Sept. 10, 1963 F. B. GOLLEY ETAL 3,103,072

GAUGING DEVICE FOR STEEL ROLLING MILL

Filed Aug. 1, 1960 3 Sheets-Sheet 1

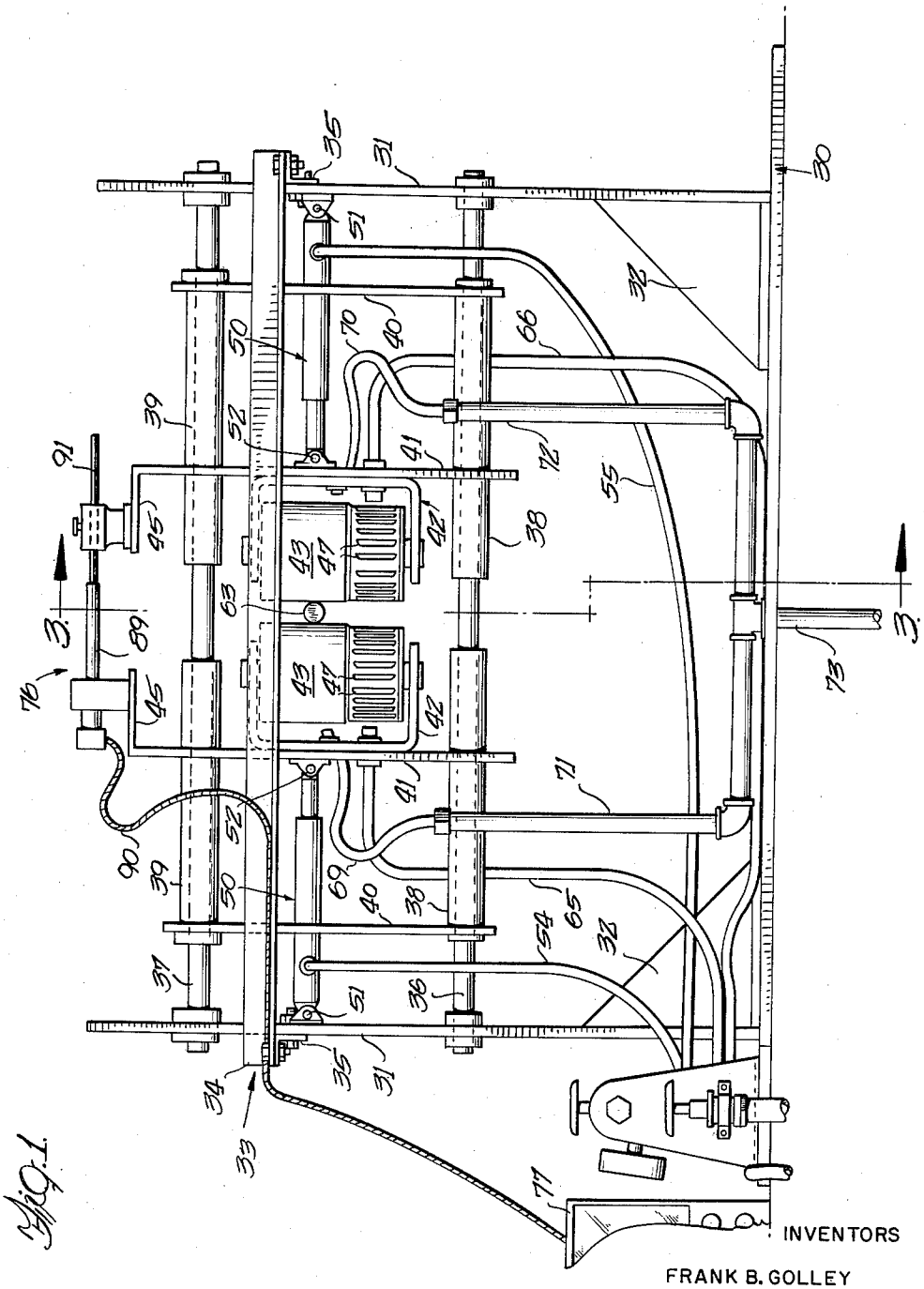


Fig. 1.

