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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number:	WO 94/04754
E01B 31/17	A1	(43) International Publication Date:	3 March 1994 (03.03.94)

(21) International Application Number: PCT/SE93/00693

(22) International Filing Date: 19 August 1993 (19.08.93)

(30) Priority data:
9202380-3 19 August 1992 (19.08.92) SE

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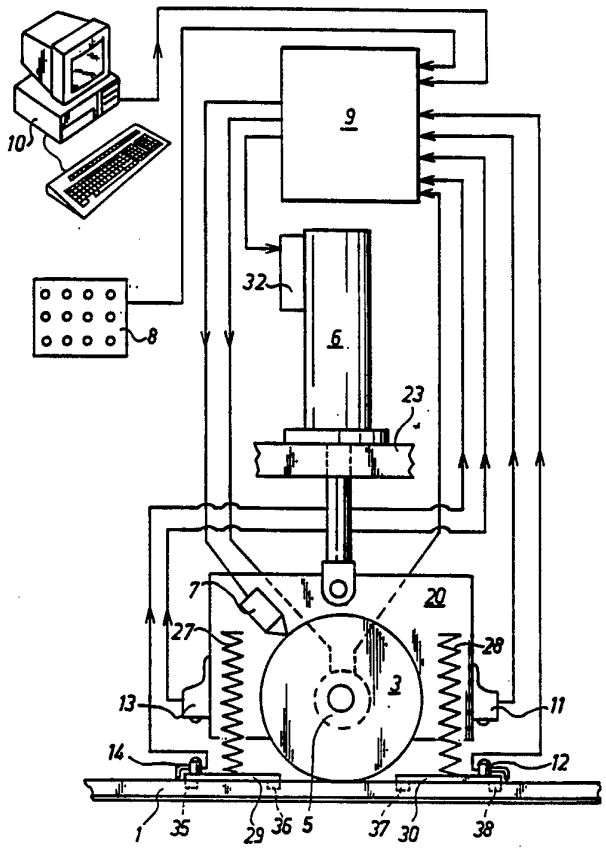
(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
With amended claims and statement.
In English translation (filed in Swedish).

(54) Title: RAIL-GRINDING VEHICLE

(57) Abstract

A rail grinding vehicle, wherein a grinding disc (3) the rotational shaft (4) of which extends transversely to the longitudinal extension of the rail to grind a rail (1), and which vehicle is provided with measurement equipment (11-14) to measure on the one hand the distance of said grinding disc (3) to the rail before and after the grinding disc as also the essentially vertical variations of the rail, from the top to the bottom, before and after the grinding disc (3), the results from said measurement operations being supplied, together with the values representative of the measured rotational speed of the grinding disc and together with start or stop orders from at least one control panel (8), into at least one control unit (9), the latter continuously calculating the desirable distance to the rail and the rotational speed of the grinding disc (3) in response to said measurement results and emitting signals to the grinding-disc actuating means (6) and motor (5), so that owing to this measuring and control method the rail will only be ground wherever required and be ground to a sufficient but not excessive degree.



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RAIL-GRINDING VEHICLE

TECHNICAL FIELD

The subject invention concerns a method of grinding rails and a rail grinding vehicle designed to perform the method, according to which a grinding disc is formed with a rotational shaft extending essentially transversely to the longitudinal direction of the rail and the distance of the grinding disc to the rail is adjustable by means of actuating means in addition to which the grinding disc is affected by at least one sharpening tool.

BACKGROUND OF THE INVENTION

That the rails on which trams and trains travel are exposed to wear, is a well-known fact. The wear is due to a number of various factors, and the degree of such wear may vary considerably along e.g. one and the same tram line. The wear leads to a certain unevenness or undulation of the rail including troughs and peaks. In a tram rail the distance separating neighbouring peaks may be in the order of one to a couple of decimeters. This undulatory or grooved condition of the rail obviously causes wheel vibrations which are transmitted to the vehicle itself, with resulting impaired comfort. For this reason, the rail is ground from time to time in order to lessen these problems.

Known types of rail grinding vehicles do not include a system for automatic evaluation of the rail quality. Instead, such evaluation is effected by ocular inspection or on the basis of notes made on board one tram carriage. This procedure might mean that the entire rail between two stops is ground when in actual fact it might only have been necessary to grind some 10 or 20 meters. In one known type of grinding vehicle a large number of rotating horizontal grinding cups having a diameter of approximately 100 mm are used. The grinding capacity of such cups

is very limited and consequently the grinding operations take very long while at the same time the grinding vehicle itself is very complex and expensive because each individual cup must be driven.

One prior-art grinding vehicle uses a large rotating grinding disc. The rotational shaft of the grinding disc extends transversely with respect to the longitudinal direction of the rail, and the action of the disc is against the rail in the manner of a spinning wheel. The grinding disc is sharpened by a sharpening tool to the desired profile configuration so that in the grinding operation it imparts the desired profile configuration also to the rail. The cutting or removal capacity of this type of grinding device is quite superior and consequently its productivity is higher. But since the quality control of the rail still is effected visually the risk that unnecessarily large amounts of the rail are ground away is considerable. The rotating grinding disc normally is guided laterally with respect to the rail by means of a wheel which rolls over the depressed part of the rail having the appearance of a ditch. For rails without such a ditch a clamp is used instead which is secured across the rail and acts as a guide on both sides thereof. However, both these methods are to some extent inaccurate with respect to lateral control and guidance of the grinding unit and thus of the grinding disc.

PURPOSE OF THE INVENTION

The purpose of the subject invention is to substantially reduce the problems outlined in the aforegoing by providing a method of grinding rails, and a rail grinding vehicle for performing the method, according to which is ensured that the rail will be ground only where required and that the grinding operation will be of high quality and high capacity.

SUMMARY OF THE INVENTION

The above purpose is achieved by a method and a rail grinding vehicle in accordance with the invention possessing the characteristics defined in the appended claims.

Thus, the method in accordance with the invention is essentially characterized in that said rail grinding vehicle is provided with measuring devices arranged to measure the distance of said grinding disc from the rail before and after the grinding disc as well as to measure essentially vertical variations of the rail, from the top to the bottom, before and after the grinding disc, the results obtained from said measuring operations being supplied together with start or stop orders from at least one control panel into at least one control computer, the latter continuously estimating the desirable distance to the rail in response to said measurement results and emitting signals to the grinding disc actuating means in order to obtain the desired adjustment, whereby owing to said measurement and control operations the rail will be ground only where required and be ground to a sufficient but not excessive degree and the grinding operation will impart to said rail an essentially correct configuration transversely. In accordance with a further development of the method in accordance with the invention the control unit is supplied with input data also from an external computer, for instance a personal computer, making it possible to alter the calculation parameters and similar information stored in the control unit. In addition, calibration of the system is performed at at regular intervals and at the original start-up by first positioning the rail-grinding vehicle on a plane rail, then lowering the grinding disc onto the rail or to a rule of known thickness positioned on the rail, and thereafter supplying the control unit with the values representative of the distance before and after the grinding disc, thus

generating a basic value representative of the distance in said control unit.

At least one of either the control panel or the control unit or the external computer could be disposed on a vehicle coupled to the rail grinding vehicle, such as a pulling or travtive vehicle, and connected to the latter vehicle via a cable. In addition, the motor and the actuating means of each grinding disc are driven from a drive unit, such as a hydraulically or electrically operated drive unit, which may be placed on the vehicle or on a vehicle coupled to said vehicle.

A very important aspect of the vehicle thus is that measuring equipment, mounted on the grinding vehicle, measures the quality of the rail before and after the grinding operation. Owing to this arrangement it becomes possible constantly to affect the grinding depth, i.e. the application of the disc with respect to the rail, whereby an acceptable rail quality after grinding is achieved. In addition, measuring equipment is provided to measure the distance of the grinding disc from the rail before and after the grinding disc. Any interference arising as a result of the grinding vehicle travellings through bends, across hill crests and through hollows, or similar irregularities, consequently is corrected because of the continuous change of the application of the grinding disc.

In accordance with a further developed embodiment of the rail grinding veicle the rail grinding unit is rotationally suspended in the vehicle chassis in bearing members the axis of rotation of which extends essentially in the longitudinal direction of the vehcile, in addition to which actuating means are provided between the chassis and the grinding unit and arranged to tend to turn the latter outwards transversely in relation to the vehicle. This turning movement outwards is prevented by guides abutting against the inner face of the rail and connected with the rail grinding unit. In consequence of this arrangement the rail grinding unit and thus the

grinding disc will always assume a correct position relatively to the rail because the guides are pressed resiliently against the inner face of the rail. This ensures correct grinding of the transverse profile configuration of the rail, irrespective of any interferences in the form of e.g. bends, crests, depressions or rail width variations. In addition, the bearing means mounting the individual grinding unit are displaceable laterallly, thus allowing the associated grinding unit to be reset to accommodate rails of other widths or to be reset for special grinding operations on the inner face of the rail.

Further particularities of the invention and the advantages afforded thereby will appear from the following detailed description of preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Some embodiments of the invention will be described in closer detail in the following with reference to the accompanying drawings, wherein identical numeral references have been used for identical parts. The rail grinding vehicle has two essentially symmetrical sides, one of which is arranged to grind one of the rails and the other one to grind the opposite rail of a rail track. Components that are identical on the two sides of the vehicle are indicated by the sign ' for one of the sides. For instance, the drive motors of the grinding discs are indicated by reference 5 and 5', respectively.

Fig. 1 illustrates schematically a control system used to control the rail grinding process. For reasons of clarity only the most essential grinding and control parts are shown in the drawing figure. For example, the chassis of the rail grinding vehicle is not shown. Instead, this part appears from Figs. 2-5.

Fig. 2 illustrates the rail grinding vehicle in a lateral view but does not show the control unit, the control panel, etcetera.

Fig. 3 is a view as seen from above of the rail grinding vehicle according to Fig. 2. On one side of the vehicle some parts below the blocking mounting beam are shown in a transverse sectional view.

