

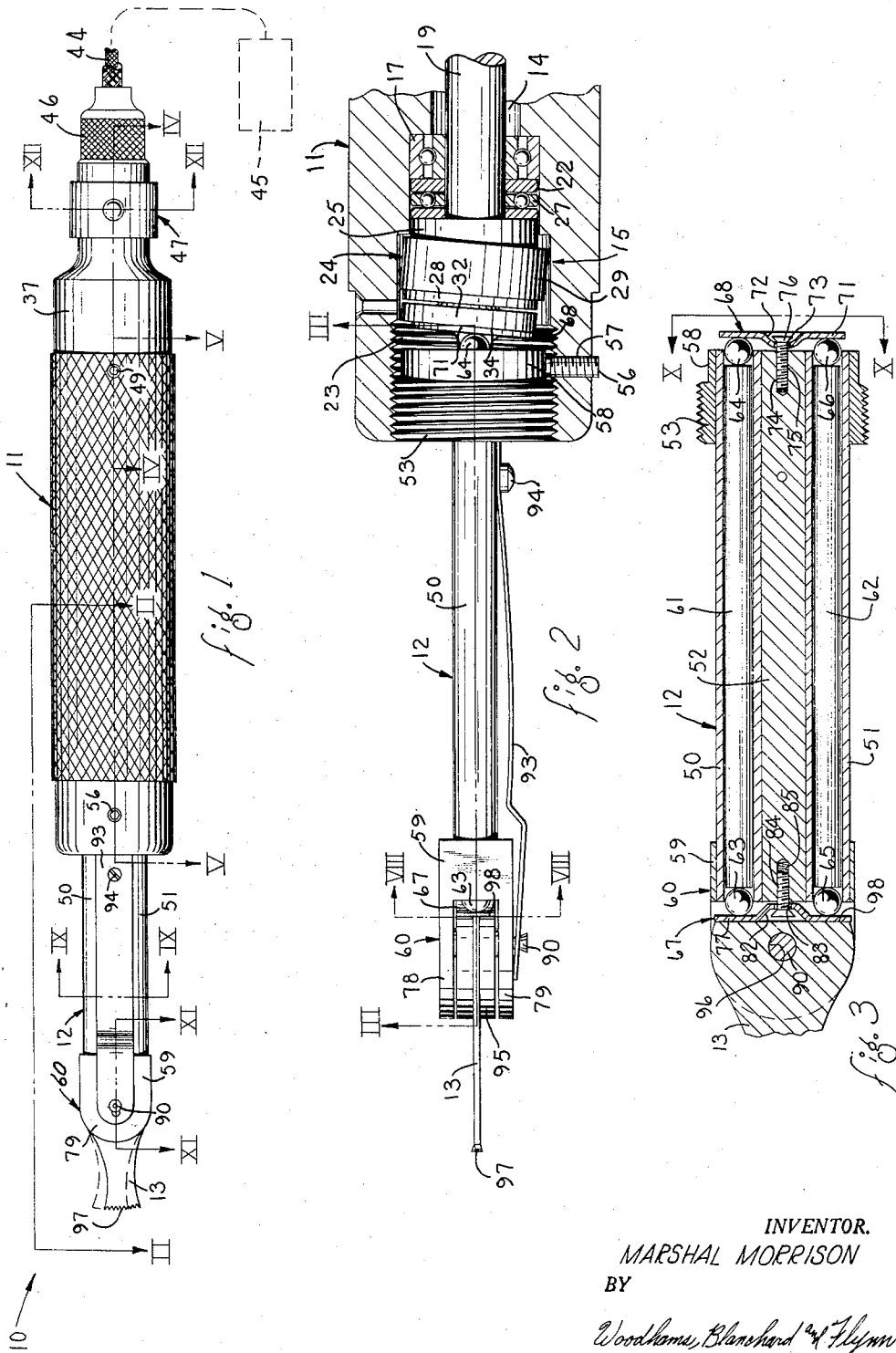
Oct. 7, 1958

M. MORRISON
SURGICAL INSTRUMENT

2,854,981

Filed Feb. 18, 1957

3 Sheets-Sheet 1



INVENTOR.
MARSHAL MORRISON
BY
Woodhouse, Blanchard & Flynn
ATTORNEYS

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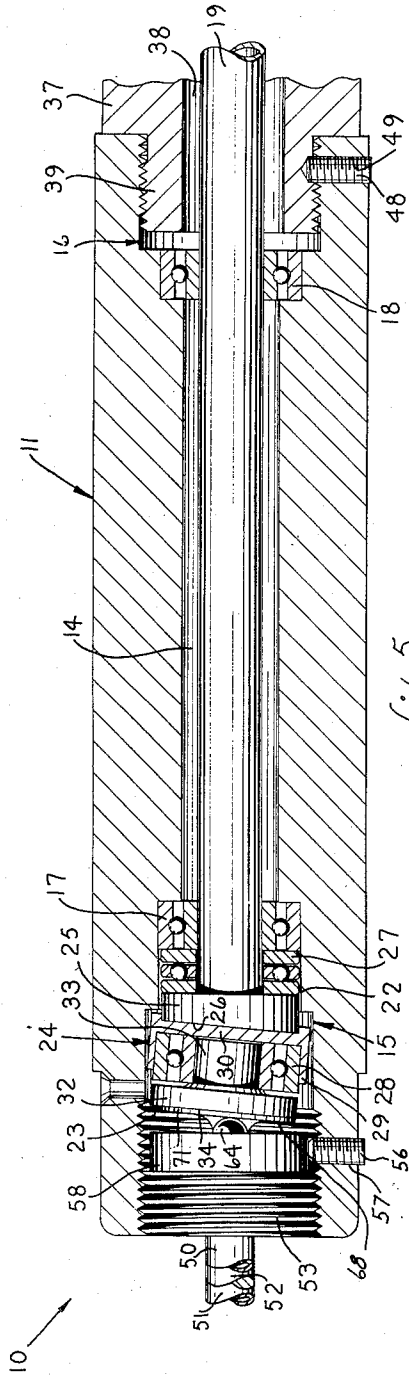


