MANUAL NO. M-101

BRIDGEPORT SERIES II MILLING MACHINE

INSTALLATION — OPERATION AND MAINTENANCE

Bridgeport® TEXTRON
Bridgeport Machines Division of Textron Inc.

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OPERATION, INSTALLATION & MAINTENANCE MANUAL

SERIES II TURRET MILLER

Bridgeport® TEXTRON

Bridgeport Machines Division of Textron Inc.

500 LINDLEY STREET, BRIDGEPORT, CONN. 06606

PIP

(Pride In Performance)

PROGRAM

INSPECTION:

We pride ourselves on the quality of the design and construction of Bridgeport Milling Machines. We prove that point by enclosing an Inspection Certificate checked and personally signed by the inspector who has run through an exhaustive set of tests and checks before releasing your machine for shipment.

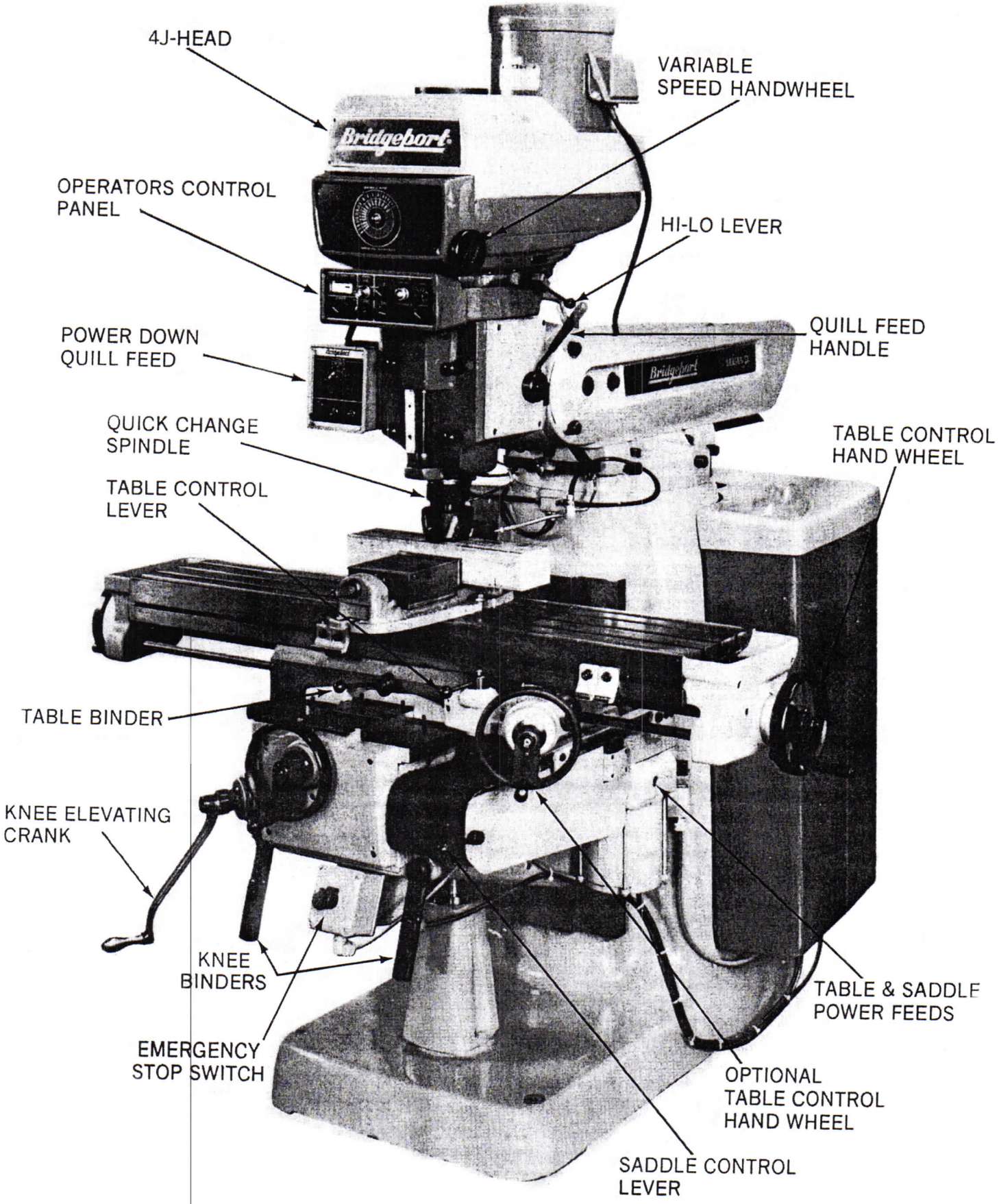
SERVICE:

With proper care and maintenance as described in this manual, there is seldom need for service with your Bridgeport machine.

But should a problem occur, your Bridgeport Dealer is ready to service, repair, and if necessary rebuild, your Bridgeport. And what he can't do on the spot or at his location, he can call on expert factory service personnel for advice and assistance.

There is a full-time crew of experienced service personnel trained and experienced exclusively on Bridgeport Millers, controls, attachments and accessories. These experts not only repair, but also train in maintenance and repair.

When you need service you can't handle yourself — call your Bridgeport Dealer. If he can't handle it, he'll call for factory service assistance. Only the dealer can authorize factory service — in or out of warranty.



Bridgeport®

SERIES II

Fig #1

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LEADING PARTICULARS

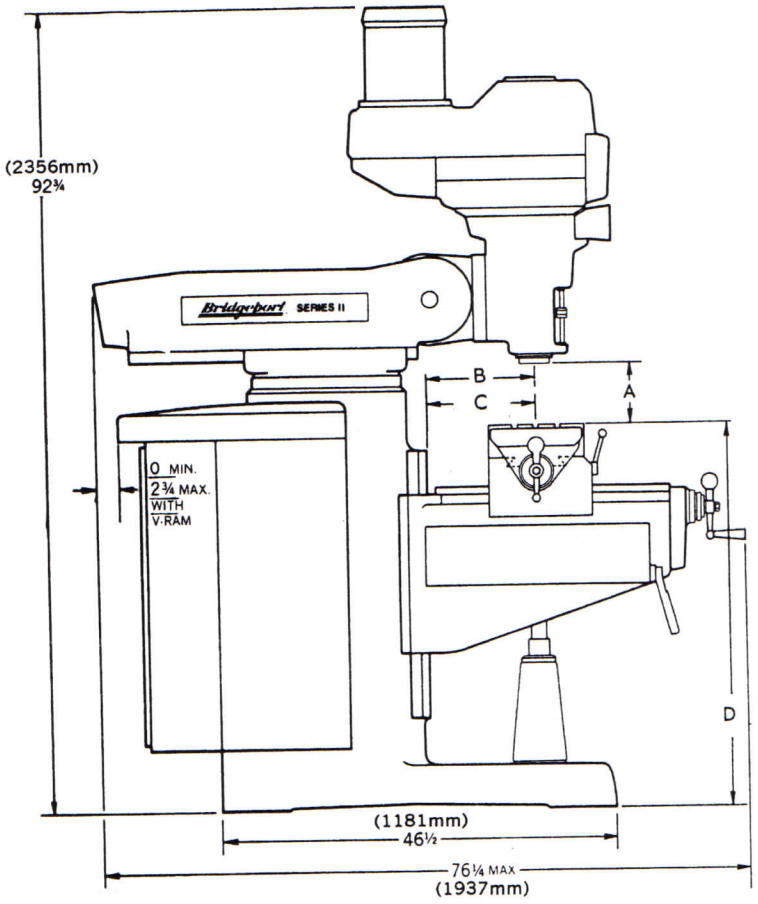
RANGE	INCH	METRIC
Table Travel (X axis) total	30"	762mm
Saddle Travel (Y axis) total	15"	381mm
Quill Travel	5"	120mm
Knee Travel (Z axis)	16"	406mm
Ram Travel (manual rack and pinion)	16"	406mm
Max. Weight of Workpiece	1000 lbs.	454kg
A* (with quick change tooling)	min. 1-7/8" - max. 17-7/8"	min. 48mm - max. 454mm
(without quick change tooling)	min. 2" - max. 18"	min. 51mm - max. 457mm
B Throat Distance	min. 10" - max. 25"	min. 254mm - max. 635mm

TABLE		
Overall Size	11" x 58"	279mm x 1473mm
Working Surface	11" x 58"	279mm x 1473mm
T-Slots (5/8" wide)	3 on 2½" Centers	3 on 63.5mm Centers
Feedrate	¾" - 24 ipm	1.9 - 61cmpm
Height Above Floor	min. 32¾" - max. 48¾"	min. 832mm - max. 1238mm
Rapid Traverse	24 ipm	61cmpm

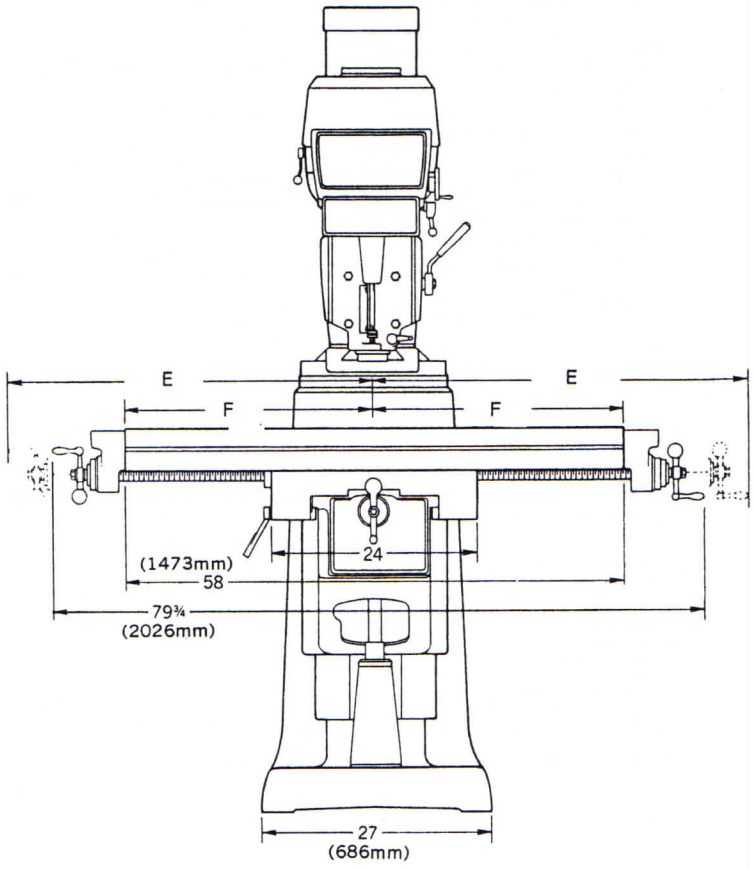
SPINDLE		
Taper - Standard	ASA #40	ASA #40
Taper - For Quick Change Tooling	Erickson #40	Erickson #40
	Universal #300	Universal #300
Speed Range - Low - infinately variable	50-400 rpm	50-400 rpm
- High - infinitely variable	450-3500 rpm	450-3500 rpm
Drive Motor	4 hp	4 hp
Drilling Capacity - mild steel	1¼" dia.	32mm dia.
Milling Capacity - mild steel	4 cu. in./min.	67 cu. cm/min.
Boring Range - mild steel	To 8" dia.	To 20.3mm dia.
Spindle Diameter	2-1/8"	54mm
Quill Diameter	4¼"	108mm

SPACE AND WEIGHT		
Floor Area	80" x 80"	2032mm x 2032mm
Height	92¾"	2356mm
Shipping Weight	4750 lbs.	2154kgs

*6-inch higher column or 6-inch riser blocks available.



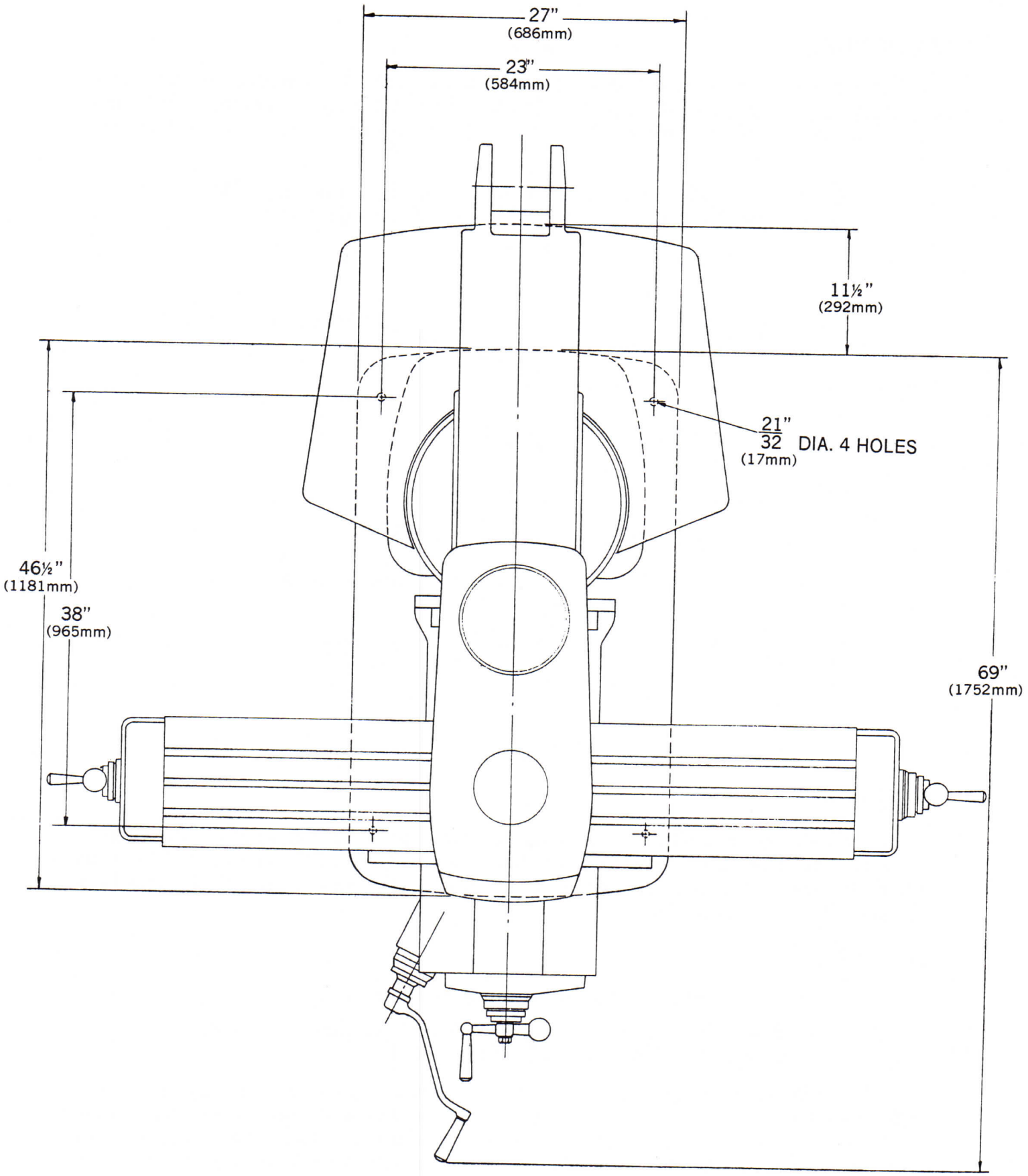
LEFT SIDE VIEW



FRONT VIEW

DIMENSION		INCH	METRIC
A	Table to Spindle Gage Line	min. 2" - max. 18"	min. 50.8mm - max. 457mm
B	Column to Quill	min. 10-5/8" - max. 26-5/8"	min. 270mm - max. 676mm
C	Column to C/L Table	min. 6" - max. 21"	min. 152mm - max. 533mm
D	Top of Table to Floor	min. 32¾" - max. 48¾"	min. 832mm - max. 1238mm
E	C/L Spindle to End of Table	min. 26-7/8" - max. 56-7/8"	min. 682mm - max. 1445mm
F	C/L Spindle to End of Work Surface	min. 12" - max. 42"	min. 305mm - max. 1067mm

Fig #2



PLAN VIEW
Fig. #3

PREPARING THE MACHINE

UNCRATING:

Carefully remove protective crating and skids so that the machine and its parts are not damaged, scratched or impaired. In the event of damage in transit, communicate at once with your Bridgeport Dealer and the transportation company making delivery.

WARNING: This machine is to be hoisted by sling only. Place the sling under the ram, using nylon rope or its equivalent.

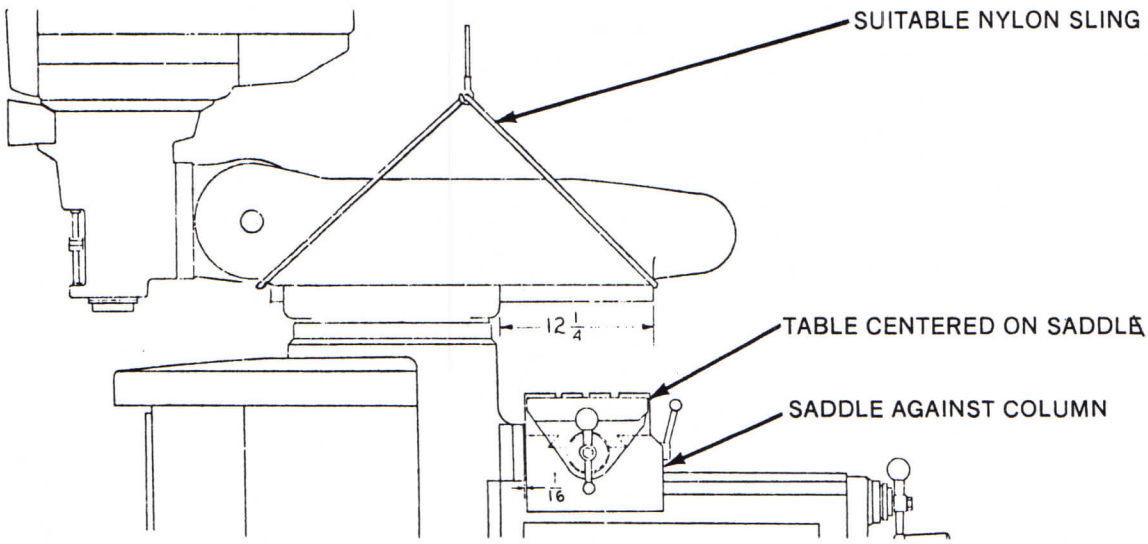


Fig. #4

SHORTAGES:

Check shipment carefully against the itemized packing list, which is included in the parts box. In case of a shortage, report it immediately to the representative from whom the machine was purchased. Indicate parts not received but which have been checked on the packing list.

CLEANING:

Thoroughly clean slush from the machine with kerosene.

WARNING: It is not recommended that gasoline or any other highly inflammable cleaning agent be used.

Do not move the table, saddle, knee or any moveable part until all ways have been well cleaned and lubricated. Manually move table, saddle and knee to limit stop in one direction. Clean and lubricate exposed ways and then move each unit to the opposite limit stop and similarly clean and lubricate the exposed ways. Loosen bolts to unlock overarm, and move it forward and backward to the full length in order to clean and lubricate.

INSTALLATION ON SOLID FOUNDATION:

The column and base are cast in one piece. When setting the machine on a concrete foundation, it is advisable to use shims, adjustable mounting pads, or thin mortar to take care of any uneveness in the floor as well as to provide a solid foundation at all points.

NOTE: It is recommended that the machine be secured to the floor to prevent movement or tipping due to off-center loading.

LEVELING MACHINE:

Set the machine by leveling the work table lengthwise and crosswise with a suitable level.

LUBRICATION:

Do not operate the machine until it is properly lubricated. The machine comes equipped with complete automatic lube system. Sunoco Waylube #80, or equivalent, should be used in this system. Bearings and motors are greased for life. Lead screws are lubricated by the lube system.

INSPECTION:

Your machine is carefully inspected and aligned before it leaves our factory. Fig. #5 and Fig. #6 show the way your machine is aligned.

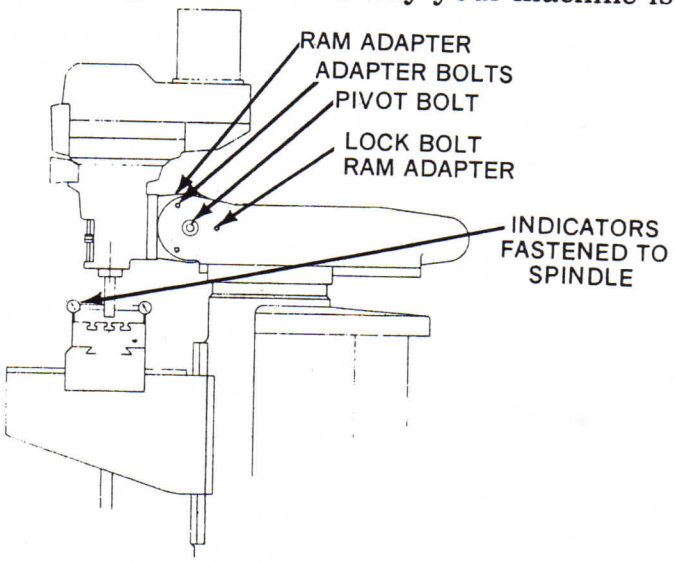


Fig. #5

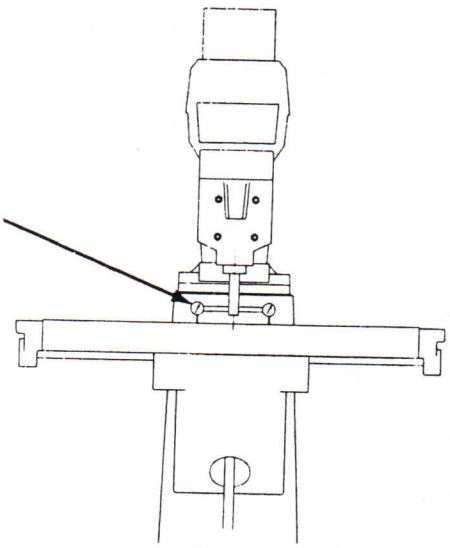


Fig. #6

ALIGNMENT OF HEAD:

Y-AXIS

If required, the head may be realigned along the Y-axis by adjusting the adapter on the overarm through the worm gear shaft on the adapter as follows:

1. Loosen the three (3) binding bolts (shown in Fig. #5), maintaining sufficient drag on them to allow fine adjustment.
2. Turn the worm gear shaft bolt at the top of the adapter until the head is square to the table surface in reference to the two Y-axis indicators on the spindle.
3. Tighten the three binding bolts to 125 ft. lbs. torque.

X-AXIS

To align the head in the X-axis direction (lateral), refer to Fig. #6. Loosen the four (4) binding bolts on the front of the head and adjust through the worm gear shaft at the lower right side of the head. Maintain sufficient drag on the bolts for fine adjustment in reference to the two X-axis indicators on the spindle. Tighten the binding bolts to 100 ft. lbs. torque.

