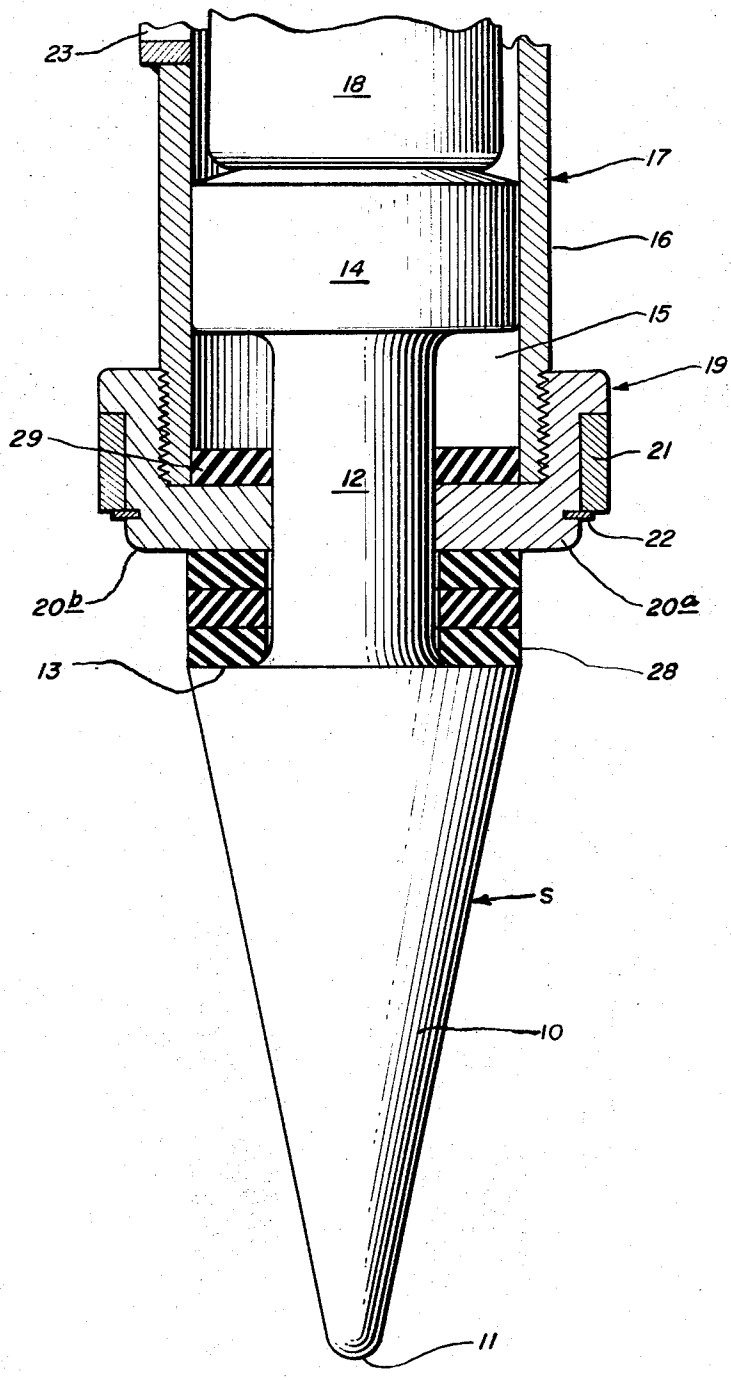
Dec. 20, 1966 C. LEAVELL 3,292,976

WORK MEMBER FOR A PERCUSSIVE TOOL

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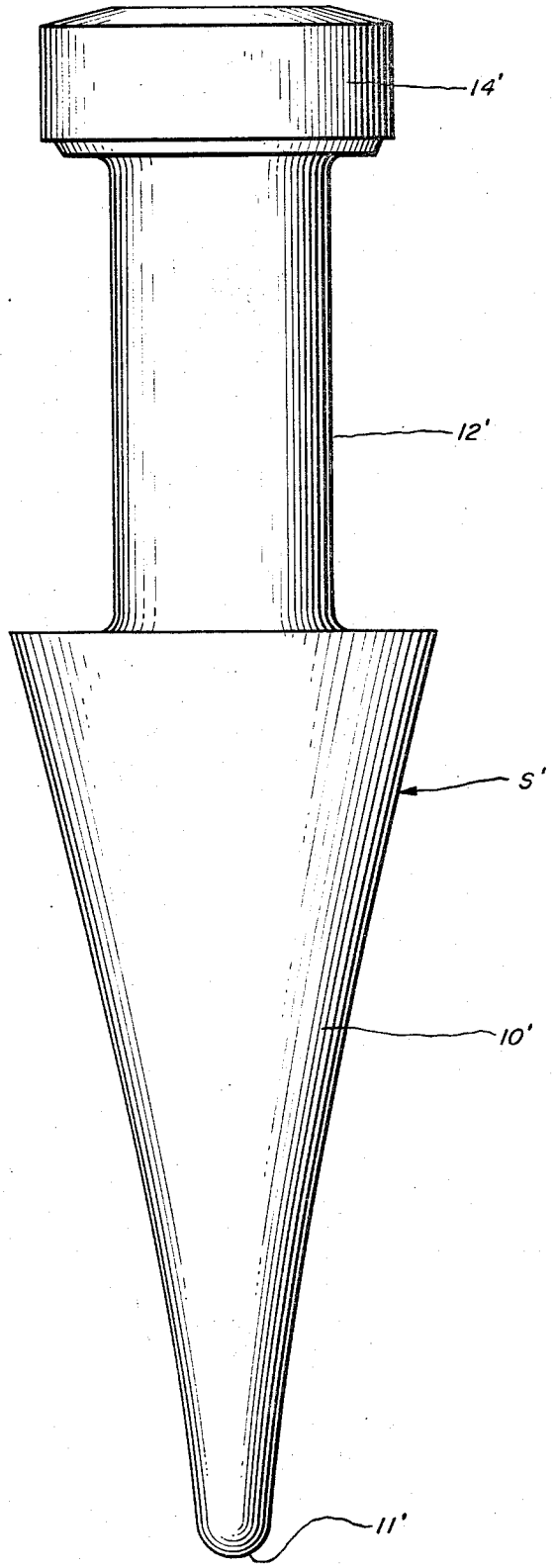
FIG. 1