fig. 5

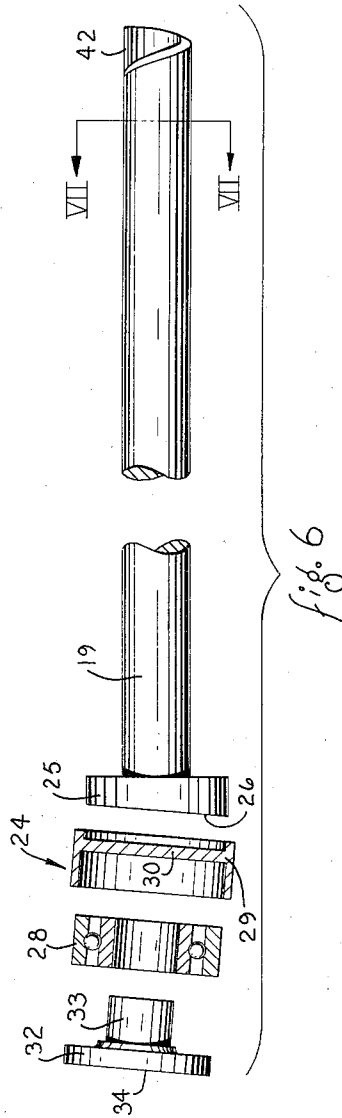


fig. 6

INVENTOR,
MARSHAL MORRISON
BY

Woodhams, Blanchard and Flynn
ATTORNEYS

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M. MORRISON

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3 Sheets-Sheet 3

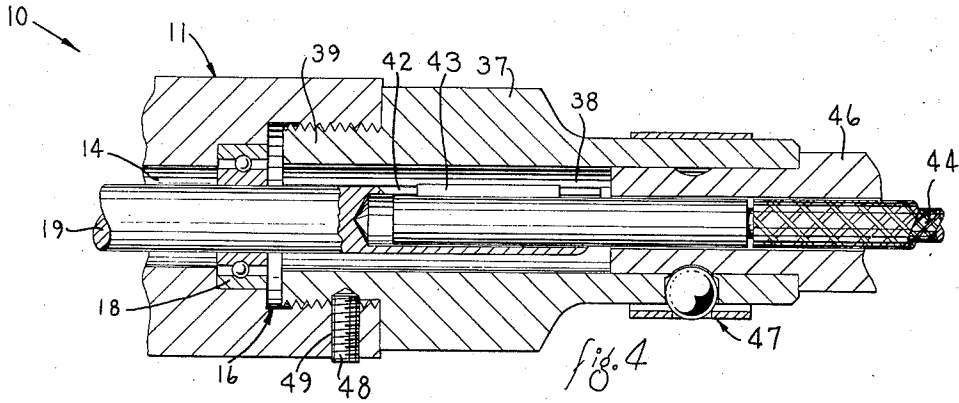


fig. 4

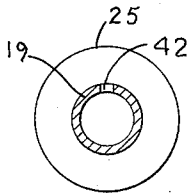


fig. 7

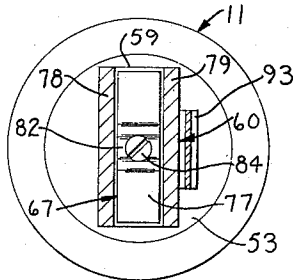


fig. 8

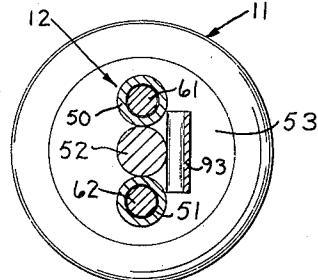


fig. 9

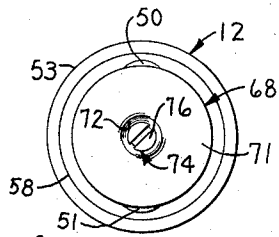


fig. 10

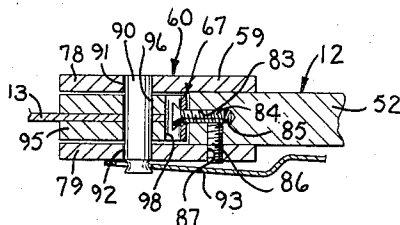


fig. 11

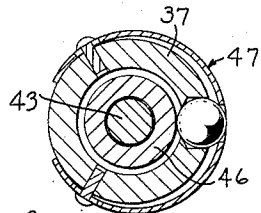


fig. 12

INVENTOR.
MARSHAL MORRISON
BY
Woodhams, Blanchard & Flynn
ATTORNEYS

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2,854,981

SURGICAL INSTRUMENT

Marshal Morrison, Plainwell, Mich., assignor to Orthopedic Frame Company, Kalamazoo, Mich., a corporation of Michigan

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6 Claims. (Cl. 128—317)

This invention relates in general to a surgical cutting implement, which can be used in very confined zones and, more particularly, to a type thereof having an arcuate cutting edge, which is oscillated about the axis of the arc of said edge.

In spite of many advances in surgical techniques, particularly in the field of bone surgery, there has long existed a pressing need for more effective and efficient instruments for carrying out surgical operations for which the theoretical procedures have been well known. For example, it has long been recognized that the incision required for positioning a bone cutting instrument is often much larger than the actual cut made in the bone structure. This is usually due to the fact that the bone cutting instruments are relatively large and, furthermore, if the incision is too small, the cutting edge may injure the soft tissue. The only instrument, with which I am familiar, which has attempted to meet this problem, is the surgical saw shown in Patent No. 2,702,550, which is assigned to the assignee of this application. However, this surgical saw was designed for use on the relatively soft bone structure in the nasal passages of a human being and is not suited for the relatively sustained and continuous use required in heavier work, as on harder and larger bones in other parts of the anatomy. It has been found that excessive heat is developed between the frictional engagement of the moving parts of this instrument, where it is used for extended periods of time or on bone structure which is highly resistant to cutting. Because of the friction, and the heat resulting therefrom, the speed of oscillation of the saw blade is also considerably limited. However, it is known that a higher rate of blade oscillation, than is presently possible with an instrument such as that shown in said patent, is highly desirable, particularly where relatively hard bone material is being cut.

