June 27, 1939. A. M. JOHNSON 2,163,604

HONING MACHINE

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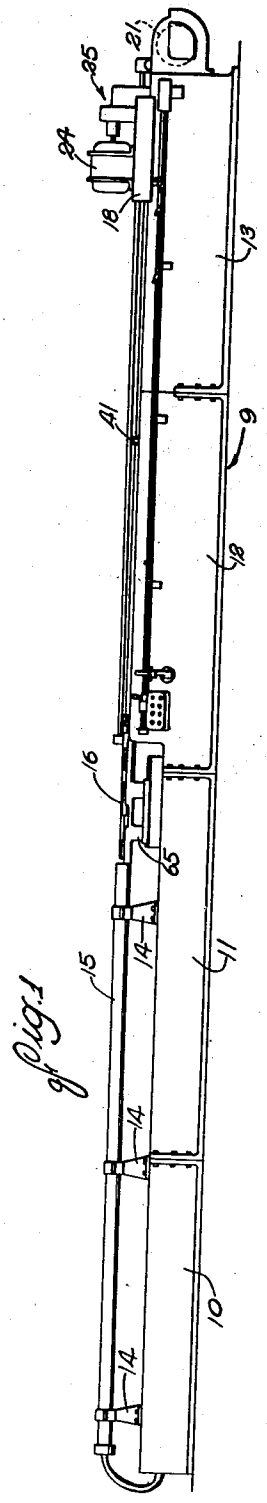