Fig. 4 is a sectional view through the rail grinding vehicle along line A-A. In dash-and-dot lines is also shown an alternative position of setting of one of the grinding devices of the vehicle.

Fig. 5 illustrates the carriage in its upper position in the sliding frame.

Fig. 6 illustrates the carriage in a slightly lowered position in which the sliding shoes of the carriage have just reached the rail.

Fig. 7 illustrates in a lateral view an alternative embodiment of the rail grinding vehicle according to which an alternative method of suspension for the front wheels is used as also a different arrangement for distance measurement and lateral guidance.

DESCRIPTION OF PREFERRED EMBODIMENTS

In Fig. 1, numeral reference 1 indicates a rail, against which bears a grinding disc 3. The grinding disc is rotatably mounted on a shaft 4 which extends transversely with respect to the rail 1. The grinding disc 3 is driven by a drive motor 5, which could be for instance a hydraulic motor or an electric motor. The grinding disc is attached to a carriage 20 and actuating means 6 are provided to raise or lower the carriage with respect to a rail grinding vehicle 2 the chassis of which does not appear from Fig. 1, as mentioned previously. The actuating means could be a hydraulically operated piston-and-cylinder unit or an electrically operated mechanical positioning mechanism which is associated with the rail grinding vehicle by means of a mounting beam 23. The latter is shown only in parts in this drawing figure and remaining parts of the rail grinding vehicle are not shown at all, for reasons of clarity. Instead, they appear from

other drawing figures. Fig. 1 illustrates parts that are intended to grind one rail 1. Parts intended to grind the opposite rail 1' are, as already mentioned, indicated by the addition of the sign '. Some parts, such as the control panel 8, the control unit 9 and the external computer 10 could be associated with only one side of the rail grinding vehicle, i.e. for the grinding of one of the rails, e.g. rail 1, but one or several of these devices could be common to both sides and be associated with the grinding means for both rails 1 and 1'. In addition, there is nothing to prevent the vehicle to be fitted with a unilateral grinding equipment for grinding one rail at a time. The control panel 8, the control unit 9 and the external computer 10 could be placed on the rail grinding vehicle itself, which would be an obvious position when the vehicle is a self-propelling unit. However, these devices could also be placed on a traction vehicle, such as a tram, which would be an obvious position if the rail grinding vehicle is not self-propelling, i.e. is not fitted with its own propulsion means.

Fig. 1 primarily aims at showing the manner in which the grinding process is controlled by the control unit 9. The latter is supplied with input data derived from measurement operations carried out before and after the grinding disc 3, and also derived from measuring the rotational speed of the drive motor 5, and it also receives input data from the control panel 8 and the external computer 10. In order to facilitate the designation of the components it is assumed herein that the rail grinding vehicle moves from the left to the right in the drawing figure. Parts to the right of the grinding disc 3 are referred to as front components and components to the left of the grinding disc as rear components. The carriage 20 on which the grinding disc 3 is mounted, is also provided with a front sliding shoe 30 and a rear sliding show 29. These are actuated by springs 28 and 27, respectively, so as to be resiliently pressed against the

rail 1. The sliding shoes are guided with respect to the carriage 20 in such a manner as to follow their movement along the rail. Each sliding shoe 29, 30 is guided with respect to the rail 1 by a number of guide shoulders 35 - 38 projecting downwards along the lateral face of the rail, and the front sliding shoe 30 is provided with a front undulation mater 12. The latter constantly measures the distance to crests and troughs in the rail. In a worn rail, obviously the vertical differences between the crests and troughs are larger, i.e. the "waviness" is more pronounced. From the measurement values obtained from the front undulation meter 12 the control unit 9 thus receives data representative of the rail quality. These values may be used as a basis for determination as to whether or not the rail need to be ground and if so, to what extent. Normally, all undulations are ground away in one grinding operation. However, should be undulations be in excess of the pre-known grinding capacity of the grinding disc, the grinding is restricted accordingly. In a corresponding manner the signals from the rear undulation meter 14 to the control unit 9 is a measure of the success of the grinding operation, i.e. of the remaining undulation after the grinding. On the basis of this quality value with respect to the grinding process changes thereto may be made, for instance such that the grinding disc is lowered further down with the aid of the actuating means 6 in case the remaining undulation after the grinding disc is too pronounced. The carriage 20 is also provided with a front distance meter 1 measuring the distance from the carriage, and thus from the grinding disc 3, to the rail. The distance of the grinding disc to the rail is determined by measuring the distance from the grinding disc centre to the sliding shoe 30, in accordance with the example shown by measuring the distance between the front distance meter 11 and the upper face of the front undulation meter 12. This measuring operation provides a constant basic value representative of the grinding disc distance to the rail.

This distance varies as the vehicle moves on the rail, for instance through bends and across depressions in the rail. By actuation of the actuation means 6 the control unit 9 thus lowers the grinding disc 3 to this original position plus any further desired grinding of the rail. Such control of the grinding operation is effected continuously, whereby the grinding level will always be maintained at the correct value, irrespective of "interferences" due to the movement of the rail grinding vehicle across hill crests or through dales or bends. In the embodiment illustrates, this is effected by the control unit emitting a signal corresponding to a desired position of the grinding disc to the servo valve 32 which is connected to the actuating means 6. The servo valve 32 then sees to it that the desired set position is obtained. The carriage 20 is also provided with a rear distance meter 13 which in the same manner as the front meter measures the distance down to the sliding shoe and thus to the rail. While grinding is in progress, the distance at the rear distance meter 13 normally will be somewhat larger due to the amount ground away. Because the sliding shoes 29, 30 slide along any crests that may be found on the rail a comparison of the distances from the two meters 13 and 11, respectively, may provide a measure of to which extent the grinding operation has changed the situation of the rail crests.

In summary, the front sliding shoe 30 slides across the rail crests while the front distance meter 11 continuously measures the distance of the rear carriage 20, and thus the grinding disc 3, down to the front sliding shoe 30 and thus to the rail crests. This provides a desired starting position in the control unit 9 to which is added the value of the desired grinding-away of the rail, which information the front undulation meter 12 supplies to the control unit 9 on the basis of its measuring results. The control unit continuously emits data regarding the desired position to the servo valve 32

which is responsible for the actuating means 6, in this case a hydraulically operated piston-and-cylinder unit, assuming the desired position, resulting in the carriage 20 and the grinding disc 3 assuming the desired position.

With the aid of the control panel 8 the grinding operations may be started or stopped in different ways. For instance, the grinding may be effected on the rail on one side of the track or on the rails on both sides. The control panel could be associated with the grinding of the rail on one track side only or be common to the rails on both sides.

The external computer is used to alter the various parameters that are programmed in the control unit 9. These may be e.g. gain parameters for various digital regulators, sensor gradients and sensor calibration data and step-by-step operation in automatic grinding disc profile configuration.

At regular intervals and at the initial start-up the grinding system must be calibrated. This is effected in the following manner. First, the vehicle is placed on a plane rail. Profiled rules of known thickness are then disposed on the rail, whereupon a push button for "position calibration" on the control panel is depressed. As a result, the grinding disc will be lowered at a low speed until it rests on the rule. When the lower speed assumes the value 0, the system itself reads the position value. This position plus the thickness of the rule equals the fundamental grinding position, i.e. level with the crests of the ridges or undulations. If no profiled rules were to be used, the fundamental position would be more uncertain, since in this case the grinding disc could rest either on a trough or a crest section of the rail.

Figs. 2-4 illustrate a preferred embodiment of the chassis of the rail grinding vehicle and also the mode of attachment of each grinding unit to the chassis. Fig. 2 illustrates the rail grinding vehicle 2 from the side. Its chassis essentially consists of two lateral beams 15, 15'

and two transverse beams 16, 17 interconnecting the two lateral beams transversely. A longitudinally extending centre beams 32 extends between the two transverse beams 16, 17. This beam 32 thus extends longitudinally, in the centre of the vehicle as seen in the transverse direction. The vehicle terminates at the front in a front beam 34 and at the rear of a rear beam 33. These beams extend between the ends of the respective side beams 15, 15' and close the vehicle at the front and at the rear. This vehicle frame is supported by one front and one rear wheel unit. The rear wheel unit consists of two wheels 18, 18' which are non-rotationally connected to a rigid shaft and with the frame by means of springs and shock absorbers. In a corresponding manner the front wheel unit is formed by wheels 19, 19' and shaft springs and shock absorbers. This structure is entirely conventional in tram chassis and therefore will not be described in any detail. As already mentioned, the rail grinding vehicle could either be self-supporting or to various degrees depend on a traction vehicle for its propulsion. The most simple version of the rail grinding vehicle is shown in continuous lines. This vehicle is entirely dependent on a traction vehicle for its function. The dash-and-dot lines indicate a drive unit 56 and a driver's cab 57, respectively. When a drive unit 56 is used for the supply of the vehicle grinding unit no external power source is required for the grinding operations. If in addition thereto the drive unit 56 drives one wheel pair, for example the front one 19, 19', the vehicle will be self-propulsive. Normally, a driver's cabin 57 is then also required from which the driver, in a standing or sitting position, can operate the control panel 8, and, if required, the external computer 10. In this case the control unit 9 preferably is positioned inside the driver's cab for weather protection. In accordance with one preferred embodiment the drive unit 56 is a diesel engine driving a hydraulic pump. The latter in turn drives the drive motors 5, 5' of the grinding disc as

also the actuation means related to the grinding disc position. In addition, the hydraulic pump may supply a hydraulic motor which drives one or both front wheels 19, 19' in a known manner. On the other hand, if a traction vehicle is used to propel the rail grinding vehicle it is natural to place the control panel 8 and the external computer 10 as also perhaps the control unit 9 in the traction vehicle. In this case the driver drives the traction vehicle and controls the grinding process from that vehicle. Also in this case a drive unit 56 may be used to operate the grinding disc and its actuation means. The positioning of the drive unit 56 and the driver's cabin 57 is of little importance to the invention and for this reason, and for reasons of clarity, these means are not shown in Figs. 3 - 5.

