July 13, 1948. W. F. MITCHELL 2,445,277

HONE

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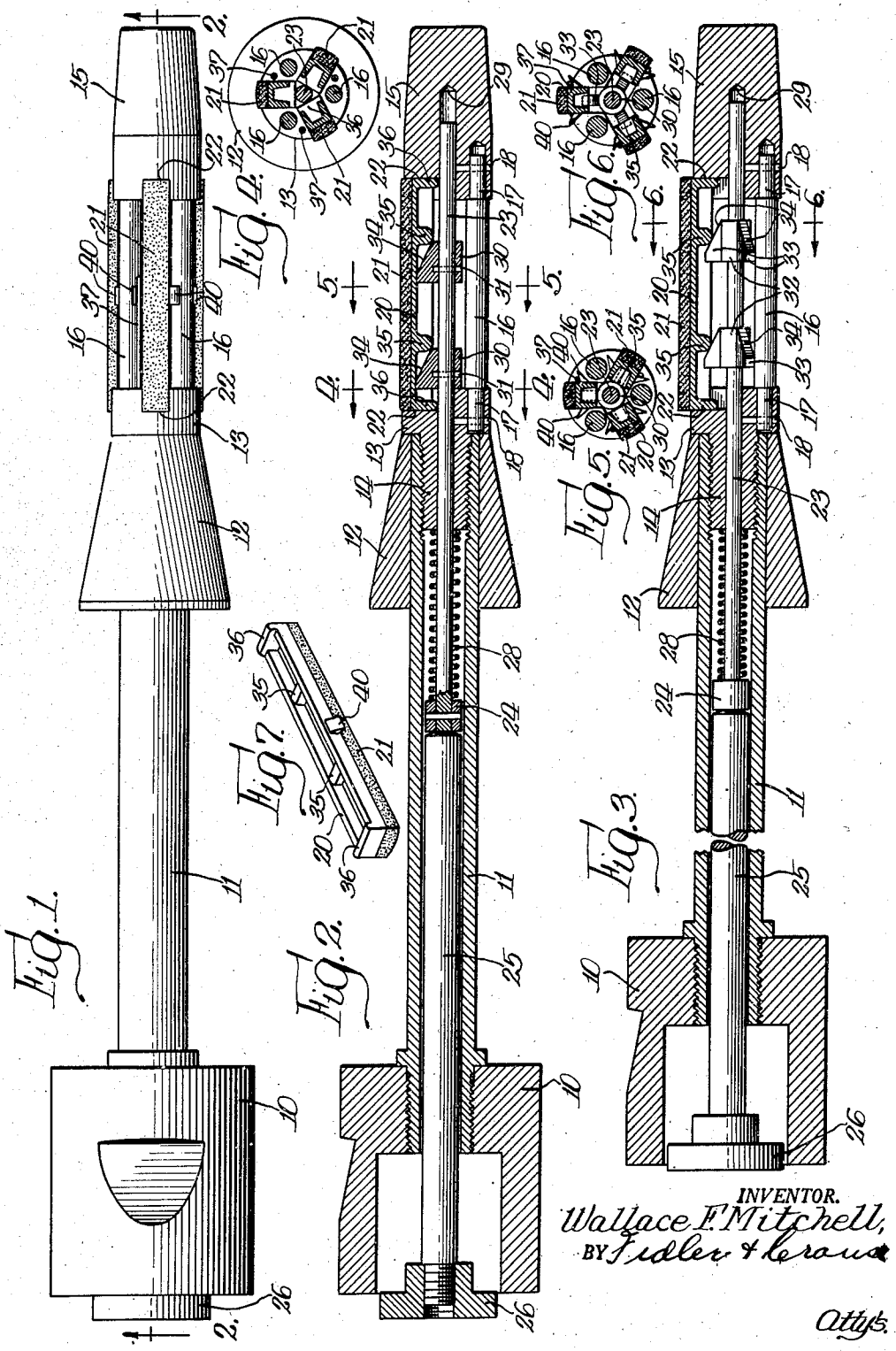