Fig. 1

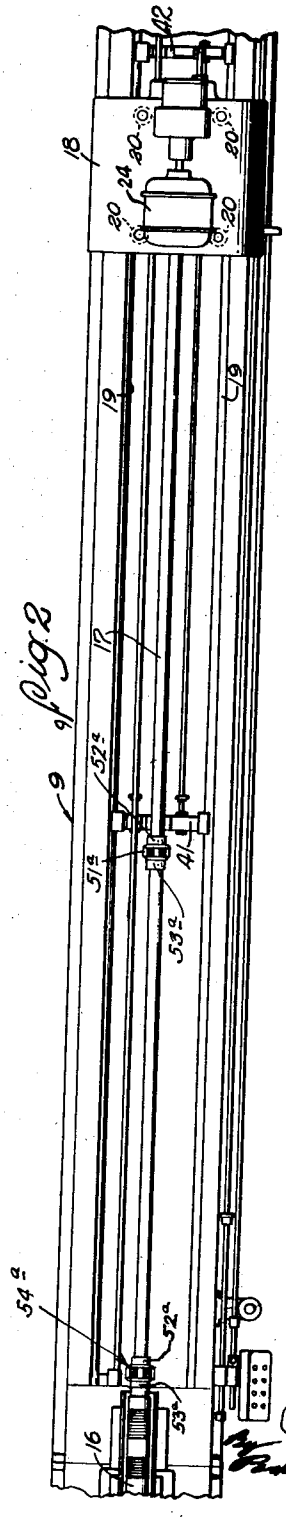


Fig. 2

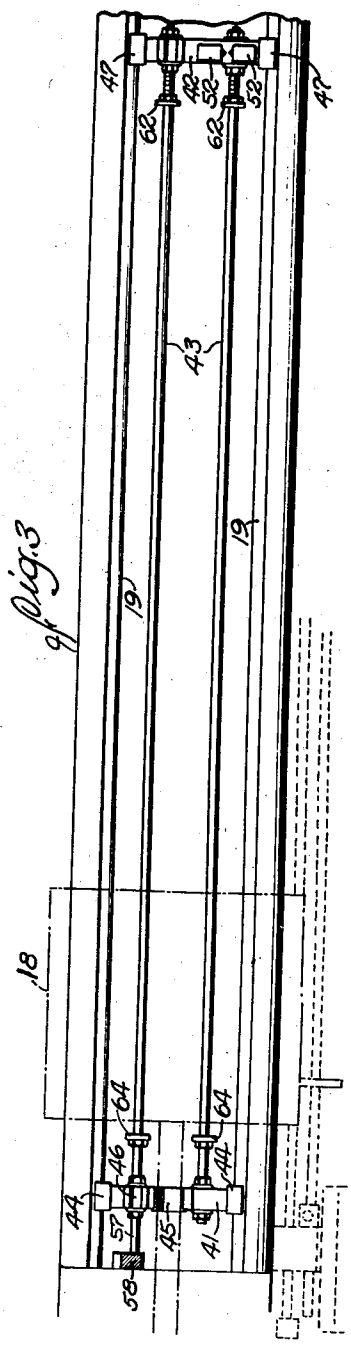


Fig. 3

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Fig. 4

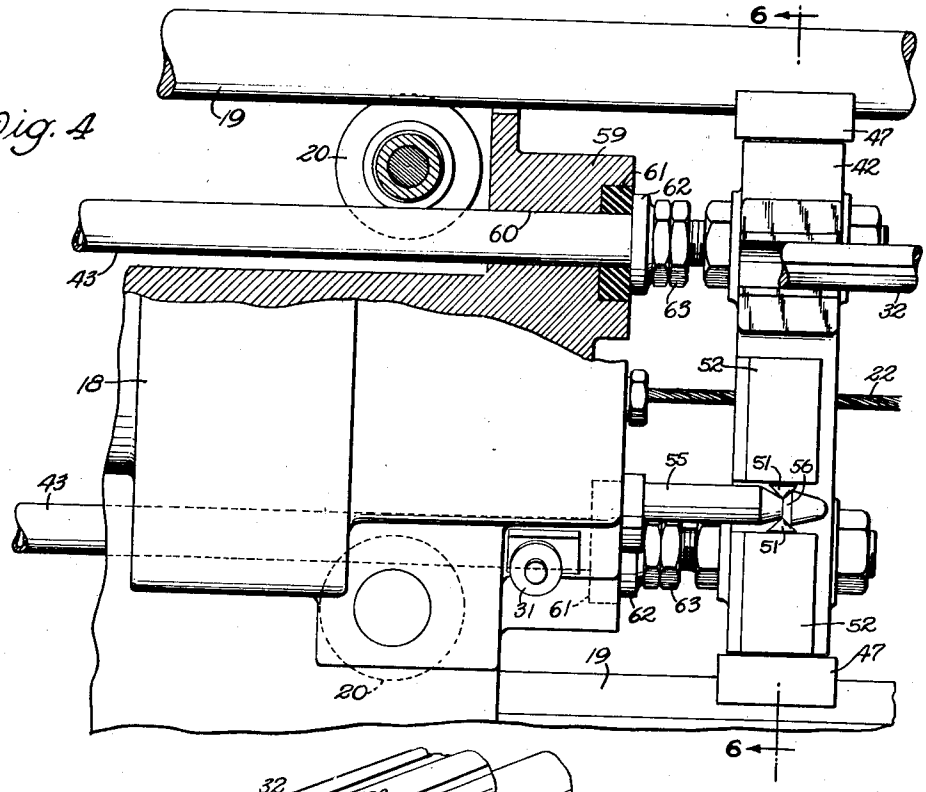
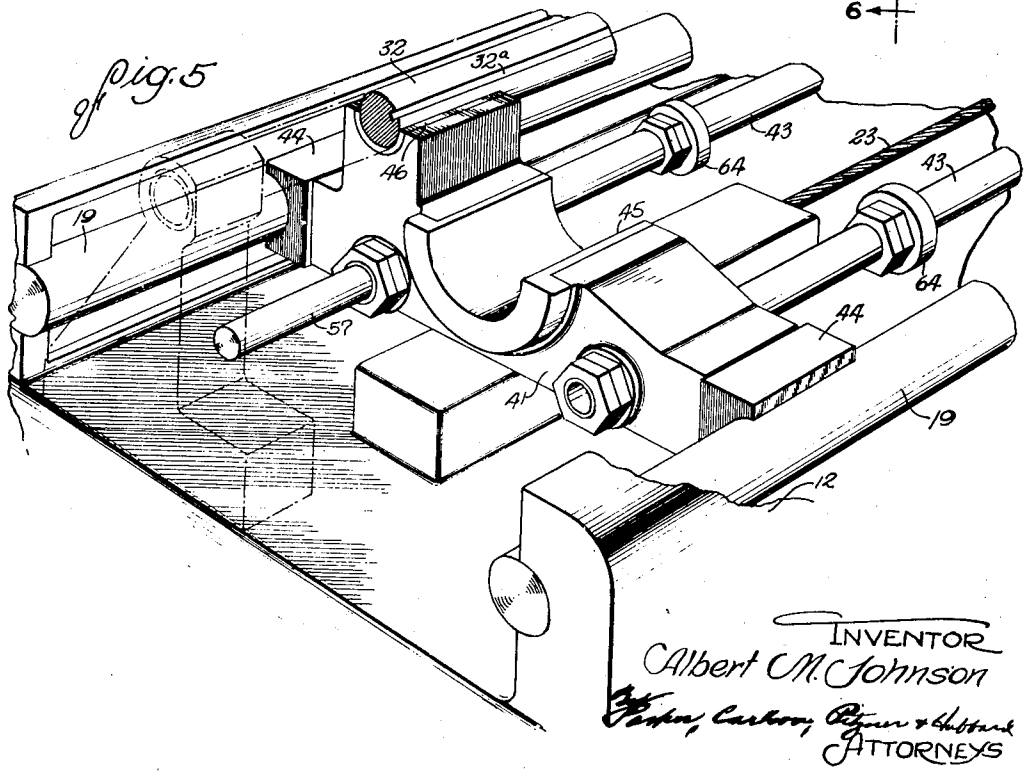