Each grinding unit is articulated to the grinding vehicle chassis. As a result, it may turn transversely with respect to the vehicle. Each grinding unit is guided with respect to its associated rails to ensure correct grinding at all times. Each grinding unit essentially consists of a rotationally mounted stand part and a carriage 20 which is arranged for vertical movements therein. The rotational stand part is constructed around an attachment beam 23, which is supported in a rear bearing unit 24 and a front bearing unit 25. In this manner, the attachment beam 23 is rotationally supported in such a manner that its axis of rotation extends essentially in parallel with the longitudinal extension of the vehicle and the rails 1, 1'. A sliding frame, essentially consisting of two legs 21 and 22, extend downwards from the attachment beam 23 to the rail 1. The carriage 20 is mounted for sliding movement inside the sliding frame 21, 22 so as to be raised or lowered relatively to the rails. An actuating means 6, for instance a hydraulically operated piston-and-cylinder unit, is secured by means of its cylinder part in the attachment beam 23. Its piston rod 26 is attached to the

carriage 20. When the piston rod 26 is moved to its extended position, the carriage 20, and thus the grinding disc 3, are displaced downwards towards the rail. When the piston rod 26 is retracted, on the other hand, they are lifted upwards, away from the rail. This arrangement is illustrated also in Figs. 5 and 6. The grinding disc 3 and its associated drive motor 5 are secured to the carriage 20. In addition, one front 30 and one rear 29 sliding shoe is secured to the carriage. The front sliding shoe 30 is fitted with a front undulation meter 12 and the rear one with a rear undulation meter 14. Furthermore, the carriage is provided with a front distance meter 11 and a rear distance meter 13. The function of these meters has already been explained in some detail. Each sliding shoe 29, 30 is pressed against the rail 1 by means of its associated spring means 27, 28. Preferably, gas-operated springs are used for this purpose but also other kinds of spring means are possible. At its rear end the rear sliding shoe 29 is provided with a rear guide shoulder 35 and at its front end with a front guide shoulder 36. Each guide shoulder extends downwards along the inner face of the rail, i.e. the side of the rail that is turned towards the vehicle centre. In a similar manner, the front sliding shoe is formed with guide shoulders 37 and 38, respectively. Both sliding shoes are resiliently suspended with respect to the carriage 20 and guided so as to move in the direction of movement of the carriage, i.e. in the same direction as the two legs 21, 22 of the sliding frame. In this manner the sliding shoes may guide the carriage 20 and consequently the grinding disc 3 with respect to the rail 1. This is essential in order to obtain correct grinding results. However, the sliding shoes are fitted with guide shoulders on one side of the rail only. Consequently, additional means are required to guide the carriage 20 away from the rail. As appears from Figs. 3 and 4, such guiding is effected by the pressure exerted by the hydraulic piston-and-cylinder units 39, 40 on the

sliding frame, urging the latter to swing slightly outwards relatively to the rail. This swinging movement is prevented by the guide shoulders 35 - 38 of the sliding shoes 29, 30. By means of one of its ends each hydraulically operated piston-and-cylinder unit 39, 40 is secured to the longitudinal centre beam 32 and by means of its opposite ends to an attachment rod 41. The latter in turn is secured in the two legs 21, 22 of the sliding frame. The hydraulically operated piston-and-cylinder units 39, 40 preferably are supplied from an accumulator so as to resiliently urge the sliding frame in the lateral direction. The resiliency ensures that the guide shoulders 35 - 38 are constantly maintained pressed against the inner face of the rail irrespective of rail bends and irrespective of changes in the spacing between the two rails 1, 1'. The articulated suspension of each grinding unit and the accurate guidence of the unit with respect to the rail ensures that the grinding disc 3 is correctly guided with respect to the rail 1. In this manner, an exact grinding result is also ensured. Other types of actuating means than those mentioned may be used, such as e.g. pneumatically operated piston-and-cylinder units, gas-operated springs or mechanical springs. It is likewise possible to use one or several levers fitted with balancing weights, the latter preferably being displaceable. In this manner it is possible to achieve a suitable magnitude of the resilient force of abutment of the guide shoulders 35-38 against the rail. In some instances it may be desirable to interrupt the abutment and to steer the guide shoulders away from the rail. When cylinders are used, this may be done by resetting of valves and in other cases it could be achieved e.g. through manual actuation on a handle or a lever.

In Figs. 1 and 2 the guide shoulders 35-38 are illustrated as short shoulders each extending along the inner face of the rail. It goes without saying that their extension in the longitudinal direction of the rail could

be longer, or that they could even be joined together so as to form one single elongated guide member for each sliding shoe. At track crossings there are interruptions in the surface against which the guide shoulders abut. For notches are necessary in one of the tracks in order to accommodate the guide flanges on the wheels on the other crossing track. Guide shoulders having a larger longitudinal extension are better fitted to cope with such interruptions. In accordance with one preferred embodiment each sliding shoe 29, 30 is provided with four guide wheels 58, each one of which rolls along the rail side. Preferably, the wheels are ball or roller bearings the domed outer ring of which rolls on the rail side. Together, the wheels have a longitudinal extension corresponding to about half the length of the sliding shoe. When constructed in accordance with this embodiment, the grinding vehicle may pass a track crossing at a low speed without it being necessary to move the sliding shoes away from the rails. Normally, grinding operations are not performed at the track crossing. The embodiment including a guide shoulder 37 and a guide wheel 58' appears from the encircled enlargements of detail components in Fig. 4. Fig. 7 illustrates a further embodiment for lateral guidance. Instead of the guide shoulders 35 - 38 or guide wheels 58 flanged wheels 59 and 60 are used for the lateral guidance function. In the case illustrated two flanged wheels 59, 60 are used in a bogie unit 61 but obviously also a single flanged wheel may be used, an arrangement that will be described in closer detail in connection with Fig. 7.

Figs. 2 and 3 also show a suction pipe 31 for removal of grinding-dust particles, said pipe extending up to the grinding point. Normally, the grinding disc rotational direction is that illustrated in Fig. 2, i.e. the disc rotation counter-acts the vehicle propulsion force, which is referred to as counter-grinding. During this type of grinding, the grinding dust will be projected forwards, in

the direction of travel. For this reason, the pipe 31 is positioned in this direction and drawn as close to the grinding point as possible. The suction pipe 31 is lined with copper in order to prevent metal particles from adhering and the pipe leads to a cyclone for separation of the grinding-dust particles.

Fig. 4 is a cross-sectional view of the grinding vehicle along line A-A in Fig. 2 and seen from the front. The figure illusrates how the hydraulic cylinder 40 tends to turn the grinding unit about the pivot point 25 and how the guide shoulders 35-38 prevent this from happening. The dash-and-dot lines show the grinding unit at the opposite side, in the position in which said unit has been moved laterally as a result of its bearing members 24' and 25' having been attached closer to the vehicle centre. In this case, the bearing member 24' is secured in the apertures 44' rather than in apertures 42' in the cross beam 16. In a corresponding manner, the bearing member 25' is secured in the attachment apertures 45' instead of in attachment apertures 43' in the cross beam 17. This setting is chosen for particularly careful grinding of the inner face of the rail 1'. The positions of the attachment apertures appear from Fig. 3. Obviously, it is quite possible to arrange a larger number of attachment apertures than that illustrated and it is likewise possible to arrange the bearing members 24, 24', 25, 25' in such a manner that they may be reset in a continuously variable or stepless manner along the respective one of the cross beams 16 and 17. Another occasion when it may be desirable to reset one or both grinding units is when the rails of a different track width are to be ground. In this case, the distance between the bearing members on either side, i.e. between bearing member 24 and 24' and between 25 and 25', then is altered by the same amount as the track width changes, i.e. it is reduced for smaller track widths and increased for larger ones. Since the hydraulically operated piston-and-cylinder units 39, 40, 339', 40' may be compressed or resiliently

extended there is no need to make any changes as to their function. In all these instances of re-setting changes each grinding unit thus is guided and controlled in the same precise manner with respect to the rails as is the case in the basic setting.

Fig. 7 illustrates an embodiment of the rail grinding vehicle which differs from the previous ones as regards the front wheel suspension as also as regards the arrangement measuring the distance to the rails and the lateral guidance of the grinding unit. The lateral frames 46, 46' of the rail grinding vehicle are configured in a different manner as regards the front section 47, 47'. This is due to the fact that the front wheel suspension 48, 48' is configured as a "multi-stage bogie". More precisely, an upper bogie link 49 is articulated to the front part 47 of the lateral frame. A rear intermediate link 50 is secured to the rear end of the upper bogie link 49 and a front intermediate link 51 is secured to the front end thereof. In turn a rear wheel bogie 52 is articulated to the rear intermediate link 50 and a front wheel bogie 53 is articulated to the front part of the intermediate link 50. In the same manner, the front and rear wheel bogies 54 and 55, respectively, are mounted to the front intermediate link 51. In this manner a particular type of bogie suspension is created, wherein no less than eight wheels abut against the rail. The eight wheels are arranged in pairs in their associated wheel bogie. This means that the front part 47 of the lateral frame 46, owing to this composite bogie arrangement, will experience a "mean value" of the rail 1 from eight different points of abutment. As a result of this arrangement, the front part 47 of the lateral beam 46 will travel very evenly. No resilient means are used in this arrangement.