PARTS LIST — FRONT VIEW — BASIC MACHINE

Part No.	Code No.	
H-88	2-06-0088	Gib Adjusting Screw
H-219	2-06-9012	Plug
H-229	2-06-0132	Adapter Pivot Stud Locknut
4H-001	2-15-0001	Column
4H-002	2-15-0002	Knee
4H-003	2-15-0003	Turret
4H-006	2-15-0006	Pedestal
4H-007	2-15-0007	Elevating Lead Screw Nut
4H-009	2-15-0009	Knee Elevating Screw
4H-011	2-15-0011	Knee Elevg. Scr. Travel Stop
4H-012	2-15-0012	Knee Elevg. Scr. Brg. Cap
4H-013	2-15-0013	Knee Elevg. Scr. Brg. Washer
4H-014	2-15-0014	Knee Elevg. Scr. Bevel Gear
4H-015	2-15-0015	Knee Elevg. Scr. Pinion Gear
4H-019	2-15-0019	Ram Pinion Shaft
4H-025	2-15-0025	Safety Pin Assembly
4H-046	2-15-0046	Ram
4H-047	2-15-0047	Saddle
4H-054	2-15-0054	Table
4H-060	2-15-0060	Saddle Lock Wrench
4H-063	2-15-0063	Washer
4H-077	1-15-5322	Shroud
4H-091	2-15-0091	Lead Screw Dial (200 Div.'s)
4H-096	2-15-0096	Cross Feed Bearing Retainer
4H-118	2-15-0118	Table Lead Screw
4H-133	2-15-0133	Table Lead Screw Nut Brkt.
4H-134	2-15-0134	Table Lead Screw Nut
4H-135	2-15-0135	Lock Nut (Lead Screw Nut)
4H-153	1-15-5027	Cover-Knee Lock Shaft
4H-158	2-15-0158	Key - 1/4 x 1/4 x 1-1/4
4H-162	2-15-0162	Saddle Locking Shaft
4H-163	2-15-0163	Vertical Screw Stop Spring
4H-164	2-15-0164	Spacer - (Saddle Locking Shaft)
4H-167	2-15-0167	Saddle Plate (Left Side)
4H-168	2-15-0168	Saddle Plate (Right Front)
4H-169	2-15-0169	Saddle Lock Plate
4H-171	2-15-0171	Nut - Hex 5/16-18 NC (For Gib Screw)
4H-177	2-15-0177	Saddle Plate (Right Rear)
4H-179	2-15-0179	Ram Adapter - (Large End)
4H-198	2-15-0198	Knee Chip Wiper Bracket
4H-201	1-15-2409	Oiler (Saddle-Table)
4H-214	1-15-5024	Plate-Felt
4H-221	2-15-0221	Chip Screw (End Bracket)
4H-222	2-15-0222	L.H. Table End Brkt. (W/O Power Fd.)
4H-223	2-15-0223	R.H. Table End Brkt. (W/O Power Fd.)
4H-224	2-15-0224	R.H. Door - Nema Enclosure
4H-225	2-15-0225	L.H. Door - Nema Enclosure
4H-228	2-15-0228	Saddle Plate (Left Side - Front)
4H-230	2-15-0230	Key - Ram Adj. Shaft
4H-231	2-15-0231	Spacer R.H. Table End Bracket

Part No.	Code No.	
4H-232	2-15-0232	Dial Ret. R.H. Table End Brkt.
4H-234	2-15-0234	Key - Lead Screw - Dial Ret.
4H-252	2-15-0252	Cover - Saddle - Opt. Handwheel
4H-253	2-15-0253	Cover - Saddle - Table Feed
4H-259	2-15-0259	Washer - Saddle Plate Mtg. Bolt
4H-292	2-15-0292	Saddle - Knee Reed Gib Clamp
4H-340	2-15-0340	Saddle - Knee Gib
4H-341	2-15-0341	Gib Screw (Saddle-Table)
4H-395	2-15-0395	Ram Adapter Bolts (Large End)
4H-397	2-15-0397	Adapter Pivot Stud
4H-456	2-15-0456	Washer (Saddle - Table Gib Scr.)
4H-517	2-15-0517	Column - Knee Gib
4H-549	2-15-0549	Ram Rack Pinion
4H-550	2-15-0550	Saddle - Knee Way Wiper (L.H.)
4H-551	2-15-0551	Saddle - Knee Way Wiper (Center)
4H-552	2-15-0552	Saddle - Knee Way Wiper (R.H.)
4H-553	2-15-0553	Rack - Ram Adjuster
4H-554	2-15-0554	Bevel Gear - Spacer (Knee Elevg.)
4H-595	1-01-0755	Dowel Pin - 3/8 dia. x 1
4H-596	1-01-1055	Soc. Hd. Cap Scr. - 5/16-18NC x 7/8
4H-598	1-01-0785	Pipe Plug - 3/4 NPT.
4H-601	1-15-1923	Lockwasher (Split) 11/16 O.D.x406 I.D. x 3/32
4H-617	1-01-1074	Soc. Hd. Cap Scr. - 3/8-16 N.C.x1
4H-619	1-01-1030	Filester Head Scr. - 1/4-20N.C.x 3/4
4H-653	1-01-1220	Soc. Set Scr. - 1/4-20 N.C.x1/4
4H-660	1-01-1217	Soc. Set Screw - #10-32NFx5/16
4H-661	1-01-1057	Soc. Hd. Cap Scr. - 5/16-18NCx1-1/2
4H-676	1-01-0291	Bearing
4H-680	1-01-1518	Flat Head Allen Scr.-#10-32NFx1/4
4H-689	1-01-1714	Hex Hd. Jam Nut - 3/4-16NF
4H-691	1-01-1154	Hex Hd. Cap Scr. - 3/8-16NCx1-3/4
4H-694	1-15-1095	Soc. Hd. Cap Scr. - 1/2-13NCx4-1/2
4H-705	1-15-2033	Spring
4H-717	1-01-3078	Key - Woodruff #7
4H-753	1-01-1034	Soc. Hd. Cap Scr. - 1/4-20NCx7/8
4H-754	1-15-1914	Washer - 15/16 I.D.x1-3/4 O.D.x1/8
4H-770	1-01-1076	Soc. Hd. Cap Scr. - 3/8-16NCx1-1/2
4H-781	1-15-0313	Bearing
4H-782	1-15-0314	Bearing
4H-793	1-01-1216	Soc. Set Screw - #10-32NFx3/16
4H-794		Bearing
4H-795	1-01-1252	Soc. Set Screw - 3/8-16NCx3/8
4H-796	1-01-1049	Soc. Hd. Cap Scr. - 5/16-18NCx3/8
4H-799	1-01-1237	Soc. Set Screw - 5/16-18NCx1/2
4H-804	1-01-0512	Roll Pin - 1/8 dia. x 3/8
4H-820	1-01-1060	Soc. Hd. Cap Scr. - 5/16-18NCx2
4H-821	1-01-0727	Dowel Pin - 1/4 dia. x 1
4H-822	1-01-1189	Button Hd. Mach. Scr. - #6-32 x 1/4
4H-834	1-01-1157	Hex Head Bolt - 3/8-16NC x 5-1/4
4H-857	1-01-1077	Soc. Hd. Cap Scr. - 3/8-16NC x 1-3/4

FRONT VIEW — BASIC MACHINE

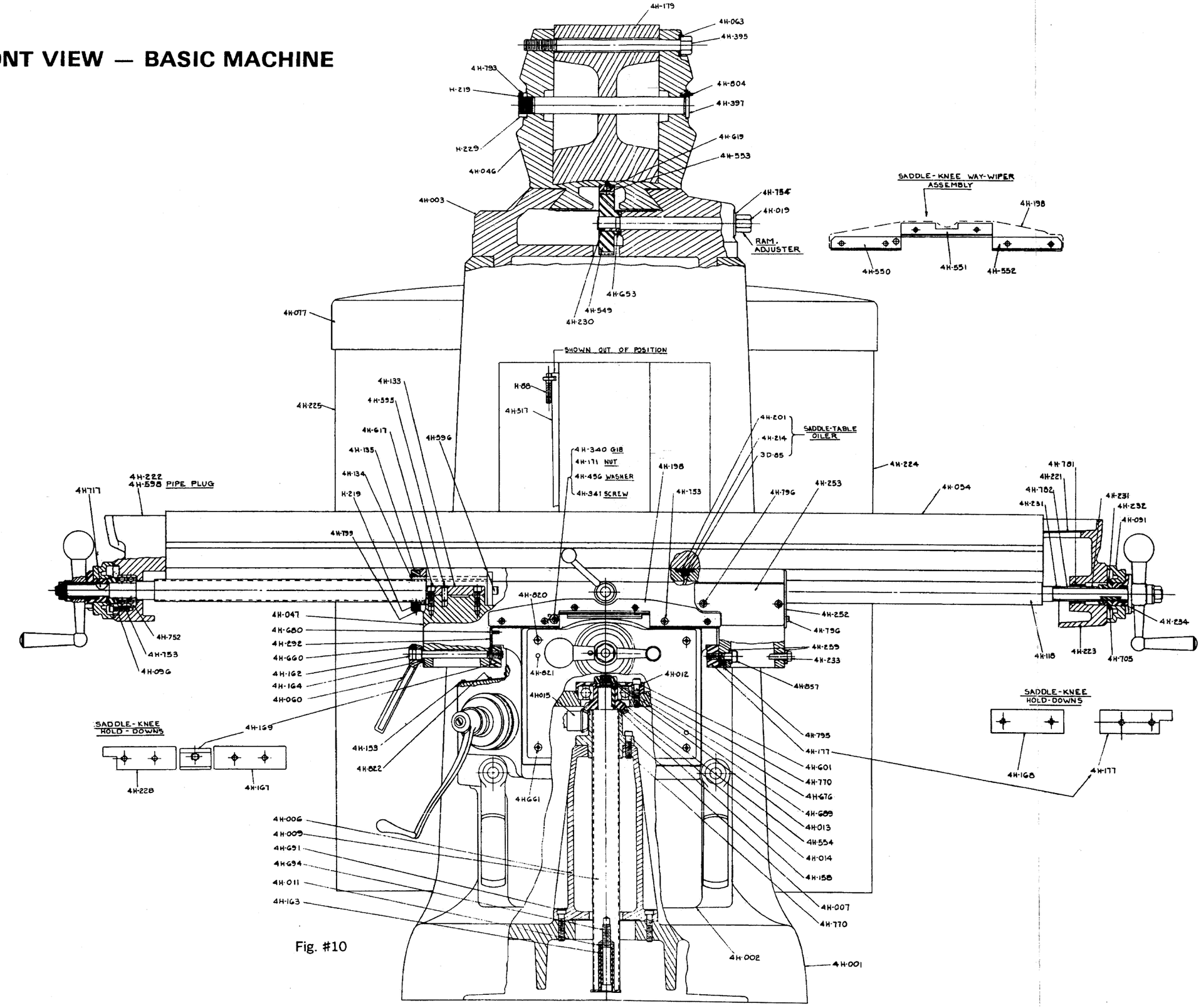


Fig. #10

PARTS LIST — BASIC MACHINE

Part No.	Code No.	
H-28	2-06-0060	Handle - Handwheel
H-88	2-06-0088	Gib Adjusting Screw
H-219	2-06-9012	Plug
H-234	2-06-0137	Ram Clamp Bar
4H-001	2-15-0001	Column
4H-002	2-15-0002	Knee
4H-003	2-15-0003	Turret
4H-006	2-15-0006	Pedestal
4H-008	2-15-0008	Spider
4H-014	2-15-0014	Knee Elevg. Screw Bevel Gear
4H-015	2-15-0015	Knee Elevg. Screw Pinion Gear
4H-024	2-15-0024	Turret Safety Clamp
4H-025	2-15-0025	Head Rotation Stop
4H-032	2-15-0032	Knee Elevg. Handle Shaft
4H-034	2-15-0034	Knee Elevating Shaft
4H-035	2-15-0035	Knee-Col. Hold Down Clamp (UR)
4H-036	2-15-0036	Knee-Col. Hold Down Clamp (U.L)
4H-038	1-15-2800	Nameplate (Ram R.S.)
4H-039	1-15-2801	Nameplate (Ram L.S.)
4H-040	2-15-0040	Hold Down Gib Col. Knee (Upper)
4H-041	2-15-0041	Knee - Column Clamp (L.H.)
4H-046	2-15-0046	Ram
4H-047	2-15-0047	Saddle
4H-054	2-15-0054	Table
4H-064	2-15-0064	Knee Lock Wrench
4H-072	2-15-0072	Ram Clamp
4H-073	2-15-0073	Ram Clamp
4H-077	1-15-5322	Shroud
4H-088	2-15-0088	Cross Feed Lead Screw Nut
4H-089	2-15-0089	C.F. Lead Screw Nut Brkt.
4H-091	2-15-0091	Lead Screw Dial (200 Div.'s)
4H-092	2-15-0092	Lead Screw Dial Retainer
4H-093	2-63-5193	Lead Screw Dial Holder
4H-095	2-15-0095	Ball Crank Spacer
4H-096	2-15-0096	Cross Feed Bearing Retainer
4H-097	2-15-0097	Lead Screw - Ball Crank
4H-098	2-15-0098	Crank Handle
4H-099	2-15-0099	Crank Handle Rod
4H-100	2-15-0100	Crank Handle Plug
4H-102	2-15-0102	Cross Feed Lead Screw
4H-105	2-15-0105	Cross Feed Scr. End Support
4H-108	2-15-0108	Lead Screw Washer
4H-110	2-15-0110	Knee Elevg. Shaft Bracket
4H-111	2-15-0111	Knee Elevating Clutch
4H-112	2-15-0112	Knee Elevating Dial
4H-113	2-15-0113	Knee Elevating Dial Washer
4H-114	2-15-0114	Knee Elevating Clutch Cover
4H-127	2-15-0127	Table Locking Clamp
4H-128	2-15-0128	Table Locking Shaft
4H-129	2-15-0129	Table Locking Handle Nut
4H-130	2-15-0130	Table Locking Handle
4H-131	2-15-0131	Table Locking Washer
4H-135	2-15-0135	Lock-Nut (Lead Screw Nut)
4H-166	2-15-0166	Sleeve - Knee Elev'g. Shaft
4H-170	2-15-0170	Plate - Knee Lead Scr. Inspection
4H-171	2-15-0171	Nut - Hex 5/16-18NC (For Gib Screw)
4H-172	2-15-0172	Saddle - Table Gib
4H-173	2-15-0173	Vert. Adj. Worm Shaft (Large End)
4H-178	2-15-0178	Vert. Adj. - Worm (Large End)
4H-179	2-15-0179	Ram Adapter - (Large End)
4H-203	2-15-0203	Washer - Knee Lock Shaft
4H-206	2-15-0206	Ram Adapter Bolt (Large End)
4H-215	2-15-0215	Knee Lock Shaft - R.H.
4H-216	2-15-0216	Handle Shaft Locking Screw
4H-217	2-15-0217	Saddle - Knee Wiper (Back L.S.)
4H-218	2-15-0218	Saddle - Knee Wiper (Back R.S.)
4H-219	2-15-0219	Saddle Wiper (Back - Center)
4H-220	2-15-0220	Knee - Column Wiper (Back)
4H-224	2-15-0224	R.H. Door Nema Enclosure
4H-225	2-15-0225	L.H. Door Nema Enclosure
4H-226	2-15-0226	Spacer - Ball Crank - Washer

Part No.	Code No.	
4H-227	2-15-0227	Key - Knee Elev'g. Ext. - Shaft
4H-229	2-15-0229	Key - Knee Elev's. Clutch Shaft
4H-241	2-15-0241	Stop Pin - Chip Guard
4H-251	2-15-0251	Cover - Knee Mtg. - P.F. Opening
4H-275	2-15-0275	Angle Plate
4H-293	2-15-0293	Ram Lock Stud
4H-331	2-15-0331	Quill Housing Adj. Gear
4H-337	2-15-0337	Knee - Column Hold Down Clamp
4H-341	2-15-0341	Gib Screw (Saddle & Table)
4H-342	2-15-0342	Gib Screw Brkt. (Saddle - Table)
4H-372	2-15-0372	Knee Elevating Crank
4H-374	2-15-0374	Knee Elevating Shaft Ext.
4H-375	2-15-0375	Elev'g. Shaft Crank Washer
4H-393	2-15-0393	Thrust Washer - Vert. Adj. (Lg. End)
4H-415	2-15-0415	Knee Lock Shaft (L.H.)
4H-441	2-15-0441	R.H. Knee - Column Clamp
4H-456	2-15-0456	Washer - (Saddle - Table Gib Scr.)
4H-467	2-15-0467	Turret Clamp Stud
4H-468	2-15-0468	Washer - Turret Clamp Bolts
4H-584	2-15-0584	Knee Bracket (W/O Power)
4H-595	1-01-0755	Dowel Pin - 3/8 dia. x 1
4H-597	1-01-1086	Soc. Hd. Cap Scr. - 3/8-16NCx4
4H-600	1-01-0729	Dowel Pin - 1/4 dia. x 1-1/4
4H-605	1-0z-0787	Dowel Pin - 1/4 dia. x 1
4H-612	1-01-1516	Flat Hd. Mach. Scr. - #10-24NCx1/4
4H-617	1-01-1074	Soc. Hd. Cap Scr. - 3/8-16NCx1
4H-624	1-15-0849	Snap Ring
4H-625	1-15-0287	Bearing
4H-626	1-15-0311	Snap Ring
4H-627	1-15-3661	Bushing
4H-644	1-15-0322	Bearing
4H-647	1-01-1534	Flat Hd. Mach. Scr. - 5/16-18NCx1/2
4H-649	1-15-1792	Locknut
4H-650	1-01-1042	Soc. Hd. Cap Scr. - 1/4-20NCx2
4H-653	1-01-1220	Soc. Set Screw - 1/4-20NCx1/4
4H-654	1-01-1052	Soc. Hd. Cap Scr. - 5/16-18NCx3/4
4H-660	1-01-1217	Soc. Set Screw - #10-32NFx5/16
4H-664	1-15-4810	Wiper, Knee - Column (U.C.)
4H-665	1-15-4811	Wiper, Knee - Column (U.R.)
4H-688	1-01-1092	Soc. Hd. Cap Scr. - 1/2-13NCx1-1/4
4H-697	1-01-1226	Soc. Set Screw - 1/4-20NCx1/8
4H-704	1-01-1275	Soc. Set Screw-Cup Point-#10-32NFx3/16
4H-705	1-15-2033	Spring
4H-706	1-01-1193	Button Hd. Mach. Scr.-#6-32NCx3/8
4H-708	1-15-0307	Bearing
4H-710	1-15-0308	Inner Race
4H-714	1-01-1724	Hex Head Nut - 5/8-11NC
4H-716	1-15-3651	Bearing
4H-717	1-01-3078	Key - Woodruff #7
4H-720	1-01-0713	Dowel - 3/16 dia. x 1/2
4H-722	1-01-1706	Hex Nut 5/8-18 Thr'd.
4H-748	1-01-1094	Soc. Hd. Cap Scr. - 1/2-13NCx1-3/4
4H-749	1-01-0719	Dowel Pin - 3/16 dia. x 1-3/4
4H-752	1-01-0271	Bearing
4H-753	1-01-1034	Soc. Hd. Cap Scr. - 1/4-20NCx7/8
4H-786	1-01-1055	Soc. Hd. Cap Scr. - 5/16-18NCx7/8
4H-789	1-01-1475	Round Head Screw - 1/4-20NCx1/2
4H-796	1-01-1049	Soc. Hd. Cap Scr. - 5/16-18NCx3/8
4H-799	1-01-1237	Soc. Set Screw - 5/16-18NCx1/2
4H-805	1-01-1251	Soc. Set Screw - 1/2-13NCx1-1/2
4H-807	1-01-0745	Dowel Pin - 5/16 dia. x 1
4H-809	1-01-1960	#10 Flat Washer
4H-810	1-01-1457	Round Head Screw - #10-32NFx5/8
4H-812	1-15-8154	Knob (Ball Crank)
4H-815	1-15-2168	Ball
4H-817	1-01-1235	Soc. Set Screw - 5/16-18NCx1/4
4H-819	1-01-1236	Soc. Set Screw - 5/16-18NCx3/8
4H-823		Nema Box
4H-824	1-01-1148	Hex Head Bolt - 3/8-16NCx1
4H-837	1-15-1214	Soc. Set Screw - #10-32NFx1/8
4H-1056	2-15-1056	Upper Chip Guard (Top of Knee)
4H-1057	2-15-1057	Lower Chip Guard (Top of Knee)

TABLE AND SADDLE WITHOUT POWER (x-y axis)

OPERATING INSTRUCTIONS

TABLE AND SADDLE CONTROLS:

The table and saddle are positioned by 5 pitch acme screws (or ball screws, optional). The machine is equipped with friction type dials that are graduated in increments of .001 inches. Ball cranks are provided as standard, handwheels are optional.

TABLE AND SADDLE CLAMPING:

To bind or clamp the table, use the handle in the front face of the saddle (over knee way). Moderate pressure will hold the table sufficiently for ordinary work. See Fig. #11.

To bind or clamp the saddle, use the handle located on the left-hand side of the saddle. A clockwise motion binds the saddle. See Fig. #12.

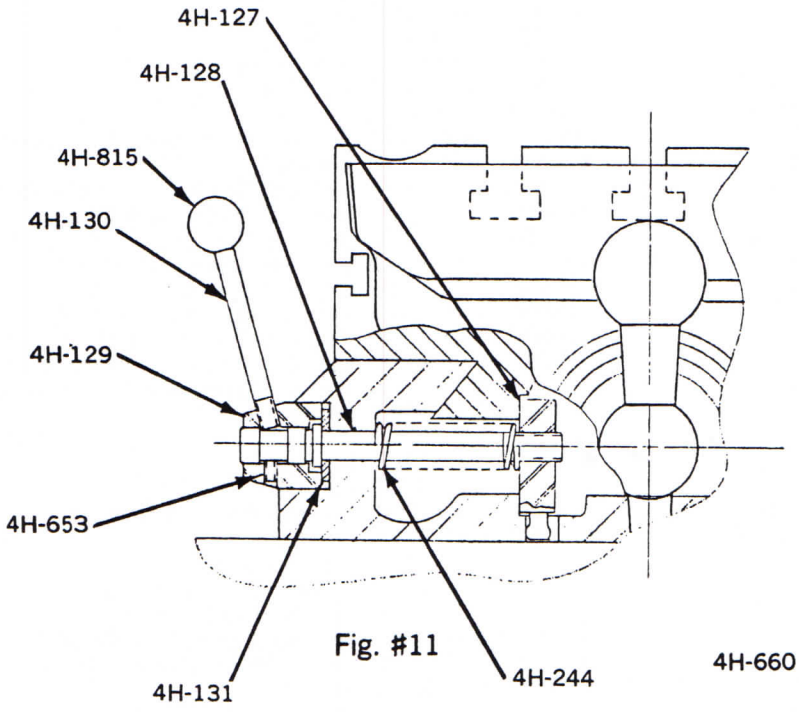


Fig. #11

Part No.	Code No.
4H-060	2-15-0060
4H-127	2-15-0127
4H-128	2-15-0128
4H-129	2-15-0129
4H-130	2-15-0130
4H-131	2-15-0131
4H-162	2-15-0162
4H-169	2-15-0169
4H-244	2-15-0244
4H-292	2-15-0292
4H-653	1-01-1220
4H-660	1-01-1217
4H-815	1-15-2168

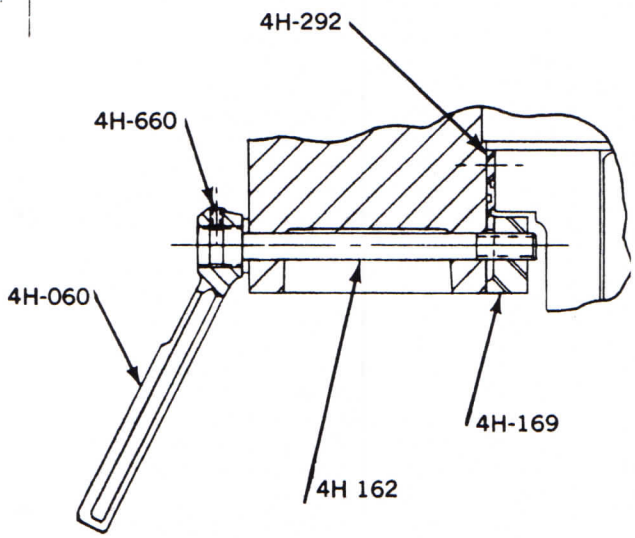


Fig. #12

SERVICING INSTRUCTIONS

LUBRICATION:

The table and saddle are lubricated by an automatic system that operates when spindle motor is running.

A float switch prevents re-starting of the spindle motor if the oil level is too low. This will not stop the spindle, just prevent re-starting after it has been shut off. The oil distributors are inside the saddle and can be exposed by removing the table.

Use only Sunoco Waylube #80 or equivalent.

The oil reservoir and pump unit is found on the left hand side of the machine column, under the side door.

ADJUSTMENT OF TABLE GIB (Fig. #13)

The table is provided with a tapered gib to keep clearance between the table and saddle to a minimum. This adjustment is made by turning the gib adjusting screw. This is found at the right hand end of the saddle, at the back of the saddle. Loosen the hex nut, adjust the gib screw clockwise until a slight drag is felt when moving the table manually away from the operator. Then tighten the hex nut **carefully**. A special wrench is provided for this purpose to avoid nicking the ways.

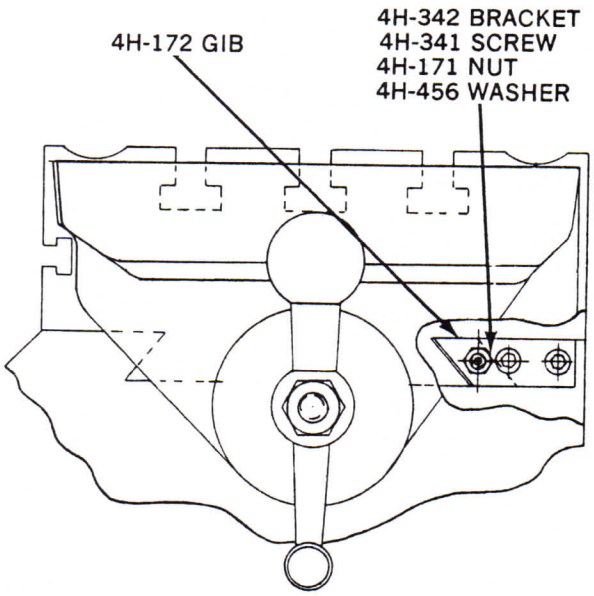


Fig. #13

Part No.	Code No.
4H-171	2-15-0171
4H-172	2-15-0172
4H-341	2-15-0341
4H-342	2-15-0342
4H-456	2-15-0456

ADJUSTMENT OF SADDLE AND KNEE GIB (Fig. #14)

A tapered gib is used for adjusting the clearance between the saddle and knee ways. To tighten this gib, use the same procedure as described for the table.

