May 21, 1963 R. E. SLATTERY 3,090,170

METHOD AND APPARATUS FOR GRINDING WELDED RAILS

Original Filed April 22, 1959

10 Sheets-Sheet 1

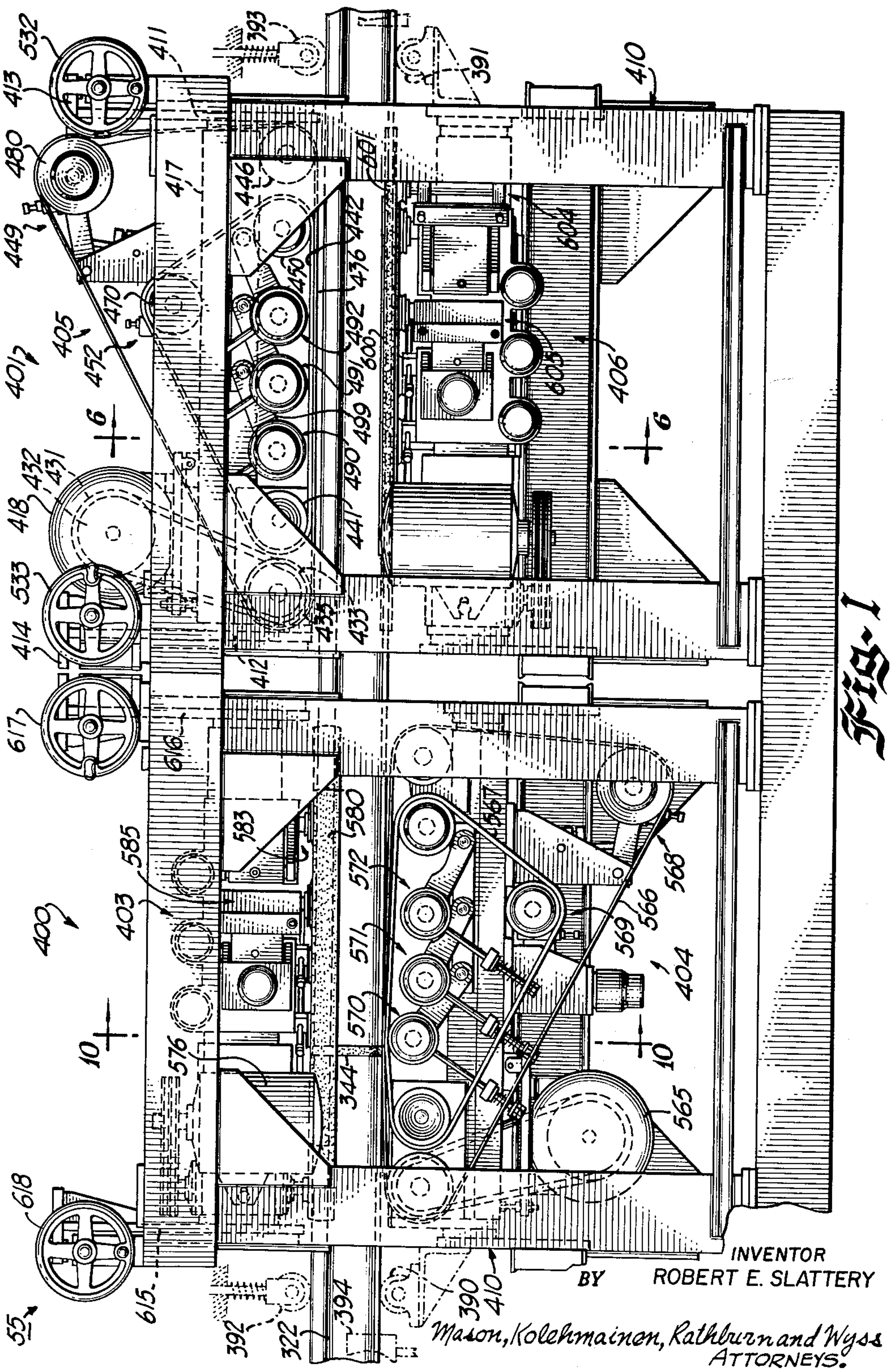

Fig. 1

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METHOD AND APPARATUS FOR GRINDING WELDED RAILS

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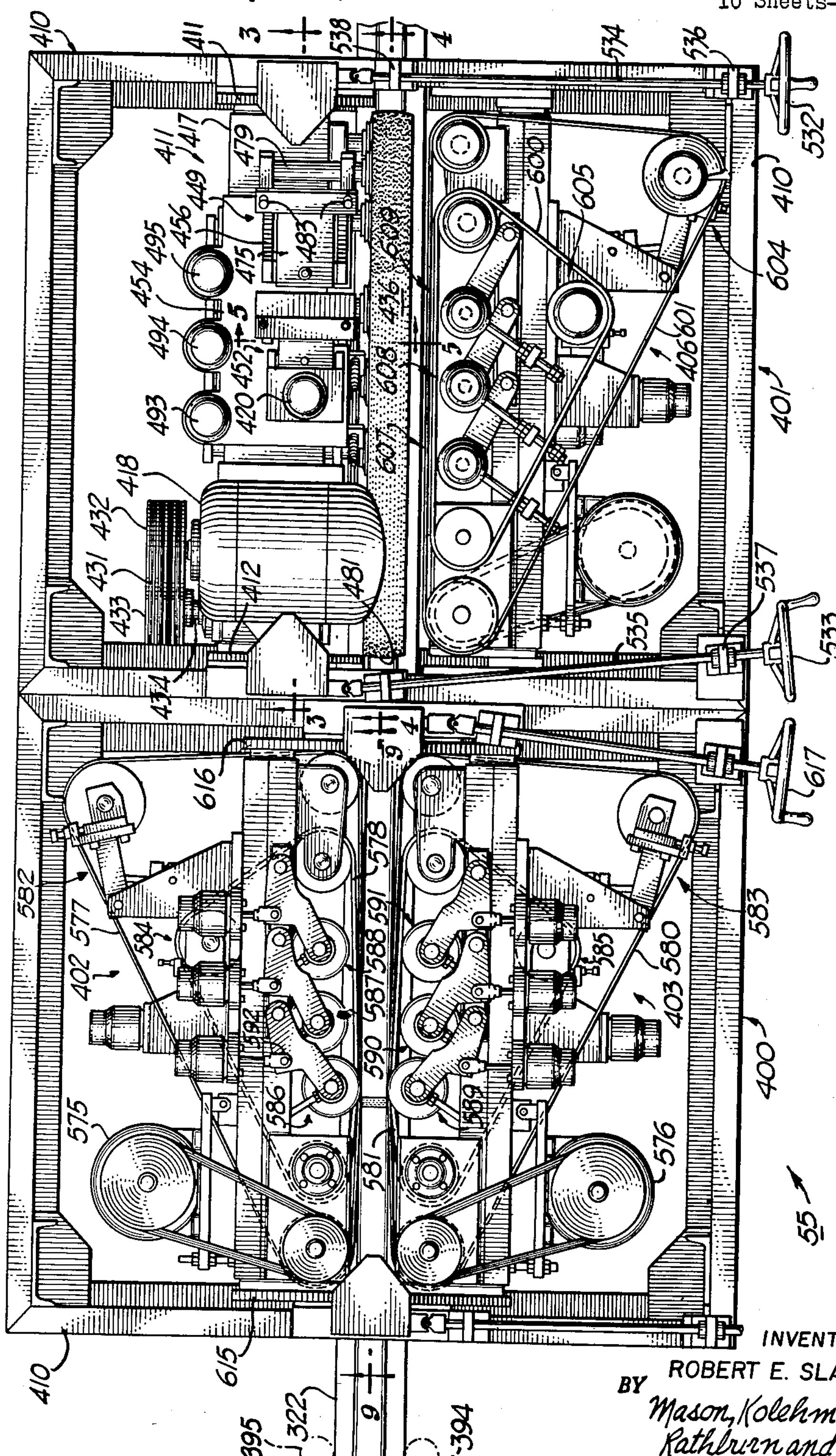

Fig. 2

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METHOD AND APPARATUS FOR GRINDING WELDED RAILS

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10 Sheets-Sheet 3

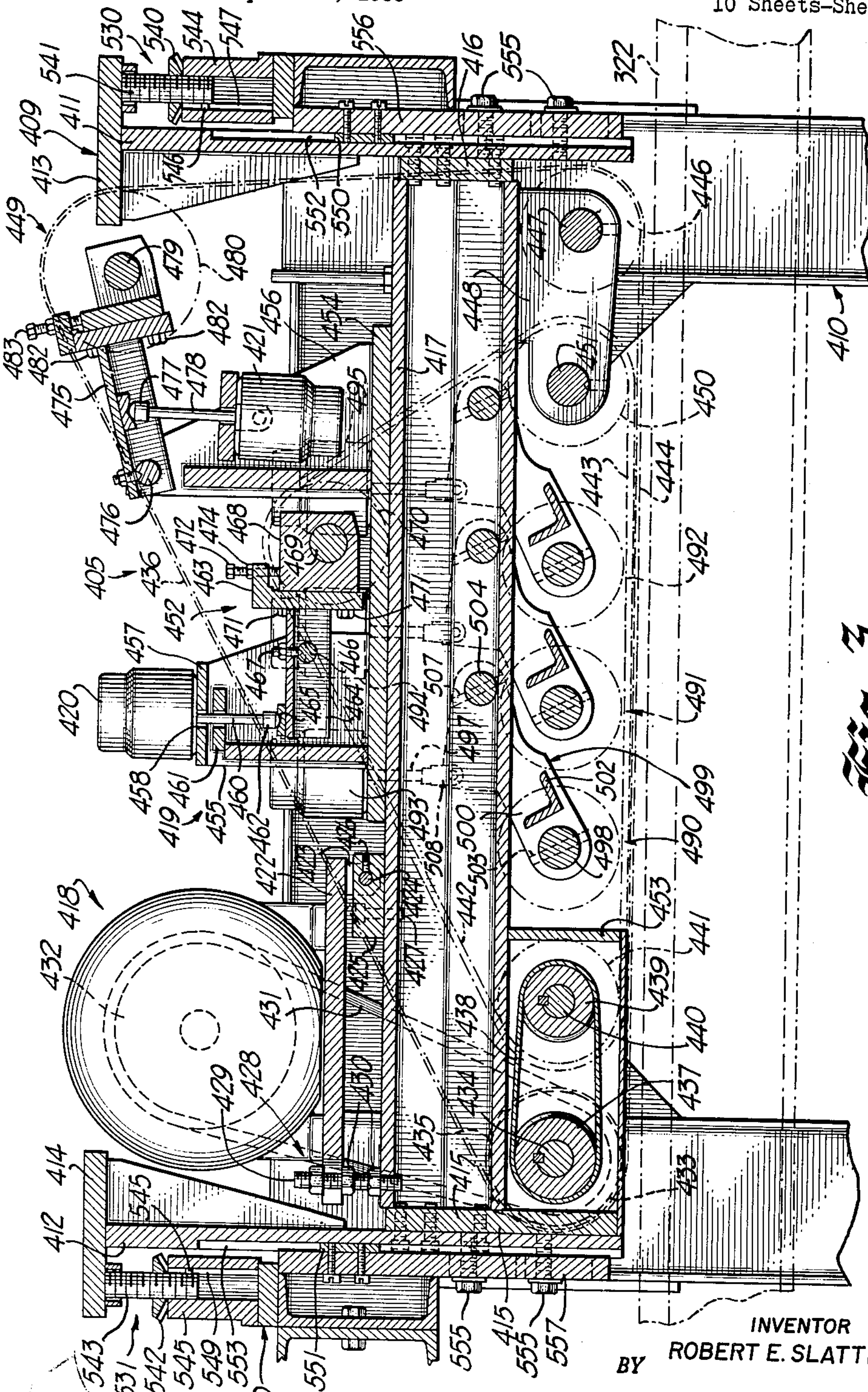

Fig. 3

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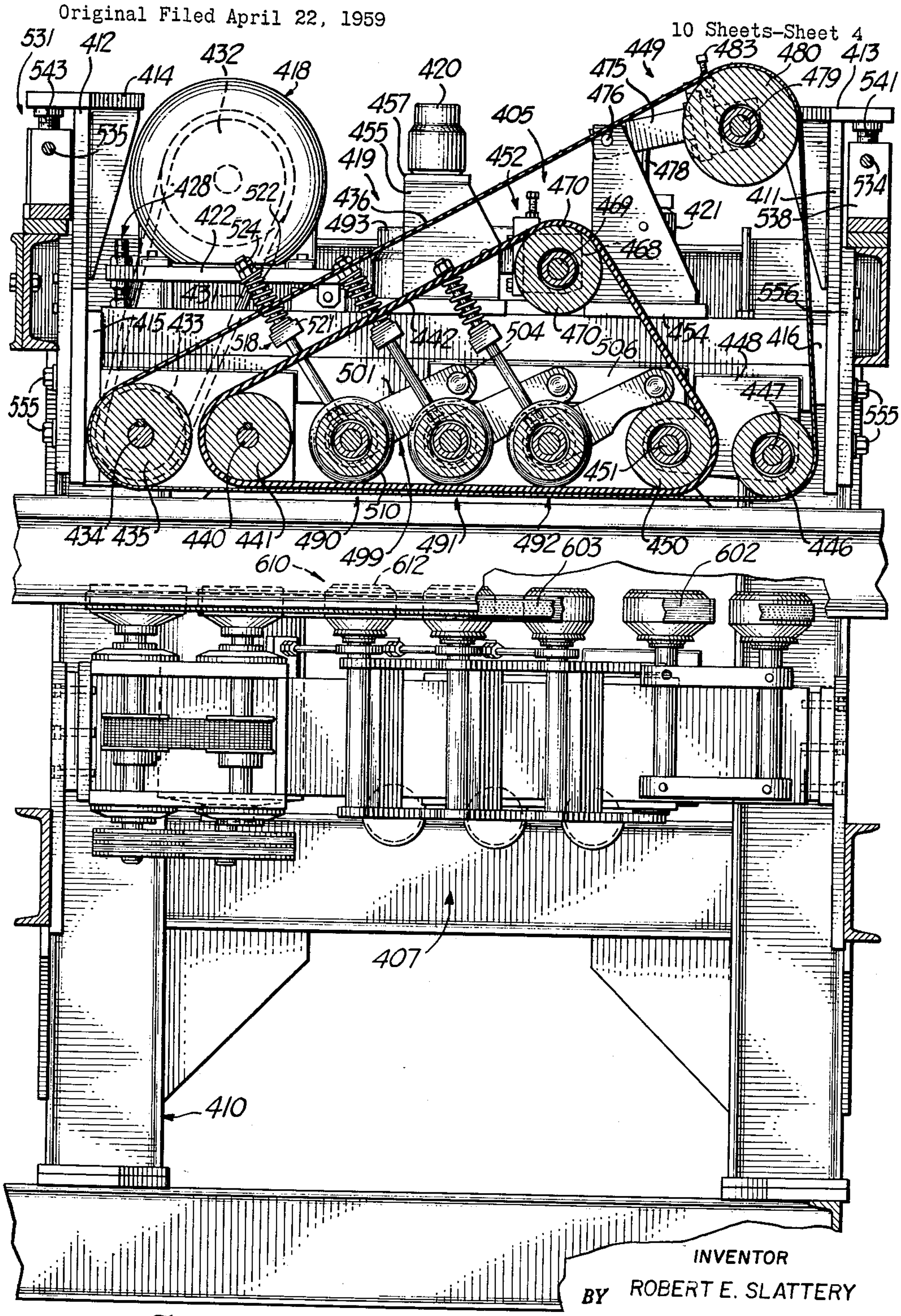

