United States Patent [19]

Taylor et al.

[11] **3,802,075**

[45] **Apr. 9, 1974**

[54] **POWER DRIVEN HEDGE TRIMMER**

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[73] Assignee: **Rockwell International Corporation**, Pittsburgh, Pa.

[22] Filed: **June 23, 1972**

[21] Appl. No.: **265,554**

Related U.S. Application Data

[62] Division of Ser. No. 107,355, Jan. 18, 1971, Pat. No. 3,699,655.

[52] **U.S. Cl.** **30/216**

[51] **Int. Cl.** **B26b 19/02**

[58] **Field of Search** ..... 30/216, 218, 219, 272 R, 30/272 A, 210, 217, 220; 56/236

[56] **References Cited**

UNITED STATES PATENTS

2,623,283	12/1952	Godfrey	30/216
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Primary Examiner—Al Lawrence Smith
Assistant Examiner—J. C. Peters

[57] **ABSTRACT**

A power driven hedge trimmer having a substantially mirror image pair of cooperating, relatively reciprocable cutter blades and being operatively interchangeable one with the other for use as either the top blade or the bottom blade in a dual cutter blade assembly. The dual cutter blade assembly is supported from a support bar having one end received in a split clam shell housing. The support bar overlies the cutter blade assembly and is supported by the housing by being separably trapped at its one end between the halves of the clam shell housing. Another feature disclosed herein pertains to a pair of axially spaced bearing plates for journalling a motor armature shaft and gear-mounting shafts. The bearing plates are trapped in position between the halves of the split clam shell housing and are constructed in such a manner that forces tending to turn or twist the bearing plates will be about an axis aligning with the rotational axis of the armature shaft.

6 Claims, 17 Drawing Figures

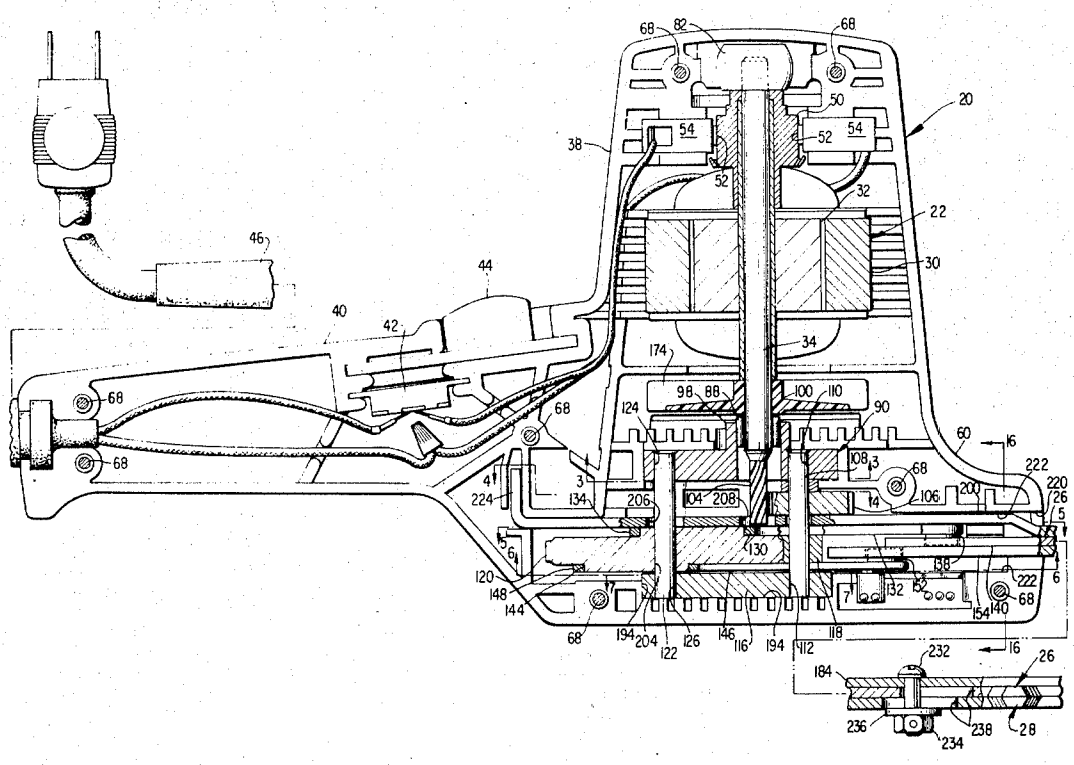


FIG. 1

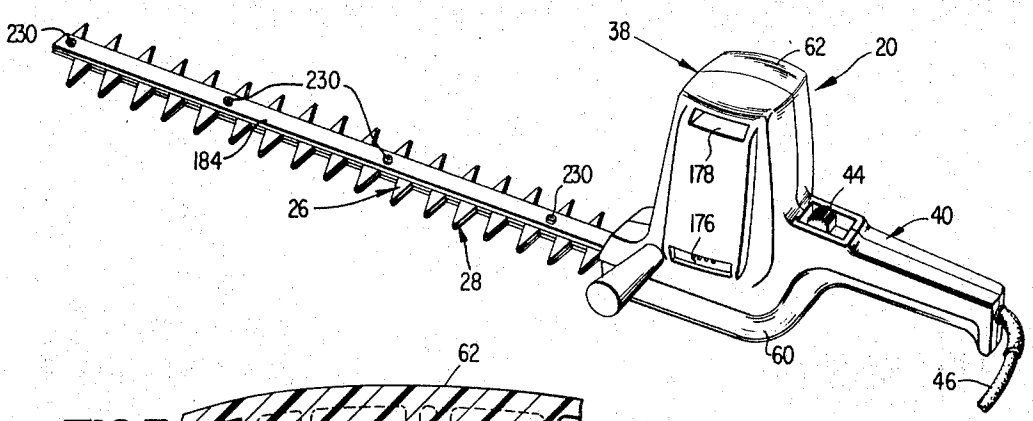


FIG. 3

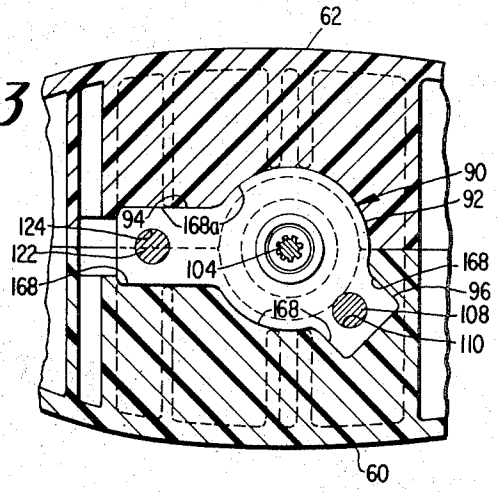
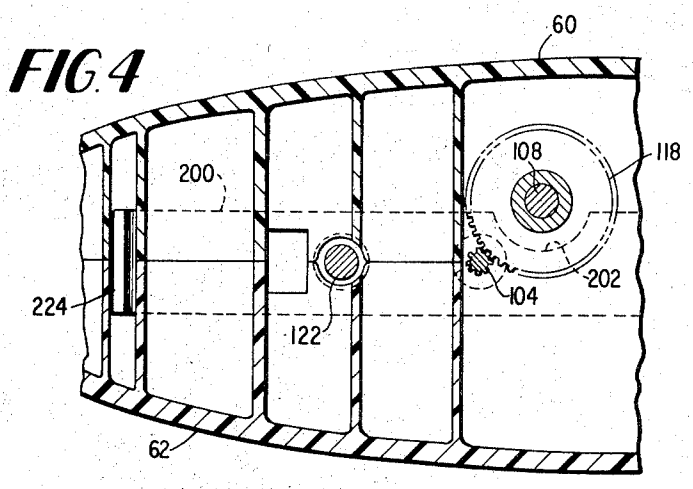