Fig. 7 also shows a different modification of the lateral guidance of the grinding unit and the measurement of the distance to the rail. For reasons of clarity a part

of the suction pipe 31 has been eliminated. A bogie unit 61 including two flanged wheels 59, 60 are positioned ahead of the grinding unit as seen in the direction of travel. A stay 62 secures the bogie unit to the front one of the two sliding-frame legs 22. One or several spring members 63, such as gas-operated springs, are secured to said leg at a higher level, said members tending to urge the bogie unit 61 against the rail. This means that the sliding frame, and therefore also the grinding unit, are laterally guided by the abutment of the flange wheels 59, 60 of the bogie unit 61 against the inner face of the rail. Another consequence of this arrangement is that the carriage 20 supporting the grinding disc 3 and the sliding shoes 29, 30 may be lifted without affecting the lateral guiding function. The grinding disc and the sliding shoes thus are guided relatively to the rail irrespective of whether they are in contact with the rail or not. This is a definite advantage, for instance at track crossings, where normally no grinding on the rails takes place. In addition, the arrangement including the flanged wheels 59, 60 is a more durable solution from the point of view of wear than are solutions including guide shoulders or guide wheels. A distance meter 64 is positioned above the bogie unit to measure the distance down to the bogie unit. In this manner a measure of the distance of the carriage, and thus of the grinding disc 3, to the rail is obtained. One advantage provided by this measuring arrangement is a purer measurement signal, i.e. a signal that includes less disturbances, than is the case from the meter 13 which measures the distance to the sliding shoe. This is due to the fact that the sliding show may vibrate, particularly when the rail is worn. Obviously, it is also possible to use a meter 11 measuring the distance to the sliding shoe. In this manner it becomes possible to compare the measurement results derived from two different measurement operations in order to obtain e.g. a probability check or a mean value. This guidance arrangement

thus includes no sliding shoes 29, 30 or guide shoulders 35-38.

When the rail to be ground is very badly worn or in need of re-profiling several successive grinding operations generally are required. This means that with the equipment in accordance with the invention it may be necessary to grind the rail three or four times in such cases. With conventional equipment eight to twelve successive grinding operations are necessary in such cases. In consequence, with the equipment in accordance with the invention special methods have been devised for coarse and fine grinding, respectively. For the rail condition may be so bad that it is difficult to obtain any reliable measurement results at all. In such cases, coarse grinding, repeated once or twice, will improve the rail condition to an extent allowing one or possibly two fine-grinding operations to be performed on the rail.

For the coarse-grinding operations therefore a guidance method has been devised, which is based on so called load compensation. This method involves establishment of a desired braking value, in percentage, of the grinding disc speed. The braking value could also be related to the diameter of the grinding disc, for instance by comprising a constant which is multiplied by the diameter. The regulation of the grinding disc rotational speed obviously has for its purpose to impart to the grinding disc the desired peripheral speed, irrespective of its state of wear, i.e. of its external diameter. At a predetermined degree of wear it may be desirable to set the disc rotational speed at 1600 rpm with a braking value of 10%. This means that the rotational speed regulation of the disc imparts to the disc drive motor a, temporary, fixed setting towards 1600 rpm. The application of the grinding disc 3 then is controlled in such a manner as to give the desired disc rotation speed, i.e. 1600 rpm less 10%. The control function is effected by actuation of the actuating means 6. In consequence of this control the

disc thus will be applied against the rail with an even force, ensuring that the disc follows the crests and troughs. The grinding of the surface thus obtained radically reduces the rail ridge formation. The conditions for the subsequent over-grinding operation thus are improved. In this type of coarse-grinding control based on the use of rail ridges meters 12 and 14 is not performed. In cases when the rail is in an extremely bad condition, distance measurement by means of distance meters 64, 11, 12 is not either performed.

When the rail condition is somewhat better it is possible to use a more advanced version of the coarse-grinding method, referred to as advance-warning coarse-grinding. This method may be suitable for coarse-grinding of railway rails. In this case the meter 64 measures the distance to the rail with the aid of the bogie unit 61. In this manner advance warning maybe transmitted to the grinding control means on any flaws in the rail ahead of the grinding disc. Such advance warning may then result in an improved grinding quality.

In fine-grinding situations, on the other hand, control based primarily on the undulations or ridges of the rail before and after the grinding disc, is used. For this purpose meters 12, 14 are used, which are positioned on the associated sliding shoe 30, 29. In accordance with a further development these meters are inductive and positioned as close the the sliding shoe centre as possible. Consequently, they measure the distance between the rail and the sliding shoe close to the sliding shoe centre. This is effected with a high degree of accuracy and at a high speed.

Each sliding shoe has a length of approximately 500 mm. This length is carefully chosen on the basis of statistics on the profile condition of worn rails. It is important with respect to the quality of the grinding results that each sliding shoe has a sufficient length and is positioned immediately adjacent the grinding disc. In

fine-grinding operations distance measuring normally is utilized before the grinding disc. Preferably it is effected by means of meter 64 and/or meter 11. Distance measuring after the grinding disc, i.e. with the aid of meter 13, is not necessary but could, of course, provide additional information. The fact that the meter 13 is not obligatory is due to it being possible to base the distance of the disc to the rail on a value representative of the distance derived e.g. from the meter 64, and on the undulatory condition of the rail before and after grinding, i.e. by means of meters 12 and 14.

In order to achieve good grinding results it is necessary to sharpen the grinding disc carefully. This preferably is done by application of a diamond roller against the grinding disc. In this case the diamond roller has a shape which upon correct sharpening of the disc imparts a correct configuration to the grinding disc and thus to the rail. Normally, the sharpening diamond is applied from time to time. It is then desirable that the application is sufficient to impart to the disc a correct configuration, but not excessively strong and/or lengthy so that the disc is worn out prematurely. In order to reach these goals the sharpening function is controlled in a special manner. More precisely, the rotational speed of the diamond roller is measured, since the rpm-value of this roller is a reliable indication of the degree of application. Normally, the application is interrupted, when the sharpening diamond has reached the same rotational speed as the grinding disc. The operation may be continued somewhat longer, should experience show this to be necessary.

CLAIMS

1. A method of grinding rails (1, 1') for vehicles travelling on rails, such as trams and trains, according to which a rail grinding vehicle (2) is provided with at least one grinding disc (3, 3') for grinding an associated rail (1, 1'), the rotational shaft (4, 4') of said grinding disc extending essentially transversely to the longitudinal extension of the rail and the grinding operation being effected by means of the disc periphery, a motor (5, 5') being provided to drive the grinding disc, the distance of said disc to the rail being adjustable with the aid of actuating means (6, 6'), in addition to which the grinding disc is affected by at least one sharpening tool (7, 7'), c h a r a c t e r i z e d in that said rail grinding vehicle (2) is provided with measuring devices (11-14, 11'-14') arranged to measure the distance of said grinding disc (3, 3') from the rail before and after the grinding disc as well as to measure essentially vertical variations of the rail, from the top to the bottom, before and after the grinding disc (3, 3'), the results obtained from said measuring operations being supplied together with start or stop orders from at least one control panel (8, 8') into at least one control computer (9, 9'), the latter continuously calculating the desirable distance to the rail in response to said measurement results and emitting signals to the grinding disc actuating means (6, 6') in order to obtain the desired adjustment, whereby owing to said measurement and control operations the rail will be ground only where required and be ground to a sufficient but not excessive degree and the grinding operation will impart to said rail an essentially correct configuration transversely.

2. A method as claimed in claim 1, c h a r a c - t e r i z e d in that the measurement results relating to the distance of said grinding disc to the rail, before

and after the grinding disc, is measured by means of one front and one rear distance meter (11 and 12, respectively), which meters measure said distance from an essentially vertically movable carriage (20), in which said grinding disc (3) is mounted, to a sliding shoe (29, 30) which is resiliently suspended and vertically movable with respect to the carriage (20), whereby the sliding shoe (29, 30) will slide under the action of a spring on the vertical peaks of the rail, and in that the essentially vertical variations of the rail, before and after the grinding disc, are measured by measuring the distance from each sliding shoe (30, 29) down to the surface of the rail by means of one front (12) and one rear (14) undulation meter.

3. A method as claimed in any one of the preceding claims, c h a r a c t e r i z e d by measuring, in addition to the values representative of the distance of the grinding disc (3, 3') from the rail and the vertical variations of the rail, before and after the griding disc, also measuring the rotational speed of the grinding disc (3, 3'), and supplying the results obtained from said measurements with respect to distance, vertical variations and rotational speed as well as start or stop orders to at least one control unit (9, 9'), the latter continuously calculating the desirable distance to the rail and the rotational speed of the grinding disc (3, 3') in response to said masurement results and emitting signals to the grinding-disc actuating means (6, 6') and the motor (5, 5') in order to obtain the desired adjustment, and also emitting signals for actuation of the grinding tool.

4. A method as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that the control unit (9, 9') is supplied with input data also from an external computer (10), such as a PC-unit, allowing alteration of the estimation parameters and similar information stored in the control unit.

5. A method as claimed in any one of the preceding claims, c h a r a c t e r i z e d by calibrating the system at regular intervals and at the original start-up by first positioning the rail-grinding vehicle (2) on a plane rail, then lowering the grinding disc onto the rail or to a rule of known thickness positioned on the rail, and thereafter supplying the control unit (9, 9') with the values representative of the distance before and after the grinding disc, thus generating a basic value representative of the distance in said control unit.

6. A rail grinding vehicle (2) in accordance with any of the preceding claims and intended for grinding rails (1, 1') for vehicles travelling on rails, such as trams and trains, said vehicle (2) being provided with at least one grinding disc (3, 3') for grinding an associated rail (1, 1'), the rotational shaft (4, 4') of said grinding disc extending essentially transversely to the longitudinal extension of the rail, the grinding disc being driven by a motor (5, 5'), such as a hydraulic or electric motor, and the distance of said disc to the rail being adjustable with the aid of actuating means (6, 6'), such as a hydraulically operated cylinder, or an electrically driven mechanical positioning member, in addition to which said grinding disc is arranged to be affected by at least one sharpening tool (7, 7'), c h a r a c t e r i z e d in that said rail grinding vehicle is provided with measurement equipment (11-14, 11'-14') measuring on the one hand the distance of said grinding disc (3, 3') to the rail before and after the grinding disc and also the essentially vertical variations of the rail, from the top to the bottom, before and after the grinding disc (3, 3'), the results from said measurement operations being supplied, together with the values representative of the measured rotational speed of the grinding disc and together with start or stop orders from at least one control panel (8, 8'), into at least one control unit (9, 9'), the latter continuously calculating

the desirable distance to the rail and the rotational speed of the grinding disc (3, 3') in response to said measurement results and emitting signals to the grinding-disc actuating means (6, 6') and to the motor (5, 5') in order to obtain the desired adjustment, and also emitting signals for actuation of the sharpening tool (7, 7'), wherein at least one of either the control panel (8, 8'), or the control unit (9, 9'), or the external computer could be disposed on a vehicle coupled to the rail grinding vehicle and connected to the latter vehicle via a cable, in addition to which the motor (5, 5') and the actuating means (6, 6') of each individual grinding disc (3) being operated from a drive unit (56), such as an hydraulic or electric drive unit, which may be positioned on the vehicle (2) or on a vehicle coupled to said vehicle.