Fig. 4

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May 21, 1963 R. E. SLATTERY 3,090,170

METHOD AND APPARATUS FOR GRINDING WELDED RAILS

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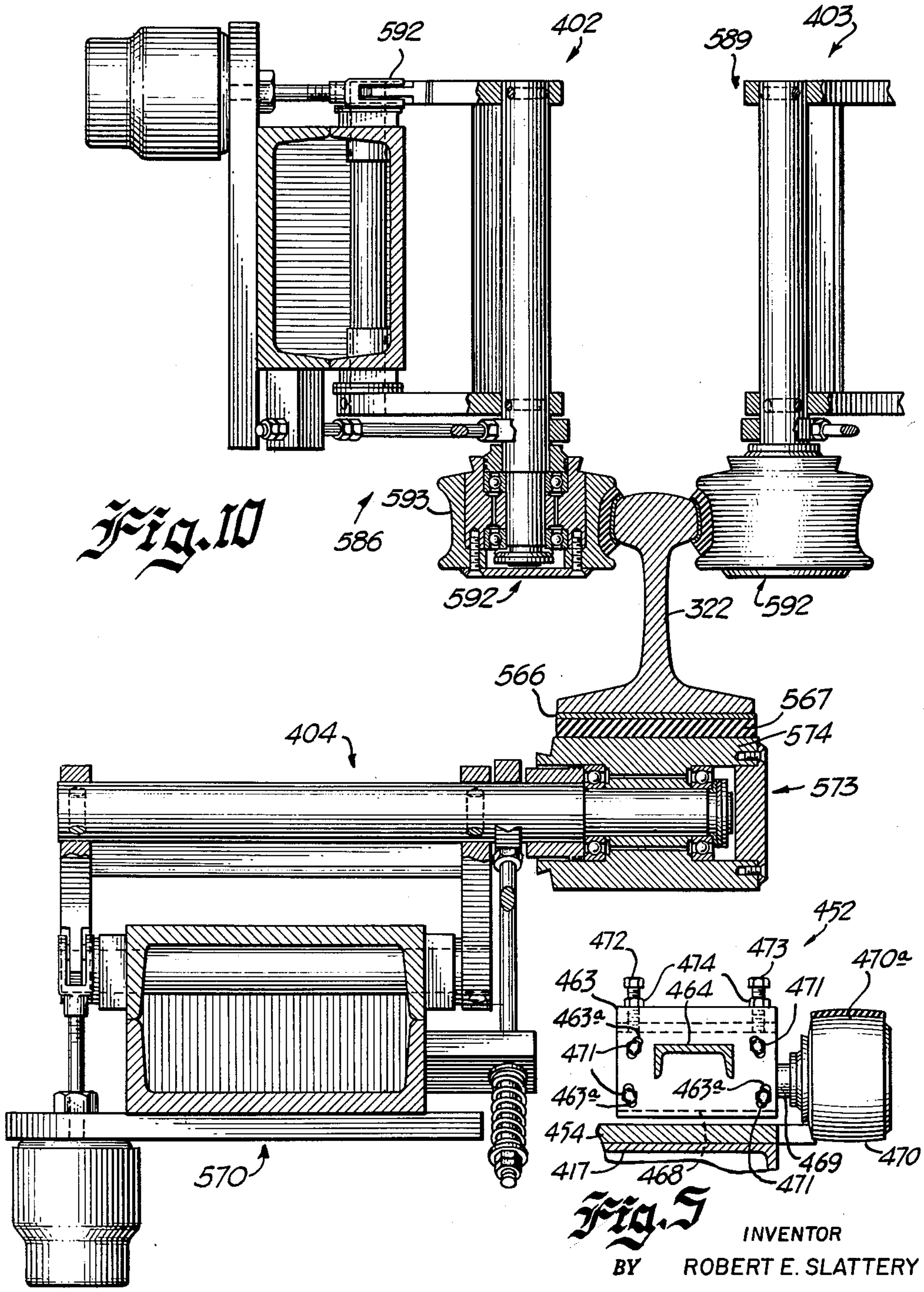

Fig. 10

Fig. 5

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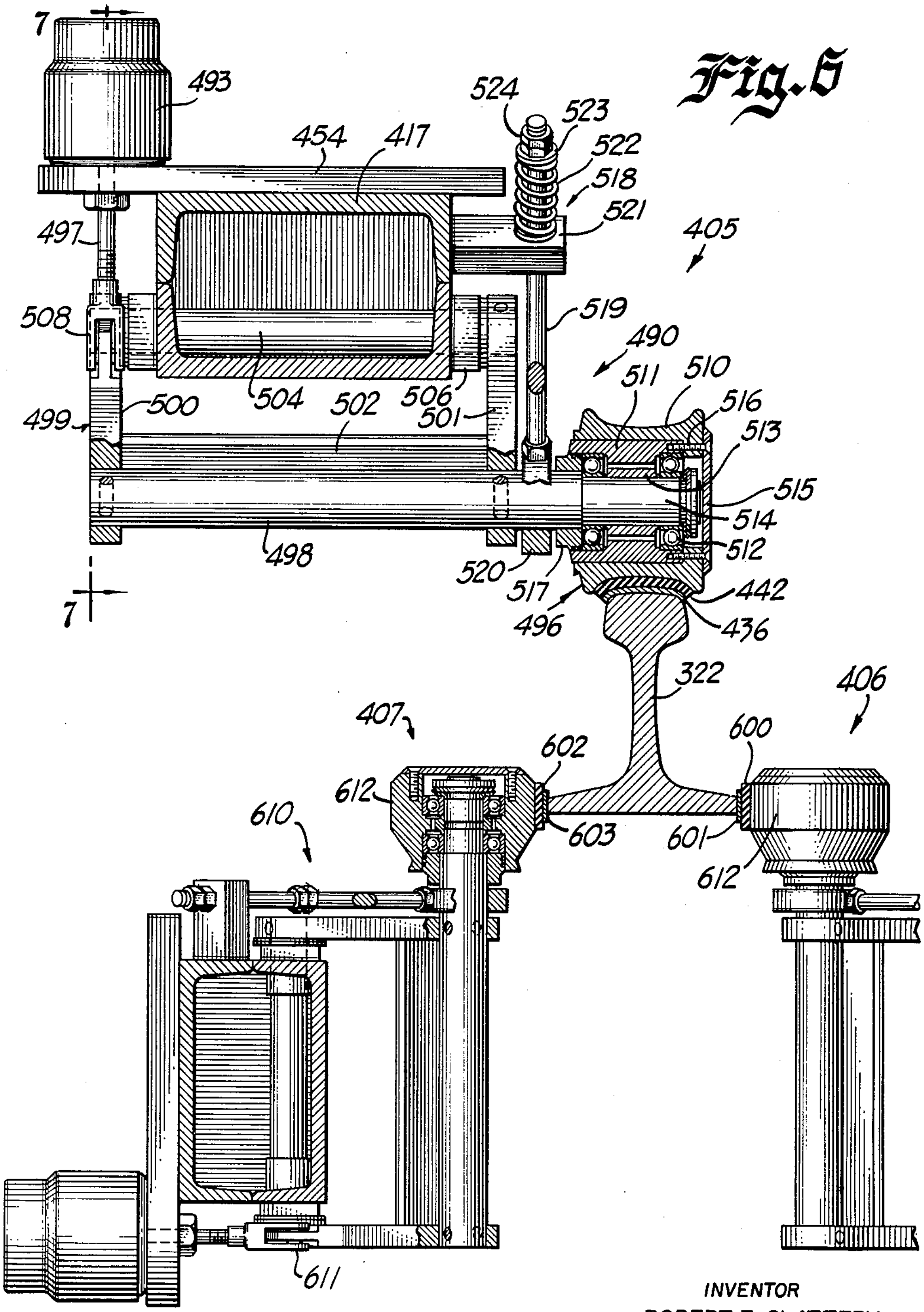

Fig. 6

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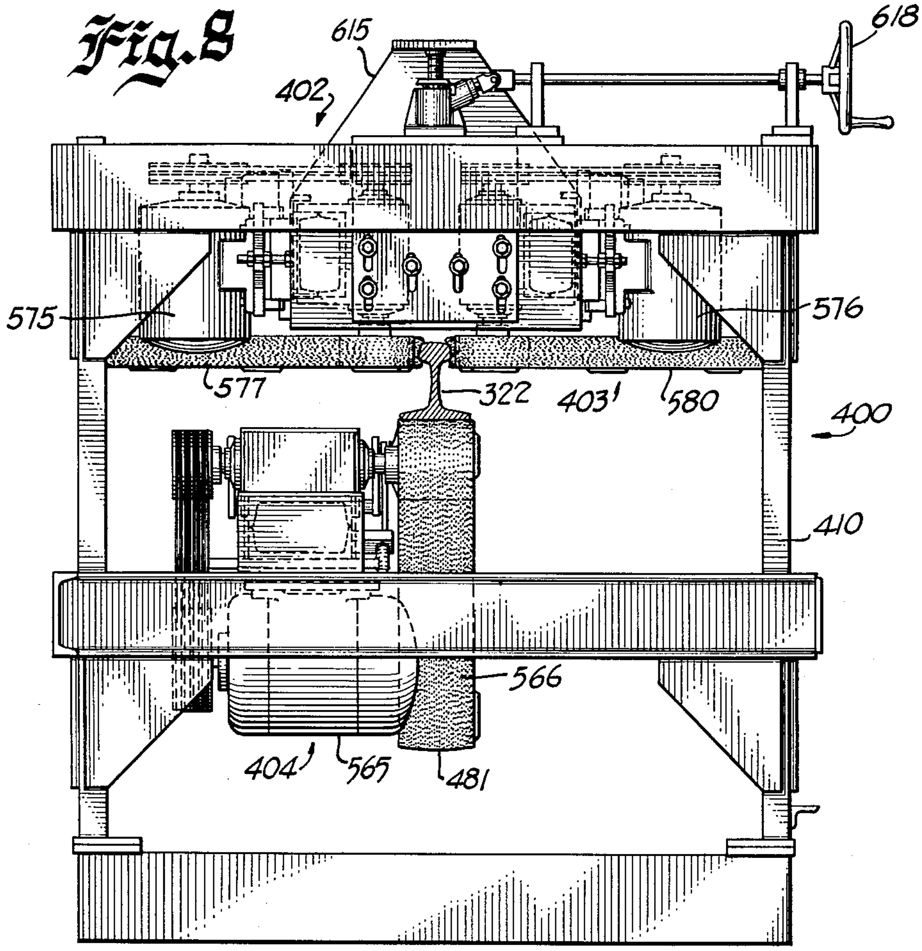
Fig. 8



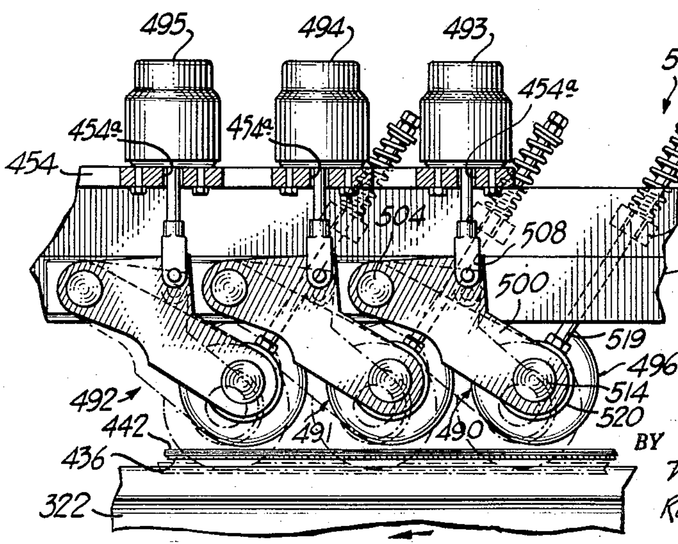


Fig. 7

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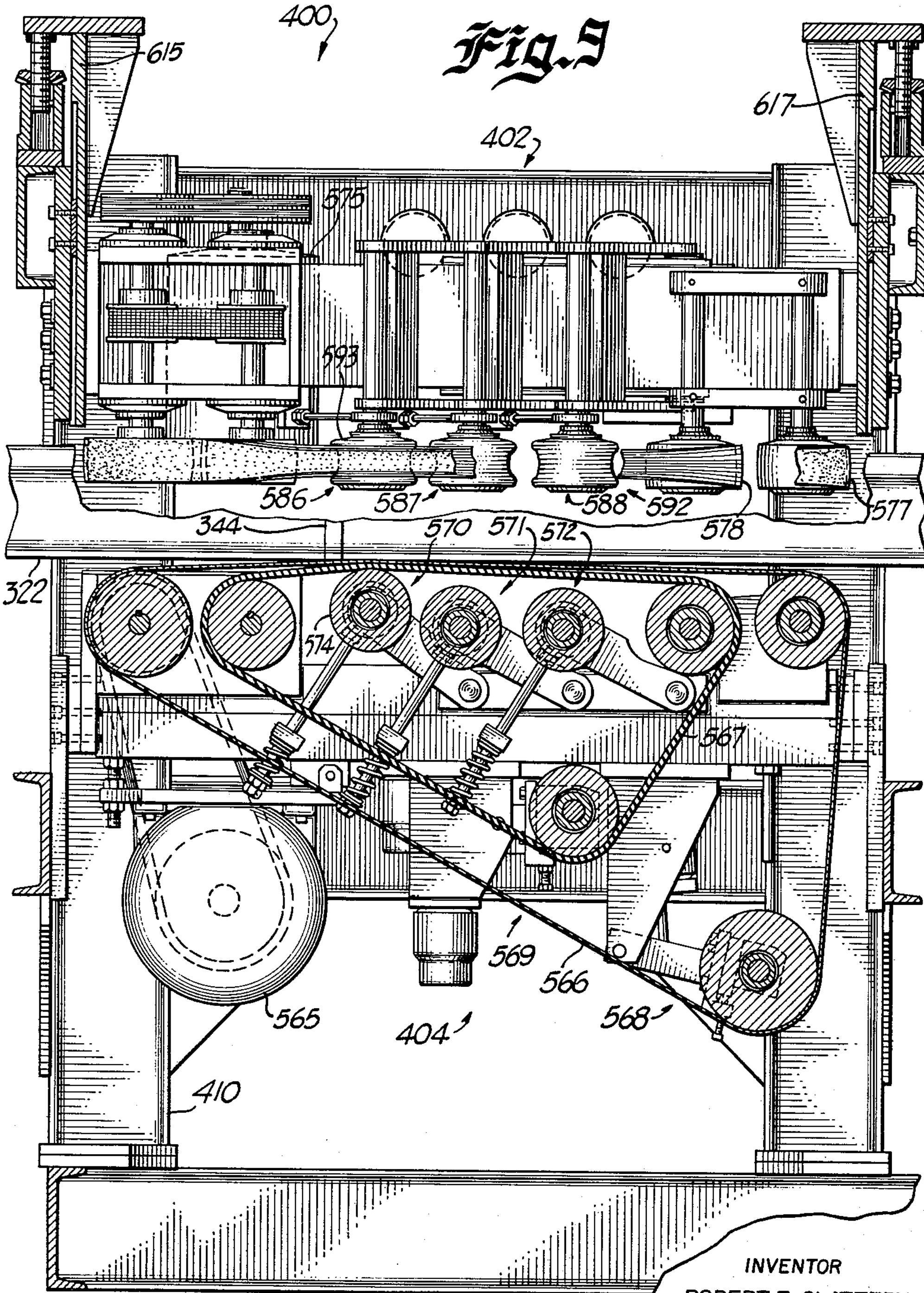