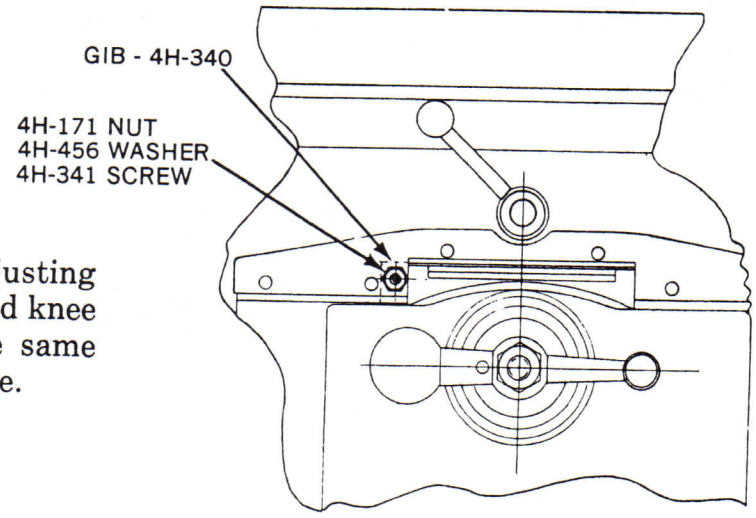
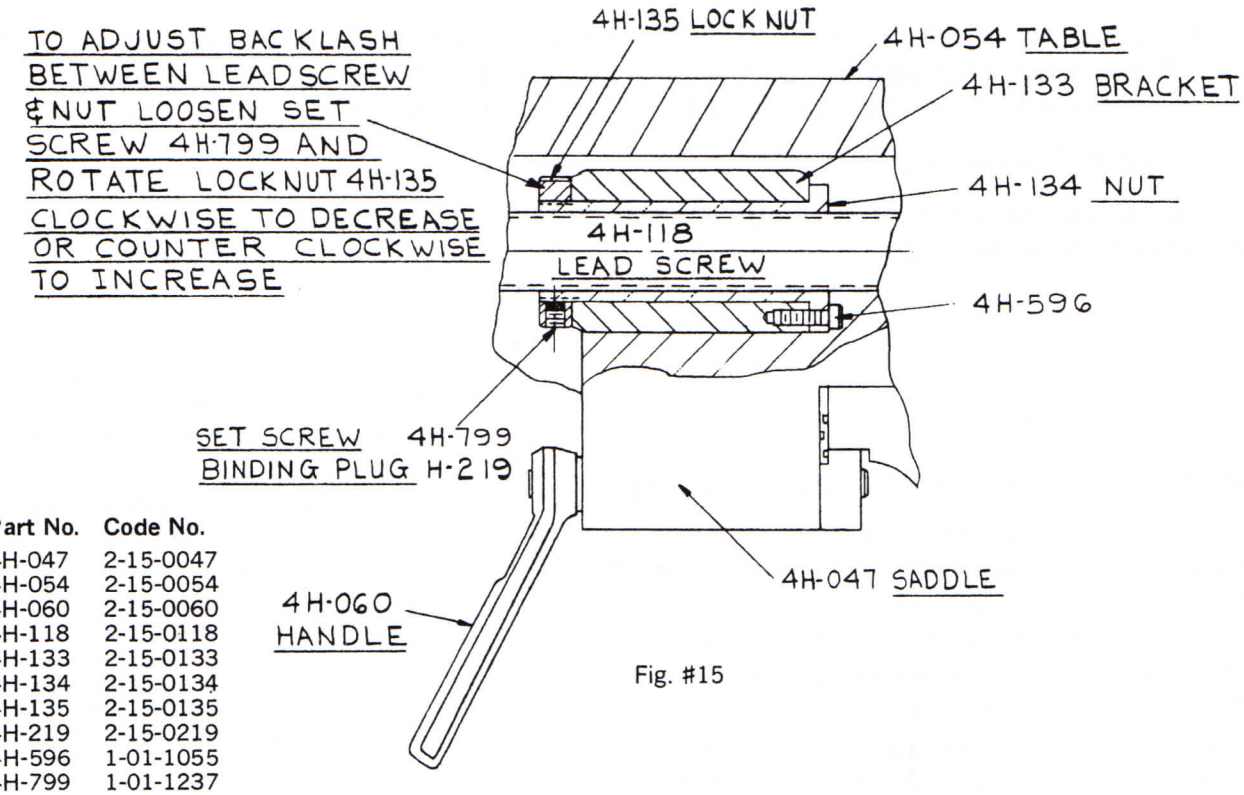


Fig. #14

BACKLASH TAKE UP X & Y AXIS LEAD SCREWS

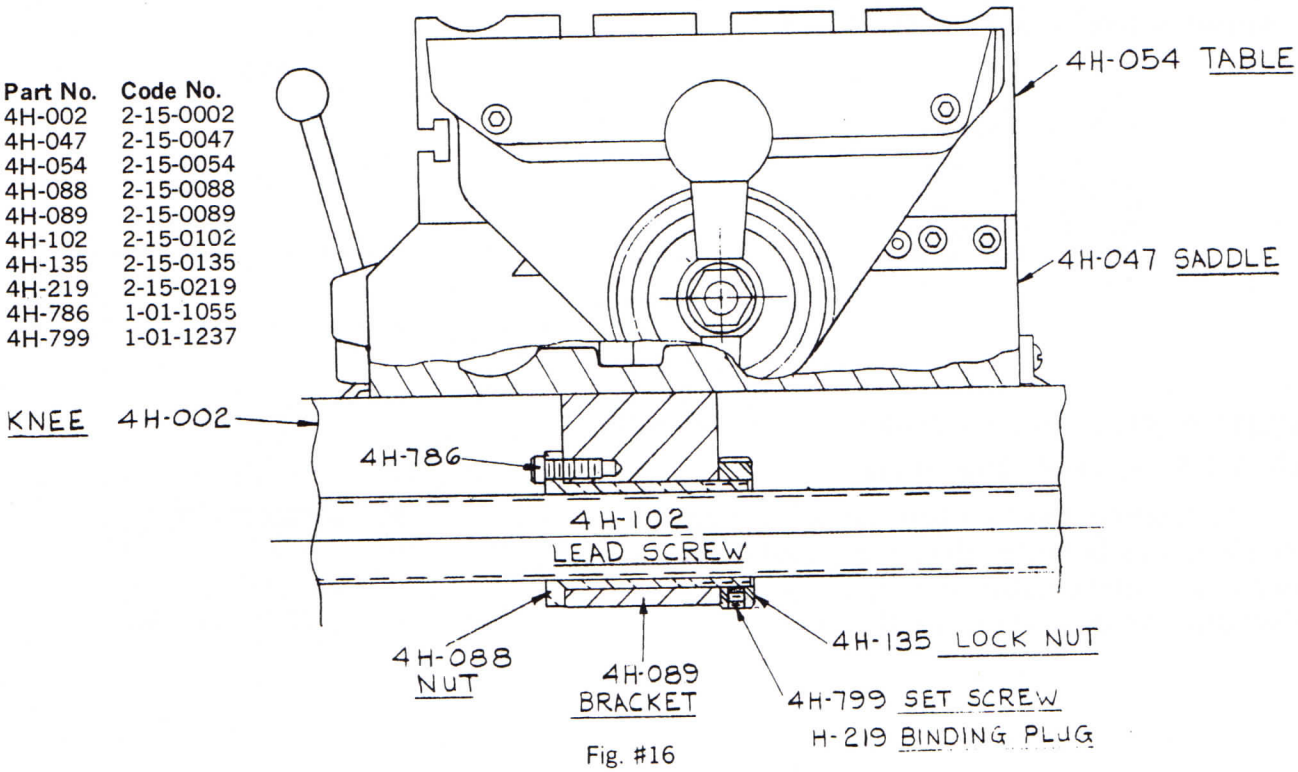
For both X & Y axis lead screws the amount of backlash is adjusted by turning the 4H-135 Nut on the lead screw nuts.

Before turning this nut loosen the 4H-799 binding screw first: Turn nut clockwise to reduce backlash.



Part No.	Code No.
4H-047	2-15-0047
4H-054	2-15-0054
4H-060	2-15-0060
4H-118	2-15-0118
4H-133	2-15-0133
4H-134	2-15-0134
4H-135	2-15-0135
4H-219	2-15-0219
4H-596	1-01-1055
4H-799	1-01-1237

Fig. #15



Part No.	Code No.
4H-002	2-15-0002
4H-047	2-15-0047
4H-054	2-15-0054
4H-088	2-15-0088
4H-089	2-15-0089
4H-102	2-15-0102
4H-135	2-15-0135
4H-219	2-15-0219
4H-786	1-01-1055
4H-799	1-01-1237

Fig. #16

REMOVING TABLE END BRACKET: (right hand side, Pt #4H-223) - See Fig. #10

Loosen and remove the hexagon nut on the end of the table lead screw along with its bushing. The ball crank (or handwheel) will slip off. The dial will also slip off at this point along with the dial bushing. Remove the Woodruff key. Remove three (3) bearing cap screws and dis-assemble cap without disturbing the bearings. Remove four (4) end bracket securing screws and detach the bracket from the table.

REMOVING TABLE END BRACKET: (left hand side, pt #4H-222) - See Fig. #10

Remove hexagon nut on the end of the table lead screw along with its bushing. Remove the dial bushing and dial and the Woodruff key. Remove four (4) end bracket cap screws and slide the bracket off the feed shaft.

TABLE LEAD SCREW REPLACEMENT: (pt #4H-118) - See Fig. #10

Complete the procedure for removing both end brackets from the table. The table lead screw can then be removed by turning all the way out of the lead screw nut.

REMOVING TABLE:

Complete the procedure for removing the table end brackets (pt # 4H-222 & pt #4H-223) and table lead screw (pt#4H-118). Loosen the table gib. - See Fig. #10.

NOTE; Gib must NOT be removed.

The table can now be removed by properly supporting it and sliding it out of the saddle ways.

REMOVING SADDLE:

Complete the procedure for removing the table. Remove the saddle-knee gib and wiper plate located on the front of the saddle.

Remove the four (4) screws located in the center of the saddle that holds the saddle lead screw nut bracket (pt #4H-089) in place. - See Fig. #16.

Remove the saddle-knee clamp assembly (See Fig. #15.)

Remove the saddle-knee hold downs (pt #4H-167 & pt #4H-169). - See Fig. #10.

Disconnect the lube hose.

The saddle can now be **lifted off.**

CAUTION: Exercise care in hoisting the saddle so the dowel pin located in the saddle casting and saddle lead screw nut bracket will slip out of the saddle without binding.

KNEE WITHOUT POWER (Z-axis)

OPERATING INSTRUCTIONS

MOVING KNEE:

To move the knee, push the knee elevating crank in until the clutch meshes. Then turn the crank in the proper direction for the required movement.

The knee elevating screw is a 5 pitch acme screw (Ball screw is optional). The machine is equipped with friction type dials that are graduated in increments of .001 inches. Binder handles on the knee to column ways should be released prior to moving knee.

CLAMPING KNEE:

Binder handles are located on each side of the knee on the front. Moving the right hand handle in a counter clockwise direction and the left hand handle in a clockwise direction, will lock the knee in place.

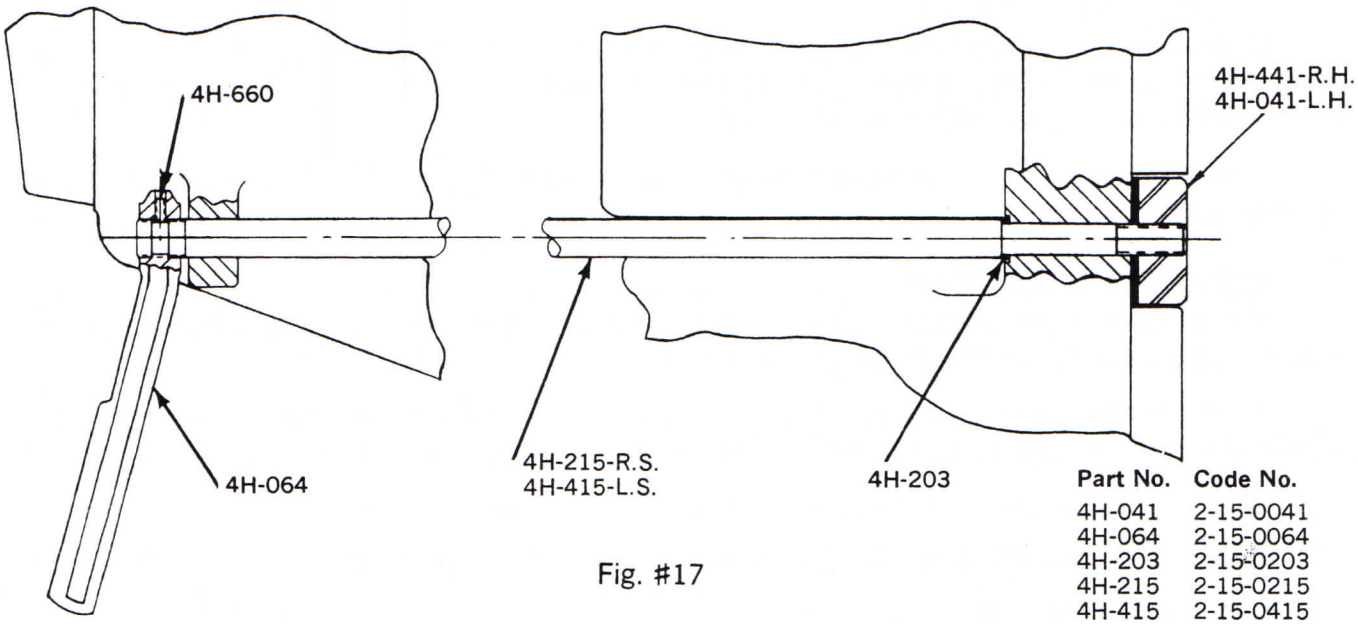


Fig. #17

Part No.	Code No.
4H-041	2-15-0041
4H-064	2-15-0064
4H-203	2-15-0203
4H-215	2-15-0215
4H-415	2-15-0415
4H-441	2-15-0441
4H-660	1-01-1217

SERVICING INSTRUCTIONS

GIB ADJUSTMENT (Knee to Column Ways): - Fig. #18.

Remove the chip wipers on the knee to column ways. The knee has three (3) gibs which are exposed after the wipers are removed.

Adjust the three gibs in the following order:

1. Center gib — turn gib screw clockwise until a very slight drag is felt while cranking the knee downward. Then back off screw 1/4 turn.
2. Right hand gib — first tighten up the two knee-to-column clamps. While the knee is in the locked position, turn the gib screw clockwise until the gib begins to bind very slightly. Then back off screw 1/4 turn.
3. Left hand gib — after the adjustment has been made on the right hand gib, keep the knee in its locked position and turn the gib screw clockwise until the gib begins to bind. Then back off screw 1/4 turn.

Replace the knee to column way wipers.

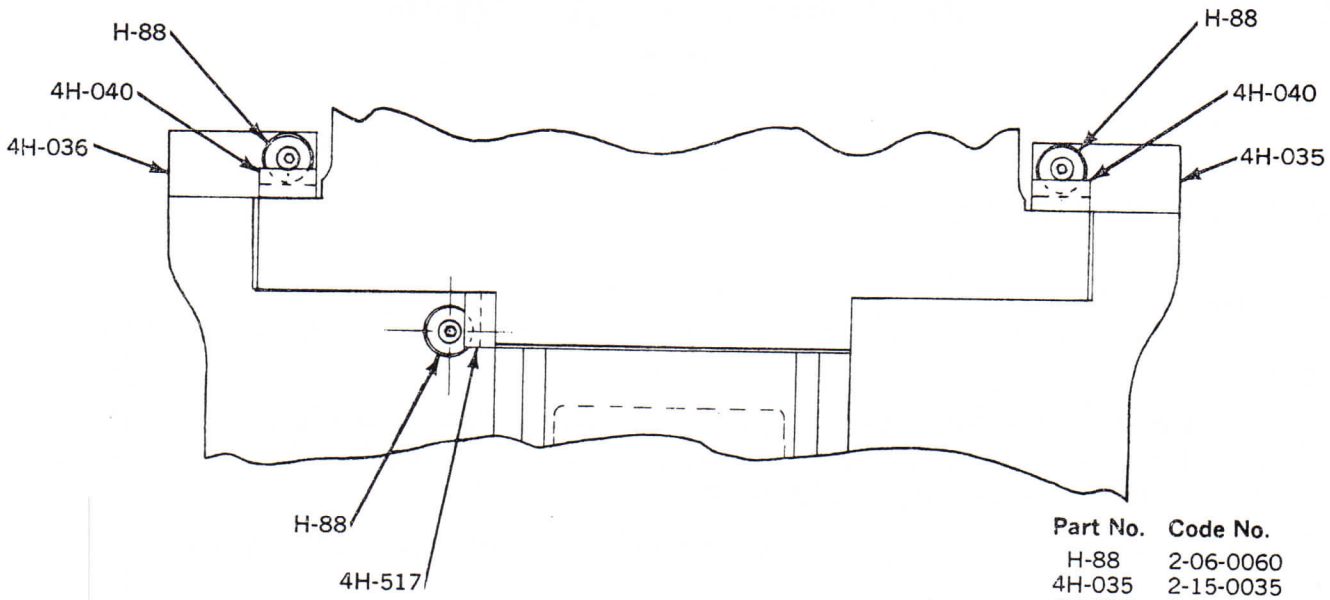


Fig. #18

Part No.	Code No.
H-88	2-06-0060
4H-035	2-15-0035
4H-036	2-15-0036
4H-040	2-15-0040
4H-517	2-15-0517

LUBRICATION:

The knee is lubricated by an automatic system with the feeder hoses on the left hand side of the knee. All points are lubricated from a distributer located inside the knee. All bearings are greased for life.

DIAL REPLACEMENT:

Remove the securing screw holding the knee elevating crank (pt #4H-372) with elevating shaft crank washer. Removing crank also removes the first half of the clutch. By loosening the set screw in the spacer (second half of clutch) it can now be removed. At this point, the dial will slide off easily. - See Fig. #26.

ELEVATING SHAFT REPLACEMENT (manual pt #4H-032) - See Fig. #10.

Follow the above procedure for dial removal. Then remove three (3) securing screws to release the bearing cap (pt#4H-049) thereby allowing the knee elevating shaft (pt#4H-034) to be withdrawn by carefully sliding the assembly out of the knee.

REMOVING KNEE:

After removing the table and saddle, remove the top knee chip guard to expose the lead screw bearing locknut which secures the knee to the knee elevating screw and pedestal. By removing the locknut, the knee can now be lifted up and off the column ways, leaving the pedestal and elevating screw on the column pad.

NOTE: Do NOT attempt to remove the knee until the binders (pt #4H-041), the gibs (pt #4H-040) and straps on the knee to column have also been removed. The lead-in hose from the lube system pump must also be disconnected at either the pump or the tee fitting on the knee. Remove lube hose at the elevating screw nut.

Do NOT remove the knee bearing cap or bearings before lifting the knee. They will be part of the knee assembly when it is hoisted off the knee elevating lead screw. (See Parts list page 11 and Fig. #9 P. 11A.)

OPTIONAL TABLE DRIVE

OPERATING INSTRUCTIONS:

TABLE TRAVERSING:

To operate the optional hand crank, push in on the crank to engage the bevel feed gears.

To traverse the table to the left, turn the crank counter clockwise. To traverse the table to the right, turn the crank clockwise. When the crank handle is released, the bevel feed gears will automatically disengage.

A friction type dial is provided, graduated in increments of .001 inches.

SERVICING INSTRUCTIONS

INSTALLATION OR REPLACEMENT:

For installation in the field, the machine must have a table feed drive shaft (4H-136, Fig. #22) in order to utilize the optional handwheel unit.

For disassembly, remove hexagon nut with washer (pt #4H-108) for right hand ball crank (or handwheel) and the crank will slide off. Remove ball crank spacer (pt #4H-095) to release lead screw dial holder (pt #4H-093) and dial (pt #4H-091). Remove table dial spring retainer (pt #4H-132) and washer.

At this point the first half of the clutch is exposed. Disassemble the clutch (pt #4H-121) and remove it along with clutch key. The second half of clutch and the remaining assembly will remain intact. Remove three (3) round head gasket plate securing screws on the inside of the right hand end bracket. Loosen the neoprene gasket and let both plate and gasket hang on table feed drive shaft.

Remove four (4) bracket securing screws and the end bracket should now slip off. The table feed gear driver (pt #4H-145) will remain on the table feed drive shaft, being held in place with a set-screw.

Now slip off the end bracket. Remove hanging gasket plate and gasket. Remove three (3) handwheel securing screws. Remove the handwheel bracket by sliding it off the table feed drive shaft.

Installation of the handwheel bracket is accomplished by reversing the above procedures.

NOTE: After completion of installation, if a slight binding is noted in operation, move table to extreme left position, loosen right end bracket securing screws and adjust position of end bracket to ease binding. Retighten securing screws.

HANDCRANK REPLACEMENT:

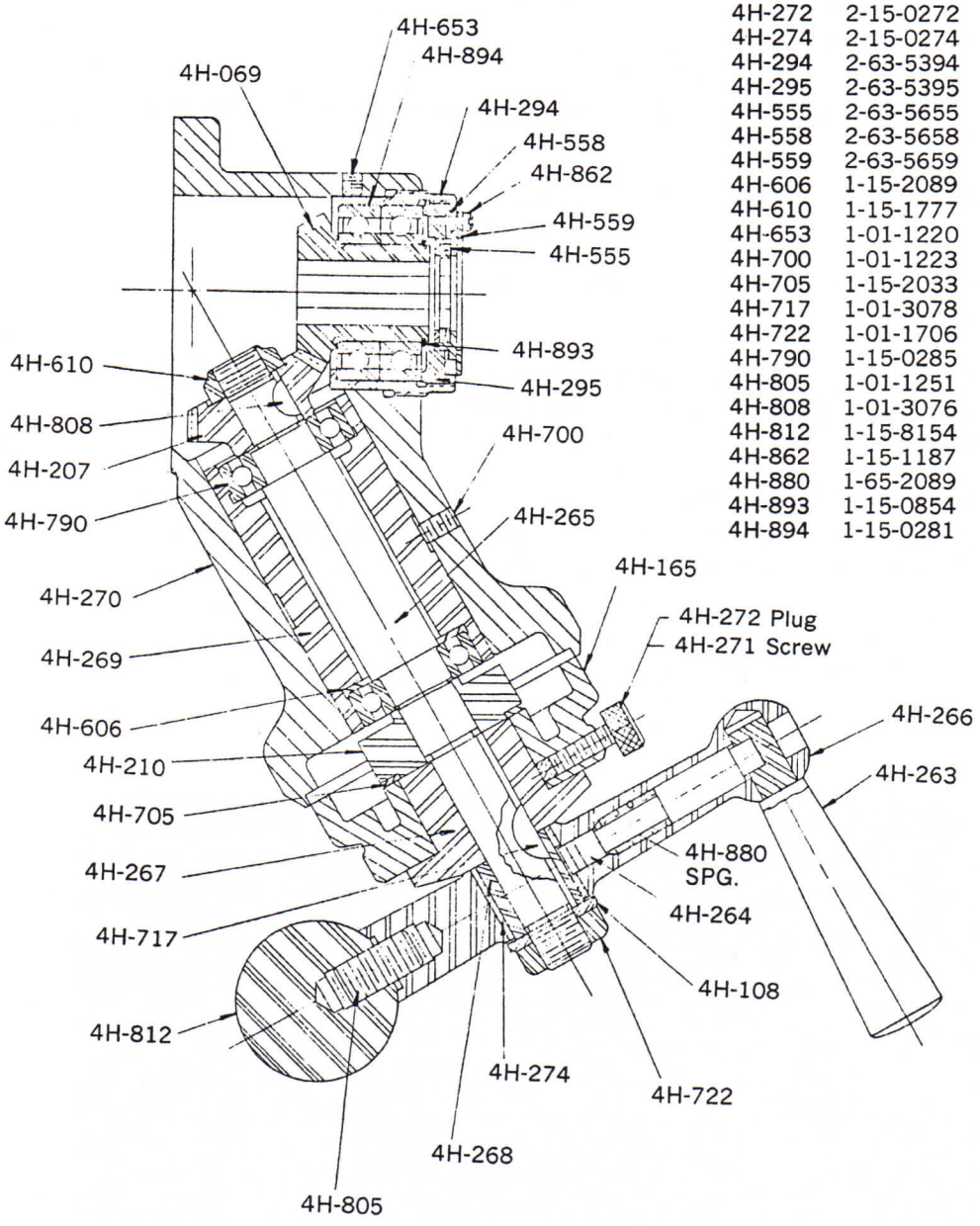
Remove hexagon nut and washer. At this point, handcrank will slip off.