Fig. 5



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HONING MACHINE

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Fig. 6

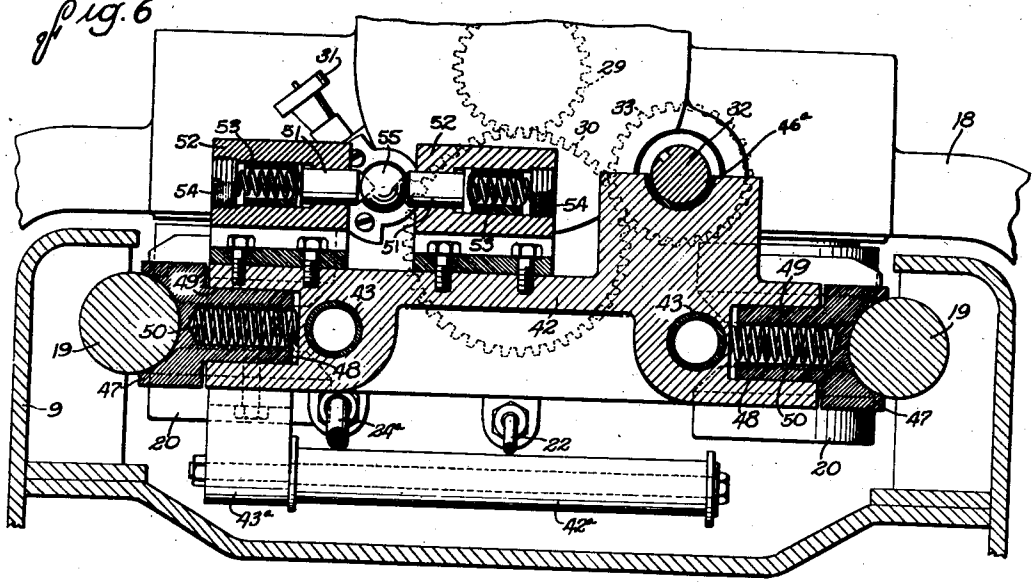


Fig. 7

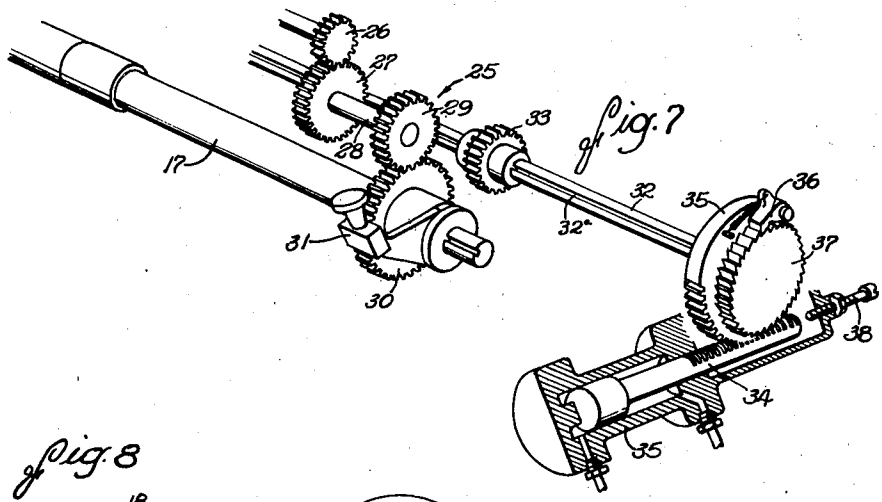
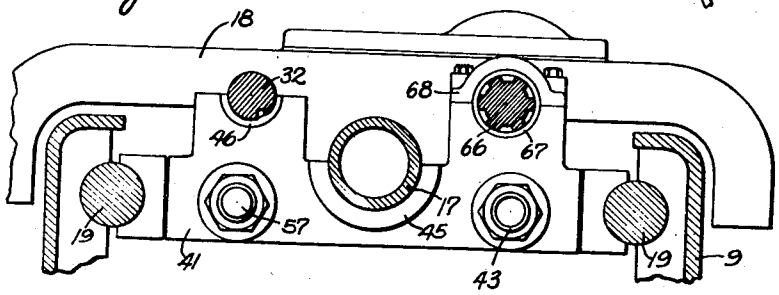


Fig. 8



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UNITED STATES PATENT OFFICE

2,163,604

HONING MACHINE

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Application April 21, 1937, Serial No. 138,127

14 Claims. (Cl. 51—34)

The invention relates to machines for dressing cylindrical surfaces by the honing or lapping process and it has particular reference to an improved honing and lapping machine of the horizontal type.