Fig. 9

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May 21, 1963 R. E. SLATTERY 3,090,170

METHOD AND APPARATUS FOR GRINDING WELDED RAILS

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Fig. 11

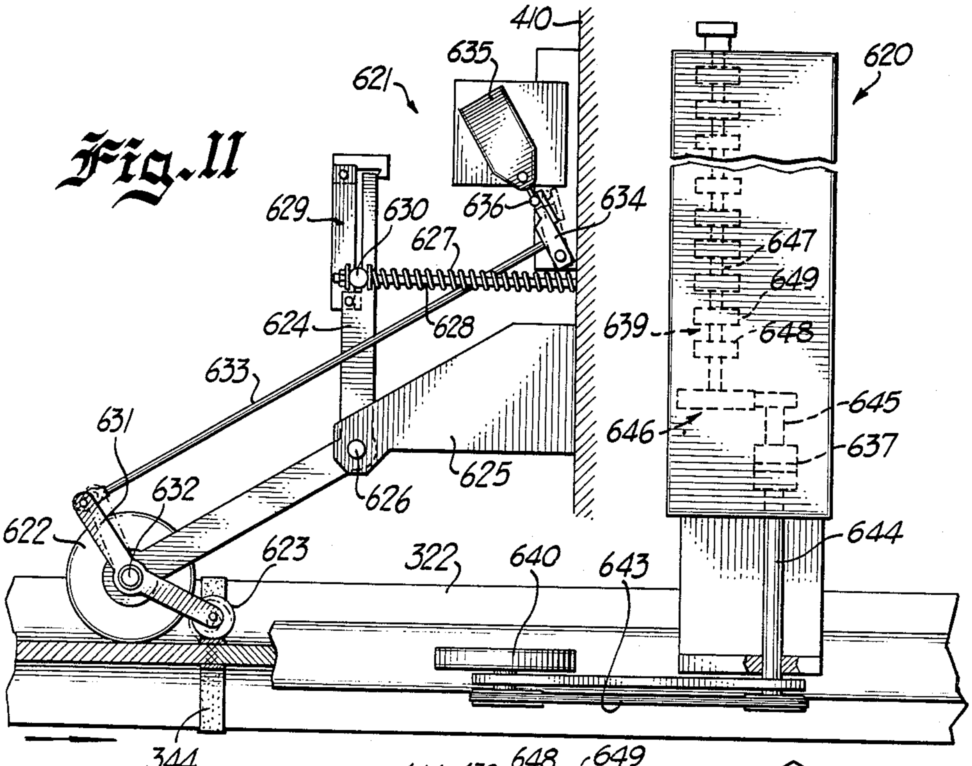


Fig. 12

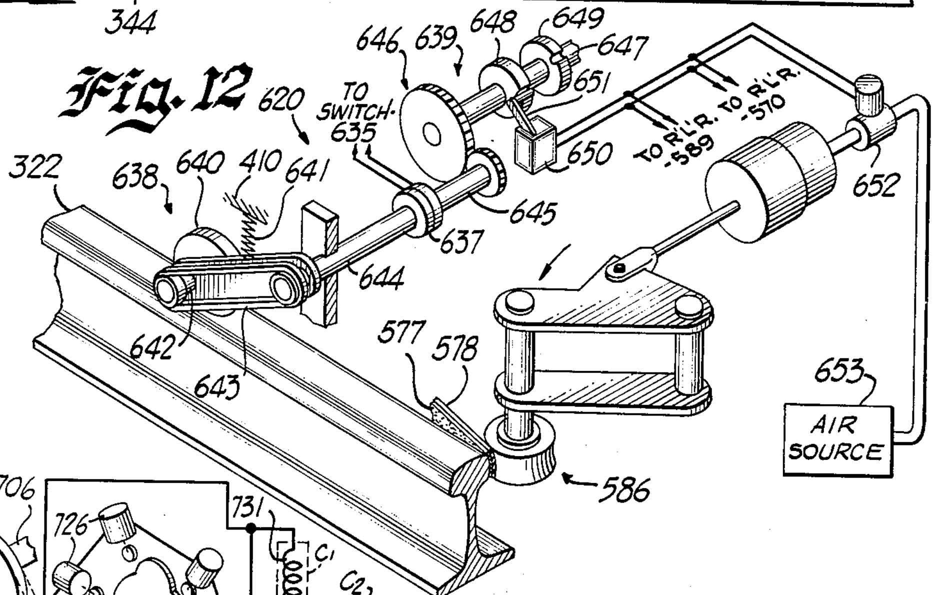
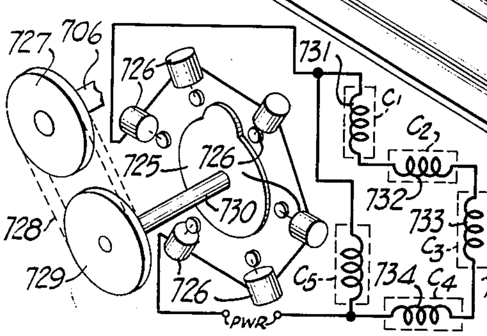


Fig. 16



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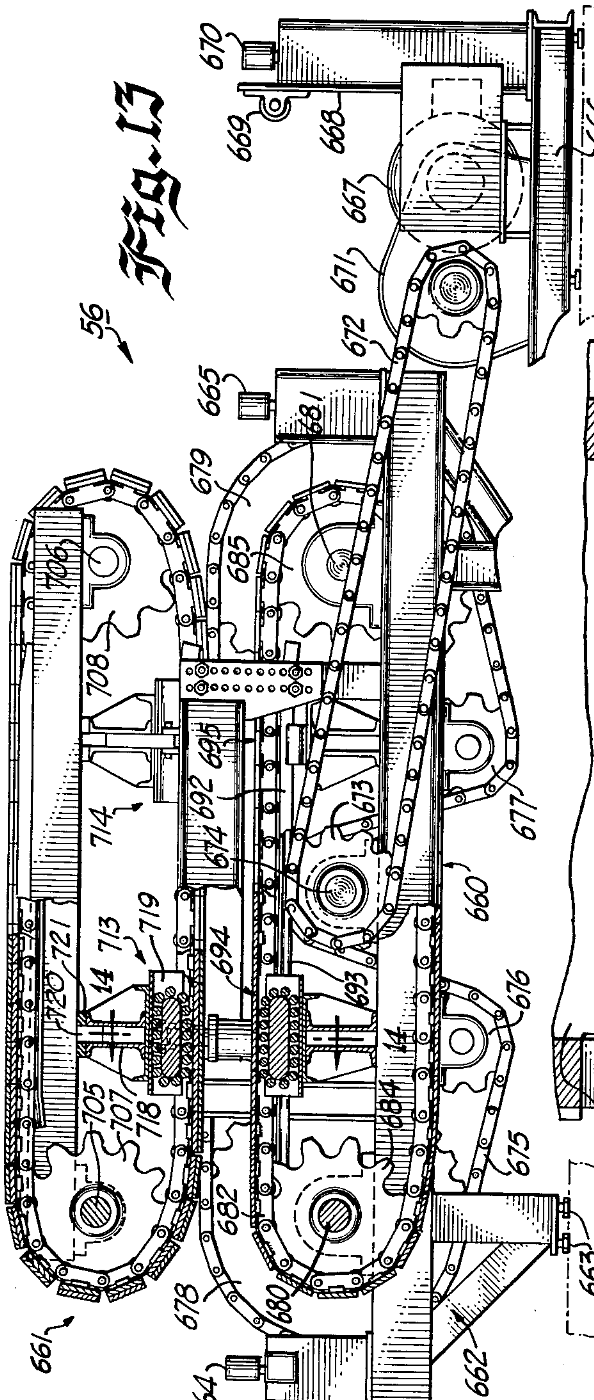

Fig. 13

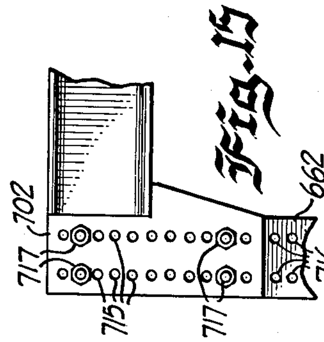

Fig. 15

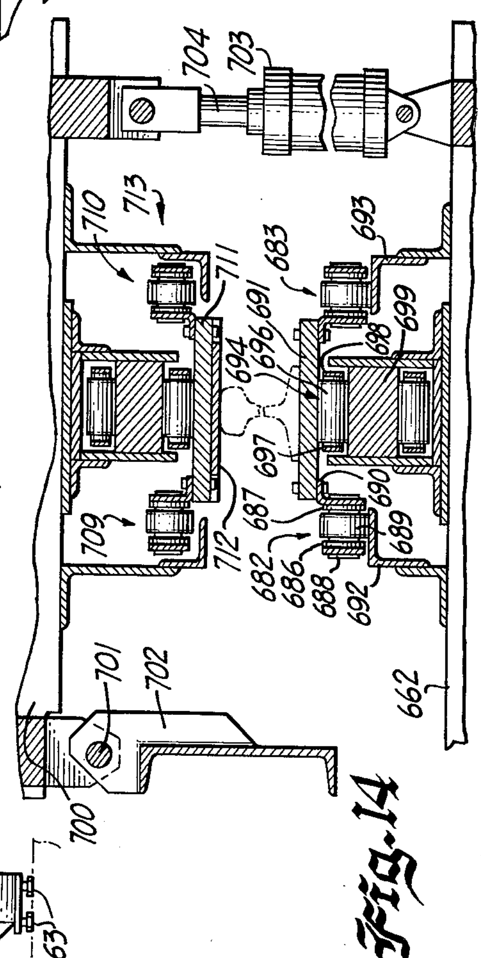

Fig. 14

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United States Patent Office

3,090,170

Patented May 21, 1963

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3,090,170

METHOD AND APPARATUS FOR GRINDING WELDED RAILS

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Continuation of application Ser. No. 808,171, Apr. 22, 1959. This application May 16, 1961, Ser. No. 120,107
44 Claims. (Cl. 51—140)

This invention relates generally to a new and improved method and apparatus for use in forming continuous rails wherein individual rail sections are welded together end to end and the invention is more particularly concerned with improvements in a method and apparatus for grinding the welded area of the rail following the welding operation. This application is a continuation of U.S. patent application Serial No. 808,171, filed April 22, 1959, now abandoned.

For a number of years it has been evident that the use of railroad tracks in the form of rail sections welded together to form a continuous strip is particularly desirable because such a construction not only increases the riding comfort of railroad passengers and reduces the shock and vibration to which rail freight is subjected but, at the same time, is substantially trouble free and, hence, requires considerably less maintenance than tracks of the type employing individual rail sections bolted or otherwise secured together. Despite the knowledge of these advantages, however, the use of welded rails has not been wide spread due partly to their excessive cost and also to the inordinate amount of time usually required to form the welded joint for the rail sections. More specifically, in order to form an efficient welded joint, it is necessary not only to weld the rail sections together but also to shear off the upset or excess weld metal and/or to grind the rail in order to form smooth surfaces for the rail base and for the running surface adapted to accommodate the wheels of the railroad car. In prior art arrangements, all of these operations have been very time consuming and, hence, both the time required to form the continuous rail and the production costs have been excessive. Thus, in the prior art arrangements the grinding operation has generally been carried out by using hand grinders at a point near the exit end of the welding equipment. This procedure is not only laborious and costly because of the use of additional help but, in addition, is time consuming because it requires that the rail be stopped while the weld is being ground.

It would, therefore, be desirable to provide a grinding apparatus which acts upon the rail while the latter is moving so that the entire rail forming process can be accelerated and the satisfaction of this desire, therefore, constitutes one of the primary objects of the present invention.

Another object of the invention is to provide apparatus for grinding the weld area as rapidly as possible following the formation of the weld so that the metal to be ground will still be hot and soft.

A further object of the invention is to provide belt type grinding apparatus which is so arranged that the belts are not required to grind large areas of the rail, thus increasing the effective life of the belts.

A further object of the invention is to provide grinding equipment employing a plurality of grinding heads each including a grinding belt acting upon the welded rail with the different belts being so arranged that each belt acts upon only a relatively small area of the rail surface with the result that the weld grind can be made very quickly and without undue wear on any of the belts.

It is also an object of the present invention to provide a grinding method and apparatus of the type described above in which the rail weld is moved relatively slowly while it is being ground but progresses much more rapidly as it passes from one grinding head to the next, thereby reducing the time required to perform a complete grinding operation and, at the same time, keeping the welded joint as hot as possible during grinding so that the metal is relatively soft and, hence, can be ground more easily.

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It is also an object of the present invention to provide a new and improved weld sensing mechanism for distinguished the welded portion of the continuous rail from the remainder in order to provide a control signal for operating the grinding equipment at the proper time.

Another object of the invention is to provide grinding equipment of the type described above wherein each of the heads includes a plurality of pressure operated rollers for urging the grinding belt against the rail surface with the rollers being automatically actuated in sequence as the weld advances.

The foregoing and other objects are realized, in accordance with the present invention by providing grinding equipment located at the exit end of the welding apparatus for grinding the welded areas of a continuous rail. The grinding equipment is provided with a plurality of grinding heads each including a driven grinding belt having a grinding surface extending longitudinally of the rail. The grinding belts are so arranged that each acts upon only a very small section of the rail surface. The heads are arranged in two spaced apart groups or stations with the grinding heads at the first station being effective to grind the sides of the rail head and the underside of the base and the grinding heads at the second station being effective to grind the running surface of the rail head and the two side edges of the base. The grinding belt of each head is urged into engagement with the rail surface to be ground by means of a plurality of fluid pressure operated contact rollers with the rollers for the running surface and the sides of the rail head being contoured to conform to the rail being formed. The entire apparatus is adjustable to handle rail sections of different diameter and different length. The pressure rollers are not rendered effective to move the belt into engagement with the rail until the welded joint has reached a point near the grinding surface of the belt and, as a result, the belts do not grind an excessive area of the rail surface. The pressure rollers are rendered automatically effective by means of a weld sensing mechanism which is actuated by ocntact with the excess metal on the rail web at the welded joint to be ground. When the weld sensing mechanism is actuated, a timing mechanism is started which functions to apply fluid pressure to the pressure operated rollers in sequence in order to force the belts against the rail in a predetermined order as the weld advances through each grinding station. The continuous welded rail is moved from the welding apparatus through the grinding equipment by means of motor operated pusher mechanism which is basically formed of two opposed endless treads respectively acting upon the base and the running surface of the continuous rail. The pusher mechanism can be rendered effective to move the rail at different speeds and is in fact operated so that the rail slows down during the time when the welded joint is passing through each of the grinding stations and is then speeded up as the welded joint passes from the first grinding station to the second station, whereby the weld metal is ground while it is still hot and soft.

