

Jan. 14, 1941.

W. W. MACFARREN

2,228,896

ROTARY FLYING BILLET SHEAR

Filed June 17, 1936

7 Sheets-Sheet 1

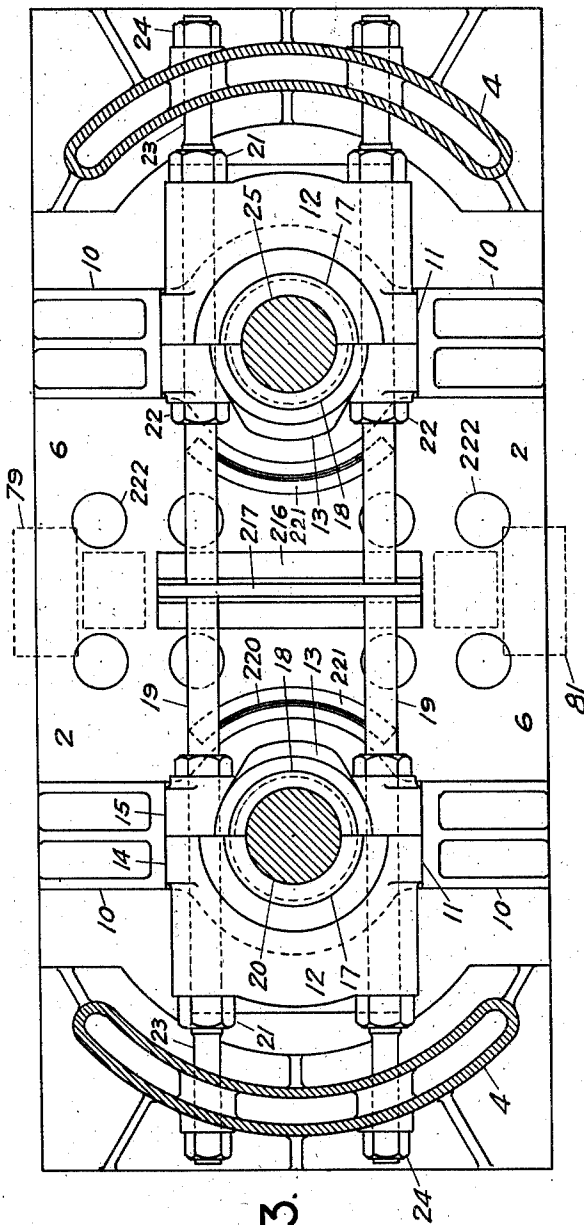


FIG. 3.

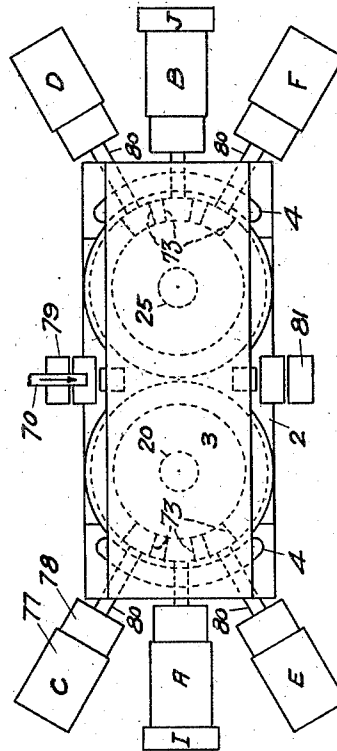


FIG. 1.

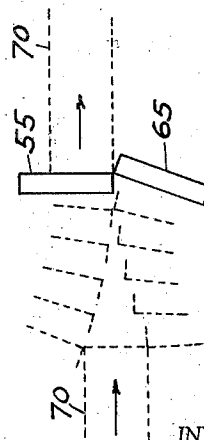


FIG. 10.

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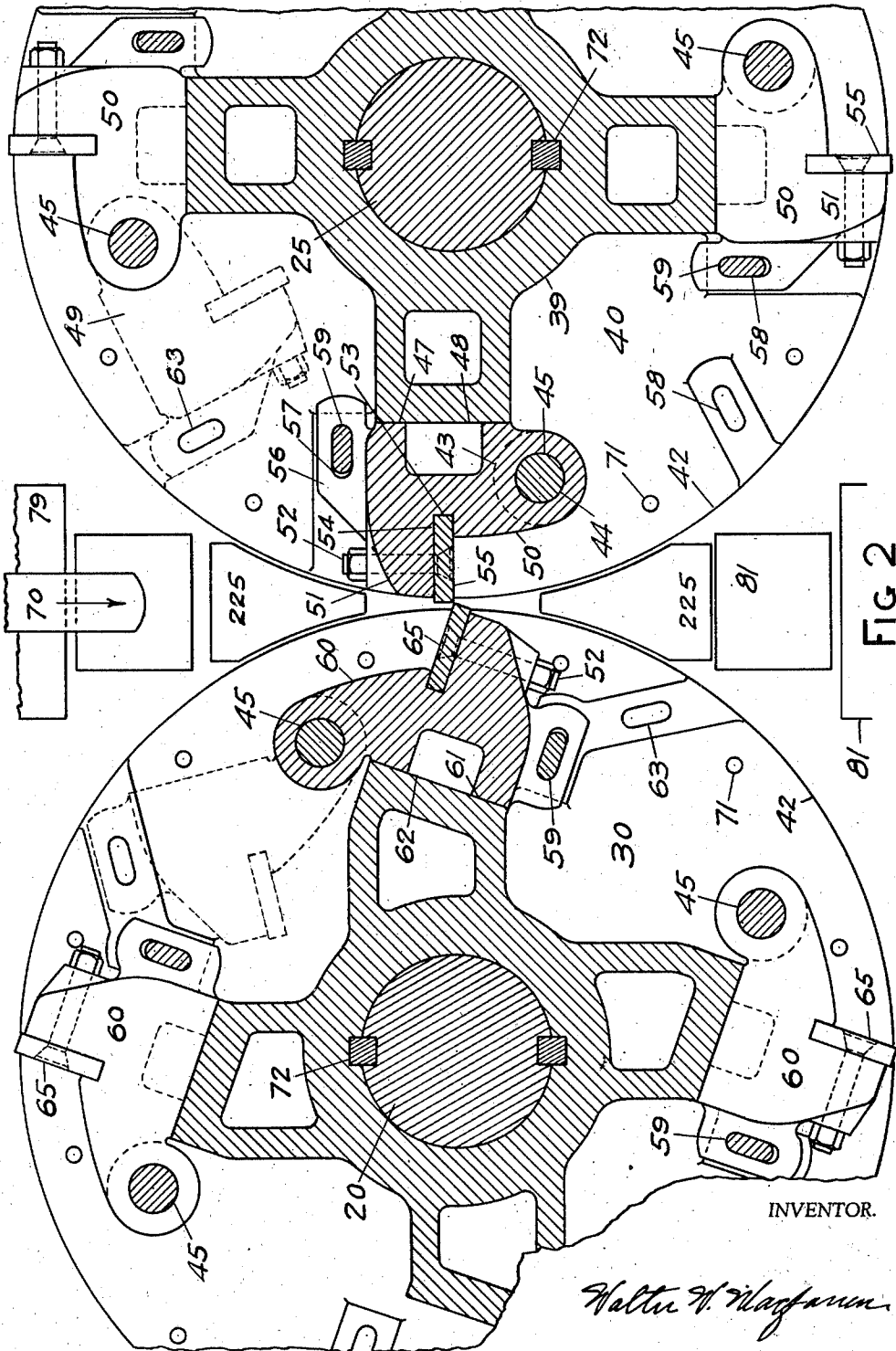
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7 Sheets-Sheet 3

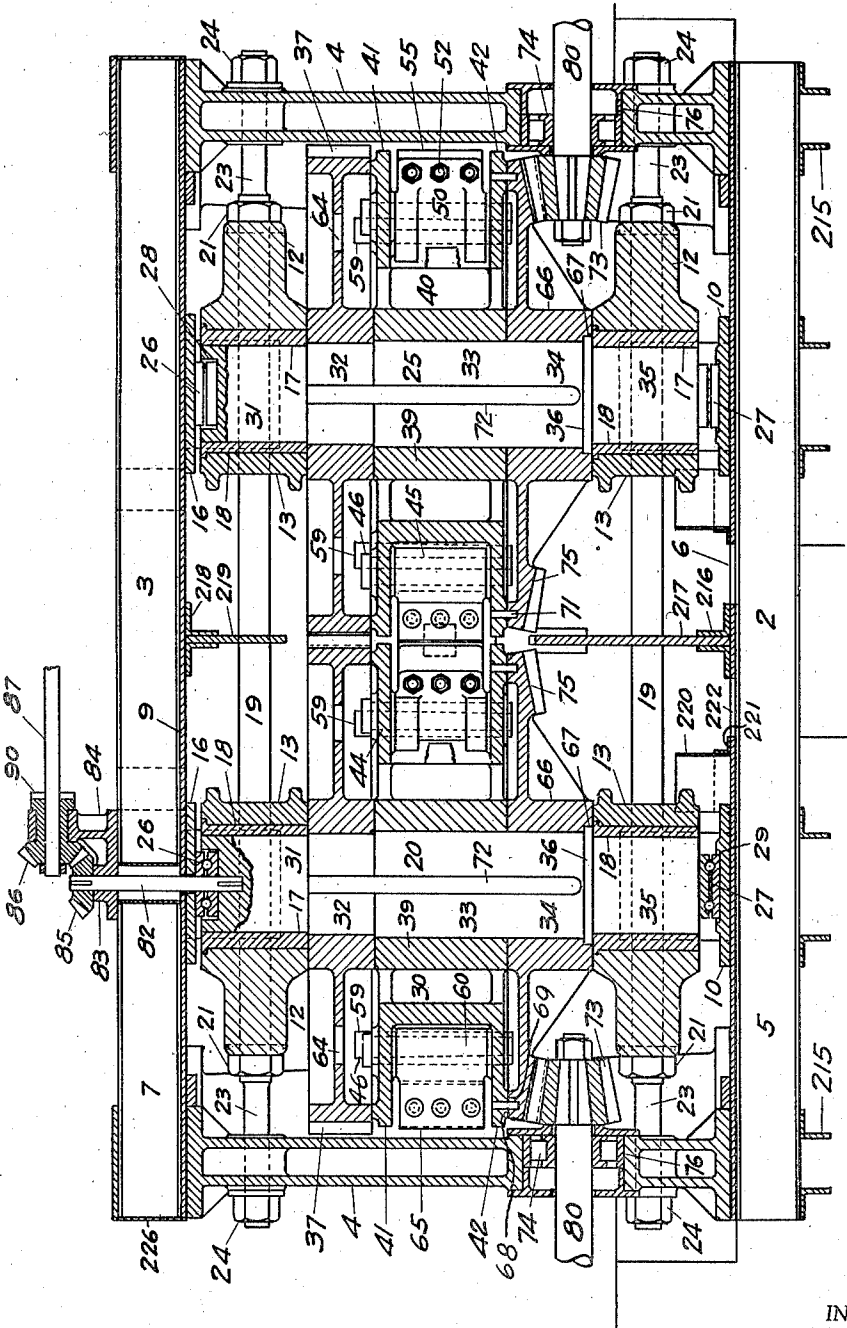


FIG. 4.