The primary object of the invention is to provide an improved honing machine of the above general character capable of dressing relatively long work pieces with a high degree of precision.

Another object is to provide novel means for supporting the tool spindle of a horizontal honing and lapping machine so as to effectually eliminate spindle vibration or "whip", thereby enabling the machine to produce an extremely true and accurate contour and a smooth finish on long work pieces.

Still another object is to provide a novel supporting structure in the nature of a traveling steady rest adapted to support a relatively long, horizontally disposed tool spindle or other elongated member intermediate its ends, without interfering with the reciprocation of the spindle through its full strike.

Other objects and advantages of the invention will become apparent from the following detailed description of the preferred embodiment illustrated in the accompanying drawings in which:

Fig. 1 is a side elevational view of a honing and lapping machine embodying the features of the invention.

Fig. 2 is a fragmentary plan view of the machine showing the tool spindle and spindle head in a retracted position.

Fig. 3 is a fragmentary plan view of the machine showing the traveling steady rest in its advanced position.

Fig. 4 is a view partly in section showing details of the spindle head and the traveling steady rest.

Fig. 5 is a fragmentary perspective view showing details of the traveling steady rest.

Fig. 6 is a transverse sectional view taken along the lines 6—6 of Fig. 4.

Fig. 7 is a schematic view of the spindle driving mechanism.

Fig. 8 is an end view of the spindle head embodying a modified form of spindle driving mechanism.

For purposes of disclosure, the invention is illustrated in drawings and will hereinafter be described in detail as embodied in a machine for honing long cylinders, but it is to be understood that it is not limited to use in such machines and that various changes and modifications in the form, construction and arrangements of the parts may be made by those skilled in the art without departing from the spirit and scope of the invention as defined by the appended claims.

The machine selected to illustrate the invention is of the same general type as that disclosed in my copending application, Serial No. 3,714, filed January 28, 1935, now Patent No. 2,106,216, granted January 25, 1938, and comprises an elongated base or frame 9 which, because of its relatively great length, may be conveniently formed of a plurality of sections 10, 11, 12 and 13, bolted or otherwise secured together in end to end relation as shown in Fig. 1. The sections 10 and 11 carry suitable fixtures 14 for supporting a work piece, such as a long cylinder 15, in position to be operated on by the machine. In the honing operation a cylindrical abrasive tool or hone 16 is reciprocated and simultaneously rotated or indexed in engagement with the surface to be dressed. The tool 16 is accordingly carried on one end of an elongated spindle 17, the other end of the spindle being journaled on a carriage or head 18 supported on the frame sections 12 and 13 for reciprocation toward a form of work.

As herein shown, the means for supporting the head 18 for reciprocation comprises a guideway and bearing structure of the type disclosed in my copending application, Serial No. 3,714, filed January 28, 1935 now Patent No. 2,106,216, granted January 25, 1938. The guideway is formed by a pair of guide bars 19, preferably of cylindrical cross section, rigidly mounted in parallel spaced relation on the side walls of the frame sections 12 and 13. A set of generally spool-shaped roller members 20 rotatably supported on the under side of the head are arranged to engage the respective guide bars to hold the head rigidly against movement transversely of the guideway while offering a minimum of frictional resistance to its reciprocation.

Any suitable means may be employed for reciprocating the head 18 on the guideway. A preferred form of reciprocating means, such as that disclosed in my copending application above mentioned, has been shown by way of illustration. This means comprises a rotatable cable drum 21 mounted at one end of the frame 9 and operatively connected with the head by means of cables 22 and 23 (Figs. 4 and 5). The cables are arranged on the drum so that when the drum is rotated in one direction, the head is advanced toward the work and, when rotated in the other direction, the head is retracted from the work. Suitable control means is utilized for

controlling the reciprocation of the head, but as this means forms no part of the present invention, it is believed unnecessary to describe the same in detail.

As shown in Figs. 1, 2, 6, and 7, the means for rotating the spindle comprises a motor 24 mounted on the head 18. Current is supplied to the motor through a cable 24a preferably arranged to be wound up on and paid out from the drum 21 as the head is reciprocated. The motor is adapted to be drivingly connected with the spindle through the medium of a suitable gear train 25. As will be seen by reference to Fig. 7, a gear 26 on the shaft of the motor is arranged to drive an intermediate gear 27 fast on a shaft 28. Another gear 29 fast on the shaft 28 is arranged to mesh with a gear 30 splined to the spindle 17. Thus by shifting the gear 30 longitudinally of the spindle, the driving connection with the motor may be engaged or disengaged at will. A hand lever 31 is provided for shifting the gear 30.

