Jan. 16, 1973 C. H. KRAMM ET AL 3,711,260

HONING STONE APPARATUS

Filed July 1, 1971

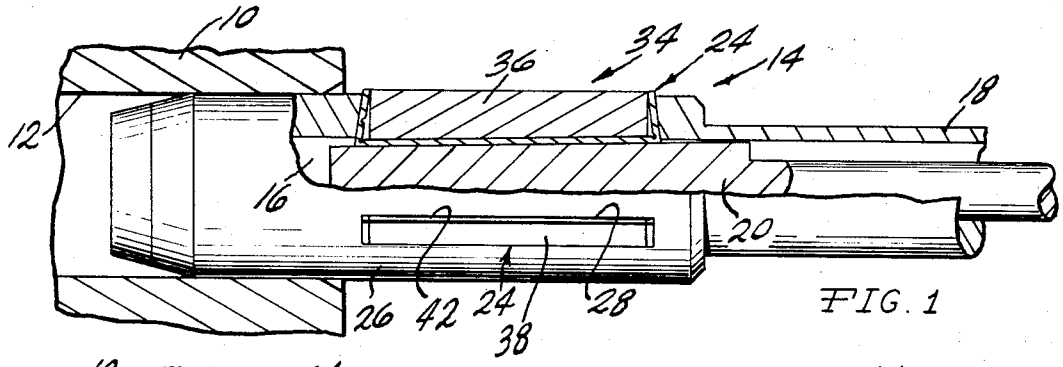

FIG. 1

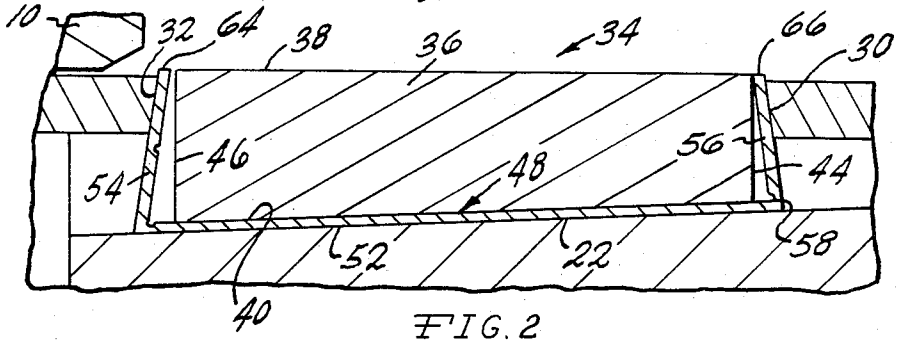

FIG. 2

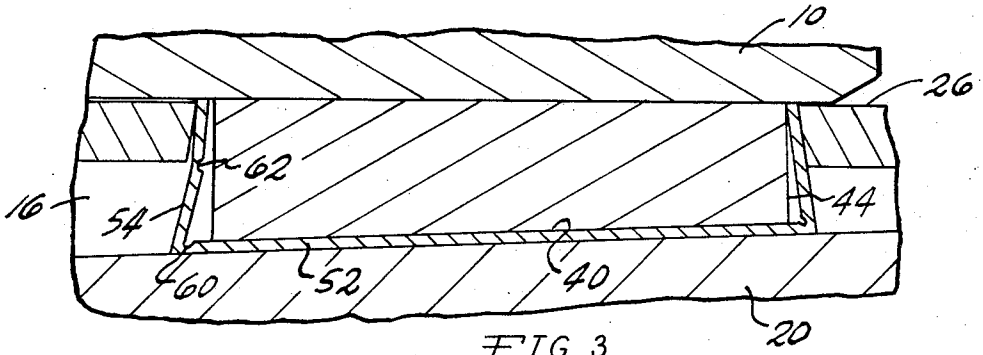

FIG. 3

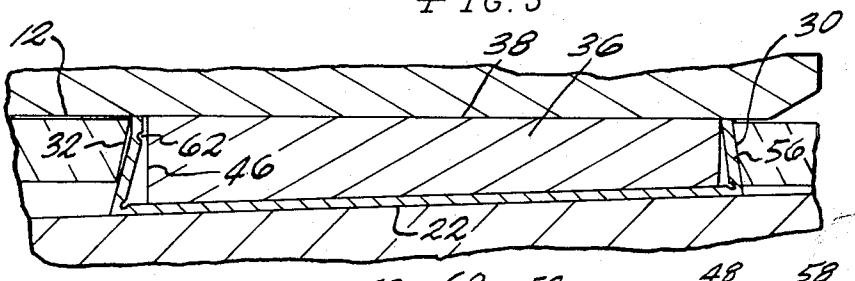

FIG. 4

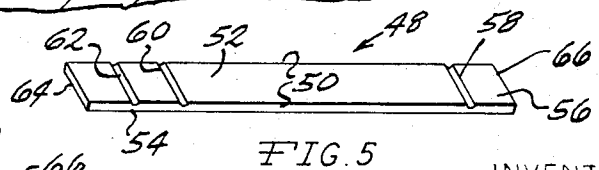

FIG. 5

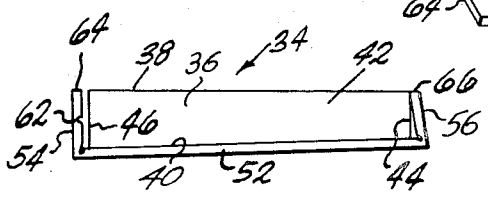

FIG. 6

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HONING STONE APPARATUS

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Continuation-in-part of application Ser. No. 54,403, July 13, 1970, now Patent No. 3,641,715. This application July 1, 1971, Ser. No. 158,908

Int. Cl. B24d 5/10, 7/00; B24b 9/02

U.S. Cl. 51—204 8 Claims

ABSTRACT OF THE DISCLOSURE

Honing apparatus including a head supporting a plurality of radially adjustable abrasive honing stones wherein the openings defined in the heads receiving the stones are of such configuration as to cooperate with retainers attached to the stones to maintain the stones in firm assembly with the head, as the stones are consumed. Oblique end faces defined at the ends of the head openings deform stone retainer leg portions adjacent, but spaced from, hone stone end surfaces, and as radial movement of the stone occurs the degree of deformation increases to maintain positive holding of the stone as its radial dimension decreases during use.

CROSS-REFERENCES TO RELATED APPLICATIONS

The instant application is a continuation-in-part of our copending application entitled Honing Apparatus, Ser. No. 54,403, filed July 13, 1970, now Pat. No. 3,641,715.

BACKGROUND OF THE INVENTION

The invention pertains to the field of honing devices wherein a plurality of honing stones are mounted within a head, and are radially adjustable outward by means of an internal member in the form of a wedge within the head and axially displaced therein.

A conventional hone construction utilized to accurately finish bores and cylinders includes a head having a plurality of radially disposed rectangular openings receiving abrasive stone bodies. Internally, the hone head includes an axially movable wedge which engages the inner surface of the stones, or stone body support, to adjust the stone body radially outward as it is consumed, and to maintain the outer surface of the abrasive stone body in engagement with the work with the proper degree of pressure.