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

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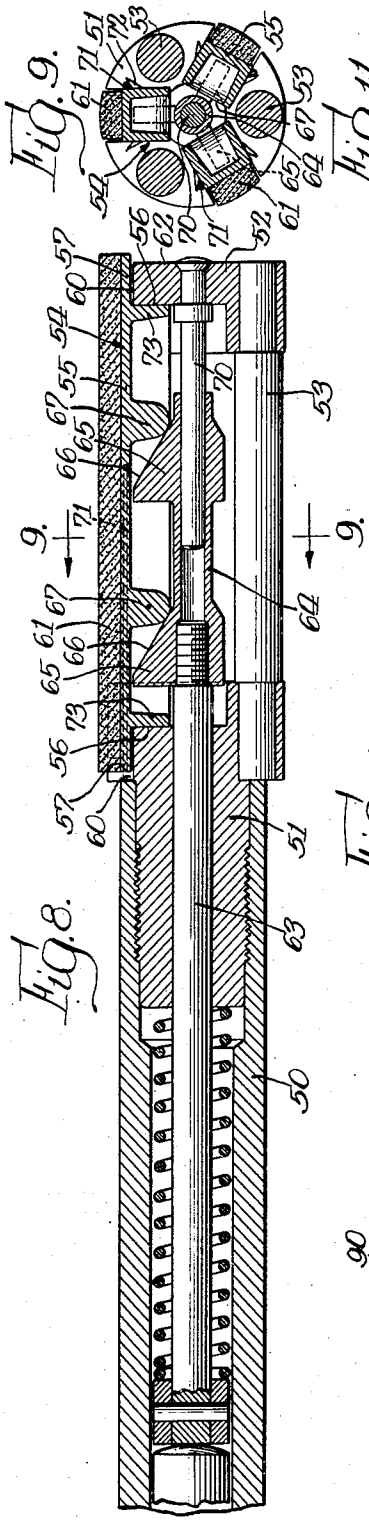


Fig. 8.

Fig. 9.

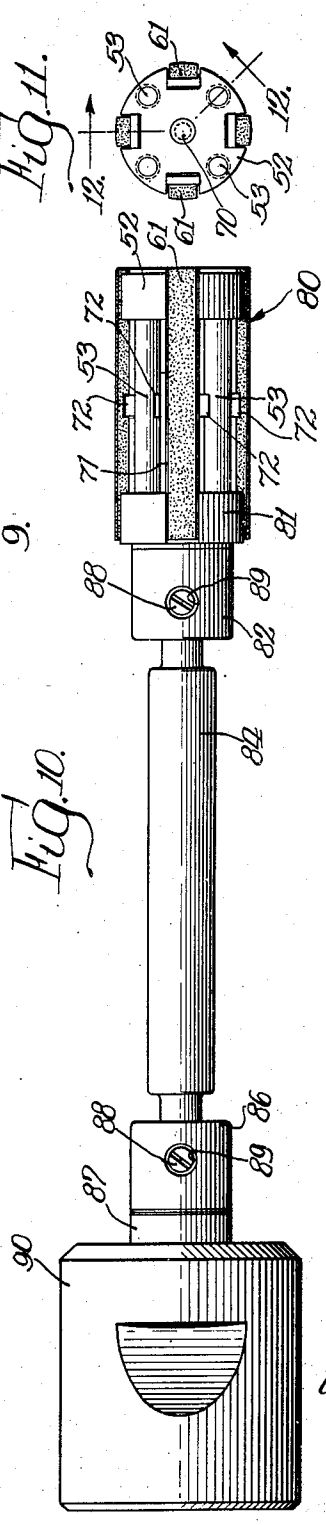


Fig. 10.

Fig. 11.