For indexing the spindle, that is, for rotating it in intermittent steps, I provide an indexing shaft 32 extending longitudinally of the guideway and journaled in suitable bearings at opposite ends thereof. The shaft is formed with a keyway 32a to provide a slidable driving connection with a gear 33 journaled on the head. The gear 33 is so positioned relative to the gear 30 on the spindle that the latter may be shifted into or out of driving engagement by means of the hand lever 31. Thus, through the medium of the gear shifting mechanism, the spindle may be selectively connected either with the motor 24 or with the indexing shaft 32 for continuous or intermittent rotation.

In the embodiment of the invention herein disclosed, the means for actuating the indexing shaft 32 comprises a piston 34 operating in a cylinder 35. Pressure fluid from any suitable source is introduced into opposite ends of the cylinder alternately to reciprocate the piston. The projecting end of the piston 34 is formed with rack teeth adapted to mesh with a suitable gear 35 loosely mounted on the shaft 32. The gear 35 carries a spring pressed pawl 36 adapted to engage the teeth of a ratchet wheel 37 fast on the end of the shaft 32. When the gear 35 is rotated in a counter-clockwise direction as viewed in Fig. 7, the pawl imparts a rotative step to the ratchet wheel and shaft 32. Rotation of the gear in a clockwise direction is ineffective to rotate the shaft, as the pawl slides over the teeth of the ratchet wheel in the usual and well known manner. The length of the step imparted to the indexing shaft 32 is regulated by varying the stroke of the piston 34. For this purpose, an adjustable stop 38 in the form of a screw is positioned to engage the end of the piston.

In order to enable the tool to be traversed through the entire length of the work, the tool spindle 17 must be of slightly greater length than the work. Thus, when relatively long cylinders are to be operated on, a correspondingly long spindle is required. Such a spindle, when supported only at the ends, will naturally bend or sag between the supporting points. This is objectionable since even relatively small deflections will cause the spindle to vibrate or "whip" when it is rotated and reciprocated at the speeds required for the honing operation. This vibration, reflected in the tool, affects the accurate functioning of the tool to such an extent that precision honing of long cylinders has heretofore been considered impractical.

The present invention overcomes the above difficulty and renders it practicable to hone cylinders of any reasonable length with the utmost precision by providing novel means for supporting the spindle at one or more intermediate points. In its preferred form, the supporting means includes a traveling steady rest arranged to reciprocate with the spindle head through predetermined portions of its forward and return strokes for supporting the spindle externally of the work and a suitable collar or collars carried on the spindle for supporting the portions entering the work.

Referring more particularly in Fig. 3 of the drawings, the steady rest in its preferred form comprises a front member 41 and a rear member 42 disposed respectively at opposite ends of the head 18 and rigidly connected as a unit by means of a pair of rods 43. The length of the connecting rods is determined by the maximum working stroke of the head 18 and, in the embodiment herein disclosed, is substantially one-half of the length of such stroke.

Referring now to Fig. 5, the front member 41 is in the form of a rigid bar extending transversely across the guideway and provided at opposite ends with suitable bearings supporting it for movement relative to the frame. In the particular form shown, the bearings comprise semi-cylindrical bearing elements 44 engaging the guide bars 19 to support the member for reciprocation on the guideway. The bearing elements may be spring-pressed outwardly into engagement with the guide bars as shown in Fig. 6, to hold the member securely in place on the guideway. Located substantially centrally of the member 41 is a bearing element 45 adapted to support the weight of the spindle 17 and arranged to permit relatively rotative and longitudinal movements between the spindle and the member. A second bearing element 46 located at one side of the bearing 45 is adapted to provide an intermediate support for the indexing shaft 32.

The rear support member 42, likewise, comprises a rectangular bar extending transversely across the guideway and is supported on the guide bars 19 by semi-cylindrical bearing elements 47. These bearing elements are formed with a rearwardly extending projection slidably supported in horizontally disposed sockets 49 formed in the ends of the member. Each of the projections 49 is bored out to receive a coiled compression spring 50 which acts to force the bearing element tightly against the cooperating guide bar 19 and thus hold the steady rest firmly on the guideway. The member 42 carries a single bearing element 46a for supporting the indexing shaft 32. As shown in Fig. 6, means is provided on the member 42 for supporting the cables 22 and 24a when the spindle head is in advanced position. The supporting means comprises, in the present instance, a horizontally disposed roller 42a mounted on a bracket 43a depending from the underside of the member.

Means is provided for automatically reciprocating the steady rest with the head 18 through a predetermined portion of each stroke to enable the member 41 to support the spindle adjacent its midpoint until it reaches the forward end of the guideway. In its further advance, the spindle is supported first by the tool guide or cradle and then by the work itself as the spindle enters the bore. For this purpose, a collar 51a is loosely mounted on the spindle and held against movement longitudinally thereof by spaced

sleeves 52a and 53a which are pinned or otherwise rigidly secured to the spindle.