INVENTORS

FRANK B. GOLLEY

ROBERT J. RACHUS

Paul O. Pippel

ATTORNEY

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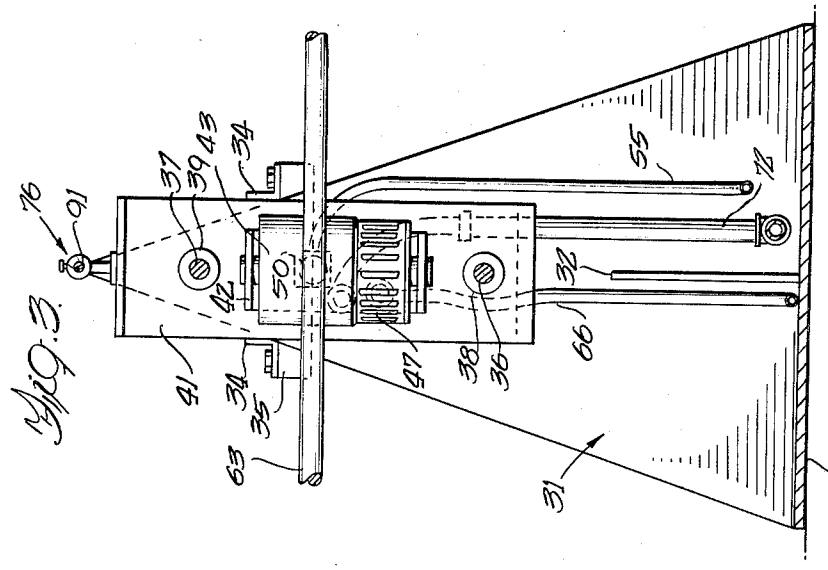


Fig. 3.

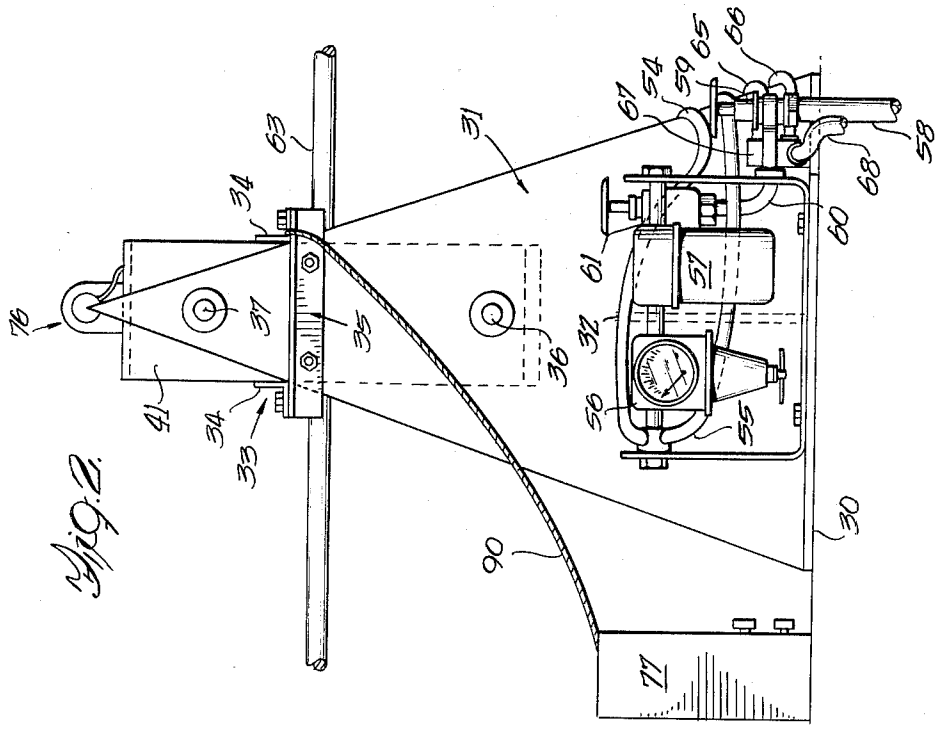


Fig. 2.