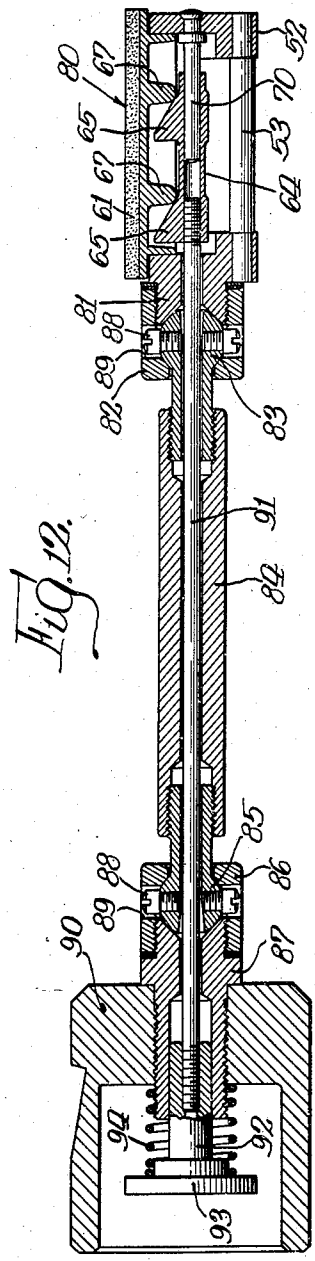


Fig. 12.

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UNITED STATES PATENT OFFICE

2,445,277

HONE

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Application September 8, 1945, Serial No. 615,165

18 Claims. (Cl. 51—184.3)

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The invention relates generally to hones and more particularly to a hone for finishing internal cylindrical surfaces.

The general object of the invention is to provide a novel hone of the foregoing type, adapted particularly for use in honing relatively small bores.

It is also an object to provide a novel hone embodying abrading stones that may be readily reversed, in case of a tendency toward more wear at one end than the other, so that each stone may be worn down evenly, and more uniform work is thereby attained.

Another object is to provide, in a hone, a novel stone carrier of rigid construction but permitting the stones to lie close to the center or axis of the hone so that the hone may be used for relatively small bores.

A further object is to provide a hone having novel expanding means arranged to cooperate with stone carriers which are reversible and which are of a construction permitting them to lie close to the center of the hone for use in relatively small bores.

Still another object is to provide a novel hone particularly suited for honing closed-end bores of relatively small diameter.

A still further object is to provide a novel hone for honing closed-end bores having stones which may be readily reversed to compensate for the tendency of the hone to wear more at its forward or bottom end and thus produce a tapered bore.

Other objects and advantages will become apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a side elevational view of a hone embodying the features of the invention.

Fig. 2 is a longitudinal sectional view taken on the line 2—2 of Fig. 1 and showing the honing stones in their contracted position.

Fig. 3 is a sectional view similar to Fig. 2 but showing the stones in an expanded position.

Fig. 4 is a transverse sectional view taken on the line 4—4 of Fig. 2.

Fig. 5 is a transverse sectional view taken on the line 5—5 of Fig. 2.

Fig. 6 is a transverse sectional view taken on the line 6—6 of Fig. 3.

Fig. 7 is a perspective view of one of the stone carriers utilized in my hone.

Fig. 8 is a fragmentary longitudinal sectional view of a modified form of hone.

Fig. 9 is a transverse sectional view on the line 9—9 of Fig. 8.

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Fig. 10 is a side elevational view of another modified form of hone.

Fig. 11 is an end view of the right-hand end of the hone shown in Fig. 10.

Fig. 12 is a longitudinal sectional view of the hone shown in Fig. 10.

A hone embodying the features of the invention is of the type comprising a plurality of radially arranged longitudinally extending abrasive stones adapted to be expanded radially for effecting honing of the work. The present construction is particularly adapted for honing relatively small bores in work pieces, and the hone is so constructed that the stone carriers may lie relatively close to the center of the hone and at the same time are of sufficiently rigid construction to attain accuracy in the work. In bores of some types, the stones of the hone have a tendency to wear to a greater extent on the front or bottom end since such end of the stones is in contact with the work piece throughout the honing operation and bears the brunt of the work. Because of the greater wear on this end of the stones, there is a tendency to produce a tapered bore. To avoid the difficulties occasioned by such wear and provide for honing a straight bore, the stone carriers are constructed in such a manner that they may be reversed in their position in the hone, that is, turned end-for-end. The stones thus may be worn down evenly without necessitating an excessive amount of dressing of the stones in order to attain a truly cylindrical bore.