DIAL REPLACEMENT:

Remove hexagon nut and bushing. Slip handwheel off shaft and the dial can now be slipped off the shaft.

OPTIONAL TABLE DRIVE ASSEMBLY

Part No.	Code No.	
4H-069	2-15-0069	Opt. Table Handwneel - Driven Gear
4H-108	2-15-0108	Lead Screw Washer
4H-165	2-15-0165	Opt. Handwheel - Lead Screw Dial (200 Div's.)
4H-207	2-15-0207	Opt. Table Handwheel - Driving Gear
4H-210	2-15-0210	Opt. Table Handwheel Brg. Retainer
4H-263	2-15-0263	Crank Handle
4H-264	2-15-0264	Actuator Pin Ballcrank
4H-265	2-15-0265	Optional Table Handwheel Shaft
4H-266	2-15-0266	Ballcrank
4H-267	2-15-0267	Dial Holder
4H-268	2-15-0268	Ballcrank Spacer
4H-269	2-15-0269	Sleeve
4H-270	2-15-0270	Handwheel Bracket
4H-271	2-15-0271	Thumb Screw For Leadscrew Dial
4H-272	2-15-0272	Plug for 4H-271
4H-274	2-15-0274	Bronze Bushing
4H-294	2-63-5394	Bevel Gear Locator
4H-295	2-63-5395	Bearing Nut
4H-555	2-63-5655	Wiper Assembly - Table Feed
4H-558	2-63-5658	Wiper Retainer T.F. Drive Shaft
4H-559	2-63-5659	Wiper Retainer Cap - T.F. Drive Shaft
4H-606	1-15-2089	Spring
4H-610	1-15-1777	Locknut - Bearing
4H-653	1-01-1220	Soc. Set Screw - 1/4-20NCx1/4
4H-700	1-01-1223	Soc. Set Screw - 1/4-20NCx3/8
4H-705	1-15-2033	Spring
4H-717	1-01-3078	Key Woodruff #7
4H-722	1-01-1706	Hex Nut - 5/8-18
4H-790	1-15-0285	Bearing
4H-805	1-01-1251	Soc. Set Screw - 1/2-13NCx1
4H-808	1-01-3076	Key - Woodruff #3
4H-812	1-15-8154	Knob - Ball Crank
4H-862	1-15-1187	Fillester Hd. Screw #6-32x1/2
4H-880	1-65-2089	Spring
4H-893	1-15-0854	Snap Ring
4H-894	1-15-0281	Bearings



OPTIONAL HANDWHEEL
ATTACHMENT

Fig. #19

TABLE AND SADDLE WITH POWER (x-y axis)

OPERATING INSTRUCTIONS:

CONTROLS:

The table and saddle are controlled from the milling head control box located on the front of the head. The following controls will be used on the control panel:

A. **Percent of Spindle Load** (top left hand corner) indicates load on the spindle when the tool is applied to the work on the table. Overload or beyond 100% will shut off the machine. (for restarting, see section E Fig. #20.)

NOTE: Refer to CAUTION on page 42 for proper use of Load Meter.

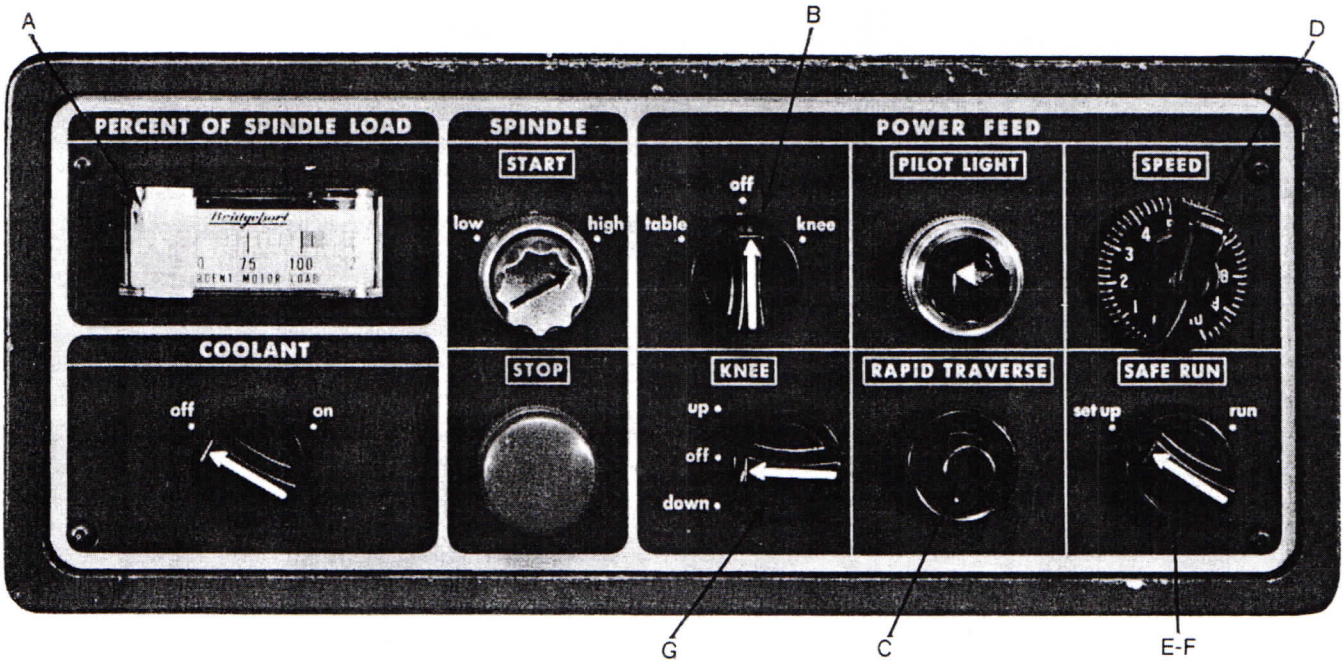
B. Table feed **Off-On** switch is used to activate the motor for table and saddle traverse.

C. **Rapid Traverse** switch is used to move the table and saddle at maximum speed.

> **WARNING:** This is not a speed switch and should **never** be used when the tool is in operation.

D. **Speed Switch** (top right) is used to regulate the speed of the table and saddle feed. The speed switch can be used to increase or decrease the speed while the machine tool is in operation.

E. **Safe Run & Setup** (lower right hand corner) electrically interlocks the spindle motor and the table power feed motor so that if the spindle motor should stall due to overload condition, the power feed motor will stop. When this occurs, the overload heaters in the spindle motor starter will open, causing the spindle motor to de-energize, thus breaking the circuit. In order to restart the motors, the reset buttons on the starter in the electrical enclosure must be manually reset.



Control Panel (pt # 4J-604)

Fig. #20

This interlocking also means that the spindle motor must be running in order to run the table power feed.

WARNING: Resetting to be done only by trained electrical personnel since electrical panel must be entered in order to reset the starter.

F. **Set Up.** The spindle and power feed can be run separately. Should the spindle motor stall, the table power feed will continue to run.

WARNING: This should be used for set up purposes ONLY.

TABLE AND SADDLE "MECHANICAL" CONTROLS: - See Fig. #21.

After the table motor has been started, the table can be moved to the left or right under power by use of the table control lever situated on the right-hand front of the saddle. This lever is returned from the operating position to neutral through the application of two (2) adjustable dogs mounted on the front of the table (it can be returned to neutral manually, also). Over-travel of the table is prevented by fixed stops that prevent the adjustable dogs from being moved beyond the safe limit.

TABLE FEED BRACKET ASSEMBLY (POWER OPERATED)

Part No.	Code No.	
4H-122	2-15-0122	Table Lead Screw Actuating Lever
4H-136	2-63-5236	Table Feed Drive Shaft
4H-143	2-63-5243	Table Feed Clutch Fork Support Rod
4H-148	2-63-5248	Table Feed Bracket
4H-149	2-63-5249	Table Feed Lever Shaft
4H-150	2-15-5250	Selector Roller for 4H-149
4H-152	2-15-5252	Detent Plunger for 4H-148
4H-154	2-15-5254	Table Feed Lever Head
4H-289	2-15-5389	Idler Gear Pin - Table Feed Control
4H-290	2-15-5390	Idler Gear Bracket - TF Control

Part No.	Code No.	
4H-291	2-63-5391	Idler Gear - Table Feed Control
4H-367	2-63-5467	Table Feed Clutch Fork
4H-607	1-01-0520	Roll Pin - 1/8 dia. x 1
4H-618	1-01-0818	Snap Ring
4H-797	1-01-1035	Soc. Hd. Cap Screw - 1/4-20NCx1
4H-798	1-01-0717	Dowel Pin - 3/16 dia. x 3/4
4H-815	1-15-2168	Ball (Handle)
4H-858	1-01-0702	Dowel Pin - 3/32 dia. x 5/8
4H-859	1-01-1203	Soc. Set Screw - #5-40 x 1/4
4H-860	1-01-1225	Soc. Set Screw - 1/4-20NCx5/8

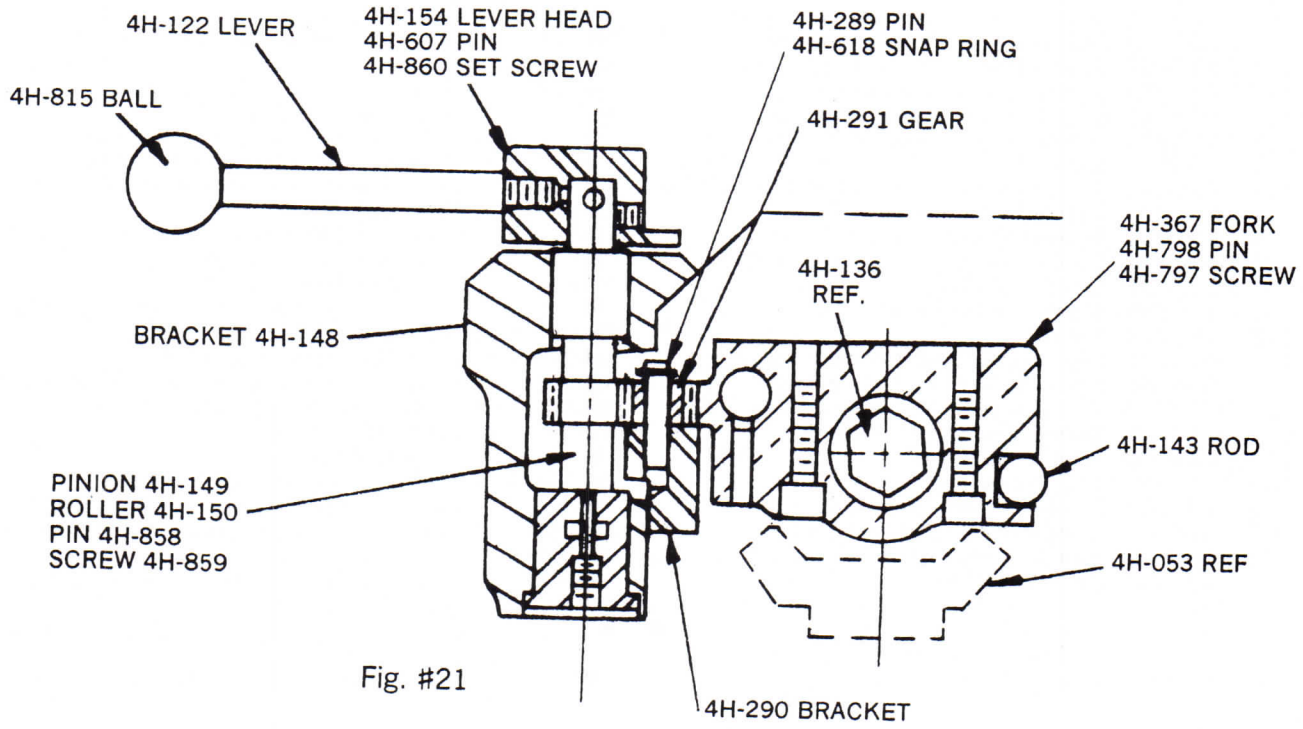


Fig. #21

SIDE VIEW BASIC MACHINE — POWER OPERATED

Part No.	Code No.	
4H-127	2-06-0122	Washer for T-Bolt
4H-128	1-01-1720	Nut
4H-001	2-15-0001	Column
4H-002	2-15-0002	Knee
4H-047	2-15-0047	Saddle
4H-048	2-63-5148	Saddle Drive Gear Housing
4H-049	2-63-5149	Front Brg. Ret'r. for 4H-048
4H-050	2-63-5150	Saddle Drive Housing Plate
4H-051	2-63-5151	Saddle Housing Spacer Block
4H-052	2-63-5152	Saddle Trans. - Vert. Shaft
4H-053	1-15-2205	Saddle Trans. - Vert. Shaft Gear
4H-054	2-15-0054	Table
4H-055	2-63-5155	Saddle Trans. - Pinion Shaft
4H-056	2-63-5156	Saddle Hs'g. - Rear Wiper - Holder
4H-057	2-63-5157	Saddle Hs'g.- Front Wiper - Holder
4H-058	2-63-5158	Deflector - Saddle Dr. Gear Hs'g.
4H-059	2-63-5159	Thrust Washer For 4H-052
4H-061	2-63-5161	Saddle Control Rack - (Rear)
4H-068	2-63-5168	Saddle Control Rack (Front)
4H-070	2-63-5170	Saddle Control Rack Holder
4H-071	2-63-5171	Saddle Control Post Housing
4H-074	2-63-5174	Saddle Control Post Pinion
4H-075	2-63-5175	Saddle Travel Adj. Bracket
4H-076	2-63-5176	Reverse - Saddle Trav. Trip Dog.
4H-078	2-63-5178	Saddle Contr. Post Pinion Cam
4H-080	2-63-5180	Cover - Saddle Contr. Rack Holder
4H-081	2-63-5181	Saddle Transmission Housing
4H-083	2-63-5183	Saddle Transmission - Drive Shaft
4H-084	2-63-5184	Saddle Trans. - Rear Br'g. End Cap
4H-085	2-63-5185	Saddle Trans. - Idler Gear
4H-086	2-63-5186	Saddle Trans. - Idler Gear Shaft
4H-087	2-63-5187	Saddle Trans. - Idler Gr. Thr. Br'g.
4H-102	2-15-0102	Cross Feed Lead Screw
4H-104	1-15-2290	C.F. Lead Screw Sprocket
4H-122	2-15-0122	Table Lead Screw Actuating Lever
4H-135	1-15-0135	Locknut
4H-136	2-63-5236	Table Feed Drive Shaft
4H-151	1-15-5025	Cover - Saddle Control
4H-154	2-63-5254	Table Feed Lever Head
4H-157	2-63-5257	Key - 3/16 x 3/16 x 7/8
4H-180	2-63-5280	Spacer - Saddle Trans. Cl. Gr. Br'g.
4H-181	2-63-5281	Saddle Trans. Rev. Clutch & Gear
4H-182	2-63-5282	Saddle Trans. - Fw'd Clutch & Gear
4H-185	2-63-5285	Saddle Trans. - M'Shaft Dr. Sprocket
4H-186	2-63-5286	Saddle Trans. - M'Shaft T-Washer
4H-187	2-63-5287	Saddle Trans. - M'Shaft Spr. T-Washer
4H-188	2-63-5288	Saddle Trans. - M'Shaft Spacer
4H-189	2-63-5289	Saddle Trans. - Knee Sub Plate
4H-190	2-63-5290	Saddle Trans. - M'Shaft Fr. Mt'g Brkt.
4H-191	2-63-5291	Saddle Trans. - M'Shaft Rear Mt'g Brkt.
4H-192	2-63-5292	Saddle Trans. - Pinion Shaft Rack M'Shaft
4H-193	2-63-5293	Saddle Trans. - Shifting Fork
4H-195	2-15-0195	Bearing Holder - Knee Bracket
4H-196	2-63-5296	Saddle Trans. - Actuating Fork Rod
4H-197	2-63-5297	Drive Shaft Saddle Trans. Gear
4H-199	2-63-5299	Washer - Power Feed Shaft
4H-213	2-15-0213	T-Bolt
4H-255	2-63-5355	Adj. - Detent Block (Saddle Contr.)
4H-256	2-63-5356	Adj. - Contr. Rod (Saddle Rack)
4H-257	2-63-5357	Stop Block (Saddle Rack Contr.)
4H-258	1-15-2092	Spring - (Saddle Rack Contr.)
4H-260	2-63-5360	Spring - Ret. Washer - Saddle Contr.
4H-283	2-63-5383	Table Feed Lever Shaft & Pinion
4H-287	2-63-5337	Saddle Control Idler Gear
4H-307	2-15-0307	Saddle Trans. Clutch M'Shaft
4H-308	2-15-0308	Saddle Trans. - Sliding Clutch
4H-314	2-63-5414	Retainer - Chip Guard - Rear
4H-328	1-13-2093	Knee Chip Guard - Spring
4H-330	2-63-5430	Chip Guard
4H-332	2-63-5432	Bracket - Chip Guard - Spring Mt'g.
4H-362	2-63-5462	Bearing Sleeve - Motor Shaft

Part No.	Code No.	
4H-451	2-63-5551	Br'g - Adj. Nut - Saddle Trans.
4H-469	2-63-5569	Saddle Trans. - Front Br'g Cap
4H-560	2-63-5660	Wiper - Saddle Housing
4H-561	2-63-5661	Wiper - Retainer
4H-583	2-63-5683	Knee Bracket - Lead Screw
4H-593	2-63-5693	Spacer for 4H-070
4H-600	1-01-0729	Dowel Pin - 1/4 dia. x 1-1/4
4H-604	1-01-1056	Soc. Hd. Cap Screw - 5/16-18NCx1-1/4
4H-605	1-01-0787	Dowel Pin - 1/4 dia. x 1
4H-607	1-01-0520	Roll Pin 1/8 dia. x 1
4H-608	1-01-1548	Pan Head Mach. Scr. - #10-32NFx3/8
4H-609	1-15-0317	Bearing
4H-610	1-15-1777	Locknut
4H-611	1-15-2221	Worm Gear
4H-614	1-41-3729	Oil Sight Glass
4H-615	1-63-0138	Motor
4H-619	1-01-1030	Filester Hd. Scr. - 1/4-20NCx3/4
4H-629	1-15-0319	Bearing
4H-630	1-15-0321	Bearing
4H-631	1-15-0312	Bearing
4H-632	1-15-3664	Bushing
4H-634	1-15-0288	Bearing
4H-636	1-15-0290	Bearing
4H-637	1-15-3129	Oil Seal
4H-638	1-01-0505	Roll Pin - 3/32 dia. x 3/8
4H-639	1-01-0744	Dowel Pin - 5/16 dia. x 1-1/2
4H-642	1-15-3721	Chain
4H-653	1-01-1220	Soc. Set Screw - 1/4-20NCx1/4
4H-654	1-01-1052	Soc. Hd. Cap Scr. - 5/16-18NCx3/4
4H-662	1-01-0708	Dowel Pin - 1/8 dia. x 1-1/8
4H-667	1-01-0745	Dowel Pin - 5/16 dia. x 1
4H-673	1-01-1815	Soc. Set Screw - #10-32NFx1/4
4H-692	1-15-0318	Bearing
4H-700	1-01-1223	Soc. Set Screw - 1/4-20NCx3/8
4H-707	1-15-3184	Wiper Seal
4H-719	1-01-1143	Hex Hd. Cap Scr. - 5/16-18NCx1
4H-724	1-01-1016	Soc. Hd. Cap Scr. - #10-32NFx3/8
4H-725	1-15-0809	Snap Ring
4H-726	1-15-0278	Bearing
4H-728	1-15-0934	O-Ring
4H-729	1-15-0843	Snap Ring
4H-730	1-15-3187	Oil Seal
4H-732	1-15-0279	Bearing
4H-733	1-01-0783	Pipe Plug - 3/8 NPT
4H-734	1-01-1031	Soc. Hd. Cap Scr. - 1/4-20NCx5/8
4H-735	1-01-1207	Soc. Set Screw - #8-32NCx1/4
4H-738	1-01-1037	Soc. Hd. Cap Scr. - 1/4-20NCx1-1/4
4H-739	1-01-1056	Soc. Hd. Cap Scr. - 5/16-18NCx1-1/4
4H-742	1-01-3077	Key - Woodruff #5
4H-751	1-01-1042	Soc. Hd. Cap Scr. - 1/4-20NCx1-5/8
4H-753	1-01-1034	Soc. Hd. Cap Scr. - 1/4-20NCx7/8
4H-766	1-01-1456	Round Head Scr. - #10-32NFx1/2
4H-815	1-15-2168	Ball
4H-817	1-01-1235	Soc. Set Screw - 5/16-18NCx1/4
4H-836	1-01-3092	Key - Woodruff #91
4H-838	1-01-0779	Pipe Plug - 1/4 NPT
4H-841	1-01-1413	Round Head Screw - #6-32NCx3/8
4H-842	1-01-1961	Lock Washer #6
4H-843	1-01-1703	Nut - Hex #6-32NC
4H-844	1-01-1360	Soc. Set Screw - Half Dog - #10-32NFx1/4
4H-845	1-01-0710	Dowel Pin - 1/8 dia. x 1-3/4
4H-846	1-15-2164	Ball - 1/4 dia.
4H-849	1-15-1778	Locknut
4H-850	1-15-1547	Pan Head Screw - #6-32NCx3/8
4H-851	1-01-1017	Soc. Hd. Cap Scr. - #10-32NFx1/2
4H-852	1-01-1456	Round Head Screw - #10-32NFx1/2
4H-853	1-17-3642	Bushing
4H-854	1-01-1051	Soc. Hd. Cap Scr. - 5/16-18NCx5/8
4H-855	1-01-0419	Pin - #4 Taper
4H-856	1-01-1369	Soc. Set Screw - Half Dog - #10-32NFx1/2
4H-876	1-01-1779	Locknut
4H-909	2-15-0909	Forward - Saddle Travel Trip Dog.