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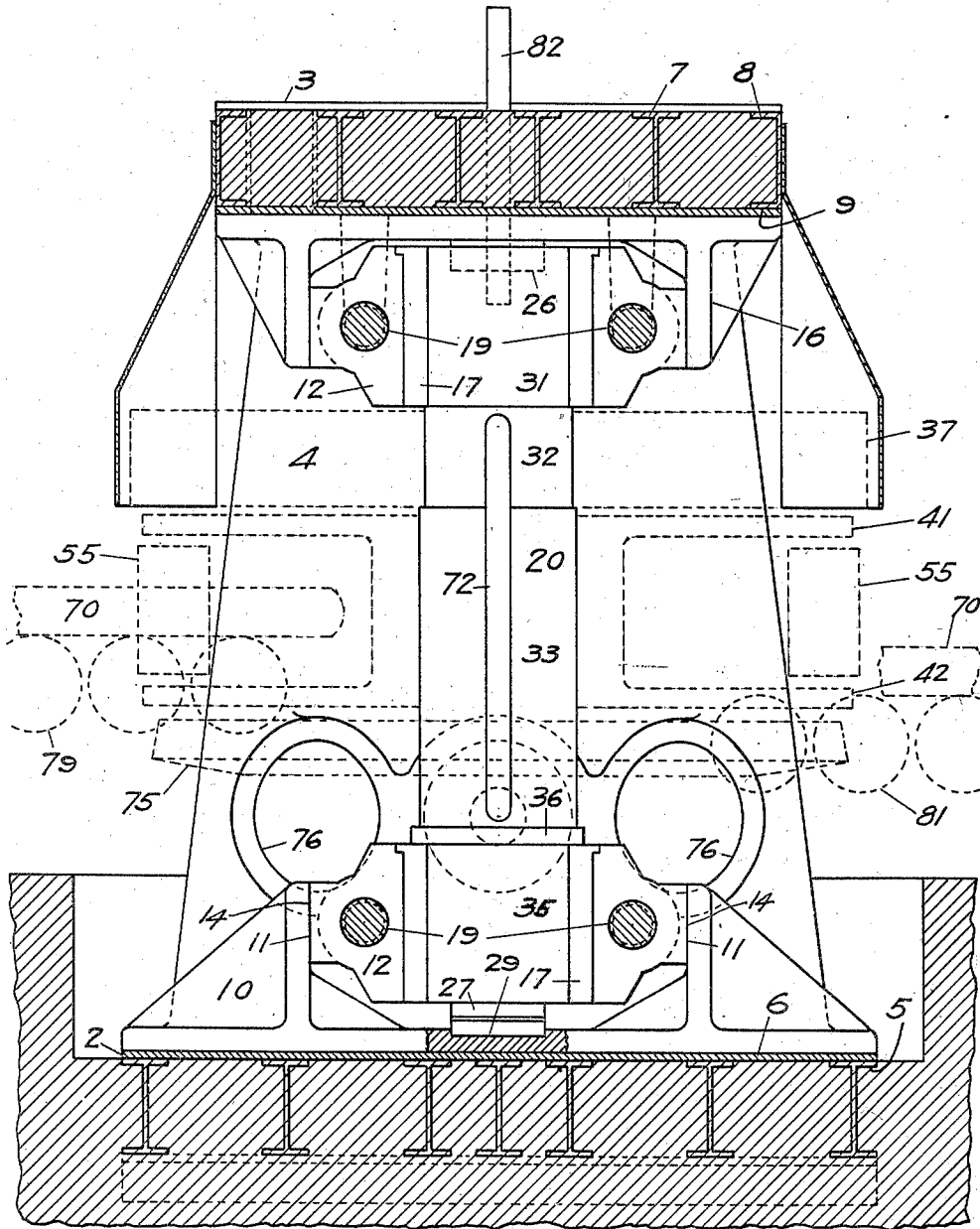
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ROTARY FLYING BILLET SHEAR

Filed June 17, 1936

7 Sheets-Sheet 4



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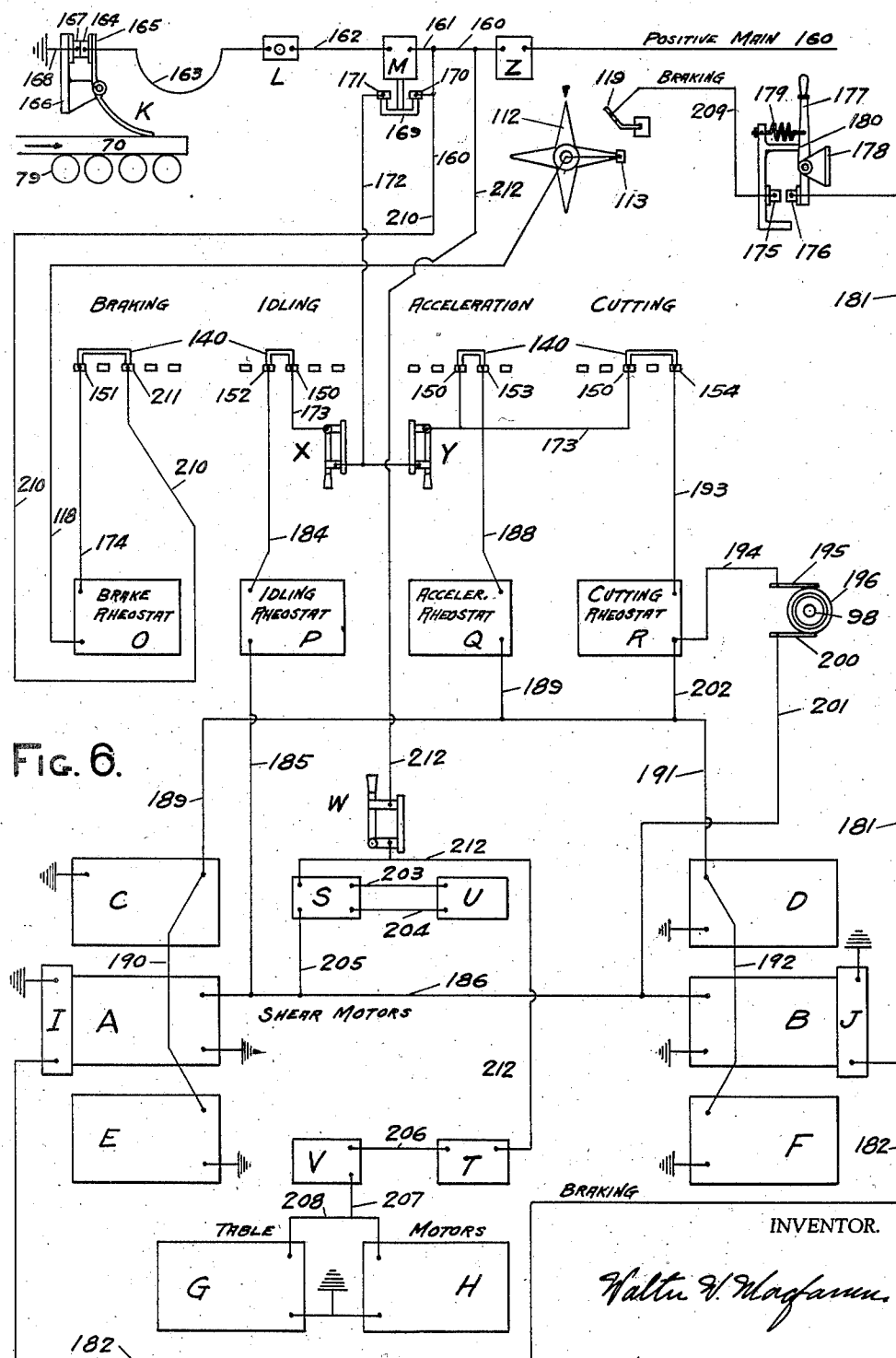
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ROTARY FLYING BILLET SHEAR

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ROTARY FLYING BILLET SHEAR

Filed June 17, 1936

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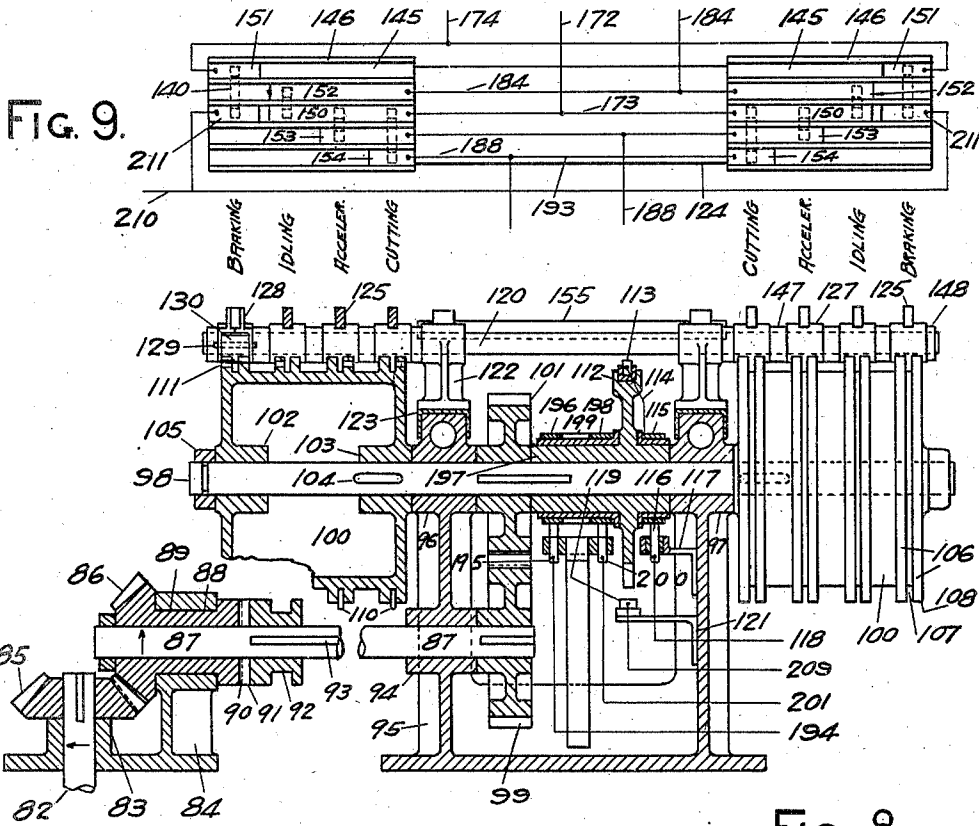


FIG. 8.

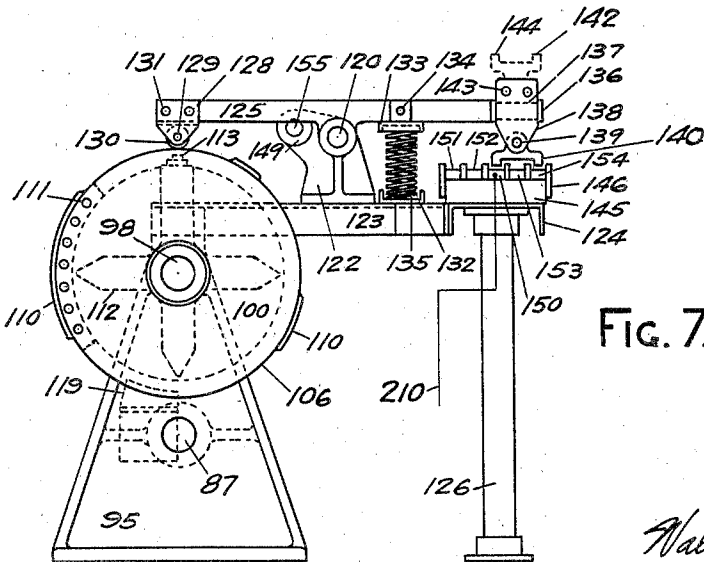


FIG. 7.