FIG. 4



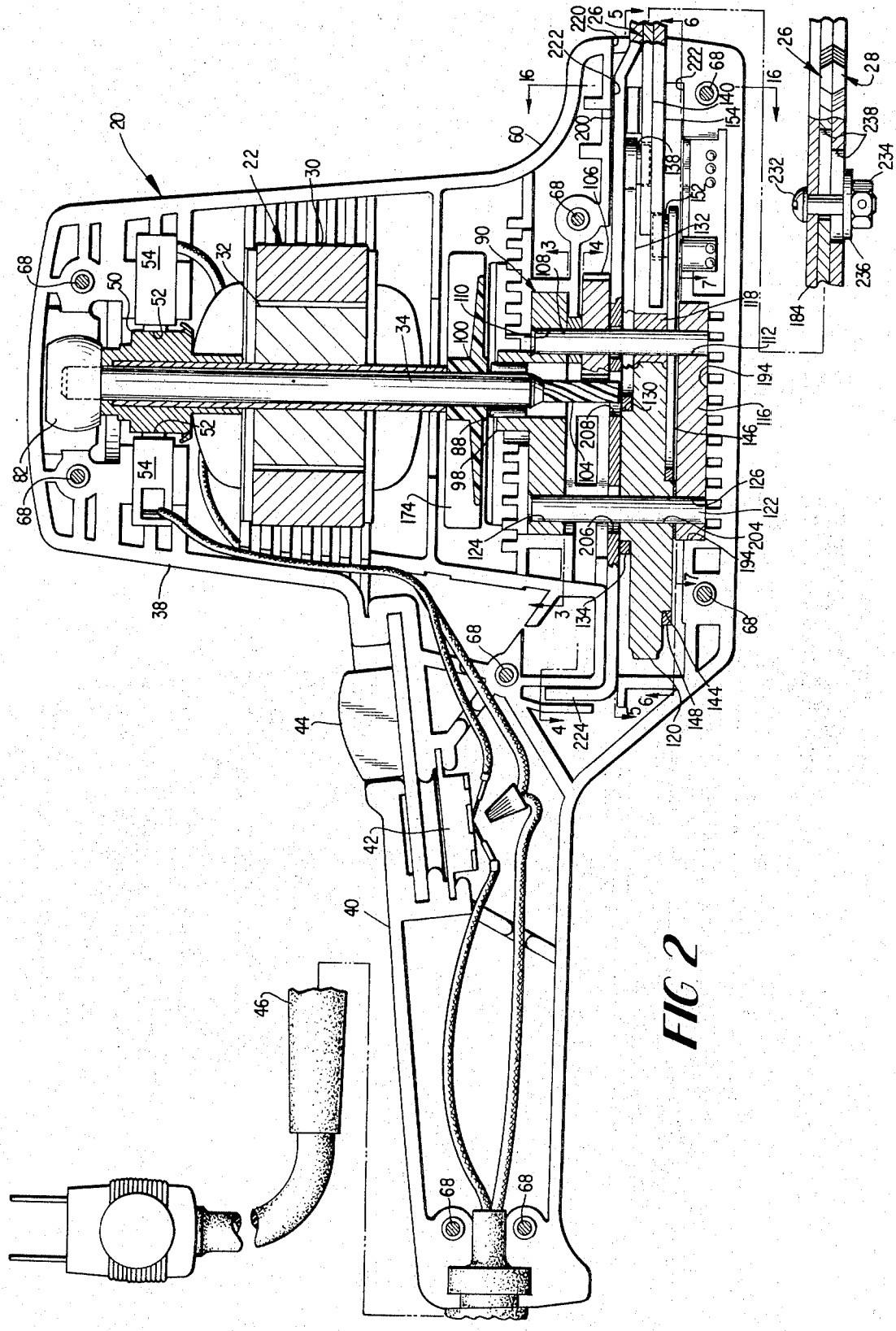


FIG 2

FIG. 5

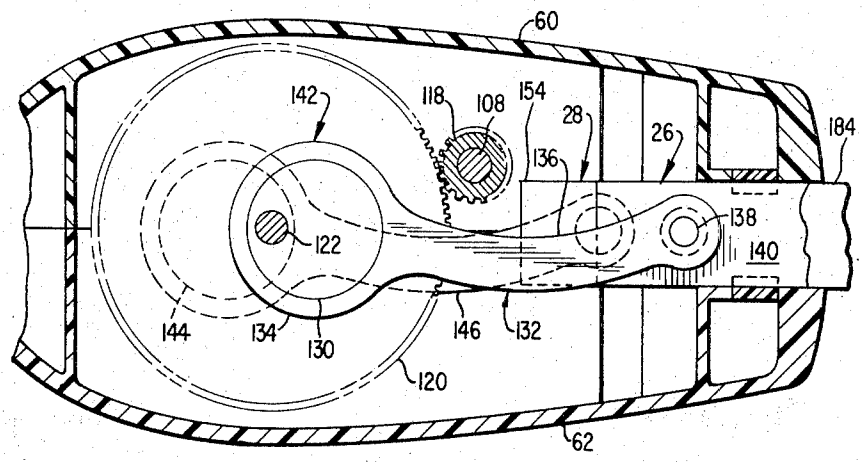


FIG. 6

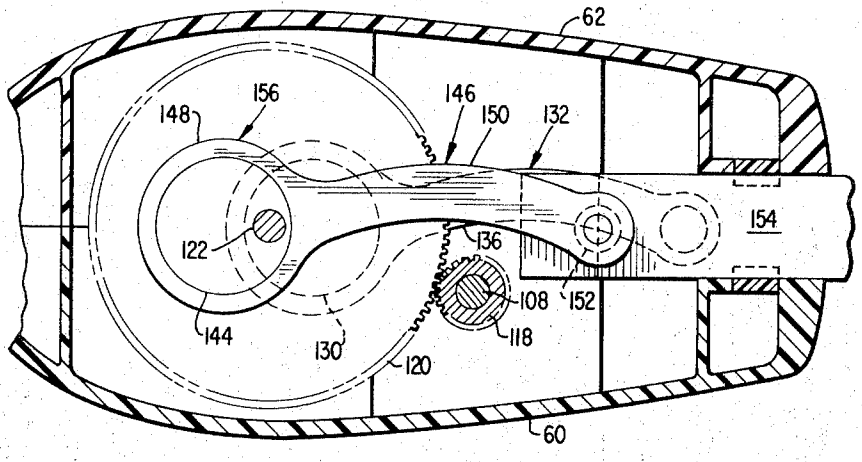
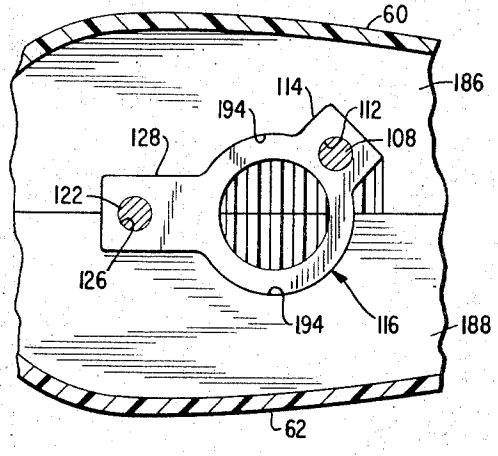


FIG. 7



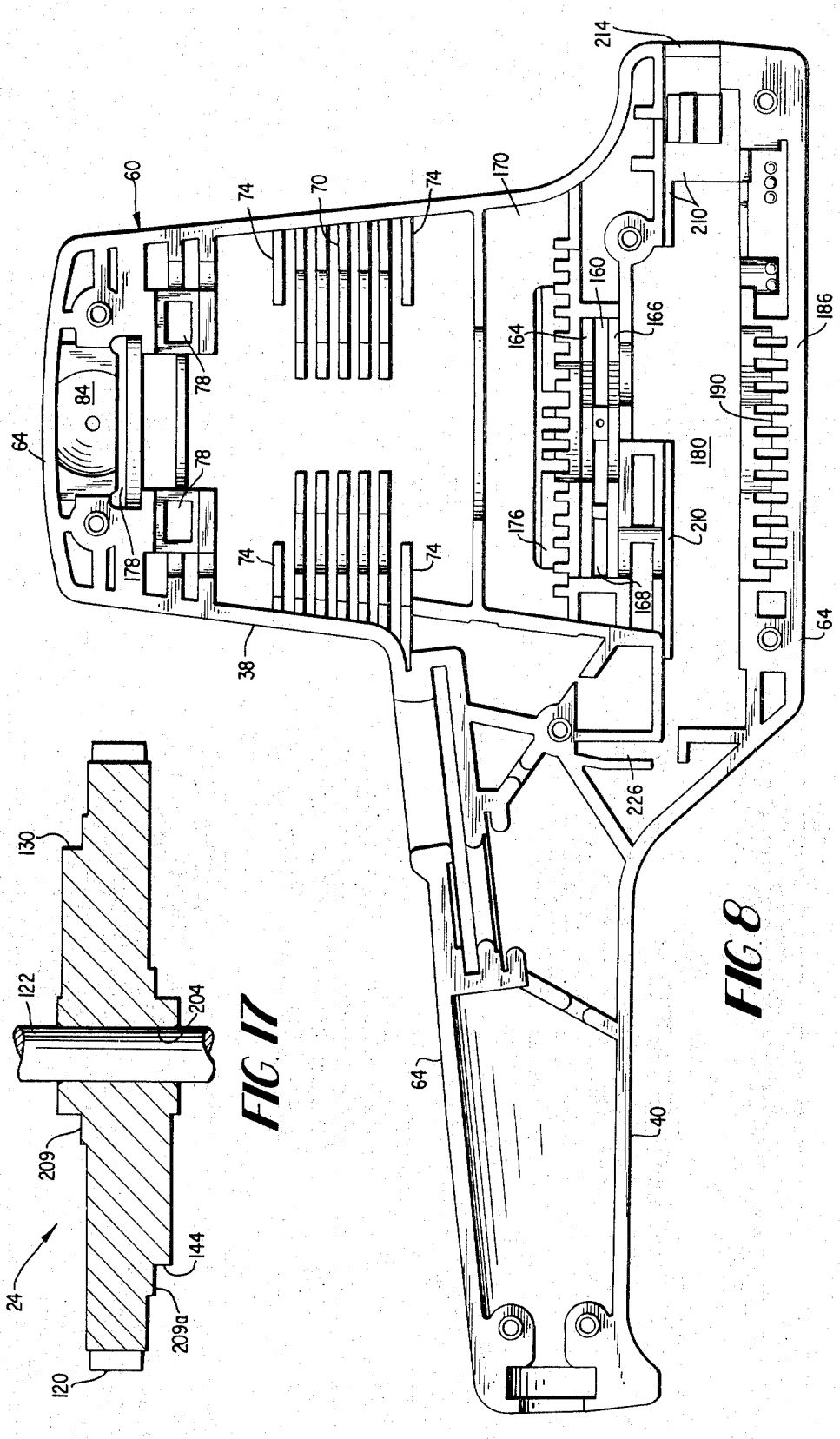

214
60
74
70
74
170
210
160
166
164
186
190
84
78
78
180
64
176
220
178
74
74
168
64
38
226
40