SIDE VIEW — BASIC MACHINE — POWER OPERATED

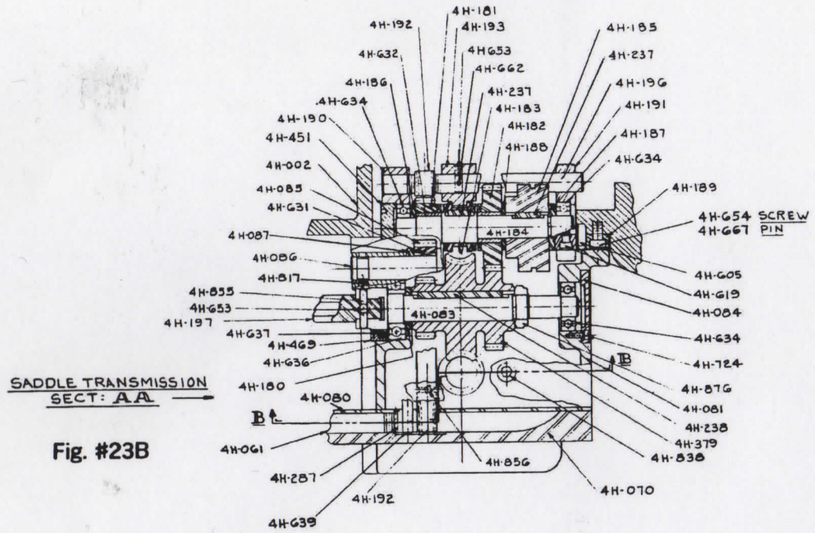


Fig. #23B

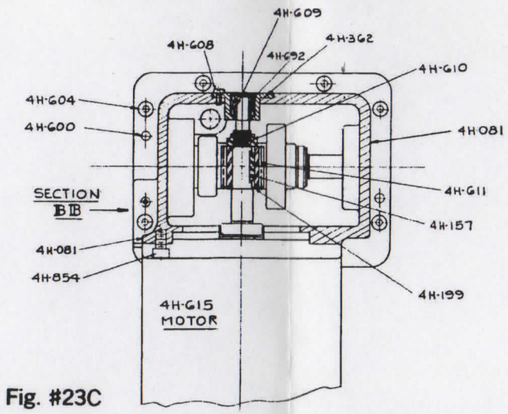


Fig. #23C

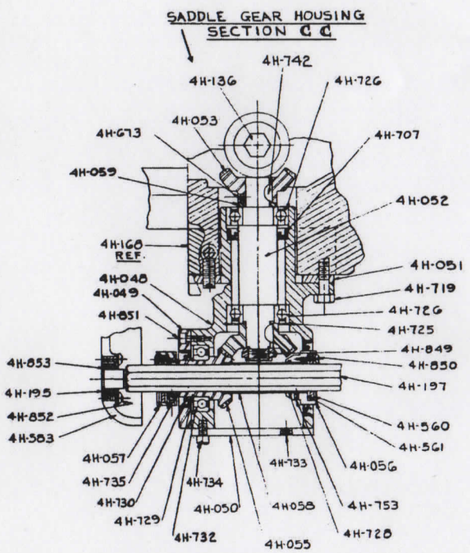


Fig. #23A

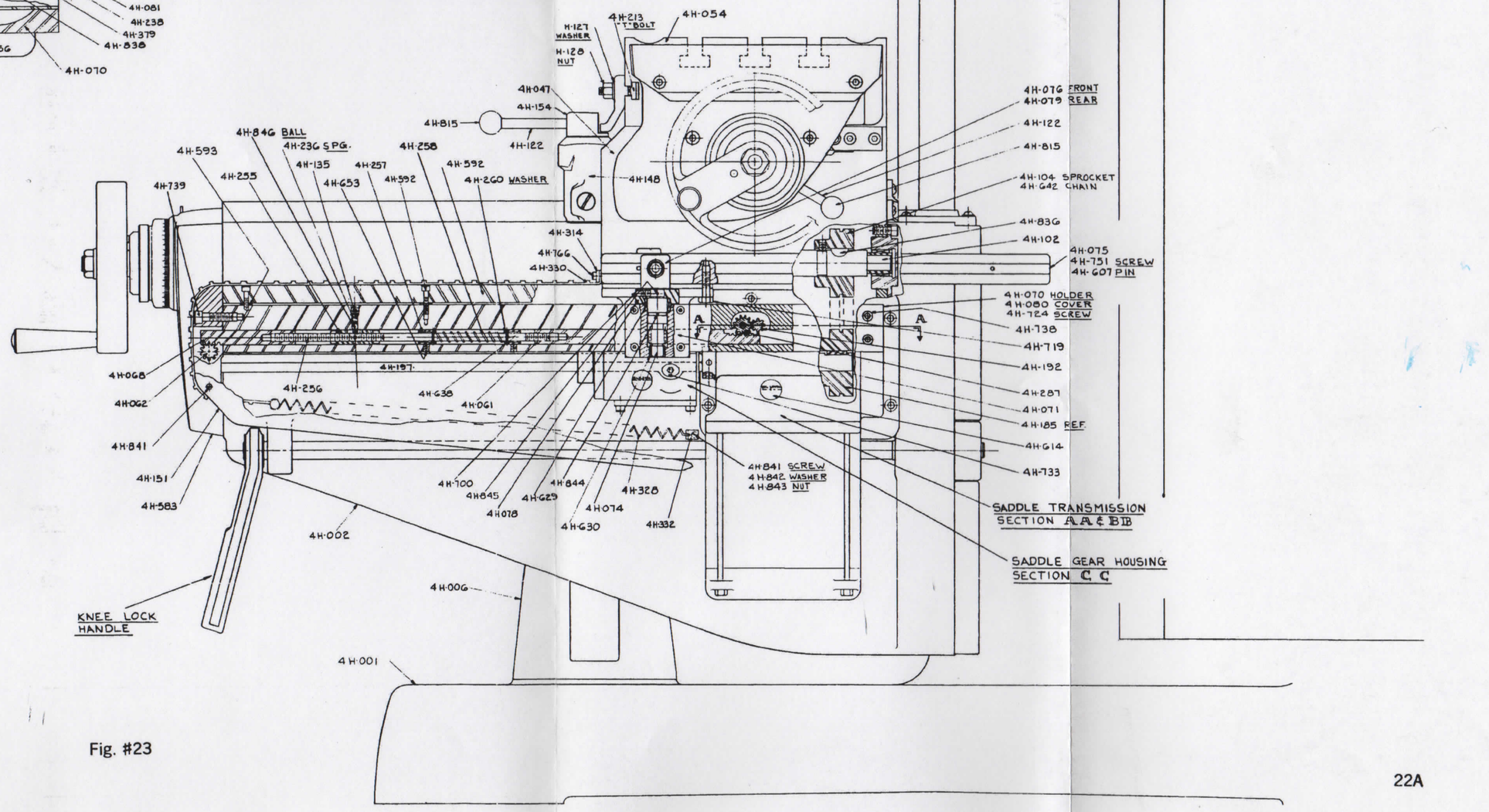


Fig. #23

BASIC MACHINE — POWER OPERATED

Part No.	Code No.	
H-126	1-06-1602	Stop Piece T-Bolt
H-127	2-06-0122	Washer
4H-047	2-15-0047	Saddle
4H-054	2-15-0054	Table
4H-093	2-63-5193	Lead Screw Dial Holder
4H-095	2-15-0095	Ballcrank Spacer
4H-096	2-15-0096	Cross Feed Bearing Retainer
4H-098	2-15-0098	Crank Handle
4H-099	2-15-0099	Crank Handle Rod
4H-100	2-15-0100	Crank Handle Plug
4H-109	2-63-5209	Table End Bracket Cover
4H-115	2-63-5215	Seal - Table End Bracket - Cover
4H-116	2-63-5216	R.H. Table End Bracket
4H-117	2-63-5217	L.H. Table End Bracket
4H-118	2-15-0118	Table Lead Screw
4H-119	2-63-5219	Table Lead Screw Sleeve
4H-120	2-63-5220	Table Lead Screw Clutch (Driver)
4H-121	2-63-5221	Table Lead Screw Clutch
4H-123	2-63-5223	Table Lead Screw Clutch Spacer
4H-124	2-63-5224	Spacer for 4H-120
4H-125	2-63-5225	Table Lead Screw Ret. Washer
4H-126	2-63-5226	Table Lead Screw Clutch Washer
4H-132	2-63-5232	Table Dial Spring Retainer
4H-137	2-63-5237	Table Feed Drive Shaft Br'g Ret.
4H-138	2-63-5238	Table Feed Clutch Br'g Housing
4H-139	2-63-5239	Table Feed Clutch (Driver)
4H-140	2-63-5240	Table Feed Clutch (Driven)
4H-141	2-63-5241	Key - 3/16 x 3/16 x 7/8
4H-144	1-15-2096	Spring - Table Feed Bracket
4H-145	2-63-5245	Table Feed Gear (Driver)
4H-146	2-63-5246	Table Feed Idler Gear
4H-147	2-63-5247	Table Feed Idler Gear Shaft
4H-152	2-63-5252	Detent Plunger for 4H-148
4H-155	2-63-5255	Table Control Trip Dog (Lower)
4H-156	2-63-5256	Table Control Trip Dog (Upper)
4H-171	2-15-0171	Nut - Hex Head - 5/16-18NC
4H-221	2-15-0221	Chip Screen (End Bracket)
4H-234	2-15-0234	Key - Lead Screw - Dial Ret.
4H-340	2-15-0340	Saddle - Knee Gib
4H-341	2-15-0341	Gib Screw (Saddle & Table)
4H-358	1-15-2089	Crank Handle Spring
4H-456	2-15-0456	Washer - (Saddle - Table Gib Screw)
4H-459	2-63-5559	Br'g Spacer - Table Bevel Gear
4H-460	2-63-5560	Br'g Spacer - Table Bevel Gear
4H-461	2-63-5561	Nut - Table Feed Clutch Br'g
4H-557	2-63-5657	Retaining Ring for 4H-555
4H-574	2-63-5674	Table Feed Detent
4H-579	2-15-0579	Lead Screw - Hand Crank
4H-583	2-63-5683	Knee Bracket - Lead Screw
4H-597	1-01-1086	Soc. Hd. Cap Scr. - 3/8-16NCx4
4H-598	1-01-0785	Pipe Plug - 3/4 NPT.
4H-599	1-01-3102	Oiler
4H-603	1-01-0705	Dowel Pin 1/8 dia. x 3/4
4H-604	1-01-1056	Soc. Hd. Cap Scr. - 5/16-18NCx1-1/4
4H-619	1-01-1030	Filester Head Scr. - 1/4-20NCx3/4
4H-633	1-01-1010	Soc. Hd. Cap Scr. - #10-24NCx1/2
4H-671	1-01-1218	Soc. Set Screw - #10-32NFx3/8
4H-716	1-15-3651	Bearing
4H-779	1-15-0325	Bearing
4H-780	1-15-0853	Snap Ring
4H-781	1-15-0313	Bearing
4H-782	1-15-0314	Bearing
4H-783	1-15-0315	Bearing
4H-784	1-15-0316	Inner Race
4H-785	1-01-0282	Bearing
4H-788	1-15-0284	Bearing
4H-799	1-01-1237	Soc. Set Screw 5/16-18NCx1/2
4H-807	1-01-0745	Dowel Pin - 5/16 dia. x 1-1/4
4H-861	1-01-1475	Round Head Screw - 1/4-20NCx1/2

BASIC MACHINE — POWER OPERATED

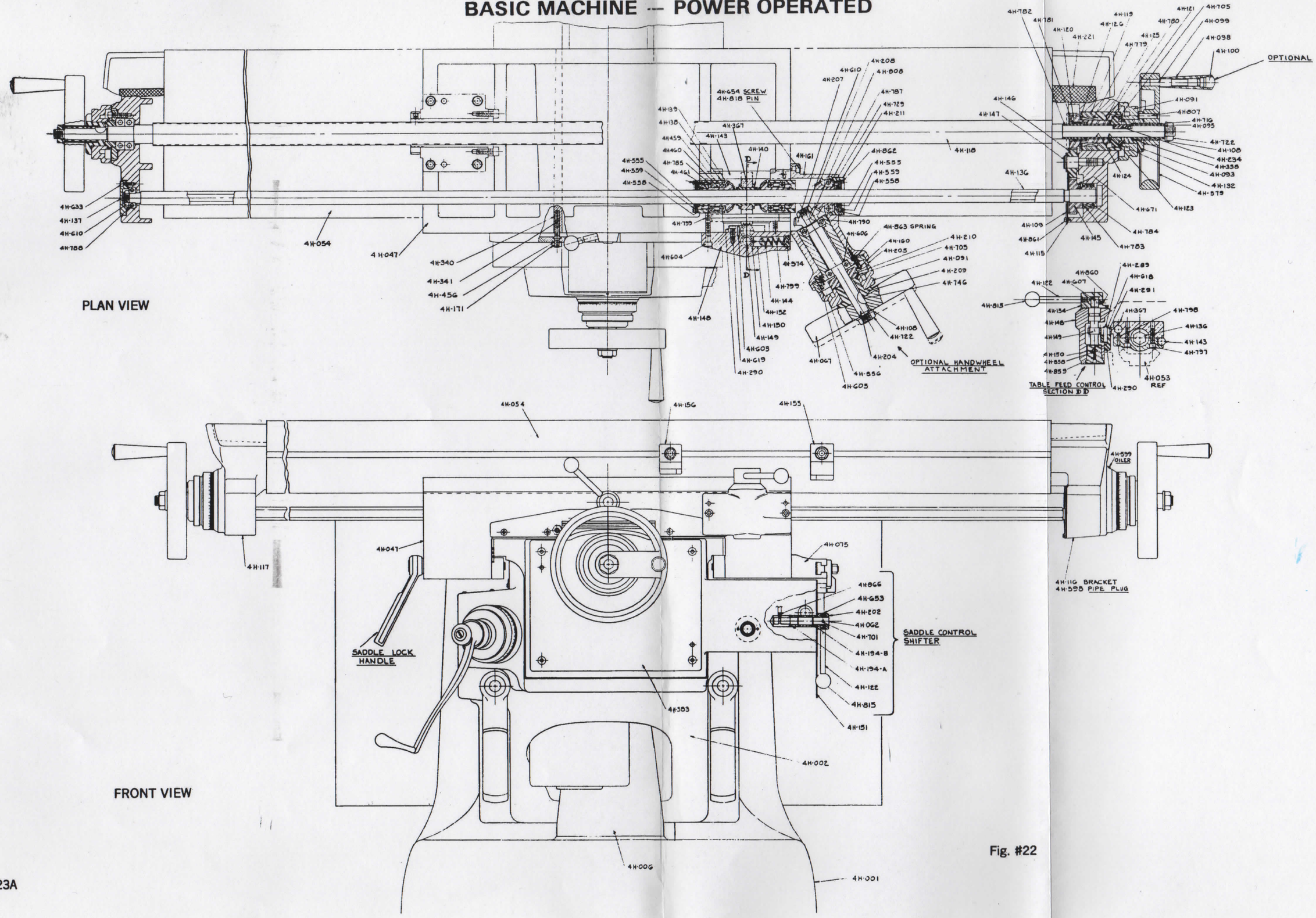


Fig. #22

The saddle can be moved under power by use of the saddle control lever situated on the right hand side of the front knee bracket. This lever is returned from its operating position to neutral through the application of two (2) adjustable dogs mounted on a holder located on the right-hand side of the knee. Over-travel of the saddle is prevented by fixed stops that prevent the adjustable dogs from being moved beyond the safe limit.

SADDLE CONTROL SHIFTER ASSEMBLY

Part No.	Code No.		Part No.	Code No.	
4H-068	2-63-5168	Saddle Control Rack	4H-285B	2-63-5385	Brg. - Table Feed Lever Shaft (Rear)
4H-122	2-15-0122	Table Lead Screw Actuating Lever	4H-583	2-63-5683	Bracket, Lead Screw Knee
4H-151	1-15-5025	Cover, Saddle Control	4H-653	1-01-1220	Soc. Set Screw - 1/4-20NCx1/4
4H-202	2-63-5302	T.F. Lever Shaft Shift Rod Hub	4H-673	1-01-1815	Set Screw
4H-283	2-63-5383	Table Feed Lever Shaft & Pinion	4H-815	1-15-2168	Ball
4H-285A	2-63-5385	Brg. - Table Feed Lever Shaft (Front)	4H-841	1-01-1413	Round Head Screw - #6-32NCx3/8

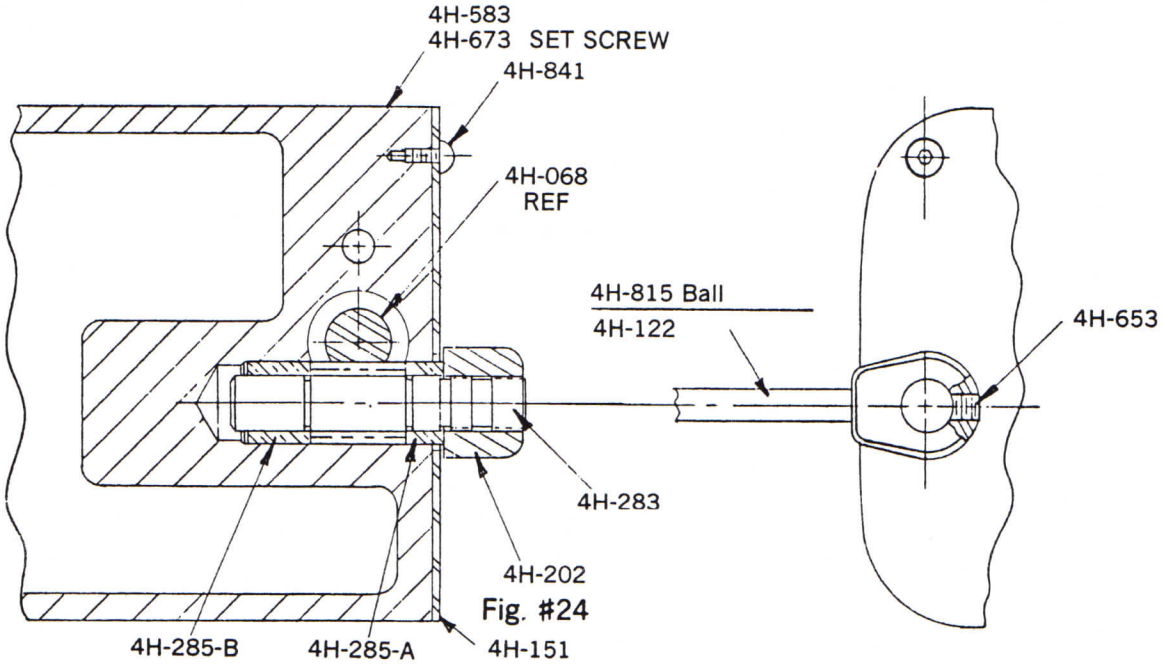


Fig. #24

NOTE: The saddle and the table movements are controlled by the same motor. Both table and saddle feeds can be operated at the same time.

SERVICING INSTRUCTIONS

REMOVING TABLE END BRACKET (right hand pt #4H-116) - See Fig. #22.

Remove hexagon nut with washer (pt #4H-108) and ball crank (or handwheel) will slip off. Remove ball crank spacer (pt #4H-095) to release lead screw dial holder (pt #4H-093) and dial (pt #4H-091). Remove table dial spring retainer (pt #4H-132) and washer. At this point, the first half of the clutch is exposed. Disassemble the clutch (pt #4H-121) and remove it along with clutch key. The second half of the clutch and the remaining assembly will remain intact. Loosen three (3) round head machine screws holding a neoprene gasket in place on the inside of the bracket. Slide gasket plate and neoprene gasket off the bracket. Remove four (4) bracket securing screws and the end bracket should now slide off. The table feed gear driver (pt #4H-145) will remain on the table feed drive shaft (pt #4H-136) being held in place with a set screw.

REMOVING TABLE END BRACKET (left hand Pt #4H-117) - See Fig. #22.

Remove hex nut and washer (pt #4H-108) and ball crank (or handwheel) will slide off. Remove bushing (pt #4H-716) to release lead screw dial holder (pt #4H-093) and dial (pt #4H-091). Remove Woodruff key. Remove three (3) table feed drive shaft bearing retainer (pt #4H-137) securing screws and disassemble retainer. Loosen locknut on table feed drive shaft (pt #4H-136). Remove the bracket securing screws and the bracket is now detachable.

TABLE LEAD SCREW REPLACEMENT: (pt #4H-118) - See Fig. #22.

Complete preceeding procedure for removal of end brackets. The table screw can now be removed by turning all the way out of the lead screw nut.

TABLE FEED SHAFT REPLACEMENT: (pt #4H-136)

Complete procedures to remove the right end bracket. Remove the securing screws and detach the optional handwheel bracket (if used). Loosen securing screws (3) and remove the table feed shaft bearing cap (pt #4H-137) from the left hand end of the shaft. Loosen and remove locknut.

CAUTION: Do NOT disturb bearings and do NOT remove two (2) set screws holding the table feed clutch bearing housing.

At this point, the table feed shaft could be pulled out of the saddle.

When replacing this shaft, carefully line up all hexagon shaped holes in wipers and clutch spool.

WARNING: Do NOT force this shaft.

REMOVING TABLE:

Follow the procedures for removal of right hand and left hand table end brackets. The table can now be removed by sliding it off the saddle ways.

NOTE: loosen the table gib — do NOT remove it.

REMOVING SADDLE:

Complete the procedure for the removal of the table. Remove the saddle to knee gib and wiper plate located on front of the saddle. Then remove the four (4) screws located in the center of the saddle that hold the saddle lead screw nut bracket (pt #4H-089) in place. Remove the saddle to knee clamp assembly (see Fig. #16) and hold downs (pt #4H-167 & pt #4H-169).

Disconnect the lube hose.

Remove the three (3) screws securing the auxiliary drive to the saddle. Make sure that this bracket is not sticking to the saddle (Permatex).

The saddle can now be LIFTED off.

CAUTION: Exercise care in hoisting the saddle so that the dowel pin located in the saddle casting and saddle lead screw nut bracket will slip out of the saddle without binding.

KNEE WITH POWER (Z-AXIS)

OPERATING INSTRUCTIONS

KNEE CONTROL:

The knee can be controlled from the variable speed head control panel, or manually by the use of a hand crank located on the left front of the knee.

The motor for the knee is activated by the **Table-Off-Knee** switch located in the upper left hand side of the power feed area of the panel (see B in Fig. #20). Knee direction is determined by a Selector switch marked KNEE **Up-Off-Down** (see G in Fig. #20).

The binders on knee to column ways should be released prior to moving or adjusting knee height. To move knee manually, release binders and use the hand crank on left hand front of the knee.

> **WARNING:** Power operating controls must be shut off before operating knee manually.

To move or position the knee manually, push the handle in until the clutch is in mesh. Then turn handle in the proper direction for required height or feed, using the dial for accuracy.

Power can be applied to table and saddle or knee. Power cannot be applied to both table and saddle, and the knee at the same time.

The knee movement is reversed by reversing the motor, whereas the table and saddle are mechanically reversed.

> NOTE: Knee movement is locked out in power operation when Hand Crank is engaged.

SERVICING INSTRUCTIONS

DIAL REPLACEMENT:

Remove securing screw and washer holding the knee elevating crank (pt #4H-372). Removing the crank also removes first half of the clutch. By loosening the set screw in the spacer (second half of clutch), it can now be removed. At this point, the dial will slide off easily.

ELEVATING SHAFT REPLACEMENT:

> **WARNING:** Before proceding, turn off the main electrical disconnect located on the door of the electrical enclosure at the rear of the machine.

Engage the knee elevating crank and elevate the knee to insure that the clutch is engaged and the power elevating worm gear is disengaged.

Remove the dial. (See preceeding section on dial replacement).

Remove the left hand side cover (pt #4H-153). Drain the oil from the knee elevating transmission and remove the torque bar (Pt #4H-235 Fig. #26) from between the transmission and the knee.

Put suitable blocking or support under the elevating motor.

WARNING: this is important as the transmission is hung on the elevating shaft and will no longer be supported when the shaft is removed.

Remove the three (3) bearing cap (pt #4H-049) securing screws. The elevating shaft can now be withdrawn by carefully sliding the assembly out of the power elevating transmission housing (part#4H-026) and out of the knee.

WARNING: Make sure that the transmission housing is properly supported.

REMOVING KNEE:

After removing the table and saddle, remove the top knee chip guard to expose the lead screw bearing locknut which secures the knee to the knee elevating screw and pedestal. By removing the locknut, the knee can now be lifted up and off the column ways, leaving the pedestal and elevating screw on the column pad.

NOTE: Do NOT attempt to remove the knee until the binders (pt #4H-041), the gibs (pt #4H-040) and straps on the knee to column have also been removed. The lead-in hose from the lube system pump must also be disconnected at either the pump or the tee fitting on the knee. Remove lube hose at the elevating screw nut.

Do NOT remove the knee bearing cap or bearings before lifting the knee. They will be part of the knee assembly when it is hoisted off the knee elevating lead screw.

KNEE POWER FEED MOTOR REPLACEMENT:

The power feed motor can be removed from the transmission without first removing the transmission, providing it is properly supported.

Remove the left hand side cover (pt #4H-153). Drain the oil out of the transmission.

There is a pilot bearing on the end of the motor shaft and a worm engaged with a worm gear. The worm gear is disconnected from the drive by pushing the crank handle into mesh. Crank the knee up 1/4 turn to insure that the crank is engaged and that the worm gear is disengaged.

When the worm gear is thus disengaged, the four (4) screws holding the motor in place can be removed and the motor dropped straight down 1/4" (6mm) or so onto suitable blocks.

CAUTION: The weight of the motor is 37 lbs. (17kgs) so be sure that the blocking is in place before the screws are removed.

The motor should come straight down for at least 1" (25mm) to avoid damaging the pilot bearing on the end of the motor shaft.