7. A rail grinding vehicle (2) as claimed in claim 6, c h a r a c t e r i z e d in that at least one rail grinding unit comprising a grinding disc (3) is rotationally suspended in the vehicle chassis by means of bearing means (24, 25), the rotational axis of which extends essentially in the longitudinal direction of the vehicle, and in that at least one actuating unit (39, 40) is arranged intermediate the chassis (32) and the grinding unit tending to turn the latter outwards transversely with respect to the vehicle, said outwards turning movement being prevented by guide members (35-38; 58; 59, 60) abutting against the inner face of the rail and connected with the rail grinding unit, thus ensuring that the grinding unit, and consequently the grinding disc (3), always assume a correct position transversely with respect to the rail irrespective of interferences, such as for instance curves, ridges, depressions and rail width variations.

8. A rail grinding vehicle as claimed in claim 7, c h a r a c t e r i z e d in that the rail grinding unit essentially consists of a stand which is rotationally

suspended owing to an arrangement according to which an attachment beam (23) is supported in bearing means (24, 25) and that two legs (21, 22) extend downwards towards the rail (1) from said attachment beam and travel in a sliding frame, said sliding frame being actuated by at least one actuating means (39, 40) secured for instance with the aid of an attachment beam (41), in that a carriage (20) travels in said sliding frame and is moved by an actuating means (6) in a direction towards or away from the rail, in that said grinding disc (3) is mounted in said carriage as well as one front (11) and one rear (13) distance meter, in addition to which a front (30) and a rear (29) sliding shoe are mounted in the carriage (20) and guided so as to be movable essentially in the very direction of movement of the carriage, and by means of resilient means (27, 28), such as gas-operated springs, the associated sliding shoe (29, 30) is pressed downwards against the rail, and in that the sliding shoes are provided with guides (35-38; 58), the front sliding shoe (30) being provided with the front undulation meter (12) and the rear sliding shoe (29) with the rear undulation meter (14).

9. A rail grinding vehicle as claimed in any one of claims 7-8, c h a r a c t e r i z e d in that each actuating means (39,40) consists of an hydraulically operated cylinder arranged to control the grinding unit turning movement in the transverse direction but also to resiliently press the grinding unit against guides (35-38; 58; 59, 60), for instance owing to an accumulator being inserted in the hydraulic cylinder supply circuit.

10. A rail grinding vehicle as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that bearing means (24, 25, 24', 25') associated with each grinding unit are displaceable laterally, stepwise or continuously, allowing readjustment of said grinding unit in correspondence to other rail widths or readjustment thereof for special grinding operations on the inner face

of the rail.

11. A rail grinding vehicle as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that at least one grinding dust suction pipe (31) extends up to the point of grinding and debouches in the direction of rotation of the grinding disc so as to throw grinding-dust particles towards the mouth, and in that said suction pipe is coated internally with copper to prevent metal particles from adhering to the pipe and leads to a separator, such as a cyclone, for separation of grinding-dust particles.

12. A rail grinding vehicle as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that the front wheel suspension comprises at least one "multi-stage bogie" having an upper bogie link (49) which is articulated to the lateral frame (46, 46') of the vehicle, and in that a front and a rear intermediary link (51 and 50, respectively) are articulated to their respective one of the two bogie link ends, said latter links each having a rear wheel bogie (52 and 54, respectively) and a front wheel bogie (53 and 55, respectively) rotationally secured thereto, said four wheel bogie units each supporting two wheels, so that in all eight wheels bear against the rail.

AMENDED CLAIMS

[received by the International Bureau on 18 January 1994 (18.01.94); original claim 1 amended; original claims 6 and 8 amended and renumbered as claims 9 and 11; new claims 2-5 added; claims 3,4,5,7,9,10,11 and 12 renumbered as claims 6,7,8,10,12,13,14 and 15 (7 pages)]

1. A method of grinding rails (1, 1') for vehicles travelling on rails, such as trams and trains, according to which a rail grinding vehicle (2) is provided with at least one grinding disc (3, 3') for grinding an associated rail (1, 1'), the rotational shaft (4, 4') of said grinding disc extending essentially transversely to the longitudinal extension of the rail and the grinding operation being effected by means of the external periphery of the disc, a motor (5, 5') being provided to drive the grinding disc, the distance of said disc to the rail being adjustable with the aid of actuating means (6, 6'), in addition to which the grinding disc is affected by at least one sharpening tool (7, 7'), c h a r a c t e r i z e d in that said rail grinding vehicle (2) is provided with measuring devices (11-14, 11'-14'), which after possible preparatory coarse-grinding operations have been carried out, measure the distance of said grinding disc (3, 3') from the rail before and possibly also after the grinding disc as well as to measure essentially vertical variations of the rail, from the top to the bottom, before and after the grinding disc (3, 3'), the results obtained from said measuring operations being supplied together with start or stop orders from at least one control panel (8, 8') into at least one control computer (9, 9'), the latter continuously calculating the desirable distance to the rail in response to said measurement results and to store data and emitting signals to the grinding disc actuating means (6, 6') in order to obtain the desired adjustment, whereby owing to said measurement and control operations the rail will be ground only where required and be ground to a sufficient but not excessive degree and the grinding operation will impart to said rail an essentially correct configuration transversely.

2. A method as claimed in claim 1, c h a r a c - t e r i z e d in that the coarse-grinding operations are charachterized in that the application of the grinding disc (3, 3') against the rails (1, 1') is effected in accordance with a predetermined criterion, of application, such as the obtainment of a certain degree of braking of the driving motor or the build-up in the actuating means (6) of a certain pressure for the application of the grinding disc.

3. A method as claimed in claim 2, c h a r a c - t e r i z e d in that for the purpose of the coarse-grinding, the application of the grinding disc (3, 3') against the rail essentially in accordance with the predetermined criterion of application is supplemented by measuring values representative of the distance of the grinding disc to the rail before the grinding disc so as thus to make it possible to obtain a forewarning of faults and the like in the rail, for instance in the area of welding joints and depressions, allowing consequential alteration of the grinding disc application and thus improvement of the grinding quality.

4. A method as claimed in any one of the preceding claims, c h a r a c t e r i z e d by measuring the values representative of the distance of the grinding disc (3, 3') from the rail before and possibly also after the grinding disc, as also the essentially vertical variations of the rails before and after the grinding disc by means of at least one front unit (30; 61) in contact with the rail, such as a sliding shoe (30) or a bogie unit (61), as also by means of at least one corresponding rear unit in contact with the rail, said units in contact with the rail being essentially vertically movable and spring-biased in the direction towards the rails with respect to an essentially vertically movable carriage (20) in which the grinding disc is mounted.

5. A method as claimed in claim 4, c h a r a c t e r i z e d by measuring the values representative of the distance of the grinding disc from the rail before and possibly also after the grinding disc by measuring the distance between the carriage (20) and a corresponding unit (29, 30; 64) in contact with the rail by means of one front (11; 64) and one rear (12) distance meter, and by measuring the essentially vertical variations of the rail, before and after the grinding disc, by measuring the distance from the unit (29, 30; 61) in contact with the rail down to the rail surface by means of one front and one rear undulation meter (12, 14).

6. A method as claimed in any one of the preceding claims, c h a r a c t e r i z e d by measuring, in addition to the values representative of the distance of the grinding disc (3, 3') from the rail and the vertical variations of the rail, before and after the griding disc, also the rotational speed of the grinding disc (3, 3'), and supplying the results obtained from said measurements with respect to distance, vertical variations and rotational speed as well as start or stop orders to at least one control unit (9, 9'), the latter continuously calculating the desirable distance to the rail and the rotational speed of the grinding disc (3, 3') in response to said measurement results and to stored data and emitting signals to the grinding-disc actuating means (6, 6') and to the motor (5, 5') in order to obtain the desired adjustment, and also emitting signals for actuation of the grinding tool.

7. A method as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that the control unit (9, 9') is supplied with input data also from an external computer (10), such as a PC-unit, allowing alteration of the calculating parameters and similar information stored in the control unit.

AMENDED SHEET (ARTICLE 19)

8. A method as claimed in any one of the preceding claims, c h a r a c t e r i z e d by calibrating the system at regular intervals and at the original start-up by first positioning the rail-grinding vehicle (2) on a plane rail, then lowering the grinding disc onto the rail or to a ruler of known thickness positioned on the rail, and thereafter supplying the control unit (9, 9') with the values representative of the distance before and after the grinding disc, thus generating a basic value representative of the distance in said control unit.

9. A rail grinding vehicle (2) intended for grinding rails (1, 1') for vehicles travelling on rails, such as trams and trains, said vehicle (2) being provided with at least one grinding disc (3, 3') for grinding an associated rail (1, 1'), the rotational shaft (4, 4') of said grinding disc extending essentially transversely to the longitudinal extension of the rail, the grinding disc being driven by a motor (5, 5'), such as a hydraulic or electric motor, and the distance of said disc to the rail being adjustable with the aid of actuating means (6, 6'), such as a hydraulically operated cylinder, or an electrically driven mechanical positioning member, in addition to which said grinding disc is arranged to be affected by at least one sharpening tool (7, 7'), c h a r a c t e r i z e d in that said rail grinding vehicle is provided with at least one control panel (8, 8'), at least one control unit (9, 9'), and possibly one external computer and with measurement equipment (11-14, 11'-14'; 64, 64') adapted to measure on the one hand the distance of said grinding disc (3, 3') to the rail before and possibly also after the grinding disc, and also adapted to measure the essentially vertical variations of the rail, from the top to the bottom, before and after the grinding disc (3, 3'), the results from the measurement operations being supplied, together with start or stop orders from said control panel (8, 8'), into a control unit (9, 9'), the latter continuously calculating the desirable distance to the rail in

response to said measurement results and to stored data and emitting signals to the grinding-disc actuating means (6, 6') in order to obtain the desired adjustment, wherein at least one of either the control panel (8, 8'), or the control unit (9, 9'), or the external computer could be disposed on a vehicle coupled to the rail grinding vehicle and connected to the latter vehicle via a cable, in addition to which the motor (5, 5') and the actuating means (6, 6') of each individual grinding disc (3) being operated from a drive unit (56), such as a hydraulic or electric drive unit, which may be positioned on the vehicle (2) or on a vehicle coupled to said vehicle.

