

Operation and Maintenance
(Including Repair Parts)
of the
No. 5 Surface Grinding Machine
Hydraulic Type



BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

FOREWORD

The No. 5 Surface Grinding Machine is of sturdy design and accurate construction, and when properly cared for and operated to best advantage, will give many years of efficient, economical service.

Part I — Operation and Maintenance

The first part of this book explains those points which effective use requires be known about the construction, operation and maintenance of this machine. In order that the machine may be operated to full advantage, and to assure the avoidance of possible trouble resulting from misuse or maladjustment, the operator, foreman and maintenance man should become familiar with the facts and procedures outlined therein.

Part II — Repair Parts

Replacement parts are illustrated and listed in the second part. In the interest of clearness, and to facilitate reassembly, all parts are shown as far as possible in the order in which they are assembled in the machine.

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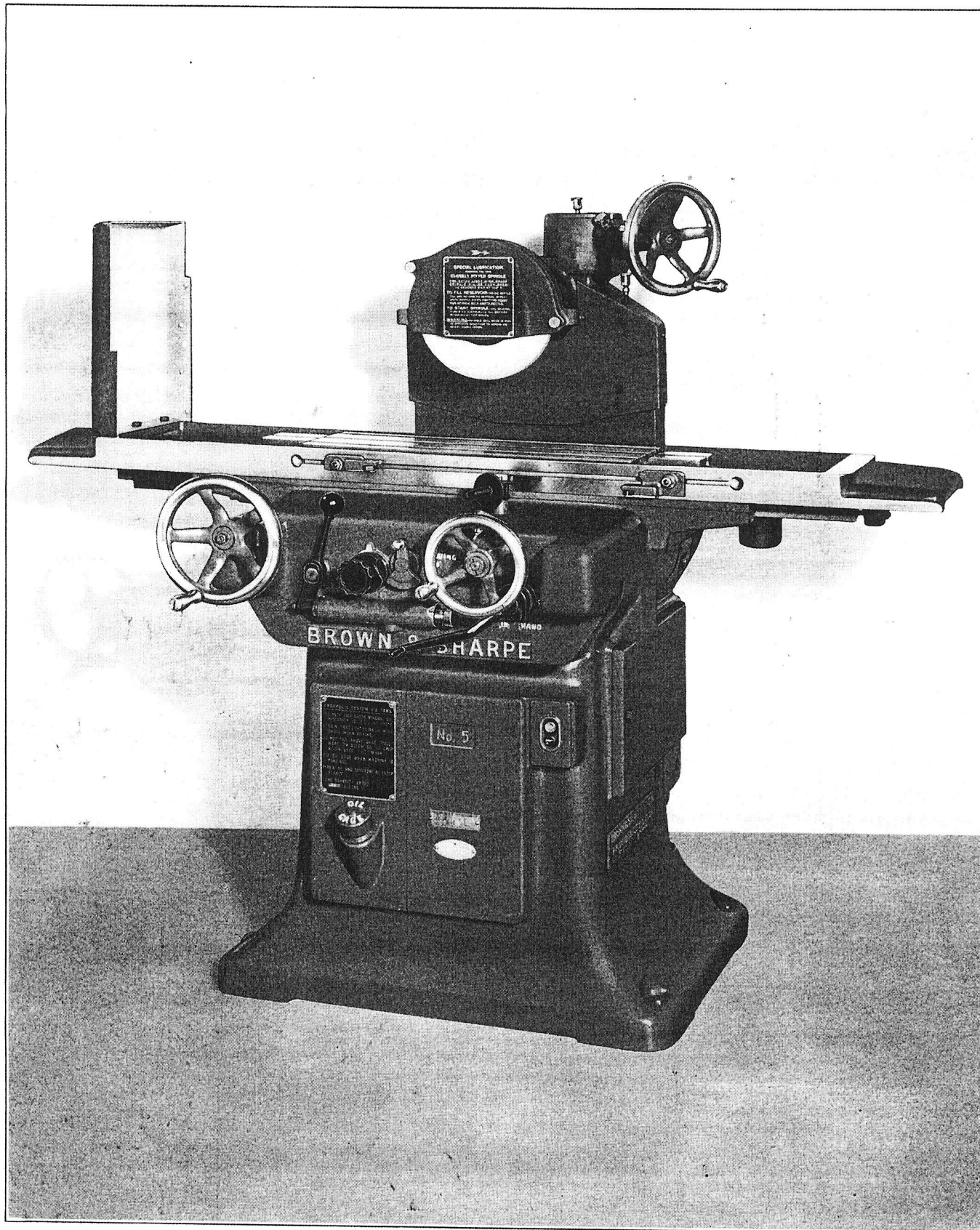


Fig. 1. The No. 5 Surface Grinding Machine (Hydraulic Type).

CHAPTER I

General Description

The No. 5 Surface Grinding Machine

Hydraulic Type

The No. 5 Surface Grinding Machine is a completely self-contained, electrically-powered, hydraulic-type machine, with horizontal wheel spindle and reciprocating table. It is designed for the efficient production of accurate flat surfaces, where precision, fine finish, and rapid removal of stock are of equal importance.

The several Attachments available considerably broaden the machine's field of usefulness, affording a means of efficiently handling practically every type of surface grinding job which ordinarily confronts the grinding room or the toolroom. These stock Attachments (which are described on pages 9 to 11 of this book) include the following:

- 4 $\frac{3}{4}$ Inch Index Centers
- Adjustable Swivel Vise
- Wet Grinding Attachment
- Exhaust Attachment
- Castered Base (for use with Wet Grinding and Exhaust Attachments)
- Magnetic Chucks (Permanent Magnet Type and Electromagnetic Type)
- Magnetic Chuck Generator (for use with Electromagnetic Type Chucks)
- Radius and Angle Wheel Truing Attachment

The hydraulic drive of both cross feed and table longitudinal movements is powerful, rapid and smooth, and provides a wide range of rates, infinitely variable. Any desired rate of longitudinal table travel is available up to 60 feet per minute; and reverse may be controlled either automatically or manually. Hydraulic cross feed of any desired amount up to .25" is automatic at each reversal of the table. For wheel truing, a steady cross feed of 12" per minute is available.

In addition to its hydraulic movements, the machine is also arranged for complete manual operation; and the change from one type of operation to the other is accomplished very easily through the controls at the front of the machine.

The oil reservoir, direct-connected motor-driven pump, automatic pressure control unit and filters are accessibly located in the base of the machine. All longitudinal and cross feed control mechanisms, hydraulic and mechanical, are com-

pactly built into the carriage, which provides a firm support for the table and is in turn supported by the two V-ways of the sturdy base. The accurate table and carriage ways, and all mechanisms within the carriage, are automatically lubricated by the hydraulic system.

The removable-unit type spindle is carried in a wide, rigid vertical slide, and is driven through a pair of endless V-belts direct from a motor mounted at the lower end of the slide. A graduated hand-wheel provides for vertical adjustment of .00025" per graduation. The front end of the spindle is tapered to receive grinding wheel sleeves.

These and other design features are explained in detail hereinafter.

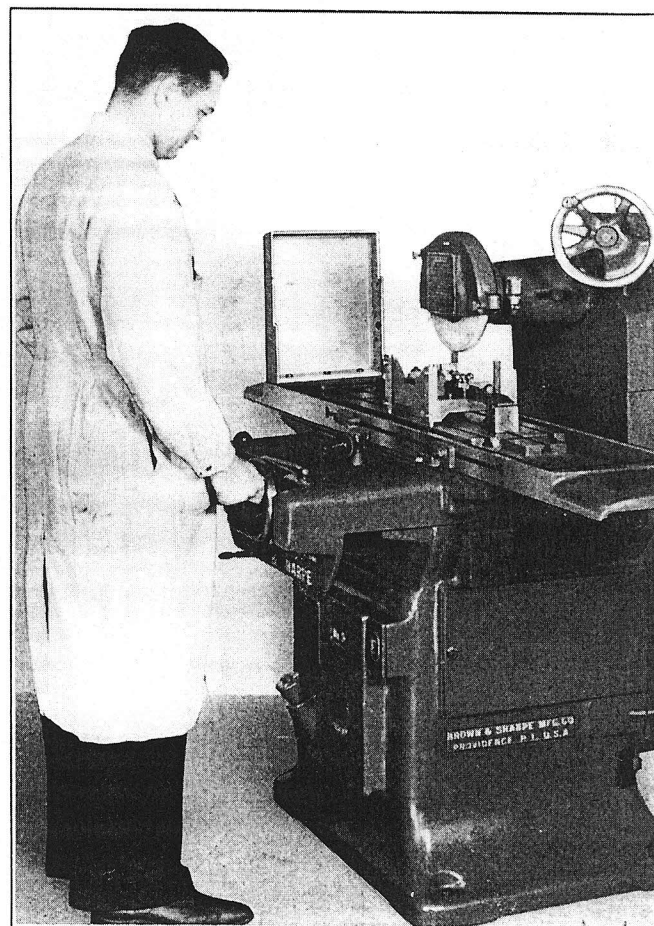


Fig. 2. Machine in Operation.

CHAPTER II

Preparing Newly-Delivered Machine for Use

Handling and Leveling. In lifting or moving the machine, always make sure that the hoisting rope does not bear against the carriage so as to lift it off its ways. It is recommended that the rope be rigged as shown in Figs. 3 and 4, using blocking as illustrated to hold the rope away from the bottom of the projecting sides of the carriage.

Given a firm and level floor, this machine can be located wherever most convenient, no special foundation being necessary. It is well, however, not to set the machine too near a source of heavy vibration; and a rigid floor is essential to good work.