WORK MEMBER FOR A PERCUSSIVE TOOL

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FIG. 2



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WORK MEMBER FOR A PERCUSSIVE TOOL

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FIG. 3

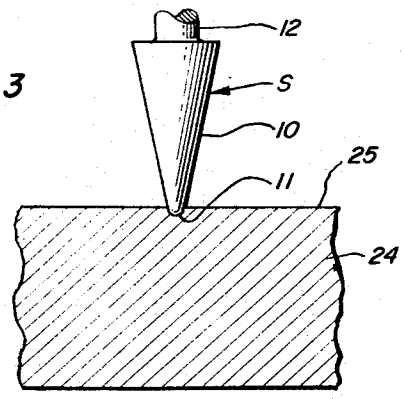


FIG. 7

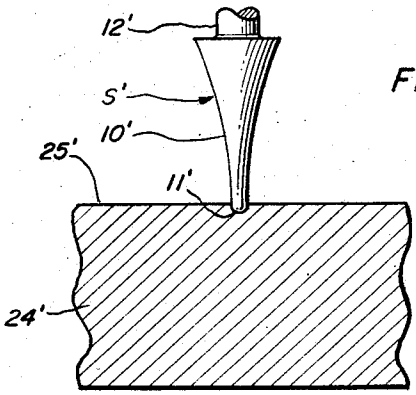


FIG. 4

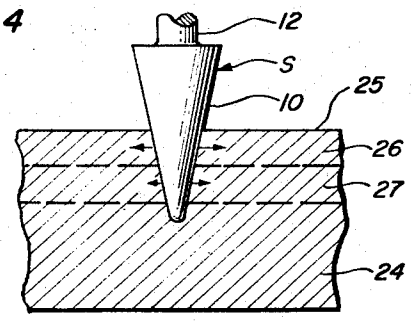


FIG. 8

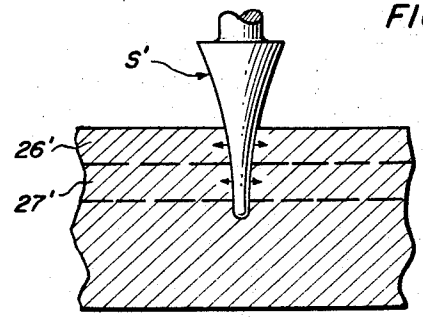


FIG. 5

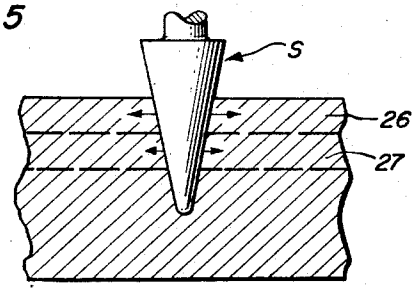


FIG. 9

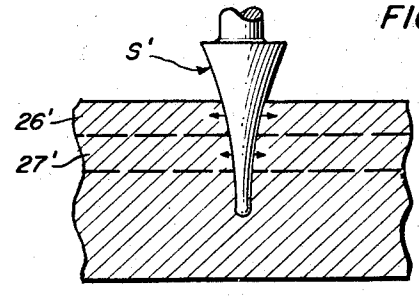


FIG. 6

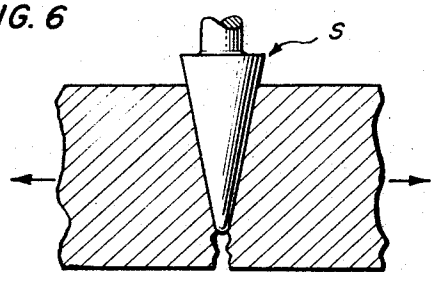
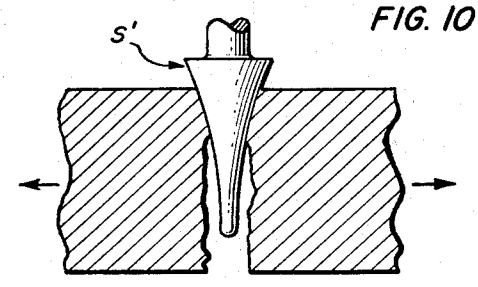


FIG. 10



United States Patent Office 3,292,976 Patented Dec. 20, 1966

3,292,976

WORK MEMBER FOR A PERCUSSIVE TOOL

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Filed July 9, 1962, Ser. No. 208,436
7 Claims. (Cl. 299—69)

This invention relates to a work member for a percussive tool, and more especially to a permanent work member particularly suited for use as the material-penetrating component of a paving breaker. In the percussive tool art, work members for a paving breaker are sometimes referred to as spikes or moil points.