The invention, both as to its origanization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the specification, taken in conjunction with the accompanying drawings in which:

FIG. 1 is a side elevational view of grinding equipment characterized by the features of the present invention;

FIG. 2 is a top plan view of the grinding equipment illustrated in FIG. 1;

FIG. 3 is a sectional view taken along a line substantially corresponding to the line 3—3 in FIG. 2 and shows particularly the construction of the grinding head acting upon the top running surface of the rail;

FIG. 4 is a sectional view taken along a line substantially corresponding to the line 4—4 in FIG. 2 with a portion of the continuous rail being broken away to facilitate the illustration;

FIG. 5 is an enlarged sectional view taken along a line substantially corresponding to line 5—5 in FIG. 2;

FIG. 6 is an enlarged sectional view taken along a line substantially corresponding to line 6—6 in FIG. 1 and shows the three grinding heads employed at the second grinding station with all of the heads being shown in grinding position;

FIG. 7 is a sectional view taken along a line substantially corresponding to line 7—7 in FIG. 6 and shows the pressure rollers of the grinding head acting upon the top running surface of the continuous rail;

FIG. 8 is an end view of the grinding equipment as viewed from the left end of FIGS. 1 and 2;

FIG. 9 is a sectional view taken along a line substantially corresponding to the line 9—9 in FIG. 2 with a portion of the continuous rail again being broken away;

FIG. 10 is an enlarged sectional view taken along a line substantially corresponding to line 10—10 in FIG. 1 and illustrating the three grinding heads employed at the first grinding station with all of the heads being shown in grinding position;

FIG. 11 is a top plan view illustrating the weld sensing mechanism for sensing the presence of the welded joint on the continuous rail with a portion of the rail head being broken away to facilitate the illustration;

FIG. 12 is a perspective, somewhat schematic, view illustrating the timing mechanism for applying the pressure rollers of the grinding equipment in sequence;

FIG. 13 is a fragmentary, side elevational view shown partly in cross section and illustrating a pusher mechanism for moving the rail through the grinding equipment;

FIG. 14 is an enlarged fragmentary sectional view taken along a line substantially corresponding to the line 14—14 in FIG. 13 and showing particularly the coaction between the drive tread and the squeeze tread of the pusher mechanism;

FIG. 15 is a fragmentary view showing the adjustment for the squeeze tread to enable the pusher mechanism to handle rails of different height; and

FIG. 16 is a partly schematic, partly diagrammatic view illustrating the operation of the counters for automatically controlling the speed of drive of the pusher mechanism.

Referring now to the drawings and particularly to FIGS. 1 and 2 thereof, the grinding equipment is there identified by reference numeral **55** and is adapted to remove those portions of an upset region **344** which remain on the head and on the base of a rail **322** after a weld has been made and after the upset has been sheared by suitable apparatus (not shown) described in copending application Serial No. 809,184 of Richard M. Ansel and assigned to the same assignee as the present invention. The grinding operation is performed as the continuous rail is advanced by a pusher mechanism **56** (FIG. 13) described in detail hereinafter and the grinding takes place at two stations respectively indicated by the reference numerals **400** and **401** in FIGS. 1 and 2, these stations being spaced apart in the direction of travel of the rail. At the first grinding station **400**, three grinding heads indicated by the reference numerals **402**, **403** and **404** are employed and each of these heads acts upon a different portion of the rail in the area of the weld. More specifically, as is best shown in FIG. 10 of the drawings, the grinding heads **402** and **403** act upon the two side edges of the top or head of the rail while the grinding head **404** is effective to grind the bottom or underside of the rail base. At the grinding station **401**, three additional grinding heads **405**, **406** and **407** are employed with the head **405** being effective to grind the top running surface of the rail while the grinding heads **406** and **407** act upon the two flat side edges of the rail base, as is best shown in FIG. 6.

The six grinding heads are mounted upon a support frame **410** formed by steel beams secured together to make up a rigid structure. The base of the frame **410** may be provided with suitable adjusting bolts for the purpose of adjusting the height of the frame so that the grinding heads are disposed at the proper level for acting upon the continuous rail **322** when the latter is advanced.

To facilitate the movement of the rail through the grinding equipment, rollers **390** and **391** (FIG. 1) are respectively mounted at the front and rear of the frame **410** and are engaged by the underside of the rail base. The rail is held against the rollers **390** and **391** by means of spring pressed upper rollers **392** and **393**, respectively, and the latter are carried by adjustable mountings which may be adjusted to permit the grinding equipment to handle rails of different height. Side rollers **394** and **395** (FIG. 2) are carried by the frame **410** at positions adjacent the rollers **390** and **392** in order to engage and hold the two side edges of the rail base. A similar pair of side rollers (not shown) engage the two side edges of the rail base at the exit end of the grinding equipment near the rollers **391** and **393**. The pair of rollers **394** and **395** cooperate with the pair of rollers at the exit end of the grinding equipment to inhibit lateral movement of the rail during the grinding operation. Heavy springs urge each of these side rollers against the rail and the mounting for each roller may be adjusted to permit the grinder to handle rails of different base width.

The two grinding heads **404** and **405** respectively acting upon the underside of the rail base and the top running surface of the rail head are generally similar in construction and may be referred to as the large grinding heads in view of the fact that these particular heads grind relatively large areas of the rail surface and, hence, require greater power in their operation than the smaller heads **402**, **403**, **406** and **407** which act upon relatively small areas of the rail. Considering first the construction of one of the large heads and referring particularly to FIGS. 3 and 4 of the drawings where the head **405** is shown in detail, it should be noted that the components of this head are supported upon a carriage **409** mounted upon the frame **410**. The carriage comprises a pair of end plates **411** and **412** respectively carrying ledges **413** and **414** at their upper ends. The end plate **412** also carries a support block **415** which is somewhat larger than a similar block **416** secured to the end plate **411**. The support blocks **415** and **416** are welded or otherwise secured to the ends of a hollow platform or base **417** formed by welding together two channel beams oriented with their channels facing each other. Supported upon the base **417** is an electric drive motor **418** and a support bracket **419** carrying a pair of piston and cylinder assemblies **420** and **421** to be described more fully hereinafter. The motor **418** is of a size sufficient to perform the grinding operation required of the large head and in one form of the invention which has been found to provide satisfactory results, a ten horsepower motor was employed. This motor is secured by suitable motor supports to a plate **422** mounted for pivotal movement upon the base **417** by means of a pair of spaced apart downwardly depending ears **423** having openings therein for accommodating a stub shaft **424** carried by support blocks **425** affixed to the base. The shaft **424** may be secured to the support block in any suitable manner as, for example, by means of set screws indicated by the reference numeral **426** in FIG. 3 and the block may be bolted to the base as indicated at **427**. The end of the plate **422** remote from the pivot shaft 424 is secured to the base 417 through an adjusting assembly 428 including an elongated bolt 429 and a plurality of lock nuts 430.

The assembly 428 may be adjusted to pivot the plate 422 about the shaft 424 in order to adjust the tension on a drive belt 431 which is trained over a first pulley 432 on the output shaft of the motor and over a second pulley 433. The pulley 433 is mounted upon a shaft 434 which also carries a roller 435 for driving an endless abrasive belt 436 in order to perform the grinding operation. In addition, the shaft 434 carries a drive pulley 437 connected through a V belt 438 to drive a pulley 439 mounted upon a drive shaft 440. The shafts 434 and 440 extend within a housing or dust guard 453 formed upon the carriage 409 at the underside of the base 417 as viewed in FIG. 3. A roller 441 mounted on the shaft 440 drives a flexible backing belt 442 made of rubber or other suitable resilient material and having a belt run 443 lying adjacent to a similar run 444 on the abrasive belt 436. Both of the runs 443 and 444 extend longitudinally of the rail and, when they are in the position shown in FIGS. 3 and 4, they are spaced slightly from the top running surface so that the abrasive belt is ineffective to grind the rail.

To form the belt run 444 referred to above, the abrasive belt 436 extends over an idler roller 446 mounted upon a suitable supporting shaft 447 journaled within a pair of spaced apart downwardly depending bracket arms 448 secured to the underside of the base 417. For the purpose of maintaining tension on the abrasive belt 436, this belt is also trained over a tensioning roller assembly indicated generally by the reference numeral 449 and operated by the piston and cylinder assembly 421.

In order to form the elongated run 443, the flexible backing belt 442 is trained over an idler roller 450 carried upon a shaft 451 journaled for rotation upon the bracket arms 448. To maintain tension upon the backing belt, the latter is also engaged by a tensioning roller assembly 452 operated by the piston and cylinder assembly 420 referred to above. The mounting bracket 419 for supporting the piston and cylinder assemblies 420 and 421 includes a mounting plate 454 secured to the upper face of the base 417 together with upwardly extending support bracket legs 455 and 456 spaced apart upon the mounting plate. The bracket legs 455 are connected by a horizontal flange or ledge 457 for carrying the piston and cylinder assembly 420 and this ledge is provided with an opening 458 accommodating the piston rod 460 of the assembly 420. The latter rod extends downwardly through a second opening formed in a guide plate 461 on the mounting bracket 419 and at its lower end carries a cap 462 in engagement with the tensioning roller assembly 452. More specifically, the assembly 452 includes a roller supporting frame formed by a roller support plate 463 and downwardly facing channel beam 464 secured at one end to the latter plate. Secured to the upper face of the beam 464 is an indexing bar 465 having a depression therein for receiving the rounded lower end of the cap 462. The roller support frame is mounted for pivotal movement upon a pin 466 having its opposed ends disposed within suitable openings in the bracket legs 455. This roller support frame may be non-rotatably secured to the shaft 466 in any suitable manner as, for example, by means of set screws 467 locked in position by appropriate lock nuts. The plate 463 carries a roller support block 468 journaling the opposed ends of a support shaft 469 carrying a roller 470 in engagement with the flexible backing belt 442.

As is best shown in FIG. 5 of the drawings, the support block 468 is locked to the plate 463 by means of locking bolts 471 but these bolts may be loosened to permit adjustment of the roller 470 to shift its horizontal axis in order to level the roller and, hence, to maintain the flexible belt 442 centered thereon. It will also be observed from FIG. 5 that the roller 470 has a slightly concave outer surface 470*a* to prevent slipping of the backing belt from side to side. The described adjustment of the roller support block is accomplished by first loosening the locking bolts 471 in order to permit relative movement between the block 468 and the plate 463 and by thereafter turning a pair of spaced apart adjusting screws 472 and 473. When the screws 472 and 473 are selectively turned, the block 468 moves upon the plate 463 while the bolts 471 are guided within arcuate slots 463*a*, formed in the plate. After the roller has been leveled, the screws 472 and 473 are locked in positiin by lock nuts 474 and the bolts 471 are retightened to hold the support block 468 in its adjusted position.

The tensioning roller assembly 449 is generally similar to assembly 452 just described and includes a roller supporting frame 475 mounted for pivotal movement about a pin 476 carried on the bracket legs 456. The underside of the frame 475 is engaged by a cap 477 carried on the upper end of a piston rod 478 forming part of the piston and cylinder assembly 421. The frame 475 supports a shaft 479 carrying a roller 480 in engagement with the abrasive belt 436. Here again, the roller 480 has a slightly curved or concave outer surface for preventing slipping of the abrasive belt 436 from side to side. A typical concave roller of this type is illustrated in FIG. 8 where the concave surface is illustrated as acting upon the belt at the region indicated by the reference numeral 481. Here again, the roller 480 may be leveled by loosening bolts 482 and by thereafter turning screws 483 corresponding to the adjusting screws 472 and 473 described above. The manner in which this adjustment is made will be evident from the foregoing description.

In order to tension the abrasive belt 436 and the backing belt 442, fluid, such as air, at a predetermined pressure is supplied from an appropriate source, for example, a compressor on the welding car, to the upper end of the piston and cylinder assembly 420 and to the lower end of the piston and cylinder assembly 421 in order to extend the piston rods 460 and 478. Extension of the rod 460 pivots the roller supporting frame of the assembly 452 about the pin 466 in a counterclockwise direction as viewed in FIG. 3 in order to apply tension to the flexible backing belt 442. Extension of the piston rod 478, on the other hand, pivots the frame 475 about the pin 476 in a counterclockwise direction as viewed in FIG. 3 so that tension is also applied to the abrasive belt 436. The pressure of the fluid delivered to the piston and cylinder assemblies 420 and 421 is adjusted through suitable valves (not shown) and is measured by gauges (also not shown) in order to assure that proper tension is maintained upon the belts 436 and 442. In the event that it becomes desirable to release the tension on either or both of the belts 436 and 442, as might be required, for example, to replace a worn or defective belt, the fluid flow to the piston and cylinder assemblies 420 and 421 is controlled to retract either or both of the piston rods 460 and 478.

The two belt runs 443 and 444 are adapted to be moved downwardly so that the undersurface of the run 444 engages the rail and this movement is accomplished by a plurality of fluid pressure operated roller devices respectively indicated by the reference numerals 490, 491 and 492. While three such pressure operated devices are illustrated in the drawings, it should be recognized that this has been done for convenience since actually the number of pressure rollers used will be governed by the grinding operation to be performed. Thus, in one installation of the present invention, it was found desirable to employ four such pressure rollers in each grinding head. In any event, the pressure rollers are moved downardly as viewed in FIG. 4 in sequence in order to force the abrasive belt against the rail, this movement being accomplished by means of piston and cylinder assemblies 493, 494 and 495 (FIGS. 3 and 7). The assemblies 493, 494 and 495 are mounted upon the upper face of the mounting plate 454 and have their piston rods extending downwardly through suitable openings 454a (FIG. 7) for connection to the pressure operated devices 490, 491 and 492, respectively. The latter devices are similar in construction and, hence, only one need be considered in detail that being the device 490 illustrated in FIG. 6 of the drawings. As there shown, the pressure operated device 490 includes a roller assembly 496 which is adapted to seat against the upper surface of the resilient backing belt 442 in order to force the abrasive belt 436 into engagement with the top of the rail when the piston rod 497 of the piston and cylinder assembly 493 is extended. To this end, the roller assembly 496 is mounted upon one end of a shaft 498 carried by a frame 499 formed by side support arms 500 and 501 interconnected by an angle brace 502. In order to prevent rotation of the shaft upon the arms 500 and 501, dowel pins indicated by the broken line 503 in FIG. 3 may be employed. The frame 499 is, in turn, secured to a shaft 504 journaled for rotation within bearing assemblies 505 and 506 mounted on opposed sides of the base 417. The ends of the arms 501 and 502 are secured to the shaft 504 by means of dowel pins 507 again indicated by the broken lines in FIG. 3. As is best shown in FIG. 7, the arm 500 is pivotally connected to a pivot fork 508 carried upon the lower end of the piston rod 497. Thus, when fluid under pressure is delivered to the upper end of the piston and cylinder assembly 493 as viewed in FIGS. 6 and 7, the piston rod 497 is extended to pivot the frame 499 about the shaft 504 in a clockwise direction as viewed in FIG. 7 to force the roller assembly 496 against the flexible backing belt 442, thereby urging the grinding surface of the abrasive belt 436 against the top running surface of the rail. The flexible belt cushions the grinding belt to absorb the shock and vibration and, at the same time, serves as an insulator for the large quantities of heat developed during the grinding operation.