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ROTARY FLYING BILLET SHEAR

Filed June 17, 1936

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DATA SHEET- 6x6 ROTARY BILLET SHEAR-CONSTANT BAR SPEED 300 F.P.M.

1	2	3	4	5	6	7	8	9	10	11	12
CUTS- Ft.	CYCLE-SECS.	KNIVES USED	SYN. OR PUL.	TIME FOR CUT IN SECS.	CUT LENGTH	FREE BAR TRAVEL	FREE BAR TIME	FREE KNIFE TRAVEL	FREE KNIFE TIME	AVERAGE KNIFE SPEED BETWEEN CUTS	MAX. OR MIN. KNIFE SPEED BETWEEN CUTS
6	1.2	8	SYN.	.25	1.25	4.75	0.95	4.75	0.95	300.0	300.0
7	1.4	8	PUL.	"	"	5.75	1.15	4.75	1.15	247.8	195.6
8	1.6	8	"	"	"	6.75	1.35	4.75	1.35	211.2	122.4
9	1.8	8	"	"	"	7.75	1.55	4.75	1.55	183.6	67.2
10	2.0	4	"	"	"	8.75	1.75	4.75	1.75	368.8	437.6
11	2.2	4	"	"	"	9.75	1.95	10.75	1.95	330.6	361.2
12	2.4	4	SYN.	.25	1.25	10.75	2.15	10.75	2.15	300.0	300.0
13	2.6	4	PUL.	"	"	11.75	2.35	10.75	2.35	274.2	248.4
14	2.8	4	"	"	"	12.75	2.55	10.75	2.55	252.6	205.2
15	3.0	4	"	"	"	13.75	2.75	10.75	2.75	234.6	169.2
16	3.2	4	"	"	"	14.75	2.95	10.75	2.95	218.4	136.8
17	3.4	4	"	"	"	15.75	3.15	10.75	3.15	204.6	109.2
18	3.6	4	"	"	"	16.75	3.35	10.75	3.35	192.6	85.2
19	3.8	4	"	"	"	17.75	3.55	10.75	3.55	181.8	63.6
20	4.0	4	"	"	"	18.75	3.75	10.75	3.75	172.2	44.4
21	4.2	4	"	"	"	19.75	3.95	10.75	3.95	163.2	26.4
22	4.4	2	"	"	"	20.75	4.15	22.75	4.15	330.0	360.0
23	4.6	2	"	"	"	21.75	4.35	22.75	4.35	318.8	327.6
24	4.8	2	SYN.	.25	1.25	22.75	4.55	22.75	4.55	300.0	300.0
25	5.0	2	PUL.	"	"	23.75	4.75	22.75	4.75	289.8	279.6
26	5.2	2	"	"	"	24.75	4.95	22.75	4.95	276.0	252.0
27	5.4	2	"	"	"	25.75	5.15	22.75	5.15	265.2	230.4
28	5.6	2	"	"	"	26.75	5.35	22.75	5.35	255.0	210.0
29	5.8	2	"	"	"	27.75	5.55	22.75	5.55	246.0	192.0
30	6.0	2	"	"	"	28.75	5.75	22.75	5.75	185.7	71.4

$$\text{KNIFE SPEED} \begin{Bmatrix} 300 \text{ F.P.M.} \\ 437.6 \text{ "} \\ 24.4 \text{ "} \end{Bmatrix} = \text{SHEAR} \begin{Bmatrix} 12.5 \\ 18.0 \\ \text{OF } 1.1 \end{Bmatrix} \text{ R.P.M.}$$

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FIG. 11.

UNITED STATES PATENT OFFICE

2,228,896

ROTARY FLYING BILLET SHEAR

Walter W. Macfarren, Los Angeles, Calif.

Application June 17, 1936, Serial No. 85,809

49 Claims. (Cl. 164-68)

My invention relates to rotary flying shears, and more particularly to heavy shears of the drum type adapted to the hot shearing of heavy billets and slabs. The present invention, as to form, comprises a pair of heavy rotary members or drums, on each of which is mounted (or may be mounted) a plurality of knife holders and knives.

The objects of my invention are:

1. To provide four cutting knives on each drum, so mounted that they are in effect detachable; so that one pair, two pairs, or four pairs of coacting knives may be locked in position and used to produce various cut lengths.

2. To provide means for maintaining a substantially constant speed of the bar being cut, as a normal condition.

3. To provide means for keeping the bar speed and the knife speed substantially equal (synchronous cutting) as a normal condition.

4. To provide means for operating the shear at a substantially constant speed for making certain cuts.

5. To provide means for operating the shear at a pulsating speed for other cuts, while keeping the bar speed uniform.

6. To provide means for starting the shear from a state of rest for making the first cut on each bar.

7. To provide means for normally keeping the bar speed uniform, with controls for varying the bar speed slightly under certain conditions, to make asynchronous cuts.

8. To provide a plurality of motors to drive the shear, and means for using one or more of these motors to operate the shear at desired speeds when idling, or between cuts.

9. To provide a method of using an additional motor, or motors during the cutting period, or when accelerating the shear.

10. To provide a pair of independent spur gears to connect the knife carrying drums.

11. To provide independent drive gears for each drum.

12. To make use of two or more motors and two or more drive pinions engaging each of the said drive gears, whereby a double or triple strength drive is obtained.

13. To carry out the method of driving both of the drum shafts by equal and independent motor drives, whereby the tooth action between the connecting gears is used merely for registering the drums and their contained knives with each other.

14. To make use of the table rollers of the ap-

proach table for controlling the speed of the bar.

15. To make use of a master controller rotated by a member in geared connection with the drums, and in a fixed ratio therewith, for timing the current supply to the driving motors, and of rheostats for varying the current supply to the various motors which drive the shear, and to the table driving motors, in such a way as to automatically start the shear, vary its speed, vary its torque, and to vary the speed of the table rollers when desired.

16. To arrange the shear drums to rotate in horizontal planes on vertical shafts, whereby a number of operating and structural advantages are secured.

17. And in general to provide a powerful and efficient shear.

The prime purpose of the apparatus is to shear, for example, 4", 5", or 6" square steel billets while hot, or slabs up to 3' x 12" into substantially equal sections of desired length, say from six to thirty feet or longer, and of any length in between, with reasonable accuracy. It will be noted that the apparatus is a generic type, and may be modified in size to shear larger or smaller sections, while retaining the same general design and methods of operation.

In the drawings:

Fig. 1 is a diagrammatic plan view of the shear, showing the positions of the six driving motors.

Fig. 2 is a partial plan view partly in section through the shear drums and the cutting knives.

Fig. 3 is a plan view partly in section, showing the lower main shaft bearings and tension rods.

Fig. 4 is a longitudinal sectional elevation through the central plane of the main drums.

Fig. 5 is a transverse sectional elevation through the machine with the position of certain parts indicated in dotted lines.

Fig. 6 is a general wiring diagram.

Fig. 7 is an end elevation of the master controller.

Fig. 8 is an elevation of the same partly in section.

Fig. 9 is a plan view of the contact bars therefore.

Fig. 10 is a diagram showing the cutting action of the knives.

Fig. 11 is a table showing speeds, cuts, etc.

My improved shear has a frame 1 composed of a bed plate 2, a cover 3, and two end members 4. The bedplate 2 comprises a number of steel beams 5, and a cover plate 6 fastened thereto as by riveting. The beams 5 rest on a suitable

foundation which may extend up between them to the under side of the cover plate 6.

The end members 4 are securely fastened to the bed plate 2 as by bolting, and support the cover 3, which is formed of beams 7 and channels 8, and a bottom plate 9, the latter being securely fastened to the beams 7 and channels 8, and the whole to the end members 4. The bed plate 2, the end members 4, and the cover 3, together form a rigid hollow rectangular frame to support and position the various working parts of the machine.

Upon the bed plate 2 there is mounted a pair of guide members 10 securely fastened thereto. Each guide member 10 is provided with a pair of vertical machined surfaces 11, between which there is mounted a lower drum shaft main bearing 12, having a cap 13. Planed ends 14 on the bearing 12, and similar ends 15 on the cap 13, engage the guiding surfaces 11 to position the bearings 12, of which there are four, two upper, and two lower.

Suspended from and rigidly secured to the cover 3 there are a pair of similar guides 16, which engage and position the upper main bearings 12 and their caps 13. Each main bearing 12 has a shell 17, which may be babbitted or provided with other types of wearing surfaces. Due to the slow speed of rotation—normally about $12\frac{1}{2}$ R. P. M.—roller bearings are not deemed necessary here, although of course, they may be used.

Each cap 13 has a similar bearing shell 18, but the shells 18 are smaller in diameter than the shells 17, which prevents rotation of both the shells 17 and 18, as will be readily understood (Fig. 3). One pair of main bearings 12 engages the left hand vertical drum shaft 20, and the other pair engages the right hand vertical drum shaft 25. At the level of the upper main bearing centers (vertically) I provide a pair of main tension rods 19. These rods extend through the upper main bearings 12 and caps 13, and are provided with full nuts 21, which take the thrust of the cutting knives. Thinner nuts 22 are provided for the caps 13.

Outside of the main nuts 21, the rods 19 have reduced ends 23, which pass through openings in the end members 4, and these ends 23 are provided with end nuts 24. Similar rods 19 are used to position the lower pair of main bearings 12. Each of the main drum shafts 25 and 20 is provided with an upper ball thrust bearing 26 and a lower ball thrust bearing 27. Each upper thrust bearing 26 sets in a recess 28 formed in one of the drum shafts 20 or 25, and its upper surface bears against one of the upper guides 16.

Each lower thrust bearing 27 sets in a recess 29 in one of the lower guides 10, and one of the drum shafts 20 or 25 rests on it. The drum shafts 20 and 25 are thus confined against vertical movement by the thrust bearings 26 and 27. The drum shaft 20 has an upper journal 31, a gear seat 32, a drum seat 33, a gear seat 34, and a lower journal 35. Between the portions 34 and 35 there is an integral collar 36, to support the weights of the bevel drive gear 75, the drum 30, and the registering spur gear 37.

From the description thus far it will be noted that the drum shafts 20 and 25 are positioned vertically by the bed plate 2 and the cover 3, horizontally in one direction by the guides 10 and 16, fastened respectively to the bed plate 2 and the cover 3; and horizontally in the other direction by the main tension rods 19. Thus the reactions due to the cuts are provided for.

It will be apparent that the nuts 21 and 22, on the rods 19, may be used to adjust the centers of the shafts 20 and 25, so that the gears 37 are in correct mesh with each other, and that the gears 75 are in correct mesh with the bevel pinions 73 for an initial setting, and that when wear on the main bearings 12 permits improper meshing of these various gears, they may be again reset to correct mesh by means of the nuts 21 and 22.

In addition, the connection of the main rods 19 with the end members 4 confines the drum shafts 20 and 25 against movement in the frame 1. Each drum shaft 20 and 25 is provided with a spur gear 37. These gears are duplicates and serve to register the shear drums 30 and 40, and the cutting knives, with each other. The gears 37 are each mounted on a gear seat 32 above one of the drums 30 or 40, and each is secured to its shaft by two keys 72.

The shaft 25 is provided with a knife carrying drum 40, which is mounted on the portion 33 of the shaft, and comprises a casting having a hub 39, an upper web 41, and a lower web 42. The upper and lower webs 41 and 42 are each provided with four equally spaced bosses 43, having bored holes 44, in which are inserted pivot pins 45. Each pin 45 is provided with a head 46 larger than the pin, and the pins 45 are a tight fit in the holes 44, and keyed to prevent rotation therein.