Reversability of the stones in a hone is of greatest advantage in a hone constructed for honing closed-end bores. Thus, in honing a bore of this character, the front or bottom end of stones is the first portion of the stones to enter the work and the last portion to be withdrawn during relative reciprocation of the hone and work. For this reason, the front end of the stones tends to undergo the greatest wear which may be compensated for, without unnecessary dressing of the stones, by reversal of the stones. The hone for performing work of this character is, of course, constructed so that the stones extend to the extreme front or bottom end of the hone to engage the work for the full depth of the bore.

I have also provided a hone embodying the features of the invention in a form suitable for use on production jobs where a fixture is provided for holding the work during honing. In this form the shank of the hone is provided with a universal connection to permit the hone to operate properly in case there is a slight misalignment between

the position of the work in the fixture and the honing machine.

As shown in Figs. 1 to 7 of the drawings, one embodiment of my invention comprises a hone having an adapter 10 of usual construction to secure the hone to the rotatably driven spindle of a honing machine. Extending forwardly from the adapter 10 is a drive shank 11 of tubular form and carrying on its front end a centering cone 12. The hone has a body structure which, in the present instance, comprises a top end plate 13 having a threaded shank portion 14 screwed into the forward end of the drive shank 11. The body structure also includes a bottom end plate 15 of generally cylindrical form but having a slightly tapered forward end. The end plates 13 and 15 are rigidly secured together in spaced relation by means providing radial passages for the stone carrier. In the present construction, said means comprises a plurality of longitudinally extending spacer bars 16, three in the present instance, having reduced end portions 17 secured in holes provided in the end plates 13 and 15 (as by radially extending pins 18).

In the spaces between the spacer bars 16 are mounted stone carriers 20 each comprising an elongated longitudinally extending channel. On the outer face of the web portion of each channel is cemented an abrasive stone 21 having a slightly curved outer surface adapted to contact and abrade the internal cylindrical surface of the work piece. Each stone carrier 20 is positioned substantially upon a radius of the hone and the ends thereof are guided for radial movement in grooves 22 cut in the opposed end faces of the end plates 13 and 15.

Outward movement of the stone carriers 20 is effected by cam means carried centrally of the hone and longitudinally movable therein. In the present instance, the cam means comprises a cam bar 23 slidably supported in axial bores in the two end plates 13, 15 and extending rearwardly from the top end plate 13. On the rear end of the cam bar is rigidly secured a sleeve 24 slidable within the tubular drive shank 11 and adapted to abut against a push bar 25 carried therein and having on its rear end a head 26. The head 26 is adapted to be moved forwardly by means of a feed bar or the like of the honing machine to which the present tool is attached. Reverse movement of the cam bar 23 is effected by a spring 28 interposed between the sleeve 24 and the shank portion 14.

The cam bar 23 carries a pair of cam members 30 in spaced relation to each other and located between the end plates 13 and 15. Each cam member 30 is rigidly secured to the cam bar as by means of a pin 31 and comprises a hub portion 32 (see Fig. 3) having a plurality of radially extending cam portions 33, one for each stone carrier. Each cam portion 33 extends radially into the channel of the stone carrier and is provided with a forwardly slanting cam surface 34 adapted to engage a portion of the stone carrier, which portion in the present instance comprises a transverse rib 35 extending crosswise within the channel and integral with the flange and web portions of the channel. It will be apparent, therefore, that forward longitudinal movement of the cam members 30 effects expanding or radially outward movement of the stone carriers 20. Longitudinal movement of the cam members 30 and consequently outward movement of the stone carriers are limited by engagement of the end of the cam bar 23 with the bottom (indicated at 29)

of the bore in the bottom end plate 15. The channel form of the carrier, particularly with the reinforcement of the transverse ribs 35, provides a rigid construction and proper support for the stones 21. However, since the cam portions 33 fit within the channels of the carriers, very little radial space is taken up thereby, and the carriers are therefore permittted to lie close to the center of the hone when in their contracted position, as shown in Fig. 2. The carriers 20 are further rendered rigid by being provided with end flanges 36 formed integrally with the side flanges and web portion of the channel.