When the machine has been positioned on the floor, the lag screws should be screwed down until nearly tight. Drive an ordinary wooden shingle under any corner (or corners) of the machine that may be low, until a spirit level placed on the top of the table shows the table to be level both longitudinally and transversely; then bring the screws up solidly. It is well, after tightening, to test the table surface once more, as the tightening may throw the machine slightly out of level.

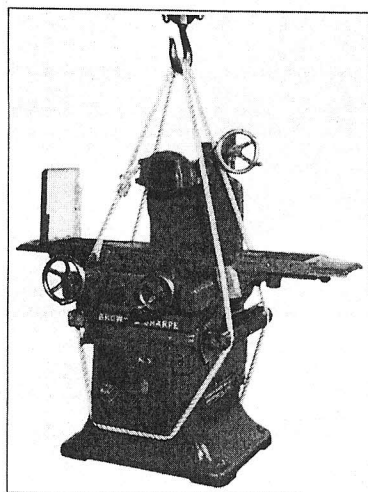


Fig. 3. Proper Method of Rigging Machine with Rope Sling.

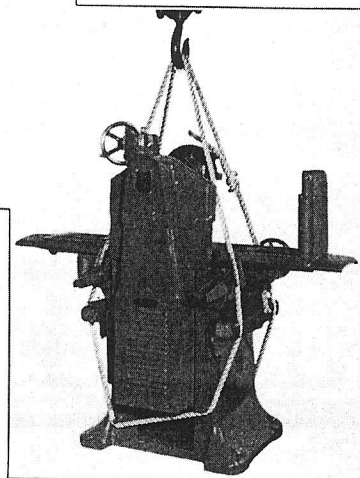


Fig. 4. Rear View of Machine in Rope Sling.

Lubricating New Machine. Before attempting to operate a new machine or one that has been idle for some time, it is essential to fill the reservoir of the hydraulic system, and to lubricate the spindle, the vertical adjustment mechanism and the ways of the vertical slide.

The oil reservoir for the hydraulic system should be filled, through the filler spout at the front of the base, until the level reaches the FULL mark on the bayonet gage attached to the cap of the spout. This will require about $8\frac{1}{2}$ gallons of oil. Use a clean, good quality, high lubricity, table way lubricant, suitable for hydraulic systems (de-waxed and sludge-free) having a viscosity of 150 S.S.U. at 100°F (Gargoyle Vacuoline No. 1405 made by Socony-Vacuum Oil Co., Inc. or an equivalent hydraulic oil).

In filling the spindle oil reservoir (cast in the spindle housing), use an extra light, high quality spindle oil having a viscosity of 30 to 36 sec. S.U.V. at 100°F . It is extremely important that no other lubricant be used in this spindle. In order not to flood the spindle, proceed in this way: Fill the bottle part of the oiler, tip it up into working position, and repeat the process until it ceases to empty.

The oilers for the spindle slide ways, elevating screw and elevating handwheel shaft (see Fig. 5, page 7) should be filled with a good grade of machine oil.

Connecting to Power Line. The machine should be connected to the power supply through either a fused disconnect switch or a fuse block. A connection should also be made to some suitable ground nearby, so that the machine will be grounded for safety at all times.

Starting. In starting the hydraulic movements for the first time, let the carriage make two complete passes (out, then in) at truing feed. Then let the table make two complete passes with the throttle control (4, Fig. 5) set for a slow rate of speed. This will clear the air out of the system and assure normal operation thereafter.

When starting a plain-bearing spindle for the first time or after a few days' idleness, press the Start button and almost immediately push the Stop button. Do this three or four times so that the bearings will be adequately lubricated before running the spindle at operating speed.

The antifriction-bearing spindle (when properly oiled) can be started immediately at any time.

CHAPTER III

Set-up Adjustments and Operating Controls

Starting and Stopping the Machine. The entire machine is started and stopped by switch 8, Fig. 5, which governs the operation of the wheel spindle

and oil pump motors. When the machine is equipped with motor-driven Attachments, the Attachment motors may be connected with the machine so as to be controlled by this main switch. All hydraulic movements are started and stopped by the lever 2, which operates the start-stop master valve. To start the hydraulic movements, pull out lever 2; to stop them, push it in.

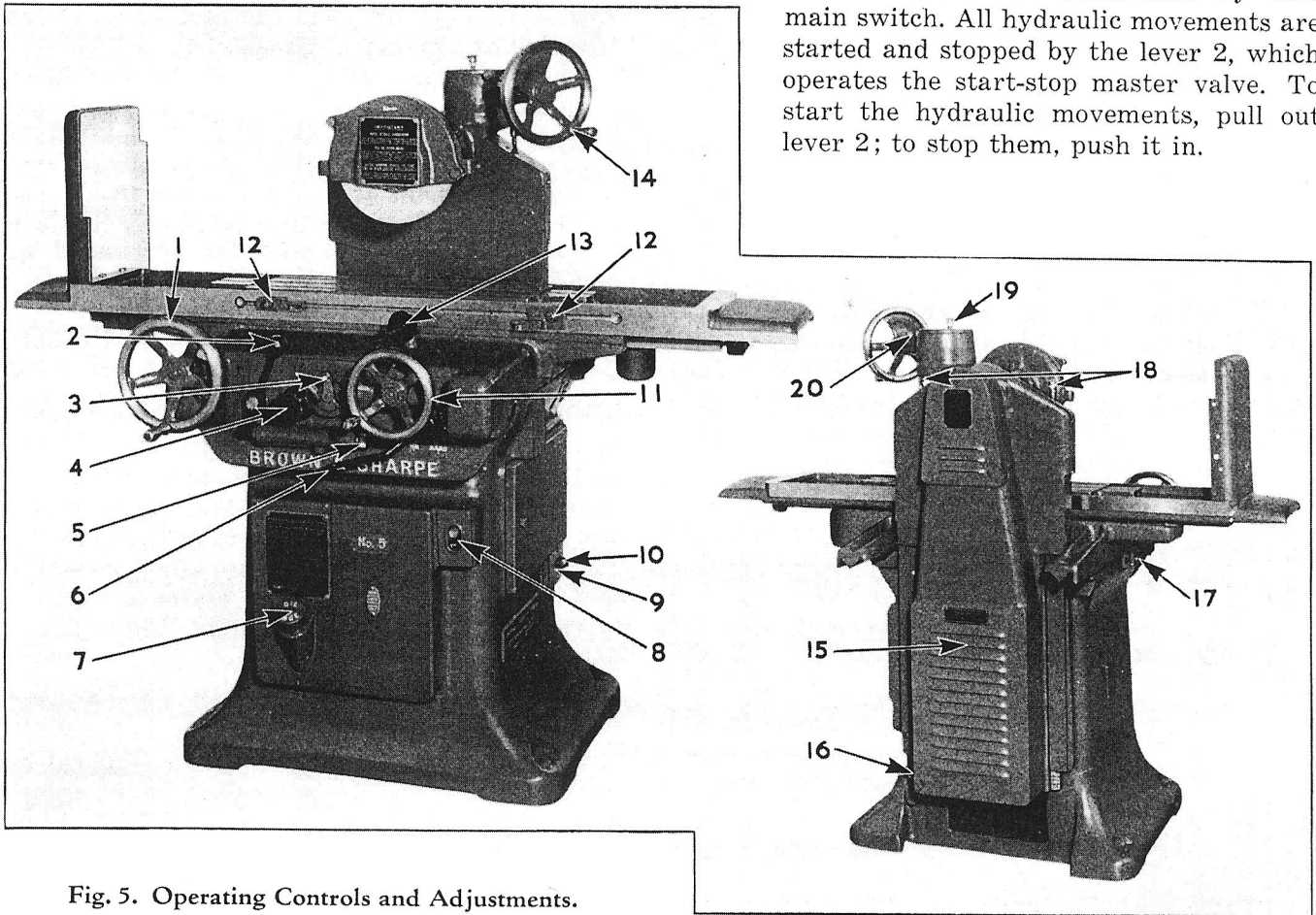


Fig. 5. Operating Controls and Adjustments.

- | | |
|---|--|
| 1. Table longitudinal handwheel. | 11. Cross feed handwheel. |
| 2. Main control valve lever; starts and stops all hydraulic movements. | 12. Adjustable table reversing dogs. |
| 3. Truing control; gives continuous cross feed of about 12" per minute. | 13. Table reversing lever; operated manually or by dogs. |
| 4. Throttle; selects rate of power table travel. | 14. Vertical adjustment handwheel. |
| 5. Graduated screw selects amount of automatic cross feed. | 15. Wheel motor mounted beneath removable guard. |
| 6. Cross feed selective lever; selects direction of hydraulic cross feed, or hand cross feed. | 16. Wheel slide taper gib adjustment. |
| 7. Oil gage and filler spout for hydraulic reservoir. | 17. Adjustable dogs disengage power cross feed. |
| 8. Main start-stop switch. | 18. Oilers for wheel slide ways. |
| 9. Provision for plug-in socket for Wet Grinding Attachment. | 19. Oiler for vertical adjustment screw. |
| 10. Inlet for power wires. | 20. Oilers for vertical adjustment handwheel shaft. |

A close-up view of the table and carriage controls is given in Fig. 26 (page 26).

When using manual controls it is important that the hydraulic pump be kept in operation as it supplies lubricant to the table and carriage ways.

In starting the hydraulic movements after the machine has been stopped for some time, the first stroke of the table should be taken with throttle 4 set for a slow rate of travel, to clear the system of any air that may have accumulated.

Vertical Adjustment of Spindle. The wheel spindle slide is moved up and down by the handwheel 14, Fig. 5, which has a graduated rim. Each graduation represents a vertical movement of .00025". One revolution of the handwheel raises the grinding wheel .050".