KNEE ASSEMBLY (Power Operated)

Part No.	Code No.	
4H-026	2-63-5126	Power Elev'g. Gear Housing
4H-027	2-63-5127	Elevating Shaft Gear Sleeve
4H-028	2-63-5128	Power Elev'g Gear Mt'g Nut
4H-029	2-63-5129	Power Elev'g Shaft Seal Sleeve
4H-032	2-15-0032	Knee Elev'g Handle Shaft
4H-033	2-15-0033	Power Elev'g Selector Key
4H-034	2-15-0034	Knee Elev'g Shaft
4H-104	1-15-2290	Cross Feed Lead Scr. End Support
4H-111	2-15-0111	Knee Elevating Clutch
4H-112	2-15-0112	Knee Elevating Dial
4H-113	2-15-0113	Knee Elevating Dial Washer
4H-114	2-15-0114	Knee Elevating Clutch Cover
4H-157	2-63-5257	Key - 3/16 x 3/16 x 7/8
4H-200	1-15-2091	Power Elev'g Selector Key Spring
4H-216	2-15-0216	Handle Shaft Locking Screw
4H-227	2-15-0227	Key - Knee Elev'g Ext. - Shaft
4H-229	2-15-0229	Key - Knee Elev'g Clutch - Shaft
4H-235	2-15-0235	Stabilizer Knee Elev'g Mot - Knee
4H-362	2-63-5462	Bearing Sleeve - Motor Shaft
4H-372	2-15-0372	Knee Elevating Crank
4H-374	2-15-0374	Knee Elev'g Shaft Extension
4H-375	2-15-0375	Elev'g Shaft Crank Washer
4H-452	2-63-5552	Power Elevating Gear
4H-608	1-01-1548	Pan Head Mach. Scr-#10-32NFx3/8
4H-609	1-15-0317	Bearing
4H-610	1-15-1777	Locknut
4H-611	1-15-2221	Worm Gear
4H-614	1-41-3279	Oil Sight
4H-615	1-63-0138	Motor
4H-620	1-01-0714	Dowel Pin - 3/16 dia. x 5/8
4H-624	1-15-0849	Snap Ring
4H-625	1-15-0287	Bearing
4H-626	1-15-0311	Snap Ring
4H-627	1-15-3661	Bushing
4H-640	1-15-0333	O-Ring
4H-644	1-15-0322	Bearing
4H-647	1-01-1534	Flat Hd. Mach. Scr. - 5/16-18NCx1/2
4H-649	1-15-1792	Locknut
4H-650	1-01-1042	Soc. Hd. Cap Scr. - 1/4-20NCx2
4H-652	1-01-1240	Soc. Set Screw - 5/16-18NCx3/4
4H-653	1-01-1220	Soc. Set Screw - 1/4-20NCx1/4
4H-654	1-01-1052	Soc. Hd. Cap Scr. - 5/16-18NCx3/4
4H-692	1-15-0318	Bearing
4H-705	1-15-2033	Spring
4H-817	1-01-1235	Soc. Set Screw - 5/16-18NCx1/4
4H-819	1-01-1236	Soc. Set Screw - 5/16-18NCx3/8
4H-832	1-15-3188	Seal
4H-836	1-01-3092	Key - Woodruff #91
4H-837	1-15-1214	Soc. Set Screw - #10-32NFx1/8
4H-839	1-01-1148	Button Head Screw - 1/4-20NCx3/4
4H-840	1-01-0778	Pipe Plug - 1/2 NPT

KNEE ASSEMBLY
(Power Operated)

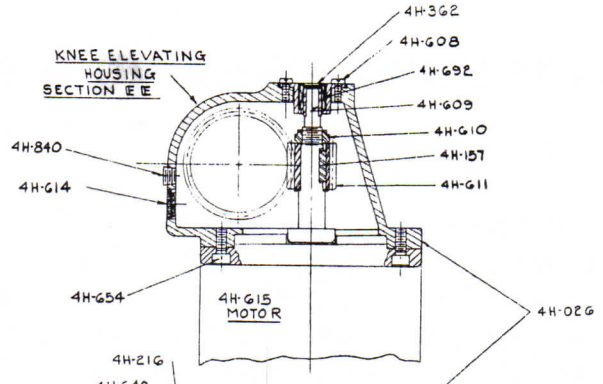


Fig. #25

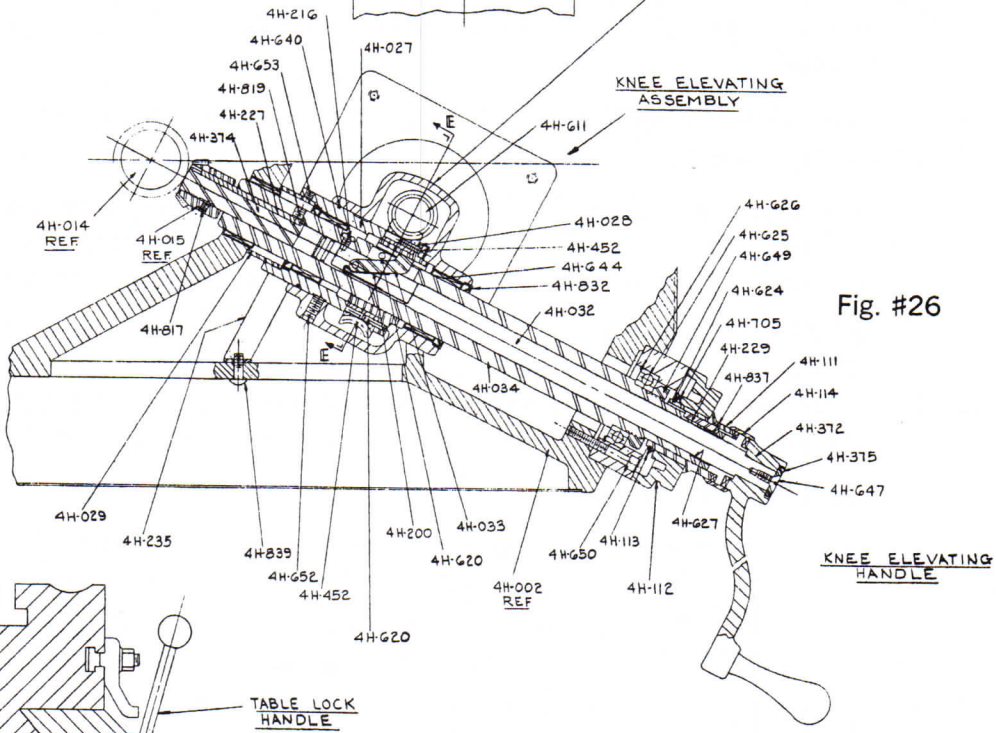


Fig. #26

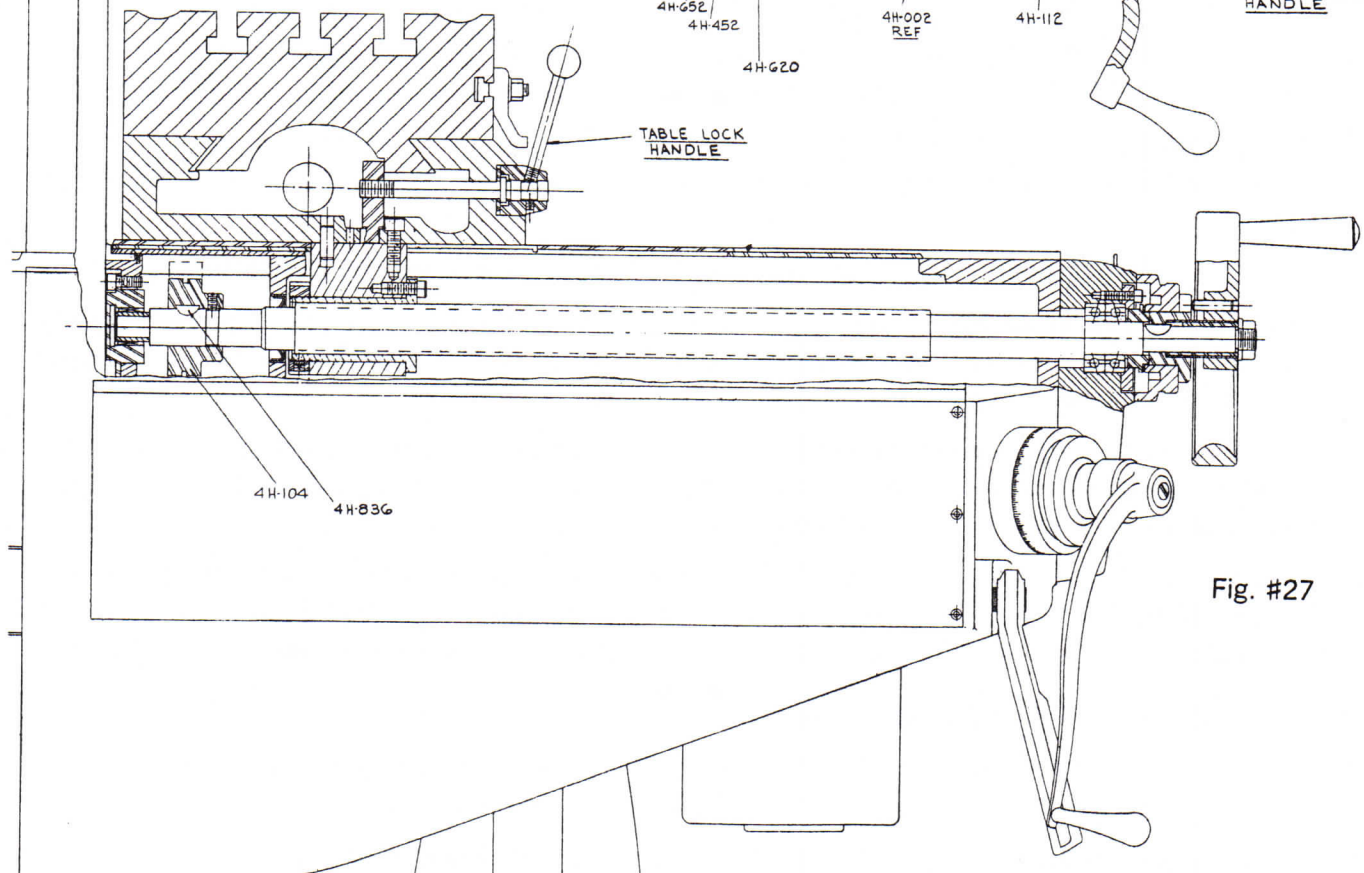


Fig. #27

4J MILLING, DRILLING & BORING HEAD

OPERATING INSTRUCTIONS

OPERATOR'S CONTROL PANEL: (See Fig. #20)

The **Spindle-ON** rotary pushbutton is used to start the 4 hp spindle motor. This is also a motor reversing switch. When the attachment is in "direct drive" (HI-SPEED) the motor and spindle are turning in the same direction. When the attachment is in "back gear" (LO-SPEED) the spindle would run backwards unless the motor direction is reversed.

The rotary pushbutton and the back gear lever are both marked "HI-LO". They should be alike or the spindle will run backwards.

The **Spindle-Off** pushbutton is located below the **Spindle-On** rotary pushbutton. This button will shut off the spindle motor. It will also shut off the table and knee power feed motors if the Power Feed selector switch is in the **SAFE-RUN** position.

SPINDLE BRAKE:

The brake lever is located on the upper left hand side of the Variable Speed Head. The lever can be moved in either direction to stop the spindle. When locking the spindle, the lever should be moved right or left and then raised.

There are no adjustments to be made for this brake.

> **WARNING:** Be certain that the spindle brake is released before starting the motor. Although the motor is protected through its magnetic starter's heater coils, longer motor life will result if the brake is released prior to starting the motor.

HI-NEUTRAL-LO LEVER:

This lever is used to put the attachment into either direct drive, neutral or back gear.

> **WARNING:** Do NOT shift to any position while motor is running.

To put the attachment into "HI" (direct drive), release the lever from either the neutral or backgear positions. Hold the spindle brake on and rotate the spindle **by hand** until the tapered clutch teeth mesh.

To put the attachment into "NEUTRAL", simply position the lever's detent pin into the "neutral" notch on the detent plate (pt #4J-301). Neutral is provided to permit free spindle rotation for indicating and set-up work.

To put the attachment into "LO" (back gear), release the lever from either the "direct drive" or "neutral" positions and move it to the "LO" (back gear) position on the detent plate. If the gear teeth do not mesh, rotate the spindle **by hand** until they do.

VARIABLE SPEED CONTROL:

> **WARNING:** DO NOT try to change speed positions until the motor is running. This could cause breakage of parts.

Spindle Speeds are adjusted by turning the small handwheel on the front of the belt housing. There are two ranges shown: 50 to 400, RPM and 450 to 3,500 RPM.

The 50 to 400 rpm speed range is obtained through the back gear drive and is referred to as the low range (LO). Both the "HI-NEUTRAL-LO" lever and the spindle start rotary pushbutton should be positioned at the "LO" position.

The 450 to 3,500 rpm speed range is obtained through direct drive and is referred to as the high range (HI). Both the "HI-NEUTRAL-LO" lever and the spindle start rotary pushbutton should be positioned at the "HI" position.

NOTE: Wear on the variable speed belt will cause a slight increase in speeds as shown on the dial. This can be corrected with the following procedure:

Using a tachometer, set the spindle speed at 3,500 rpm. Remove the speed indicating plate (pt #4J578). Using an allen wrench, loosen (do NOT remove) the right hand stop screw (pt #4J943) and move it down against the stop. Tighten screw.

To reset low speed, set the spindle speed at the low speed stop (left hand stop screw pt #4J943). Loosen (do NOT remove) this screw and adjust the low speed to 450 rpm. using a tachometer. Tighten screw and replace speed indicating dial (pt #4J-578). Re-position the dial to match the tachometer reading.

(NOTE: when the belt is sufficiently worn so that speed adjustment is no longer possible, it should be replaced.)

DRAWBAR:

In tightening or loosening the drawbar, it is necessary to lock the spindle. To lock the spindle, use the spindle brake and lock handle (located on left side of belt housing) turning it to either right or left until it binds, then raise the handle.

The drawbar has a 5/8-11 R.H. thread and should be tightened with normal amount of pressure, using wrench furnished with machine.

QUILL STOP TUBE: (pt #4J-272)

This is used to stop the quill travel when working at given depths.

QUILL STOP ADJUSTING NUTS: (pt #4J-288)

These are used for setting of depths. Each graduation on the nut indicates one thousandths of depth, read directly from the scale mounted along side of it. The depth may be obtained by setting the micrometer nut in conjunction with the quill stop tube (pt #4J-272).

SWIVELING HEAD (LEFT TO RIGHT):

Loosen four (4) nuts (pt #4J-339) on the face of the spindle housing. With a wrench, turn the hex head shaft located on the rear of the housing. Move the head to desired angle and secure the four nuts.

WARNING: The securing nuts MUST be tightened before starting the head motor. Tighten nuts to 100 in. lb. torque.

ADAPTER (4H-242) STOP PIN:

A pin is inserted in the side of the Ram Adapter (on most machines) which will prevent pivoting of the head beyond approximately 30°.

To pivot the head beyond this angle, 1st pivot the head approximately 15° to 20° . Then pull out the pin until the detent plunger holds the pin clear of the T bolts. Then pivot the head to the desired angle.

After the head is positioned push the pin back in to its stop (if possible).

SWIVELING HEAD (FRONT TO REAR):

Loosen the three (3) hex head nuts located on the ram in order to release head adapter. With wrench, turn hex head shaft (located on top in vicinity of adapter) to swivel the head to desired angle.

> **WARNING:** When the head has been swiveled to required angle, the securing screws MUST be tight before starting motor.

MANUAL QUILL FEED HANDLE:

The manual quill feed handle is located on the right hand side of the quill housing. A downward motion of the handle lowers the spindle. An upward motion of the handle raises the spindle and tool away from the work.

SERVICING INSTRUCTIONS

LUBRICATION:

Bearings, gears and quill are all pre-greased, and should not require future greasing for the life of the drive.

Bearings - pre-packed with BRB Lifetime Grease.

Back Gears - pre-packed with Sunoco #741 E.P. Grease or Mobil Lux #1 E.P.

Quill O.D. — Oil cup — Light Spindle Oil.

Quill Feed Pinion — pre-packed with BRB Lifetime Grease.

REMOVING MOTOR:

1. Run the attachment to the bottom of either speed range and shut off the motor. This puts the vari-drive belt in the proper position for disassembly.

2. Disconnect the power and remove the motor plug from the receptacle on the side of the electrical enclosure.

3. Remove motor pulley cover (pt #4J-221)

4. Use two (2) 1/4-20x1-1/2" long socket head cap screws to fasten spring retainer (pt #4J-236) on the lower end of the motor shaft to the lower vari-drive pulley (pt #4J-229). This will reduce the hazard of personal injury that is always present when a heavy spring is under compression. When the pulley, spring retainer and spring are securely fastened as a single unit, crank the speed dial to the top speed position.

5. Now, remove the screws that fasten the motor to the belt housing.

6. Remove the retaining ring (pt #4J-846) from the end of the motor shaft and position the motor so that the bottom pulley, spring, and spring retainer can be slipped off the motor shaft as a unit.

7. With the lower pulley removed, the motor can now be positioned over the top opening in the belt housing and carefully lifted out. NOTE: Motor weight is approximately 65 lbs. (30kgs).

CHANGING VARIABLE SPEED BELT:

Complete the operations for removing the motor. Then remove the top spindle cap (pt #4J-227) and the speed changer housing (pt #4J 329).

> **NOTE:** In order to remove the speed changer housing, the anchored end of the speed changer chain (pt #4J-209) has to be unfastened.

Remove the six (6) screws holding the belt housing (pt #4J-217) to its sub-plate (pt #4J-218). The belt housing is now held in place by two (2) dowel pins at the positions shown in Fig. #28. The belt housing can now be removed from its sub-plate.

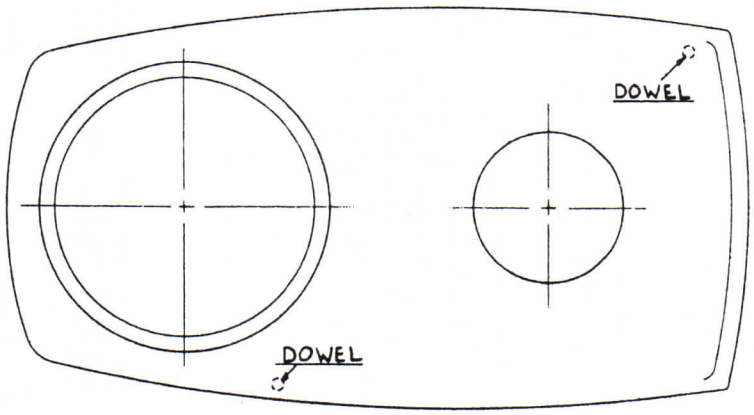


Fig. #28

Remove the old belt and replace it with a new belt. (NOTE: Do NOT use a substitute belt purchased from other than a Bridgeport dealer. Vibration and heat could result from the use of the wrong belt.)

CHANGING TIMING BELT:

Complete the operations for the removal of the motor and the variable speed belt. Then put the HI-NEUTRAL-LO lever in the "LO" position, remove the drawbar and lower the spindle.

Remove the screws holding 4J-218 and 4J-219 housings together. There are two (2) dowel pins still holding these parts together at the locations shown in Fig. #29.

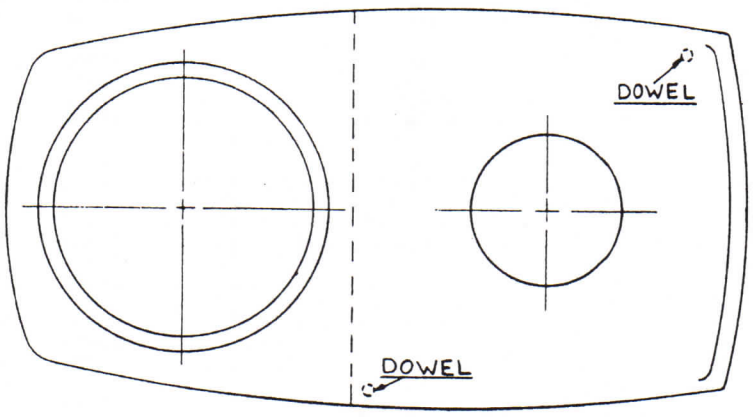


Fig. #29

The housings can now be separated by lifting the upper housing straight up off the dowels.

As the housings are being separated, the timing belt still connects them, resisting the separating movement. The separation can be assisted by gently pushing the timing belt off the large pulley (pt #4J-250) as the 4J-218 housing is being raised.

Remove the old belt and replace with a new one.