One of the prominent features of my invention lies in the fact that the stone carriers herein disclosed may be turned end-for-end in the hone in order that both ends of the stones may be worn down evenly. For this purpose, the transverse ribs 35 are symmetrically positioned relative to the ends of the carrier, and each rib has a cam contacting surface which is symmetrical in form so that it may engage the slanting cam surface 34 in the same way when turned in either direction. Thus, the stone carriers when they become worn on one end more than on the other may be reversed in the hone. This eliminates the necessity of dressing down the unworn portion of the stones in order to attain a perfectly cylindrical non-tapering surface on the work piece.

Since the cam members 30 expand or move the stone carriers outwardly, means is provided for moving the stones inwardly when the cam members are retracted, as well as to hold the stone carriers 20 in tight engagement with the cam members. In the present instance, such means comprises a plurality of spring rods or wires 37, one for each carrier, and engaging the carriers intermediate their ends. Preferably, the springs 37 are mounted in the top end plate 13 and extend forwardly therefrom alongside each carrier to engage a laterally extending lug 40 on the side face of the carrier. The lug 40 is preferably positioned at the mid point of the carrier and a corresponding lug is provided on the opposite side in order to engage the spring when the stone carrier is turned end-for-end. By merely detaching the springs 37 from the lugs 40, the stone carrier may be readily removed. Inward movement of each carrier is limited by the transverse end walls 36 engaging the cam bar 23.

By providing two cam members 30 which engage the stone carriers at longitudinally spaced points, the stone carriers are moved outwardly in true parallelism with the axis of the hone, and the two cam members thereby support the stones in such relationship even though only a portion of the length of the stones may be in contact with the work during certain portions of the operation of the hone. The springs 37 engaging the lugs 40 on the stone carriers, which are located substantially at the mid point of the carriers, provide an even force maintaining the stone carriers against both cam members.

The two modified forms of hone shown in Figs. 8 to 12, inclusive, are of a type adapted for use in honing closed-end bores or bores terminating in an internal shoulder. These two forms of hones are provided with reversible stone carriers since unequal wear of one end of the stones relative to the other is more apt to occur in honing such bores.

In the form of hone shown in Figs. 8 and 9, the drive shank construction is similar to that shown in Fig. 1 and is provided with an adapter (not shown) of the same character as shown in Fig. 1.

In Figs. 8 and 9, the drive shank, indicated at 50, is internally threaded at its forward end to receive therein a top end plate 51. In spaced relation to the top end plate 51 is a bottom end plate 52, the two end plates being connected by a plurality of spacer bars 53, providing with the end plates a plurality of angularly spaced radial openings.

Mounted in these angularly spaced openings is a plurality of stone carriers, indicated generally at 54. Each stone carrier comprises a channel-shaped, inwardly opening portion 55 slidably mounted in radial grooves 56 formed in the end plates 51 and 52. The web portion of the channel of each stone carrier extends beyond the ends of the main portion of the channel, as at 57, to lie within longitudinal grooves 60 cut in the peripheries of the end plates. The stone, indicated at 61, is of a length equal to the length of the channel portion plus the extensions 57 on the ends thereof. Thus, as is apparent from Fig. 8, the stone 61 extends at least as far as the outer or forward face 62 of the bottom end plate 52, and preferably slightly beyond the face 62, so that the stones may engage the bore for the full depth thereof.

Since the bottom end plate 52 cannot extend beyond the end of the stones and thus is limited in length, the cam means for expanding the stones, or moving them radially outward, is of a somewhat different character from that shown in the first form. Thus, in the form shown in Figs. 8 and 9, I provide a cam bar 63 slidably mounted in the upper end plate 51 and threaded into a cam member comprising a tubular body portion 64. Integrally formed with the tubular body portion 64 and extending radially therefrom are a plurality of wings or cams 65, two for each stone carrier, extending into the channel portions of the stone carriers and provided with cam surfaces 66 engaging transverse ribs 67 in the channel portions. To slidably support the cam member, a cam centering pin 70 is rigidly secured in an axial position in the bottom end plate 52 and extends into the tubular body portion 64 of the cam member. Thus, the cam member is slidably supported in properly centered relation to the various stone carriers by the centering pin 70.