It is also important that the stroke of the cutting blade at a point along the cutting edge thereof be less than approximately $\frac{1}{8}$ inch, in order to avoid injury to the tissues surrounding the bone, which is being cut.

Accordingly, a principal object of this invention has been the provision of a surgical saw, especially designed for working on relatively hard, bony material of the human body, which is located in regions which are difficult to reach or wherein the space for conducting the operation is limited.

A further object of this invention is the provision of a surgical saw, as aforesaid, by the use of which the incision required for reaching the bone to be cut can be substantially smaller than previously necessary to accommodate existing saws for the same, or similar purposes.

A further object of this invention has been the provision of a surgical saw, as aforesaid, wherein the cutting edge of the saw is located at the end of a projection, or beam, having a relatively small cross-section, wherein an oscillatory movement of the cutting edge on said saw is effected by means extending through said projection, and wherein said surgical saw converts rotational motion,

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developed by means such as an electric motor, into said oscillatory movement of the saw edge with an absolute minimum of frictional losses, hence, with an absolute minimum of heat generation.

5 A further object of this invention has been the provision of a surgical saw, as aforesaid, which can be operated with a minimum of effort, and the cutting blade of which can be easily and quickly removed, as for cleaning, and then returned or replaced for operation without concern for sensitive adjustments or critical areas which might otherwise reduce the effectiveness of the instrument.

Other objects and purposes of the invention will become apparent to persons familiar with this type of equipment upon reading the following specification and examining the accompanying drawings, in which:

Figure 1 is a side elevational view of a sagittal plane, surgical saw characterizing the invention.

Figure 2 is a partially elevational view and partially centrally cross-sectional view of a fragment of Figure 1, about as indicated by the cutting line II—II.

Figure 3 is a sectional view taken along the line III—III of Figure 2.

Figure 4 is a sectional view taken along the line IV—IV of Figure 1.

Figure 5 is a sectional view taken along the line V—V of Figure 1.

Figure 6 is an exploded, broken view, partially in central cross-section, of the drive shaft of said saw.

Figure 7 is a sectional view taken along the line VII—VII of Figure 6.

Figure 8 is a sectional view taken along the line VIII—VIII of Figure 2.

Figure 9 is a sectional view taken along the line IX—IX of Figure 1.

Figure 10 is an end elevational view of the structure shown in Figure 3, as indicated by the cutting line at X—X.

Figure 11 is a sectional view taken along the line XI—XI of Figure 1.

Figure 12 is a sectional view taken along the line XII—XII of Figure 1.

General description

45 In order to meet the objects and purposes set forth above, there has been provided a sagittal plane, surgical saw comprised of a hollow handle, in which a drive shaft is rotatably supported, and from one end of which there projects a blade-supporting beam, the lengthwise axis of said beam being a substantial extension of the rotational axis of said drive shaft. The saw blade is pivotally supported upon the free end of the beam, which slidably supports a pair of thrust rods, operable by said drive shaft, for effecting oscillatory movement of said saw blade about an axis transverse of said beam in response to rotational movement of said drive shaft.

For the purpose of convenience in description, the terms "inner," "outer," and derivatives thereof, will have reference to the geometric center of the surgical saw, and parts thereof. The terms "front," "rear," and derivatives thereof, will have reference, respectively, to the left and right ends of said surgical saw and parts thereof, as appearing in Figures 1 to 5.