INVENTORS

FRANK B. GOLLEY

ROBERT J. RACHUS

Paul O. Pippel

ATTORNEY

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Fig. 4

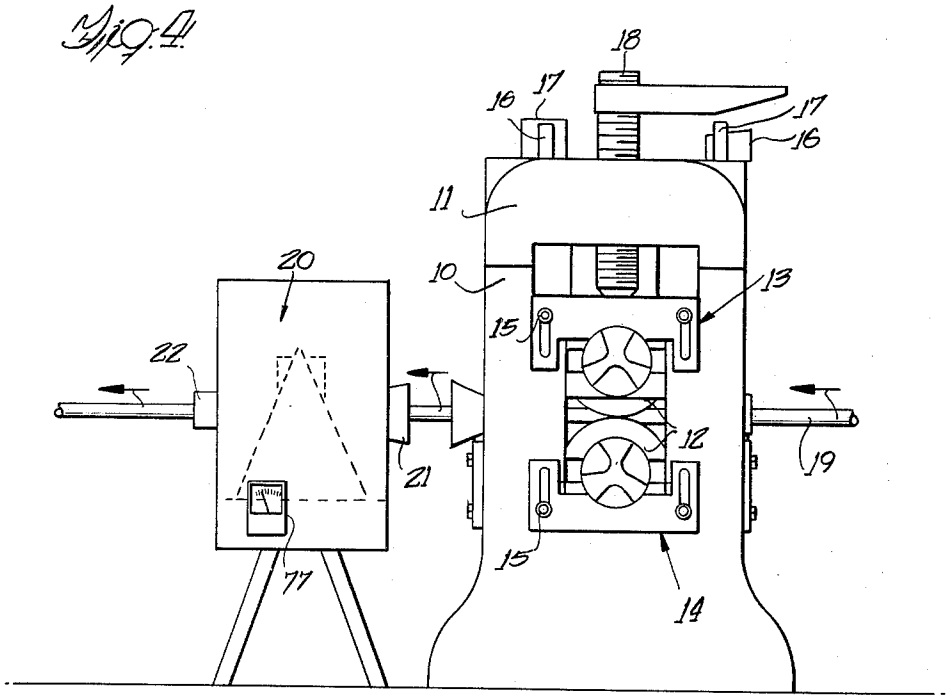
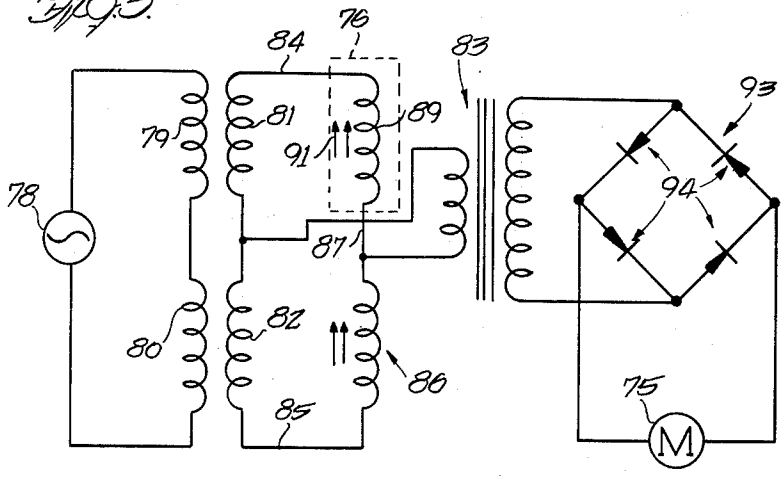


Fig. 5



INVENTORS

FRANK B. GOLLEY
ROBERT J. RACHUS

Paul O. Pippel

ATTORNEY

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GAUGING DEVICE FOR STEEL ROLLING MILL

Frank B. Golley, Chicago, and Robert J. Rachus, Oak Lawn, Ill., assignors to International Harvester Company, Chicago, Ill., a corporation of New Jersey

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This invention relates generally to continuous gauging devices, and more particularly to a gauging device for continuously measuring the dimensions of hot steel bars while being rolled.

Generally in the art, the gauging of steel bars or rods for size while being hot rolled is a costly and time-consuming procedure. This is due to a number of factors, two of the most troublesome being the high temperature of the steel while being rolled and the movements or oscillations of the steel as it travels through the rolling mill. A rapidly moving and wavering hot steel bar is difficult to gauge with any degree of accuracy.

It is the object of the present invention to provide a gauging device for a steel rolling mill which will accurately and continuously indicate the diameter of the hot rod.

It is a further object of the present invention to provide a continuous gauging arrangement for a hot bar which will follow the rod as it wavers or oscillates in leaving a rolling mill with the waverings of the rod producing substantially no error in the readings of the device.

It is a further object of the present invention to provide a gauging device for hot steel bar or rod which will continuously gauge the bar or rod without overheating, which will rapidly adjust to movements of the hot bar or rod at different longitudinal speeds and which will continuously translate the dimension of the bar or diameter of the rod into an electrical current value.

Other objects and features of the present invention will be apparent upon a perusal of the following specification and drawings of which:

FIGURE 1 is a front elevational view of a gauging device constructed according to the present invention;

FIGURE 2 is an end-elevational view of the structure shown in FIGURE 1;

FIGURE 3 is a cross-sectional view of the structure shown in FIGURE 1 taken along the line 3—3 of FIGURE 1;

FIGURE 4 is a side-elevational view showing the general arrangement of the present invention with a rolling mill; and

FIGURE 5 is a circuit diagram of the electrical circuit for the gauging device.