The conventional paving breaker structure usually includes a casing provided interiorly with a cylinder having a piston reciprocable therein; and such piston functions as a hammer element which, in the course of its reciprocatory movement, transmits repetitive impact forces through the intermediate agency of a tappet or anvil to a work member removably supported by the casing for limited axial movements relative thereto. Such work member extends from the tool casing and is provided at its outer end with a point-shaped configuration that facilitates penetration by the work member of a concrete slab or other work material to be fractured and broken thereby upon operation of the tool. Such work material is penetrated by the spike or work member as a consequence of the repetitive impact forces transmitted thereto by the reciprocating hammer-piston, and sometimes one and usually several penetrations of the material sufficiently weakens the same to an extent that fracture thereof generally can be effected by the spike.

A problem of considerable significance that is encountered in the use of conventional paving breakers in the demolition of concrete slab and other material masses concerns the inconvenient and costly requirement for frequent replacement of the material-penetrating spike element which, typically, is an elongated steel bar usually having a relatively long shank of hexagonal cross section and a relatively short, tapered point formed integrally therewith that most often is four sided. By way of further explanation, an ordinary spike used with a heavy-duty paving breaker has a transverse dimension from face to face along the material-penetrating portion of the hexagonal shank thereof of about one and one-quarter inches, a length of approximately twenty inches, and a weight of approximately 7.5 pounds. The problem referred to pertains to such ordinary spikes, and there are at least two facets to such problem: the first concerns deterioration of the spike point, and the second concerns flexural breakage of the spike above the point thereof.

Deterioration of the spike point occurs (*a*) through abrasion thereof which necessarily accompanies each penetration by the spike of a work material, and (*b*) through softening or semi-fluid deformation thereof caused by the heat imparted to the point as a consequence of the resistance to penetration by a work material as it is compressively attacked by the spike. The abrasive action of the work material on the spike point dulls the same and tends to malform the point to a generally-rounded configuration. The fluid deformation caused by the temperature elevation of the spike point often contributes suddenly and critically to the rounding thereof and, in addition, can cause the point to enlarge in cross section; whereupon the spike, as a result of these two actions, may assume a bulbous "material-penetrating" end—contrasted to a point—if the spike is used for a sufficient length of time without resharpening the point thereof. Any deviation of the material-penetrating end of the conventional spike from a true wedge-shaped or pointed configuration makes the penetration operation exceedingly inefficient; and, as a consequence, the usual practice is to sharpen

the spike point at frequent intervals, often after just a few hours of use.

Flexural breakage of the spike occurs whenever a bending force of sufficient magnitude is applied thereto. This may occur, for example, when the spike has penetrated a work material to an extent that the spike in its entirety cannot be or is not readily displaceable laterally therein. If after such penetration the spike point engages a stone or steel reinforcing rod or some other substance that resists further straight-line penetration and tends to displace the point transversely, the repetitive impact forces being delivered to the spike may result in the application of a bending force thereto of sufficient magnitude to cause such flexural breakage.

Quite evidently then, the spikes presently used are acknowledged to be impermanent components since they must be frequently replaced and interchanged, and in the course of a working day several different spikes may be used with any one paving breaker. Consequently, spikes are forged components having rather crude tolerances because it is economically infeasible to machine-finish, or finish to close tolerances, even the upper-end portion of the spike which is inserted into and slideably engages the paving breaker casing. Because of this, a machined, axially slideable tappet or anvil member extending upwardly through the lower-end closure of the working cylinder and into the space below the hammer element to receive impact therefrom is necessarily used in each tool—first, as a pneumatic seal that permits the lower end portion of the working cylinder to be pressurized; and secondly, as a dust barrier to protect the interior of the working cylinder and hammer-piston reciprocable therein from the abrasive action of dust and dirt which would enter the cylinder through the spaces defined by the loose fit of the spike with the tool casing and lower-end closure of the working cylinder in the absence of such tappet element. Such a tappet element is typically machined or finished to a relatively close sliding fit with the walls of the opening providing access therefor through such lower-end closure of the cylinder and does provide an effective dust barrier and pneumatic seal; but considerable impact energy is wastefully dissipated in the transference thereof through such tappet element from the hammer-piston to the work member.

It is well understood that concrete and similar bonded-aggregate work materials have significantly greater strength in compression than in tension, and, for example, the usual concretes have a ratio of compressive strength to tensile strength of at least 10-to-1. This fact suggests a very substantial inefficiency in the demolition characteristics of the spikes or work members presently in use, for in a predominant degree the attack made thereby on a work material is against the compressive strength thereof rather than against its much smaller-valued tensile strength. Consequently, an inordinately large percentage of the total impact force and energy developed by a paving breaker for delivery to a work material is wasted in overcoming the compressive resistance thereof, and only a small portion of such total is available to tensionally crack or break the concrete so that such breakage occurs only after the expenditure of relatively great quantities of energy to first weaken the material by the penetration of the spike therein against the major compressive strength thereof.