Upon each pin 45 there is pivoted a knife holder 50, which has a flat bearing or thrust surface 47 which engages a similar flat surface 48 formed on a hollow projection of the hub 39, and extending across between the webs 41 and 42. Each knife holder 50 carries a shear knife 55, the cutting surface of which is on a radius of the drum 40. These are the "straight" knives, and the surface 48 is at a right angle to the radius of the drum. Each knife 55 is backed by a portion 51 of the knife holder 50, through which bolts 52 may extend to secure the knife 55 in the usual manner. The inner edge 53 of each knife 55 engages a groove 54 in the knife holder 50.

Adjacent to the drum webs 41 and 42, a pair of lugs 56 on each knife holder 50 are formed, and provided with slots 57 which register with corresponding slots 58 in the drum webs 41 and 42. Tapered keys 59 extend through the slots 57 and 58, and secure the knife holder 50 rigidly in contact with its seat 48. On the drum 30 there are mounted four equally spaced knife holders 60, which are of similar construction to the knife holders 50 and are provided with knives 65, which may be duplicates of the knives 55.

The knife holders 60 may be secured by duplicate pivot pins 45 and duplicate keys 59, but are provided with inclined seats 61 which bear against inclined surfaces 62, similar to the surfaces 48 of the drum 40. The knives 65 are also inclined to the drum radius as shown in Fig. 2 and in the cutting diagram Fig. 10. These figures show that at the start of the cut, the knives 55 engage the bar 70 obliquely, with one corner only and in such a way that the knife is well backed up by its holder 50. They also show that at the start of the cut, the inclined knives 65 engage the bar 70 squarely, in the manner of an ordinary stationary shear, and that in this position the knives 65 are also well backed up.

This is most important, as the maximum knife pressure occurs at the start of the cut. At the end of the cut, or when the adjacent corners of knives 55 and 65 most nearly approach each 75

other, these conditions are reversed, the knives 55 being square with the bar 70 and the knives 65 being inclined thereto. It will now be seen why at least one set of shear knives (those on one drum) are inclined. It will be obvious also that the knives on both drums may be inclined a less amount instead of the construction shown, if desired.

The reason for pivoting the knife holders is obviously so that they may be swung into an inoperative position when not in use, as indicated in dotted lines at 49. In previous patents of this inventor (1,849,501 and 1,965,523) and in the patents to other inventors (Edwards 1,304,034 etc.) there are shown machines provided with radially adjustable knives, which can be retracted when a cut is not desired. For such a heavy machine as that herein shown this construction would be costly, if not impracticable for lack of space to position such heavy parts. The present arrangement gives a similar result at greatly lessened cost, and probably with increased reliability for heavy service.

To continue the description, when the knife holders 50 or 60 are swung into inoperative position, as shown at 49 in Fig. 2, the same keys 59 are used to lock them in this position.

When this is done the keys 59 are withdrawn from the slots 58 and replaced in a series of slots 62 formed in the upper and lower drum webs 41 and 42, in appropriate locations. Since the keys 59 are tapered lengthwise to facilitate entrance and to obtain close contact, they must be inserted from the top and dropped into the appropriate slots. To provide for this, clearance openings 64 are formed in the webs of the gears 37, and a pair of openings, one for each drum 30 and 40, is provided in the bottom plate 9 of cover 3.

By rotating the drum so the key to be changed is under one of these openings, it may be withdrawn or replaced, preferably by the use of a small power hoist located on the cover 3. In a similar way the pivot pins 45 may be withdrawn or replaced if this should be necessary. Below each drum 30 or 40 on the shafts 20 and 25, there is mounted a main bevel drive gear 75, having a hub 66 provided with a counterbore 67, which engages the shaft collar 36. The upper end of each hub 66 abuts against a drum 30 or 40, so that the gear 75 and the drum 30 or 40 above it are supported by the collar 36. The rim of the gear 75 has a machined surface 68 which contacts a similar surface 69 on the drum 30 (or 40). Dowel pins 71 may be set in as shown to connect the gear 75 and the drum.

Each shaft 20 or 25 has two keys 72 which engage the gear 75 and its connected drum. Each main bevel gear 75 meshes with three bevel drive pinions 73, (see Figs. 1, 4, and 5) these pinions 73 being mounted on drive shafts 80 arranged to radiate from the center of each of the drum shafts 20 and 25 (three from each) as shown in Fig. 1. The inner end of each shaft 80 is supported by a roller bearing 74 mounted in a bore 76 formed in one of the end frame members 4. A similar drive is employed for the drum 40.

Referring to Fig. 4, the plate between the pinion 73 and the bearing 74 may be of the diameter indicated and be split, or it may be in one piece and of a diameter small enough to go through the bore 76, for removal.

Referring to Fig. 1, each of the six shafts 80 has an individual motor to drive it. These motors are designated A-B-C-D-E-F and may for present purposes be assumed to be of the

built-in gear reduction type, the motor frame proper being indicated by the numeral 77, and the gear case by the numeral 78.

Each of the shafts 80 extends into one of the gear cases 78, and is secured to the main drive gear therein, or the gear case shafts and the shafts 80 may be connected outside the gear cases by any suitable form of couplings. From a mechanical standpoint this form of drive gives three gear tooth contacts or driving points on each main drive gear 75, so that the gear is in effect three times as strong as if only one drive pinion 73 were used, or for the same strength only one third the diameter. Also the motors may be of sizes interchangeable with others used in the mill.

In Fig. 1, approach table rollers are indicated at 79, and delivery table rollers at 81. From shaft 20 a small vertical shaft 82 extends up through the cover 3, and engages a bearing 83 formed in a bracket 84, secured to the top of the cover 3. Referring to Fig. 3, at the upper end of shaft 82 there is mounted a miter gear 85 which meshes with and drives a miter gear 86, loosely mounted on a horizontal shaft 87. The gear 86 has a long hub 88 forming a journal which rotates in the bearing 89 of the bracket 84.

Four clutch teeth 90 on the hub 88 co-act with four clutch teeth 91 on a four jawed clutch 92, which is connected to the shaft 87 by a key 93. By means of this four jawed clutch, any one of the four pairs of knives may be used as the starting pair. A standard 95 is fastened to the upper surface of the cover 3, which latter may form the operator's pulpit. The right end of the shaft 87 is supported by a bearing 94 in the standard 95. Directly above the shaft 87 there is mounted a parallel shaft 98, in bearings 96 and 97.

The shafts 87 and 98 are connected by a pair of equal spur gears 99 and 101, and as the gears 85 and 86 are also equal gears, the shaft 98 rotates in synchronism (equal speed) with the drum shaft 20. The shaft 98 overhangs the bearings 96 and 97 an equal amount at each end, and on each of these overhanging ends there may be mounted a cam drum 100, which carries the cam segments 110 for operating the contactors 140, which supply current for the operating motors A-B-C-D-E-F.

As the ends of the shaft 98 overhang, the cam drums 100 can be slipped over either end while the machine is running. Thus one cam drum can be controlling the machine for a certain length of cut, and another cam drum 100 can be placed on the other end of the shaft 98 in readiness for the next length to be cut. The drums 100 are hollow, and can be cheaply made of cast iron. They are each provided with two hubs 102 and 103, the latter of which is keyed to the shaft 98 by the key 104, and retained on the shaft by a set collar 105. Each cam drum 100 is provided with four pairs of flanges 106, between each pair of which there is formed a machined groove 107, these latter being all of the same width and bottom diameter.

The outer surfaces 108 of the flanges 106 are turned to a uniform diameter to form a smooth track for the cam rollers 130. Within the grooves 107 there are secured segmental metal cams 110 which are curved to fit the bottoms of the grooves 107, and which are of a thickness slightly less than the width of these grooves. The cam segments 110 are held in position by set screws 111, a number of which are set in one of each pair of flanges 106.

On the shaft 98, between the gear 101 and the bearing 97, there is fixed a four pointed "star wheel" 112, each point of which represents one of the four cutting knives on one of the main drums 30 or 40, so that the position of the knives is always indicated. One arm of the wheel 112 carries an insulated contactor 113, which is connected by a wire 114 with an insulated metal ring 115, which latter is continuously engaged by a brush 116 set in a bracket 117, insulated therefrom and connected to a wire 118.

The contactor 113 is arranged to contact at each revolution of the shaft 98, with an insulated contact block 119 supported by a bracket 121. These elements form a portion of the brake circuit to be described in detail later. A small shaft 120 is rigidly mounted in a pair of brackets 122, each supported on a channel bar 123, and serves as a fixed pivot for a series of contactor levers 125.

One end of each channel 123 is supported by a lug over one of the bearings 96 or 97, and the other end is fastened to a channel 124, which is supported by a pair of light columns 126 from the top of the cover 3. Each lever 125 is provided with a boss 127, which is bored to fit the shaft 120 loosely. At one end of each lever 125 there is mounted a small roller 130 on a pin 129, the latter being fixed between two plates 128, which are secured to the lever 125 by a pair of bolts 131.

It will be seen from Fig. 8 that the levers 125 are mounted just over the cam drums 100, in such a manner that each lever 125 has its roller 130 centered over one of the cam grooves 107, in position to be engaged by one of the contactor cams 110 as it rotates. Adjacent to the brackets 122 and resting on the channels 123, there is a small channel 132, and to each lever 125 there is fastened a spring cup by a bolt 134. For each lever 125 there is an independent coiled spring 135 resting on the channel 132, and engaging a cup 133 to keep the cam roller 130 tightly pressed against the pair of flanges 106, upon which the roller 130 rides.

As shown in Fig. 7, the right end of each lever 125 is provided with a pair of integral collars 136 between which there is formed a cylindrical surface or journal 137. Upon this journal 137 there is mounted a pair of clamps 138, which are made of some suitable insulating material such as hard fiber or Bakelite. Between each two clamps 138 there is placed a metal contactor 140, which is secured between the clamps 138 by a single bolt 139, upon which it is pivoted. The contactors 140 each have a pair of bent ends 142, which form contact surfaces to engage a pair of bars below them. Each pair of co-acting clamps 138 is clamped to the journal 137 by two bolts 143. By manipulating these bolts 143, the contactors 140 may be locked either in a working position, or in an inoperative position as shown by dotted lines at 144 in Fig. 7. Upon the channel 124 there are mounted two blocks of insulating material 145, such as slate.

These blocks 145 are somewhat longer than the width of the cam drums 100. There are six insulating strips 146 secured to each block 145, forming five parallel grooves in which are mounted two sets of copper bars to supply certain circuits. In the center groove is mounted the bar 150 which is supplied with current from the positive main. To one side of it are located the bars 151 and 152, and at the other side are placed the bars 153 and 154.

It will be seen that the contactors 140 of Fig. 7 when down, will connect the bars 150 and 154. Similar contactors 140 on other levers 125 are arranged to connect the bar 150 with each of the other bars 151, 152, and 153. Each cam drum 100 and associated parts may thus control four electric circuits.

The cam levers 125 are spaced apart by separators 147, and set collars 148 are provided at the ends of the shaft 120. On each bracket 122 there is a boss 149 in the bores of which is placed a lock bar 155, which is long enough to extend from boss to boss 149 and to project either to the right or left (Fig. 8) an amount sufficient to engage the four cam levers 125 on either side, that is, one side at a time. By swinging the contactors 140 to their inoperative position shown at 144, and locking them there by the bolts 143, and then lifting the cam rollers 130 off the cams about an inch, the lock bar 155 may be set underneath four of the cam levers 125 so as to hold them clear of the cams 110 when the said four cams are not in use.