An outer ring 510 forming part of the roller assembly 496 has its outer surface contoured as indicated in FIG. 6 to correspond to the top running surface of the rail to be ground and, hence, this roller bends the flexible belt and the abrasive belt around the top of the rail. The outer ring 510 is secured to a bearing race 511 riding upon ball bearings 512 which, in turn, engage an inner bearing race 513 mounted upon a reduced diameter portion 514 of the shaft 498. A cover plate 515 is attached to the ring 510 by machine screws 516 which pass into engagement with the outer race 511 in order to secure the latter to the ring. A dust guard 517 is employed at the inner end of the roller assembly to protect the bearings.

For the purpose of returning the pressure operated roller from the extended position indicated in broken lines in FIG. 7 to the retracted position illustrated in solid lines, there is provided a biasing spring assembly indicated generally by the reference character 518 and including an elongated rod 519 having one end suitably secured to a collar 520 affixed to the shaft 498. The rod extends through an opening in a support block 521 mounted upon the side of the base 417 and its upwardly protruding end is encircled by a coil spring 522 for biasing the frame 499 in a clockwise direction as viewed in FIGS. 3 and 4. To this end, the spring is seated between the block 521 and a washer 523 which is retained upon the upper end of the rod 519 by means of lock nuts 524. The biasing spring assembly 518 is thus effective automatically to return the pressure operated roller 490 to its retracted position when the fluid pressure flow to the upper end of the piston and cylinder assembly 493 is relieved.

The grinding head 405 is adapted to be raised or lowered upon the frame 410 in order to adjust the grinding equipment for rails of different height and, to this end, as is shown in FIG. 3, jacks 530 and 531 are provided to act between the main frame 410 and the carriage. The jacks are operated by manually rotatable cranks or hand

wheels 532 and 533 accessible from the exterior of the equipment. These cranks, as is best shown in FIG. 2 of the drawings, are respectively mounted upon support shafts 534 and 535 extending through bearing supports 536 and 537 secured to the frame 410. The inner ends of the shafts 534 and 535 are supported by bearing blocks, as indicated at 538 for the shaft 534, and each of these shafts is connected through a universal joint to drive a gear (not shown) meshing with a bevel gear forming part of the associated jack. Thus, the shaft 534 drives the bevel gear 540 (FIG. 3) which is internally threaded to ride upon a jack shaft 541 and, in similar manner, the shaft 535 drives a bevel gear 542 which is internally threaded to ride upon a jack shaft 543. The shafts 541 and 543 are respectively secured at their upper ends to the ledges 413 and 414 on the carriage 409 and at their lower ends are keyed to fixed sleeves 544 and 545 on the frame 410. To this end, the shaft 541 carries a fixed pin riding within a keyway 547 in the sleeve 544 while the shaft 543 carries a similar pin 548 accommodated within an elongated keyway 549. The vertical movement of the carriage 409 along the main frame 410 is guided by blocks 550 and 551 bolted to the main frame 410 and riding within guide slots 552 and 553 respectively formed in the end plates 411 and 412. Thus, when the hand cranks 532 and 533 are turned, the carriage 409 is raised or lowered upon the frame 410 to adjust the height of the grinding head 405 and when the desired level is attained the carriage 409 is locked in position by tightening locking bolts 555 which extend through elongated openings formed in plates 556 and 557 of the main frame and are accommodated within tapped openings formed in the end plates 411 and 412. The elongated openings are indicated in FIG. 3 by the dotted lines in the plates 411 and 412 adjacent the bolts 555 and, when the bolts are loosened, these openings permit limited movement of the carriage during the adjustment described above.

As previously indicated, the grinding head 404 is similar to the head 405 described above and it too may be referred to as a large grinding head in view of the fact that it employs a large driving motor of the same size as the motor 418 employed on the head 405. Thus, as is best shown in FIG. 1 of the drawings, the grinding head 404 includes a motor 565 for driving an abrasive belt 566 and a flexible backing belt 567 through a drive arrangement which is identical to that described above for the grinding head 405. Tension is maintained on the abrasive grinding belt by means of a fluid pressure operated tensioning roller assembly 568, which is identical to the assembly 449 employed on the head 405 and, in similar manner, tension is maintained on the flexible backing belt 567 by means of a tensioning roller assembly 569 which corresponds to the assembly 452 described above. The grinding head 404 further includes a plurality of pressure operated rollers 570, 571 and 572 acting in sequence upon the flexible belt 567 to force the grinding belt 566 into engagement with the underside of the rail base. As is best shown in FIG. 10 of the drawings, the pressure rollers 570, 571 and 572 are identical to the corresponding pressure rollers employed in the grinding head 405 except that they employ a roller assembly 573 which is somewhat wider than the roller assembly 496 previously described since its width corresponds to the width of the rail base. Moreover, since the underside of the rail base is flat the surface of the roller assembly 573 is smooth as indicated by the reference numeral 574 and is not contoured like the outer ring 510 employed on each of the roller assemblies 496 of the grinding head 405. Also, the carriage supporting the grinding head 404 is not adapted to be moved up or down on the main frame 410 since the level of operation of the grinding head 404 is established by adjusting the bolts at the base of the main frame for raising or lowering the frame with respect to the floor of the welding car 51. In all other respects, the grinding head 404 is identical to the head 405 described above.

The two smaller heads 402 and 403 are also generally similar to the large head 405 but, since the power required for operating the two heads 402 and 403 is considerably less than that required for operating the larger grinding heads 404 and 405, the heads 402 and 403 respectively include electric motors 575 and 576 which are considerably smaller than the corresponding motors 418 and 565 described above. In one form of the invention found to provide satisfactory results, five horsepower motors were used to drive the heads 402 and 403. As is best shown in FIG. 2, the motor 575 is connected to drive an abrasive belt 577 and a flexible backing belt 578 through a drive connection which is identical to that employed in the grinding head 405 and described above. The motor 576 drives an abrasive grinding belt 580 and a flexible backing belt 581 via a similar drive connection. Tension on the abrasive grinding belts 577 and 580 is maintained by fluid pressure operated tensioning roller assemblies 582 and 583, respectively, which are similar to the assembly 449 described above. Tension is maintained on the flexible backing belts 578 and 581 by means of fluid pressure operated tensioning roller assemblies 584 and 585, respectively, which are similar to the assembly 452 described above. The abrasive belt 577 is adapted to be forced into engagement with one side edge of the rail head by means of sequentially operated pressure rollers 586, 587 and 588 which are similar to the pressure operated rollers 490, 491 and 492 described above. In corresponding manner, the abrasive grinding belt 580 is adapted to be urged against the other side edge of the rail head by a similar set of sequentially operated pressure rollers 589, 590 and 591. As will be observed from FIG. 10, each of the assemblies 586 to 591 includes a roller assembly indicated by the reference numeral 592 having a surface 593 contoured to correspond with the contour of the side edge of the rail head. The outer ring of the roller assembly is dimensioned to permit the flexible backing belt and the abrasive belt to fit between the outer surface of the roller and the rail so that the flexible belt will perform the grinding function. The two carriages for the heads 402 and 403 are connected together by suitable support structures 615 and 616 (FIG. 2) located at their opposed ends so that these carriages are united for joint movement upon the main frame 410 in order to adjust the position of the heads to permit the grinding of rails of different cross sectional dimensions. The adjustment of the position of the two carriages for the heads 402 and 403 is accomplished by turning hand cranks 617 and 618 (FIG. 1). These hand cranks are connected in the manner indicated above to operate jacks for raising or lowering the carriages of the two grinding heads until these heads are positioned to correspond to the rail being ground, whereupon they are locked in the manner previously described.

The grinding heads 406 and 407 acting upon the two side edges of the rail base are similar to the grinding heads 402 and 403 since they include relatively small driving motors for driving their associated abrasive grinding belts and the corresponding flexible backing belt. The backing belt for the head 406 is indicated in FIGS. 1 and 2 by the reference numeral 600 while the abrasive belt is indicated by the reference numeral 601. The backing belt for the head 407 is designated in FIG. 6 by the reference numeral 602 and the abrasive belt bears the reference numeral 603. Tension is maintained on the abrasive belt and on the backing belt of each of the heads 406 and 407 by fluid operated tensioning roller assemblies of the type described above, the assembly for tensioning the belt 601 being indicated in FIGS. 1 and 2 by the reference character 604 and the assembly for tensioning the backing belt 600 being designated by reference numeral 605. The abrasive belt 601 is urged against one side edge of the rail base by selectively supplying fluid under pressure in sequence to piston and cylinder assemblies associated with pressure operated rollers 607, 608 and 609 and a similar series of rollers is employed for urging the abrasive belt 603 against the other side edge of the rail base although only one of these pressure roller assemblies is shown in the drawings and this is designated by the reference numeral 610 in FIG. 3. The pressure rollers employed in the heads 406 and 407 differ somewhat from the pressure rollers employed on the heads 402 and 403, in that the outer surface of their roller assemblies 612 (FIG. 6) are smooth or flat since they are adapted to urge their associated abrasive belts against flat areas on the two side edges of the rail base. In addition, no provision is made for raising or lowering the heads 406 and 407 upon the main frame 410 in view of the fact that the level of operation of these two heads is controlled by adjusting the bolts at the base of the main frame.

The fluid operated pressure rollers of each grinding head are adapted to be advanced in sequence as the welded joint 344 of the continuous rail reaches a position just ahead of the roller. This arrangement prevents the abrasive belt of each head from being moved into engagement with the continuous rail for an excessive period of time and avoids the grinding of the rail except in the vicinity of the welded joint. The pressure roller is extended just prior to the time when the welded joint moves to a position in alignment with the roller so that the rail will be ground just ahead of the welded joint and a smooth blend is, therefore, achieved. The fluid pressure is maintained on the applied roller for a predetermined period of time sufficient to allow the welded joint to pass the roller and is then automatically relieved to permit the roller to be moved to retracted position. Thus, when the welded joint 344 passes through the heads 402, 403 and 404 in its advancement from left to right as viewed in FIGS. 1 and 2, the first pressure rollers 570, 586 and 589 of each of these heads are applied simultaneously, i.e., they are moved to their extended positions shown in FIGS. 1 and 2, and they remain extended until the weld moves beyond these rollers, thus grinding the welded joint. As the weld advances somewhat further toward the right, the fluid pressure on the rollers 570, 586 and 590 is relieved to permit the latter to retract and the pressure rollers 571, 587 and 590 are simultaneously applied. In similar manner, when the weld moves past the rollers 571, 587 and 590, the latter rollers are retracted and the rollers 572, 588 and 591 are simultaneously extended. All of the pressure rollers of the heads 402, 403 and 404 are retracted when the weld advances from the first grinding station 400 to the second grinding station 401. When the welded joint reaches a point just ahead of the pressure operated roller 490, the latter is moved to its extended position simultaneously with the operation of the pressure rollers 607 and 610 (FIG. 6) of the heads 406 and 407, respectively. The operation then continues in an obvious manner as the welded joint passes the second grinding station.

In the event that rail sections of different size or shape are used, the roller assemblies of the various heads must be replaced. Thus, the roller assemblies in the head 404 must be of the same width as the base of the rail, the roller assemblies of the heads 406 and 407 must be wide enough to grind the two side edges of the base and the contour of the roller assemblies of the heads 402, 403 and 405 must conform to that of the rail to be ground. In addition to replacing the rollers, the hand wheels 532 and 533 must be turned to adjust the height of the head 405 to the proper level and a similar adjustment must be made for the heads 402 and 403 by turning hand wheels 617 and 618.

The mechanism for sequentially applying the pressure operated rollers is illustrated in FIGS. 11 and 12 and includes a weld sensing arrangement for distinguishing the welded joint **344** from the remaining portion of the continuous rail **322** and a timing mechanism indicated by the reference numeral **620** operated by the forward movement of the continuous rail for controlling the supply of fluid pressure to the piston and cylinder assemblies of the pressure rollers in the grinding heads. The weld sensing mechanism is indicated by the reference numeral **621** and includes a pair of rollers **622** and **623** adapted to engage the web of the continuous rail **322**. The roller **622** is mounted for rotation upon one end of a link arm **624** which is, in turn, mounted for pivotal movement upon a pivot pin **626** carried on a bracket **625** which is secured in fixed position adjacent the path of movement of the rail as, for example, to the frame **410** of the grinding equipment **55**. The link arm **624** is biased to pivot about the pin **626** in a counterclockwise direction as viewed in FIG. 11 by a coil spring **627** encircling a guide rod **628**. One end of the rod **628** is secured to the frame **410** of the grinding equipment while its other end extends loosely through a pin **630** which is held in position on the link arm **624** by a clamping and latching assembly **629**. Thus, the spring **627** acts upon the pin **630** to urge the arm **624** to a position where the rollers **622** and **623** are seated against the web of the continuous rail **322**.

The roller **623** is supported upon one end of an arm **631** which, in turn, is mounted for pivotal movement about a shaft **632** supporting the roller **622**. The other end of the arm **631** is connected through a rod **633** to a switch operating finger **634** which is adapted to actuate a switch **635** when the roller **623** is engaged by the sheared upset **344** surrounding the welded joint. More specifically, when the upset **344** engages the roller **623**, the arm **631** and the switch actuating finger **634** are moved from the broken line positions indicated in FIG. 11 to the solid line positions, whereupon the finger engages an actuating arm **636** for the switch **635**. The switch **635** is actuated only by differential movement between the two rollers **622** and **623**. Thus, when the roller **622** is engaged by the upset **344**, the arm **624** pivots about the pin **626** in a clockwise direction to compress the spring **627** but this pivotal movement is not accompanied by actuation of the switch **635** in view of the fact that the arm **631** does not pivot about the shaft **632** at this time. Moreover, lateral movement of the continuous rail **322** toward or away from the rollers **622** and **623** does not result in actuation of the switch **635** since this movement merely moves the two rollers jointly and does not cause the arm **631** to pivot about the shaft **632**. Therefore, the mechanism **621** is capable of distinguishing between the welded portion of the rail and the remainder of the rail web so that the switch **635** is actuated at the precise instant when the roller **623** is engaged by the raised weld. The switch **635** is a timed switch which, following its energization, remains closed for a predetermined interval sufficient to permit the weld to pass through both of the grinding stations **400** and **401**.