FIG. 8

130
122
204
209
144
24
209a
120

FIG. 17

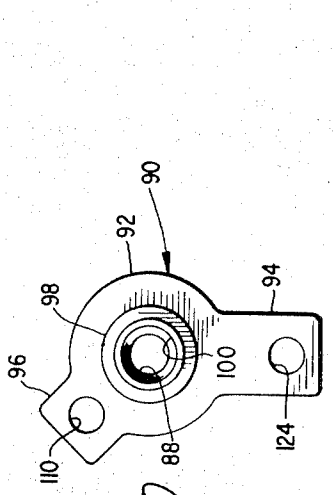

90
92
94
98
100
96
110
88
124

FIG. 10

40
66
66
228
62
38
72
66
212
168a
178
76
76
192
188
164a
80
86
182
80
166a
80
176
76
76
162
172
212
66
216

FIG. 9

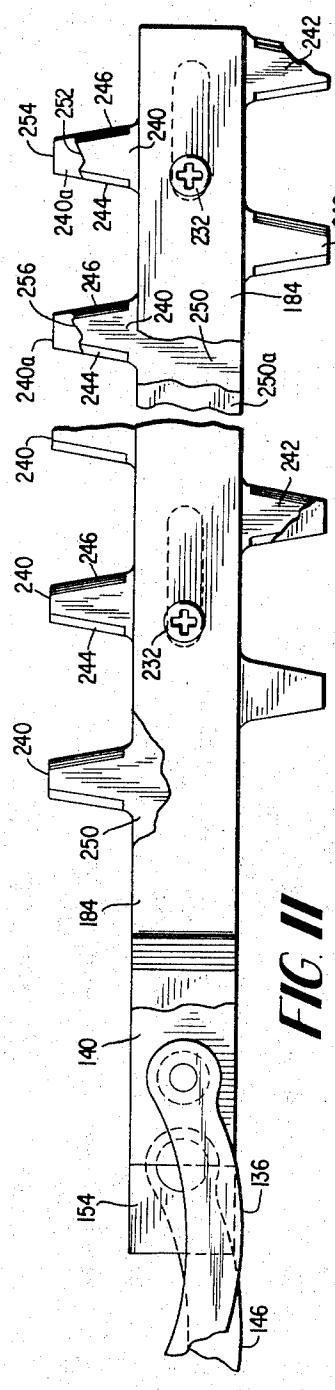


FIG. 11

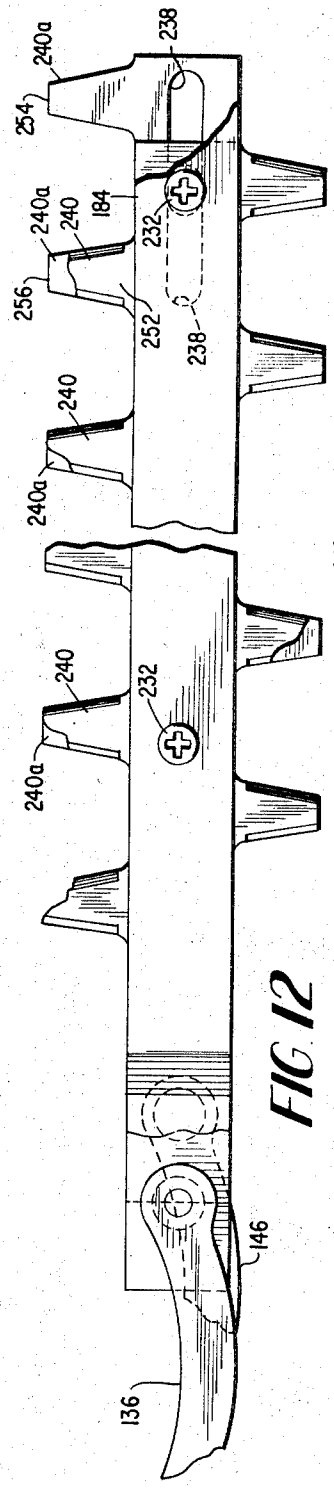


FIG. 12

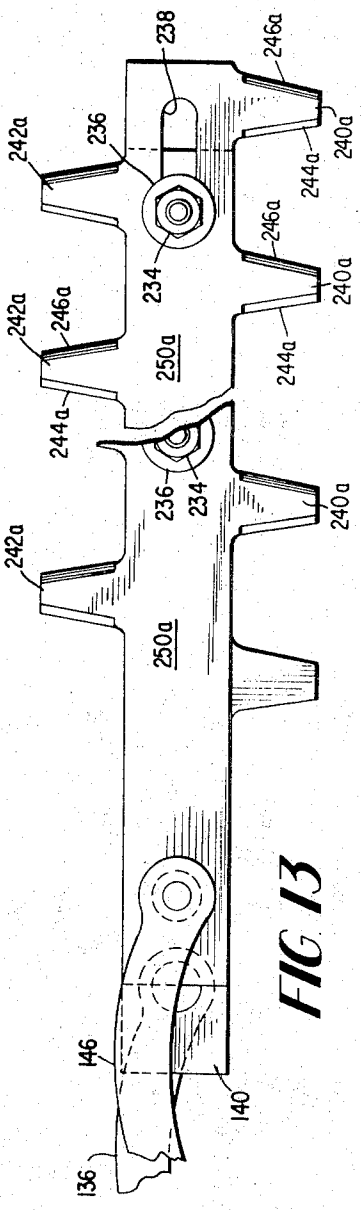


FIG. 13

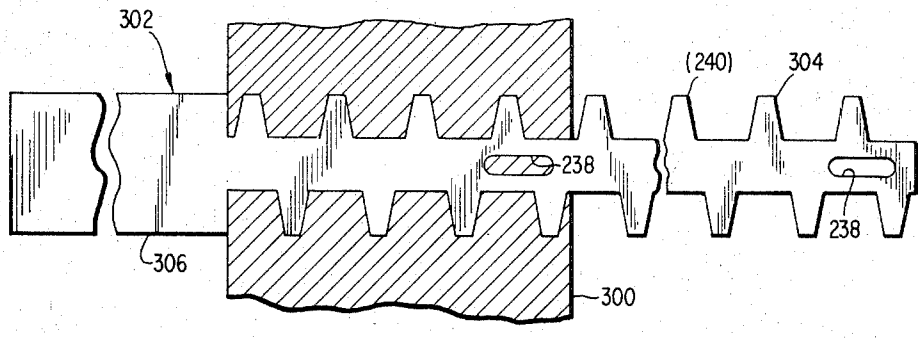


FIG. 14

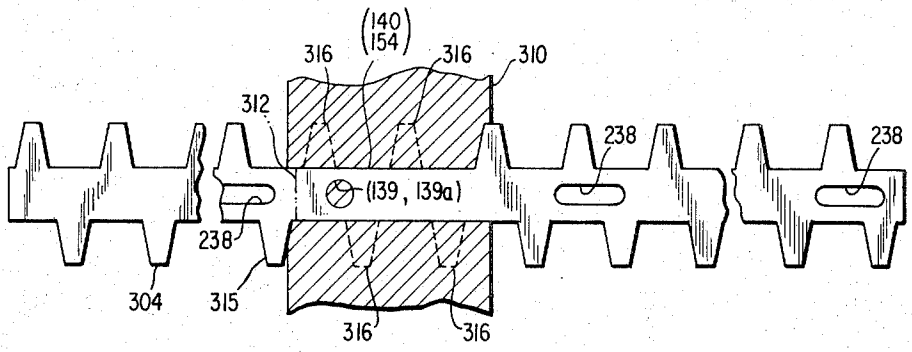


FIG. 15

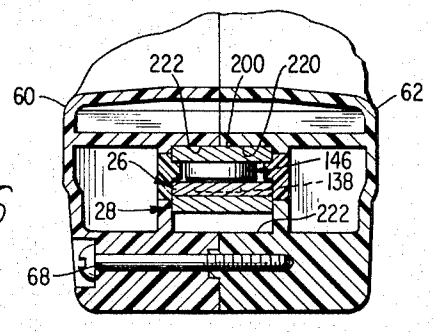


FIG. 16

POWER DRIVEN HEDGE TRIMMER

This is a division of application Ser. No. 107,355, filed Jan. 18, 1971, now U.S. Pat. No. 3,699,655, issued Oct. 24, 1972.

FIELD OF INVENTION

This invention relates to power driven tools and is particularly concerned with portable, electrically powered hedge trimmers and a novel method for making hedge trimmer cutter blades.