Detailed construction

As shown in Figure 1, the surgical saw 10, to which this invention relates, has an elongated, manually engageable body 11 and an elongated beam 12, one end of which is removably supported upon the front end of said body 11 and the other end of which removably supports a cutting blade 13. The body 11, which is preferably cylindrical and fabricated from a durable material, such

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as stainless steel, has a co-axial bore 14 (Figure 5) extending completely therethrough. The front and rear portions 15 and 16, respectively, of the bore 14 are enlarged and internally threaded adjacent to their respective outer ends. Bearings 17 and 18 are disposed within the enlarged portions 15 and 16 at the inner ends thereof, for the purpose of rotatably supporting a drive shaft 19.

The enlarged portion 15 (Figure 5) includes a cylindrical chamber 22 between the threaded, front end 23 and the bearing 17. A motion-converting device 24 (Figures 2, 5 and 6) is disposed within the chamber 22. The device 24 includes a head 25 which has a circular cross-section of substantially greater diameter than the shaft 19 and which is co-axially secured to the front end of said shaft 19 within the chamber 22. The head 25 is provided with a substantially circular and planar, front end surface 26, which is disposed at a relatively small, acute angle with respect to a plane perpendicular to the rotational axis of the shaft 19. In one particular embodiment, this angle is approximately 4 degrees (Figure 6) and the centerline distance between the rods 61 and 62 (Figure 9), which are described in detail hereinafter, is about $\frac{3}{8}$ inch. A thrust bearing 27 is disposed within the chamber 22 between the head 25 and the radial bearing 17. A cylindrical sleeve 29, having a transverse partition 30 between the ends thereof, is mounted upon the front end of said head 25 so that said partition is snugly adjacent to the surface 26. A radial bearing 28 is mounted within the sleeve 29 on the side of said partition opposite said head 25, so that the axis of said bearing 28 is substantially perpendicular to, and co-axial with, said end surface 26.

A circular cam plate 32 is provided with an integral stub shaft 33, which is supported within the radial bearing 28. Said cam plate 32 has a substantially planar cam surface 34 on the front side thereof which is preferably parallel with the end surface 26 and, therefore, at substantially the same angle with the axis of shaft 19. Thus, as the shaft 19 is rotated, the axis of the stub shaft 33 will sweep through a conical path and the cam plate 32 will wobble with respect to said drive shaft, said cam surface 34 continuously remaining at the same angle with respect to the axis of said shaft.

A connecting sleeve 37 (Figure 4), having a co-axial bore 38, is provided with an externally threaded end portion 39, which is threadedly received into the rear end portion 16 of the body 11. The adjacent, or rear, end of the drive shaft 19, which extends co-axially into the bore 38, has a slotted, co-axial recess 42 (Figures 4, 6 and 7) for slidable, but non-rotatable, reception of the drive end 43 (Figure 4) of a flexible cable 44, the other end of which is connected in any suitable manner to a prime mover 45 (Figure 1). The cable 44 is rotatably supported adjacent to its drive end 43 within a connecting member 46, which member is removably held with respect to the connecting sleeve 37 by means of the coupling device 47 (Figures 4 and 12). A set screw 48 is threadedly received through a radially disposed, set screw opening 49, which communicates with the rear end portion 16 of the bore 14 in the body 11. Said screw 48 engages the end portion 39 of the connecting sleeve 37, whereby the sleeve 37 is held against rotation with respect to said body 11.

The beam 12 is comprised, in this particular embodiment, of a pair of substantially identical metal tubes 50 and 51 (Figures 1 and 3), which are secured, as by brazing, to diametrically opposite sides of, and substantially parallel with, the support rod 52. The tubes 50 and 51 and rod 52 extend through, and are rigidly supported at corresponding ends of each within, and upon, the externally threaded plug 53 (Figures 2 and 9), which is threadedly receivable into the front end portion 15 of the bore 14 in the body 11. A set screw 56 is threadedly received through a radially disposed, set screw opening 57, which communicates with the front end portion 15

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of the bore 14 in the body 11. Said screw 56 engages the peripheral surface 58 of the plug 53 to hold same against rotation in a substantially conventional manner. The front ends of the tubes 50 and 51 and the support rod 52 extend through, and are supported upon, the base 59 of the bifurcated blade support head 60.