The stone carriers are symmetrical relative to a transverse plane at their mid point so that they may be reversed in the body structure comprising the end plates and the spacer bars 53. Thus, in honing a closed-end bore, when the forward ends of the stones wear to such an extent as to tend to produce a tapered bore, they may be reversed in the body structure of the hone so that the wear on the two ends of each stone may thus be equalized. This construction, therefore, avoids the necessity of heavily dressing the stones to maintain a straight cylindrical bore.

The stones are yieldably held in engagement with the cam surfaces 65 by means of spring rods 71 extending from the top end plate 51 and engaging ears 72 formed on the sides of the stone carriers adjacent their longitudinal mid point. The channel-shaped portion of each stone carrier is preferably closed at its ends by transverse walls 73 which engage the bottoms of the grooves 56 to hold the stone carriers against endwise movement during action of the cam surfaces 66 on the ribs 67.

The form of hone shown in Figs. 10, 11 and 12 is adapted particularly for production work. In this kind of work, a fixture to receive a work piece during the honing operation is provided. It is, of course, difficult to maintain work pieces, when clamped in such a fixture, with the bore to be honed absolutely coaxial with the spindle of the honing machine. The hone of Figs. 10, 11 and 12 is, therefore, so constructed that any slight misalignment between the work and the honing machine spindle may be compensated for so that the bore may be accurately honed.

To this end, I provide a honing head structure similar to that shown in Figs. 8 and 9 and adapted for honing closed-end bores. The honing head, indicated generally at 80, is adapted to be connected to the machine through universal connections so that the honing head may operate in a position slightly out of line with the driving spindle of the honing machine. In this form, the honing head is provided with a top end plate 81 adapted to be threaded into a drive cap 82. The drive cap and the adjacent end of the top end plate 81 are provided with spherical surfaces to receive a ball member 83. The ball member 83 is threaded into a drive shank 84. On the other end of the drive shank 84 is a similar ball connection comprising a ball member 85, a cap 86 and a universal joint adapter 87. Drive of the parts is effected through drive pins in the form of set screws 88 threaded transversely into the ball members 83 and 85 and having their heads loosely positioned in radial apertures 89 in the drive caps 82 and 86. The universal joint adapter is threaded into a drive adapter 90 adapted to be connected to the drive spindle of the honing machine. Thus, through the universal connections afforded by the ball members 83 and 85, the honing head 80 may be slightly out of line with the driving spindle.

Provision is also made for actuation of the cam members of the honing head under conditions of such misalignment. To this end, a cam bar or push rod 91 extends through the top end plate 81, the drive shank 84 and its two universal connections, and into the universal joint adapter 87. However, the diameter of the push rod 91 is slightly less than the internal diameter of any of these parts so that the push rod fits loosely therein and thus may flex when the honing head 80 is out of line with the drive spindle of the machine. The push rod 91 thus may be reciprocated to actuate the cam member in the honing head when the push rod is in its flexed condition. The upper or rear end of the push rod 91 is preferably threaded in the shank portion 92 of a push pad 93 adapted to engage and be actuated by the feed bar of the honing machine. The shank portion 92 is slidably mounted in the universal joint adapter 87 and, to hold the cam member in the honing head in the stone-retracted position, a coil spring 94 is mounted within the drive adapter 90 to bear at one end against the pad 93 and, at its other end, against the drive adapter.

It will be apparent that this last-described form, by the universal connections of the drive shank 84 with the drive adapter 90 and the honing head 80, permits rotation of the hone when the work piece is slightly out of alignment with the driving spindle of the housing machine. Similiarly, the loose fit of the push rod 91 within the various parts of the device permits flexing thereof without binding so that the cam member of the honing head 80 may be freely actuated in such misaligned position.

I claim:

1. A hone comprising body structure provided with angularly spaced radial openings, a plurality of channel-shaped stone carriers mounted in said openings for radial movement, and a pair of longitudinally spaced cam members mounted in said body structure for longitudinal movement, each stone carrier having a pair of transverse ribs extending between and connected to the channel flanges and engaging said cam members, said ribs being symmetrically shaped and positioned relative to the ends of the carrier to permit end-for-end reversal of the stone carriers.