The present embodiment is the preferred embodiment, but it is to be understood that changes can be made in the present embodiment by one skilled in the art without departing from the spirit and scope of the present invention.

For a general description of the present invention reference is made to the drawings. As may be seen in FIGURE 4 wherein a common type rolling mill is shown in a side-elevational view, the mill stand comprises a base **10**, a cap **11** and a pair of shaping rolls **12**. The shaping rolls **12** are aligned one above the other and are secured in proper cooperative operating relationship by bearings **13** and **14**, bearings **13** at each end of the base **10** for supporting and aligning the bottom roll **12** and bearings **14** at each end of the base **10** for supporting and aligning the upper roll **12**. The bearings **13** and **14** are secured to the base **10** by bolts **15**. The cap **11** is secured to the base by wedges **16** which are driven into slotted ears **17** of the base **10** and engage the top of the head **11**. A manually operated screw **18** at each

end of the mill is threaded through the cap **11** and bears against the journal bearing of the upper roll **12** to maintain proper pressure between the rolls **12**. The hot bar or rod **19** is fed into one side of the mill and progresses between the rolls **12** and out of the other side thereof. The end portions of the rolls **12** are notched for receiving suitable power spindles for the rotation of the rolls as the steel bar or rod **19** moves through the mill. Generally the average speed of the bar or rod through such a mill is 1800 ft. per minute, the average temperature of the rod while moving through the mill is 1900° F., and the size rod of the present embodiment may be between approximately ⅜" to 1½" in diameter. The mill is constantly cooled by running water in order to permit continuous rolling. It is contemplated that the present invention be mounted in a container or other protective means **20** such as shown in FIGURE 4 with an inlet nozzle **21** and an outlet nozzle **22** for directing the rod **19** through the gauging device. The container **20** is positioned closely adjacent to the delivery guides of the mill for easy entrance of the bar or rod into the gauging device for measurement thereof.

The gauging device of the subject invention comprises two cylinders of a relatively light material so that their moments of inertia are low, which are rotatively carried in a frame for free rotation therein. The frames for the cylinders are provided with means for urging them together and the frames are in turn carried in a supporting arrangement which permits lateral movement of both frames together as a unit. One branch of a balancing network or impedance bridge is carried by the cylinder supporting frames and the balancing network is connected for translation of the distance between the cylinders at any one time into an electrical meter reading. Air hoses carried by the frames are provided for rotating the cylinders at approximately the linear speed of the rod being rolled, and a pair of flexible water lines also carried by the frames provide for cooling of the cylinders. As the pair of cylinders are rotated by compressed air from the hoses at the linear speed of the rod and, as the cylinders are cooled by the water lines, the hot rod is delivered through the engaging surfaces of the cylinders. The rod will move the cylinders apart a distance equal to the diameter of the rod and as the rod wavers laterally the pair of cylinders will follow the movements of the rod, the cylinders at all times being urged against the rod. The branch of the balancing network carried by the cylinder frames will unbalance the bridge causing an output signal to be produced which is proportional to the diameter of the rod and which is registered on a volt meter. Although the present embodiment contemplates the use of a direct reading volt meter, other types of recording meters may be used.

Turning next to a detailed description of the present invention continued reference is made to the drawings. A base **30** is provided upon which are carried a pair of spaced-apart upstanding plates **31**. The plates **31** are suitably braced relative to the base **30** by the reinforcing plates **32**. A rectangular frame **33** comprising side frame members **34** and end frame members **35** is carried on the plates **31** and extends therebetween. The upstanding plates **31** further carry a pair of rods **36** and **37**. Rod **36** is secured to the plates **31** and extends horizontally therebetween below the frame **33**. Rod **37** also is secured to the plates **31** and extends horizontally therebetween above the frame **33**.