A pair of thrust rods 61 and 62 (Figure 3) are axially and slidably disposed within the tubes 50 and 51, respectively, and are slightly shorter than their respective tubes. Two pairs of bearing balls 63, 64, 65 and 66 (Figure 3) are disposed at opposite ends, respectively, of the thrust rods 61 and 62 and extend partially into the tubes 50 and 51. Said bearing balls, which are preferably of substantially the same diameter as the inside diameter of the tubes with which they are associated, are held snugly against the ends of said thrust rods by means of the bearing ball retainers 67 and 68. The bearing ball retainer 68, located at the rear, or body, end of the beam 12 (Figures 3 and 10) is comprised of a circular plate 71 having a central portion which is off-set to provide a recess 72, and having a co-axial screw opening 73. A retainer screw 74 is slidably received through said opening 73 and threadedly received into the threaded screw opening 75 in the rear end of the support rod 52. The head 76 of said screw 74 is disposed in the recess 72 for pivotally and rotatably supporting the plate 71 with respect to the rear end of the beam 12, and against the bearing balls 64 and 66.

The rear surface of the plate 71 (Figures 2 and 5) on the retainer 68 is snugly, but slidably, engageable with the cam surface 34 on the cam plate 32 when the threaded plug 53 on the beam 12 is threadedly disposed within the front end portion 15 of the bore 14.

The bearing ball retainer 67 (Figures 3, 8 and 11) is comprised of an elongated plate 77 which is disposed between the parallel arms 78 and 79 of the blade support head 60. Said plate 77 has a centrally disposed, offset portion 82, through which an opening 83 is provided for slidable reception of a retainer screw 84. Said screw 84 is threadedly received into an appropriate opening 85 in the adjacent end of the support rod 52 for pivotally holding said plate 77 with respect thereto, and against the bearing balls 63 and 65. A set screw opening 87 (Figure 11) is provided through the blade support base 59 and the adjacent portion of the rod 52, and communicates with the retainer screw opening 83. A set screw 86 is threadedly received into the opening 87 for engaging and holding the retainer screw in a selected position. Accordingly, by proper adjustment of the screws 76, 84 and 86, the bearing ball retainers 67 and 68 will cooperate to prevent dislodgement of their respective bearing balls from their positions adjacent to the ends of the thrust rods 61 and 62, while permitting said thrust rods to reciprocate simultaneously with respect to the beam 12 and in opposite, axial directions with respect to each other.

The blade support 60 is provided with a pivot shaft 90, which slidably extends through the shaft openings 91 and 92 (Figure 11) in the support arms 78 and 79, respectively. Said shaft 90 is rotatably supported at one end upon, and held in place by, the front end of the flexible member 93, the rear end of which is secured, as by means of the screw 94 (Figures 1 and 2) upon the beam 12 at a point spaced substantially from the blade support 60. Thus, by bending the member 93 away from the beam 12, the pivot shaft 90 can be moved out of its position extending through the arms 78 and 79.

The blade 13 (Figures 1 and 2) is provided with a hub member 95, having a shaft opening 96, through which the pivot shaft 90 is slidably receivable for rotatably supporting said hub member. The blade 13 is provided with a cutting edge 97 and said hub 95 is provided with a flat surface 98 (Figures 3 and 11) along a chord line thereof, which is on the diametrically opposite side of said hub 95 from the cutting edge 97 of the

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blade 13, in this particular embodiment. The surface 98 is arranged with respect to the shaft opening 96 so that it will snugly, but slidably, engage the adjacent side of the elongated plate 77 when the blade 13 is supported upon the pivot shaft 90. It will be recognized that the chord surface 98 can be placed in a variety of positions around said hub 95 and with respect to said cutting edge 97, depending upon the direction in which it is desired to have the cutting edge 97 extend from the end of the beam 12.