BACKGROUND & SUMMARY & OBJECTS OF INVENTION

One of the major objects of this invention is to provide a novel hedge trimmer in which a support bar or other cutter blade support member is uniquely secured in the hedge trimmer housing.

Heretofore it has been the practice to fasten a comb or other stationary cutter blade support member to the bottom wall of the portable hedge trimmer housing in order to provide a firm support for the cutter blade or blades. This construction is typically shown in U.S. Pat. Nos. 3,212,188, 3,200,493, and 3,193,925 among others. These conventional constructions are further characterized in the cutter blade support member, which is fastened to the hedge trimmer housing, is typically a stationary comb having teeth that coact with the teeth on the reciprocable cutter blade.

In contrast to the foregoing conventional hedge trimmer construction, the hedge trimmer of this invention provides a cutter blade support bar which is mounted by being trapped in position between mating halves of a split clam shell type housing. The cutter blade support bar, which supports two mutually reciprocable cutter blades in the preferred embodiment of this invention, is fixed in place solely by separable seating engagement with opposing surfaces in the split clam shell housing.

Another important object of this invention is to provide a novel, compact, simplified drive train and bearing assembly for transmitting reciprocating motion to one or more cutter blades in a hedge trimmer.

According to the preferred embodiment of this invention, the foregoing object is attained by providing for dual crank assembly having a motor driven gear and a pair of connecting rods having crank ends which interfitting snap over raised eccentrics on opposite side faces of the motor driven gear. The opposite ends of the connecting rods are pin-connected respectively to two overlapping cutter blades in such a manner that the cutter blades are reciprocated in opposite directions. The motor driven crank assembly gear lies axially between the crank ends of the connecting rods, and the connecting rods extend in parallel planes that are parallel with the cutter blades. The pin-connected ends of the cutter blades lie between the adjacent ends of the connecting rods, and the above-mentioned support bar, which supports the cutter blades for reciprocating motion, overlies the dual crank assembly and the motor driven crank assembly gear to provide a compact and simplified arrangement of parts.

In the preferred embodiment of this invention, the hedge trimmer has an electric motor in the hedge trimmer housing, and the armature shaft of the motor is drive connected to the above-mentioned motor driven crank assembly gear by a gear on the inboard end of the armature shaft and intermediate gearing drive connecting the armature shaft gear to the motor driven crank assembly gear. The crank assembly gear is mounted on a first shaft, and the intermediate gearing is mounted on a second shaft, with these first and second shafts being parallel to the motor armature shaft. The first and second shafts and the inboard end of the armature shaft are journalled only by means of axially spaced apart intermediate and bottom bearing plates. The intermediate bearing plate journals the inboard armature shaft end and corresponding ends of the above-mentioned first and second shafts, while the bottom bearing plate journals the opposite ends of the first and second gear shafts.

In further contributing to the compact arrangement of housed parts, the bottom bearing plate is seated on the bottom wall of the hedge trimmer housing to thus underlie the crank assembly mentioned above, while the intermediate bearing plate is disposed between the motor and the housed end of the cutter blade support bar.

Another major object of this invention is to provide a novel electric motor driven power tool wherein the armature shaft and gear-mounting shafts are journalled by bearing plates of the type mentioned above and wherein the bearing plates are arranged, constructed and supported in such a manner that forces tending to turn or twist at least that bearing plate which journals the armature shaft are not applied about an axis that is eccentric to the armature shaft to cause objectionable rocking or swinging motion of the armature shaft.

Heretofore, dual shaft-journalling bearing plates have been utilized in power tools as shown, for example, in U.S. Pat. No. 3,536,943. The construction and arrangement of parts in this patent, however, results in the application of objectionable torsional forces about an axis that is eccentric to the armature shaft, thus tending to pull or swing the armature shaft around the eccentric axis. In U.S. Pat. No. 3,536,943 an intermediate bearing plate journals the inboard end of the armature shaft and corresponding ends of two gear reduction shafts. The armature shaft is eccentric with respect to the effective center of intermediate bearing plate. Therefore, if either of the two gear reduction shafts are swung about a point eccentric to its axis as a result of manufacturing tolerances or assembly error, the armature shaft will similarly be objectionably swung about a point eccentric to its axis.

In contrast to the foregoing conventional construction, the two bearing plates in this invention are effectively self-centering about the armature shaft axis. More specifically, each bearing plate of this invention has a pair of angularly spaced apart ears or wings extending radially from a central portion, and a gear reduction shaft bores are formed in these ears in such a manner that lines extending radially of these bores and medially intersecting their associated ears intersect at a point on the armature shaft axis. Furthermore, the fit of the bearing plate ears with the entrapping halves of the split clam shell housing is relatively loose as compared with the relative tight fit that is provided for between the central portion of each bearing plate and the entrapping halves of the split shell housing. As a result, the ears of each bearing plate are slightly floating about an axis that is coincident with the armature shaft axis. By avoiding a tight fit at the bearing plate ears when the bearing plates are trapped between mating halves of

the split clam shell housing each bearing plate will not be twisted or turned about an axis eccentric to the armature shaft axis when the bearing plates are trapped in position by securing the mating halves of the split clam shell housing together.

Another major object of this invention is to provide a novel hedge trimmer dual cutter blade assembly having two reciprocating double-edged cutter blades that are interchangeable.

According to the foregoing aspect of this invention one cutter blade may be used as either the top blade or the bottom blade in the dual cutter blade assembly. As a result, manufacture and stocking of separate top and bottom cutter blades is obviated. Furthermore, the reciprocation of two cutter blades counter to each other results in counterbalancing forces that minimize the reaction on the operator or the person handling the tool.

According to this invention the top and bottom cutter blades of the dual cutter blade assembly are the mirror image of each other. Furthermore, each cutter blade has two rows of laterally oppositely extending shearing teeth, and the teeth in the two rows are uniformly staggered relative to each other by an offsetting distance that is equal to the throw imparted to each cutter blade by the crank assembly. The throw for each cutter blade is made equal to one-half of the pitch between adjacent cutter blade teeth. The teeth on the top cutter blade will align with the teeth on the bottom cutter blade when the cutter blades are at opposite limits of their linear strokes. As a consequence, the maximum available width between the coacting teeth on the top and bottom cutter blades is provided for to achieve optimum cutting action.

To maintain this maximum width between coacting cutting teeth when either one of a mirror image pair cutter blades is used as either the top cutter blade or the bottom cutter blade, the teeth are required to be staggered in the previously described manner to accommodate the offset that occurs between the top and bottom blades by virtue of the throw of the crank assembly.

According to a further aspect of this invention the above-described interchangeable mirror image pair of top and bottom cutter blades are manufactured in a novel manner by first blanking out the staggered, uniformly pitched teeth throughout an appropriate length of a strip of stock. The blanked stock is significantly longer than the longest blade that is excepted to be made. For example, it may be ten feet long. The blanking dies are normally not this long. As a result, the stock is blanked in end-to-end segments or sections, the lengths of which correspond to the size of the die. For example, the die may be of such a size as to blank out 5 inch lengths.

The thusly blanked elongated strip of stock then may be stored until such time that a supply of cutter blades of one length or another may be needed. Typical cutter blade lengths are 15, 20 and 25 in. and are preferably integered multiples of the blanking die length. To complete the manufacture of any one of these cutter blade lengths, the partially stamped stock is subjected to a second operation wherein the crank-connecting shank of the blade is formed by removing a number of the previously formed teeth at a region corresponding to the desired length of the blade. The thusly formed blade is cut off from the remainder of the stock at its desired length. Numerous cutter blades of selected lengths thus may be made from the same strip of blanked stock, and the thusly fabricated blades may be used as either the top cutter blade or the bottom cutter blade in the dual cutter assembly.

Further objects of this invention will appear as the description proceeds in connection with the below-described drawings and the appended claims.

DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view of a double-edged hedge trimmer constructed according to the principles of this invention;

FIG. **2** is a fragmentary side elevation showing the trimmer of FIG. **1** with one of the halves of the longitudinally split clam shell housing removed to illustrate the internal parts of the trimmer;

FIG. **3** is a section taken substantially along lines **3—3** of FIG. **2**;

FIG. **4** is a section taken substantially along lines **4—4** of FIG. **2**;

FIG. **5** is a section taken substantially along lines **5—5** of FIG. **2**;

FIG. **6** is a section taken substantially along lines **6—6** of FIG. **2**;

FIG. **7** is a section taken substantially along lines **7—7** of FIG. **2**;

FIG. **8** is an interior side elevation of the left-hand half of the split clam shell housing shown in FIG. **1**;

FIG. **9** is an interior side elevation of the righthand half of the split clam shell housing shown in FIG. **1**;

FIG. **10** is a plan view of the intermediate bearing plate shown in FIG. **2**;

FIG. **11** is a fragmentary top plan view of the dual double edged cutter blade assembly shown in FIG. **1**, with the top blade being in the forward limit of its cutting stroke and the bottom blade being in the rearward limit of its cutting stroke;

FIG. **12** is a fragmentary top plan view similar to FIG. **11**, but showing the top cutter blade in the rearward limit of its cutting stroke and the bottom blade in its forward limit of its cutting stroke;

FIG. **13** is a fragmentary bottom plan view of the bottom cutter blade shown in FIGS. **1**, **11**, and **12**;

FIG. **14** is a partially schematic, sectioned fragmentary, top plan view showing a first step for forming the cutter blades shown in FIG. **1**;

FIG. **15** is a sectioned, partially schematic, fragmentary, top plan showing subsequent operations which follows the forming step illustrated in FIG. **14**;

FIG. **16** is a section taken substantially along lines **16—16** of FIG. **2**; and

FIG. **17** is an enlarged fragmentary section of the drive gear and crank eccentrics shown in FIG. **2**.