The collar 51a is preferably of slightly smaller diameter than the bore of the work piece and tapered at opposite ends to facilitate its entry into the same. This collar rests on the tool guide as it approaches the work and engages the walls of the bore on entering the work, thus supporting the spindle to prevent sagging and the resultant "whip." It will be understood that different collars will be used for different sized bores, thus alining the spindle exactly in the center of the bore. Similar collars may be provided at other points when required, a collar 54a being shown at the tool end of the spindle in the present instance.

As herein shown, the means for moving the steady rest in a forward direction comprises a latch mechanism on the member 42 for detachably connecting the member with the head whereby the member and its associated elements are drawn forwardly by the head as it advances toward the work.

While any suitable latch mechanism may be employed for connecting the head with the steady rest, the preferred form of the mechanism shown in Figs. 4 and 6 of the drawings comprises a pair of plungers 51 slidably mounted in opposed relation in brackets 52 bolted or otherwise rigidly secured to the upper face of the member 42. Each plunger is urged outwardly by means of a compression spring 53 disposed within the hollow rear end of the plunger and bearing against an adjusting screw 54 threaded into the bracket.

The plungers 51 are adapted to cooperate with a latch element in the form of a rigid pin 55 projecting rearwardly from the head 18. For this purpose, the plungers are formed with beveled or pointed ends adapted to engage in a generally V-shaped circumferential groove 56 formed in the pin 55. The pin tapers gradually to a relatively blunt, rounded point to facilitate its entry between the plungers and serves to cam them apart as the head approaches the member 42. The plungers then enter the groove 56 under the action of the springs and thus serve to grip the pin. This gripping action may be readily adjusted by means of the screws 54 so that the member 42 and other elements of the steady rest are drawn forwardly by the head as it advances toward the work.

The steady rest thus follows the head in its forward stroke and the member 41 supports the spindle at its midpoint until the member reaches the end of the guideway. At this point, a pin 57 (Figs. 3 and 5) projecting forwardly from the member 41 engages a stationary stop 58 on the frame and interrupts the forward movement of the steady rest. As the head continues its advance, the sloping rear face of the groove 56 cams the plungers 51 outwardly to disengage the member 42 from the head. The steady rest remains in advanced positions while the head 18 completes its forward stroke and during the initial portion of its return stroke. During this time, the member 42 is positioned substantially in the center of the guideway. As the head approaches the member, the latch is re-engaged, that is, the pin 55 enters between the plungers 51 as above described, thereby conditioning the latch mechanism for operation in the succeeding stroke.

Through the remainder of its return stroke, the head 18 pushes the steady rest along with it. To this end, the head is provided with a pair of downwardly projecting arms 59 having openings 60 therein for slidably receiving the connecting rods 43 of the steady rest. A bushing 61, preferably of resilient material, set in the rear face of each arm is adapted to engage a stop element in the form of a collar 62 rigidly secured to the associated connecting rod 43. The collars 62 are preferably screw-threaded on the rod so that they can be adjusted as required to effect engagement with the member 61 at the instant the plungers 51 enter the groove 56. Thus when the direction of the movement of the head is reversed, the steady rest is enabled to follow without objectionable lost motion. Lock nuts 63 serve to hold the stop elements in adjusted position.

At times, particularly when a work piece is being set up in the machine, it may be necessary to advance the head toward the work while the latch mechanism is disengaged. In order to enable the head to move the steady rest to its advanced position under these conditions, stop elements 64 are provided on the connecting rods 43 adjacent the front support member 41. These stop elements may be similar in all respects to the elements 62 and are adapted to be engaged by resilient members, similar to the members 61, on the head. In this case, the steady rest moves with the head through the latter portion of its forward stroke instead of through the initial portion of its stroke as is normally the case.

When the machine is at rest with the tool retracted from the work, the tool 16 and outer end of the spindle 17 are supported on a tool rest 65 mounted on the frame adjacent the end of the work piece. The carriage 18 and steady rest stand at the rear end of the guideway. With the steady rest in this position, the front member 41 is disposed approximately at the midpoint of the spindle and supports the weight of the spindle, thereby preventing it from sagging or bending. Thus, although the machine may be idle for an extended period, no objectionable strains are placed on the spindle.

Upon starting the machine, the head 18 advances to carry the tool into the work and, through the medium of the latch mechanism, draws the steady rest along with it. The steady rest moves forwardly with the head through the initial portion of its stroke until the pin 57 engages the stationary stop 58. This stops the forward movement of the steady rest and disengages the latch mechanism so that the spindle supporting member 41 remains standing adjacent the forward end of the guideway while the head continues its stroke and advances the tool to the distant end of the work.

The steady rest remains stationary during the initial portion of the return stroke of the head and until the resilient member or bumper 61 engages the stop elements 62 on the connecting rods of the steady rest. The head, acting through the stop elements, pushes the steady rest back to the rear end of the guideway. At the same time the latch mechanism is engaged to operatively connect the steady rest for movement with the head in its next forward stroke.