Operation

Prior to operation of the surgical saw 10, the retainer screw 84 (Figure 3) is tightened until the balls 63, 64, 65 and 66 are firmly held between said retainers 67 and 68 and the adjacent ends of the rods 61 and 62. The retainer screw 84 is then locked in position by the set screws 86 (Figure 11). A blade 13 (Figure 2) of the proper type is mounted upon the blade head 60, by moving the shaft 90 axially sidewardly, placing said hub 95 between the support arms 78 and 79, and then inserting the shaft 90 into the shaft opening 96 in the hub 95. The threaded plug 53 of the beam 12 is disposed within the threaded end 15 of the body 11 and held there by the set screw 56, so that the plate 71 of the bearing ball retainer 68 will snugly, but slidably, engage the cam surface 34 of the motion-converting device 24. The connecting member 46 is inserted into the connecting sleeve 37 (Figure 4), so that the drive end 43 of the flexible cable 44 is received into the slot 42 in the adjacent end of the drive shaft 19, whereby rotation of the cable 44 (Figure 1) by the prime mover 45 will effect a rotation of said drive shaft 19. The coupling device 47 releasably holds the connecting member 46 within the connecting sleeve 37, thereby holding the drive end 43 of said cable 44 in positive engagement with the drive shaft 19.

Accordingly, if the prime mover 45 is energized, the drive shaft 19 will be rotated with respect to the body 11, thereby causing said cam plate 32 to wobble with respect to the adjacent end of the beam 12. Due to the engagement between the cam surface 34 on the cam plate 32 and the bearing ball retainer 68, the wobbling of the cam plate 32 results in a movement of one of the bearing balls 64 and 66 toward the blade head 60 during a half-revolution of said shaft 19, immediately followed by an urging of the other of said bearing balls 64 and 66 toward said blade head 60 during the remaining half of a revolution of said drive shaft 19. Due to the snug engagement between the bearing balls, thrust rods and bearing ball retainers, as shown in Figure 3, movement of one of the thrust rods and its associated bearing balls in one direction will be automatically accompanied by axial movement of the other of said thrust rods and its associated bearing balls in the opposite direction. Thus, the reciprocal movement of the bearing balls 64 and 66 is translated by the thrust rods 61 and 62 and the bearing balls 63 and 65 into a pivotal, oscillatory movement of the plate 77 of the bearing ball retainer 67 about its offset portion 82. In turn, pivotal movement of said plate 77, which is snugly engaged by the chord surface 98 on the hub 95, is translated into a pivotal oscillation of the blade 13, hence of the cutting edge 97 thereof, about the axis of said hub 95.

As shown particularly in Figures 3 and 5, conversion of the rotary motion of the pivot shaft 90 into the pivotal oscillation of the blade 13 is accomplished with anti-friction, ball bearing engagement between virtually all surfaces where friction would otherwise become a material consideration. The retainers 67 and 68 are held by the screws 84 and 74, sufficiently loosely with respect to the beam 12, that the retainers will operate substantially independently of contact with said screws, except as said screws keep said retainers centered with respect to said beam.

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Although a particular, preferred embodiment of the invention has been described hereinabove for illustrative purposes, it will be understood that variations or modifications thereof, which lie within the scope of the invention, are fully contemplated unless specifically stated to the contrary in the appended claims.

I claim:

1. A cutting instrument, comprising: a body having a drive shaft rotatably supported therein; a beam supported upon said body and extending therefrom along the extended rotational drive axis of said shaft; a cutting blade pivotally supported upon the free end of said beam for movement about a blade axis transverse of said beam, said blade having a non-cutting driving edge which is spaced from said blade axis and arranged substantially transverse of said drive axis; a pair of substantially parallel, thrust rods extending along said beam and substantially between the driving edge of said blade and the adjacent end of said drive shaft; a bevel plate rotatably supported upon the adjacent end of said drive shaft, and having a surface continuously disposed at a small angle to a plane perpendicular to the axis of said drive shaft: first anti-friction means snugly disposed between said surface and the adjacent ends of said thrust rods; and second anti-friction means snugly disposed between said driving edge and the other ends of said thrust rods, whereby rotation of said drive shaft effects a wobbling of said surface, hence a reciprocation of said thrust rods and oscillation of said cutting blade.