Transverse Adjustment. Since the wheel spindle has a vertical adjustment only, transverse adjustment is obtained by moving the carriage (on which the table is mounted), by means of handwheel 11, Fig. 5. To engage this movement, put selective lever 6 in its central position (marked HAND on the front plate casting). The handwheel is graduated to .001" to permit accurate setting, and is automatically disengaged when lever 6 is positioned for hydraulic cross feed.

Cross Feed. Manual cross feed is provided by handwheel 11, as just described.

Automatic hydraulic cross feed operates in either direction, in any amount up to .25" at each reversal of the table. The amount of feed is controlled by the screw 5, Fig. 5, which is graduated to indicate the setting. The direction of feed (in or out is governed by lever 6.

For wheel truing, a steady transverse power movement of about 12" per minute is obtained by turning truing control 3 to the right. A mechanical interlock with the throttle knob 4 prevents the simultaneous engagement of truing feed and longitudinal table movement; for the throttle must be set at *off* position before the truing cross feed can be engaged, and as long as it is engaged, the throttle cannot be opened.

Adjustable dogs 17 (Fig. 5), on the left side of the base of the machine, can be set to throw out the automatic cross feed at any point in either direction of feed. Longitudinal table travel also is stopped simultaneously.

Longitudinal Table Travel. Manual longitudinal table movement is provided by handwheel 1, Fig. 5 a pinion on the other end of its shaft engaging the rack on the under side of the table. One revolution of the handwheel moves the table approximately 21½". Whenever hydraulic power is in use, the handwheel pinion and rack are automatically disengaged by a tie-in with the hydraulic system. A spring mechanism automatically re-engages the handwheel pinion and rack when hydraulic power is turned off.

Hydraulic longitudinal table movement is controlled by graduated throttle 4 and table reversing lever 13, Fig. 5. Any desired rate of movement is obtainable, from zero (with throttle turned all the way to the right) to 60 feet per minute.

The latches on the adjustable table dogs 12, which operate against reversing lever 13 for automatic table reverse, can be turned back to permit movement of the table beyond the reversing point without disturbing the settings of the dogs. When this is done, use of the lower rates of table movement is recommended to avoid possibility of damaging cylinder head and piston.

Reversing lever 13 turns very easily, and its convenient location allows the operator to save time by reversing the table by hand on narrow work or pieces of irregular shape.

Oil Level. When the machine is in operation, the oil level in the reservoir in the base should be between the two marks on bayonet type oil gage 7, Fig. 5 (marked FULL and LOW).

Oil should always be visible in the constant-level oiler on the right side of the spindle unit (shown in Fig. 18, page 16).

CHAPTER IV

Equipment and Attachments

Wheel Truing Fixture

The Wheel Truing Fixture, with diamond tool holder, illustrated in Fig. 6, is furnished with the machine as part of the regular equipment, to provide a ready means of truing grinding wheels. The fixture is clamped in position on the table by a T-bolt, which is tightened by the handle.

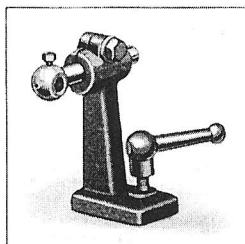


Fig. 6.

The diamond tool can be furnished at extra cost.

Wheel Sleeve Puller

The Wheel Sleeve Puller (Fig. 7) furnished with the machine, enables wheels to be removed from the spindle without the hammering which would otherwise be required by a tight-fitting wheel sleeve.

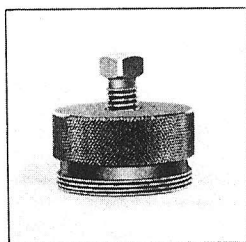


Fig. 7.

By threading the outer member into the wheel sleeve and tightening the inner screw against the end of the spindle, wheels can be removed without any

harmful jarring of the spindle.

The Wheel Sleeve Puller is also used, in a similar manner, with the spindle sheave when it becomes necessary to remove it from the spindle.

4 3/4 Inch Index Centers (Furnished at Extra Cost)

These Index Centers are convenient for grinding taps, reamers, formed cutters and similar work calling for exact spacing of the more common numbers of divisions upon the periphery of the work.

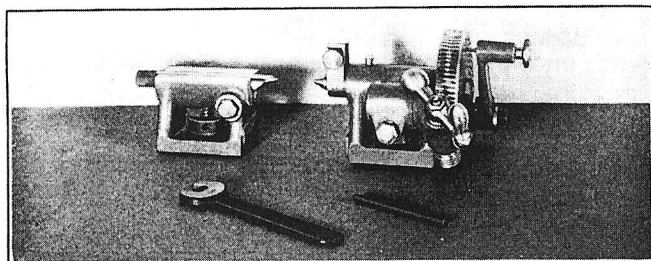


Fig. 8. 4 3/4 Inch Index Centers.

The index plate provides for indexing all divisions from 2 to 14 and all even numbers from 18 to 28. The wormwheel can be turned by the worm, or the worm can be disengaged and the wheel turned by hand. The ratio of worm to wormwheel is 75 to 1.

Used alone, the centers swing 4 3/4" diameter. Raising blocks can be used to increase the swing to 8 1/4" if desired. The combined base length with centers together is 8 1/2".

Adjustable Swivel Vise (Furnished at Extra Cost)

This vise (Fig. 9) can be set at any angle to the T-slots of the table and held in position by the

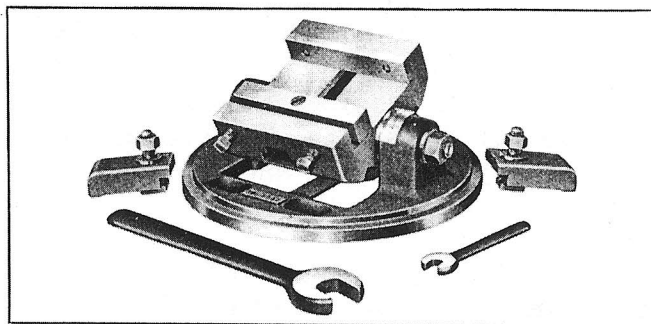


Fig. 9. Adjustable Swivel Vise.

clamps illustrated. It is pivoted so that it can be tilted to any angle to 45° either side of horizontal, a graduated arc indicating the setting in degrees. The jaws are of hardened tool steel, 5" wide and 1" deep, and open 2 3/4". The height of the vise (from bottom of base to top of jaws) is 4".

Wet Grinding Attachment (Furnished at Extra Cost)

This durably-built Attachment (Fig. 10), when mounted in place, requires no more floor space than is ordinarily needed for the grinding machine alone.

Water is supplied to the wheel through flexible piping and a nozzle attached to the wheel guard, from a motor-driven (1/4 H.P.) centrifugal pump immersed in the supply tank. An adjustable splash guard fitted to the left side of the wheel guard assists in confining the water within the limits of the Attachment.

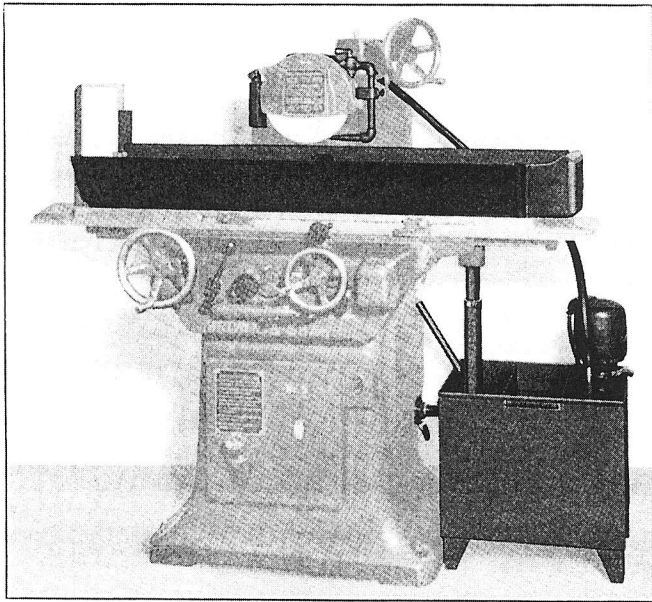


Fig. 10. Wet Grinding Attachment.

The table splash guards consist of an end guard, a one-piece front guard and a two-piece overlapping adjustable rear guard. Coolant is collected in the table channels and flows to a trough in the carriage, which, in turn, discharges into the tank through piping and a flexible hose. The floor-type tank, of 18 gallons capacity, is of welded steel construction, and has a two-plate removable baffle unit for efficient settling.

The motor has an overload relay and is connected to power through the plug and socket at the side of the machine, as illustrated. The wiring is such that the Attachment runs only when the grinding machine motors are running.

This Attachment is furnished with guards suitable for use when grinding surfaces up to 6" above the top of the table.

Exhaust Attachment

(Furnished at Extra Cost)

This motor-driven Attachment removes dust and grit from the grinding operation by suction and deposits it in a separator tank, leaving the air well cleaned.

An exhaust nozzle attached to the wheel guard is connected by means of a flexible pipe to an exhauster fan mounted on the separator tank, as shown in Fig. 11. The exhauster discharges into the separator compartment, where the air and dust are driven through the spiral centrifugal separa-

tor. The foreign matter is thrown into the dust compartment by centrifugal force, while the cleaned air passes into the expansion compartment and finally is discharged through two renewable, viscous-coated filter pads.

The exhauster fan is driven by a $\frac{1}{4}$ H.P. flange-type motor controlled by a starting switch having overload protection, and is designed to be connected direct to the power line. However, if the grinding machine is fitted with the socket and internal wiring used with the Wet Grinding Attachment, equipping the Exhaust Attachment with a plug and cable will allow this Attachment also to be plugged in so as to be started and stopped with the grinding machine motors.