DETAILED DESCRIPTION

Referring now to the drawings and more particularly to FIGS. **1** and **2**, the portable, hand manipulatable, power driven hedge trimmer incorporating the principles of the invention is shown to comprise a hollow, longitudinally split, clam shell type housing or casing **20**. Housing **20** contains the cutter drive mechanism which include an electric motor **22** (FIG. **2**) for transmitting motion to reciprocate a pair of double edged cutter blades **26** and **28**.

Motor **22** may be of conventional construction and, as best shown in FIG. **2**, comprises a stator **30** having

field windings peripherally surrounding an armature **32.** Armature **32** is mounted on an armature shaft **34** which extends coaxially through stator **30** and which is drive connected by a gear reduction drive train to cutter blades **26** and **28** in a manner to explained in detail later on.

With continued reference to FIGS. **1** and **2,** housing **20** has a hollow body portion **38** and a rearwardly extending grip type handle **40.** Body portion **38** receives motor **22** and the above-mentioned drive train. Handle **40** houses an electrical on-off switch **42** having a manually manipulatable switch actuator or trigger **44** for controlling operation of motor **22.** Power is supplied to operate motor **22** through a conventional power cord **46** having conductors for supplying current to stator **30** under the control of switch **42.**

As shown in FIG. **2,** a commutator **50,** forming a part of motor **22,** is carried by shaft **34** and is electrically connected to armature **32** in the usual manner. Brush elements **52,** which are spring biased into electrical contact with the commutator periphery, are mounted in electrical non-conductive brush holders **54.** Armature **32** and commutator **50** are preferably electrically insulated from shaft **34** by any suitable means.

As shown in FIGS. **1, 8,** and **9,** housing **20** is longitudinally divided into two complementary shells **60** and **62** to provide a clam shell type enclosure for the internal parts of the hedge trimmer. Shells **60** and **62** are separately molded from a suitable, electrically nonconductive plastic and have oppositely dished curvatures to define the interior, mechanism-receiving cavities as hereinafter described.

Shells **60** and **62** are respectively formed with mating longitudinal edge surfaces **64** and **66** which seat against each other along a planar interface that longitudinally and medially intersects body portion **38,** handle **40** and the cutter assembly. The rotational axis of shaft **34** lies substantially in a plane containing this interface. Machine screws **68** (see FIG. **2**) extending through bores in shell **62** are threaded into tapped bores in shell **60** to firmly and rigidly secure shells **60** and **62** together.

With continued reference to FIGS. **8** and **9,** shells **60** and **62** are respectively formed with ribbed, complementary cavities **70** and **72** which mate to form a motor compartment that interfittingly receives and confines stator **30.** End ribs **74** and **76** respectively formed integrally with shells **60** and **62** confine stator **30** against axial movement. Shell **60** is also formed with cavities **78** (FIG. **8**) which interfittingly receive brush holders. Resilient pads **80** (FIG. **9**) made of rubber or other suitable material are mounted in shell **62** and engage brush holders **54** to confine them in cavities **78.**

The outboard end of shaft **34** is journalled in a bearing **82** (FIG. **2**). Bearing **82,** which preferably comprises a spherically contoured knuckle, is interfittingly seated for limited universal rocking movement in opposed complimentary cavities **84** (FIG. **8**) and **86** (FIG. **9**). Cavities **84** and **86** are respectively formed in shells **60** and **62,** and bearing **82** trapped and thus confined in position between shells **60** and **62** solely by separable seating engagement with the wall surfaces of cavities **84** and **86.**

From the construction thus far described, it will be appreciated that stator **30,** brush holders **54,** and bearing **82** are trapped in position and thereby confined between shells **60** and **62** only by separable seating engagement with the cavity-defining surfaces of housing **20.**

The inboard end of shaft **34** is, as shown in FIG. **2,** journalled by a bearing sleeve **88** in a metallic bearing plate **90.** As best shown in FIGS. **4** and **10,** bearing plate **90** is formed with a central hub portion **92** and a pair of angularly spaced apart flat-sided ear portions **94** and **96** which extend radially from hub portion **92.** Portion **92,** as shown in FIG. **2,** is centrally formed with a raised boss **98,** and sleeve bearing **88** is coaxially pressed into the upper end of a cylindrically smooth walled bore **100** which is formed coaxially through boss **98** and the bearing plate.

As shown in FIG. **2,** armature shaft **34** extends coaxially through and beyond bore **100,** and the inboard end of shaft **34** projecting beyond bearing plate **90** is formed with a spiral gear **104.** Gear **104,** as shown in FIGS. **2** and **4,** meshes with a large diametered gear **106** which is coaxially fixed on a shaft **108.** One end of shaft **108** is journalled in a bore **110** that is formed through ear portion **96.** The other end of shaft **108** is journalled in a bore **112.** Bore **112** is formed through an ear portion **114** (see FIG. **7**) of a bottom bearing plate **116.**

Coaxially fixed on shaft **108** in a second gear **118** (see FIG. **5**) which constantly meshes with a crank arm drive gear **120.** The diameter of gear **120** is considerably greater than that of gears **106** and **118,** and the diameter of gear **106** is greater than that of gear **118.**

As shown in FIG. **2,** gear **120** is fixed on a shaft **122.** One end of shaft **122** is journalled in a bore **124** that is formed through ear portion **94** of bearing plate **90.** The other end of shaft **122** is journalled in bore **126.** Bore **126** is formed through a second ear portion **128** (see FIG. **7**) of bearing plate **116.**

The axes of bores **124** and **126** are axially aligned and parallel with the axis of bore **100** and the rotational axis of armature shaft **34.** Likewise, the axes of bores **110** and **112** are axially aligned and parallel with the axis of bore **100** and the rotational axis of shaft **34.** Thus, the rotational axis of shafts **34, 108,** and **122** are in parallel spaced apart relation with respect to each other.

As shown in FIGS. **2** and **5,** gear **120** is integrally formed with a raised, circular eccentric **130.** Eccentric **130** is in the form of a solid, uniformly diametered cylindrical boss which projects upwardly from the flat upwardly facing side face of gear **120.** Eccentric **130** serves as a crank pin for a flat-sided connecting rod **132.**

As shown in FIG. **5,** connecting rod **132** has an annular crank end portion **134** and an elongated arm portion **136.** End portion **134** interfittingly snaps over eccentric **130.** A connecting pin **138** (FIG. **2**) is fixed to the end of arm portion **136** remote from end portion **134.** Pin **138** is interfittingly snapped into an aperture **139** that is formed through a flat-sided end shank portion **140** of cutter blade **26.**

From the foregoing it will be appreciated that eccentric **130,** connecting rod **132** and pin **138** form a crank assembly **142** (FIG. **5**) for translating the rotary motion of gear **120** to linearly reciprocate cutter blade **26.**

Referring now to FIGS. **2** and **6,** gear **120** is integrally formed with a second raised, circular crank eccentric **144.** Eccentric **144** is in the form of a solid cylindrical boss which projects from the flat downwardly facing side of gear **120.** Eccentric **144** serves as a crank pin for a second flat-sided connecting rod **146.**

As shown in FIG. 6, connecting rod 146 is the mirror image of rod 132 and has an annular crank end portion 148 and an elongated arm portion 150. End portion 148 interfittingly snaps over eccentric 144. A connecting pin 152, which is rigidly fixed to the end of arm portion 150 remote from end portion 148, is interfittingly snaped into an aperture 139*a* formed through a flat-sided end shank portion 154 of cutter blade 28. Thus, eccentric 144, connecting rod 146 and pin 152 form a second crank assembly 156 for translating the rotary motion of gear 120 to linearly reciprocate cutter blade 28.

It will be appreciated that connecting rods 132 and 146 are respectively mounted on eccentrics 130 and 144 for rotation about the centers of their respective eccentrics. The centers of eccentric 130 and 144 are radially offset from the rotational axis of gear 120, and connecting rods 132 and 146 are swingable about the concentric axis that are parallel to the rotational axis of gear 120. The centers of eccentrics 130 and 144 are disposed on opposite sides of the rotational axis of gear 120 and are spaced 180 degrees apart along a radial line perpendicularly intersecting the rotational axis of gear 120. Thus, crank assemblies 142 and 156 are 180 degrees out of phase to reciprocate cutter blades 26 and 28 in opposite directions. Cutter blade 26 will therefore be at the forward limit of its stroke (see FIG. 11) when cutter blade 28 is at the rearward limit of its stroke, and when cutter blade 26 is at the rearward limit of its stroke (see FIG. 12), cutter blade 28 will be at the forward limit of its stroke.