The rods **36** and **37** are provided for freely slidably carrying a pair of cylinder asemblies. Each cylinder assembly comprises a lower sleeve **38**, an upper sleeve **39**, a pair of plates **40** and **41**, a U-shaped frame or bracket **42** and a cylinder **43**. The lower sleeves **38** are journaled

on the rod 36 for free movement therealong and the upper sleeves 39 are journaled on the rod 37 for free horizontal sliding movement therealong. The plates 40 are each secured to one end of one sleeve 38 and one sleeve 39. Each of the other plates 41 is secured to one of the sleeves 38 and one of the sleeves 39 at a position spaced from plate 40 and toward the center of the base frame. The plates 40 and 41 have a width substantially equal to the horizontal distance between the frame members 34. Each of the plates 41 has a flange 45 formed on the upper end thereof which extends toward the center of the base frame. Each of the U-shaped frames 42 is secured to one of the plates 41 between sleeves 38 and 39 and on the side of the plate 41 toward the center of the base frame. The legs of each of the U-shaped frames 42 extend horizontally and are adapted to receive bearings for the cylinders 43. Each of the cylinders 43 is formed of a relatively light metal and have a plurality of vanes 47 formed around the circumference of the lower portion thereof. The ends of each of the cylinders 43 are provided with bearing means which are supported in the frames 42. When the two cylinder assemblies are moved together, the smooth upper portion of the cylinders 43 will engage each other along a vertical line.

A pair of air cylinders 50 are provided for urging the cylinder asesmblies toward each other. The head end of each of the air cylinders is pivotally carried on one of the upstanding plates 31 by pivotal mounting means 51. The cylinders 50 extend through suitable openings in the plates 40 and the rod end of each air cylinder 50 is pivotally connected to one of the plates 41 by pivotal mounting means 52. Pivotal mounting means 52 are mounted on the plates 41 substantially midway between the rods 36 and 37 and substantially in horizontal alignment with the smooth areas of the cylinders 43 so that the cylinder assemblies are easily moved on the rods 36 and 37 by the air cylinders 50 and whereby the cylinders 43 will be urged together along a line perpendicular to the axes of the rods 36 and 37. The air cylinders 50 are one-way cylinders having air hoses 54 and 55 connected into the head ends thereof. The piston rods of the air cylinders 50 are loose fitting in that air may escape from the cylinders about the periphery of the piston rods. The amount of air which may escape is less than the amount deliverable to the head end of each cylinder 50. The other ends of the air hoses 54 and 55 are connected to the outlet of a pressure regulator 56 and an air filter 57. Air is delivered to the filter 57 from an air source line 58 connected to valve 59 which in turn is connected through conduit 60 to valve 61 which in turn is connected to the air filter 57. By appropriate adjustments of the air valves and the pressure regulator, sufficient air is delivered through air hoses 54 and 55 to the air cylinders 50 to project the cylinder assemblies toward each other with a consequent meeting of the cylinders 43. Since the air hoses 54 and 55 are connected to a common source and since the pressure or bias supplied by each cylinder 50 is opposed by that of the other, any lateral movements of the rod 63 during the rolling operation will carry the two cylinders 43 integrally therewith, with one air cylinder 50 being retracted as the other air cylinder 50 is extended. Thus it may be seen that within the limits of the plates 31, the cylinder assemblies will be biased in rolling contact with the rod being rolled and will accurately follow the rod as it may laterally waver during the rolling operation thereof. The spacing between the plates 31 is selected as one which is more than sufficient for the maximum variation of size, and the maximum horizontal variations of movement of the rod 63 as it is rolled in the particular rolling mill. The air pressure in the air cylinders 50 is further of such a value as to permit the easy entrance of rod 63 or rods of other sizes between cylinders 43 without deforming the cylinders 43, but maintaining sufficient pressure to keep the cylinders 43 biased against the sides of the rod 63 continuously.

Additional air hoses 65 and 66 are provided for initially rotating the cylinders 43 to prevent damage thereto by the rod 63 engaging the cylinder assemblies at a speed of approximately 1800 feet per minute. One end of each of the hoses 65 and 66 is carried by one of the plates 41 and extends therethrough in vertical alignment with the vanes 47 on one of the cylinders 43 and to one side of the axis thereof so that air directed from that end of the hoses 65 and 66 will cause the cylinders 43 to rotate in the same direction, the sides thereof engaging the rod 63, that the rod is moving in leaving the rolling mill. The other ends of the hoses 65 and 66 are connected to a header 67 which in turn is connected to an air supply hose 68. In operation, the cylinders 43 are rotated by the air from the hoses 65 and 66 to a speed wherein the surface of the upper portions of the cylinders 43 rotates at a linear speed approximately equal to the linear speed of the rod 63 as it leaves the rolling mill.

As the cylinders 43 would be quickly overheated by the hot rod 63 if they were not cooled, a pair of flexible water supply hoses 69 and 70 are provided. One end of the hoses 69 and 70 is carried through the plates 41 at a position adjacent the upper portion of the cylinders 43 so that any water delivered from that end of those hoses is directed against the upper surfaces of the cylinders 43. The other ends of the hoses 69 and 70 are connected to supply pipes 71 and 72 which in turn are connected to a water supply line 73.