10. A rail grinding vehicle (2) as claimed in claim 9, c h a r a c t e r i z e d in that at least one rail grinding unit comprising a grinding disc (3) is rotationally suspended in the vehicle chassis by means of bearing means (24, 25), the rotational axis of which extends essentially in the longitudinal direction of the vehicle, and in that at least one actuating unit (39, 40) is arranged intermediate the chassis (32) and the grinding unit tending to turn the latter outwards transversely with respect to the vehicle, said outwards turning movement being prevented by guide members (35-38; 58; 59, 60) abutting against the inner face of the rail and connected with the rail grinding unit, thus ensuring that the grinding unit, and consequently the grinding disc (3), always assume a correct position transversely with respect to the rail irrespective of interferences, such as for instance curves, ridges, depressions and rail width variations.

11. A rail grinding vehicle as claimed in claim 10, c h a r a c t e r i z e d in that the rail grinding unit essentially consists of a stand which is rotationally suspended owing to an arrangement according to which an attachment beam (23) is supported in bearing means (24, 25) and that two legs (21, 22) extend downwards towards the rail (1) from said attachment beam and travel in a sliding frame, said sliding frame being actuated by at

least one actuating means (39, 40) secured for instance with the aid of an attachment beam (41), in that a carriage (20) travels in said sliding frame and is moved by an actuating means (6) in a direction towards or away from the rail, in that said grinding disc (3) is mounted in said carriage as well as one front (11, 11'; 64) and possibly also one rear (13) distance meter, in addition to which a front unit (30; 61) and a rear unit (29) in contact with the rail are mounted in the carriage (20) and guided so as to be movable essentially in the very direction of movement of the carriage, and by means of resilient means (27, 28, 63), such as gas-operated springs, the associated unit (29, 30; 61) in contact with the rail is pressed downwards against the rail, and in that the units in contact with the rail are provided with guides (35-38; 58, 59, 60), the front unit (30; 61) being provided with the front undulation meter (12) and the rear unit (29) with a rear undulation meter (14).

12. A rail grinding vehicle as claimed in any one of claims 10-11, c h a r a c t e r i z e d in that each actuating means (39,40) consists of an hydraulically operated cylinder arranged to control the grinding unit turning movement in the transverse direction but also to resiliently press the grinding unit against guides (35-38; 58; 59, 60), for instance owing to an accumulator being inserted in the hydraulic cylinder supply circuit.

13. A rail grinding vehicle as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that bearing means (24, 25, 24', 25') associated with each grinding unit are displaceable laterally, stepwise or continuously, allowing readjustment of said grinding unit in correspondence to other rail widths or readjustment thereof for special grinding operations on the inner face of the rail.

14. A rail grinding vehicle as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that at least one grinding-dust suction pipe (31) extends up to

the point of grinding and debouches in the direction of rotation of the grinding disc so as to throw grinding-dust particles towards the mouth, and in that said suction pipe is coated internally with copper to prevent metal particles from adhering to the pipe and leads to a separator, such as a cyclone, for separation of grinding-dust particles.

15. A rail grinding vehicle as claimed in any one of the preceding claims, c h a r a c t e r i z e d in that the front wheel suspension comprises at least one "multi-stage bogie" having an upper bogie link (49) which is articulated to the lateral frame (46, 46') of the vehicle, and in that a front and a rear intermediary link (51 and 50, respectively) are articulated to their respective one of the two bogie link ends, said latter links each having a rear wheel bogie (52 and 54, respectively) and a front wheel bogie (53 and 55, respectively) rotationally secured thereto, said four wheel bogie units each supporting two wheels, so that in all eight wheels bear against the rail.

STATEMENT UNDER ARTICLE 19

In the first claim, the following has been added:

- On line 18 ", which after possible preparatory coarse-grinding operations have been carried out,".

- On line 21: "possibly also".

The first feature appears from the International Application of August 19, 1993, in Swedish, page 15, line 21-33.

The second feature appears from the basic document of August 19, 1992, in Swedish, page 8, lines 1-13, and from the International Application, in Swedish, page 17, line 8-14.

Claim 9 corresponds to the old claim 6 but is amended so it corresponds to claim 1.

Claim 11 corresponds to the old claim 8 but is slightly amended in that "units in contact with the rail" of claim 4 and 5 is used.

Fig. 1

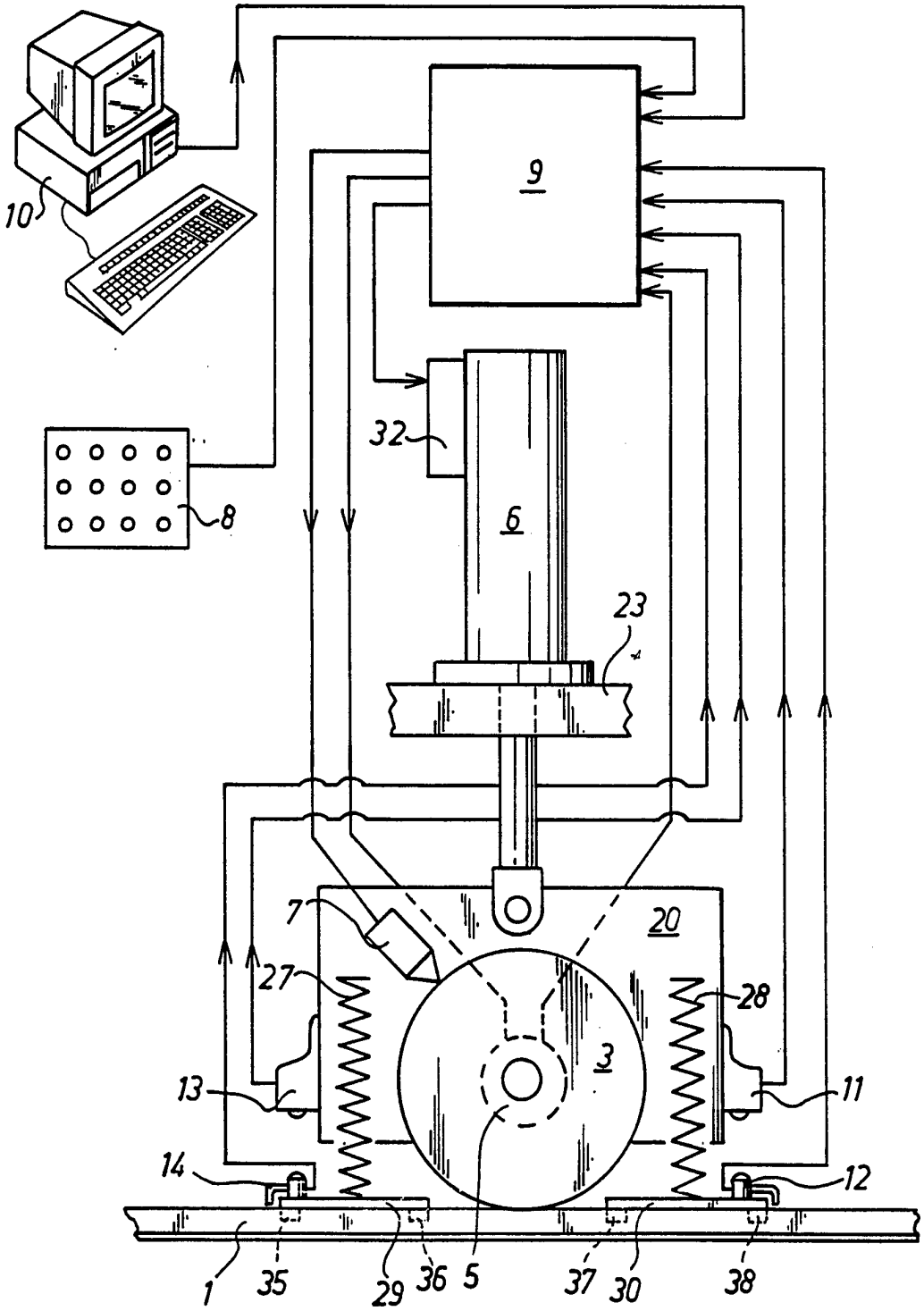
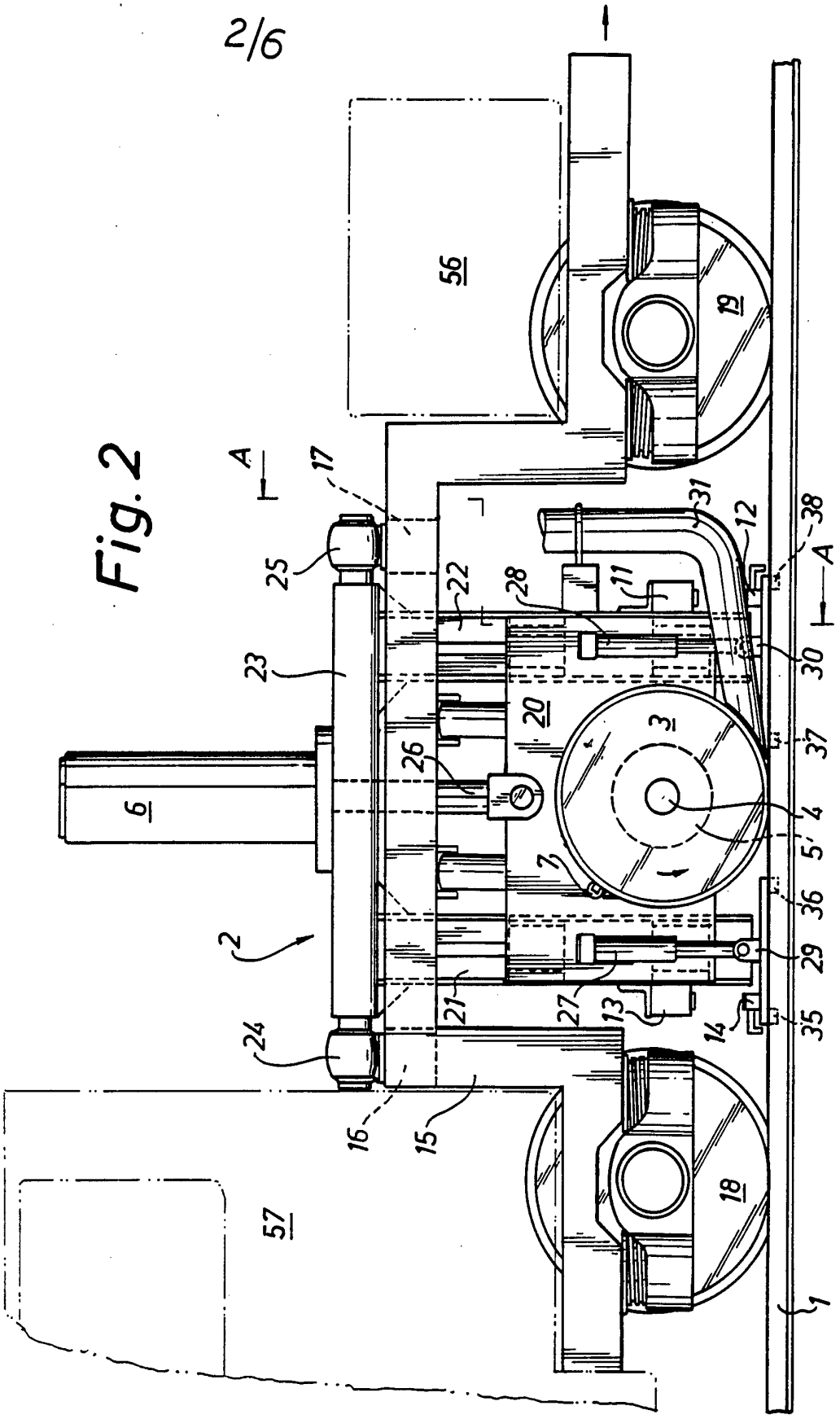