Actuation of the switch **635** is effective to initiate operation of the timing mechanism **620** and, to this end, this switch is connected in a circuit including an electrically operated clutch **637**. The clutch **637** is adapted, when energized, to connect a driving mechanism **638** to a cam mechanism **639** which, in turn, controls the valves for admitting fluid to operate the pressure rollers of the grinding heads. The driving mechanism **638** includes a roller **640** carried upon suitable supporting structure and biased into engagement with the top running surface of the rail **322** by means of a biasing spring **641** acting between the roller supporting structure and the frame **410** of the grinding equipment. When the rail **322** is advanced, the roller **640** turns in a counterclockwise direction as viewed in FIG. 12 to drive a roller support shaft **642** which is connected by a chain or belt **643** to turn a shaft **644** driving one element of the electrically operated clutch **637**. The other element of the clutch **637** drives an output shaft **645** which functions as the input to the camming mechanism **639**. To this end, the shaft **645** is connected through suitable reducing gears **646** to drive a cam shaft **647** supporting a plurality of cams **648**, **649**, etc. One cam may be provided for each of the pressure operated devices employed in the grinding heads, although since the pressure rollers of the three grinding heads at each station are operated in sequence with one roller from each head being actuated simultaneously with a roller from each of the other two heads, a total of six cams will suffice.

Considering now the operation of the timing mechanism **620** beginning with the instant when the weld **344** engages the roller **623** to close the switch **635**, it will be observed that the clutch **637** is, at this time, energized via a circuit including a source of power and the switch **635**, thereby rendering the roller **640** effective to drive the camming mechanism **639**. The shaft **647** rotates while the rail advances and, when the cam **648** reaches a predetermined position, it becomes effective to close a switch **650** having its actuating arm **651** biased into engagement with the periphery of the cam. When the switch **650** is closed, a circuit including a source of power (not shown) is completed for energizing and opening a solenoid operated valve **652** connected between a fluid source **653** and the piston and cylinder assembly for actuating the pressure roller **586**. Thus, when the valve **652** is opened, the pressure roller **586** is extended and it acts through the backing belt **578** to force the abrasive belt **577** into engagement with the rail **322**. At the same time, the closing of the switch **650** results in extending the pressure rollers **570** and **589** to render the grinding heads **403** and **404** effective to perform their grinding operations. The cam **648** is so oriented on the shaft **647** that the switch **650** closes after the welded joint **344** has advanced from the position where it engages the roller **623** to a point where it is located just ahead of the pressure rollers **570**, **586** and **589**. The roller **640**, in effect, measures the distance between the roller **623** and the point of application of the rollers **570**, **586** and **589** to make certain that the latter rollers are not extended until the weld reaches the proper position to begin the grinding. After the welded joint passes the rollers **570**, **586** and **589**, the switch **650** is opened by the cam **648** and the valve **652** closes to retract the rollers **570**, **586** and **589**. A short time thereafter the cam **649** becomes effective to close its associated switch and to extend the rollers **571**, **587** and **590**. The operation then continues in an obvious manner while the welded joint passes through both of the grinding stations **400** and **401**. The switch **635** is merely effective to transmit a pulse to the clutch **637** which then remains closed during one revolution of the cam shaft **647**. At the completion of this revolution the clutch **637** is automatically disengaged. Thus, the roller **640** continues to rotate, but the cam shaft **647** is not turned until the succeeding weld engages the roller **623** during the next cycle of operation.

As was indicated previously the continuous rail is moved through the grinding equipment by the pusher mechanism illustrated in FIGS. 13, 14 and 15 which comprises a driven endless tread **660** acting upon the underside of the rail base and an upper idler or squeeze tread **661** acting upon the top running surface of the rail. The lower tread may be selectively driven in either direction to advance or to back up the rail while the upper tread applies pressure for squeezing the rail to develop a tremendous traction of sufficient magnitude to handle very long rail sections. To this end, the lower tread is mounted upon a rigid support frame **662**, the level of which may be adjusted by means of adjustable feet in the form of adjusting bolts **663**. The bolts **663** are so adjusted that the top run of the tread **660** as viewed in FIG. 13 is at the proper level for receiving the rail base. The frame **662** supports a pair of guide rolls **664** at the entrance end of the pusher mechanism and a second pair of guide rolls 665 at the exit end of the pusher mechanism. A base 666, which is preferably part of the main frame 662, supports a drive assembly for driving the lower tread 660. This base 666 also supports a mast 668 carrying a horizontally disposed roller 669 for engaging the underside of the base in order to support the continuous rail as it leaves the welding car. The mast 668 also supports a pair of guide rolls 670 disposed adjacent the bottom support roller 669. The three pairs of guide rolls 664, 665 and 670 are mounted for rotation about vertical axes and engage the side edges of the rail base to inhibit lateral movement. The mounting arrangement is such that the guide rolls of each pair may be adjusted toward or away from each other to handle rails of different base widths and they may also be adjusted vertically to insure their proper engagement with the side edges of the rail base.

The drive assembly includes a reversible electric motor 667 connected through suitable reduction gearing 671 to drive a sprocket engaging a chain 672. The latter chain, in turn, engages a sprocket 673 mounted upon a shaft 674 rotatably journaled upon the main frame 662. The shaft 674 also carries a sprocket driving a chain 675 which forms what may be referred to as a symmetrical serpentine drive since it meshes with tensioning sprockets 676 and 677 and with large sprockets 678 and 679 respectively carried upon shafts 680 and 681 journaled upon the main frame 662. Each of the shafts 680 and 681 carries a pair of spaced apart sprockets engaging endless single loop type chains 682 and 683 forming part of the drive tread 660. Only one of the two sprockets mounted upon the shaft 680 is visible in FIG. 13 and this is designated by the reference numeral 684. Similarly, only one of the drive sprockets mounted upon the shaft 681 is visible in FIG. 13 and it is designated by the reference character 685. As is best shown in FIG. 14, the chains 682 and 683 are of similar construction and each includes two parallel sets of links interconnected by shafts supporting rollers disposed between the links. Thus, for example, one set of links for the chain 682 is indicated in FIG. 36 by the reference numeral 686 while the other or parallel set of links is designated as 687. Each pair of links in the set 686 is pivotally supported upon a shaft 688 which also pivotally supports a pair of links in the link set 687. A roller 689 having a diameter somewhat greater than the width of the links is carried upon the shaft 688 between the two link sets. Each of the links in the set 687 is provided with a shelf or platform 690 for supporting a metal shoe or plate 691. Along one of its sides the shoe 691 is bolted or otherwise secured to the shelf 690 and along its other side it is similarly secured to a corresponding shelf formed on the chain 683.

When the motor 687 is rendered effective to drive the tread 660 the rollers of the two chains 682 and 683 roll along the top surfaces of guide brackets 692 and 693 secured to the frame 662. The shoes 691, on the other hand, are engaged and supported by a plurality of roller assemblies indicated by the reference numerals 694 and 695. Although two such roller assemblies are illustrated in FIG. 13, it should be understood that actually any number may be employed as required to provide sufficient support for the drive tread 660. Since the two roller assemblies 694 and 695 are identical, only the one assembly, namely the assembly 694 shown in FIG. 14, will be considered in detail. This roller assembly includes a plurality of elongated rollers 696 having their opposed ends connected together by a pair of parallel endless link arrangements 697 and 698. The rollers move over a support block 699 carried upon suitable fixed support structure on the frame 662. This block includes flat upper and lower roller engaging surfaces and rounded ends for permitting movement of the rollers 696. Thus, when the tread 660 is driven by the motor 667, the shoes 691 roll along the rollers 696 to turn the latter and drive them over the surface of the block 699.

The squeeze or idler tread 661 is supported upon a frame 700 mounted for pivotal movement about pivot pins 701 (FIG. 14) carried by support structure 702 adjustably but rigidly secured to the main frame 662. The frame 700 is adapted to be moved about the pivot pins 701 by means of a plurality of piston and cylinder assemblies 703 having their lower ends pivotally supported upon the main frame 662. Fluid flow to these assemblies is controlled by a common valve so that all of them are actuated simultaneously. When the fluid under pressure is admitted to bottom or lower ends of the piston and cylinder assemblies 703 as viewed in FIGS. 13 and 14, the piston rods 704 of these assemblies are extended to pivot the frame 700 about the pins 701 in a counterclockwise direction as viewed in FIG. 14, thus moving the squeeze tread 661 out of engagement with the top of the rail and also out of the path of movement of the rail. When fluid pressure is admitted to the upper ends of the piston and cylinder assemblies 703, the piston rods 704 are retracted and the frame 700 is pivoted about the pins 701 in a clockwise direction as viewed in FIG. 14, thereby causing the squeeze tread 661 to engage the top running surface of the continuous rail 322 and to squeeze the latter rail under very high pressure against the drive tread 660 so that a tremendous traction is exerted on the rail. When the reversible motor 667 is turned in the forward direction the sprockets on the shaft 681 serve as drive sprockets and they are driven in a clockwise direction as viewed in FIG. 13 to advance the chains 682 and 683 from left to right. However, when the motor 667 is reversed, and when the squeeze tread 661 is effective to clamp the rail against the drive tread 660, the sprockets on the shaft 680 provide the drive for the chains 682 and 683 and, since they are turned in a counterclockwise direction at this time, the chains and the rail section are moved from right to left. The symmetrical serpentine drive including the chain 675 permits the chains 682 and 683 to be driven by different sprockets when the motor is reversed and this is an important feature of the present invention.

The frame 700 carries bearing assemblies for supporting shafts 705 and 706 which mount pairs of drive sprockets engaging a pair of endless chains making up the squeeze belt 661. The pair of spaced apart drive sprockets mounted on the shaft 705 are indicated by the reference numeral 707 while those mounted upon the shaft 706 are indicated by the reference numeral 708. The two chains engaged by the sprockets 707 and 708 are respectively indicated in FIG. 14 by the reference numerals 709 and 710 and these chains are identical to the chains 682 and 683 previously described. The chains support plates or shoes 711 which, in turn, carry facing plates 712 formed of a material, such as aluminum, which is somewhat softer than the steel head of the rail 322 so that the very large pressure applied to the top running surface of the rail by the tread 661 will not damage the rail. At the same time, the use of a relatively soft facing plate upon the hard shoes 711 produces better gripping action between the squeeze tread 661 and the rail head. The shoes 711 roll along endless roller assemblies 713 and 714 which are supported upon the frame 700 and are similar to the assembly 694 described above. The pressure exerted by the piston and cylinder assemblies 703 upon the frame 700 is transmitted to the drive tread 660 through the pressure roller assemblies 713 and 714, through the shoes and the facing plates of the tread 660 and through the rail itself.

In accordance with an important feature of the present invention the roller assembly 713 is vertically aligned with the roller assembly 694 and the roller assembly 714 is vertically aligned with the roller assembly 695 and, as a consequence, all of the pressure applied by the piston and cylinder assemblies 703 is exerted across the pairs of roller assemblies which have only relatively rigid metal parts interposed therebetween. Thus, this very high pressure can exert a large tractive force upon the rail without distorting or damaging the other components such as the chains of the upper and lower treads. Another important advantage of this invention resides in the mounting arrangement for the roller assemblies 713 and 714 of the squeeze treads 661. More specifically, each of these assemblies is floating upon or resiliently supported from the upper frame 700 so that the two roller assemblies may move slightly independently of each other in order to accommodate slight differences in rail size or minor deviations in the contour of the rail. Without this feature, one of the roller assemblies might supply all or a major portion of the pressure to the rail and, as a consequence, the traction might, under some circumstances, be insufficient to move the rail. The mounting arrangement for the roller assembly 713 is shown in FIG. 13 as including a column 718 secured at its lower end to suitable roller support structure 719. A post 720 depending downwardly from the upper frame 700 telescopes within the column 718 so that the support structure is actually movable with respect to the frame. A resilient cushion 721 formed of rubber or the like surrounds the post 720 and is interposed between the top of the column and the underside of frame 700 in order to provide the floating mount referred to above. In view of the foregoing description, it will be apparent that slight changes in rail size or minor deviations in shape will cause one of the roller support structures of the assemblies 713 or 714 to rise against the resilient cushion so that the pressure applied to the rail is distributed substantially equally between the two assemblies 713 and 714, thus avoiding the disadvantages described above.

In order to adjust the squeeze tread for the purpose of handling rail sections of different height, the frame 702 is adjustably secured to the frame 700. As is shown in FIG. 15, this adjustment is effected by means of a series of holes 715 formed in the frame 702 and by a series of apertures 716 in the main frame. The spacing between the holes 715 obviously differs from that between the holes 716 so that securing bolts 717 may be passed through different ones of the holes 715 and 716 in order to permit adjustment of the frame 702. Actually, two pairs of aligned holes 715 are employed at opposed ends of the frame 702 for cooperation with two pairs of aligned holes 716 although only one end of the frame 702 and one set of holes is illustrated in FIG. 15, the remaining set being shown in FIG. 13. While the frame 702 may be adjusted to handle rails of different height both sides of the squeeze tread 661 remain parallel and in the same horizontal plane for each adjustment. Thus, the squeeze tread is never canted or inclined and its shoes 711 and facing plates 712 remain horizontal when the tread is applied.

The pusher mechanism 56 is effective to push the continuous rail through a weld testing station spaced from its right end as viewed in FIG. 13 and onto a suitable rail receiving means, as for example, a train of flat cars located beyond the testing station. Alternatively, of course, the welded rail may be passed onto suitable storage racks. In either case, rails up to a quarter mile in length are formed and are stored upon the rail receiving means so that they can be transported to the area where they are to be used. It will be understood that in use the quarter mile rails are joined together by conventional connecting plates with a slight spacing between the ends of adjacent rails in order to permit expansion or contraction of the rails in response to changes in temperature.

The motor 667 of the drive assembly for the pusher mechanism has associated therewith a spring set magnet brake (not shown) for accurately stopping the rail at the end of its advancement by the pusher mechanism. This motor is of the two-speed, constant torque, alternating current type and, to this end, includes high speed windings and low speed windings which may be selectively energized in order to advance the rail in a forward direction either at high speed or at low speed. The rail can be backed up or reversed only at high speed.

In operation, the rail is adapted to be moved from the welding apparatus at the high speed until the new weld reaches the first grinding station 400 where the speed of travel of the rail is reduced to the low speed during the first grinding operation. After the new weld has passed through the first grinding station, the rail is again advanced at the high speed until the weld reaches the second grinding station 401. During passage of the weld through the second station the pusher mechanism is again rendered effective to move the rail at the low speed. After the weld moves through the second grinding station, the pusher moves the rail at high speed until the brake on the pusher mechanism is applied to stop the end of the continuous rail at the center of the welding and shearing apparatus.

