum Fahrzeugbremsenaufbau in eine erste Richtung einschließt; und wenn die Einstellung in die erste Richtung die Bewegung des Drehmaschinens körpers reduziert, Fortsetzen des Einstellens der Orientierung des Drehmaschinens körpers relativ zum Fahrzeugbremsenaufbau in die erste Richtung, bis die Einstellung die Bewegung des Drehmaschinens körpers erhöht, und nach der Einstellung der Orientierung in die erste Richtung, die die Bewegung des Drehmaschinens körpers (34,52) erhöht. Einstellung der Orientierung des Drehmaschinens körpers relativ zum Fahrzeugbremsenaufbau in eine zweite Richtung; und wenn die Einstellung in die zweite Richtung die Bewegung des Drehmaschinens körpers erhöht, und nach der Einstellung der Orientierung in die zweite Richtung, die die Bewegung des Drehmaschinens körpers (34,52) reduziert, Fortsetzen des Einstellens der Orientierung des Drehmaschinens körpers relativ zum Fahrzeugbremsenaufbau in die zweite Richtung, bis die Einstellung die Ausrichtung des Drehmaschinens körpers verbessert.

18. Verfahren nach Anspruch 17, wobei der Schritt, der das Signal verwendet, das axiale Ausrichten der Antriebswelle (68,124) bezüglich einer Rotationsachse der Brems scheibe aufweist.
19. Verfahren nach Anspruch 18, wobei das Drehmaschinenystem für die im Fahrzeug eingebaute Bremse ein Ausrichtungssystem (50, 12, 144) aufweist, das mindestens eine Einstellscheibe (90, 92) aufweist, und das Ausrichtungssystem die Ausrichtung des Drehmaschinenkörpers (34, 52) relativ zum Fahrzeugbremseaufbau einstellt; wobei die Antriebswelle (68, 124) bezüglich der Rotationsachse der Bremsscheibe axial ausgerichtet wird, indem die Rotationsorientierung der Einstellscheibe (90, 92) geändert wird.

20. Verfahren nach Anspruch 19, wobei das Ausrichtungssystem ferner mindestens eine Hemmscheibe (94, 96) aufweist, und die Rotationsorientierung der Einstellscheibe (90, 92) eingestellt wird, indem die Hemmscheibe (94, 96) in einem ersten Zustand, in der sie der Rotation der Antriebswelle folgt, und in einem zweiten Zustand betrieben wird, in der sie relativ zur Rotation der Antriebswelle rotiert.

21. Verfahren nach Anspruch 20, wobei die Hemmscheibe (94, 96) eine Arretierungsscheibe mit vorstehenden Zähnen aufweist und das Ausrichtungssystem ferner ein Zahnsperrklinkenglied aufweist, das betriebsfähig ist, mit mindestens einem Zahn der Arretierungsscheibe in Eingriff zu treten; wobei die Hemmscheibe (94, 96) in dem zweiten Zustand betrieben wird, indem sie der Rotation der Antriebswelle folgt und in einem zweiten Zustand betrieben wird, in der sie relativ zur Rotation der Antriebswelle rotiert.

22. Verfahren nach Anspruch 17, das ferner das erneute Plandrehen der Bremsscheibe unter Verwendung des Schneidkopfes (36) aufweist.

23. Verfahren nach Anspruch 17, wobei das Signal verwendet wird, indem die Orientierung des Drehmaschinenkörpers (34, 52) relativ zum Fahrzeugbremseaufbau in eine erste Richtung eingestellt wird, und wenn die Einstellung in die erste Richtung die Bewegung des Drehmaschinenkörpers reduziert, die Orientierung des Drehmaschinenkörpers (34, 52) relativ zum Fahrzeugbremseaufbau in die erste Richtung weiter eingestellt wird, bis die Ausrichtung des Drehmaschinenkörpers in einen Schwellenbetrag fällt oder die Einstellung die Ausrichtung des Drehmaschinenkörpers verschlechtert.