Fig. 2


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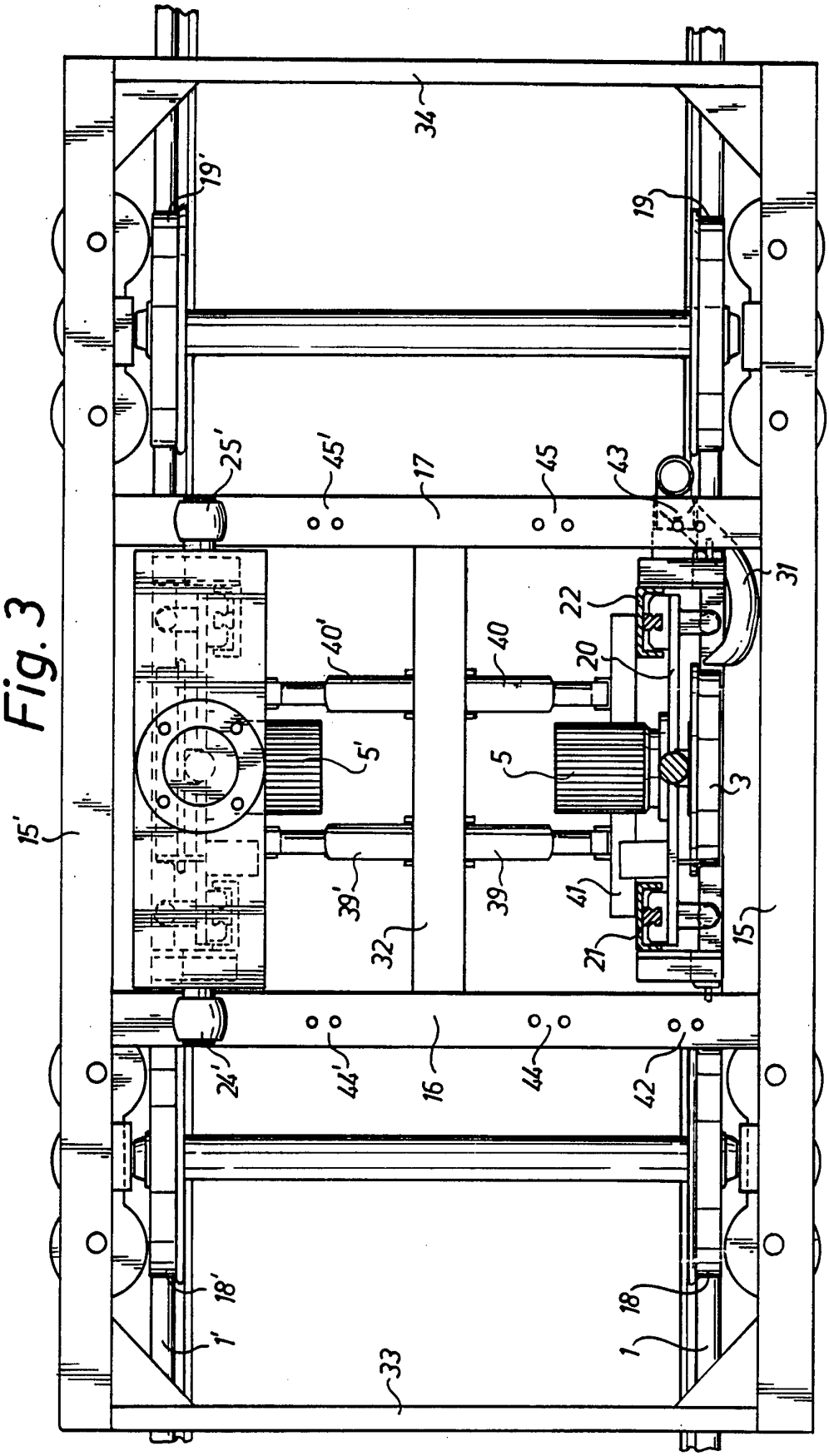
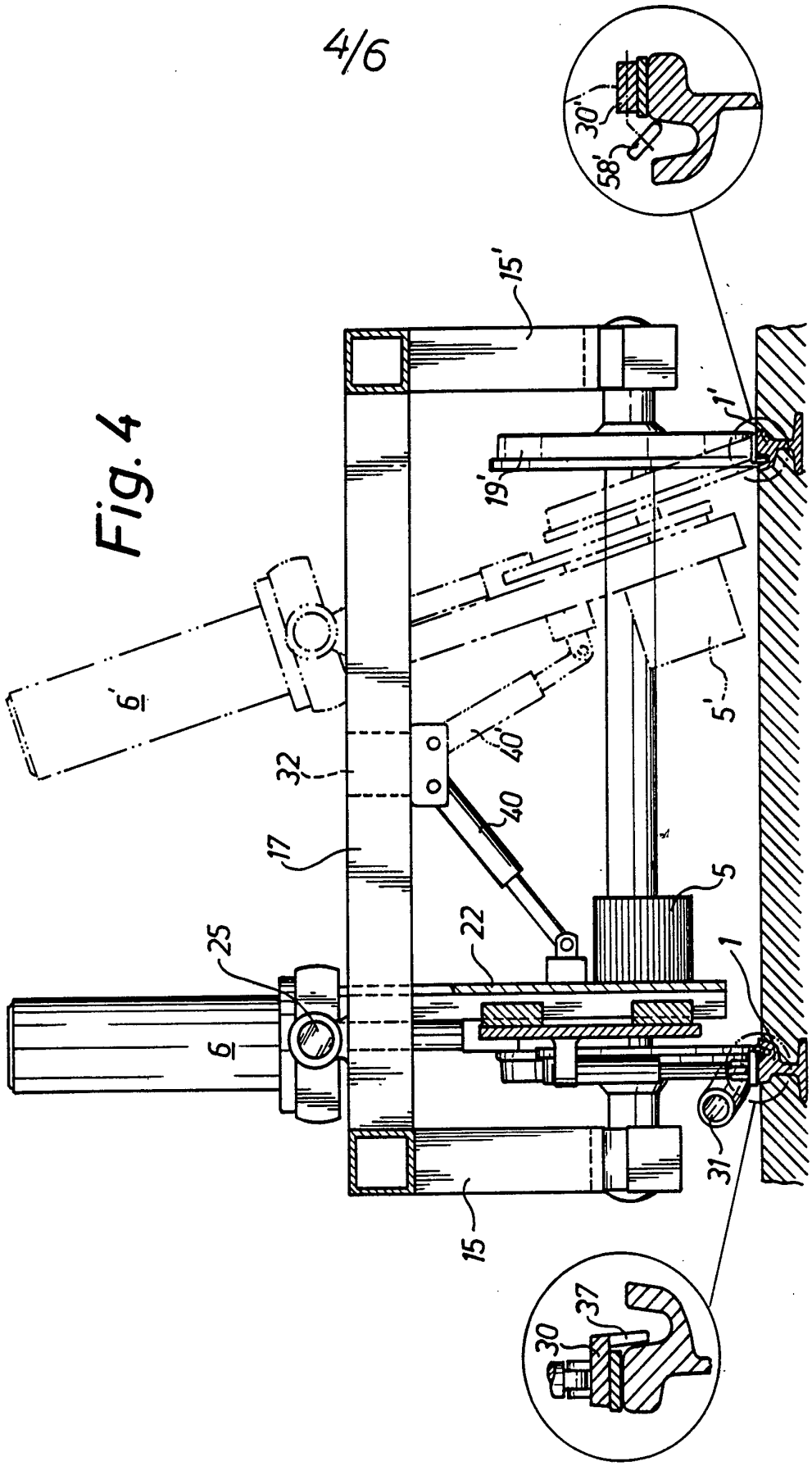