A balancing network is used in the present embodiment to translate the diameter of the rod 63 into a meter reading on the meter 75. All of the components shown in FIGURE 5 other than the adjustable coil 76 may be mounted in the case 77. The output of a signal source 78 is connected across the identical input coils 79 and 80. Coil 79 is inductively coupled to coil 81 and coil 80 is inductively coupled to coil 82. One end of each of coils 81 and 82 is interconnected and connected to one side of the primary of transformer 83. The other end of coil 81 is connected by conductor 84 to one end of the adjustable coil 76. The other end of coil 82 is connected by conductor 85 to one end of the adjustable coil 86. The other end of adjustable coil 76 is connected by conductor 87 to the other end of adjustable coil 86 and to the other side of the primary coil of transformer 83. The coil 89 of adjustable coil 76 is carried on one flange 45 of one of the cylinder assemblies and conductors 84 and 87 are carried through cable 90 to the case 77, as can be seen in FIGURE 1. The core 91 of adjustable coil 76 is carried on the other flange 45 of the other cylinder assembly and is positioned within coil 89 so that the inductive reactance of adjustable coil 76 is varied as the cylinder assemblies are moved toward and away from each other. The output winding of the transformer 83 is connected to a full wave rectifier 93 which comprises rectifiers 94 which may be of the copper oxide or selenium type. The output of the full wave rectifier 93 is connected across the meter 75. Without a rod 63 between the cylinders 43 and with the cylinders 43 in engagement with each other, the adjustable coil 86 may be adjusted to balance the impedance bridge of coils 81, 82, 76 and 86 so that no output is delivered to the primary of transformer 83. The meter 75 will then show a zero reading. When the rod 63 is disposed between the cylinders 43, the core 91 will be moved out of the coil 89 of adjustable coil 76 an identical amount. This will unbalance the bridge and an output will be delivered to the transformer 83 which will be converted on the meter 75 to a scale reading indicating the diameter of the rod 63. As the rod 63 continuously moves between the cylinders 43, the meter 75 will continuosuly indicate the diameter thereof.

In conclusion, the subject invention will continuously indicate the dimension of a hot bar or the diameter of a

hot rod which is rapidly moving through a rolling mill and which may laterally waver as it leaves the rolling mill. If the meter reading indicates that the bar or rod is of a dimension other than the dimension desired to be rolled, it is a simple matter to adjust the rolling mill to more closely approach the desired dimension, further checking the adjusted dimension of the bar or rod as it leaves the rolling mill.

Having described the invention, what is considered new and desired to be protected by Letters Patent is:

1. In a gauging device for hot rod traversing a rolling mill, a pair of cylinders, a pair of frames, each of said cylinders rotatively carried in one of said frames, means for biasing said frames toward each other whereby said cylinders cooperate in rolling contact along a line parallel to the axes of said cylinders so that any hot rod passing between said cylinders will separate said cylinders a distance equal to the diameter of said rod and will engage said cylinders in rolling contact, said means for biasing said frames further being formed to permit said frames to integrally move along an axis perpendicular to the axes of said cylinders whereby said cylinders will follow any lateral movements of said rod to retain contact therewith, each of said cylinders being further formed to have a plurality of vanes disposed about the periphery thereof, air conduit means carried by each of said frames and disposed in alignment with said vanes so that air issuing from said conduit means will strike said vanes on said cylinders to rotate said cylinders in the same direction at their line of contact that any hot rod moves in passing therebetween, means for adjustably delivering compressed air to said air conduit means for initially rotating said cylinders at substantially the same speed as any hot rod to be passed therebetween, and remote indicating means connected to said frames for continuously indicating the distance between said cylinders as said rod moves longitudinally therebetween.

2. In a gauging device for hot rod traversing a rolling mill, a pair of cylinders, a pair of frames, each of said cylinders rotatively carried in one of said frames, means for biasing said frames toward each other whereby said cylinders cooperate in rolling contact along a line parallel to the axes of said cylinders so that any hot rod passing between said cylinders will separate said cylinders a distance equal to the diameter of said rod and will engage said cylinders in rolling contact, said means for biasing said frames further being formed to permit said frames to integrally move along an axis perpendicular to the axes of said cylinders whereby said cylinders will follow any lateral movements of said rod to retain contact therewith, the lower portion of each of said cylinders removed from contact with said hot rod being formed to have a plurality of vanes disposed about the periphery thereof, air hose means carried by each of said frames and disposed in alignment with said vanes so that any air issuing from said air hose means will rotate said cylinders in the same direction at the line of contact therebetween that any hot rod travels in passing therebetween, means for adjustably delivering air under pressure to said air hose means for initially rotating said cylinders at a linear peripheral speed substantially equal to the speed of any hot rod to be passed therebetween, water hose means carried by each of said frames above said air hose means and in alignment with the portions of said cylinders in rolling contact with said hot rod for directing cooling water onto said cylinders as said cylinders are rotated, means for delivering water to said water hose means, and remote indicating means connected to said frames for continuously indicating the distance between said cylinders as said rod moves longitudinally therebetween.