While the steady rest above described is designed particularly for use in a machine in which the tool is rotated and reciprocated relative to a stationarily supported work piece, it will be evident that it may also be used to advantage in machines in which a work piece, such as a long shaft, is rotated and reciprocated relative to a stationary tool. Under such conditions, the steady rest will support the work piece at an in-

termediate point and effectively prevent sagging or bending of the same.

Fig. 8 shows a modified arrangement of the head 18 designed to reduce the weight of the reciprocating parts of the machine. In this instance, the motor for rotating the tool spindle 17 is mounted on the frame of the machine and arranged to drive the spindle through the medium of a shaft 66 extending longitudinally of the runway and having a splined driving connection with the gear 29 on the head. Gear shifting mechanism such as that shown in Fig. 7 may be provided for connecting the spindle with the drive shaft 66 or indexing shaft 32, selectively.

When the modified head construction is employed, the front member 41 of the steady rest is provided with an additional bearing element 67 for supporting the shaft 66 at an intermediate point. As shown in Fig. 8, the element 67 is of cylindrical form and is arranged to be secured in place of the member by a suitable cap 68 bolted to the member.

It will be apparent from the foregoing that the invention provides a honing machine of novel and advantageous construction which is particularly adapted for dressing long work pieces with a high degree of precision. The long spindle required for traversing the tool through the entire length of the work is effectively supported at an intermediate point to prevent the spindle from bending thereby materially reducing spindle vibration or "whip". Support for the spindle is provided by a traveling steady rest of novel construction which is adapted to be reciprocated automatically through predetermined portions of the forward and return strokes of the spindle head to enable it to perform its intended function with maximum efficiency.

I claim as my invention:

1. In a honing machine, in combination, an elongated frame, a longitudinally extending guideway on the frame, a head reciprocable on said guideway, an elongated tool supporting spindle journaled at one end in said head and reciprocable therewith, and a traveling steady rest for supporting the spindle at an intermediate point comprising front and rear members disposed on opposite sides of said head and mounted for reciprocation on said guideway, means rigidly connecting said members together, a bearing element on said front member for receiving the spindle, and latch means on said rear member for detachably connecting the member with said head to cause the steady rest to move with the head through a portion of its stroke.

2. In a honing machine, in combination, an elongated frame, a longitudinally extending guideway on the frame, a head reciprocable on said guideway, an elongated rotary tool supporting spindle projecting from said head and reciprocable therewith, and means for supporting said spindle externally of said head comprising a pair of members disposed on opposite sides of the head and supported for reciprocation on said guideway, a pair of spaced rods rigidly connecting said members together, said head having openings providing passages for said rods, a bearing element on one of said members for supporting said spindle, latch means on the other member for detachably connecting the member with the head to cause the supporting means to move with the head through a portion of its forward movement, and rigid elements on said rods engageable by cooperating elements on the head to cause the supporting means to move with the head in its rearward movement.

3. In a honing machine, in combination, an elongated frame, a longitudinally extending guideway on the frame, a head reciprocable on said guideway, an elongated rotary tool supporting spindle projecting from said head and reciprocable therewith, and means for supporting said spindle externally of said head comprising a pair of members disposed on opposite sides of the head and supported for reciprocation on said guideway, a pair of spaced rods rigidly connecting said members together, said head having openings providing passages for said rods, a bearing element on one of said members for supporting said spindle, latch means on the other member for detachably connecting the member with the head to cause the supporting means to move with the head through a portion of its forward stroke, and a stop on said frame cooperating with stop engaging means on one of said members for disengaging said latch means and for interrupting the movement of said supporting means before the head reaches the end of its forward stroke.

4. In a honing machine, in combination, an elongated frame, a longitudinally extending guideway on the frame, a head reciprocable on said guideway, an elongated rotary tool supporting spindle projecting from said head and reciprocable therewith, and means for supporting said spindle externally of said head comprising a pair of members disposed on opposite sides of the head and supported for reciprocation on said guideway, a pair of spaced rods rigidly connecting said members together, said head having openings providing passages for said rods, a bearing element on one of said members for supporting said spindle, latch means on the other member for detachably connecting the member with the head to cause the supporting means to move with the head through a portion of its forward stroke, said latch means including a pin projecting from said head into the path of one of said members, a circumferential groove formed on said pin, and a pair of oppositely disposed spring pressed plungers on said one member for yieldably engaging in said groove.