In known hone constructions as the stone is consumed the radial dimension of the body decreases, and, with conventional stone body constructions, consuming of the stone increases the likelihood of the stone inadvertently escaping its opening in the hone head, which creates serious problems due to the possibility of damage to the workpiece, and also creates a safety hazard. Another disadvantage with conventional hone stone constructions lies in the necessity of discarding the stone long before all of the abrasive material has been consumed due to the necessity of maintaining a sufficient radial stone dimension to maintain the stone in the head opening. Thus, it is common practice to discard the stone when approximately one half, or less, of the stone has actually been consumed in use.

Several attempts have been made to overcome the problem of retaining the abrasive stone body within the honing head, and such attempts are typified by disclosures shown in U.S. Pats. 3,037,333; 3,264,789 and 3,403,481.

Previously constructed hone stone body retainers have not overcome all of the disadvantages attendant with this type of tool, and prior stone constructions have been of such configuration that only a limited area of abrasive stone body is in engagement with the workpiece which increases the working time to produce a desired amount of workpiece metal removal.

SUMMARY OF THE INVENTION

It is a basic object of the invention to provide a unique hone head and stone body assembly whereby high metal removing capacities may be achieved in a tool of relatively limited size, and yet the hone stone body may be positively retained within the head under all conditions of stone wear, and greater accuracies may be maintained with an increase in the effective usable life of hone stones.

In the practice of the invention a positive retaining relationship between the hone head and the hone stone body assembly is created by an overlapping and interlocking relationship between the surfaces defining the hone head opening and the components of the stone body retainer. As the stone body and retainer assembly is moved radially outward during use, the surfaces of the opening engaging the retainer deform the retainer in such a manner as to maintain, and even increase, the degree of frictional engagement between the stone retainer and the head, and thereby permit a greater portion of the stone to be utilized than is possible with conventional honing devices of this type.