Revidications

1. Système de resurfaçage de frein à disque installé sur un véhicule pour réaliser le resurfaçage d'un disque de frein d'un ensemble de frein de véhicule, le système de resurfaçage de frein comprenant un corps de resurfaçage (34, 52) équipé d'un moteur d'entraînement (30); une tête de coupe (36) fixée de façon opérationnelle au corps de surfaçage (34, 52); un arbre d'entraînement (68, 124); et un système d'alignement (50, 120, 144), qui comprend:

   un capteur (210, 226, 228; 236; 238; 244; 400) pouvant agir de manière à produire un signal indicatif d'un déplacement du corps de resurfaçage (34, 52) par rapport à l'ensemble de frein du véhicule;
   un adaptateur d'entrée (66, 122, 146) fixé à l'arbre d'entraînement (68, 124) pour tourner avec l'arbre d'entraînement;
   un adaptateur de moyeu (40, 54) configuré de manière à être fixé, en fonctionnement, à un moyeu (44) d'un véhicule et à tourner avec l'arbre d'entraînement, et
   un mécanisme d'ajustement (50, 120, 124) coupé à l'adaptateur d'entrée (66, 122, 146) et à l'adaptateur de moyeu (40, 54) pour ajuster l'alignement du corps de resurfaçage et de la tête de coupe (26) par rapport à l'axe de rotation du moyeu (44);

   caractérisé en ce qu'un dispositif de commande électronique (412) répond au capteur (210-400) de manière à délivrer un signal de commande pour amener le mécanisme d'ajustement à ajuster automatiquement l'alignement axial de l'adaptateur d'entrée (66, 122, 146) par rapport à un axe de rotation de l'adaptateur de moyeu (40, 54), ce qui a pour effet que tout déplacement du corps de resurfaçage (34, 52) est réduit, et en ce que le mécanisme d'ajustement (50, 120, 144) comprend au moins un disque d'arrêt (94, 96, 128, 130) couplé à l'adaptateur d'entrée (66, 122, 146) et pouvant agir de manière à suivre sélectivement la rotation de l'arbre d'entraînement (68, 124) ou à tourner par rapport à l'arbre d'entraînement en réponse audit signal de commande, et
   au moins un composant d'ajustement (90, 92) agencé sous la forme d'un disque associé au disque d'arrêt (94, 96) et pouvant agir de manière à tourner en réponse à la rotation relative du disque d'arrêt, ce qui a pour effet que l'alignement axial de l'adaptateur d'entrée (66, 122, 146) par rapport à l'adaptateur de moyeu (40, 54) varie par rapport à l'orientation en rotation du composant d'ajustement.

2. Système selon la revendication 1, comprenant en outre un tirant (58) qui s'étend à travers le corps de resurfaçage (52) et l'adaptateur d'entrée (66, 122, 146) est raccordé à l'adaptateur de moyeu (40, 54).

3. Système selon la revendication 1 ou 2, selon lequel le mécanisme d'ajustement (50, 120, 144) est acti-
vé par la rotation de l'arbre d'entraînement (68, 124).

4. Système selon la revendication 1 ou 2, dans lequel le mécanisme d'ajustement (50, 120, 144) est activé par la rotation de l'adaptateur d'entrée (46, 122, 146).

5. Système selon l'une quelconque des revendications précédentes, selon lequel le mécanisme d'ajustement (50, 120, 144) comprend en outre au moins un mécanisme d'arrêt (98, 100) associé au disque d'arrêt (94, 96), le mécanisme d'arrêt pouvant agir de manière à se déplacer entre une première position, dans laquelle le disque d'arrêt tourne par rapport à l'arbre d'entraînement (68, 124) et une seconde position dans laquelle le disque d'arrêt suit la rotation de l'arbre d'entraînement, le mécanisme d'arrêt se déplaçant entre les première et seconde positions en réponse à un signal de commande.

6. Système selon la revendication 5, dans lequel le mécanisme d'arrêt (98, 100) comprend un élément électromagnétique et un élément de saisie apte à se déplacer depuis la seconde position vers la première position en réponse à un signal de commande.