5. In a honing machine, in combination, a reciprocating head, an elongated spindle journaled at one end in said head, a tool carried on the other end of said spindle for operating on the internal surface of an elongated cylindrical work piece, means for rotating said spindle, means for reciprocating said head and said spindle to advance the tool into the work piece and to withdraw the same therefrom, and an auxiliary support for said spindle comprising a spindle supporting member adapted to be positioned substantially midway between the ends of the spindle when the tool is withdrawn from the work piece, and means for causing said member to move with said spindle while the tool is advanced part way into the work piece and to dwell while the tool is advanced the rest of the way into the work piece.

6. In a machine tool of the class described, in combination, an elongated frame, a guideway extending longitudinally of said frame, a head mounted for reciprocation on said guideway and adapted to support an elongated member, means for supporting said member externally of said head comprising a steady rest mounted on said guideway, means for reciprocating said steady rest with said head through a predetermined portion of its stroke, and means for interrupting the

reciprocation of said steady rest while the head executes the remaining portion of its stroke.

7. In a machine tool, in combination, a reciprocating head, an elongated rotatable tool supporting spindle journaled at one end in said head and reciprocable therewith, a member for supporting said spindle at an intermediate point, means for operatively connecting said member with said head to move the member with the head in its reciprocation, and means for disconnecting said member before the head reaches the end of its reciprocatory stroke.

8. In a machine tool, in combination, a reciprocating head, an elongated rotatable member supported at one end on said head and reciprocable therewith, a steady rest for supporting said member at an intermediate point, latch means connecting said steady rest for movement with the head through a portion of its stroke in one direction, means for disengaging said latch means and for holding the steady rest stationary while the head completes its stroke in said one direction, and means operative in response to the movement of the head in the other direction for reengaging said latch means to condition the steady rest for movement with the head in its succeeding stroke in said one direction.

9. In a machine for dressing long cylindrical work pieces, in combination, a frame, means at one end of the frame for supporting the work, a head supported on the other end of the machine for movement toward and from the work, a spindle journaled at one end on said head and carrying at its other end a tool for operating on the work, said spindle being of sufficient length to permit the tool to be traversed from one end of the work to the other, and means for supporting the spindle at a point intermediate its ends, said means comprising a supporting member on which the spindle is adapted to rest, means for moving said member forwardly with the spindle while the tool is advanced part way into the work, means for holding said member stationary while the tool is advanced the rest of the way into the work and while the tool is withdrawn part way from the work, and means for moving said member with the spindle while the tool is withdrawn the rest of the way from the work.

10. In a machine tool, in combination, an elongated frame, a head supported for reciprocation longitudinally of the frame, an elongated rotary tool supporting spindle projecting from said head and reciprocable therewith, and means for supporting said spindle externally of said head comprising a pair of members disposed on opposite sides of the head and supported for reciprocation on the frame, means rigidly connecting said members together as a unit, a bearing element on one of said members for supporting the spindle, latch means on the other member engageable with a cooperating latch element on said head whereby the supporting means is pulled along by the head through a portion of its forward stroke, and relatively rigid stop elements spaced from said other member and engageable by said head whereby the supporting means is pushed along by the head through a portion of its return stroke.

11. In a machine tool, in combination, a frame, a reciprocating head, a guideway for said head comprising a pair of guide bars rigidly supported on the frame in parallel spaced relation, an elongated tool supporting spindle journaled at one end in said head, and a traveling steady rest for the spindle, said steady rest including a spindle supporting member disposed between the bars of said guideway having a pair of bearing elements spring pressed outwardly into engagement with the respective bars to slidably support the member thereon, and a bearing element on said member for supporting said spindle.

12. In a machine tool, in combination, an elongated frame, a reciprocating head, a guideway for said head comprising a pair of guide bars extending longitudinally of the frame and rigidly supported thereon in parallel spaced relation, an elongated tool spindle journaled at one end in said head and reciprocable therewith, means for rotating said spindle including a shaft journaled on said frame and extending parallel to said guideway, means carried by said head for drivingly connecting the shaft and the spindle, an intermediate support for said spindle and said shaft comprising a member movably supported on said guideway, said member having one bearing element for supporting the spindle and a second bearing element for supporting the shaft, means for causing said support to move with said head during a predetermined portion of its stroke, and means for interrupting the movement of the support while the head executes the remaining portion of its stroke.

13. In a honing machine, in combination, an elongated frame, a head mounted for reciprocation longitudinally of the frame, a tool supporting spindle journaled on said head, a motor mounted on said head and reciprocable therewith, a shaft journaled on and extending longitudinally of the frame, power actuated means for rotating said shaft in intermittent steps, and means on said head selectively operable to connect either said motor or said shaft in driving relation to said spindle.

14. In a machine tool, in combination, a head adapted to be reciprocated through forward and return strokes of predetermined length, an elongated tool supporting spindle projecting from said head and reciprocable therewith, means for supporting said spindle at an intermediate point, and mechanism interposed between said head and said supporting means operative to reciprocate said supporting means through forward and return strokes substantially shorter than the forward and return strokes of said head.

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