In the practice of the invention the hone head includes a plurality of radially extending elongated openings of a rectangular configuration having a length substantially parallel to the axis of the head, and end faces defining the longitudinal ends of the opening. The end faces are obliquely related to the hone head axis in such a manner that the inner portions of the opening end faces are a greater distance from each other than the outer portions, i.e., the end faces are related in an outwardly converging direction. The hone stone body is also of a rectangular elongated configuration having lateral sides, an outer surface which constitutes the work surface, an inner surface disposed toward the head wedge actuator, and end surfaces substantially perpendicularly disposed to the stone body length. The stone body, itself, is of a wedge-like configuration due to the wedge configuration of the actuator, the radial dimension of the stone body being greater adjacent one end surface than at the other.

A metallic, nonferrous retainer is attached to the hone stone body, and includes a base portion of a planar configuration bonded to the stone body inner surface by a suitable adhesive. Leg portions of an initial flat planar configuration extend radially outward from the base portion adjacent the stone body end surfaces, but slightly spaced therefrom wherein the dimension separating the leg portions adjacent the base portion is greater than the dimension separating the stone body end surfaces adjacent the body inner surface. Thus, the leg portions may be deformed inwardly toward the stone body.

Deformation of the retainer leg portions toward the stone body is facilitated by fold indentations defined in the retainer at the intersections of the base portion with the leg portions, and also defined in the surface of the

leg portion of greatest radial length disposed toward the adjacent stone body end surface. Such indentations facilitate the bending and deformation of the leg portions in accord with the inventive concepts.

The dimensions of the head openings, and the stone and retainer assembly is such that the initial insertion of the stone and retainer assembly into an opening causes a deformation of the leg portions which serves to frictionally retain the stone and retainer within the head opening. As the hone is used, and the stones are consumed and radially displaced outwardly by the wedge-type actuator, the opening end faces, due to their oblique relationship, engage the leg portions forcing the leg portions inwardly toward the stone body to insure a continued high frictional engagement between the head and the stone and retainer assembly during radial movement thereof. The nonferrous nature of the retainer, which is preferably formed of brass, bronze or aluminum, or similar soft metal alloy, permits the retainer leg portions to be worn away by the workpiece as the stone body is consumed without scratching or otherwise defacing the workpiece surface being machined. The retainer construction is such as to occupy little space, and thus a relatively large stone may be employed in a head of relatively small size with the practice of the invention. This improved ratio decreases machining time, which is of prime importance in high production metal finishing machines.

DESCRIPTION OF THE DRAWINGS

The aforementioned objects and advantages of the invention will be appreciated from the following description and accompanying drawings wherein:

FIG. 1 is a detail, elevational, sectional view of a hone head and stone body and retainer assembly in accord with the invention illustrating the initial alignment of the head with a workpiece,

FIG. 2 is an enlarged, elevational, sectional view similar to FIG. 1 illustrating the details of the stone and retainer,

FIG. 3 is an elevational, sectional view similar to FIG. 2 illustrating the relationship of the components during use wherein the stone is partially consumed,

FIG. 4 is an elevational, sectional view similar to FIG. 3 illustrating the relationship of components when the stone body has been approximately half consumed during use,

FIG. 5 is a perspective view illustrating the stone body retainer prior to bending and assembly with a stone body, and

FIG. 6 is an elevational view of a stone body and formed retainer assembly prior to insertion into a honing head.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates a honing head constructed in accord with the invention having new hone stone bodies inserted therein, and prior to the insertion of the head into the bore of the workpiece to be machined. In FIG. 1 the workpiece is indicated at **10** and includes a cylindrical bore **12** to be honed. The hone head **14** is of a cylindrical configuration having a hollow center **16** and a hollow shank **18** whreby the head is attached to conventional supporting and operating structure, not shown. A wedge hone stone actuator **20** is axially positionable within the hollow center **16** in a known manner, and the wedge actuator includes a plurality of wedge or cam surfaces **22** obliquely related to the head length operably engageable with the hone stone assemblies for radially displacing the hone stone assemblies outwardly during use.

The head **14** is provided with a plurality of rectangular openings generally indicated at **24** which extend in a radial direction intersecting the cylindrical hone exterior surface **26** and the hollow center **16**. The openings **24**

are defined by longitudinally extending edge surfaces **28**, and end faces **30** and **32**. As is best appreciated from FIGS. 2 through 4, the end faces **30** and **32** are obliquely related to the surface **26** and the longitudinal axis of the head **14**. The end faces are of a substantially flat or planar configuration and the spacing between the end faces adjacent the hollow center **16** is greater than the spacing therebetween adjacent the exterior surface **26**. Thus, the end faces **30** and **32** are disposed in an outwardly converging direction, and in actual practice the end faces depart from the vertical with respect to the relationship shown in FIGS. 2 through 4 by approximately 7½ degrees.