3. In a gauging device for hot rod traversing a rolling mill, a first frame member, a pair of rods secured in said first frame member in a parallel spaced-apart relationship to each other, a pair of frames, each of said frames slidably carried on said pair of rods whereby said pair of frames are freely movable toward and away from each other, a pair of cylinders each of said cylinders rotatively carried on one of said pair of frames for rotation about an axis perpendicular to the longitudinal axis of said pair of rods and positioned in said frame so that when said frames are moved toward each other said cylinders will cooperate in rolling contact along a line parallel to the axes of said cylinders, a biasing means for biasing said pair of frames toward each other whereby a hot rod may be passed between said cylinders to separate said cylinders a distance equal to the diameter of said hot rod and whereby said cylinders will engage said hot rod in rolling contact, said biasing means further being formed to permit said pair of frames to integrally move along said pair of rods whereby said cylinders will follow any lateral movements of said hot rod to retain contact therewith, the lower portion of each of said cylinders removed from contact with said hot rod being formed to have a plurality of vanes disposed about the periphery thereof, air conduit means carried by each of said pair of frames and disposed in alignment with said vanes so that air issuing from said air conduit means will strike said vanes on said cylinders to rotate said cylinders in the same direction at their line of contact that any hot rod moves in passing therebetween, means for adjustably delivering compressed air to said air conduit means for initially rotating said cylinders at substantially the same speed as any hot rod to be passed therebetween, and remote indicating means connected to said pair of frames for continuously indicating the distance between said cylinders as said hot rod moves longitudinally therebetween.

4. In a gauging device as claimed in claim 3, wherein water hose means is provided carried by each of said pair of frames above said air conduit means and in alignment with the portions of said cylinders in rolling contact with said hot rod for directing cooling water onto said cylinders as said cylinders are rotated, and means for delivering water to said water hose means.

5. In a gauging device for hot rod traversing a rolling mill, a base frame member comprising a pair of spaced-apart plates, a pair of rods secured between said plates in a parallel spaced-apart relationship to each other, a pair of frames, each of said frames slidably carried on said pair of rods whereby said pair of frames are freely movable toward and away from each other, a pair of cylinders, each of said cylinders rotatively carried on one of said pair of frames for rotation about an axis perpendicular to the longitudinal axis of said pair of rods and positioned in said frame so that when said frames are moved toward each other said cylinders will cooperate in rolling contact along a line parallel to the axes of said cylinders, a pair of air cylinders, each of said air cylinders connected between one of said plates and one of said frames and disposed substantially parallel to the longitudinal axis of said pair of rods so that when said air cylinders are extended said frames are moved toward each other, means for adjustably delivering compressed air to the head end of each of said air cylinders, each of said air cylinders being formed to permit a portion of the air delivered thereto to escape from the rod end of said air cylinder so that when air is delivered to said air cylinders, said air cylinders will move said frames to bias such cylinders together and will permit said frames to integrally move along said pair of rods whereby said cylinders will separate a distance equal to the diameter of any hot rod passing therebetween and will follow any lateral movements of said hot rod to retain contact therewith, and remote indicating means connected to said frames for continuously indicating the distance between said cylinders as said hot rod moves longitudinally therebetween.