In addition to this inefficient employment of the impact forces developed by a paving breaker, and as a consequence thereof, it has been found that conventional spikes frequently become stalled during a demolition operation—that is, become unable further to penetrate the work material with each blow or series of blows transmitted by the reciprocable hammer-piston to the spike. When such condition of stalling occurs or is ap-

proximated, the impact energy then delivered to the spike is dissipated almost entirely as heat, and since concrete is a relatively poor thermal conductor, the temperature of the spike point may then become elevated sufficiently to cause the aforementioned condition of fluid deformation of the spike point.

In view of the foregoing, an object of the present invention is in the provision of apparatus for and a method of fracturing or demolishing work materials such as concrete slabs and the like that utilize the relative weakness thereof in tension and concentrate a significantly increased component of the destructive force imparted to such work material as an attack particularly against the low tensile strength thereof.

Another object of the invention is that of providing a method of breaking or demolishing a concrete mass or mass of similar material in which such mass is penetrated through an exterior surface thereof, in which laterally directed forces are simultaneously applied to the mass along the path of such penetration and generally normal to the axis thereof to stress such mass in tension, and in which such lateral forces are progressively increased in magnitude with the progress of such penetration toward a value sufficient to effect fracture of the mass.

Another object is to provide a work member or spike composition having a point geometrically defined to maximize the resistance of such point to abrasive deformation, and incorporating a sufficiency of properly distributed metal in the shank thereabove to critically increase resistance of the same to flexural breakage from the application of bending forces thereto of a greater magnitude than is ordinarily encountered in demolition work.

Still another object of the invention is in the provision of such an improved spike or work member having a material-penetrating point generally approximating a hemispherical configuration so as to maximize resistance thereof to abrasive deformation, and a maximum or great-circle diameter therethrough of sufficiently small value in relation to the associated percussive power so that efficient penetration of a work material is not significantly inhibited by the non-pointed configuration of the spike point.

A further object is that of providing a spike in which the point thereof has a generally hemispherical configuration, in which the maximum cross sectional area of such point is substantially less than the corresponding maximum cross sectional area of the conventional pyramidal spike point so that the effective compressive resistance to penetration encountered by such hemispherical point in penetrating a work material is actually less than such resistance encountered by such conventional spike point.

Yet a further object is to provide an improved spike element comprising as the lower end portion thereof a work-material penetrating small-diametered hemispherically pointed tapered section having a characteristic of indefinite durability which by eliminating frequent replacement and resharpening costs economically justifies the increased cost of close-tolerance dimensioning and finishing of the upper end portion thereof to perform the pneumatic seal and dust seal functions of the ordinary tappet member so that, by the therefore practicable omission of the same, impact force and energy can be transmitted from the hammer-piston to such improved spike element with increased efficiency.

Still a further object is the provision of an indefinitely durable spike element of the character described which is adapted to receive and utilize impact energy with increased efficiency and is therefore adapted to contribute to operational economics both materially lowered maintenance costs and substantial wage savings.

Additional objects and advantages of the invention will become apparent as the specification develops.

Exemplary embodiments of the invention are illustrated in the accompanying drawings, in which—

FIGURE 1 is a broken vertical sectional view showing a spike or work member embodying the invention in operative association with a percussive tool;

FIGURE 2 is a side view in elevation of a modified spike or work member;

FIGURES 3 through 6 are side views, primarily in elevation, of the spike illustrated in FIGURE 1 shown in relation to a work material; and such figures respectively illustrate successive stages in a cycle of penetration and fracture of the work material by the spike; and

FIGURES 7 through 10 are side views, primarily in elevation, of the modified spike illustrated in FIGURE 2 shown in relation to a work material; and such figures respectively illustrate successive stages in a cycle of penetration and fracture of the work material by the modified spike.

Description of structure

The structural exemplification of the invention illustrated in FIGURES 1 and 3 through 6 of the drawings includes a work member or spike element S having a shank **10** of tapered configuration which at its outer or lower end terminates in a point **11**. At its upper end, the shank **10** is equipped with an axially extending stem **12** formed integrally therewith that is generally cylindrical and has a diameter substantially less than that of the enlarged upper-end portion of the tapered shank. An annular surface or shoulder **13** is defined by such enlarged upper-end portion of the shank **10** along the plane of its mergence with the stem **12**.

The stem **12** at its upper end is equipped with an enlarged head forming a piston **14** that extends into the lower-end portion of a working cylinder **15** defined by the casing **16** of a percussive tool, generally denoted by the numeral **17**. Reciprocable within the cylinder **15** is a hammer-piston **18** adapted to deliver repetitive blows or impact forces directly to the enlarged head **14** of the spike, and the hammer-piston is reciprocated along the longitudinal axis of the cylinder **15** by pressure fluid applied to the opposite ends of the hammer-piston in a manner to effect such reciprocation thereof. The spike is retained in operative asssociation with the percussive tool **17** by a retainer **19** in the form of a split nut having sections **20***a* and **20***b* which threadedly engage the lower-end portion of the casing **16** and extend inwardly therefrom in circumjacent relation with the stem **12** below the head **14** thereof. The sections **20***a* and **20***b* of the nut are maintained in threaded engagement with the casing by a constraining ring that extends about the nut sections, as shown, and is held in place by a split snap washer **22**.