7. Système selon la revendication 5 ou 6, dans lequel au moins deux disques d'arrêt (94, 96) sont fixés de manière à pouvoir tourner à l'adaptateur d'entrée (66) de telle sorte que les disques d'arrêt suivent la rotation de l'adaptateur d'entrée lorsque le mécanisme d'arrêt (98, 100) est dans la seconde position, et qu'au moins l'un des disques d'arrêt (94, 96) tourne par rapport à l'adaptateur d'entrée lorsque le mécanisme d'arrêt est dans la première position.

8. Système selon l'une des revendications 1 à 4, selon lequel le mécanisme d'ajustement (50, 120, 144) comprend un premier composant d'ajustement (90) associé à un premier disque d'arrêt (94) et pouvant agir de manière à tourner en réponse à la rotation relative du premier disque d'arrêt, et un second composant d'ajustement (92) associé à un second disque d'arrêt (96) et pouvant agir de manière à tourner en réponse à la rotation relative du second disque d'arrêt (96); l'alignement axial de l'adaptateur d'entrée (66) peut influer sur le premier composant d'ajustement (90, 92).

9. Système selon la revendication 8, dans lequel les premier et second composants d'ajustement (90, 92) comprennent des disques obliques possédant des surfaces obliques opposées en relation d'aboutement.

10. Système selon la revendication 8, comprenant en outre un premier train d'engrenages (102, 106, 110, 112) associé de façon opérationnelle au premier disque d'arrêt (94) et au premier composant d'ajustement; et un second train d'engrenages associé de façon opérationnelle au second disque d'arrêt (96) et au second composant d'ajustement; chaque train d'engrenages suivant le déplacement du disque d'arrêt correspondant (94, 96) de manière à déplacer le composant d'ajustement correspondant (90, 92).

11. Système selon l'une quelconque des revendications précédentes, selon lequel le disque d'arrêt (94, 96, 128, 130) comprend une roue en étoile possédant une pluralité de dents saillantes.

12. Système selon la revendication 11, dans lequel le ou un mécanisme d'arrêt comprend un élément électromagnétique (98, 100) et un élément de saisie pouvant agir de manière à coopérer avec au moins l'une desdites dents.

13. Système selon l'une quelconque des revendications 8 à 10, selon lequel le dispositif de commande électronique (412) génère des signaux de commande de manière à commander de façon cadencée l'actionnement d'un mécanisme d'arrêt de telle sorte que l'organe de saisie vienne dans la première position à un instant approprié pour venir en contact avec l'un des disques d'arrêt (94, 96).

14. Système selon l'une quelconque des revendications précédentes, dans lequel le capteur (210, 400) comprend un capteur d'orientation (210-400) apte à produire un signal d'orientation indicatif de l'orientation en rotation de l'adaptateur d'entrée (122).

15. Système selon la revendication 1, dans lequel l'arbre d'entrée (124) fixé à l'adaptateur d'entrée (122) est un premier arbre d'entraînement, et le système inclut en outre un second arbre d'entraînement (1276), qui peut être entraîné de façon rétrograde par rapport au premier arbre d'entraînement (124) de manière à ajuster l'orientation d'un composant d'ajustement (140), ce qui a pour effet que seul un composant d'ajustement (140) est requis dans le mécanisme d'ajustement (120).

16. Système selon la revendication 1, dans lequel le disque d'arrêt (94, 96; 128, 130) possède un axe de rotation qui est décalé par rapport à un axe de rotation de l'adaptateur d'entrée (122).