The capacity of the exhauster is 312 cu. ft. per minute, giving a velocity of approximately 4700 ft. per minute through the $3\frac{1}{2}$ " diameter suction hose. The suction hose is made of a wire helix embedded in rubber, and has a fabric covering.

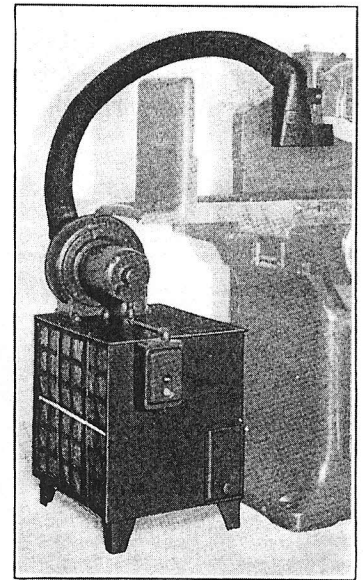


Fig. 11. Exhaust Attachment.

Castered Base — For Use with Wet Grinding and Exhaust Attachments *(Furnished at Extra Cost)*

This movable base or dolly is designed as a mounting for either the coolant tank of the Wet Grinding Attachment or the separator tank of the Exhaust Attachment, and equips them to be moved

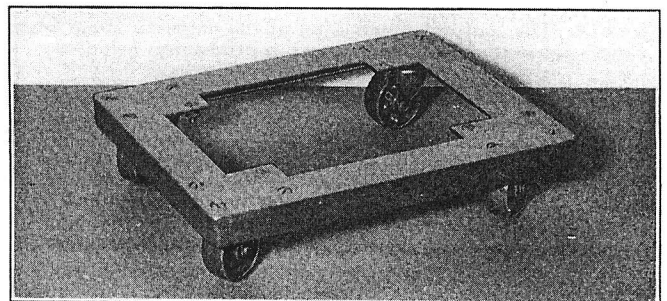


Fig. 12. Castered Base.

with ease from one machine to another or to a convenient place for emptying and cleaning. Sturdily constructed of heavy steel, it fits into the corners formed by the feet of the tank, giving the tank a steady support about $\frac{1}{4}$ " off the floor. Four 3" ball bearing swiveled casters provide ease of movement.

Magnetic Chucks

(Furnished at Extra Cost)

Permanent Magnet Type* chucks Nos. 510, 618 and 824 provide a quick, easy means of holding a variety of ferrous work for surface grinding. Brown & Sharpe Magnetic Chucks of the Permanent Magnet Type are for sale only in the United States of America, its Territories and Canada.

Electromagnetic Type* chucks and their controlling equipment are also available.

*Detailed information on application.

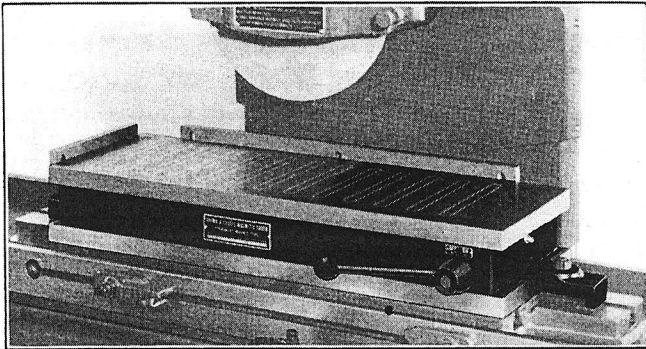


Fig. 13. No. 618 Magnetic Chuck (Permanent Magnet Type).

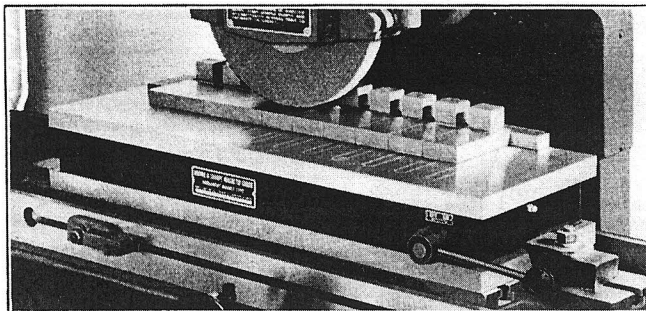


Fig. 14. The uniform distribution of the magnetic force adapts chucks for holding groups of parts in production grinding.

Magnetic Chuck Generator

(Furnished at Extra Cost)

The Magnetic Chuck Generator furnishes current for an electromagnetic chuck when direct current is not otherwise available. The generator is driven from the spindle motor through a V-belt. Adjustment of belt tension is provided.

Included with the generator are two pulleys and V-belt, and a welded steel guard louvered for ven-

tilation which fully encloses all moving parts.

Radius and Angle Wheel Truing Attachment

(Furnished at Extra Cost)

This Attachment (Fig. 15) is designed to provide an accurate and efficient means of shaping abrasive wheels used on the No. 5 Surface Grinding Machine. It is particularly useful when grinding such work as lamination dies, flat forming tools and other pieces requiring wheels having radial or angular faces. By its use, outlines having convex or concave radii varying from 0 to 1", and face angles up to 90° either side of zero, can be formed; and numerous combinations of radial and angular shapes otherwise difficult to obtain can easily be developed.

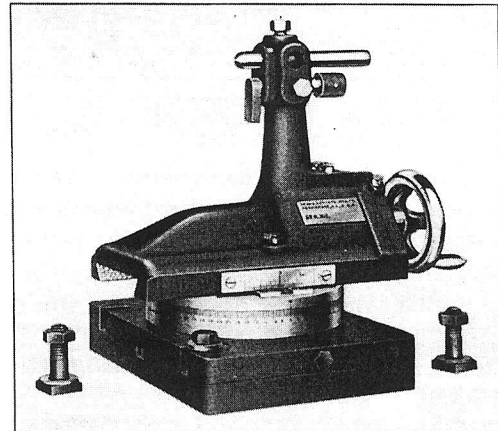


Fig. 15. Radius and Angle Wheel Truing Attachment.

The base of the Attachment has a tongue which fits the T-slots in the table to provide correct alignment. The top of the base is graduated in degrees to 90° each side of zero, and carries a swivel platen which can be clamped in angular position. On the platen is mounted a slide which can be adjusted longitudinally by means of a handwheel, this adjustment being indicated by a scale reading to 1" each side of zero, by 64ths. A clamping screw locks the slide in position, and a gib and adjusting screws provide means of compensation for wear.

An upright, integral with the slide, holds the diamond tool and diamond tool setting gage, either parallel (for forming radii) or at right angles (for forming angular surfaces) to the slide.

The diamond can be furnished at extra cost. An auxiliary base (shown in the above illustration), for use with the Attachment when a magnetic chuck is used, is furnished as regular equipment.

CHAPTER V

Grinding Wheels — Selection, Care and Use

Grinding wheels are made of crushed abrasive or cutting grit held together by a substance known as the bond.

Abrasive. The most common abrasives are aluminum oxide and silicon carbide.

Aluminum oxide crystals, though not particularly hard, are tough and hence are usually preferred for grinding materials of high tensile strength such as alloy and high-speed steels. This abrasive is known by such trade names as Borolon, Aloxite, Alundum and others.

Silicon carbide crystals are very hard but quite brittle; hence wheels of this material are used in grinding easily-penetrated materials such as copper, rubber and celluloid, and hard materials of low tensile strength such as cast iron and cast bronze. This abrasive is known by the trade names Electrolon, Carborundum, Crystolon and others.

Bond. Differences in bond give the grinding wheels varied characteristics.

Vitrified clay is the bond most commonly used. Wheels of this type are usually preferred for general production and toolroom grinding, for they are unaffected by heat, cold, water and oils and have many other advantages. They are usually not as strong as wheels of other bonds, however, and have practically no elasticity; consequently it is not advisable to attempt a heavy side cut with wheels of this type.

Silicate or semi-vitrified wheels (bonded with sodium silicate) as a rule cut smoothly and with little heat, hence are suitable for work requiring a delicate edge such as cutter or tool grinding.

Shellac forms a strong bond, and very thin wheels made of it are safe. These wheels produce a smooth finish and deep side cuts can be taken.

Rubber forms a bond of great strength, and wheels bonded with this material are used to cut grooves and for similar work.

Grain. This term refers to the size of the particles of abrasive used in the wheel. A 36-grain wheel, for example, is one made of abrasive that will just pass through a 36-mesh screen (that is, a screen having 36 meshes or openings per linear inch).

Several sizes of abrasive are often combined to produce a wheel of special characteristics. Such a wheel is called a *combination* wheel.

The grains commonly used for surface grinding range from 46 to 80. For rough grinding, when the

finish is not important, coarse-grain wheels are used. When the finish is more important or the surface to be ground is narrow and requires a sharp edge, fine-grain wheels are used. Combination wheels usually cut fast yet leave a good finish.

Grade. Wheels from which the grit is readily torn are known as soft bond or soft grade wheels, while those that strongly retain the grit are called hard bond or hard grade. Note that the term *grade* refers to the breakdown resistance of the wheel and not to the hardness of the abrasive.

The grade of grinding wheels is designated in different ways by the various manufacturers. In most cases it is indicated by letters, though some makers employ a numerical system. Comparing two wheels of the same grade designation but of different grain, the finer-grain wheel will be the harder, due to the greater compactness of the abrasive. Also, in general, the faster a wheel runs, the harder it will act.

In general, hard grade wheels are used in grinding soft steel, annealed carbon steel and similar metals. Medium grade wheels are used on such metals as brass and bronze; and soft grade wheels are used on the very hard metals and cast iron. If coolant is used, the wheel used should be of harder grade than if the job were ground without coolant. Also, the greater the contact between work and wheel the softer the grade should be.