6. In a gauging device for hot rod traversing a rolling mill, a base frame member comprising a pair of spaced-

apart upstanding plates, a pair of rods horizontally secured between said upstanding plates in a vertically spaced-apart relationship to each other, a pair of frames, each of said frames slidably carried on said pair of rods whereby said pair of frames are freely movable toward and away from each other, a pair of cylinders, each of said cylinders rotatively carried on one of said pair of frames for rotation about a vertical axis and positioned in said frames so that when said frames are moved toward each other said cylinders will cooperate in rolling contact along a line parallel to the axes of said cylinders, a pair of air cylinders, each of said air cylinders connected between one of said upstanding plates and one of said frames and disposed in a substantially horizontal direction so that when said air cylinders are extended said frames are moved toward each other, means for adjustably delivering compressed air to the head end of each of said air cylinders, each of said air cylinders bieng formed to permit a portion of the air delivered thereto to escape from the rod end of said air cylinder so that when air is delivered to said air cylinders, said air cylinders will move said frames to bias said cylinders together and will permit said frames to integrally move along an axis perpendicular to the axes of said cylinders whereby said cylinders will separate a distance equal to the diameter of any hot rod passing therebetween and will follow any lateral movements of said hot rod to retain contact therewith, and remote indicating means connected to said frames for continuously indicating the distance between said cylinders as said hot rod moves longitudinally therebetween.

7. In a gauging device for hot rod traversing a rolling mill, a base frame member comprising a pair of spaced-apart upstanding plates, a pair of rods horizontally secured between said upstanding plates in a vertically spaced-apart relationship to each other, a pair of frames, each of said frames slidably carried on said pair of rods whereby said pair of frames are freely movable toward and away from each other, a pair of cylinders, each of said cylinders rotatively carried on one of said pair of frames for rotation about a vertical axis and positioned in said frame so that when said frames are moved toward each other said cylinders will cooperate in rolling contact along a line parallel to the axes of said cylinders, a pair of air cylinders, each of said air cylinders connected between one of said upstanding plates and one of said frames and disposed in a substantially horizontal direction so that when said air cylinders are extended said frames are moved toward each other, means for adjustably delivering compressed air to the head end of each of said air cylinders, each of said air cylinders being formed to permit a portion of the air delivered thereto to escape from the rod end thereof so that when air is delivered to said air cylinders said air cylinders will move said frames to bias said cylinders together and will permit said frames to integrally move along an axis perpendicular to the axes of said cylinders whereby said cylinders will separate a distance equal to the diameter of any hot rod passing therebetween and will follow any lateral movements of said hot rod to retain contact therewith, an electrical sensing element having two portions and being formed to change in its electrical characteristics as the two portions are moved relative to each other, means mounting each of said portions of said electrical sensing element on one of said frames in cooperation with each other so that the electrical characteristics of said electrical sensing element are changed as said cylinders are moved toward and away from each other by any hot rod passing therebetween, and remote indicating means connected to said electrical sensing element and operating responsive to the changes in the electrical characteristics of said electrical sensing element for continuously indicating the distance between said cylinders as said hot rod moves longitudinally therebetween.

8. In a gauging device for hot rod traversing a rolling mill, a base member comprising a pair of spaced-apart upstanding plates, a pair of rods horizontally secured between said upstanding plates in a vertically-spaced apart relation to each other, a pair of frames, each of said frames slidably carried on said pair of rods whereby said frames are freely movable toward and away from each other, a pair of cylinders, each of said cylinders rotatively carried on one of said pair of frames for rotation about a vertical axis and positioned in said frame so that when said frames are moved toward each other said cylinders will cooperate in rolling contact along a line parallel to the axes of said cylinders, a pair of air cylinders, each of said air cylinders connected between one of said upstanding plates and one of said frames and disposed in a substantially horizontal direction so that when said air cylinders are extended said frames are moved toward each other, means for adjustably delivering compressed air to the head end of each of said air cylinders, each of said air cylinders being formed to permit a portion of the air delivered thereto to escape from the rod end of said air cylinder so that when air is delivered to said air cylinders said air cylinders will move said frames to bias said cylinders together and will permit said frames to integrally move along an axis perpendicular to the axes of said cylinders whereby said cylinders will separate a distance equal to the diameter of any hot rod passing therebetween and will follow any lateral movements of said hot rod to retain contact therewith, the lower portion of each of said cylinders removed from contact with said rod being formed to have a plurality of vanes disposed about the periphery thereof, air conduit means carried by each of said frames and disposed in alignment with said vanes so that air issuing from said air conduit means will strike said vanes on said cylinders to rotate said cylinders in the same direction at their line of contact that any hot rod moves in passing therebetween, means for adjustably delivering compressed air to said air conduit means for initially rotating said cylinders at substantially the same speed as any hot rod to be passed therebetween, and remote indicating means connected to said frames for continuously indicating the distance between said cylinders as said hot rod moves longitudinally therebetween.

9. In a gauging device as claimed in claim 8 wherein water hose means are provided carried by each of said frames above said air hose means and in alignment with the portions of said cylinders in rolling contact with said hot rod for directing cooling water onto said cylinders as said cylinders are rotated, and means for delivering water to said water hose means.

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