The described rail movement may be accomplished either manually by operating suitable switches to energize the motor 667 at appropriate times to effect the slow down or speed up of the rail or, alternatively, automatic operation may be provided. For automatic operation, it is necessary to provide suitable mechanism for measuring the rail travel and for effecting the necessary control operations in proper sequence as the rail advances. To this end, one of the shafts of the squeeze tread 661, for example, the shaft 706 shown in FIG. 16 carries a sprocket 727 driving a chain 728 which, in turn, drives a sprocket 729 and a shaft 730 having mounted thereon one or more cams 725 engaging and opening a group of limit switches 726 in sequence. The switches are so arranged that they are opened at uniformly spaced intervals with each interval representing a given increment of movement of the rail. In accordance with one embodiment of the invention six switches are employed and each switch operation represents a two inch increment of travel of the rail. However, any number of these switches may be employed as determined by the increment of distance measurement desired and the number of cams 725 required to operate these switches will be determined by the space available for mounting the switches. Actually, a single cam will suffice if the number of switches used can be uniformly spaced about the cam periphery but, if not, two or more cams may be required. In any event, the switches 726 are connected in series with a power source and with coils 731, 732, 733 and 734 of counter devices C_1, C_2, C_3, C_4 and C_5. The circuit is energized from a power source which applies power through a normally closed set of relay contacts (not shown) of a relay which is energized when the pusher is reversed so that the set of contacts opens to prevent their operation while the rail is being backed up. When the welding and shearing operations are completed, pusher mechanism immediately becomes effective to advance the rail at the high forward speed and the counter devices C_1, C_2, C_3 and C_4 begin to count. Each of the counter devices counts the number of energizations of its associated coil as the circuit is alternately made and broken by opening the switches 726 in sequence and each counter is set to operate when it has completed its count by actuating one or more sets of counter contacts. The count required to operate the various counters may be adjusted in accordance with the spacing between the various components of the system and the counters C_1, C_2, C_3, C_4 and C_5 are set to complete their counts at different times. Thus, counter C_1 is set to complete its count first and it is adjusted so that it operates its contacts when the new weld reaches a position adjacent the first grinding station 400. The contacts of counter C_1 are effective to interrupt the circuit to the high speed winding of the pusher motor 667 and to complete a circuit to the low speed winding of this motor so that the rail is advanced at low speed after the counter C_1 completes its count. A short time later, the counter C_2 completes its count whereupon its contacts break the circuit to the low speed winding of the pusher motor and recomplete the circuit to the high speed winding. The counter C_2 is adjusted to complete its count as soon as the new weld on the rail has passed through the first grinding station and, hence, at this time the rail is again moved forward at high speed. Counter C_3 is adjusted to complete its count when the new weld reaches a position adjacent the second grinding head 401, at which time the contacts of this counter become effective to break the circuit to the high speed winding of the pusher motor and to recomplete the circuit to the low speed winding. Therefore, the rail progresses at slow speed until the counter C_4 completes its count, an event which occurs as soon as the new weld has passed through the second grinding station 401. The contacts of counter C_4 are effective at the completion of the count to break the circuit to the low speed winding of the pusher motor and to recomplete the circuit to the high speed winding so that the rail advances at high speed until the counter C_5 completes its count. The counter C_5 is adjusted so that its count is completed when the trailing end of the rail has moved to the proper position for the next welding operation to take place. When the counter C_5 has completed its count its contacts are effective to break the circuit to the high speed winding of the pusher motor so that the latter motor is no longer energized and also to apply the brake on the pusher mechanism in order to hold the rail in position to make the next weld.

While there has been illustrated a particular embodiment of the present invention, it should be understood that many modifications will be apparent to those skilled in the art and it is, therefore, intended in the appended claims to cover all such modifications falling within the true spirit and scope of the invention.

What is claimed as new and is desired to be secured by Letters Patent of the United States is:

1. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment, rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including a plurality of grinding heads each including a grinding belt and respectively acting upon the top, the bottom and the side edges of the continuous rail in the region of the weld for the purpose of removing weld material, each head including biasing means for moving the belt into and out of engagement with the rail, a first of said grinding heads being spaced from a second of said heads in the direction of travel of the continuous rail, and said mechanism including means for continuously passing the continuous rail through the grinding equipment and for automatically varying the speed of travel in such manner that the continuous rail travels at relatively high speed until the weld reaches a position in the vicinity but in advance of the biasing means of the second grinding head whereupon the speed decreases to a relatively low value while the weld passes the second grinding head, the last named means being operable to increase the speed of travel of the continuous rail to said relatively high speed as the weld passes from the second grinding head to a position near but in advance of the biasing means of the first grinding head, to then decrease the speed of travel to said relatively low value during movement of the weld past the first grinding head, and then to increase the speed of travel to said relatively high speed when the weld moves beyond the first grinding head.

2. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment, rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including a plurality of grinding heads each including a grinding belt and respectively acting upon the continuous rail in the region of the weld, each head including biasing means for moving the belt into and out of engagement with the rail, a first of said grinding heads being spaced from a second of said heads in the direction of travel of the continuous rail, and said mechanism including means for automatically varying the speed of travel in such manner that the continuous rail travels at relatively high speed until the weld reaches a position in the vicinity but in advance of the biasing means of the second grinding head whereupon the speed decreases to a relatively low value while the weld passes the second grinding head, the last named means being operable to increase the speed of travel of the continuous rail to said relatively high speed as the weld passes from the second grinding head to a position near but in advance of the biasing means of the first grinding head, to then decrease the speed of travel to said relatively low value during movement of the weld past the first grinding head, and then to increase the speed of travel to said relatively high speed when the weld moves beyond the first grinding head.

3. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including first and second groups of grinding heads each including a grinding belt acting upon the continuous rail in the region of the weld, each of said groups including three grinding heads and the two groups being spaced apart in the direction of travel of the continuous rail, the heads of one group being respectively effective to grind the rail top and the two side edges of the rail base and the heads of the other group being respectively effective to grind the bottom of the rail base and the two side edges of the rail top, each head including biasing means for moving the belt into and out of engagement with the rail, and said mechanism including means for automatically varying the speed of travel of the continuous rail through the grinding equipment in such manner that the rail travels at relatively high speed until the weld reaches a position in the vicinity but in advance of the biasing means of the first group of grinding heads whereupon the speed decreases to a relatively low value while the weld passes the first group of grinding heads, the last named means being operable to increase the speed of travel of the continuous rail to said relatively high speed as the weld passes from the first group of grinding heads to a position near but in advance of the biasing means of the second group of grinding heads, to then decrease the speed of travel to said relatively low value during movement of the weld past the second group of grinding heads, and then to increase the speed of travel to said relatively high speed when the weld moves beyond the second group of grinding heads.

4. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including first and second groups of grinding heads each including a grinding belt acting upon the continuous rail in the region of the weld, each of said groups including three grinding heads and the two groups being spaced apart in the direction of travel of the continuous rail, the heads of one group being respectively effective to grind the rail top and the two side edges of the rail base and the heads of the other group being respectively effective to grind the bottom of the rail base and the two side edges of the rail top, and said mechanism including means for automatically varying the speed of travel of the continuous rail through the grinding equipment so that the rail travels at relatively high speed until the weld reaches a position in the vicinity but in advance of the biasing means of the first group of grinding heads whereupon the speed de-

creases to a relatively low value while the weld passes the first group of grinding heads, the last named means being operable to increase the speed of travel of the continuous rail to said relatively high speed as the weld passes from the first group of grinding heads to a position near but in advance of the biasing means of the second group of grinding heads, to then decrease the speed of travel to said relatively low value during movement of the weld past the second group of grinding heads, and then to increase the speed of travel to said relatively high speed when the weld moves beyond the second group of grinding heads, the last named means including a device for sensing the longitudinal movement of the rail together with apparatus responsive to said device for automatically varying the speed of travel of the rail.

5. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relatiionship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including first and second grinding heads spaced apart in the direction of travel of the continuous rail and each including a grinding belt acting upon the continuous rail in the region of the weld, each head including biasing means for moving the belt into and out of engagement with the rail, and said mechanism including means for automatically varying the speed of travel of the continuous rail through the grinding equipment in such manner that the rail travels at relatively high speed until the weld reaches a position in the vicinity but in advance of the biasing means of the first group of grinding heads whereupon the speed decreases to a relatively low value while the weld passes the first group of grinding heads, the last named means being operable to increase the speed of travel of the continuous rail to said relatively high speed as the weld passes from the first group of grinding heads to a position near but in advance of the biasing means of the second group of grinding heads, to then decrease the speed of travel to said relatively low value during movement of the weld past the second group of grinding heads, and then to increase the speed of travel to said relatively high speed when the weld moves beyond the second group of grinding heads, the last named means including a device for sensing the longitudinal movement of the rail together with apparatus responsive to said device for automatically varying the speed of travel of the rail.

6. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including six grinding heads each including a grinding belt acting upon the rail in the vicinity of the weld, said grinding heads being so spaced about the rail that a first of the heads is effective to grind the top of the rail, a second of the heads is effective to grind the bottom of the rail base, a third and a fourth of the heads are respectively effective to grind the two side edges of the rail base, and a fifth and a sixth of the heads are respectively effective to grind the two side edges of the rail top, each grinding head including at least one pressure operated roller normally positioned to maintain the belt out of engagement with the rail and movable to force the belt against the rail, and means for moving the rollers to force the belts against the rail only when the welded portion of the rail is disposed adjacent the grinding heads.

7. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including a grinding head having an abrasive belt acting upon the continuous rail in the region of the weld, said head including a plurality of rollers spaced apart in the direction of travel of the rail each normally positioned to maintain said belt out of engagement with the rail, and means operable in response to movement of the rail for moving said rollers in sequence to force said belt against the rail as the weld advances.

8. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment, rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including two groups of grinding heads each including a grinding belt acting upon the continuous rail in the region of the weld, each of said groups including three grinding heads and the two groups being spaced apart in the direction of travel of the continuous rail, each head including biasing means for moving the belt into and out of engagement with the rail, the heads of one group being respectively effective to grind the rail top and the two side edges of the rail base and the heads of the other group being respectively effective to grind the bottom of the rail base and the two side edges of the rail top, means for actuating the biasing means of each head to force the belt against the rail as the weld advances, and means for manually adjusting the positions of the grinding heads acting upon the rail top and the two side edges of the rail top in order to accommodate rails of different size.

9. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment, rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including six grinding heads each including a grinding belt acting upon the rail in the vicinity of the weld, each head including biasing means for moving the belt into and out of engagement with the rail, said grinding heads being so spaced about the rail that a first of the heads is effective to grind the top of the rail, a second of the heads is effective to grind the bottom of the rail base, the third and fourth of the heads being respectively effective to grind the two side edges of the rail base, and the fifth and sixth of the heads being respectively effective to grind the two side edges of the rail top, means for actuating the biasing means of each head to force the belt against the rail as the weld advances, and manually operated means for adjusting the positions of the grinding heads acting upon the rail top and the two side edges of the rail top in order to accommodate rails of different size.

10. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment, rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including six grinding heads each including a grinding belt having a portion extending along the rail and acting upon the rail in the vicinity of the weld, said grinding heads being so spaced about the rail that a first of the heads is effective to grind the top of the rail, a second of the heads is effective to grind the bottom of the rail base, the third and fourth of the heads being respectively effective to grind the two side edges of the rail base, and the fifth and sixth of the heads being respectively effective to grind the two side edges of the rail top, each of said heads including a flexible backing belt extending along said portion of the grinding belt, each of said heads further including a plurality of pressure rollers acting upon said flexible belt to force the grinding belt against the rail, and means for actuating said pressure rollers to force the grinding belt against the

rail only when the weld is located adjacent said grinding belt portion.

11. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including a plurality of grinding heads respectively acting upon the continuous rail in the region of the weld, each of said grinding heads including a flexible grinding belt having a portion extending along the rail, each head also including a plurality of pressure rollers spaced apart along the direction of travel of the rail and movable between an actuated position wherein the belt is forced against the rail and a released position wherein the belt is ineffective to grind the rail, and means actuated in response to movement of the rail for moving the pressure rollers of each head to their actuated positions in sequence as the weld is advanced.

12. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including a plurality of grinding heads respectively acting upon the continuous rail in the region of the weld, each of said grinding heads including a flexible grinding belt having a portion extending along the rail, each head also including a plurality of pressure rollers spaced apart along the direction of travel of the rail and movable between an actuated position wherein the belt is forced against the rail and a released position wherein the belt is ineffective to grind the rail, means driven by movement of the rail for moving the pressure rollers of each head to their actuated positions in sequence as the weld is advanced, a weld sensing mechanism engaging the rail for determining the presence of the weld, and means operated by the sensing mechanism for starting the operation of the pressure roller moving means.

13. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment from its inlet end to its outlet end, said grinding equipment including a plurality of grinding heads respectively acting upon the continuous rail in the region of the weld, each of said grinding heads including a flexible grinding belt having a portion extending along the rail, each head also including a plurality of pressure rollers spaced apart along the direction of travel of the rail and movable between an actuated position wherein the belt is forced against the rail and a released position wherein the belt is ineffective to grind the rail, fluid pressure operated means for moving said rollers between their released and actuated positions, a source of fluid pressure, means including a plurality of electrically operated control valves for selectively supplying fluid pressure from the source to the fluid pressure operated means, a weld sensing mechanism positioned near the inlet end of the grinding equipment and engaging the rail for distinguishing a weld on the rail from the remainder of the rail, an electrical switch actuated by said sensing mechanism when said mechanism engages a weld on the rail, a plurality of cams mounted upon a common drive shaft, a rail engaging roller driven by the longitudinal movement of the rail when passing from the inlet end of the grinding equipment to the outlet end, means including an electrically operated clutch for connecting the roller to the common drive shaft, a circuit including said switch for energizing said clutch when the sensing mechanism engages a weld in the rail, a plurality of switches respectively operated by said cams, and a plurality of electrical circuits each including one of the last named switches for actuating the control valves, said cams being disposed upon said shaft so that the pressure rollers are moved to their actuated positions in sequence when the weld reaches a position near the rollers.

14. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment from its inlet end to its outlet end, said grinding equipment including a plurality of grinding heads respectively acting upon the continuous rail in the region of the weld, each of said grinding heads including a flexible grinding belt having a portion extending along the rail, each head also including a plurality of pressure rollers spaced apart along the direction of travel of the rail and movable between an actuated position wherein the belt is forced against the rail and a released position wherein the belt is ineffective to grind the rail, fluid pressure operated means for moving said rollers between their released and actuated positions, a source of fluid pressure, means including a plurality of control valves for selectively supplying fluid pressure from the source to the fluid pressure operated means, a weld sensing mechanism engaging the rail and mounted for movement when it engages a weld on the rail, a rail engaging roller driven by the longitudinal movement of the rail when passing from the inlet end of the grinding equipment to the outlet end, means driven by said roller for operating the valves in sequence in order to move the pressure rollers to their actuated positions, and means operated by the movement of the sensing mechanism for rendering the valve operating means effective.