Selection of Grinding Wheels. As indicated above, a most important consideration in the selection of grinding wheels is the nature of the material to be ground. Surface speeds of wheel and work, amount of material to be removed, and accuracy and quality of finish desired are also matters to be considered.

The abrasive, grain, grade and bond of the wheels regularly furnished with the Brown & Sharpe No. 5 Surface Grinding Machine are such as to suit these wheels to general-purpose grinding. However, the material, finish requirements or volume of work may often make desirable the use of a wheel more perfectly suited to the particular job at hand. The various wheel manufacturers publish literature which will be of particular help in selecting grinding wheels of their own make; or, if desired, all details of the grinding operation may be submitted to the wheel manufacturer for advice and recommendations.

Changing Wheels. In removing a wheel from the spindle, always use the wheel sleeve puller (described on page 9), to avoid any chance of cracking the wheel or damaging the spindle bearings by pounding.

It is recommended that extra wheel sleeves be procured, so that each wheel may be kept on its own wheel sleeve. Thus, in changing from one type of wheel to another, wheel and sleeve can be changed as a unit, and will remain concentric. To leave the wheel sleeve on the spindle and change wheels by replacing them on the sleeve would result in an objectionable consumption of time and wheel material in truing each time to required concentricity.

In putting a wheel on the spindle, slip the sleeve over the spindle end and tighten by means of the clamping nut, not by hammering.

Mounting Wheels. A wheel should fit easily on the wheel sleeve, yet not loosely, for if loose it cannot be accurately centered and will consequently be out of balance. The sleeve should not be wrapped with paper, etc., to make a wheel fit when the hole is too large. It is preferable from all standpoints either to discard such a wheel or recast the core.

A wheel that fits a trifle tightly may crack if forced on the sleeve. If the hole is only a slight amount under size it can easily be scraped out; or, if lead bushed, enough metal can be removed to make the wheel fit easily on the sleeve.

The inner of the two flanges between which the wheel is mounted, is integral with the wheel sleeve. (See Fig. 16.) The outer flange consists of a steel disk or washer, and is keyed to the wheel sleeve to prevent it from turning and loosening the clamping nut.

To equalize clamping pressure, washers of cardboard or rubber should be placed between the bearing surfaces of the flanges and the wheel. (Two rubber washers are furnished with the machine.) Many wheels come furnished with a ring of heavy blotting paper attached to each side, which is adequate for the purpose.

The clamping nut should be tightened just enough to hold the wheel firmly in place; otherwise, clamping pressure may crack the wheel. A newly-mounted wheel should always be rung before using, to make sure there are no flaws.

Balance of Wheel. It is essential that the wheel run perfectly true and without vibration. Grinding

wheels today are carefully balanced by the manufacturer, and, in the case of wheels of the size furnished for use on this machine, should not require attention in this respect other than truing. A wheel that runs badly out of balance after truing should be discarded or returned to the wheel manufacturer; though in cases of necessity, the condition may be corrected by *digging out* part of the

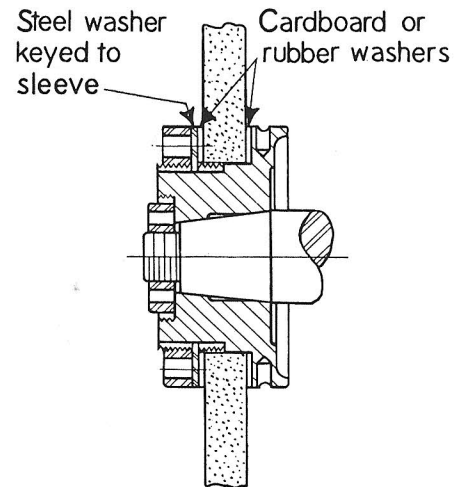


Fig. 16. Proper Method of Mounting Grinding Wheel.

wheel (beneath the flange) and filling with lead as indicated by a knife-edge test for static balance.

Wheel Speed. The speed of the spindle (2300 R.P.M.) gives the wheel a surface speed of 6000 feet per minute for a 10" wheel, and 4800 feet per minute when the wheel is 8" in diameter.

Wheel Truing. Using the Wheel Truing Fixture provided with the machine (described on page 9), the truing diamond may be applied to the wheel along any line on the lower half of the wheel circumference, though preferably at the bottom of the wheel. Both hand and power cross feed are available, the latter giving a smooth, continuous transverse movement of 12" per minute.

Safety. Due to the possibility of being thrust too abruptly into the work, or cracked because of careless handling or improper mounting on the wheel sleeve, there is always more or less likelihood of a grinding wheel bursting.

The No. 5 Surface Grinding Machine, like all Brown & Sharpe Grinding Machines, is fitted with wheel guards constructed in compliance with safety code standards. Under no condition should a grinding wheel be run without a guard.

CHAPTER VI

Wheel Spindle and Wheel Slide — Construction, Care and Adjustment

Wheel Spindle

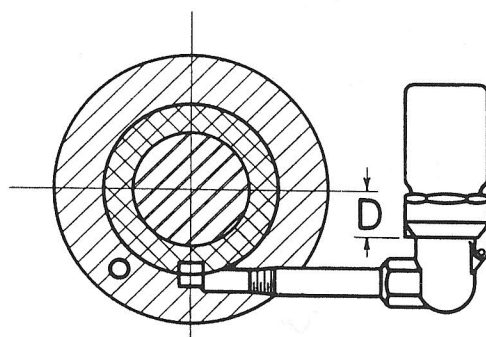
This machine is regularly equipped with a plain-bearing spindle unit, though an antifriction-bearing spindle unit is supplied, when specified, at extra cost. The spindles are of removable-unit-type construction and are interchangeable.

Both ends of the spindle are tapered, to take the wheel sleeve and the driving pulley respectively. In removing a wheel sleeve or pulley be sure to use the *wheel sleeve puller* (furnished with the machine) to avoid damaging the spindle bearings by hammering.

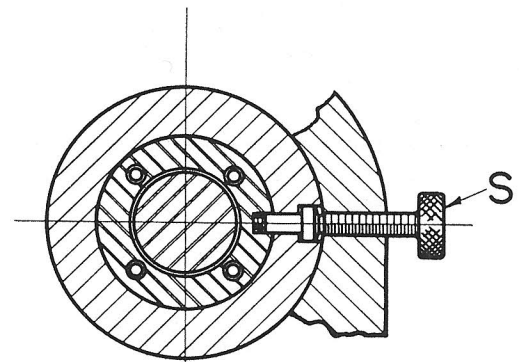
A grinding machine spindle may be properly classified as a high-precision tool. The accuracy of

construction required will be realized from the fact that a variation of one hundred-thousandth of an inch (.00001") in a ground flat surface will be visible to the naked eye as a wheel mark. Consequently, the best results can be obtained only if the spindle is treated with the consideration due to any fine precision instrument. *Hammering on the ends of the spindle, dropping it on the floor or work bench, etc. must be carefully avoided* if the spindle is to be kept in proper running condition.

If eventually a spindle should need repair or adjustment, we recommend that it be returned to our factory for reconditioning. By installing an extra spindle unit kept on hand for such contingen-



SECTION A-B



SECTION C-D

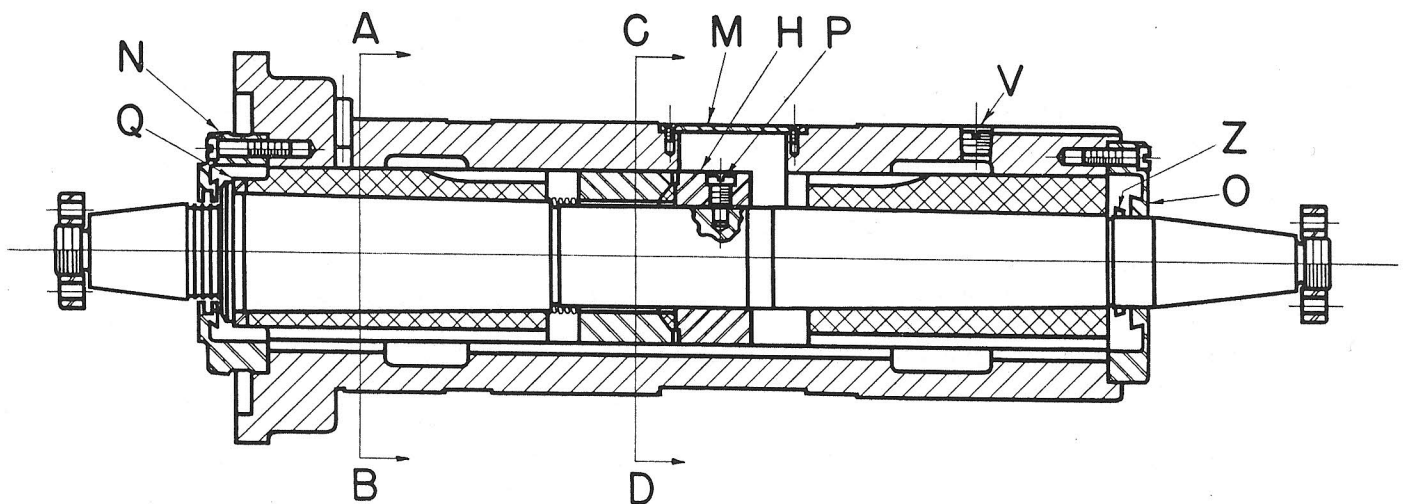


Fig. 17. Plain Bearing Spindle Unit

cies, production can continue with little interruption; for it is a quick and simple matter to change spindles on this machine. If necessary, however, detailed instructions given below and in the following pages will frequently permit the required work to be done successfully in the customer's shop by a careful workman having adequate skill and equipment.