In Figs. 2 and 4 the webs 41 and 42 of the drums 30 and 40, are mounted so as to leave about an inch of clearance between them. In Fig. 2, I show the relation of the table rollers 79 and 81, webs 42, and the guides 225. In Fig. 4, cross angles 215 are secured as by riveting to the beams 5 and underneath the same. On the center line between the drums 30 and 40 and above the cover plate 6, a pair of angles 216 secured to the beams 5, support a vertical plate 217 through which the lower pair of main rods 19 pass in close fitting holes.

A similar pair of angles 218 and a plate 219 are secured under the plate 9 to engage the upper pair of main rods 19. These supports prevent vibration of the rods 19. On each side of the center plate 217 there is placed a curved vertical plate 220 connected by an angle 221 to the cover plate 6, to prevent scale and dirt from reaching the thrust bearings 21. As the bars pass through the shear scale falls on the lower drum webs 42, and is dropped off their outer edges. Openings 222 are formed in the plate 6 to allow this scale to fall through into a pit from whence it may be removed at convenient intervals.

End pieces 226 are secured to the beams 7 and channels 8 of the cover 3, so that the spaces between these members may be filled with concrete. By using small steel scrap such as rivet punchings and a grout of Portland cement, considerable mass can be added to the cover 3 at small expense, which will reduce noise and vibration. The hollow interiors of the end members 4 can be similarly treated after erection.

In Fig. 5, segmental gear covers 230 are shown secured to the channels 8, to cover the outer edge of each main gear 37.

In addition to the control elements, a pair of tachometers may be provided, one driven from the shear and showing the peripheral speed of the knives in feet per minute, and the other driven from the approach table rollers and showing their surface speed in feet per minute, as aids to the operator in controlling the cut lengths.

It has been assumed so far that the shear driving motors A-B-C-D-E-F are duplicates and therefore of equal size. This is a matter of convenience only, and not one of necessity. It is only necessary that each motor does its share of the work, and that no one of the bevel drive pinions 73 is over loaded.

The stress and wear are well distributed on the bevel drive gears. Because there are four evenly spaced knives on each drum, there are also four evenly spaced points of maximum wear on each bevel gear 75, and as there are three pinions 73 engaging each main drive gear 75, there are thus twelve points of maximum tooth stress and wear on each of these gears.

Having now covered the mechanical description of my improved rotary billet shear, I will describe the cuts to be made, and the manner and method of making them, before describing the electrical circuits in detail. The machine under discussion is designed to shear 4", 5", or 6" square billets of various lengths. Since this is fairly heavy duty, and since it usually requires a longer period of time to roll the bar than to shear it, it is not herein proposed to shear the bar at the delivery speed of the mill. This would be especially difficult for a reversing blooming mill, as such mills have varying delivery speeds.

The present method of cutting therefore involves the delivery of the bar clear of the mill rolls onto a shear approach table before the cutting action begins. However, for a continuous mill the shear could engage the bar as it issued from the last stand of rolls. The approach table may be assumed to deliver the bar to the shear at a speed of 300 feet per minute, which in the following discussion will be the cutting speed for all cuts. This speed may be maintained substantially constant by the table motors, under controls to be described later.

In order to clearly present the operations required to cut the various lengths, the table Fig. 11 gives various data. The periphery of the knife travel is assumed as 24 feet, and by the use of four pairs of knives this periphery may be divided into quarters, halves, or used as a whole, with respectively four pairs, two pairs, or one pair of knives in use.

When the peripheral speed of the knives is kept constantly equal to the lineal speed of the bar we have synchronous cutting, and can then cut lengths of six feet, twelve feet, or twenty four feet. However, it is desired to cut all lengths between six feet and thirty feet. The table Fig. 11 shows how this may be done. For instance, if the shear is cutting six foot sections at a bar speed of 300 feet per minute, it is obvious that if the bar speed be kept constant at that figure (table speed), and the shear speed reduced between cuts, a certain amount, we can cut seven foot sections, but it is imperative that at the instant of cutting the knife speed and the bar speed shall be the same. This involves the use of "pulsating" speeds.

In order to obtain a definite short crop end from the leading end of the bar, it is necessary to start the shear at a definite point in the advance of the bar, and to have a certain pair of knives at the starting point. This involves starting and stopping the shear for each bar, but this is not objectionable as there is ample time between bars. In order to keep the cutting speed the same for various sizes of bars, the torque at the cutting instant must be varied in proportion to the resistance offered by the bar.

When using six motors as indicated, it is of advantage to use some of the motors (as drivers) all the time, and others only part of the time. For shearing the maximum sections (6" x 6") I propose to use two of the motors during the idling period between cuts, four of the motors

for starting and quick acceleration, and all six of the motors for cutting.

Therefore, to obtain the effects indicated in the table Fig. 11 it is necessary to fully control the following speeds, times, and forces.

1. The idling period for synchronous cutting at 300 F. P. M. This is done by the use of two motors taking an adjusted supply of current through a rheostat.

2. The idling period for asynchronous cutting, which is effected by the same motors and the same rheostat, with perhaps a different amount of current supply.

3. A variable idling speed or "lag", which is effected by the same two motors and rheostat, in combination with an intermittent cam controlled current supply.

4. Starting the shear from rest and accelerating to the constant cutting speed—this is a task of a fixed value—the same for every start—and may be accomplished by four motors and a controlling rheostat, the current supply being timed by a "flag" or automatic switch and cams.

5. Stopping the shear with a certain pair of knives in a definite position ready for the next start. This may be done by a timed braking effect of proper intensity.

6. Fixing the amount of current required to cut each different size of section, and exactly timing the supply of this current to the time required to make the cut.

7. Accelerating the shear drums just prior to the cut and after a considerable drop in speed (lag).

8. Accelerating above the normal idling speed of 300 F. P. M. for certain cuts.

9. Synchronizing the shear speed with the speed of the feeding rollers of the approach table.

10. Automatically braking the driving motors to reduce the shear speed quickly for certain cuts.

11. Reversing hand controls for the shear and for the table for repairs, adjustments, cobbles etc.

This list of requirements appears to be difficult and complicated, but it becomes surprisingly simple when use is made of an automatic cam controlled master controller, in combination with a separate circuit for each desired function, and a flag operated start.

Referring now to the general wiring diagram Fig. 6, when the advancing bar 70 raises the flag K as shown, current flows from the positive main 160 through a wire 161 to a magnetic switch M, and thence through a wire 162 and through the closed push button switch L to a wire 163 leading to a contact 164 on the flag lever 165 which is pivoted to a bracket 166, this bracket being mounted on a support (not shown) which is adjustable to and from the shear to vary the length of the front crop end.

The moving contact 164 is now in contact with the stationary contact 167 from which a wire 168 leads to a ground. In reality all the grounds shown would connect to a negative main, the grounds being shown merely to simplify the diagram.

The flag contacts 164 and 167 having thus closed a circuit through the coil of the magnetic switch M, the main contactor 169 is raised into contact with the contacts 170 and 171, thus energizing the positive mains 172 and 173 through the switches X and Y. The main 212 supplies current to the shear controller S, and to the table controller T, through the switch W and the table rheostat V.

The main 173 supplies current to the contact bars 150 for the cam operated contactors of the idling, accelerating, and cutting circuits. In the description of Figs. 7 and 8, it was explained that there are only two sets of contact bars 151—152—153—154, and only one, or two connected bars 150, but in Fig. 6 for the sake of clearness, four sets of these bars are shown so that the four circuits controlled by them may be easily visualized. Also, for clearness all the power circuits are shown as being closed; this will however never be the case at the same time, as each circuit will be closed by the cam actuated contactors 140 at the appropriate moment for the service demanded by the various motors A—B—C—D—E—F.

Considering first the brake circuit, current flows from the main 160 to a separate contact bar 211 through a wire 210, and thence through one of the contactors 140 to the contact bar 151, and thence through the wire 174 to the brake rheostat O, and thence by a wire 113 to the brush 116 supplying the ring 115, and through a wire 114 to the contact 113 (see Fig. 8) on the star wheel 112.

When the rotating contact 113 reaches the contact 119, current may flow through the wire 209 to a stationary contact 175 which is in position to be engaged by a movable contact 176 mounted on a hand lever 177, which is pivoted to a bracket 178. The lever 177 is held by a spring 179 against a stop 180, so that the contacts 175 and 176 are normally separated and the circuit is open.

When, at the appropriate moment, this circuit is closed, current may flow through a wire 181 to the brake J, and thence by a wire 182 to the brake I, and thence to ground.

It will be noted that the brakes I and J are applied by the application of the current, and released when the brake circuit is open. These brakes may be of any usual or desired kind. As the braking action is required for certain cuts only, and only when the shear is idling between cuts, or to stop the shear between bars, brakes are furnished only for the two motors A and B, and the brakes are normally not applied.

For the idling circuit, current flows from the main 173 to a contact bar 150, and thence through a contactor 140 to the contact bar 152. From the bar 152 current flows through a wire 184 to the idling rheostat P, and thence through a wire 185 to a wire 186 which supplies the motors A and B.

For the accelerating circuit, current flows from the main 173 to a contact bar 150 and thence through a contactor 140 to the contact bar 153, and thence through a wire 188 to the accelerating rheostat Q. From thence a wire 189 leads to a wire 190 connecting with the motors C and E. From the wire 189 a second wire 191 leads to motor D, and a third wire 192 leads to motor F. Thus motors C—D—E—F are connected for starting and acceleration.

For cutting all six motors may be used, and current flows from main 173 to one of the contact bars 150, and thence through a contactor 140 to the contact bar 154. From bar 154 a wire 193 leads to the rheostat R, and a second wire 194 leads to the brush 195. A wire 202 leads from a connection with the wire 194 to a connection with the wires 189 and 191. The brush 195 contacts an insulated ring 196 mounted on the hub 197 of the star wheel 112, which

is in turn mounted on the shaft 98 and keyed thereto.

At the opposite side of the hub 197 there are mounted four contacts 198 which are of sufficient length (around the hub 197) to supply current during each cutting period. These contacts 198 are connected to the ring 196 by cross pieces 199, so as to be supplied with current thereby.

The four contacts 198 are spaced equally around the hub 197 and the said hub is so positioned on the shaft 98, that each time a pair of knives on the main drums 30 and 40 are in position to make a cut, the contacts 198 are in position to supply current to the cutting circuit. A brush 200 successively engages the contacts 198 and carries current to a wire 201, which connects with the wire 186 supplying the motors A and B. Thus all the motors A—B—C—D—E—F may be operated to drive the shear at the cutting instant.

There are thus three power circuits in addition to the brake circuit, 1st: the idling circuit through rheostat P, wires 184, 185, and 186 to motors A and B; 2nd: the acceleration circuit through rheostat Q, and wires 189, 190, 191, and 192 to the four motors C—D—E—F; and 3rd: the cutting circuit through the rheostat R, and the wires 193, 202, 189, 190, 191, 192, 194, 201, 186, and the brushes 195 and 200, to all six motors A—B—C—D—E—F.

Each of these circuits has its own rheostat to regulate the amount of current supplied, and in each of the circuits the current supply is timed by the cam controlled contactors 140, to give complete control of the motor operations. For the purpose of turning the shear over for inspection, knife changes, knife holder settings etc., I provide a reversing controller S with a bank of resistance U. Current may flow from main 212 through the switch W to the controller S, and from thence to and from the resistance U over wires 203 and 204, and thence by a wire 205 to the wire 186 leading to the idling motors A and B. At such times as controller S is used, the switches X and Y may be opened.

In addition to the shear motors A—B—C—D—E—F controls are shown for the approach or feed table motors G and H. The wire 212 is extended to the controller T which is connected to the rheostat V by a wire or wires 206, from whence wires 207 and 208 lead to motors G and H. During normal operation of the shear the controller T may be in the full on position for forward motion (feed to shear), and the speed of the motors G and H may be set at a substantially fixed value by the rheostat V.