The hone stone body and retainer assembly **34** is represented in FIG. 6. A hone stone body **36** itself consists of an abrasive material in the form of grains bonded together with a suitable bonder, usually in the form of a resin. The body **36** includes an outer surface **38**, an inner surface **40**, lateral side edges **42**, and end surfaces **44** and **46**. As will be appreciated from the drawing, the inner surface **40** is nonparallel with respect to the outer surface **38**, and the departure from a parallel relationship is complementary to the angle of the wedge surface **22** whereby the outer surface **38** will be disposed substantially parallel to the head longitudinal axis, while the surface **40** is parallel to, and thus fully backed and supported by the wedge surface **22**. This angular relationship between the surfaces **38** and **40** results in the radial dimension of the end surface **46** being greater than that of the end surface **44**. In the disclosed embodiment the end surfaces **44** and **46** are substantially perpendicular to the outer surface **38**.

The retainer for the stone body, as generally indicated at **48**, is preferably formed of a strip of nonferrous, relatively soft material such as copper, bronze, aluminum or the like. The retainer **48**, prior to forming, is of a configuration as illustrated in FIG. 5 including lateral sides **50**, a base portion **52**, a large leg portion **54**, and a smaller leg portion **56**. Indentation or fold means are defined at **58** and **60** between the base portions, and such indentations are preferably defined by a stamping process. A linear fold indentation **62** is also defined in the leg portion **54** intermediate the intersection of fold indentation **60** and the leg portion free end **64**.

When assembled to the stone body **36**, the leg portions **54** and **56** are angularly disposed with respect to the base portion **52** as will be appreciated in FIG. 6. The fold indentations **58** and **60** permit a "sharp" bend with respect to the leg portions and the base portion, and the leg portion **56** preferably defines an angle slightly less than 90° with the base portion **52**, while the leg portion **54** may be disposed at substantially 90° with respect to the base portion prior to insertion of the stone body and retainer assembly **34** into a hone head openings **24**.

The retainer **48** is fixed to the stone body **36** by an adhesive applied intermediate the stone body inner surface **40** and the base portion **52**, and in this manner a permanent interconnection between the abrasive stone body and the retainer is achieved.

The length of the head opening **24**, and the length of the stone and retainer assembly **34** is such that the abrasive stone assembly may be inserted into an opening **24** by first inserting the leg portion **54** end into the "deep" portion of the opening and deforming the leg portion **54** toward the stone body **36** by engagement therewith by the end face **32**. Thereupon, the end of the stone and retainer assembly **34** defined by the leg portion **56** may be inserted into the head opening adjacent end face **30** and a relationship such as illustrated in FIGS. 1 and 2 will occur.

It will be appreciated from the relationship of FIGS. 1 and 2 that the end face **30** is in substantially complete engagement with the leg portion **56**, and the free end **66** of the leg portion is touching the end surface **44** adjacent the stone outer surface **38**. However, a spacing exists be-

tween the free end **64** of the leg portion **54** and the end surface **46**. Of course, the fact that the spacing between the leg portions **54** and **56** adjacent the base portion **52** is greater than the spacing between the end surfaces **44** and **46** adjacent the inner surface **40** permits the desired "inward" deflection of the leg portions, and the inherent resiliency of the metal of the leg portions aids in maintaining the initial engagement of the stone and retainer assembly within the head opening.

With a "new" honing stone assembly **34** the wedge actuator **20** will be shifted to the right, FIGS. 1 and 2, in order that the stone surface **38** will be in substantial alignment with the head surface **26** and only project slightly beyond the hone exterior surface.

The fact that the end faces **30** and **32** are obliquely disposed defines an "undercut" which, in conjunction with the deflection and close fit relative to the leg portions **54** and **56** creates an effective means for holding a new stone and retainer assembly **34** in the associated head opening **24**. The head **14** is inserted in the workpiece bore **12** and the workpiece and head are relatively rotated or oscillated, and as the stone is gradually consumed, the wedge **20** is moved to the left to maintain a firm pressure between the stone outer surface and the workpiece bore. As appreciated in FIG. 3, wherein a portion of the stone has been consumed, the engagement between the leg portion **54** and the end face **32** causes the leg portion to deform inwardly, the primary bending occurring at the indentation **62**. Also, as the stone is moved outwardly during use the end face **30** will maintain engagement with the leg portion **56** whereby a firm frictional engagement between the end face and the retainer leg portions exist during all phases of operation, thereby producing an effective holding grip between the stone assembly and the head.