17. Procédé de resurfaçage d'un disque de frein d'un
ensemble de frein de véhicule utilisant le système selon l'une quelconque des revendications 1 à 16, le procédé consistant à:

prévoir un système de surfaçage de frein sur le véhicule comportant un corps de surface (34, 52) équipé d'un moteur d'entraînement (30); une tête de coupe (36) fixée de façon opérationnelle au corps de surfaçage, et un arbre d'entraînement rotatif (68, 124) fixant au véhicule le système de resurfaçage de frein situé sur le véhicule;
déclencher la rotation du disque de frein;
produire un signal indicatif du déplacement du corps de resurfaçage par rapport à l'ensemble de frein du véhicule lorsque l'arbre d'entraînement tourne; et
utiliser le signal, lorsque l'arbre d'entraînement tourne, pour ajuster de façon automatique l'orientation du corps de resurfaçage par rapport à l'ensemble de frein du véhicule de manière à réduire tout déplacement de ce type, en maintenant de ce fait l'alignement du corps de resurfaçage par rapport à l'ensemble de frein du véhicule, incluant un ajustement de l'orientation du corps de resurfaçage (34, 52) par rapport à l'ensemble de frein du véhicule dans une première direction; et si l'ajustement dans la première direction réduit le déplacement du corps de resurfaçage, continuer à ajuster l'orientation du corps de resurfaçage par rapport à l'ensemble de frein du véhicule dans la première direction jusqu'à ce que l'ajustement augmente le déplacement du corps de resurfaçage, et après ajustement de l'orientation dans la première direction, qui augmente le déplacement du corps de resurfaçage (34, 52), ajuster l'orientation du corps de resurfaçage par rapport à l'ensemble de frein du véhicule dans une seconde direction; et si l'ajustement dans la seconde direction réduit le déplacement du corps de resurfaçage (34, 52), continuer à ajuster l'orientation du corps de resurfaçage par rapport à l'ensemble de frein du véhicule dans la seconde direction, jusqu'à ce que l'ajustement améliore l'alignement du corps de resurfaçage.

18. Procédé selon la revendication 17, selon lequel l'étape d'utilisation dudit signal comprend l'alignement axial de l'arbre d'entraînement (68, 124) par rapport à un axe de rotation du disque de frein.

19. Procédé selon la revendication 18, selon lequel le système de resurfaçage de frein sur un véhicule comprend un système d'alignement (50, 12, 144) comprenant au moins un disque d'ajustement (90, 92), et le système d'alignement ajuste l'alignement du corps de resurfaçage (34, 52) par rapport à l'en-
semble de frein du véhicule; l'arbre d'entraînement (68, 124) étant aligné axialement par rapport à l'axe de rotation du disque de frein par modification de l'orientation de rotation du disque d'ajustement (90, 92).

20. Procédé selon la revendication 19, selon lequel le système d'alignement comprend en outre au moins un disque d'arrêt (94, 96), et l'orientation en rotation du disque d'ajustement (90, 92) est ajustée au moyen de l'actionnement du disque d'arrêt (94, 96) dans une première étape pour suivre la rotation de l'arbre d'entraînement et dans un second état pour tourner par rapport à la rotation de l'arbre d'entraînement.

21. Procédé selon la revendication 20, selon lequel le disque d'arrêt (94, 96) comprend une roue en étoile comportant des dents saillantes, et le système d'alignement comporte en outre un élément de saisie denté pouvant agir de manière à coopérer avec au moins une dent de la roue en étoile; le disque d'arrêt (94, 96) étant actionné dans le dit second état au moyen de l'actionnement de l'élément de saisie denté pour qu'il vienne en contact avec une dent de la roue en étoile.

22. Procédé selon la revendication 17, comprenant en outre le resurfaçage du disque de frein moyennant l'utilisation de la tête de coupe (36).

23. Procédé selon la revendication 17, selon lequel le dit signal est utilisé par ajustement de la rotation du corps de resurfaçage (34, 52) par rapport à l'ensemble de frein du véhicule dans une première direction et, si l'ajustement dans la première direction réduit le déplacement du corps de resurfaçage, on continue à ajuster l'orientation du corps de resurfaçage (34, 52) par rapport à l'ensemble de frein du véhicule dans la première direction jusqu'à ce que l'alignement du corps de resurfaçage se situe en deçà d'une valeur de seuil ou que l'ajustement altère l'alignement du corps de resurfaçage.
**Fig. 15a**

**Fig. 15b**

**Fig. 15c**

**Fig. 15d**

**Fig. 15e**

**Fig. 15f**

**Fig. 15g**