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Fig. 3

Fig. 4



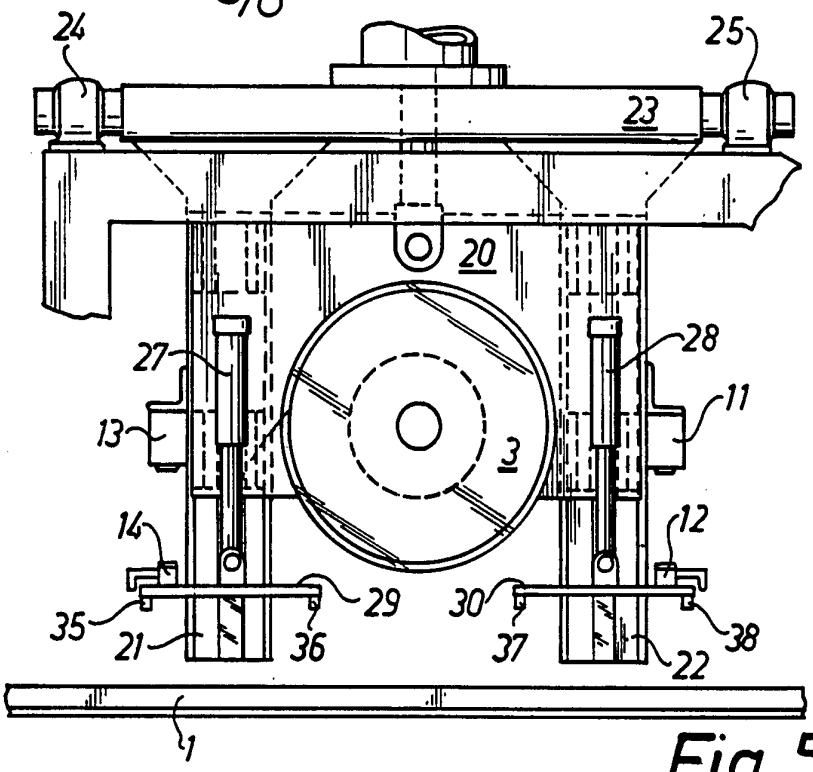

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Fig. 5

Fig. 6

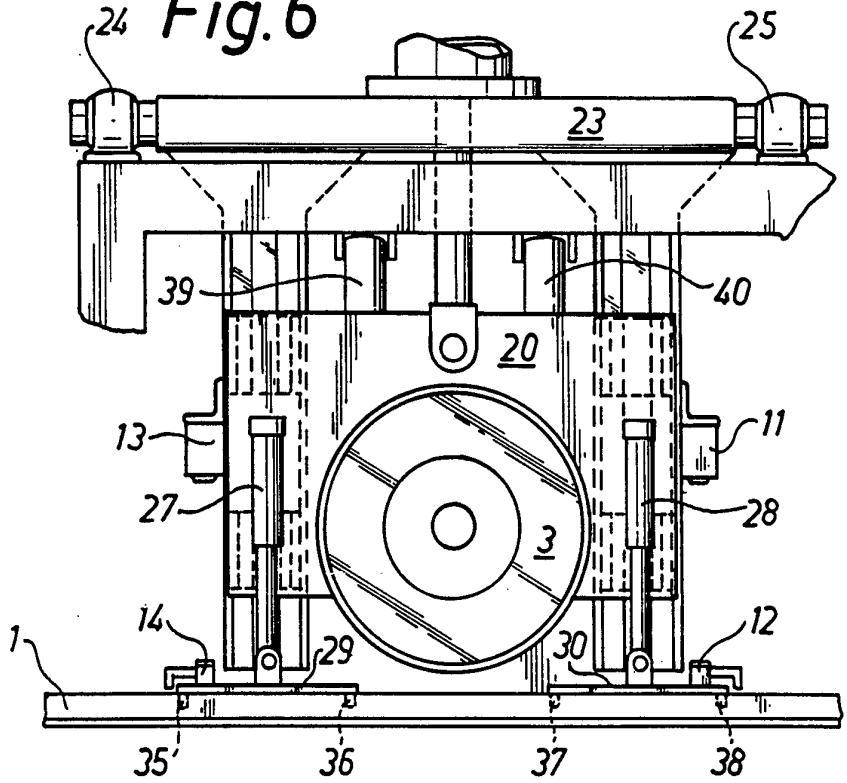
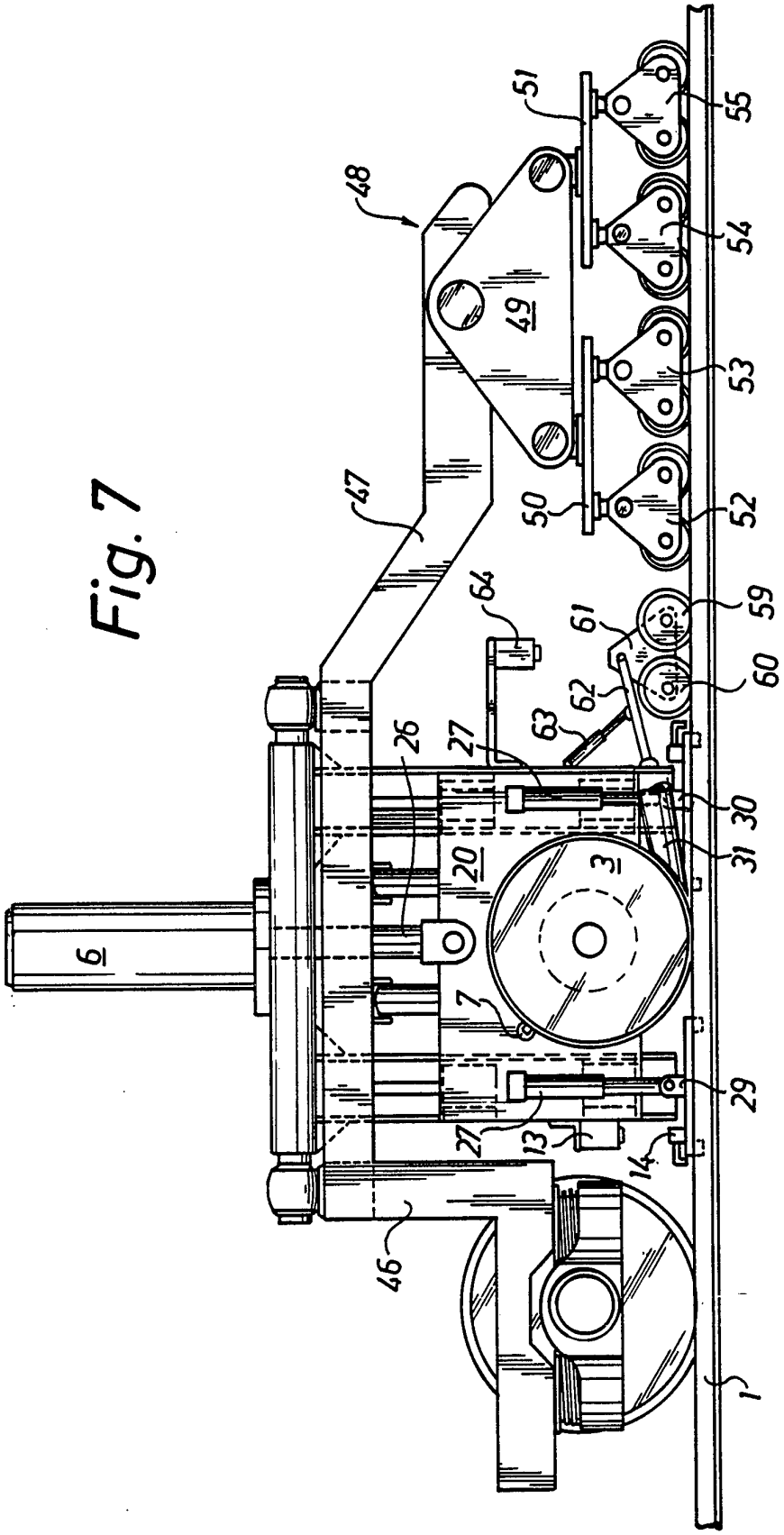

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Fig. 7


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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 93/00693

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: E01B 31/17
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: E01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5086591 (R. PANETTI), 11 February 1992 (11.02.92), column 8, line 7 - line 58; column 9, line 12 - line 32, figures 11,15	1-6
Y	US, A, 4347688 (F. SCHEUCHZER ET AL), 7 Sept 1982 (07.09.82), column 2, line 44 - column 3, line 23, figure 4	1-6
A	WO, A1, 8802300 (ROTRAFER S.P.A.), 7 April 1988 (07.04.88), page 1, 1st paragraph	1

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 November 1993	30 -11- 1993
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Joakim Grip Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 93/00693

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, B2, 2112533 (SCHEUCHZER, F. ET AL), 3 November 1977 (03.11.77) -- --------	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

16/10/93

International application No.
PCT/SE 93/00693

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 5086591	11/02/92	AU-B- 628630	17/09/92
		AU-A- 6131190	28/02/91
		CA-A- 2022567	01/03/91
		CH-A- 680598	30/09/92
		DE-U- 6900045	17/12/92
		EP-A,B- 0415105	06/03/91
		SE-T3- 0415105	
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		CH-A- 614476	30/11/79
		DE-A,C- 2843649	12/04/79
		FR-A,B- 2405329	04/05/79
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		EP-A,B- 0318521	07/06/89
		SE-T3- 0318521	
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		CH-A- 549693	31/05/74
		FR-A- 2083451	17/12/71
		NL-A- 7103759	22/09/71
		CH-A- 562920	13/06/75