As the wear on the hone stone **36** continues the leg portion relationship with respect to the head opening end faces is similar to that shown in FIG. 4. As the base portion **52** approaches end faces **30** and **32** the degree of deformation of the leg portions toward the stone body **36** increases, and the free end **64** of the leg portion **54** approaches, and may engage the stone end surface **46**. Thus, even though the radial dimension of the stone as defined by the distance separating the surfaces **38** and **40** reduces, an effective holding relationship between the head and the stone and retainer assembly is maintained.

As will be appreciated from the drawings, the free ends **64** and **66** of the leg portions engage the workpiece bore **12**. However, due to the soft and nonferrous nature of the material of the leg portions, scoring or scratching of the workpiece does not occur in that the workpiece is usually of steel, and thus considerably harder than the material of the retainer.

When it is desired to remove the worn stone from the associated head opening **24** the installation procedure is reversed, the leg portion **56** being first lifted from the opening **24** and once the leg portion **56** clears the end face **30** the stone may be easily withdrawn from the opening. Usually, a clearance exists between the free end **64** of the leg portion **54** and the stone end surface **46**, and this clearance aids in shifting the stone and retainer assembly to the left slightly to facilitate removal.

It will be appreciated that in the practice of the invention a firm and efficient holding relationship between the honing head opening and the stone and retainer assembly is maintained throughout the life of the stone body, and the invention eliminates the previous troublesome occurrence of the stone body dropping or falling from the honing head opening. In that, except for the cross-sectional area of the leg portions **54** and **56**, the opening **24** is completely occupied by the abrasive outer surface **38**, and a most efficient relationship is established between the size of the openings **24** and the effective abrasive area of the hone stone contained therein, resulting in a very efficient and rapid cutting hone head for a given size head.

Various modifications to the inventive concept may be apparent to those skilled in the art without departing from the spirit and scope of the invention.

We claim:

1. A hone stone and head assembly comprising, in combination, an elongated honing head having an axis, a hollow center, an annular wall and an exterior surface, at least one radially extending elongated rectangular opening defined in said head wall intersecting said hollow center and said exterior surface, said opening including end faces defining the opening length, said end faces being obliquely related to each other in a converging direction from said hollow center to said exterior surface, an abrasive stone body of an elongated configuration received within said opening, said body including a longitudinal axis, lateral sides, an outer surface, an inner surface and first and second end surfaces, said end surfaces being transversely disposed to said body axis, a retainer attached to said stone body, said retainer including a base portion affixed to said stone body inner surface and deformable first and second leg portions extending from said base portion in adjacent relationship to said stone body end surfaces, the spacing between said leg portions at said base portions being greater than the distance between said stone end surfaces adjacent said inner surface, said leg portions engaging said opening end faces and said end faces deforming said leg portions toward said stone body upon radial outward movement of said stone body and retainer through said opening, and stone body and retainer actuating means within said head hollow center selectively radially moving said stone body and retainer outwardly through said opening.

2. In a hone stone and head assembly as in claim **1** wherein said retainer is formed of a relatively soft nonferrous metal.

3. In a hone stone and head assembly as in claim **1** wherein said first stone end surface is of greater radial dimension than said second end surface, said first leg portion including an inner surface disposed toward said first stone end surface and fold forming means defined in said leg portion inner surface spaced from said retainer base portion.

4. In a hone stone and head assembly as in claim **3** wherein said fold forming means comprises a linear indentation defined in said first inner surface substantially parallel to said stone inner surface and retainer base portion.

5. A hone stone assembly for use with honing heads having rectangular stone receiving openings and an internal stone support and expander comprising, in combination, an abrasive stone body of an elongated configuration having first and second ends, lateral sides, an outer surface and an inner surface, a retainer attached to said body, said retainer including a base portion attached to said body inner surface and first and second deformable leg portions extending from said base portion disposed adjacent said body first and second ends, respectively, the spacing between said leg portions adjacent said base portion being greater than the spacing between said stone body ends whereby the free ends of said leg portions may be deflected inwardly toward said body.

6. In a hone stone and head assembly as in claim **5** wherein said retainer is formed of a relatively soft nonferrous metal.

7. In a hone stone and head assembly as in claim **5** wherein said first stone end surface is of greater radial dimension than said second end surface, said first leg portion including an inner surface disposed toward said first stone end surface and fold forming means defined in said inner surface spaced from said retainer base portion.

8. In a hone stone and head assembly as in claim **7** wherein said fold forming means comprises a linear inden-

tation defined in said first inner surface substantially parallel to said stone inner surface and retainer base portion.

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U.S. Cl. X.R.

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