In some cases it will be of advantage to vary this speed somewhat as will appear later. When it may be desired to reverse or manipulate the table rollers, the controller T and the rheostat V may be operated together. It will be noted that the main 160 supplies all current for the operation of the shear motors, and also that for the table motors. Thus changes in line voltage will be felt by all these motors to an equal degree. A circuit breaker Z may be provided in the main 160, switches X and Y in the mains 173, and a switch W in the main 212.

It is probable that the four separate rheostats O, P, Q, and R could have their resistances combined into a single bank, and still retain the individual control over the various circuits affected, by having a separate control handle for

each circuit operating on a section of the whole resistance.

The operation of my improved rotary shear varies with the cuts being made, as shown in the table Fig. 11. The simplest method of operation is that used for the synchronous cuts of six, twelve, and twenty-four feet, in which the shear speed and the bar speed are substantially and constantly the same, after the shear has attained full speed. Assuming a bar speed of 300 F. P. M., this is fixed by the setting of the table rheostat V. Assuming two seconds are required to bring the shear drums 30 and 40 from a state of rest to a speed of 300 F. P. M., this will equal ten feet of travel of the bar 70, and the flag K may be set ten feet ahead of the point of engagement of the knives, plus the length of the desired front crop end—say two feet—or a total of twelve feet from the point where the knives first grip the bar.

As the work required to bring the shear drums, motors, gearing, etc. from rest to the desired speed is made up of acceleration, which is practically constant (except for differences in the positions of the knife holders), and of friction which is also nearly constant, the amount of current required to start the shear from a uniform position of the drums, and the time of application of this current will be substantially constant at all times and for all cut lengths.

This amount of current may be regulated by the acceleration rheostat Q, and the timing may be controlled by the appropriate contactor cams 110. Thus a regulated amount of current may be supplied for a length of time just sufficient to bring the shear from a state of rest to the desired speed of 300 feet per minute just before the knives engage the bar. The setting of the rheostat Q will therefore be normally the same for starting on all cuts, but it may be varied slightly if necessary at any time.

Just prior to the engagement of the bar by the knives, the cutting current is supplied to all six of the shear driving motors by the appropriate contactor 140 through the cutting rheostat R.

Both the amount of the current supply and the time of its application will vary with the thickness of the section cut—the first because there is more power needed for the thicker sections, and the second because the point of knife engagement varies with the thickness cut. The temperature of the bar will also be a factor.

Theoretically, it would therefore be necessary to have a different set of cam sectors 110 for each thickness cut, to obtain a different timing, and a different setting of rheostat R to obtain a different ampere delivery, but practically, in most cases the timing may be obtained with sufficient accuracy by changing the setting of the acceleration rheostat Q, and the current supply may be regulated by rheostat R.

The above method takes care of six, twelve, and twenty four foot cuts, during which the shear speed remains substantially constant between the first and last cuts on each bar, and also substantially the same as the bar speed.

Considering now a seven foot cut, col. 11 of the table Fig. 11 shows that the average knife speed between cuts must be reduced to 247.8 feet per minute, the speed at the cutting instant remaining at 300 F. P. M., and the speed of the bar 70 being substantially constant at 300 F. P. M. Col. 12 of the table also shows that the minimum

speed of the shear drums for a seven foot cut would be 195.6 feet per minute.

In the table all the figures in col. 12 have been calculated on the basis of uniform acceleration and deceleration as a matter of convenience. The figure 195.6 F. P. M. is therefore a depression or negative peak in the acceleration diagram. In practice however, the acceleration and deceleration may be sharper, as four motors are available for acceleration, and powerful brakes for deceleration.

The minimum speeds in col. 12 may therefore be considerably higher, and the maximum speeds considerably lower than those shown. For a seven foot cut the shear would be started from a state of rest as usual, accelerated to full speed, supplied with cutting current for the proper time and in the proper amount, and then have all the shear motors cut out for a short period to allow the shear drums to lag with respect to the bar. After sufficient lag, the idling motors would be cut in again and if necessary, following this, the accelerating motors would be cut in long enough to bring the drums up to speed just before the cutting current is supplied to all six motors to make the cut.

It will now be seen that for each cut length a different cam drum 100 must be used, with cams 110 appropriate to the demands of the various circuits. These cams may be laid out and constructed with sufficient accuracy after some experience or trial operation of the shear, but they can always be modified in place. The cycle for a seven foot cut on a 6" x 6" bar would then be as follows, after the preliminary starting period:

1. Cutting with all six motors—time 0.25 secs.—bar travel 1.25 ft.
2. Indeterminate idling period with all power off the shear drums—to be determined by trial.
3. Idling motors on if necessary.
4. Acceleration just before the next cut.

At the end of each bar, and independent of the cut lengths, the shear must be stopped in readiness to start again for the next bar, and with the number one pair (starting pair) of knives in a predetermined position.

This is accomplished as follows: After the last cut has been made on each bar, the shear operator presses the push button switch L, which opens the coil circuit of the magnetic switch M, and allows the contactor 169 to drop, thus cutting off the current supply to the shear motors A—B—C—D—E—F, but not to the table motors G and H, which may run constantly or be under the control of another operator through separate controls (not shown).

The brake circuit also remains ready to be energized. At the same time the shear operator pulls the lever 177 to close the brake circuit through the contacts 175 and 176, and holds this circuit closed until the brakes are applied by the timing contacts 113 and 119, and the shear drums have come to rest. He then releases the lever 177, when the spring 179 opens the circuit through the contacts 175 and 176, thus leaving the brakes off and the shear drums ready to be started again for the first cut on the succeeding bar, which is accomplished automatically by the flag K and magnetic switch M.

From the table Fig. 11, it will be noted that cuts from six to nine feet inclusive are made with all four pairs of knives (8 knives) that cuts from ten to twenty one feet inclusive are made with two opposite pairs of knives (4 knives)—and that

cuts above twenty-one feet in length are made with only one pair of knives (2 knives).

Before starting a series of cuts it is therefore necessary to swing the shear knife holders 50 and 60 into operative position and lock them there by the keys 59, and to swing those knife holders not chosen for cutting, into their inoperative positions and lock them there. For seven, eight, and nine foot cuts, the operation is similar, the only difference being in the amount of lag of the shear drums to allow more or less of the bar 70 to pass.

For a ten foot cut however, a new condition arises. Here it is necessary to speed up the shear drums because only four knives (2 pairs) are in use. This may be accomplished merely by starting the acceleration period before each cut sooner than usual, by the proper cams 110, and thus allowing the drums to reach a higher speed, and then cutting off the supply of accelerating current in time for the drums to drop to cutting speed just before the cutting current is switched on. As before stated, the maximum speed of 437.6 F. P. M. shown for this cut, may be much less with faster acceleration.

An eleven foot cut requires a similar operation with a lower maximum speed of the shear drums. A twelve foot cut is made in just the same way as a six foot cut, except that only two pairs of knives are used to make these cuts. Cuts from thirteen to twenty one feet inclusive are made in a way similar to that for seven, eight, or nine foot cuts, except that only two pairs of knives are cutting.

For twenty two and twenty three foot cuts the operation is similar to that for ten and eleven foot cuts, as the drum speeds must be increased between cuts. A twenty four foot cut is made synchronously like six and twelve foot cuts, using only a single pair of knives.

For all cuts twenty five feet and over there is a lag between cuts, using a single pair of knives. For cuts over thirty feet this lag may become nearly a full stop, in which case the shear drums would be allowed to drift to a near stop, and then be accelerated to cutting speed just before the cut. In all cases the cutting current should be applied just before the knives engage the bar.

In timing the shear for a stop, some one pair of knives (if more than one pair are in use), must be selected to stop at the desired position in readiness to make a first cut when the shear is again started. This pair of knives may be called the number one pair. If however the same pair was used continuously the wear on them would be greater than that on the other knives, so I have provided the four jawed clutch 92, the four jaws of which register with the four pairs of cutting knives. By shifting the clutch to any one of its four engageable positions, any one of the four pairs of evenly spaced knives may be made the starting or number one pair.

It may now be seen why four pairs of cutting knives are used. It is because no other number is so efficient, convenient and economical.

Without at least four pairs of knives all the cuts listed in the table could not be made. With more than four pairs of knives space is not available to fold the knife holders into inoperative positions. No less than eight pairs of knives would give equal facility of operation, and this would double the cost of the knives and knife holders.

The speed of 300 F. P. M. is believed to be practicable for a 6" x 6" billet, and higher speeds could be used for smaller sizes. Obviously these cutting speeds may be as low as desired.

For cuts intermediate of the even lengths given in the table (viz. 6-7-8 . . . 28-29-30 ft.) similar methods of operation may be used with a special cam drum 100 and cams 110 being required for each cut length. For slight differences from the standard even lengths given, say 7'-11" or 8'-1", the table rollers 79 and the shear drums 30 and 40 could be operated asynchronously by merely changing the setting of the table rheostat V, without making any other change. For heavy sections however this is not recommended except at low speeds.

It will be noted that I employ wholly new principles and mechanism for synchronizing the bar speed and the knife speed. Some prior inventors have given the shear drums variable speeds by change gears and differential gears from a constant speed motor—others have used "Scotch yokes," elliptic gears, and various other mechanisms to mechanically effect a pulsating speed of the shear knives. Several inventors have used pinch rolls for controlling the speed of the bar. In all these cases electric motors are used to drive the shear, and in practically all of them roller tables are used to convey the bar to the shear to within the reach of the feeding mechanism used.

In the present invention I control the speed of the shear at either a uniform, variable, or pulsating speed, solely by the use of the driving motors, and in addition I control the torque of the motors by pre-adjusted rheostats, thus dispensing with all mechanical speed changing devices.

I also use the table rollers of the shear approach table to control the speed of the bar, and synchronize their operation with that of the shear in such a manner as to obtain sufficient accuracy for cutting billets, thus eliminating pinch rolls. I also provide automatic means for starting the shear, and means for both synchronous and asynchronous operation thereof.

It will be evident that a horizontal shear such as that shown has certain advantages over a shear in which the drums rotate in vertical planes. These are:

1. The horizontal shear is lower, wider, and more stable.

2. The pivoted knife holders may be swung manually merely against the friction of their pivots.

3. The distortion of the billet is less—there is no lifting of the same by the knives when cutting.

4. The delivery from the shear of short rear crop ends is much facilitated by a continuous support.

5. An inexpensive structural frame may be used.

6. Idling friction is less due to ball thrust bearings.

7. The machine is more accessible than a vertical machine.

8. No large gear covers are needed.

The disadvantages as compared to a vertical shear are:

1. Bevel drive gears are necessary, or at least preferable.

2. The shear (as shown) can cut only one bar at a time.

3. Slabs must be sheared on edge.

Regarding the use of six motors to drive the shear, this is a matter of mechanical convenience and possibly of economy in first cost, coupled with probably increased electrical efficiency due to fuller loads on the idling motors during the idling periods. It will be noted that since all

the motors are geared to the shear, they rotate together whether all or only some of them are energized.

However it is evident that the shear could be driven by two or four motors, or even by a single motor geared to both knife drums. These are matters for the individual designer and specific conditions.

The machine can be dismantled as follows:

10 The bracket 84 and the standard 95 can be lifted off the cover 3, leaving the vertical shaft 82 in place. The cover 3 can then be lifted off the end members 4 carrying with it the upper tension rods 19 and the upper bearings 12, which lift off the drum shafts 20 and 25.