End Play Take-up. End play in the plain-bearing spindle is taken up by compression springs which act against a thrust collar in the spindle assembly. (A section drawing of the spindle is shown on page 14.)

In grinding shoulders with the inner face of the grinding wheel, the pressure of the work on the wheel tends to move the wheel outward. To prevent this movement, clamp the thrust collar by tightening the knurled screw S on the side of the wheel slide barrel (Fig. 18). To take up end play after doing this, simply release and then tighten the clamp screw. **CAUTION:** The clamp screw should be tightened only while the spindle is running, and only after it has reached its maximum temperature ($\frac{1}{2}$ hour of running).

Since the clamp screw merely holds the thrust collar in position and does not govern the closeness of adjustment, there is no reason to use excessive clamping pressure.

For normal surface grinding or when grinding shoulders with the outer face of the wheel, the clamp screw can be released, leaving the thrust springs to take up end play automatically.

In the antifriction-bearing spindle, end thrust in both directions is taken by two opposed preloaded ball thrust bearings.

Removing Spindle Unit from Machine. Take off the grinding wheel, using the wheel sleeve puller. Unclamp the wheel guard and remove it from the spindle unit. The spindle is held in place by two hollow set screws at the top of the barrel cast integral with the wheel slide. (See Fig. 18). A pin in the top front of the spindle unit fits a slot in the barrel to properly locate the spindle in the machine.

Remove the guards on the rear of the upright, raise the driving motor to relieve the belt tension (as described on page 18) and lift the belts off the spindle pulley; then pull the spindle unit out of the head.

Plain-Bearing Spindle Unit

The plain-bearing spindle is ground to extremely close limits of concentricity, straightness and finish, and has unusually small clearance between the tapered bearing surfaces and special bronze boxes. End play is taken up by compression springs as previously explained, and adjustment for wear can be made as described below.

Lubrication. The spindle is lubricated automatically from a reservoir supplied by a constant-level oiler (see Fig. 17).

Due to the unusually small clearance, the oil used in this spindle must be an *extra-light*, high-quality spindle oil having a viscosity of 30 to 36 seconds S. U. V. at 100° F. Using a heavier lubricant such as ordinary spindle oil will cause excessive heating and will result in the spindle seizing.

To fill the spindle reservoir, tilt the constant-level oiler bottle down and fill it through the spout, then tip it back into working position. Never start a spindle without oil showing in the oiler bottle.

Take particular care to keep the oil clean. Use a clean oil can, and always wipe the oiler bottle and adjacent parts before tilting the bottle for filling. An oil space of .00011" has no room for grit and dirt.

Correct Height of Oiler. To assure proper height of oil in the spindle reservoir, the vertical distance D (Fig. 17) from the center of the spindle to the top edge of the cup (with bottle swung down) must be $2\frac{5}{32}$ " plus or minus $\frac{1}{64}$ ".

Disassembling and Repairing the Plain-Bearing Spindle Unit

Removing the Spindle. Remove the spindle unit from the machine as described at left, grip it securely in a horizontal position between the soft (leather or brass) jaws of a vise, and proceed as follows:

1. Unscrew the nut that holds the pulley on the spindle and, with the use of the wheel puller, remove the pulley.
2. Take out the five Rear Bearing Dust Guard screws and remove the guard O (Fig 17).
3. Slide off the oil slinger Z. If this happens to be difficult to move, wait until the spindle is pushed out (step 6); at that time the slinger will free itself.
4. Take out the Front Bearing Dust Guard screws and remove the guard N.
5. Remove the Spindle Bearing Sleeve Cover M, and take out the teated screw P.
6. The spindle can now be cleared from the oil slinger Z and the thrust collar H, and removed from the unit by tapping the rear end with a soft hammer. Care must be used to tap the spindle lightly so as not to disturb the spindle boxes.

Checking Oil Space in Boxes. The taper in the front and rear boxes is a continuous one—that is, the two boxes are like one long taper box with a section cut away in the middle. The thickness of the oil space is governed by the thickness of the spindle front box thrust washer Q and should be .00018" to .00020".

With the spindle boxes properly scraped, the correct thickness of washer Q is determined as follows:

1. Leave the spindle sleeve clamped horizontally in the vise, strap it to a plate or otherwise secure it against endwise movement.
2. Insert the spindle with washer Q in place but leaving off all other parts. (It makes no difference if the washer is too thick for a fit.)
3. Fasten a dial indicator so it cannot move with relation to the spindle unit and set the point of the indicator on the rear end of the spindle.
4. Push the spindle in so that washer Q is well seated and set the indicator to read zero.
5. Remove the spindle, take off washer Q and put the spindle back in the sleeve. Push the spindle into the boxes with a force of approximately 6 lbs. to get metal-to-metal contact, and note the indicator reading. Be careful to use only enough pressure to bring the spindle in contact with the boxes; for excessive pressure will distort the spindle and

boxes, causing a faulty indicator reading and resulting in too small an oil space.

6. To determine the required thickness of washer Q, subtract the indicator reading from the measured thickness of the washer and add .0065". Bring the washer to the required thickness by grinding and lapping, working to the limits plus .00025" minus .00000".

Repairing a Stuck Spindle. A spindle which has stalled or become stuck in the boxes will project quite noticeably at the front box thrust washer Q. This looks like a much more serious condition than it actually is; for if the spindle should be held away from the boxes by as little as .0005" on a side, the space at the front washer would be increased by about $\frac{1}{32}$ " due to the small angle of taper of the boxes.

Disassemble the spindle as instructed above and examine the bearing surfaces in both boxes. If there are just a few high spots in one of the boxes they can usually be removed by careful scraping, using the spindle as a test plug. Carefully clean the

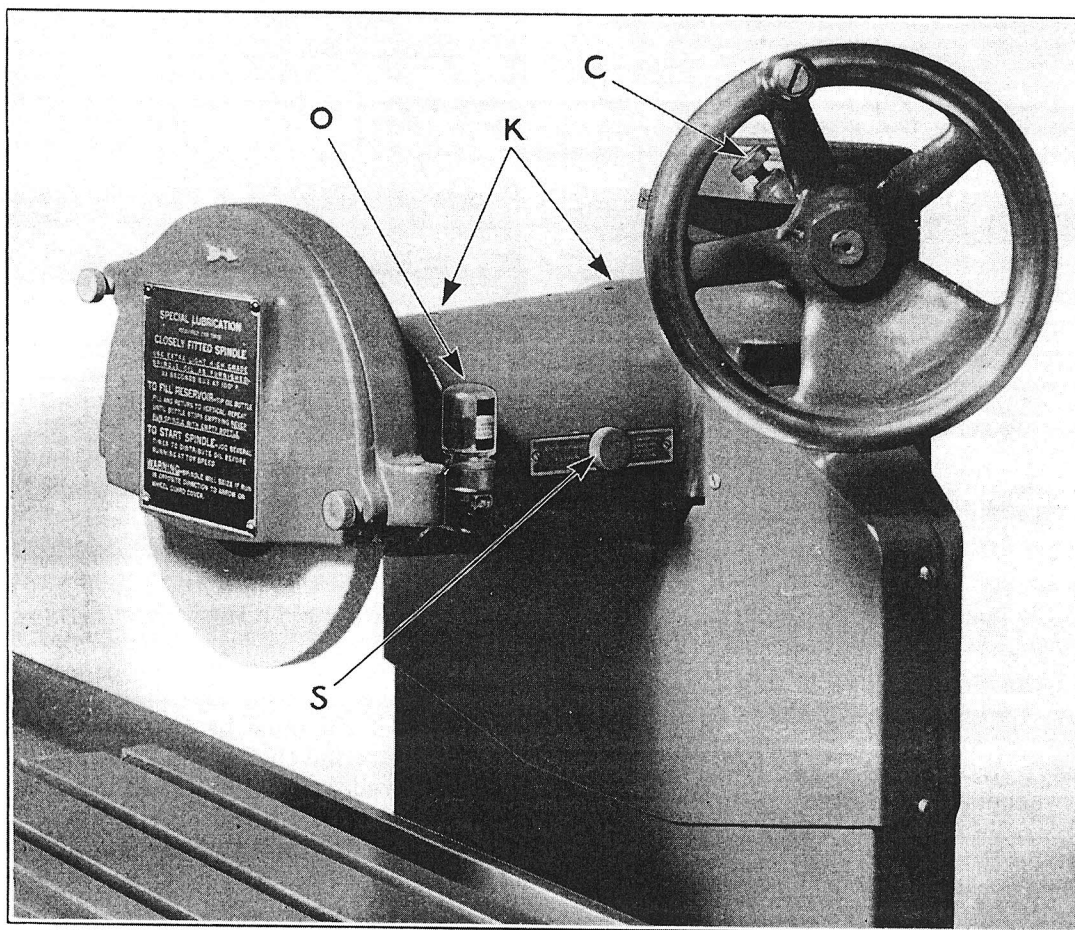


Fig. 18. Close-up of Wheel Slide.

- | | |
|--|----------------------------------|
| C. Wheel slide vertical adjustment clamp. | O. Constant-level oiler. |
| K. Set screws; hold spindle unit in place. | S. Thrust spring retainer clamp. |

spindle of any adhering foreign matter and make sure that all fine chips or dust of bronze are cleaned out of the boxes before testing. In removing the high spots, continue the scraping until the spindle goes into the boxes with the original washer bearing against the end of the front box. After completing this operation it is advisable, even if only a few spots were scraped, to check the thickness of the oil space as described above.