The percussive tool **17** is adapted to deliver high-valued impact forces to the spike S—for example, blows upward of approximately 150 foot-pounds, and preferably in excess of 200 foot-pounds, which are adequate to positively drive the aforesaid enlarged upper-end portion of the shank subjacent the shoulder **13** thereof, in contrast to the relatively low-valued impact forces in the order of 60 to 75 foot-pounds developed by commercially available paving breakers which have been found to be definitely inadequate for this purpose. The tool **17** may be a paving breaker of the type disclosed in Leavell Patent No. 2,679,826, which is a pneumatically-actuated paving breaker that, in addition to developing and transmitting such high-valued blows to a work member, has vibrationless characteristics in that substantially no sensible vibration is present in the handle-equipped casing thereof during tool operation. Considering the tool **17** to be of such type and embodying the principles thereof, the hammer-piston **18** is continuously urged downwardly toward impact engagement with the head **14** of the spike S by pneumatic pressure continuously acting downwardly against the upper surface of the hammer-piston, and it is reciprocated upwardly against such continuous pressure by an intermit-

tently applied pressure force of superior value cyclically admitted to the lower-end portion of the cylinder **15** through one or more ports **23** to act upwardly against the lower surface of the hammer-piston.

The spike S is intended to be of permanent or semi-permanent character, as will be brought out in greater detail hereinafter; and in consequence of this consideration, the enlarged head **14** thereof is machined or otherwise finished to close tolerances so as to slidingly and sealingly engage the walls of the cylinder **15** along the lower-end portion thereof.

The spike S, as mentioned hereinbefore, has a tapered configuration along the shank **10** thereof progressively enlarging in cross section from the point **11** to the surface defining the shoulder **13**; and in the form illustrated, the tapered shank has a generally conical configuration which is a particular type of taper that is advantageously employed. The tapered form shown is generally that of a right circular cone and the side wall thereof is substantially straight (that is, not stepped, concave nor convex), although some deviation from such straight-sided configuration in either a concave or convex sense is permissible and in certain instances advantageous, as will be brought out in detail hereinafter.

The spike S has substantial mass, as illustrated in FIGURE 1, wherein an exemplary structure is drawn to approximately full scale, but the point **11** thereof is relatively small in its maximum cross sectional area although it has a generally hemispherical configuration. As a specific example, one form of spike used quite successfully has a point diameter of approximately 0.656 of an inch so that the maximum cross sectional area of the point (that is, of the plane defined by the mergence thereof with the tapered shank) is approximately 0.34 of a square inch. Thus, the maximum cross sectional area of the point **11** which is resisted in its penetration of a work material by the compressive strength thereof, is quite small relative to the corresponding cross sectional area of a conventional 1¼ inch hexagonal spike which is about 1.35 square inches—four times as great. The small size of the point **11** is tolerable because of the large mass of properly distributed metal used to support the same; namely, the tapered shank **10** of the spike; and such small point is, quite evidently, advantageous in that the total resistance to penetration exerted thereagainst by the compressive strength of a work material is usefully minimized thereby.

Such hemispherical configuration is additionally advantageous in that it is the optimum configuration of the point **11** for resisting abrasive deterioration thereof caused by repeated penetrations of a work material. It will be apparent that the point **11** may be varied from the hemispherical configuration illustrated and, by way of example, it could be more sharply pointed in which case it might have a pyramidal or cone-shaped form, but it has been found in actual use that any increase in penetration rate attributable to sharpening the point is inconsequential. Furthermore, any such increase in penetration rate would be merely temporary in character because abrasion during continued use would dull the point and tend to restore it to the generally hemispherical form shown. The point **11** could also be flattened substantially, in which case the penetration rate might be slightly decreased, but again, abrasive action would tend to restore the point to the illustrated configuration thereof. In view of the fact that all such deviations are of temporary character, it will be understood that the hemispherical form of the point as shown represents the final or restored stage of such deviate forms as well as the optimum non-deteriorating form preferably imposed by initial manufacture. Because of the unique shape-stability characteristic of this rapidly-penetrating hemispherical form, which cannot be materially improved by temporarily sharpening it, it will be clear that the hemispherical point form contributes to permanent spike design the positive advantage of minimizing the rate of abrasive removal of metal in the vicinity of the point.

Operational description

In a demolition cycle, the point **11** of the work member or spike element S is placed against an exterior surface of a work material or material mass which is to be fractured and broken. Most frequently, the work material **24** will be a concrete slab, as illustrated in the drawings, in which case the exterior surface **25** thereof will have a generally horizontal disposition. However, as is well understood in the art, the work material may comprise any one of a number of admixtures of various aggregates and bonding materials therefor, or layers of the same or different admixtures, or it may be a reinforced or unreinforced mass, and the mass of work material may be vertically rather than horizontally disposed, in which case the spike S will be horizontally oriented. And, in certain instances, for example, in the case of a concrete roof, ceiling or arch, the spike S may be upwardly oriented so as to attack the undersurface of such work material.