15 The drum shafts 20 and 25 can then be lifted out, with the attached gears 37 and 75 and the drums 30 and 40, leaving the lower bearings 12 in place. To get the lower bearings 12 and the lower tension rods 19 out, it is necessary to move the end members 4 endwise of the frame to clear the ends of the rods 19. The bearing shells 17 and 18 may be changed by slacking off the cap nuts 22, and backing off the caps 13 until the shell 18 can be removed, and then the shell 17 can be twisted out of the bearing 12.

25 Having now fully described my invention as embodied in a preferred form, and set forth the several methods of operating it and the results to be obtained thereby, I claim as my invention:

30 1. A horizontal rotary flying shear comprising a pair of rotary drums mounted on parallel vertical fixed axes for rotation about the same, coacting shear knives carried by the said drums and rotating in horizontal planes, means for feeding a bar to the shear at one constant level to be cut into sections, means for discharging the cut sections from the shear at a constant lower level, and means for driving the shear drums.

35 2. A horizontal rotary flying shear comprising a frame, a pair of rotary drums mounted on parallel vertical fixed axes for rotation about the same, a shear knife on each of the said drums coacting with the knife on the other drum, means for feeding a bar to be sheared to the knives, means for driving the said drums, and means for adjusting the distance between the centers of the vertical axes independently of the said frame.

40 3. A horizontal rotary flying shear comprising a pair of rotary drums mounted on parallel vertical shafts for rotation about the same, coacting shear knives on the drums, a vertical shaft fixed to one of the drum shafts and above the same, a horizontal shaft connected to the said vertical shaft and driven thereby, a second horizontal shaft located above the first and driven thereby at a speed equal to that of the drum shaft, and a pointer on one of the said horizontal shafts to indicate the position of the shear knives.

45 4. A horizontal rotary flying shear comprising a pair of rotary drums mounted on parallel vertical shafts for rotation about the same, coacting shear knives on the drums, a vertical shaft fixed to one of the drum shafts and above the same, a horizontal shaft connected to the said vertical shaft and driven thereby, a second horizontal shaft located above the first and driven thereby at a speed equal to that of the drum shaft, detachable cams mounted on said second shaft, and contactors actuated by the said cams for controlling the application of driving forces to the drum shafts.

50 5. A horizontal rotary flying shear comprising a four piece including a bed plate, a cover, and

two end members, a pair of parallel vertical shafts, means for driving the same, a drum on each of the said shafts, a shear knife on each of the said drums, these knives coacting with each other to shear a bar passing between them, upper and lower bearings for each of the said shafts, a pair of tension rods connecting the said upper bearings, a second pair of tension rods connecting the said lower bearings, guides for the upper bearings secured to the cover, 10 guides for the lower bearings secured to the bed plate, and connections between all of the said tension rods and each of the said end members.

6. A horizontal rotary flying shear comprising a four piece frame, including a bed plate, a cover, 15 and two end members, a pair of parallel vertical shafts, means for driving the same, a drum on each of the said shafts, a shear knife on each of the said drums, these knives coacting with each other to shear a bar passing between them, upper and lower bearings for each of the said shafts, caps for each of the said four bearings, a pair of tension rods passing through the said upper bearings, their caps, and the said end members, a second pair of tension rods passing 25 through the said lower bearings, their caps and the said end members, and nuts on all the said tension rods at each bearing, at each cap, and at each end member, to position the said bearings and caps in the frame.

7. A horizontal rotary flying shear comprising a four piece frame including a bed plate, a cover, and two end members, a pair of parallel vertical shafts, means for driving the same, a drum on each of the said shafts, a shear knife on each 35 of the said drums, these knives coacting with each other to shear a bar passing between them, upper and lower bearings for each of the said shafts, a pair of tension rods connecting the said upper bearings, a second pair of tension rods connecting the said lower bearings, connections between the ends of all the said tension rods and the said end members, a support extending from the mid portion of the said upper tension rods to the said cover, and a second support extending 45 from the mid portion of the said lower tension rods to the said bed plate.

8. A horizontal rotary flying shear comprising a pair of vertical shafts, each of the said shafts having a lower journal bearing, a bevel drive gear above the said bearing, a drum above the said drive gear, a shear knife on the said drum, the knife on one drum coacting with the knife on the other drum to shear a bar passing between them, a spur gear above each drum, the said 55 two spur gears meshing with each other to register the knives, an upper journal bearing for each of the said shafts, means for driving the bevel drive gears, means for supporting and fixing the journal bearings, and means for supporting the said shafts and the parts mounted thereon against vertical movement independently of the said journal bearings.

9. A horizontal rotary flying shear comprising a frame having a cover portion, a pair of vertical 65 shafts, a drum on each of the said shafts, registering spur gears above the drums which connect the said vertical shafts, means for driving the said shafts, a knife holder on each of the said drums, a knife on each of the said knife holders, these knives coacting to shear a bar passing between the drums, members for securing the knife holders to the drums, and openings in the said spur gears and the said cover for removing the said securing members.

10. A horizontal rotary flying shear comprising a four part frame composed of a bed plate, a cover, and two end members, a pair of drums mounted for rotation on fixed vertical axes, means for driving the said drums, coating shear knives on the said drums, the said cover being composed of a number of rolled steel sections and a bottom plate, the said base plate being also composed of a number of rolled steel sections and a cover plate, and the interstices between the rolled steel sections of the base plate and the cover plate being filled with concrete or other heavy material to reduce noise and vibration, and to provide additional mass in the structure to absorb shocks.

11. A horizontal rotary flying shear comprising a four part frame composed of a base plate, a cover, and two end members, a pair of drums mounted for rotation on fixed vertical axes, means for driving the said drums, coating shear knives on the said drums, and the said cover being adapted to form an elevated floor or pulpit upon which the operating controls may be mounted.

12. A horizontal rotary flying shear comprising a frame having top, bottom, and end portions, a pair of vertical shafts, means for driving the same, upper and lower bearings for the said shafts, a drum on each of the said shafts between the said upper and lower bearings, coating shear knives on the said drums, a pair of tension rods connecting the said upper shaft bearings and extending to the end frame members, and slots in the said end frame members to receive the ends of the said tension rods and extending to the tops of the said end frame members, whereby the said pair of tension rods and the said upper shaft bearings may be removed together after the top frame member has been removed.

13. A horizontal rotary flying shear comprising a frame, two parallel vertical shafts mounted therein, and geared together, a bevel drive gear on one of the said shafts, a drum on each of the said shafts, coating shear knives on the said drums, a drive shaft, a bevel pinion thereon meshing with the said bevel drive gear, an opening in the end of the said frame, and a bearing in the said opening for the said drive shaft, the diameter of the said opening being large enough to permit removal of the said bevel drive pinion through the said opening, without removing the said pinion from its shaft.

14. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, a shear knife on each of the said drums coating with a knife on the other drum to shear a moving bar, a motor or motors for driving the shear, and four separate electrical circuits for controlling the operation thereof, including a braking circuit, an idling circuit, an accelerating circuit, and a cutting circuit; means for regulating the amount of current supply to each of the said four circuits, and means for timing the application of the said current supply to each of the said four circuits.

15. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, a shear knife on each of the said drums coating with a knife on the other drum to shear a moving bar, a motor or motors for driving the shear, and four separate electrical circuits for controlling the operation thereof including a braking circuit, an idling circuit, an accelerating circuit, and a cutting circuit; an independent rheostat for each of the

said four circuits to regulate the amount of current supply to each circuit, and automatic mechanically timed contactors for energizing and de-energizing the said four circuits to control the operation of the shear.

16. A horizontal rotary flying shear comprising a pair of rotary drums mounted on parallel vertical shafts for rotation about the same, coating shear knives on the drums, a vertical shaft fixed to one of the drum shafts and positioned above the same, a horizontal shaft connected to the said vertical shaft by bevel gears, a second horizontal shaft located above the first and driven thereby at a speed equal to that of the drum shafts, motors for driving the drum shafts, detachable cams mounted on the said second shaft, and contactors actuated by the said cams for controlling the current supply to the said driving motors, to make the desired shearing cuts.

17. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation on fixed centers, coating knives carried by the said drums, means for feeding the bar to be sheared to the knives, means for driving the drums, a master controller driven in a fixed ratio to one of the drums, the said controller including detachable cams, contact bars for distributing current to the driving motors, and contactors operated by the said cams and engaging the said contact bars, for timing the application of the said current to the said motors.

18. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation on fixed centers, spaced coating knives carried by the said drums, means for feeding the bar to be sheared to the knives, means for driving the drums, a master controller driven in a fixed ratio from one of the drums, the said controller including detachable cams, rocker arms actuated thereby, contact bars for distributing current to the driving motors, a contact bar for supplying current to an electrically operated brake, and contactors operated by the said cams and engaging the said contact bars to time the application of the said driving and braking currents.

19. A rotary flying shear comprising a pair of rotary drums mounted to rotate on fixed centers and geared together, coating shear knives on the said drums, a plurality of motors for driving the said drums, an electrically operated brake for stopping the said drums, the said drums being normally stationary between the approach of successive bars and their engagement by the shear, a brake circuit, three power circuits each controlling certain of the driving motors, a positive main, contact bars for supplying the various circuits with current, mechanically operated contactors for connecting the various contact bars with the positive main, a magnetic switch for controlling the current supply to all of the power circuits, a shunt from the positive main to energize the coil of the magnetic switch through one fixed and one moveable contact, and a flag or lever actuated by each advancing bar as it nears the shear for closing the said shunt circuit and thus closing the said magnetic switch in readiness to supply current to the motor circuits, in combination with a cam shaft and cams for operating the said contactors at desired times.

20. A rotary flying shear comprising a pair of rotary drums mounted to rotate on fixed centers and geared together, coating shear knives on the said drums, a plurality of motors for driving the said drums, an electrically operated brake for stopping the said drums, the said drums being

normally stationary between the approach of successive bars and their engagement by the shear, automatic means for starting the shear from a state of rest in a fixed relation to the leading end of each advancing bar, by the application of a regulated supply of current to certain of the driving motors, the said amount of current being proportioned to bring the shear drums up to a substantially set speed just before the cutting period, automatic means for discontinuing the said current supply, and automatic means for supplying an increased amount of current to the said motors, and a similar supply to a certain additional motor or motors to make the desired cut.

21. A rotary flying shear comprising a pair of rotary drums mounted to rotate on fixed centers and geared together, coacting shear knives on the said drums, a plurality of motors for driving the said drums, an electrically operated brake for stopping the said drums, the said drums being normally stationary between the approach of successive bars and their engagement by the shear, means for starting the shear at the approach of each bar to be cut, means for adjusting the amount of current supplied to make the cut to the section to be cut, means for timing the application of the said current to the time required to make the cut, means for operating the shear between cuts at a desired speed to fix the lengths of the sections cut, and means for stopping the shear drums in a definite position after the last cut is made on each bar.

22. A rotary flying shear comprising a pair of rotary drums mounted to rotate on fixed centers and geared together, coacting shear knives on the said drums, a plurality of motors for driving the said drums, an electrically operated brake for stopping the said drums, the said drums being normally stationary between the approach of successive bars and their engagement by the shear, means for feeding the bar to be cut to the knives, and six electric operating circuits including a braking circuit, an idling circuit, an accelerating circuit, and a cutting circuit; the said four circuits being automatically controlled both as to the time of application and the amount of current supply, a manually controlled manipulating circuit for the shear drum, and a manually controlled manipulating circuit for the feeding means.