2. A hone comprising structure provided with angularly spaced radial openings, a plurality of elongate stone carriers mounted in said openings for radial movement, each carrier having a pair of lugs extending laterally from opposite side edges of the carrier, a spring for each carrier mounted in and extending from said body structure in a direction parallel to said carriers, each spring having a free end engaging a lug on a carrier and tending to move the carrier inwardly, the free ends of said spring being unobstructed outwardly whereby they are disengageable from the respective carriers merely upon outward movement, and longitudinally movable cam means carried by the body structure for moving the carriers outwardly, each carrier having means engaged by said cam means, which is symmetrically shaped and positioned relative to the ends of the carrier to permit end-for-end reversal thereof, the other lug on each carrier being engaged by the spring when the carrier is so reversed.

3. A hone comprising body structure provided with angularly spaced radial openings, a plurality of stone carriers mounted in said openings for radial movement, each carrier comprising a longitudinally extending inwardly opening channel with a pair of longitudinally spaced transverse ribs within the channel extending between and integral with the flanges of said channel, and a pair of longitudinally spaced cam members mounted within said body structure for longitudinal movement and having cam portions extending into and guided slidably in the channels and engaging said ribs for moving said carriers outwardly.

4. A hone comprising body structure provided with angularly spaced radial openings, a plurality of stone carriers mounted in said openings for radial movement, each carrier comprising a longitudinally extending inwardly opening channel and cam surfaces in said channel, and cam means having cam portions slidably positioned within the channels and guided thereby in engagement with said cam surfaces for moving the carriers outwardly.

5. A hone comprising body structure provided with angularly spaced radial openings, a plurality of stone carriers mounted in said openings for radial movement, each carrier comprising a longitudinally extending inwardly opening channel with spaced transverse ribs therein, and cam means comprising a cam bar carrying cam portions extending into the channels for sliding movement therein, each cam portion having a beveled face engaging one of said ribs to effect outward movement of the carrier, each carrier also having transverse walls at its ends connected between the side flanges of the channel and adapted to engage the cam bar to limit inward movment of the channel.

6. A hone comprising body structure provided with angularly spaced radial openings, a plurality of stone carriers mounted in said openings for radial movement, each carrier comprising a longitudinally extending inwardly opening channel with spaced transverse ribs therein connected between the flanges of said channel, and cam means comprising a longitudinally movable bar axially positioned within the body structure and carrying a pair of cam members having radially extending cam portions slidable within the channels for guiding said cam means and engaging said ribs to move the carriers outwardly.

7. A hone comprising a pair of spaced end plates having radial grooves in their opposed faces, a plurality of angularly spaced spacer bars rigidly connecting said end plates, a plurality of stone carriers mounted between the spacer bars and extending into said grooves and guided thereby for radial movement, a longitudinally movable cam bar slidably mounted in axial bores in said end plates, a pair of cam members mounted in spaced relation on said cam bar between said end plates and engaging said carriers at spaced points for moving said carriers outwardly, and springs carried by one of said end plates and extending along said carriers externally thereof, said springs bearing against said carriers intermediate the cam members to constitute the sole means tending to move said carriers inwardly, said spring means being unobstructed outwardly of said carriers whereby they are disengageable from said carriers merely upon movement outwardly away from said carriers.

8. A hone comprising a pair of spaced end plates, a plurality of angularly spaced spacer bars rigidly connecting said end plates, a plurality of stone carriers mounted between said spacer bars and guided for radial movement by said end plates, each carrier having a laterally extending lug on one side face intermediate its ends, longitudinally movable cam means slidably supported by said end plates for moving the carriers outwardly, and elongated spring rods extending longitudinally from one of said end plates alongside the respective carriers with their free ends engaging said lugs and tending to move said carriers inwardly, said carriers being symmetrical about a transverse medial axis and reversible end-for-end in said end plates.

9. A stone carrier for a hone of the character described comprising an elongated channel-shaped member with the web portion of the channel having a flat outer fact adapted to have a stone cemented thereto, cam engaging ribs extending transversely within the channel from flange to flange and integral with both the flange and web portions of the channel and closed end walls extending from flange to flange for positioning said carriers in an endwise direction in a hone body.