In any event, the point **11** is placed against an exterior surface of the work material, and energization of the percussive tool **17** reciprocates the hammer-piston **18** thereof into repetitive impact engagement with the enlarged head **14** of the spike. One or more high-energy blows will be effective to initially drive the small-area point **11** of the spike into the work material **24**, as shown in FIGURE 3. The magnitude of the compressive resistance of the work material to such penetration is directly related to the area thereof under attack by the spike point; and, as indicated in FIGURE 3, such area under attack is substantially equal to the projected area of the transverse plane defining the mergence of the point **11** of the spike with the tapered shank thereof—only 0.34 square inch in the specific example heretofore set forth.

The spike S progressively penetrates the work material **24** as a consequence of the repetitive impact forces delivered thereto; and in contrast to a conventional work member, the spike S at the same time it is penetrating the work material wedgingly applies high-valued lateral force components thereto that tend to be greatest in magnitude along and near the penetrated exterior surface of the work material. Such lateral force components are normal in orientation relative to the longitudinal axis of the spike, as shown in FIGURE 4, and they are applied to the work material **24** at substantially each point that it is in engagement with the tapered surface or surfaces of the spike. Therefore, for a spike having substantially straight side walls, as in the case of a right cone or pyramid, the lateral force components are applied to the work material at substantially each incremental surface area thereof along the length of the penetration made therein by the tapered surface of the spike. In FIGURES 4 and 5 the mass of work material **24** is divided by broken lines into layers respectively identified by the numerals **26** and **27**, and the relative magnitudes of the lateral force components respectively acting thereon along the plane of the drawing are indicated by the length of the arrows located within such layers.

Accordingly, it will be noted in FIGURE 4 that the force arrows within layer **26** have a greater length than the force arrows within the layer **27**, which pictorially indicates that the magnitude of the lateral force components concentrated within the layer **26** exceeds the magnitude of the lateral force components concentrated within the layer **27**. This condition occurs because the laterally-pressing surface area of the spike in engagement with the layer **26** exceeds the laterally-pressing surface area thereof in engagement with the layer **27**. Therefore, and because the shank **10** of the spike progressively enlarges from the point **11** toward its upper end, the lateral force concentration, which quite apparently is attacking the work material **24** in tension, is greatest toward the penetrated exterior surface **25** thereof.

As shown by comparison of FIGURES 4 and 5, the lateral force components developed by the spike S against any layer of the work material **24** are progressively increased in magnitude as the spike progressively penetrates the work material to greater depths. Thus, the force arrows located in the layer **26**, as shown in FIGURE 5, are of greater length than the force arrows shown in FIGURE 4 which are located in the layer **26**, because at this later time the spike has penetrated the work material **24** to a greater depth.

The lateral force components in each layer continue to increase in magnitude as penetration proceeds until fracture of the work material **24** occurs, as indicated in FIGURE 6; and if the fracture is a complete breakage, the resulting segments of the work material are displaced relative to each other whenever the forces tending to resist such relative displacement are not inexorable relative to the magnitude of the forces in opposition thereto which are laterally applied by the penetrating spike S.

It has been found, quite surprisingly, that a spike S formed in accordance with the present invention is effective to fracture a thick mass of work material **24** seemingly independently of the axial length of the material-penetrating portion of the spike. Apparently, this is because the lateral forces applied by the spike to the work material **24** and which attack the same in tension usually exceed the total effective tensile strength of the material irrespective of the thickness thereof. As concerns specific examples, a spike formed in accordance with the present invention and having an axial length of only seven inches from the lower surface of the point **11** to the surface of the shoulder **13**, has repeatedly fractured exceptionally strong concrete slabs (i.e., seven, eight and nine-bag mix, as compared with excellent roadway concrete which is usually five or six-bag mix) of various thicknesses, namely up to fourteen inches, which is substantially thicker than concrete slabs normally encountered. In certain other tests, a large concrete block having a thickness in excess of two feet was quickly fractured through its entire thickness by a spike of the same dimensions.

After a long history of development, it may be stated that spikes formed in accordance with the present invention positively do not break in flexure, although the mass of steel at the plane defined by the mergence of the point **11** with the tapered shank of the spike amounts to only 25% to 15% of the mass of steel at the corresponding location or at any point thereabove along the hexagonal shank of a conventional spike. Moreover, although some abrasion of the point **11** of a spike formed in accordance with the invention must always occur, it has been found that the rate thereof is insignificant and wholly negligible in such spikes, and that no apparent deterioration of the points thereof has occurred from thermally-induced fluid deformation. Apparently such fluid deformation is completely or almost wholly obviated because the spike and point thereof remain quite cool relative to the temperature elevations exhibited by conventional spikes. This result, it is believed, may be attributed in large measure to minimization of the strongly-resisted compressive attack on a work material during penetration thereof by tapered spikes made in accordance with my invention and maximization of the weakly-resisted tensile attack thereupon.

Modification

A modified spike is illustrated in FIGURES 2 and 7 through 10, and in both structural and functional terms such spike is generally similar to the spike S heretofore described. For this reason the modified spike in its entirety is denoted with the letter S′ and the primed form of the same numerals used to designate component parts of the spike S is adapted to identify the respective corresponding component parts of the spike S′.