23. A rotary flying shear comprising a pair of rotary drums mounted to rotate on fixed centers and geared together, coacting shear knives on the said drums, a plurality of motors for driving the said drums, an electrically operated brake for stopping the said drums, the said drums being normally stationary between the approach of successive bars and their engagement by the shear, a series of cams driven from one of the said drums at an even speed therewith, a rocker arm actuated by each of the said cams, a contactor mounted at one end of each rocker arm, contact bars adjacent to the said contactors to complete certain circuits to the brake and to the driving motors, and means for locking the said contactors on the said rocker arms in either an operative or an inoperative position.

24. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers a motor for driving the same, spaced coacting knives carried by the said drums, means for feeding the bar to be sheared to the knives, at a substantially constant speed, means for starting the shear from rest at the approach of each bar to be sheared, and means

for operating the shear driving motor during the passage of a bar through the shear, at a pulsating speed to vary the cut section lengths.

25. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers a motor for driving the same, spaced coacting knives carried by the said drums, means for feeding the bar to be sheared to the knives at a substantially constant speed, means for starting the shear from rest at the approach of each bar to be sheared, and means for operating said driving motor during the passage of each bar through the shear, either at a substantially constant speed or at a pulsating speed, as desired.

26. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, spaced coacting knives carried by the said drums, means for feeding the bar to be sheared to the knives, means for starting the idle shear from a state of rest and accelerating it to a speed in substantial equality with the speed of the bar, means for supplying additional current during the cutting periods to maintain this equality of speed between the shear and the bar, and means operating subsequent to each cut for allowing the shear speed to fall below the bar speed during an interval calculated to produce a definite lag, before the shear is again accelerated for the next cut.

27. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, coacting knives carried by the said drums, means for feeding the bar to be sheared to the knives, means for starting, stopping, and varying the speed of the shear drums during the passage of each bar there-through, one or more electric motors for driving the said drums, and a master controller driven in synchronism with the said drums and arranged to control the driving motor or motors to produce a desired cycle of operations on each bar.

28. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, coacting knives carried by the said drums, means for feeding the bar to be sheared to the knives, means for starting, stopping, and varying the speed of the shear drums during the passage of each bar there-through, one or more electric motors for driving the shear drums, and a master controller geared to one of the shear drums at an even speed therewith, and arranged to automatically control the driving motor or motors to produce a desired cycle of operations on each bar.

29. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, coacting knives carried by the said drums, means for feeding the bar to be sheared to the knives, means for starting, stopping, and varying the speed of the shear drums during the passage of each bar there-through, one or more electric motors for driving the said drums, and a master controller driven in synchronism with the shear drums and arranged to control the driving motor or motors, said master controller including a number of adjustable cams each controlling the timing of the current supply to certain of the said motors.

30. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, coacting knives carried by the said drums, means for feeding the bar to be sheared to the knives, means for starting, stopping, and varying the speed of the shear

drums during the passage of each bar there-through, one or more electric motors for driving the said drums, and a master controller driven in synchronism with the shear drums and arranged to control the driving motor or motors, the said master controller including a number of adjustable cams each controlling the current supply to certain of the said motors, and means for substituting other cams to vary the timing of the current supply to the said motors for other operating cycles.

31. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, coacting knives carried by the said drums, means for feeding the bar to be sheared to the knives, means for starting, stopping, and varying the speed of the shear drums during the passage of each bar there-through, one or more electric motors for driving the said drums, and a master controller driven in synchronism with the shear drums and arranged to control the driving motor or motors, by timing the current supply to them, in combination with means for predetermining the amount of such current supply for each cross section of bar cut, and for different lengths of cut sections.

32. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, coacting knives carried by the said drums, means for feeding the bar to be sheared to the knives, means for starting, stopping, and varying the speed of the shear drums during the passage of each bar there-through, one or more electric motors for driving the shear drums, in combination with means for regulating the driving forces applied to the shear drums, and means for timing the application of the said driving forces to suit the demands of the instant cycle.

33. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, a plurality of pairs of coacting shear knives carried by the said drums, means for feeding the bar to be sheared to the knives, a motor or motors for driving the said drums, and means operating after the passage of each bar through the shear for stopping the said drums with one of the said pairs of knives in a definite position in readiness to make a first cut on the succeeding bar when the shear is again started, in combination with means for altering the angular relation between the said stopping means and the shear knives, in such a manner that any coacting pair of knives may be selected to make the first cut on a series of bars.

34. A rotary flying shear comprising a pair of rotary drums mounted on parallel axes for rotation about fixed centers, a plurality of pairs of coacting shear knives carried by the said drums, means for feeding the bar to be sheared to the knives, a motor or motors for driving the said drums, a shaft connected to one of the said drums, a second shaft geared to the said first shaft by even gears, a series of cams on the said second shaft, and contactors operated by the said cams in a desired sequence to control the driving motors, to cut a bar into sections.

35. A rotary flying shear comprising a frame, two parallel shafts mounted therein for rotation about fixed centers, a drum on each of the said shafts, a shear knife on each of the said drums, the said knives coacting to shear a bar passing between them, at least one of the said knives having its cutting face located in a non-radial

plane and each of said knives having a fixed angular relation to its shaft during periods of operation, and means for driving the said drums.

36. A rotary flying shear comprising a frame, two parallel shafts mounted therein for rotation about fixed centers, a drum on each of the said shafts, a shear knife on each of the said drums, the said knives coacting to shear a bar passing between them, one of the said knives having its cutting face located in a radial plane through the center of the drum shaft, and its cutting edge substantially at a right angle thereto, and the other of the said knives having its cutting face located in a non-radial plane, and means for driving the said drums.

37. A flying shear comprising a frame, two rotary drums mounted to rotate on parallel fixed axes, means for driving the drums, a plurality of shear knives on each of the said drums, the knives on one drum coacting respectively with the knives on the other drum to shear a bar passing between them, and the knives of one drum all being mounted with their cutting faces located substantially in radial drum planes, while the knives of the other drum are all mounted with their cutting faces in non-radial planes in such a manner that the two coacting knives of each pair occupy non-parallel positions both at the beginning and ending of each cut.

38. A flying shear comprising a frame, two rotary drums mounted to rotate on parallel fixed axes, means for driving the said drums, a plurality of shear knives on each of the said drums, the knives of one drum being mounted to engage the bar squarely at the beginning of a cut and obliquely at its end, while the knives of the other drum are mounted so as to engage the bar obliquely at the beginning of the cut and squarely at its end.

39. A rotary flying shear comprising a pair of rotary drums mounted to rotate on fixed centers and geared together, coacting shear knives on the said drums, a plurality of motors for driving the said drums half of said motors being geared directly to each of said drums, electrically operated brakes for stopping the said drums one of said brakes being geared directly to each of said drums, the said drums being normally stationary between the approach of successive bars and their engagement by the shear, automatic means for starting the shear from a state of rest in a fixed relation to the leading end of each advancing bar, and manually controlled means for stopping the shear in a definite position in readiness for the next start.

40. A rotary flying shear comprising a pair of rotary drums mounted to rotate on fixed centers and geared together, coacting shear knives on the said drums, a plurality of motors for driving the said drums, an electrically operated brake for stopping the said drums, the said drums being normally stationary between the approach of successive bars and their engagement by the shear, means for preadjusting the current supply to the driving motors to enable the shear to cut various cross sections up to a designed maximum, means for cutting a range of section lengths, means for controlling the speed of the advancing bars, means for starting, stopping, and varying the speed of the shear drums in desired sequences, and means for centralizing the various operating controls at the operator's position.

41. A rotary flying shear comprising a pair of rotary drums mounted to rotate on fixed centers

and geared together, coacting shear knives on the said drums, a plurality of motors for driving the said drums, an electrically operated brake for stopping the said drums, the said drums being normally stationary between the approach of successive bars and their engagement by the shear, means for starting the shear automatically at the approach of each bar to be sheared, means for controlling its speed when running, and means for manually controlling the rotation of the shear drums either in a forward or reverse direction for adjustments or repairs.

42. A rotary flying shear comprising a pair of rotary drums mounted to rotate on fixed centers and geared together, coacting shear knives on the said drums, a plurality of motors for driving the said drums, an electrically operated brake for stopping the said drums, the said drums being normally stationary between the approach of successive bars and their engagement by the shear, an operator's station, means controlled from the said station for starting and stopping the shear to make the cuts, for preadjusting the power supply to suit the cuts, for varying the speed of the shear drums between cuts, and for adjusting the speed of the roller table which feeds the bar to the shear.

43. A rotary flying shear comprising a pair of rotary drums mounted to rotate on fixed centers and geared together, coacting shear knives on the said drums, a plurality of motors for driving the said drums, an electrically operated brake for stopping the said drums, the said drums being normally stationary between the approach of successive bars and their engagement by the shear, a shaft driven by one of the said drums at an even speed therewith, the said shaft being mounted at a convenient height above the operator's platform and having overhanging ends, and each end of the said shaft being adapted to receive one of a series of cam holders, changeable cams therefor, circuit controlling contactors operated by the said cams for each end of the said shaft, and means for locking the said contactors at one end of the said shaft in an inoperative position, whereby the shear may be controlled by the cams on the other end of the said shaft, and a new set of cams may be placed in position on the idle end of the said shaft, in readiness for the next length to be cut, and while the shear is in operation.

44. The method of operating a rotary flying shear to cut sections of substantially equal length from a moving metal bar, comprising the following steps: starting the shear from rest for each long bar to be sheared, and accelerating the shear to the bar speed; and then cutting off successive sections at a speed substantially equal to the bar speed by intermittently increasing the current supply to the driving motors at the cutting instant by a predetermined amount.

45. The method of operating a rotary flying shear to cut sections of substantially equal length from a moving metal bar, comprising the following steps: starting the shear from rest for each

long bar to be sheared, and accelerating the shear to the bar speed; then cutting off a section at a speed substantially equal to the bar speed by increasing the current supply to the driving motors by a predetermined amount; then reducing the speed of the shear below that of the bar by a decrease of driving force; then re-accelerating the shear to the bar speed just before the next succeeding cut; and then cutting at bar speed as before.

46. The method of operating a rotary flying shear to cut sections of substantially equal length from a moving metal bar, comprising the following steps: starting the shear from rest for each long bar to be sheared, and accelerating the shear to bar speed; then cutting off a section at a speed substantially equal to the bar speed by increasing the current supply to the driving motors by a predetermined amount; then increasing the speed of the shear above that of the bar for a short period; then decreasing the speed of the shear to the speed of the bar; and then cutting again at substantially the bar speed.

47. The method of operating a rotary flying shear to cut sections of substantially equal length from a moving metal bar, comprising the following steps: starting the shear from rest for each long bar to be sheared, and accelerating the shear to the bar speed; then cutting off a section at a speed substantially equal to the bar speed by increasing the current supply to the driving motors by a predetermined amount at the cutting instant; then accelerating or decelerating the shear prior to the next cut; and then bringing the shear substantially to bar speed and cutting at that speed.

48. A rotary flying shear comprising a pair of rotary knife carriers mounted on parallel axes for rotation about fixed centers, a shear knife on each of said carriers, said knives co-operating to shear a moving bar passing between them, means for feeding the bar to the shear, one or more electric motors for driving said knife carriers, a master controller driven in a fixed ratio to the rotary motion of said knife carriers, wiring connecting the said controller with the said motor or motors, and means whereby the said controller may distribute current to the said motor or motors to produce a repetitive cutting cycle, the said current supply being so timed, and so graduated in amount, as to meet at all times the instant torque demanded by said knife carriers to perform said cutting cycle.

49. The method of operating a rotary flying shear to cut sections from a moving metal bar, comprising first, starting the shear from rest for each long bar to be subdivided; second, driving the shear continuously during the subdivision of the said bar; third, driving the shear during the idling periods by a motor or motors; and fourth, bringing into service an additional motor or motors, to furnish additional power during the cutting periods.

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