PARTS LIST - 4J VARIABLE SPEED HEAD

J-284	1/4-20 Bakelite Ball Handle
2J-519	Brake Lock Cam
2J-653	Speed Handle Nameplate
4J-202	Quill Spring Housing
4J-203	Quill Spring Hub
4J-206	Key 1/4 x 1/4 x 2
4J-209	Speed Changer Chain
4J-210	Key 3/16 x 3/16 x 1-3/8
4J-217	Belt Housing
4J-218	Belt Housing Base
4J-219	Gear Housing
4J-220	Fixed Clutch Bracket
4J-221	Motor Pulley Cover
4J-222	Quill Housing
4J-223	Countershaft
4J-224	Spindle Pulley Hub
4J-225	Quill
4J-226	Stationary Motor - Varidisc
4J-227	Belt Housing Top Brg. Cap.
4J-228	Adjustable Driven Varidisc
4J-229	Adustable Motor Varidisc
4J-230	Splined Gear Hub
4J-231	Brake Mounting Hub
4J-232	End Cap - Brg. Bull Gear Sleeve
4J-233	Pinion Gear Brg. - Gr. Adj.
4J-234	Bull Gear Pinion
4J-235	Spindle Bull Gear
4J-236	Adj. Varidisc Spring Collar
4J-237	Bull Gear Brg. Sleeve
4J-238	Stationary Driven Varidisc
4J-239	Drive Clutches
4J-241	Bearing Retainer
4J-242	Speed Change Shaft Brg. Block
4J-243	Spindle - Drawbar type
4J-244	Nose Piece
4J-245	Top Grease Res. for Spindle
4J-246	Bottom Bearing Spacers (outer)
4J-247	Bottom Bearing Spacer (inner)
4J-248	Bearing Spacer (long)
4J-249	Top Bearing Spacer
4J-250	Timing Belt Pulley
4J-253	Spring Guide Pin
4J-263	Quill Micrometer Screw
4J-264	Micrometer Screw Spacer
4J-265	Micrometer Nut
4J-267	Thrust Cap for Changer Plate
4J-272	Stop Tube for Quill
4J-279	Quill Cover
4J-283	Bull Gear Shifting Rod
4J-284	Brake Shoe
4J-285	Ret. Cap - Brake Mtg. Hub
4J-286	Clock Spring (Quill C'Balance)
4J-288	Micro Quill Stop Nut
4J-299	Chain Hold Down (Speed Changer)
4J-300	Speed Changer Gear-Drum
4J-301	Hi-Lo Detent Plate
4J-302	Brake Lock and Handle
4J-303	Hi-Lo Pinion Block
4J-304	Hi-Lo Shift Crank
4J-305	Hi-Lo Detent Plunger
4J-306	Brake Lock Shaft
4J-307	Brake Lock Shaft Sleeve
4J-308	Brake Finger Pivot Stud
4J-309	Brake Operating Finger
4J-311	Brake Shoe Pivot Sleeve
4J-312	Roller - Brake Cam - Finger
4J-317	Driver Gear
4J-318	Quill Return Spring Hub Spacer
4J-319	Return Spring Hub Driving Key
4J-322	Driving Key - Lock Bolt
4J-329	Speed Changer Housing
4J-332	Quill Housing Adj. Worm
4J-333	Quill Housing Adj. Worm Shaft
4J-334	Quill Aligning Key
4J-337	Tee Bolt Sleeve
4J-339	Quill Housing Tee Bolt Nut
4J-344	Speed Changer Shaft
4J-345	Quill Housing Tee Bolt
4J-347	Washer for 4J-345
4J-349	Quill Binder - Front
4J-350	Quill Binder - Stud
4J-351	Quill Binder Stud Handle
4J-352	Quill Binder - Rear
4J-353	Speed Control Handle
4J-354	Drive Key - (used on 4J-243)
4J-356	Speed Control Worm
4J-363	Quill Rack Pinion Shaft Washer
4J-380	Speed Changer Plate
4J-381	Speed Changer Plate Arm
4J-398	Grease Guard - Clutch Brkt.
4J-399	Top Bearing Hsg. C'Shaft
4J-476	Spring for 4J-303
4J-477	Brake Spring
4J-479	Drum Shaft
4J-530	Oil Guard - Drive Clutch Mtg.
4J-531	Gear Housing Plate
4J-532	Bottom - Pulley Flange
4J-533	Top - Pulley Flange
4J-534	Shaft - Speed Changer Arm
4J-536	Rear Assem. Bolts for Hsg.
4J-537	Spacer - Brg. - Timing Belt Pulley
4J-538	Front Assem. Bolts for Hsg.
4J-539	Bull Gear Brg. Sleeve Washer
4J-540	Key for Driven Varidisc
4J-541	Key for Driving Vardisc
4J-542	Driving Varidisc Bushing
4J-543	Driven Varidisc Bushing
4J-544	Adj. Nut - Splined Gear Hub
4J-545	Brg. Spacer - Splined Mtg. Hub
4J-563	Lock Key (Adj. Varidisc Collar)
4J-565	Spacer - Quill Pinion Gear
4J-567	Shaft - Speed Changer Arm
4J-568	Key - Motor Shaft - Varidisc
4J-569	Key - Varidisc - Spindle Hub
4J-577	Control Box Housing
4J-578	Speed Dial
4J-579	Gasket - Control Hsg. - Plate
4J-580	Plate - Speed Changer Housing
4J-582	Quill Housing Cover
4J-583	Legend Plate (with coolant)
4J-584	Micrometer Scale
4J-587	Nut (Spindle Pulley Hub)
4J-590	Drawbar Washer
4J-591	Pinion Gear Shaft (Hand Feed)
4J-592	R.H. Cover for 4J-222
4J-593	Pin - Quill Spg. Housing
4J-595	Drawbar
4J-598	Name Plate (Belt Housing)
4J-813	Key - Woodruff #6
4J-817	Key - Woodruff #808
4J-818	Key - Woodruff #304
4J-819	Bearing - Ball
4J-820	Bearing, Ball
4J-821	Bearing, Ball
4J-822	Motor - 4 HP - TEFC 4 Pole - AC
4J-823	Bearing, Ball
4J-824	Soc. Hd. Cap Scr. - #10-32NFx5/16
4J-825	Flat Hd. Mach. Scr. - #10-32NFx1/2
4J-829	Soc. Hd. Cap Scr. - #10-24NCx1/2
4J-830	Soc. Hd. Cap Scr. - #10-32NFx1/2
4J-831	Soc. Hd. Cap Scr. - 1/4-20NCx5/8
4J-833	Soc. Hd. Cap Scr. - 3/8-16NCx3
4J-834	Soc. Set Screw - 5/16-18NCx1/4
4J-835	Soc. Hd. Cap Scr. - 5/16-18NCx1
4J-836	Soc. Set Screw - 1/4-20NCx3/8
4J-837	Soc. Hd. Cap Scr. - 1/4-20NCx1/2
4J-838	Spg. Washer
4J-839	Spring (For Bullgear Quill)
4J-840	Spring - 95#a3800rpm. - 290#a 55 rpm.
4J-841	Soc. Hd. Cap Scr. - #10-32NFx5/8
4J-844	Bushing, Bronze
4J-845	Pin 1/4 dia. x 1-1/4
4J-846	Snap Ring
4J-847	Snap Ring
4J-848	Snap Ring
4J-849	Soc. Hd. Cap Scr. - 1/4-20NCx1
4J-850	Soc. Hd. Cap Scr. - 5/16-18NCx7-1/2
4J-851	Soc. Hd. Cap Scr. - 5/16-18NCx5-1/4
4J-854	Pin - 1/8 dia. x 3/4
4J-855	Soc. Hd. Cap Scr. - #10-24NCx7/8
4J-856	Soc. Hd. Cap Scr. - 1/4-20NCx1-1/8
4J-857	Soc. Hd. Cap Scr. - 1/4-20NCx3/4
4J-861	Hex Head Scr. - 3/8-16NCx7/8
4J-863	Variable Speed Belt
4J-865	Spindle Timing Belt
4J-866	Hex Jam Nut (Finished) - 1" - 14NF
4J-872	Dowel Pin - 1/4 dia. x 3/4
4J-873	Dowel Pin - 3/16 dia. x 1
4J-874	Snap Ring
4J-879	Key - Woodruff #405
4J-881	Dowel Pin - 3/16 dia. x 1/2
4J-882	Soc. Hd. Cap Scr. - #10-24NC x 3/8
4J-883	Snap Ring
4J-884	Spring Washer
4J-885	Bearing, Bronze
4J-886	Key - Woodruff #404
4J-887	Bearing, Ball
4J-888	Bearing, Ball
4J-889	Locknut
4J-890	Lockwasher
4J-892	Bearing, Bronze
4J-893	Snap Ring
4J-894	Snap Ring
4J-897	Soc. Set Scr. - Cup Pt. - 1/4-20NCx1/4
4J-898	Soc. Hd. Cap Scr. - 5/16-18NCx1
4J-905	Soc. Hd. Cap Scr. - 1/4-20NCx2-1/2
4J-906	Soc. Hd. Cap Scr. - 1/4-20NCx7/8
4J-914	Soc. Set Screw - 1/4-20NCx3/16
4J-916	Flat Hd. Mach. Scr. - #10-32NFx3/8
4J-918	Spring Washer
4J-925	Button Hd. Screw - #6-32NCx3/8
4J-926	Flat Hd. Mach. Scr. #10-32NCx3/8
4J-934	Dowel Pin - 1/8 dia. x 3/16
4J-935	Soc. Hd. Cap Scr. - #10-24NCx1/2
4J-936	Soc. Set Scr. - Half Dog - 5/16-18NCx1/4
4J-938	Bushing, Bronze
4J-939	Spirol Pin - 5/32 dia. x 1
4J-940	Thrust Bearing - Oilite - TB-814
4J-941	Spring Washer
4J-942	Washer, Plain 1/2 I.D.
4J-944	Nut - Square - 1/4-20NC
4J-945	Washer, Plain - 1/4 I.D.
4J-946	Pin - Spirol - 5/32 dia. x 1-1/4
4J-947	Soc. Set Scr. - Cup Pt. #10-24NCx1/2
4J-948	Soc. Hd. Cap Scr. - #10-24NCx5/8
4J-950	Nut - Jam - 5/16 - 18NC
4J-951	Handle
4J-952	Butt. Hd. Cap Scr. - #6-32NCx1/4
4J-953	Soc. Hd. Cap Scr. - 5/16-18NCx2-3/4
4J-954	Bearing
4J-955	Bearing
4J-956	Soc. Set Scr. - Cup Point - #6-32NFx1/4
4J-957	Soc. Set Scr. - Cup Pt. - 5/16-18NCx1/4
4J-958	Bearing, Bronze
4J-959	Butt. Hd. Cap Scr. - #8-32NCx1/4
4J-960	Nut - Hexagon Hd.-Black - 1/2-13NC
4J-961	Washer - Plain - Black - 1/2-13NC
4J-962	Soc. Hd. Cap Scr. - 5/16-18NCx1-1/4
4J-963	Soc. Hd. Cap Scr. - 5/16-18NCx3/4
4J-964	Soc. Set Scr. - Cup Pt. - 1/4-20NCx3/8
4J-965	Soc. Hd. Cap Scr. 1/4-20NCx3/8
4J-966	Ball - Steel - Spherical Type - .200 Dia.
4J-967	Soc. Hd. Cap Scr. - #10-32NFx1/2
4J-968	Dowel Pin - 5/16 dia. x 1-1/4
4J-969	O-Ring
4J-970	Nut - Allen - Hex. Soc. 3/8-24NF
4J-979	Roll Pin - 5/32 dia. x 7/8
4J-986	Pipe Plug - 1 NPT - Soc. Hd. Type

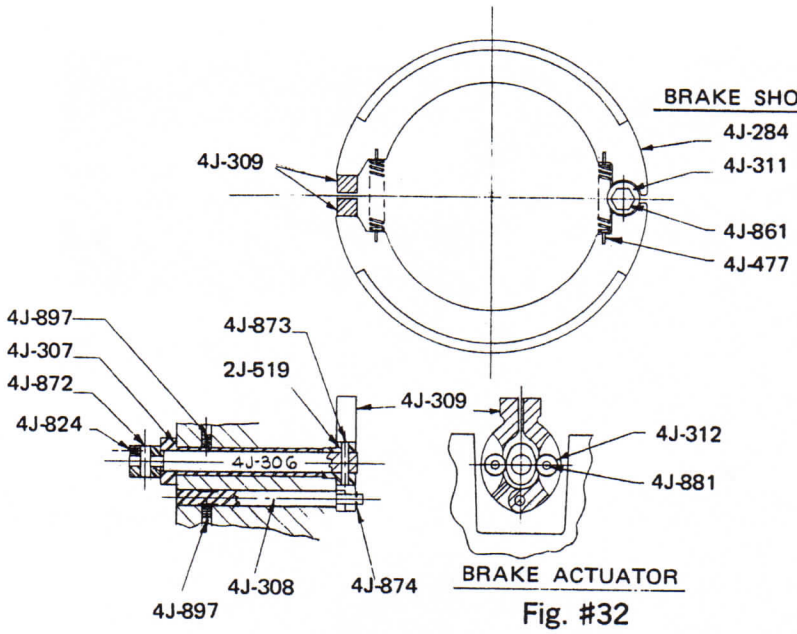


Fig. #32

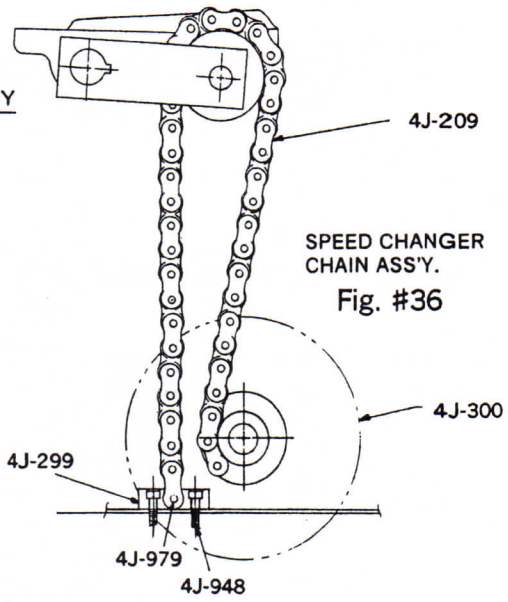


Fig. #36

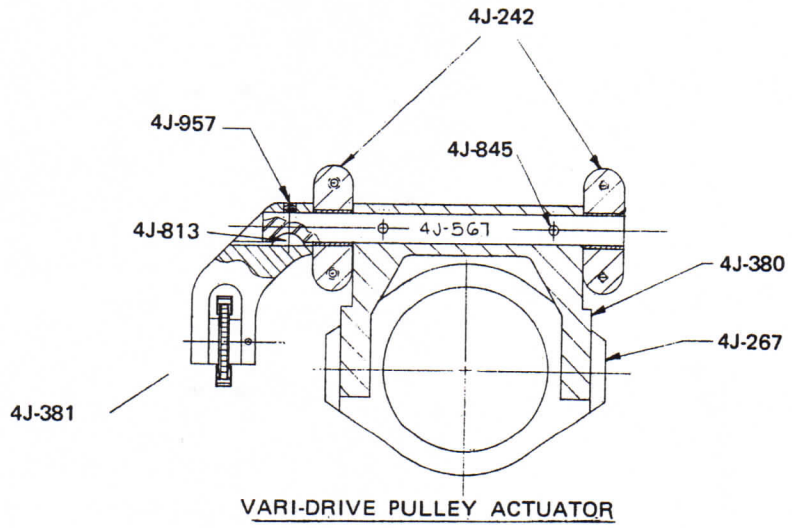


Fig. #34

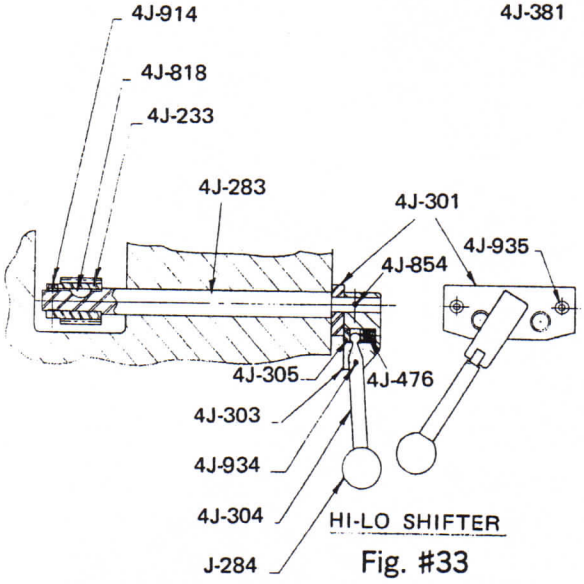


Fig. #33

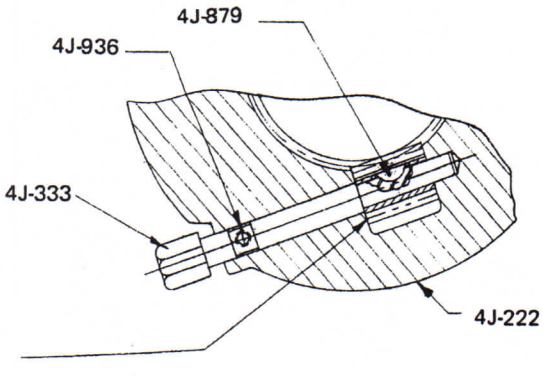


Fig. #35

FRONT VIEW — 4J VARIABLE SPEED HEAD

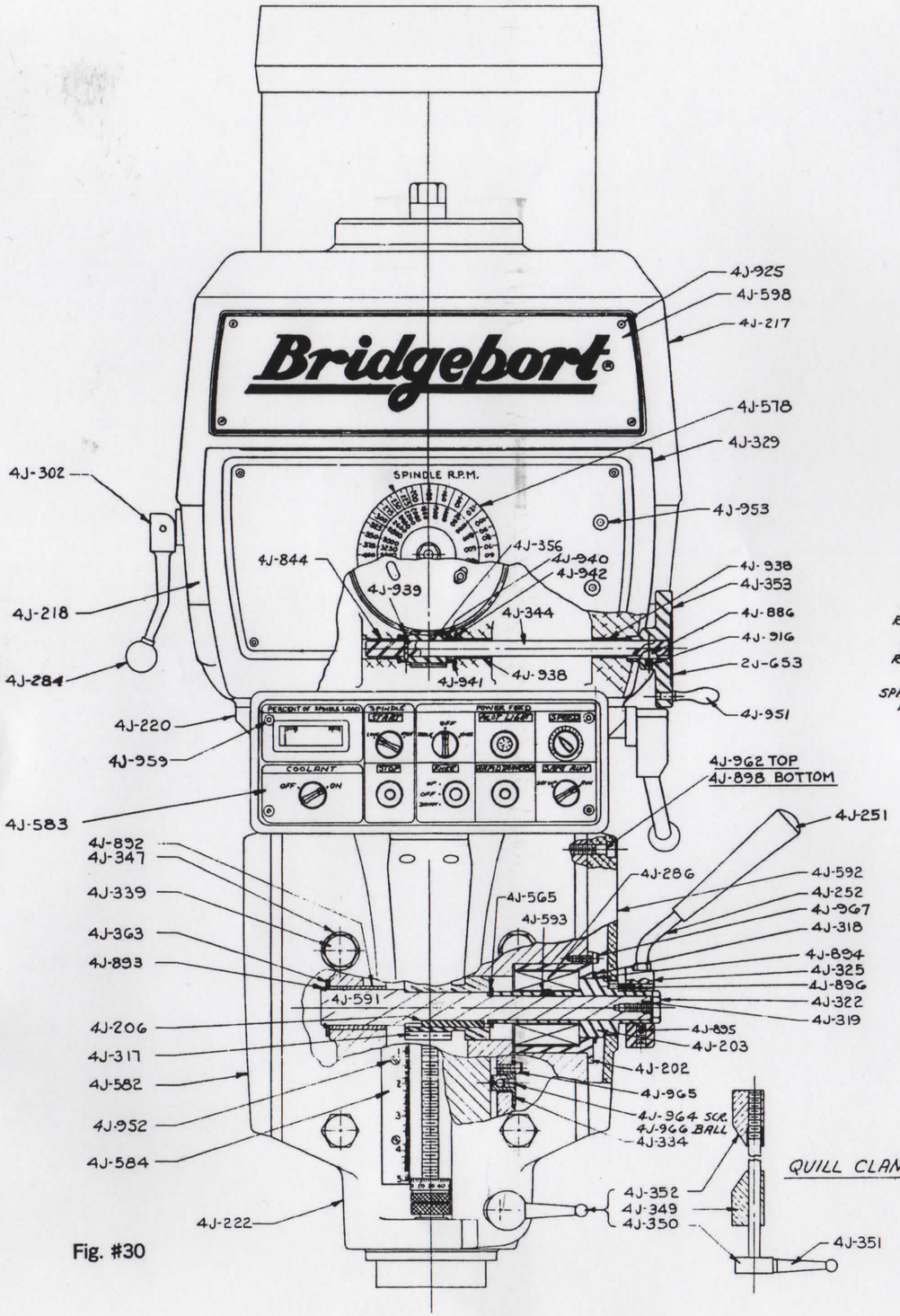


Fig. #30

SIDE VIEW — 4J VARIABLE SPEED HEAD

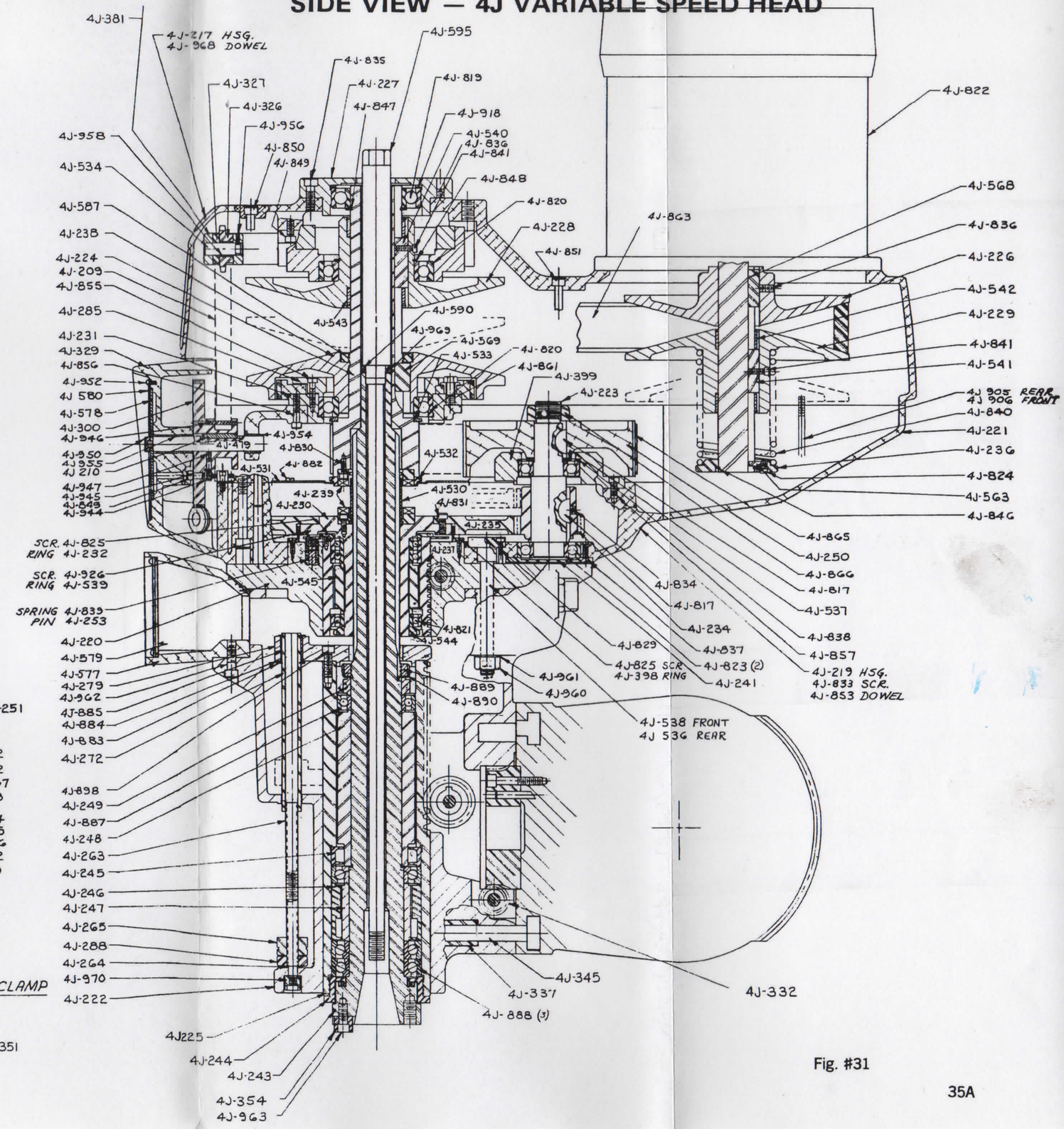
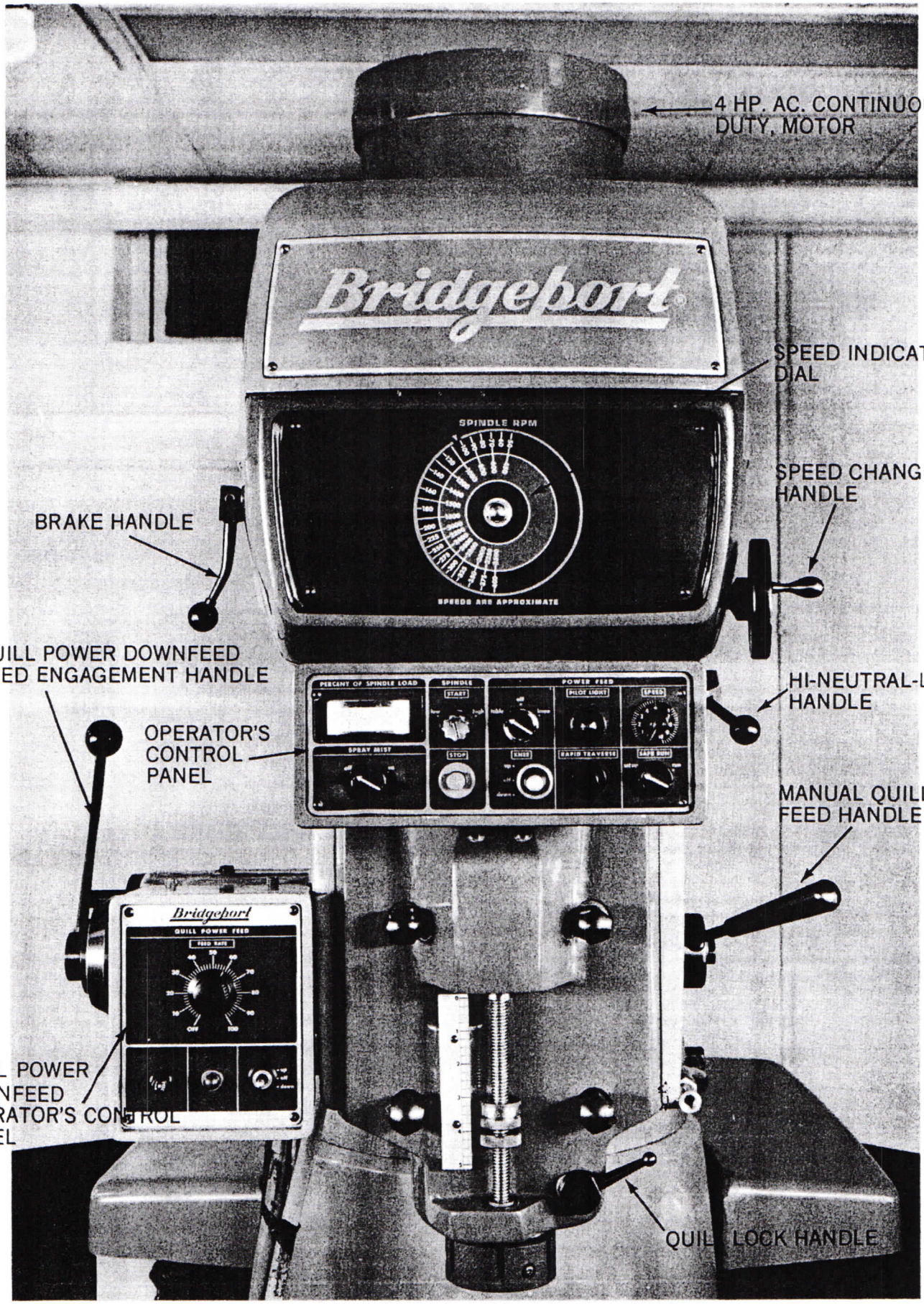


Fig. #31



4J VARIABLE SPEED HEAD

Fig. #37

POWER QUILL FEED

OPERATING INSTRUCTIONS

LOCATION:
The power quill feed housing is mounted on the left side of the quill housing (pt #4J-222).