15. A sensing mechanism for use on a welded rail to distinguish a raised weld from the remainder of the rail, said mechanism comprising a first support arm mounted for pivotal movement about a fixed axis, a first roller mounted on said first support arm and engaging the rail so that the first support arm is pivoted about said axis as the roller moves both in response to movement of the rail laterally of its longitudinal axis and changes in rail size, a second support arm mounted for pivotal movement upon the first support arm, a second roller carried by the second support arm and engaging the rail at a point displaced longitudinally of the rail from the first roller, said second support arm being pivoted about the first support arm solely in response to changes in dimension of the rail and this pivoting movement being independent of rail movement laterally of its longitudinal axis, and means operably connected to the second support arm for sensing changes in rail size above a predetermined amount in order to distinguish a raised weld on the rail from the remaining portions of the rail.

16. A sensing mechanism for use on a welded rail to distinguish a raised weld from the remainder of the rail, said mechanism comprising support structure mounted for pivotal movement about a fixed axis, a first rail engaging member mounted on said support arm and engaging the rail so that the support structure pivots about said axis both in response to movement of the rail laterally of its longitudinal axis and in response to changes in rail size, a sensing arm mounted for pivotal movement upon the support structure, a second rail engaging member operably connected to the sensing arm and engaging the rail at a point displaced longitudinally of the rail from the first member, said sensing arm being pivoted solely in response to changes in dimension of the rail and this pivoting movement being independent of rail movement laterally of its longitudinal axis, and means operably connected to the sensing arm for sensing changes in rail size above a predetermined amount in

order to distinguish a raised weld on the rail from the remaining portions of the rail.

17. A sensing mechanism for use on a welded rail to distinguish a raised weld from the remainder of the rail, said mechanism comprising first and second movable rail engaging mechanisms engaging the rail at different points, means mounting the second mechanism for movement both in response to movement of the rail laterally of its longitudinal axis and in response to changes in rail size, means mounting the first mechanism for movement upon the second mechanism solely in response to changes in dimension of the rail and independently of rail movement laterally of its longitudinal axis, and means operably connected to the first mechanism for sensing changes in rail size above a predetermined amount in order to distinguish a raised weld on the rail from the remaining portions of the rail.

18. A sensing mechanism for use on a welded rail to distinguish a raised weld from the remainder of the rail, said mechanism comprising mechanism acting upon a moving welded rail and including a member movable solely in response to changes in dimension of the rail and independently of rail movement laterally of its longitudinal axis, and means operably connected to said member for sensing changes in rail size above a predetermined amount in order to distinguish a raised weld on the rail from the remaining portions of the rail.

19. A method of grinding a welded rail which comprises the steps of moving the weld area of the rail continuously and without interruption past first and second fixed grinding stations spaced apart in the direction of movement of the rail, grinding at one of said stations the top running surface of the rail and the two side edges of the rail in the weld area while the weld on the rail is passing therethrough, grinding at the other of the grinding stations the underside of the base and the two side edges of the top running surface of the rail in the weld area while the weld on the rail is passing therethrough, slowing down the movement of the rail as the weld area passes through the first grinding station, speeding up the movement of the rail as the weld area passes from the first station to the second station, and again slowing down the movement of the rail as the weld area passes through the second station.

20. A method of grinding a welded rail which comprises the steps of moving the welded area of the rail continuously and without interruption past first and second fixed grinding stations spaced apart in the direction of movement of the rail, grinding a plurality of different portions of the rail in the welded area at the first station for a fixed predetermined interval while the rail is moving therethrough, grinding a different group of portions of the welded area of the rail at the other of the grinding stations for a fixed predetermined interval while the rail is moving therethrough, slowing down the movement of the rail as the welded area passes through the first grinding station, speeding up the movement of the rail as the welded area passes from the first station to the second station, and again slowing down the movement of the rail as the welded area passes through the second station.

21. A method of grinding a welded rail which comprises the steps of relatively moving the rail continuously and without interruption through first and second grinding stations spaced apart in the direction of movement of the rail, grinding at one of said stations the top running surface of the rail and the two side edges of the rail in the welded area, grinding at the other of the grinding stations the underside of the base and the two side edges of the top running surface in the welded area of the rail, slowing down the relative movement between the rail and the grinding stations when the welded area is in the first grinding station, speeding up the relative movement between the rail and the grinding stations when the welded area is between the first and second stations, and again slowing down the relative movement between the rail and the grinding stations when the welded area is in the second station.

22. A method of grinding a welded rail comprising the steps of relatively moving the welded rail and a plurality of spaced apart grinding heads, grinding different portions of the rail in the weld area with each of said heads, slowing down the relative movement between the rail and the grinding heads when the weld area reaches a position in the vicinity but in advance of each grinding head, and speeding up the relative movement between the rail and the grinding heads when the weld area is passing between the grinding heads.

23. A method of grinding a welded rail comprising the steps of moving the welded rail past a plurality of fixed grinding stations spaced apart in the direction of movement of the rail, grinding different portions of the rail in the weld area at each of said stations for a predetermined fixed interval while the rail is moving therethrough, slowing down the movement of the rail as the weld area passes through each grinding station, and speeding up the movement of the rail as the weld area passes between the grinding stations.

24. A method of grinding a welded rail comprising the steps of moving the welded rail past first and second fixed grinding stations spaced apart in the direction of movement of the rail, grinding the weld area on the rail at each of said stations for a predetermined fixed interval while the rail is moving therethrough, slowing down the movement of the rail as the weld area passes through each grinding station, and speeding up the movement of the rail as the weld area passes between the first and second grinding stations.

25. A method of grinding a welded rail comprising the steps of moving the welded rail past a plurality of fixed grinding stations spaced apart in the direction of movement of the rail, grinding the weld area on the rail at each of said stations for a predetermined fixed interval while the rail is moving therethrough, slowing down the movement of the rail as the weld area passes through each grinding station, and speeding up the movement of the rail as the weld area passes between the grinding stations.

26. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including a grinding head acting upon the continuous rail in the region of the weld, said grinding head including a flexible grinding belt having a portion extending along the rail, said head also including a plurality of pressure rollers spaced apart along the direction of travel of the rail and movable between an actuated position wherein the belt is forced against the rail and a released position wherein the belt is ineffective to grind the rail, weld sensing means for distinguishing between the weld and the remaining portion of the rail, and means actuated by the weld sensing means for moving the pressure rollers to their actuated positions in sequence as the weld is advanced.

27. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including a grinding head acting upon the continuous rail in the region of the weld, said grinding head including a flexible grinding belt having a portion extending along the rail, said head also including at least one pressure roller movable between an actuated position wherein the belt is forced against the rail and a released position wherein the belt is ineffective to grind the rail, means driven by movement of the rail for moving the pressure roller to its actuated position as the weld is advanced, a weld sensing mechanism engaging the rail for determining the presence of the weld,

and means actuated by the sensing mechanism for operating the pressure roller moving means.

28. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including a plurality of grinding heads each including a grinding belt having a portion extending along the rail and acting upon the rail in the vicinity of the weld, said grinding heads being spaced about the periphery of the rail to engage different portions thereof, each of said heads including a flexible backing belt extending along said portion of the grinding belt, each of said heads further including a plurality of pressure rollers acting upon said flexible belt to force the grinding belt against the rail, and means controlled by the rail movement for automatically actuating said pressure rollers to force the grinding belt against the rail only when the weld is located adjacent said grinding belt portion.

29. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment from its inlet end to its outlet end, said grinding equipment including a grinding head acting upon the continuous rail in the region of the weld, said grinding head including a flexible grinding belt having a portion extending along the rail, said head also including a plurality of pressure rollers spaced apart along the direction of travel of the rail and movable between an actuated position wherein the belt is forced against the rail and a released position wherein the belt is ineffective to grind the rail, fluid pressure operated means for moving said rollers between their released and actuated positions, a source of fluid pressure, means including a plurality of electrically operated control valves for selectively supplying fluid pressure from the source to the fluid pressure operated means, a weld sensing mechanism positioned near the inlet end of the grinding equipment and engaging the rail for distinguishing a weld on the rail from the remainder of the rail, an electrical switch actuated by said sensing mechanism when said mechanism engages a weld on the rail, a plurality of cams mounted upon a common drive shaft, a rail engaging roller driven by the longitudinal movement of the rail when passing from the inlet end of the grinding equipment to the outlet end, means including an electrically operated clutch for connecting the roller to the common drive shaft, a circuit including said switch for energizing said clutch when the sensing mechanism engages a weld in the rail, a plurality of switches respectively operated by said cams, and a plurality of electrical circuits each including one of the last named switches for actuating the control valves, said cams being disposed upon said shaft so that the pressure rollers are moved to their actuated positions in sequence when the weld reaches a position near the rollers.

30. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment from its inlet end to its outlet end, said grinding equipment including a grinding head acting upon the continuous rail in the region of the weld, said grinding head including a flexible grinding belt having a portion extending along the rail, said head also including a plurality of pressure rollers spaced apart along the direction of travel of the rail and movable between an actuated position wherein the belt is forced against the rail and a released position wherein the belt is ineffective to grind the rail, fluid pressure operated means for moving said rollers between their released and actuated positions, a source of fluid pressure, means including a plurality of control valves for selectively supplying fluid pressure from the source to the fluid pressure operated means, a weld sensing mechanism engaging the rail and mounted for movement when it engages a weld on the rail, a rail engaging roller driven by the longitudinal movement of the rail when passing from the inlet end of the grinding equipment to the outlet end, means driven by said roller for operating the valves in sequence in order to move the pressure rollers to their actuated positions, and means operated by the movement of the sensing mechanism for rendering the valve operating means effective.

31. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment, and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including a grinding head acting upon the continuous rail in the region of the weld, means for moving the grinding head into and out of engagement with the rail, weld sensing means located in advance of said grinding head for distinguishing between the weld and the remaining portion of the rail, and means actuated by the weld sensing means for rendering the grinding head moving means effective to move the grinding head into engagement with the rail when the welded rail is advanced by the rail moving mechanism.

32. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment, and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including a grinding head acting upon the continuous rail in the region of the weld, means normally maintaining the grinding head out of engagement with the rail, means for rendering the last named means ineffective and for moving the grinding head into and out of engagement with the rail, weld sensing means located in advance of said grinding head for distinguishing between the weld and the remaining portion of the rail, and means actuated by the weld sensing means for rendering the grinding head moving means effective to move the grinding head into engagement with the rail only when the welded portion of the rail is advanced by the rail moving mechanism to a position adjacent the grinding head.

33. In a grinding apparatus for use in grinding welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of grinding equipment and rail moving mechanism for passing the continuous rail through the grinding equipment, said grinding equipment including an endless grinding belt including a portion for acting upon the continuous rail in the region of the weld, means for moving said grinding belt portion into and out of engagement with the rail, weld sensing means located in advance of said grinding head for distinguishing between the weld and the remaining portion of the rail, and means actuated by the weld sensing means for rendering the grinding belt moving means effective to move said grinding belt portion against the rail when the welded portion of the rail is advanced by the rail moving mechanism to a position adjacent said grinding belt portion.

34. In an apparatus for use in removing flash metal from the upset around welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of flash removing equipment, and rail moving mechanism for passing the continuous rail through the flash removing equipment, said flash removing equipment including structure acting upon the continuous rail in the region of the weld, means for moving said structure into and out of engagement with the rail, weld sensing means located in advance of said flash removing equipment for distinguishing between the weld and the remaining portion of the rail, and means

actuated by the weld sensing means for rendering the structure moving means effective to move said structure into engagement with the rail when the welded rail is advanced by the rail moving mechanism.

35. In an apparatus for use in removing flash metal from the upset around welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of flash removing equipment, and rail moving mechanism for passing the continuous rail through the flash removing equipment, said flash removing equipment including structure acting upon the continuous rail in the region of the weld, weld sensing means located in advance of said flash removing equipment for distinguishing between the weld and the remaining portion of the rail, and means actuated by the weld sensing means for rendering said structure effective to act upon the rail only when the welded portion of the rail is advanced by the rail moving mechanism to a position adjacent said structure.

36. In an apparatus for use in removing flash metal from the upset around welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of flash removing equipment, and rail moving mechanism for passing the continuous rail through the flash removing equipment, said flash removing equipment including structure acting upon the continuous rail in the region of the weld, control means for moving said structure into and out of engagement with the rail, weld sensing means located in advance of said flash removing equipment for distinguishing between the welded joint of the rail and the remaining portion of the rail, and means actuated by the weld sensing means for rendering the control means effective to move said structure into engagement with the rail only after the welded joint of the rail has been advanced by the rail moving mechanism from the weld sensing means to a position adjacent said structure.

37. The structure defined by claim 36 wherein the control means includes a rail engaging element driven by the rail movement together with means driven by said rail engaging element and controlled by said weld sensing means for moving the structure into engagement with the rail only after the welded joint has passed a predetermined distance beyond the weld sensing means.

38. The apparatus defined by claim 36 wherein the control means includes a rail engaging element driven by the rail movement, means driven by said element for developing an electrical signal, the operation of the last named means being initiated by said weld sensing means and said electrical signal being developed after said rail engaging element has been driven a predetermined amount following the initiation of operation of said last named means, said structure moving means being responsive to said electrical signal to move said structure into engagement with the rail.

39. The apparatus defined by claim 36 wherein the weld sensing means comprises mechanism acting upon a moving welded rail and including a member movable solely in response to changes in dimension of the rail and independently of rail movement laterally of its longitudinal axis, and means operably connected to said member for sensing changes in rail size above a predetermined amount in order to distinguish a raised weld on the rail from the remaining portions of the rail.

40. The apparatus defined by claim 37 wherein the weld sensing means comprises mechanism acting upon a moving welded rail and including a member movable solely in response to changes in dimension of the rail and independently of rail movement laterally of its longitudinal axis, and means operably connected to said member for sensing changes in rail size above a predetermined amount in order to distinguish a raised weld on the rail from the remaining portions of the rail.

41. In an apparatus for use in removing flash metal from the upset around welds produced by welding rail sections together in end to end relationship to form a continuous rail, the combination of flash removing equipment, and rail moving mechanism for passing the continuous rail through the flash removing equipment, said flash removing equipment including structure acting upon the continuous rail in the region of the weld, weld sensing means located in advance of said flash removing equipment for distinguishing between the flash area around the welded joint of the rail and the remaining portion of the rail, and control means actuated by the weld sensing means for rendering said structure effective to remove at least a portion of the flash area only when the welded joint of the rail is advanced by the rail moving mechanism from the weld sensing means to a position adjacent said structure.

42. The structure defined by claim 41 wherein the control means includes a rail engaging element driven by the rail movement together with means driven by said rail engaging element and controlled by said weld sensing means for rendering said structure effective only after the welded joint has passed a predetermined distance beyond the weld sensing means.

43. The apparatus defined by claim 41 wherein the control means includes a rail engaging element driven by the rail movement, means driven by said element for developing an electrical signal, the operation of the last named means being initiated by said weld sensing means and said electrical signal being developed after said rail engaging element has been driven a predetermined amount following the initiation of operation of said last named means, said control means being responsive to said electrical signal to render said structure effective.

44. The apparatus defined by claim 41 wherein the weld sensing means comprises mechanism acting upon a moving welded rail and including a member movable solely in response to changes in dimension of the rail and independently of rail movement laterally of its longitudinal axis, and means operably connected to said member for sensing changes in rail size above a predetermined amount in order to distinguish a raised weld on the rail from the remaining portions of the rail.

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