2. A cutting instrument, comprising: a body having a drive shaft rotatably supported therein; a beam supported upon said body and projecting therefrom along the extended rotational axis of said shaft; a cutting blade pivotally supported upon the free end of said beam for movement about an axis transverse of said beam, said blade having a non-cutting edge spaced from its pivotal axis; a pair of substantially parallel, thrust rods axially and slidably supported with respect to said beam, said rods extending between, and being spaced slightly from, said edge and the adjacent end of said drive shaft; first anti-friction means disposed between said thrust rods and said adjacent end of said shaft; means mounted upon said adjacent end of said drive shaft and having a beveled surface snugly engageable with said first anti-friction means for effecting axial movement of said thrust rods; second anti-friction means snugly disposed between said thrust rods and said edge, for effecting oscillatory movement of said blade in response to axial movement of said thrust rods, the first and second anti-friction means being arranged so that movement of one thrust rod in one axial direction is simultaneously accompanied by axial movement of the other thrust rod in the opposite direction.

3. The structure of claim 2, wherein said first and second anti-friction means both include bearing balls engaged with the ends of said thrust rods and bearing ball retainers pivotally supported upon said beam for holding said bearing balls snugly against said rods, one of said retainers being engageable with said beveled surface and the other of said retainers being engageable with said edge.

4. In a surgical instrument having a rotatable shaft, a cutting blade lying substantially in a plane including the axis of said shaft and means pivotally supporting said blade for oscillatory movement in said plane around a blade axis, means for converting rotational movement of said shaft into oscillatory movement of said blade, comprising: a pair of thrust rods extending substantially parallel with said shaft axis between said blade and one end of said shaft; means connected to said blade supporting means and supporting said rods for axial movement; a device, including anti-friction means, associated with said one end of said shaft and the ends of said thrust rods adjacent to said shaft for effecting intermittent, axial movement of said rods toward and away from said blade; and means including anti-friction means being

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snugly disposed between the other ends of said thrust rods and said blade, for converting the movement of said thrust rods into oscillatory motion of said blade about said blade axis.

5 5. In a surgical instrument having a rotatable drive shaft, a cutting blade spaced from said shaft and intersected by the extended axis thereof, and structure rotatably supporting said shaft and pivotally supporting said blade, mechanism for converting rotation of said shaft into oscillatory movement of said blade, comprising: a pair of parallel thrust rods substantially parallel with said axis and extending substantially between said blade and the adjacent end of said shaft; housing means connected to said blade supporting structure and supporting said rods for reciprocal movement; a bevel plate rotatably supported upon said adjacent end of said shaft and having a surface constantly inclined slightly to a plane perpendicular to said axis of said shaft; a pair of bearing balls disposed at opposite ends of each of said rods; and bearing ball retainers pivotally and rotatably supported with respect to said housing means for snugly holding said bearing balls against said rods, one of said retainers being engageable with said surface and the other of said retainers being engageable with said blade, whereby

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rotation of said shaft effects a reciprocation of said rods and an oscillation of said blade.

6. In a surgical instrument having a rotatable shaft, a cutting blade, means pivotally supporting said blade for oscillatory movement about a blade axis, means for converting rotational movement of said shaft into oscillatory movement of said blade, comprising: a pair of thrust rods extending substantially parallel with the axis of said shaft between said blade and one end of said shaft; means connected to said blade supporting means and supporting said rods for axial movement; a device, including anti-friction means, associated with said one end of said shaft and the ends of said thrust rods adjacent to said shaft for effecting intermittent, axial movement of said rods toward and away from said blade; and means including anti-friction means, snugly disposed between the other ends of said thrust rods and said blade for converting the movement of said thrust rods into oscillatory motion of said blade about said blade axis.

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