As shown in FIGS. 8 and 9, shells 60 and 62 are respectively formed with opposed coacting cavities 160 (FIG. 8) and 162 (FIG. 9) for receiving and trapping bearing plate 90. Ear portion 96 is received in cavity 160 (see FIG. 3). The remainder of plate 90 is received half in cavity 160 and half in cavity 162 meeting along a medial line that extends radially of and perpendicularly intersects the axes of bores 100 and 124. Thus, when shells 60 and 62 are secured together, bearing plate 90 is trapped in position and thus confined against movement in cavities 160 and 162 only by separable seating engagement with the cavity-defining surfaces of shells 60 and 62.

As shown in FIG. 8, cavity 160 is defined by two spaced part, substantially parallel, inwardly extending wall portions 164 and 166 and a longitudinal end wall portion 168 that integrally joins wall portions 164 and 166 together. Cavity 162, as shown in FIG. 9, is formed with similar wall portions, and like reference numerals suffixed by the letter "a" have been applied to designate the corresponding wall portions of cavity 162. Thus bearing plate 90 is axially confined with a relatively tight fit between wall portions 164 and 164*a* on one side and wall portions 166 and 166*a* on the other side. Wall portions 164 and 164*a* are essentially contained in a common plane that substantially perpendicularly intersects the rotational axis of shaft 34. Similarly wall portions 166 and 166*a* are essentially contained in a common plane that also substantially perpendicularly intersects the rotational axis of shaft 34. Plate 90 is confine against movement transversely of shaft 34 by seating engagement with wall portions 168 and 168*a*.

The fit between the central bearing plate portion 92 and and the opposing cavity-defining wall portions 168 and 168*a* is close and relatively tight, whereas the fit between each of the bearing plate ear portions 94 and 96 and the contacted parts of wall portions 168 and 168*a* is somewhat looser. As a result, a close, tight fit is provided at bearing plate portion 92 in a direction extending transversely of bore 100, while a looser fit (i.e. greater clearance) is provided at ears 94 and 96 in a direction also extending transversely of bore 100. Thus, in a transverse direction, ears 94 and 96 are slightly floating in cavities 160 and 162 about the axis of bore 100 which is centrally located. With this construction, any tendency of bearing plate 90 to twist or rotate during or after assembly will be about the centrally located axis of bore 100 which aligns with the rotational axis of shaft. Such twisting or turning of plate 90 may occur as a result of torque applied by shaft 34 and/or accumulative tolerances of housing 20 and the parts contained therein. As a result, any twisting, turning or rotation that may be imparted to plate 90 will be about an axis substantially aligning with shaft 34 and will therefore not rock or swing shaft 34 out of alignment. It will be appreciated that if plate 90 twisted or turned about an axis eccentric to the rotational axis of shaft 34, it would objectionably cause rocking or swinging motion of shaft 34.

Motor torque transmitted to plate 90 will be absorbed by shells 60 and 62 at ear portions 94 and 96. Plate 90 is effectively self-centering about the axis of shaft 34. More specifically, a line radially intersecting the axis of bore 110 and medially intersecting ear portion 96 and a line radially intersecting the axis of bore 124 and medially intersecting ear portion 94 intersect at a point on the rotational axis of shaft 34, and since ear portions 94 and 96 are slightly floating as described above, plate 90 will not be twisted or turned about an axis eccentric to the rotational axis of shaft 34 when plate 90 is trapped in position by securing shells 60 and 62 together.

Referring to FIGS. 2, 8, and 9, a fan compartment is formed in housing 20 axially between the previously described motor compartment and the bearing plate enclosure defined by cavities 160 and 162. The fan compartment is defined by opposed, complementary cavities 170 (FIG. 8) and 172 (FIG. 9) that are respectively formed in shells 60 and 62. A fan 174 is freely received in the compartment defined by cavities 170 and 172 and is fixed on shaft 34 adjacent to the inboard end thereof. By rotating fan 174 with shaft 34, air is drawn through openings 176 in housing 20, is directed through motor 22 to cool the motor parts, and is exhausted through openings 178 which are also formed in housing 20.

The boss portions 98 of bearing plate 90 extends upwardly beyond wall portions 164 and 164*a* and has a flat end face that may provide a thrust bearing seating surface for the assembly of shaft 34 and fan 174.

Below cavities 160 and 162 shells 60 and 62 are respectively formed with two enlarged, opposed, essentially complementary cavities 180 (FIG. 8) and 182 (FIG. 9) which cooperate to define a single compartment for receiving gears 106, 118, and 120, bearing plate 116, shanks 140 and 154 of cutter blade 26 and 28 respectively, the inner end of a stationary, flat-sided cutter blade support bar 184, and crank assemblies 142 and 156. The compartment defined by cavities 180 and 182 may be filled with grease or the like.

Shells 60 and 62 respectively have bottom walls 186 and 188 which respectively delimit the bottoms of cavi-

ties 180 and 182. The inner edges of bottom walls 186 and 188 butt against each other to define the exterior bottom of housing 20.

Referring to FIGS. 2, 8 and 9, bottom wall 186 is recessed at 190 (FIG. 8) and bottom wall 188 is recessed at 192 (FIG. 9) to define a recessed seat 194 (see FIGS. 2 and 7) which interfittingly receives bearing plate 116.

As best shown in FIG. 7, the ear portions 114 and 128 of bearing plate 116 are integrally joined together by a central annular portion 198. Ear portions 144 and 128 extend radially from central portion 198.

Bearing plate 116 is transversely (i.e. transversely of shafts 108 and 122) trapped and confined against movement between the upstanding wall portions that delimit seat 194. Bearing plate 116 is flat-sided and is seated on the flat, ribbed, interior bottom surfaces of walls 186 and 188. Connecting rod 146 overlies and seats on bearing plate 116. Gear 120 is disposed axially between the crank ends of rods 146 and 132. The cutter blade shanks 140 and 154, which slidable seat against each other extend between the pin-connected ends of connecting rods 132 and 146 and are spaced from gear 120. Thus connecting rod 146 underlies gear 120 and shank 154, and connecting rod 132 overlies gear 120 and shank 140.

Bearing plate 116 is thus confined against axial displacement between bottom walls 186 and 188 on one side and connecting rod 146 on the other side. Connecting rod 146 is confined against axial displacement (relative to shaft 122) between gear 120 and bearing plate 116. Connecting rod 132 is confined against axial movement (relative to shaft 122) between gear 120 and the inner end portion of support bar 184. This support bar end portion is indicated at 200 In FIG. 2 and is upwardly offset from the remainder of the bar so as to be vertically spaced by a relatively small distance above shank 140 and gear 120. Connecting rod 132 is disposed in this space. End portion 200 thus overlies shank 140, connecting rod 132 and gear 120. As shown, connecting rods 132 and 146 extend along parallel planes that normally intersect the rotational axis of shaft 122.

As shown in FIGS. 3 and 4, the parallel axes of shafts 34 and 122 are contained in a common plane which also contains the interface between shells 60 and 62. This plane also medially intersects end portion 200 and shanks 140 and 154. The axis of shaft 108 is laterally offset to one side of this plane, and end portion 200 is notched at 202 (FIG. 4) to provide a clearance for gear 118. As best shown in FIG. 2, a horizontal plane containing end portion 200 passes normally through gear 118. Arm portion 136 of connecting rod 132 is laterally offset to one side of gear 118 as best shown in FIG. 5.

To accommodate the above-mentioned position of shaft 108, ear portion 96 is disposed at an obtuse angle relative to ear portion 94, and radial lines extending from the axes of bores 110 and 124 intersect each other at an obtuse angle. Bearing plate 116 is similarly constructed in that an equal obtuse angle is provided between ears 114 and 128 and between intersecting lines extending radially of bores 112 and 126. Gear 106 partially overlies end portion 200 as best shown in FIG. 4.

Referring back to FIG. 2, gear 120 is coaxially formed with a through bore 204 for coaxially receiving shaft 122. Bore 204 is disposed eccentrically of but parallel to the axes of eccentrics 130 and 144. Shaft extends upwardly through bore 204 and freely through an enlarged aperture 206 in end portion 200. The free end of gear 104 is freely received in an enlarged aperture 208 which is also formed through end portion 200.

The foregoing construction provides for a simplified, economical, exceptionally compact, easily accessible arrangement of internal parts.

Bearing plate 116 is also effectively self-centering about the rotational axis of shaft 34 so that it does objectionably apply forces to plate 90 to act about an axis eccentric to the armature shaft axis to cause the armature shaft to be deflected from a properly oriented position. More specifically, the fit between central portion 198 and the opposing upstanding wall portions of cavities 190 and 192 is relatively tight, whereas the fit between each of the ear portions 114 and 128 and the opposing upstanding wall portions of cavities 190 and 192 is somewhat looser. As a result, ear portions 114 and 128 are slightly floating similar to the ear portions of plate 90. Furthermore, a line radially intersecting the axis of bore 112 and medially intersecting ear portion 114 and a line centrally intersecting the axis of bore 126 and medially intersecting ear portion 128 will intersect each other at a point along the rotational axis of shaft 34. Therefore, any forces tending to turn or twist plate 116 will be about an axis aligning with that of shaft 34 and not about an axis that is eccentric to the rotational axis of shaft 34.