If the bearing surfaces have become badly scored a thorough rescraping job will be required, again using the spindle as a test plug. Watch the alignment as shown by the bearing on both boxes, and scrape the seized box or boxes so that the spindle will center properly in both boxes, as the scraping nears completion. After completing the scraping, clean all parts thoroughly and correct the thickness of the front box thrust washer Q to give the proper oil space as described above. Then, the concentricity of the spindle in relation to the outside diameter of the sleeve should be checked. This is done by inserting the spindle in the sleeve and mounting the unit between centers. The unit should revolve on the spindle with a runout of not more than .0005".

Reassembling the Plain-Bearing Spindle Unit

First make sure that all parts are perfectly clean and that dirt or dust will not get into the spindle sleeve during reassembly. Then, holding the spindle sleeve between brass or leather vise jaws, proceed as follows:

1. Put the front box thrust washer Q on the spindle and insert the spindle in the boxes, slipping the thrust spring retainer (with springs in place), the central thrust washer and the thrust collar H onto the spindle in that order as shown in Fig. 17. Make sure that the pins in the front and central thrust washers are inserted in their holes.

The thrust collar H is made a wringing fit on the spindle, and the hole must *not* be enlarged to make it fit more freely.

2. Fasten the thrust collar H in position. The teated screw P engages one of three radial holes spaced 120° apart around the spindle and at different distances from the spindle end. When the front box thrust washer Q is at full normal thickness ($\frac{7}{32}$ " or more), locate thrust collar H so screw P will engage the hole nearest the rear end of the spindle. When washer Q is reduced to less than $\frac{1}{8}$ " thick, put screw P in the middle hole; and when washer Q has been thinned to $\frac{1}{16}$ ", put screw P in the hole nearest the front of the spindle. This maintains proper pressure of the thrust springs as the spindle is brought inward.

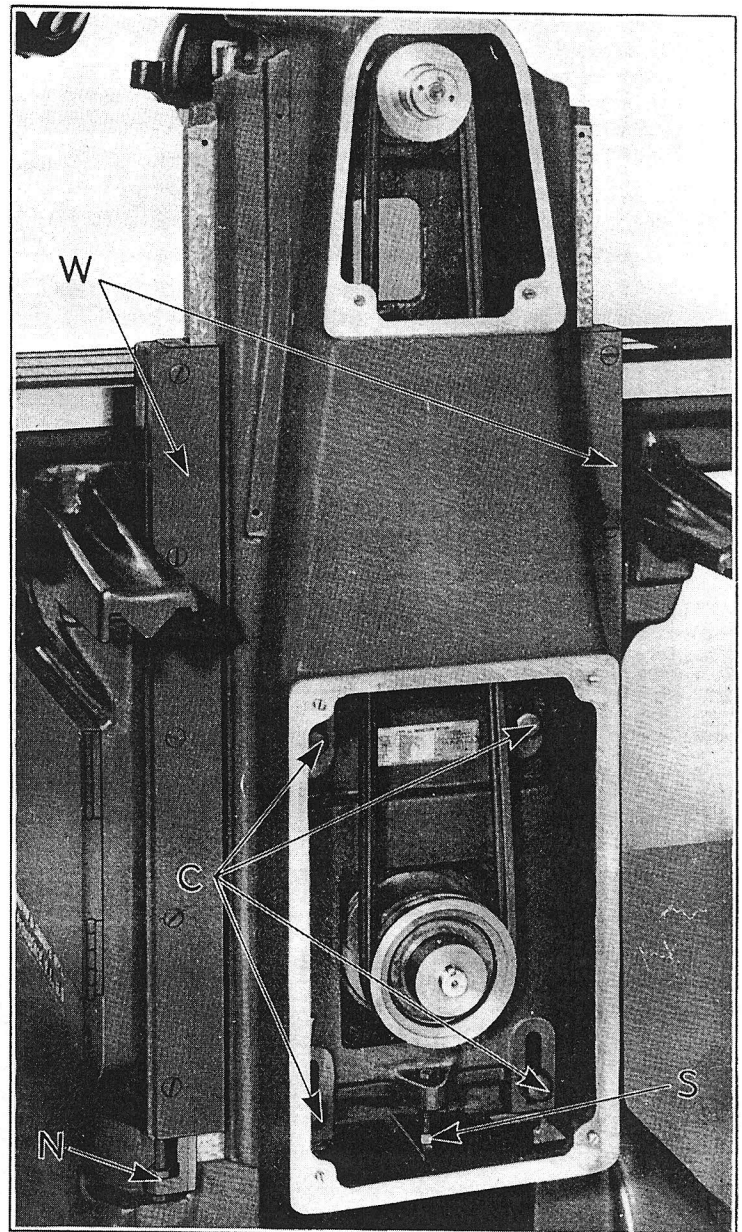


Fig. 19. Rear View of Wheel Slide (guards removed), showing motor bracket clamp screws (C) and adjusting screw (S); gib adjusting nuts (N); and wheel slide straps (W).

3. Replace the spindle bearing sleeve cover M. Since this cover must be oil tight, put a thin coat of shellac around the hole in the sleeve on the area to be covered by the gasket. Be careful not to get any shellac on the spindle. Then with gasket and cover in position, tighten the screws.

4. Replace the oil slinger Z, locating it within $\frac{1}{8}$ " of the end of the rear box to make sure that guard 0 will not come in contact with it.

Replace the spindle rear guard 0 and the driving pulley, thus completing the spindle assembly.

Replacing Spindle Unit in Machine. Insert the spindle unit in the spindle head of the machine. The clamping screws K (Fig. 18) should be set up lightly, just enough to keep the unit from moving. Heavy pressure is not necessary and will distort the spindle, causing it to stick.

Slip the driving belts over the pulley and adjust the belt tension as described below.

Antifriction-Bearing Spindle Unit

The spindle in this unit is mounted on super-precision, preloaded roller bearings at both front and rear. End thrust in both directions is taken by two opposed preloaded ball thrust bearings. Grease lubrication is used and the spindle's cool running temperature is quickly reached.

Lubrication. The unit is sealed and requires no additional lubrication or adjustment after it leaves the factory. As dirt cannot enter past the seal, this spindle has a long trouble-free life.

Maintenance. Because of the extreme care required in disassembling and reassembling this spindle, we strongly recommend that any antifriction-bearing spindle unit which needs repair be returned to our factory for reconditioning.

Wheel Slide Mechanism

Adjustment of Belt Tension. Tension in the spindle driving belts is adjusted by raising or lowering the motor, which is mounted on a bracket at the bottom of the wheel slide. After running down screw S (Fig. 19) until its head contacts the bottom of the wheel slide, the four clamp screws C are released and the belt tension adjusted by turning screw S.

The belts are tested for adjustment by taking one of them between thumb and fingers at a point 6" below the center of the top sheave, and squeezing the two sides together until there is no further stretch. When, at this point, the distance between the inside surfaces of the belt is $1\frac{1}{2}$ ", the belt is in proper adjustment.

After adjusting the belts, screws C should be tightened and screw S backed off to relieve any stress which might distort the wheel slide ways.

Vertical Adjustment Mechanism. This mechanism should require no adjustment, nor any care other than to keep it properly lubricated.

The handwheel shaft bearings are lubricated by oilers (No. 20, Fig. 5, page 7). Fill weekly with machine oil of about 300 S.S.U. at 100° F.

The elevating screw, and the bevel gear which turns it, are lubricated by oiler 19, Fig. 5, which should be filled weekly with the same grade of machine oil.

Wheel Slide. The design of this unit is such that the vertical ways will very seldom need compensating for wear. If, however, in the course of time, the ways become worn so that looseness can be felt when the slide is manually *shaken* from side to side, the looseness can be taken up as follows:

Back off the gib by means of the adjusting nut N (Fig. 19); then run the slide its full length, to make sure that there is no binding due to dirt or tightness of the clamping straps W. Next, slowly raise the gib until it just begins to take hold, as indicated by the *feel* of the handwheel; then back off the gib slightly, just to the point where the handwheel turns freely again and the wheel slide descends by its own weight, then lock in position with the check nut.

The oil cups at the top of the ways should be filled weekly with machine oil.

Possible Sources of Spindle Trouble

Work shows wheel marks (chatter finish).

Chatter may be due to poor choice of wheel or speed of table for the material being ground.

Grinding wheel may be out of balance; if so, it should be balanced or replaced. (See page 13.)

Slipping or *whipping* of driving belts due to excessive looseness. Test and adjust as instructed.

Spindle runs too hot or stalls.

*Wrong kind of oil. Use only an extra light, high quality spindle oil having a viscosity of 30 to 36 S.S.U. at 100° F.

*Insufficient oil. Check the vertical position of the constant-level oiler, as instructed on page 15.

May be due to taking too heavy a cut, beyond the capacity of the machine.

Belts may be too tight, causing excessive pressure on rear bearing. Test belts, as instructed.

Excessive tightening of the two set-screws which hold the spindle unit in the wheel slide barrel may be warping the spindle unit out of line.

Spindle leaks oil:

*This may be due to an excessive oil supply. For correct method of filling reservoir in spindle housing, see page 15.

*Make certain that hole in breather screw V (Fig. 17) has not been closed with grease or dirt.

*Plain-bearing spindle only. For antifriction-bearing spindle see paragraph on lubrication.

CHAPTER VII

Hydraulic System — Operation, Care and Adjustment

The information given in the first part of this chapter, while not essential to the set-up and operation of the machine, will give a good understanding of how the hydraulic system operates. This knowledge will be of considerable help to the maintenance man, and may also be of interest and value to the operator.

Hydraulic System. The hydraulic system provides all power movements of the table and carriage, and in addition lubricates the table and carriage ways and all adjacent mechanisms.