As stated hereinbefore, deviations from the straight-sided taper provided by the spike S, especially in either a concave or convex sense, may be incorporated in the spike structure; and such a deviation in the concave direction is especially advantageous and is embodied in the spike S′. More particularly, it is desirable with certain paving breakers, such as the tool shown in the aforementioned Leavell Patent No. 2,679,826, to have a "quick-sticking" spike—that is, one which is frictionally gripped and constrained by a work material almost immediately after it has been initially penetrated by the spike point. This result is desirable because it obviates the tendency of the spike to bounce or rebound upwardly from the work material before it has penetrated the same to any appreciable extent. The spike S′ has this quick-sticking characteristic which is attained by reducing the angle of taper of the shank **10′** adjacent the generally hemispherical point **11′**.

Accordingly, the shape of the shank **10′** is such that the side walls thereof are approximately straight for a very short axial distance above the point **11′**, and the cross sectional area of the spike shank along this short distance is substantially the same as the maximum cross sectional area of the spike point **11′**. Beyond this short shank section, the side walls of the shank gradually curve upwardly and outwardly to provide the same with a generally concave taper. As in the case of the spike S, the shank **10′** is generally conical and at its upper end is equipped with an integrally formed stem **12′** of reduced cross section having an enlarged head **14′** adapted to be slideably received within a percussive tool, all as heretofore described in connection with the spike S.

In a demolition cycle, the point **11′** of the spike is placed against an exterior surface of a work material or material mass **24′** which is to be fractured and broken. Energization of the percussive tool, of which the spike S′ forms a permanent or semi-permanent component thereof, causes the spike to progressively penetrate the work material **24′** through the exterior surface **25′** thereof as a consequence of the repetitive impact forces delivered to the spike. As the short, approximately straight sided section of the shank **10′** enters the work material, it is frictionally gripped thereby with a frictional force having a magnitude sufficient to strongly constrain the spike within the mass. Beyond such short section, the tapered side walls of the shank apply lateral force components to the work material that tend to be greatest in magnitude along and near the penetrated surface **25′** thereof. Such lateral force components are essentially normal in orientation relative to the longitudinal axis of the spike, as shown in FIGURE 8; and they are applied to the work material at substantially each point that it is in engagement with the tapered surface or surfaces of the spike. Therefore, since the shank **10′** is tapered along its entire length above the relatively short, approximately straight-sided section thereof adjacent the point **11′**, such lateral force components are applied to the work material substantially along the entire length of the penetration made therein by the spike.

In FIGURES 8 and 9 the mass of work material **24′** is divided by broken lines into layers respectively identified by the numerals **26′** and **27′**; and the relative magnitudes of the lateral force components respectively acting thereon along the plane of the drawing are indicated by the lengths of the arrows located within such layers. Accordingly, it will be noted in FIGURE 8 that the force arrows within the layer **26′** have a greater length than the force arrows within the layer **27′**, which pictorially indicates that the magnitude of the lateral force components concentrated within the layer **26′** exceeds the magnitude of the lateral force components concentrated within the layer **27′**. This condition occurs because the laterally-pressing surface area of the spike in engagement with the layer **26′** exceeds the laterally-pressing surface area thereof in engagement with the layer **27′**. Therefore, and because the shank **10′** of the spike progres-

sively enlarges toward the upper end thereof, the lateral force concentration, which quite apparently is attacking the work material **24'** in tension, is greatest toward the penetrated exterior surface **25'** thereof.

As shown by comparison of FIGURES 8 and 9, the lateral force components developed by the spike S' against any layer of the work material **24'** are progressively increased in magnitude as the spike progressively penetrates the work material to greater depths. Thus, the force arrows located in the layer **26'**, as shown in FIGURE 9, are of greater length than the force arrows shown in FIGURE 8 which are located in the layer **26'**, because at this later time the spike has penetrated the work material **24'** to a greater depth.

The lateral force components in each layer continue to increase in magnitude as penetration proceeds until fracture of the work material **24'** occurs, as indicated in FIGURE 10; and if the fracture is a complete breakage, the resulting segments of the work material are displaced relative to each other whenever the forces tending to resist such relative displacement are not inexorable relative to the magnitude of the forces in opposition thereto which are laterally applied by the penetrating spikes S'.

In contrast to the spike S (as is evident by comparing FIGURES 6 and 10), the lower-end portion of the spike shank **10'** is released from engagement with the work material **24'** upon separation of the fragments thereof, and this action occurs because of the concave configuration of the spike shank which more rapidly increases in cross sectional area toward the upper-end portion thereof. It will be obvious that this same concave configuration also tends advantageously to concentrate even more of the laterally developed forces attacking the work material in tension along and near the penetrated surface thereof, relative to the aggregate value of all such forces, than in the case of the straight-sided spike S.

This statement that such factor of even greater near-surface concentration by the concave configuration of the laterally effective forces tensionally attacking the slab of work material with the object of usefully fragmenting the same by over-stressing it in tension is an advantageous factor refers to the particular mode of such useful separation of the work material into fragments which is the optimum mode as concerns minization of required force and energy magnitudes. For this optimum mode of fragmentation of a slab of work material consists in subjecting it to a separating action which is essentially a tearing action wherein the generally transverse extension of the separation commences immediately at the penetrated surface of the slab and thereatfer progressively extends farther and farther toward the opposite surface thereof until such opposite surface is also fractured and the break is complete. It will be understood that the maximum laterally effective force development required in the course of completing such tearing action amounts to only a very minute fraction of the laterally effective force which would be required to produce a break of the same area in the alternative manner in which the break, instead of progressing from one surface to the other surface of the slab, would be produced instantaneously by the application of a sufficient total lateral force homogeneously over the entire area of such instantaneous break. Evidently then, the concave configuration of the tapered shank of the spike S' is even more efficient than the straight-sided configuration of the tapered shank of the spike S in producing such low-force and low-energy progressive tearing action of a slab of work material by virtue of the specialization of the concave configuration for affording such factor of even greater near-surface concentration of such laterally effective demolition forces.