As best shown in FIG. 17, the annular crank end portion 134 of rod 132 is seated on the flat face of a slightly raised uniformly diametered land 209 which is formed on the upwardly facing side of gear 120 in peripherally surrounding relation to eccentric 130. Land 209 is raised slightly above the side face of gear 120 by about four to six thousands of an inch. As a result of seating end portion 134 on land 209 the remainder of connecting rod 132 will be spaced slightly from gear 120, thus reducing the area of contact between gear 120 and rod 132 and thereby reducing the amount of friction that is produced by contact of rod 132 with gear 120.

An annular land similar to land 209 and indicated at 209a in FIG. 17 is formed peripherally around eccentric 144 in the same manner as just described for land 209. Connecting rod end portion 148 seats on land 209a so that the remainder of rod 146 is spaced from gear 120 to reduce the contact area between rod 146 and gear 120.

At the forward wall of housing 20, shells 60 and 62 are formed with complementary notches 214 (FIG. 8) and 216 (FIG. 9) which define a slot 220 (FIG. 16) through which the assembly of cutter blades 26 and 28 and support bar 184 extend.

End portion 200 of support bar 184 is securely trapped between shells 60 and 62 when the shells are secured together. In a transverse direction, end portion 200 is confined between upstanding wall portions 210 and 212 (see FIGS. 8, 9 and 16) of cavities 180 and 182. The assembly of support bar 184 and cutter blades 26 and 28, in the region where it extends through slot 220, is vertically confined between overlying and underlying wall surfaces indicated at 222 in FIG. 16. Wall surfaces 222 delimit an inward extension of slot 220 which provides an entrance to cavities 180 and 182.

End portion **200** of support bar **184** extends through the compartment defined by cavities **180** and **182** and terminates at its rearward end in an upturned tab **224.** Tab **224** is received and trapped in complementary cavities **226** (FIG. **8**) and **228** (FIG. **9**) which are respectively formed in shells **60** and **62** at the juncture between handle **40** and body portion **38.** Abutment of tab **224** with opposing wall surfaces of cavities **226** and **228** provide an anchor to confine support bar **184** against longitudinal movement. It will be appreciated that the assembly of support bar **184** and cutter blades **26** and **28** are trapped in position between shells **60** and **62** only by separable seating engagement with interior cavity-defining surfaces of shells **60** and **62.**

As shown in FIG. **2,** the assembly of support bar **184** and cutter blades **26** and **28** extends beyond housing, with cutter blade **26** slightly overlying cutter blade **28** and support bar **184** overlying cutter blade **26.** The externally extending portions of cutter blades **26** and **28** are supported for relative linear reciprocating motion from support bar **184** by a series of longitudinally spaced apart nut and bolt assemblies **230** (FIG. **1**). Each assembly **230,** as shown in FIG. **2,** comprises a bolt **232,** a nut **234** and a washer **236.** Bolt **232** extends through an interfitting aperture in support bar **184** and slidably through longitudinally elongated, overlaping apertures **238** in cutter blades **26** and **28.** Washer **236** is confined between nut **234** and the underside of cutter blade **20** so that the assembly of cutter blade **26** and **28** and support bar **184** are confined between the head of bolt **232** and washer **236.** The elongation of apertures **238** enables each of the cutter blades to linearly reciprocate relative to bar **184** while being guided and confined to longitudinal motion by engagement of the side edges of apertures **238** with the peripheries of bolts **232.**

As shown in FIGS. **11** and **12,** cutter blade **26** comprises an elongated, flat-sided, straight plate or bar which is formed along both side edges with separate, oppositely laterally extending sets of substantially flat-side, parallel, equidistantly spaced apart shearing teeth **240** and **242.** The roots of the teeth in sets **240** and **242** are uniformly equal. The teeth of sets **240** and **242** have a partial V-shaped configuration, being tapered to converge toward their outer ends. Each of the cutter teeth has oppositely facing, welded cutting edges as indicated at **244** and **246.** These cutting edges extend transversely of the direction in which cutter blade **26** is reciprocated. The spacings or widths between adjacent teeth in each of the sets **240** and **242** are uniformly equal, with all of the teeth being identically dimensioned.

Still referring to FIGS. **11** and **12,** each of the teeth in sets **240** and **242** are equidistantly staggered with respect to each other. More specifically, each tooth in set **240** is so staggered with respect to the teeth in set **242** that a line medially intersecting each tooth in set **240** and perpendicularly intersecting the longitudinal reciprocation axis of cutter blade **26** extends equidistantly between two adjacent teeth in set **242.** It will be appreciated that the teeth in set **242** are staggered relative to those in set **240** in the same manner. The number of teeth in row **240** is equal to the number of teeth in row **242.**

The cutter bar section, which is indicated at **250** and which extends between teeth sets **240** and **242,** has a uniform width which is substantially equal to the uniform width of support bar **184.** Support bar **184** is flat-sided and straight except for the previously described offset at end portion **200.**

Cutter blade **28,** (see FIGS. **11–13**) is the mirror image of cutter blade **26.** Accordingly, like reference numerals suffixed by the lettter "a" have been applied to designated the corresponding portions of cutter blade **28.** With this construction it will be appreciated that cutter blades **26** and **28** are interchangeable simply by turning one of the cutters over through an angle of 180°. In other words, either of the cutter blades **26** and **28** may be used as either the top or bottom cutter blade in the hedge trimmer assembly. This eliminates the necessity of manufacturing and stocking separate top and bottom cutter blades.

The throws provided by crank assemblies **142** and **156** are equal to each other to or at least closely approaching one-half the pitch between adjacent teeth in each of the teeth sets on cutter blades **26** and **28.** Since blades **26** and **28** are concomitantly reciprocated in opposite directions then the total throw of one cutter blade relative to the other will be substantially equal to the pitch between adjacent teeth. The pitch between teeth in sets **240, 242, 240***a*, and **242***a* is uniform.

Thus, as shown in FIG. **11,** when cutter blade **26** is at the forward limit of its stroke, cutter blade **28** is at the rearward limit of its stroke and the teeth in sets **240** and **242** will align with corresponding teeth in sets **240***a* and **242***a* respectively, thereby providing the full unobstructed blade opening width between adjacent teeth for receiving the shurbbery or other matter being trimmed.

From the positions of cutter blades **26** and **28** shown in FIG. **11,** cutter blade **26** is moved rearwardly and cutter blade **28** is moved forward to the positions shown in FIG. **12** where cutter blade **26** is at the rearward limit of its cutting stroke and where cutter blade **28** is at the forward limit of its cutting stroke. Considering the relative motion of cutter blades **26** and **28,** it is clear that each tooth will relatively be moved through a distance substantially equal to the pitch between adjacent teeth so that in the positions of cutter blades **26** and **28** shown in FIGS. **11** and **12,** the teeth in sets **240** and **242** will align with corresponding teeth in sets **240***a* and **242***a* respectively. For example, in FIG. **11,** the tooth indicated at **252** in set **240** will align with the tooth **254** in set **240***a*, and when cutter blades **26** and **28** are reciprocation to their positions shown in FIG. **12,** tooth **252** will align with the preceding tooth in set **240***a* as indicated at **256.** Thus in the positions of cutter blades **26** and **28** shown in FIG. **12** the full unobstructed blade opening width between adjacent teeth is again provided for receiving the shrubbery or other matter being cut.

To make cutter blades **26** and **28** effectively interchangeable without any reduction in the cutting action of the hedge trimmer, the cutter blade teeth on opposite sides of each blade are required to be staggered in the manner previously described to accommodate the offset that occurs between the top and bottom cutter blades by virtue of the oppositely directed throws of the crank assemblies. By virtue of this staggered tooth relation, the full width between teeth will be unobstructed at opposite limits of blade reciprocation even when blade **28** is used as the top blade and blade **26** is used as the bottom blade.

The dual cutter blade construction of this invention lends itself to a novel method of manufacturing the blades. Initially, a suitable strip of stock is provided for in the form of an elongated flat-sided bar or plate. Annealed steel may be used to make the strip of stock. The strip of stock in unblanked form may be of any desired length from which a multiplicity of cutter blades can be fabricated. For example, the strip of stock may be 10 feet long.

In the next step of fabrication, two rows laterally oppositely extending cutter teeth are formed respectively on opposite sides of the stock as shown in FIG. **14.** The teeth in one row will be staggered relatively to the teeth in the other row in the manner previously described. That is, a line medially intersecting each of the teeth in one row and normally intersecting the longitudinal axis of the stock will extend medially between adjacent teeth in the other row.

These two rows of relatively staggered teeth are formed through the entire usable length of the stock that is intended to be used in fabricating the cutter blades. Preferably, to avoid waste the two rows of teeth are formed throughout the entire length of the stock.

Formation of the cutter blade teeth may be effected by stamping them out of the strip of stock in a blanking die of suitable form. Preferably the length of the blanking die and the desired lengths of differently sized cutter blades are so selected that the desired lengths of the blades are integered multiples of the length of the die. For example, it may be desired to fabricate different length of cutter blades such as 15, 20 and 25 inch lengths. A suitable die length would therefore be 5 inches.