10. A stone carrier for a hone of the character described comprising an elongated channel-shaped member with the web portion of the channel having a flat outer face adapted to have a stone cemented thereto, and a pair of cam engaging ribs positioned transversely within the channel, the ribs being equally spaced from the respective ends of the channel and of symmetric form to permit end-for-end reversal of the carrier when placed in a hone.

11. A stone carrier for a hone of the character described comprising an elongated channel-shaped member with the web portion of the channel having a flat outer face adapted to have a stone cemented thereto, a pair of cam engaging ribs positioned within the channel, and a

pair of lugs extending laterally from the respective sides of the channel, said ribs being symmetrically shaped and positioned relative to the ends of the carrier and either of said lugs being engageable by a spring to permit end-for-end reversal of the carrier when placed in a hone.

12. A hone comprising a body structure provided with a plurality of angularly spaced radial openings, a plurality of stone carriers mounted in the respective openings for radial movement, and cam means for moving said carriers radially comprising a tubular body mounted axially within said body structure and having a pair of longitudinally spaced sets of cam portions engaging each carrier at longitudinally spaced points, a longitudinally movable bar fixed in one end of said tubular body for moving said cam portions, and a centering pin fixed in said body structure and extending into the other end of said tubular body for slidably supporting said tubular body.

13. A hone comprising a body structure provided with a plurality of angularly spaced radial openings, a plurality of stone carriers mounted in the respective openings for radial movement, and cam means for moving said carriers radially comprising a tubular body having cam surfaces engaging each carrier, a bar supported for longitudinally slidable movement by said body structure and fixed in one end of said tubular body, and a centering pin fixed in said body structure and extending into the other end of said tubular body for slidably supporting said tubular body.

14. A hone comprising a body structure comprising top and bottom end plates, and a plurality of spacer bars rigidly connecting said end plates and providing a plurality of angularly spaced radial openings, a plurality of stone carriers mounted in the respective openings for radial movement, and cam means for moving said carriers radially comprising a tubular body mounted centrally within said body structure between said end plates and having cam surfaces engaging each carrier, a longitudinally movable bar axially positioned in and slidably supported by said top end plate and fixed in the adjacent end of said tubular body, and a centering pin centrally fixed in said bottom end plate and extending into the adjacent end of said tubular body for slidably supporting the latter.

15. A hone comprising a body structure provided with a plurality of angularly spaced radial openings, a plurality of stone carriers mounted in the respective openings, and longitudinally movable cam means mounted within the body structure for shifting said stone carriers outward, each carrier being symmetrically formed for reversal in the body structure and having stone supporting portions of sufficient length to extend at least to the front end face of said body structure to hone closed-end bores for the full depth thereof.

16. A hone comprising a body structure provided with a plurality of angularly spaced radial openings, longitudinally movable cam means mounted in said body structure, and a plurality of stone carriers shiftable by said cam means, each having a channel portion mounted in one of said openings and symmetrically formed for reversal in the body structure, each carrier also having extensions at its ends of sufficient length to extend at the front end of the hone to the front end face of the body structure to hone closed-end bores for the full depth thereof.

17. A hone comprising a body structure comprising top and bottom end plates, and a plurality of spacer bars rigidly holding said end plates in spaced relation, each end plate having a plurality of radial grooves in its inner face and longitudinal grooves in its periphery, longitudinally movable cam means in said body structure, and a plurality of stone carriers radially shiftable by said cam means, each stone carrier having a channel portion mounted in radial grooves of the end plates and stone-supporting portion extending into longitudinal grooves in the peripheries of the end plates, said stone-supporting portion being of sufficient length to extend to the front end face of the bottom end plate to hone closed-end bores for the full depth thereof.

18. A hone comprising a body structure comprising top and bottom end plates, and a plurality of spacer bars rigidly holding said end plates in spaced relation, each end plate having a plurality of radial grooves in its inner face and longitudinal grooves in its periphery, longitudinally movable cam means in said body structure, and a plurality of radially shiftable stone carriers, each having a portion mounted in radial grooves in the plates and cooperating with said cam means, and a stone-supporting portion extending into longitudinal grooves in the peripheries of the end plates, said stone-supporting portion being of sufficient length to extend to the front end face of the bottom end plate to hone closed-end bores for the full depth thereof.

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