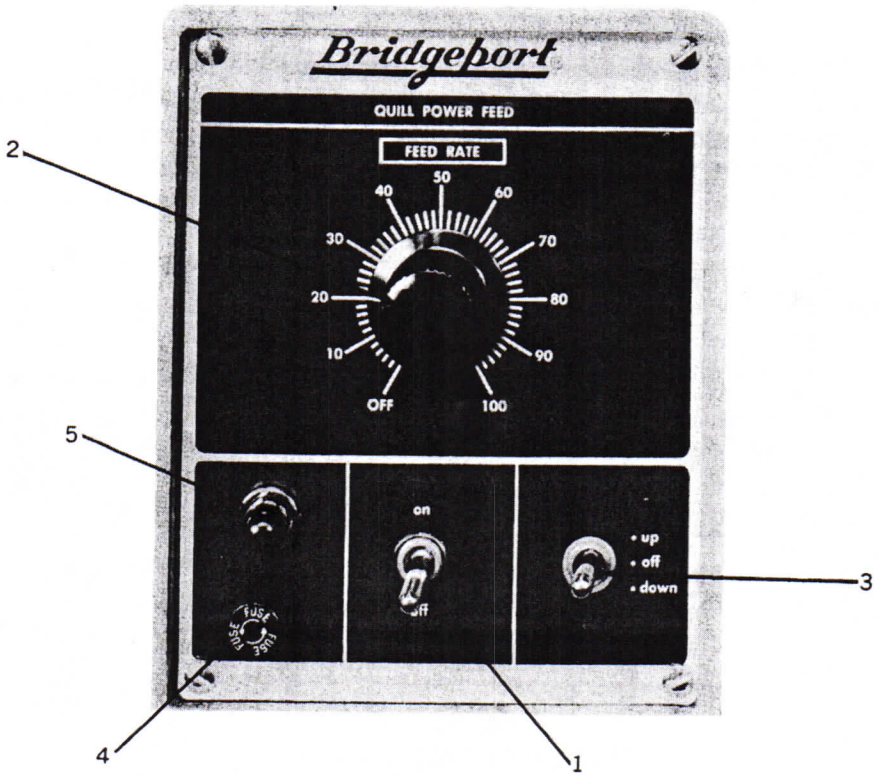
OPERATOR'S CONTROL:
The downfeed clutch (pt #4J-717) engagement handle (pt #4J-251) is mounted on a serrated shaft on the left side of the power quill feed housing.

The clutch is engaged by moving the handle (pt #4J-251) forward toward the operator, exerting light to medium pressure on the handle to insure that there is enough quill thrust (approximately 900 lbs. (408kgs) thrust available).

NOTE: When the quill feed handle on the right side of the quill housing is used, the downfeed clutch **must** be disengaged.

The SCR (electrical) controller is mounted on the front portion of the quill feed housing.

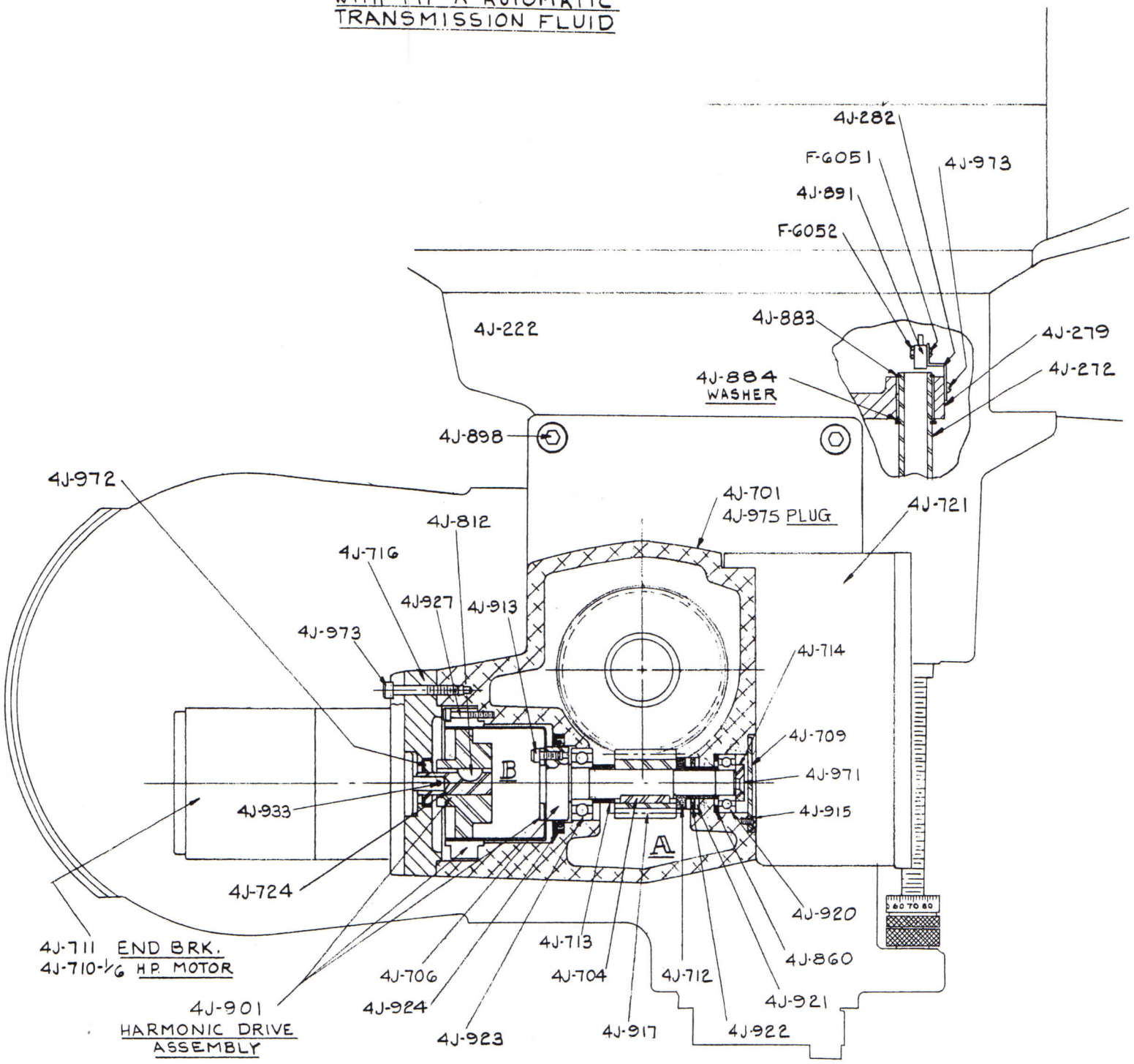
1. ON-OFF switch - controls 110v power to the unit.
2. Potentiometer - controls feed rate of quill.
3. UP-OFF-DOWN - Controls feed direction.
4. Fuse.
5. Pilot light - indicates when power is on.



POWER QUILL FEED CONTROLS
Fig. #38

LOCATION A - FILL TO OIL LEVEL WITH #90 E.P. GEAR OIL

LOCATION B - FILL TO OIL LEVEL WITH TYP "A" AUTOMATIC TRANSMISSION FLUID



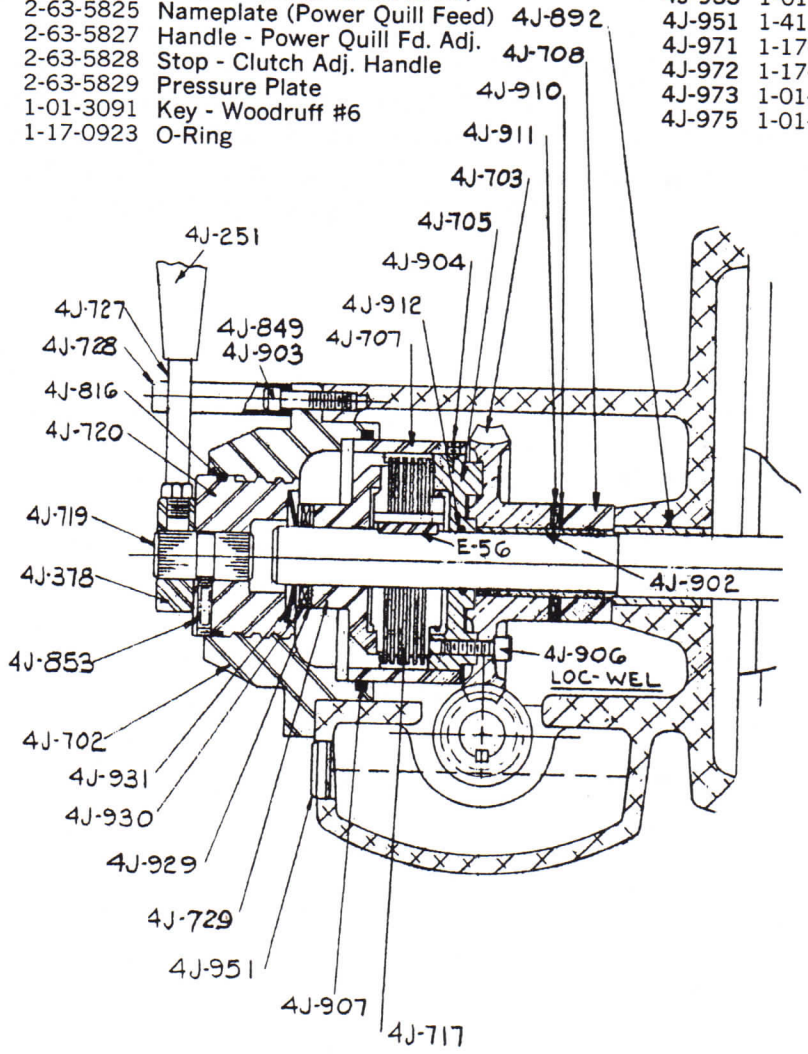
SIDE VIEW
QUILL HOUSING ASSEMBLY

Fig. #39

QUILL HOUSING ASSEMBLY

Part No.	Code No.	
E-56	2-24-0085	Key - 1/4 x 5/16 x 1-1/4
F-6051	1-01-1404	Rd. Hd. Mach. 532 - #4-40NC
F-6052	1-01-1701	Nut - Hex - #4-40NC
4J-261	2-17-0261	Washer - Adj. Collar Handle
4J-272	2-17-0272	Stop Tube for Quill
4J-279	2-17-0279	Quill Cover
4J-282	1-17-2609	Mt'g Brkt. Quill Limit Switch
4J-378	2-17-0378	Quill Clutch Feed Handle Hub
4J-701	2-63-5801	Housing
4J-702	2-63-5802	Clutch Thrust Ring
4J-703	2-63-5803	Worm Wheel
4J-705	2-63-5805	Feed Clutch Cup
4J-706	2-63-5806	Shaft
4J-707	2-63-5807	Ring
4J-708	2-63-5808	Spacer Thrust Brg. Housing
4J-709	2-63-5809	Cover
4J-710	1-63-0193	Motor
4J-711	2-63-5811	Motor End Bracket
4J-712	2-63-5812	Spacer
4J-713	2-63-5813	Spacer
4J-714	2-63-5814	Bearing Retainer
4J-716	2-63-5816	Adapter
4J-717	1-17-3735	Clutch
4J-719	2-63-5819	Adj. Collar Handle
4J-720	2-63-5820	Clutch Spring Adj. Collar
4J-721	2-17-0721	Control Box Housing
4J-722	2-63-5822	Pinion Gear Shaft
4J-724	2-63-5824	Adapter (Motor Shaft Drive)
4J-726	2-63-5825	Nameplate (Power Quill Feed)
4J-727	2-63-5827	Handle - Power Quill Fd. Adj.
4J-728	2-63-5828	Stop - Clutch Adj. Handle
4J-729	2-63-5829	Pressure Plate
4J-812	1-01-3091	Key - Woodruff #6
4J-816	1-17-0923	O-Ring

Part No.	Code No.	
4J-826	1-01-1455	Rd. Hd. Mach. Scr. - #10-32NFx3/8
4J-849	1-01-1035	Soc. Hd. Cap Scr. - 1/4-20NCx1
4J-853	1-01-1227	Soc. Set Screw - #10-32NFx3/4
4J-860	1-17-1980	Spring Washer
4J-883	1-17-0839	Snap Ring
4J-884	1-17-1979	Spring Washer
4J-891	1-01-2653	Micro-Switch
4J-892	1-17-3660	Bronze Bearing
4J-898	1-01-1053	Soc. Hd. Cap Scr. - 5/16-18NCx1
4J-901	1-63-2220	Harmonic Drive
4J-902	1-17-3667	Bushing
4J-903	1-01-1033	Soc. Hd. Cap Scr. - 1/4-20NCx3/4
4J-904	1-01-1215	Soc. Set Screw - #10-32NFx1/4
4J-906	1-01-1034	Soc. Hd. Cap Scr. Lok-well-5/16-18NCx3-1/2
4J-907	1-15-0920	O-Ring
4J-910	1-17-0335	Thrust Race
4J-911	1-17-0327	Needle Bearing
4J-912	1-17-0921	O-Ring
4J-913	1-01-1016	Soc. Hd. Cap Scr. #10-32NFx3/8
4J-915	1-01-1548	Pan Hd. Mach. Scr. - #10-32NFx3/8
4J-917	1-17-2224	Worm Gear
4J-920	1-17-0292	Bearing
4J-921	1-17-0328	Thrust Race
4J-922	1-17-0329	Needle Bearing
4J-923	1-17-0288	Bearing
4J-924	1-17-0935	O-Ring
4J-927	1-01-1008	Soc. Hd. Cap Scr. - #8-32x7/8
4J-929	1-17-0330	Thrust Race
4J-930	1-17-0331	Bearing
4J-931	1-17-2090	Spring
4J-933	1-01-0520	Dowel Pin - 1/8 dia. x 1
4J-951	1-41-3279	Oil Sight Glass
4J-971	1-17-1139	Allen Hex Soc. Flat Hd. Scr. #10-32x3/8
4J-972	1-17-3189	Oil Seal
4J-973	1-01-1411	Rd. Hd. Screw - #6-32x1/4
4J-975	1-01-0779	Pipe Plug - 1/4 NPT



FRONT VIEW
QUILL HOUSING ASSEMBLY

Fig. #40

REMOVING MOTOR:

Remove four (4) 1/4-20x1-1/2" long securing screws holding the Motor End Bracket (pt #4J-711) and the adapter (pt #4J-716) in place. Remove the motor carefully as the "wave generator" assembly of the "Harmonic Drive" is attached to the motor shaft. Remove the motor shaft free of the Harmonic Drive by removing the 1/8" (3.175mm) diameter roll pin.

REMOVING HARMONIC DRIVE (pt #4J-901):

Follow preceding procedure for "Removal of Motor". Also remove six (6) securing screws of the outer portion (pt #4J-927) and remove six (6) securing screws of the inner portion (pt #4J-913). The "Circular Spline" section of the Harmonic Drive can now be removed.

REMOVING HARMONIC DRIVE SHAFT (pt #4J-706):

Follow preceding procedures for "Removal of Motor" and "Removal of Harmonic Drive". Now remove four (4) securing pan head screws on the cover (pt #4J-709). Next remove securing screws (pt #4J-916) holding the Bearing Retainer (pt #4J-714). The worm drive shaft can now be removed.

REMOVAL OF CLUTCH AND WORM GEAR:

Follow preceding procedures for "Removal of Motors," and "Harmonic Drive" and Drive shaft. Now remove four (4) securing screws (pt #4J-903) releasing the Clutch Thrust Ring (pt #4J-702). Pull Ring out of assembiy along with Seal (pt #4J-907), Spring Washer (pt #4J-931) and Clutch Spring Adjusting Collar (pt #4J-720). Slide off bearing (pt #s4J-929 & 930) and Spacer Thrust Bearing Pressure Plate (pt #4J-729). At this point, remove Pressure Plate (pt #4J-729) and Clutch (pt #4J-717) will be free to slide off Pinion Gear Shaft (pt #4J-722). Remove key. Ring (pt #4J-707) and Feed Clutch Cup (pt #4J-705) can be removed along with the worm gear (pt #4J-703).

CUTTING FLUIDS

Cutting fluids, which are generally emulsions of soluble oil and water, are used as a means of protecting the cutters and improving the quality of the finish of the work.

There are three functions of cutting fluids:

A. COOLING

B. REDUCTION OF FRICTION

C. FLUSHING OF CHIPS

COOLING

Since a large amount of heat is generated in metal cutting, particularly in the cutting of steels, it becomes necessary to have a means of conducting away this heat as it is generated. This is essential because the heating of the tool point causes a reduction in its resistance to abrasion, hastening dullness or wear, and it also adversely affects the quality of the finish of the work, due to the forming of a large built-up edge on the cutter teeth.

Aside from these points, a sufficient supply of coolant maintains a comparatively low temperature of the work piece.

REDUCTION OF FRICTION

Due to the high friction in milling steels, aided by high temperatures which are created in milling, a built-up edge is formed on the tool. As this built-up edge increases it becomes more and more unstable until fragments of the built-up edge break off both with the chip and the work piece.

This intermittent building up and breaking down of the built-up edge occurs at an extremely rapid rate. It is this action which causes the roughness on the milled surface.

FLUSHING OF CHIPS

Cooling fluid should be supplied in ample quantity to flush away the chip from the cutter and work piece. This reduces the possibility of marring the finish surface. Chips that are allowed to remain in the path of the cutter are carried into the cut again.

SUGGESTED FEEDS FOR MILLING CUTTERS

The rate of production in milling depends directly upon the rate at which the work passes the cutter. This statement is true insofar as actual machining is concerned, exclusive of the time involved in handling, loading, etc.

The maximum feed rate which can be used satisfactorily for any job is limited to the lowest rate determined from the following requirements:

1. The feed rate must not be so high as to load machine beyond its rated horsepower.

2. The feed rate must not be so high as to produce excessive load on the teeth of cutter for any given material or depth of cut. This load is determined by the feed per tooth.

3. The feed rate must not be so high as to impair the finish desired. From the standpoint of efficiency of metal removal and freedom from chatter, the feed per tooth should be as large as possible, consistent with the power available, finish desired, and permissible feed per tooth.

CAUTION: The purpose of the Load Meter is **only** to prevent overloading of the spindle motor at full horsepower. The meter is **not** accurate below 75-80% of full horsepower. It is quite possible to overload the spindle motor when using large diameter cutters (3" and above). On the other hand, it is very seldom possible to draw 4 HP when using cutters under 2 inches in diameter, even in tough die steel.

Thickness of chip per tooth, number of teeth per cutter and cutter RPM will determine the maximum feedrate. This can usually be achieved while running below the 100% mark on the Load Meter.

Some operators have tried to increase the feedrate until the Load Meter shows 100%. This results in presenting the workpiece to the cutter at a feedrate well in excess of the maximum stock removal rate of the cutter. This severely overloads the power feed transmission and exerts excessive side thrust against the spindle. Broken cutters and machine damage can result from such poor machining practice.

The correct procedure for using the Load Meter is as follows:

1. Calculate your recommended stock removal and determine your proper feedrate accordingly.
2. During the cutting operation, refer to the Load Meter to be sure you are not over the 100% mark.

The following table lists the recommended feed per tooth for different cutters when milling various materials. These values are based on average conditions and serve only as a guide to avoid overloading the cutters. There are many other influencing factors such as rigidity of the work, fixture, cutter or arbor, the depth or width of cut, etc., any of which may limit the feed rate. In such cases the proper feed rate can be determined only by experience and GOOD JUDGEMENT.

In reference to the cutter speeds table listed on the adjacent pages bear in mind that the depth of cut is an influencing factor on speeds and feeds. Generally speaking finish cuts or light milling (approximately from .005 to .060 depth of cut) may be done from 10% to 50% faster than the roughing speeds and feeds listed previously.

The following formulas may be easily used to convert the cutting speed in feet per minute (F.P.M.) to R.P.M.

$$\text{RPM} = \frac{\text{cutting speed x } 3.82}{\text{cutter dia.}} = \text{RPM} = \frac{140 \text{ x } 3.82}{4} = 133.7 \text{ RPM} = 133 \text{ approx.}$$

EXAMPLE
Work piece is C1117 steel
Recommended cutting speed is 140 surface feet per min.
Cutter is H.S.S. 4" dia.

To determine feed in inches per minute (F.I.P.M.) for a given tooth load the following formula may be used.

F.I.P.M. = No. of teeth in cutter x R.P.M. x tooth load
$14 \times 133 \times .008 = 14.89 =$
F.I.P.M. = 15 in/min. approx.

PERMISSIBLE CHIP THICKNESS PER TOOTH FOR MILLING CUTTERS

Materials	Face Mill				Side & Slotting				End Mills				Spiral Mills				Saws				Form Mill			
	H.S.S.	COBALT	REX ALLOY	CARBIDE	H.S.S.	COBALT	REX ALLOY	CARBIDE	H.S.S.			CARBIDE	H.S.S.				H.S.S.				H.S.S.			
X-1335 C-1018 C-1045	.013			.012	.008			.011	.006			.005	.010				.003				.004			
B-1112 B-1113 E-33	.015			.015	.009			.012	.008			.006	.012				.003				.005			
C-1117 C-1137 C-1141 C-1144 (X-1335) (Stress Proof)	.011			.012	.009			.011	.005			.004	.009				.002				.004			
C-1015 4615 Carp 158 Sam #4 Hy-Ten B-3X Maxel #4	.008			.012	.005			.011	.004			.003	.006				.002				.003			
Brg. Bronze Yellow Brass	.022	.030	.040	.040	.013	.022	.030	.035	.011			.008	.017				.004				.007			
Alum	.022	.030	.040	.040	.013	.022	.030	.035	.011			.008	.017				.004				.007			
C.I.	.018	.022	.027	.020	.014	.020	.025	.018	.004			.007					.003				.005			

CUTTER MATERIAL

MATL.	MACHINABILITY RATING	H.S.S.	COBALT H.S.S.	TANTUNG OR REXALLOY	CARBIDE
C-1018	78	115-125	140-150		285-300
C-1045	57	85- 95	105-115		220-235
B-1112	100	150-160	185-195		370-390
B-1113	136	200-215	250-265		500-530
E-33	160	240-255	300-320		600-650
C-1117	91	135-145	165-175		335-355
C-1137	72	110-115	130-140		265-280
C-1141	70	105-110	125-135		255-270
C-1144	76	115-125	140-150		280-295
X-1335	72	110-115	130-140		265-280
(Stress Proof) X-1335	90	133-142	162-170		330-350
C-1015 Tube	55	82- 88	100-110		200-215
4615	66	100-110	120-130		240-255
Carp 158	51	75- 85	95-105		190-205
Sam 4	66	100-110	120-130		240-255
Hy Ten B 3X	60	90-100	110-120		220-235
Maxel #4	60	90-100	110-120		220-235
Yellow Brass		350-450	425-525	625-750	800-900
Alum.		750-800	1000-1100	1150-1275	1600-1700
Brg. Brz.		325-400	400-500	500-600	700-800
C. I.		90- 98	98-112	112-125	325-375

GENERAL SPEED RECOMMENDATIONS

Material to be Cut	Feet Per Minute		
	Rough Cut	Rough and Finish	Light and Finish Cut
Cast Iron-Soft-(Under 200 Brinnell)	70	80-90	120
Cast Iron-Med.-(200-300 Brinnell)	55	60-70	90
Cast Iron-Hard-(Over 200 Brinnell)	40	50-60	70
Steel (Chrome Nickel 40-45 Shore)	30	40	50
Steel (Stainless)	60	80	90
Steel (Low Carbon)	80	90	140
Steel (High Carbon)	40	50	70
Bronze (Medium)	90	120	150
Bronze (Hard)	65	90	130
Brass (Hard)	100	150	200
Copper	150	200	300
Duraluminum	400	----	600
Aluminum	600	----	1000

TABLE OF CUTTING SPEEDS AND FEEDS

Feet Per Minute	15	20	25	30	40	50	60	70	80	90	100
Diameter, Inches	Revolutions Per Minute										
1/16"	917	1222	1528	1833	2445	3056	3667	4278	4889	5500	6112
1/8"	458	611	764	917	1222	1528	1833	2139	2445	2750	3056
3/16"	306	407	509	611	815	1019	1222	1426	1630	1833	2037
1/4"	229	306	382	458	611	764	917	1070	1375	1375	1528
5/16"	183	244	306	367	489	611	733	856	978	1100	1222
3/8"	153	204	255	306	407	509	611	713	815	917	1019
7/16"	131	175	218	262	349	437	524	611	698	786	873
1/2"	115	153	191	229	306	382	458	535	611	688	764
5/8"	91	122	153	183	244	306	367	428	489	550	611
3/4"	76	102	127	153	204	255	306	357	407	458	509
7/8"	65	87	109	131	175	218	262	306	349	393	437
1"	57	76	95	115	153	191	229	267	306	344	382
1 1/8"	50	67	84	102	136	170	204	238	272	306	340
1 1/4"	45	61	76	91	122	153	183	214	244	275	306
1 3/8"	41	55	69	83	111	139	167	194	222	250	278
1 1/2"	38	50	63	76	102	127	153	178	204	229	255
1 5/8"	35	47	58	70	94	118	141	165	188	212	235
1 3/4"	32	43	54	65	87	109	131	153	175	196	218
1 7/8"	30	40	50	61	81	102	122	143	163	183	204
2"	28	38	47	57	76	95	115	134	153	172	191