The spike S' also has all of the advantageous characteristics described with reference to the spike S, including maximum resistance to abrasive deterioration of the point, substantial elimination of flexural breakage, and the operational economies associated with the consequent property of indefinite durability.

General considerations

It is advantageous in use of a work member or spike in a percussive tool to resiliently relate the same to the casing thereof in order to protect the casing from impact forces which might otherwise be transmitted thereto if the spike were sufficiently accelerated in either axial direction to propel stop-surfaces carried by the spike into possibly destructive engagement with corresponding stop surfaces carried by the casing to interrelate the casing and spike for limited relative axial movement. Such a resilient relationship of the spike to the casing is shown in FIGURE 1 and is provided by the structures **28** and **29** which are respectively disposed in circumjacent relation with the stem **12** of the spike. Although such resilient structures may take variant forms, those shown have been found effective and each comprises one or more rubber rings which are mounted on the stem by stretching the same over the enlarged upper end of the spike shank **10**. Any one of several commercially available rubber compositions of adequately high durometer may be used in this way to form the rings, and the various rings or laminations of the doughnut-shaped structure **28** may be adhesively bonded to each other.

It is evident from the foregoing description that spikes embodying the present invention are capable of being employed as permanent or semi-permanent components in percussive tool structures, whence it becomes economically feasible to accurately finish the upper-end portion of the spike. As a result, such upper-end portion provides an excellent pneumatic seal permitting cylinder structure thereabove to be pressurized. Additionally, such accurately-finished upper-end portion of the spike affords an excellent associated dust barrier function.

It is further evident from the foregoing description that the instant invention comprehends not only an improved demolition spike or work member structure but also a specialized method for more efficiently demolishing concrete slabs and other material masses. In such method the material mass is penetrated through an exterior surface thereof and at substantially the same time lateral compressive forces are applied generally along the surface formed in the mass by such penetration to significantly stress the mass in tension, such lateral compressive forces and associated tensional stresses being increased progressively toward values thereof at which fracture is accomplished. More particularly, the relatively low tensile strength of such material masses is made the basis of an improved method for fracturing the same in which a significant component of the entire destructive force imparted to such material mass is properly concentrated to produce an efficient tearing-action attack against the low tensile strength of the mass.

While in the foregoing specification embodiments of the invention have been set forth in considerable detail for purposes of making an adequate disclosure thereof, it will be apparent to those skilled in the art that numerous changes may be made in such details without departing from the spirit and principles of the invention.

I claim:

1. The combination with a paving breaker having a casing providing a cylinder having therein a reciprocable hammer-piston operative to develop relatively high-valued impact forces for transmission to a work material in the demolition thereof, of a work member for transmitting such impact forces to such work material and comprising a shank equipped at one end thereof with an integral point and at the other end thereof with an integral stem, said point having a generally hemispherical configuration defining the material-engaging surface thereof, said stem having at least a portion thereof finished to relatively close tolerances slidably and sealingly received within said cylinder and being of substantially the

same cross sectional area as said cylinder to completely fill the same transversely and thereby effectively provide a lower end closure therefor, and said shank having a generally tapered configuration enlarging significantly in cross section toward said stem from its smallest cross section adjacent said point, said tapered configuration being circumferentially uniform so as to define a circle at any cross section of said shank taken therealong.

2. The combination of claim 1 in which said tapered configuration defines an inverted right-angle cone.

3. The combination of claim 1 in which said tapered configuration has a generally concave contour.

4. A work member for use with a paving breaker having a reciprocable hammer-piston adapted to repetitively deliver relatively high-valued impact forces to said work member in the demolition of work material, comprising a shank equipped at one end thereof with an integral point and at its other end with an integral stem, said point having a generally hemispherical configuration defining the material-engaging surface thereof, said stem defining an impact-receiving element for transmission thereto of such impact forces from such hammer-piston, and said shank having a generally tapered configuration enlarging significantly in cross section toward said stem from its smallest cross section adjacent said point.

5. A work member for use with a paving breaker having a reciprocable hammer-piston adapted to repetitively deliver relatively high-valued impact forces to said work member in the demolition of a work material, comprising a shank equipped at one end thereof with an integral point and at its other end with an integral stem, said point having a generally hemispherical configuration defining

the material-engaging surface thereof, said stem defining an impact-receiving element for transmission thereto of such impact forces from such hammer-piston, and said shank having a generally tapered configuration enlarging significantly in cross section toward said stem from its smallest cross section adjacent said point, said tapered configuration being circumferentially uniform so as to define a circle at any cross section of said shank taken therealong.

6. The work member of claim 5 in which said tapered configuration is an inverted right-angle cone.

7. The work member of claim 5 in which said tapered configuration has a generally concave contour.

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