The unblanked strip of stock is fed into the blanking die which is indicated at **300** in FIG. **14.** In die **300,** a section or segment of the unblanked strip of stock corresponding to the length of the die is blanked to form the cutter blade teeth on opposite sides of the strip as shown. After each blanking or stamping operation, the strip of stock is advanced in the die by a distance equal to the die's length, and the next section is stamped or blanked. This operation is continued, thus blanking out end-to-end sections of the strip of stock until the full usable length of the strip of stock has been stamped with teeth on both side edges. Thus, at the end of this first blanking operation, two rows of laterally extending cutter blade teeth are formed at both side edges of the strip. It will be appreciated that there is no additional spacing between adjacent, blanked out sections other than the pitch between the teeth. Instead, the pitch of the teeth in both rows will be uniformly equal throughout the entire blanked out length of the strip of stock.

In FIG. **14,** the strip of stock is indicated at **302** and is partially blanked out as shown. The blank portion of strip **302** is indicated at **304,** and the unblanked portion is indicated at **306.**

In addition to forming both rows of cutter blade teeth in this first blanking operation, apertures **238** are also blanked out. The number of these apertures to be blanked out in each blanked section of strip **302** is determined by the length of the blanked section. In this embodiment strip **302** is blanked out in five inch linear sections, and for this length there will be one aperture (**238**) per blanked section as shown. Thus, the spacing between apertures **238** in the blanked out strip of stock will be uniform. In this embodiment, each blanked-out five inch section will have four cutter blade teeth on each side and one aperture **238.**

After this blanking step the blanked strip of stock may be stored or stocked if a supply of cutter blades is not needed at the time. When a supply of cutter blades is desired, the blanked strip of stock is removed from storage and subjected to a combination cutting and punching operation to form the cutter blade shank (**140, 154**) and the crank pin-receiving aperture (**139, 139*a***) and also to cut the cutter blade off from the remainder of the strip of stock at its desired length.

Preliminary to cutting the blade from the remainder of the strip, the cutoff line is located as determined by the selected cutter blade length. This may be done by counting off the necessary number of blanked sections from one end of the blanked strip of stock to locate the last section that will complete the desired length of the cutter blade. For example, assume that it is desired to make a 20 inch cutter blade from the blanked strip of stock in which the blanked end-to-end sections are each five inches long. To locate the last or shank end section and the cutoff line, the fourth blanked section is located from one end of the blanked strip of stock. This located section of the blanked strip of stock is placed in a cutoff die as shown in FIG. **15** wherein the cutoff die is indicated at **310.**

In the cutoff die the desired length of the cutter blade is cut off from the remainder of the blanked stock as indicated at **312,** and a predetermined number of cutter blade teeth are cut off as indicated at **316** to form the toothless shank of the cutter blade. In this embodiment the cutter blade shank is formed by cutting off the last two cutter blade teeth on each side of the blade.

The cutoff line indicated at **312** preferably extends between one of the cutter blade teeth on one side and one of the two nearest cutter blade teeth on the other side. As shown, the cutoff line at **312** extends between tooth **315** on one side and the next tooth **316** which is staggered form tooth **315** on the other side of the blanked strip of stock. Tooth **316** is one of the four teeth that are removed to form the cutter blade shank. By cutting off the selected length of the cutter blade in this manner, tooth **315** will therefore be usable in making up the next cutter blade that is to be cut from the blanked strip of stock.

At the same time that the last four teeth are cut off to form the cutter blade shank, the crank pin-receiving aperture (**139, 139*a***) may be punched out as indicated at **318** in FIG. **15.**

It will be appreciated that the length of the cutter blade is not limited to an integered multiple of the length of each blanked section or segment of the blanked strip of stock. Instead, the blanked stock may be cut to provide a cutter blade of any selected length.

The thusly cut off cutter blade will consequently have its two rows of staggered teeth, the crank pin-receiving aperture (**139, 139*a***) and the reciprocating guide aperture **238.** This blade may be used as either the top cutter blade or the bottom cutter in the dual cutter blade assembly as previously described.

To complete a dual cutter blade assembly a second cutter blade having a length substantially equal to that of the first cut-off cutter blade is cut off from the remainder of the blanked strip of stock, with the length of the second cutter blade being preferably taken from

the cutoff line at **312** to the shank end of the second cutter blade. In cutting off the second cutter blade from the remainder of the blanked strip of stock, the two endmost cutter blade teeth on each side at the shank end are removed, and the crank pin-receiving aperture (**139, 139***a*) is punched out preferably in the same die or dies used for the first cutter blade so that when the second cutter blade is turned over relative to the first cutter blade, it will be the mirror image of the first cutter blade.

From the foregoing cutter blade construction and method it will be appreciated that the top and bottom cutter blades to be assembled as a pair in a hedge trimmer need only be the mirror image of each in the region extending from the crank pin-receiving apertures **139** and **139***a* to the end of the toothed, overlapping regions where cutter blade teeth on one of the cutter blades will be coacting with teeth on the other cutter blade to provide a shearing action. Thus, one cutter blade, at its end remote from the shank or at its end extending beyond the crank pin-receiving aperture (**139, 139***a*) may be longer than its mating cutter blade, but this would serve not benefical purpose as far as cutting action is concerned.

From the foregoing description it will be appreciated that a multiplicity of cutter blades of variable, selected lengths may be cut from a single blanked strip of stock, and each cutter blade may be utilized as either the top cutter blade or the bottom cutter in an assembled pair.

After the cutter blades are cut from the blanked strip of stock, they may be nickel penetrated by placing them in random order in a basket and dipping the basket in liquified nickel. It will be appreciated that it is unnecessary to pair off the cutter blades and to keep them paired off during this and subsequent finishing operations or during any storage stocking periods between operations. For convenience, however, blades of like lengths may be segregated from blades of different lengths, but for a multiplicity of blades of a given length it is unnecessary to pair off the blades and to keep them paired off upon being cut from the blanked strip of stock.

Following the nickel penetration step, the cutter blade teeth are shaved on one or both sides in a shaving die to form the previously described cutting edges **244** and **246.** After shaving, the blades are fed to a sander for deburring.

It will be appreciated that the foregoing construction and method of cutter blade fabrication is simple and inexpensive. It eliminates storage problems, and it eliminates the necessity of making separate top and bottom blades that can only be used as the top or bottom blade. It will also be appreciated that connecting rods **132** and **146** are respectively pivotally connected to the shank ends of cutter blades **26** and **28** by pins **138** and **152.**

We claim:

1. In a power driven hedge trimmer, a pair of overlapping cooperating, relatively reciprocable cutter blades, a housing receiving corresponding ends of said cutter blades, and drive means for said cutter blades, said drive means being mounted in said housing and including a first gear which is mounted for rotation, means for rotating said first gear about a rotational axis, a crank assembly comprising a pair of raised bosses on opposite side faces of said first gear and a pair of connecting rods having corresponding ends respectively coaxially mounted on said bosses for rotation about the respective centers of said bosses, the opposite ends of said connecting rods being respectively pivotally connected to said corresponding ends of said cutter blades, said bosses being offset relative to each other and arranged eccentrically of said rotational axis to provide for the reciprocation of said blades respectively in opposite directions through the connections provided by said connecting rods, said means for rotating said first gear comprising (a) an electric motor having an armature shaft, (b) a second gear on said armature shaft, (c) and intermediate gear means drive connecting said second gear to said first gear, a pair of parallel spaced apart gear-mounting shafts respectively mounting said first gear and said gear means, and a pair of bearing plates spaced axially apart along the axes of said gear-mounting shafts on opposite sides of said crank assembly, one of said bearing plates journalling corresponding ends of said gear-mounting shafts, and the other of said bearing plates journalling the opposite ends of said gear-mounting shafts.

2. In a power driven hedge trimmer, a pair of overlapping, elongated members having coacting sets of cutting teeth, a housing receiving corresponding ends of said members, drive means mounted in said housing and drive connected to at least one of said corresponding ends for reciprocating at least one of said members relative to the other, said drive means comprising means operatively connected to said at least one corresponding end and being operable to convert rotary motion into reciprocating motion for reciprocating said at least one member, a motor having a rotary output element and first and second gear means drive connecting said output element to said converting means, a pair of parallel spaced apart shafts respectively mounting said first and second gear means, and a pair of bearing plates formed separately of said housing and spaced axially apart along the axes of said shafts on opposite sides of said converting means, one of said bearing plates journalling corresponding ends of said shafts, and the other of said bearing plates journalling the opposite ends of said shafts.

3. The power driven hedge trimmer defined in claim **2** wherein both of said members are cutter blades, wherein said converting means is operatively connected to both of said corresponding ends to reciprocate said cutter blades respectively in opposite directions, and wherein said corresponding ends are in planes that transversely intersect the axes of said shafts between said bearing plates.

4. The power driven hedge trimmer defined in claim **3** wherein said housing has a bottom wall beneath said corresponding ends and wherein one of said bearing plates is seated on the interior surface of said bottom wall.

5. The power driven hedge trimmer defined in claim **2** wherein at least the portion of said housing receiving said drive means is divided into two separately formed, mating shells, and wherein said each of said bearing plates is trapped in position between cavity-defining interior wall surfaces of said shells and is secured against transverse movement in said housing only by separable seating engagement with said cavity-defining surfaces.

6. The power driven hedge trimmer defined in claim **2** wherein said bearing plates are formed separately of said members, and wherein portions of said members are between said bearing plates.

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