Most of the units of the hydraulic system are located in the carriage.

The oil reservoir is in the base, with a bayonet gage and filler spout in the left-hand cover plate leading to it. The motor-driven pump is mounted on the right-hand cover plate, and to the pump are connected the high and low pressure relief valves, a filter, and the flexible pipes which carry oil to and from the valve case in the carriage. (See Fig. 25, page 23.)

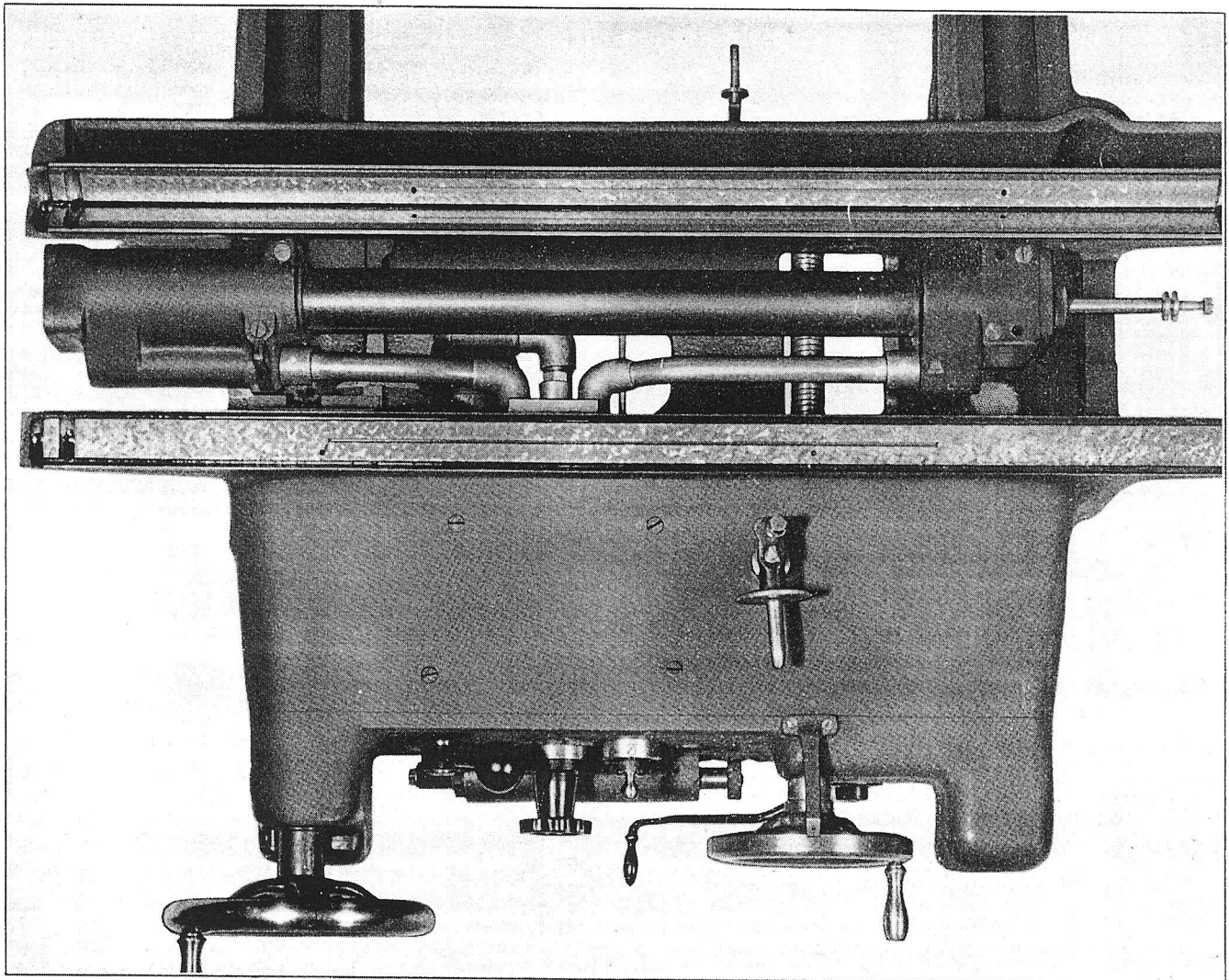


Fig. 20. Top View of Carriage, Table Removed.

Note position of table handwheel, cross feed handwheel and screw, table ram cylinder and piping, and hydraulic controls at front.

Normal drainage is caught on a shelf or oil pan cast integral with the base, and must pass through a filter before returning to the reservoir. A sheet metal pan fastened to the bottom of the carriage prevents oil from dripping onto the floor when the carriage is in the forward position.

The oil supplied to the pump is well guarded against dirt and grit. Any oil that gets outside the hydraulic system can return only through the filter in the oil pan. Another filter connected with the pump piping provides a differential effect equivalent to filtering all the oil in the system every 20

to 40 minutes; and finally, a dam or baffle in the reservoir, past which the remainder of the exhaust oil must flow to reach the pump suction pipe, permits the settling-out of any grit that may have been picked up, and forces out any air bubbles.

Schematic Diagrams. Longitudinal and cross feed power movements are operated and controlled by the units shown in the schematic diagrams and described therewith. (See insert opposite page 26.) These diagrams include the entire hydraulic system with the exception of a pipe which carries

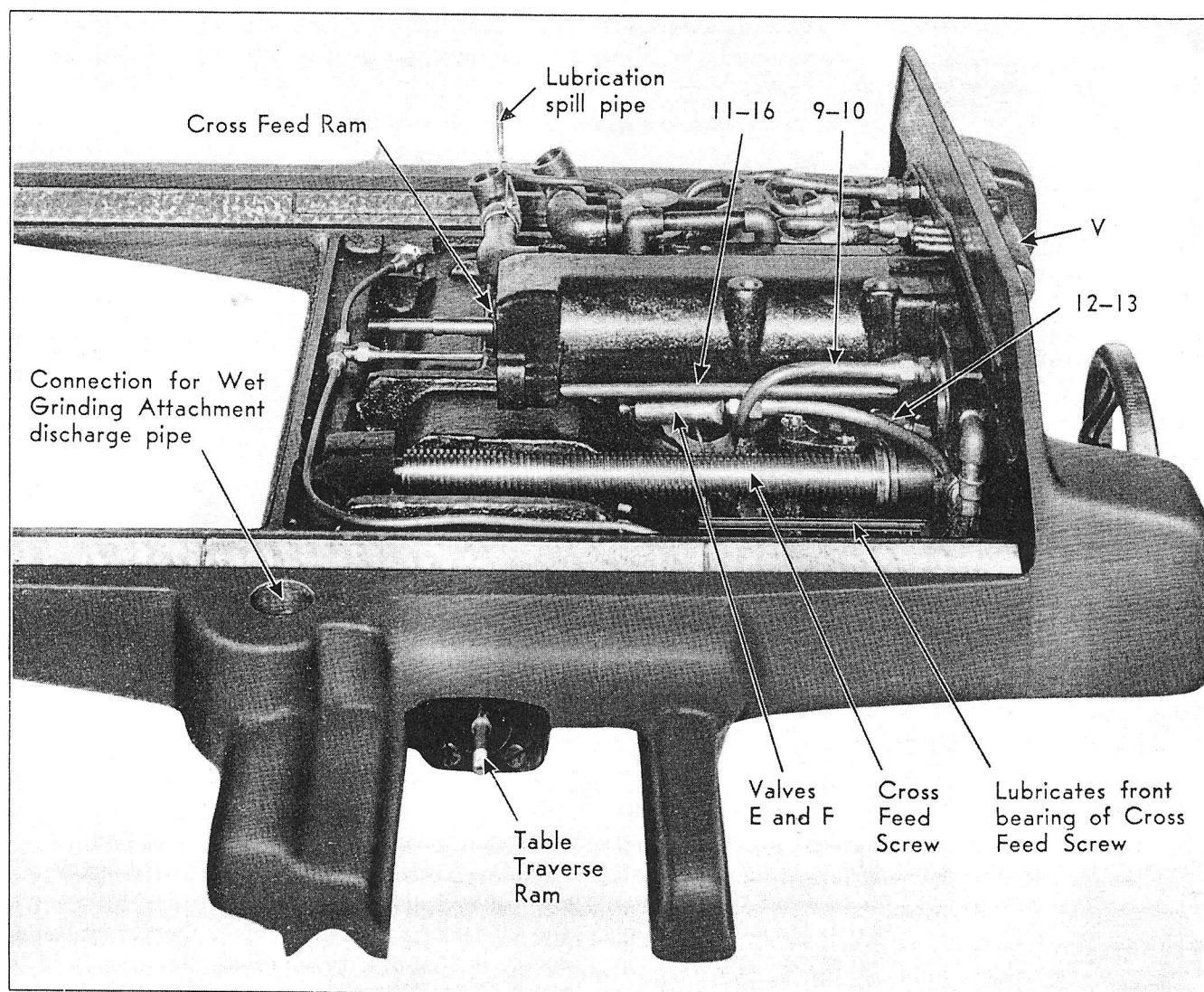


Fig. 21.

Figs. 21, 22, 23 and 24. Carriage Assembly.

Note that in all of these views, the carriage is shown taken off the machine and turned upside-down. As an aid to orientation, note the location of the cross feed screw and handwheel, and the transverse V-ways; also, compare with Fig. 20 on preceding page.

The valves and other units here indicated are given

the same designations as in the schematic diagrams opposite page 26.

Numbers identifying a given pipe refer to the numbered junction points on the schematic diagrams which are connected by that pipe. For example, the pipe numbered 12-13 in Fig. 21 is represented on Diagram II by the line joining points 12 and 13.

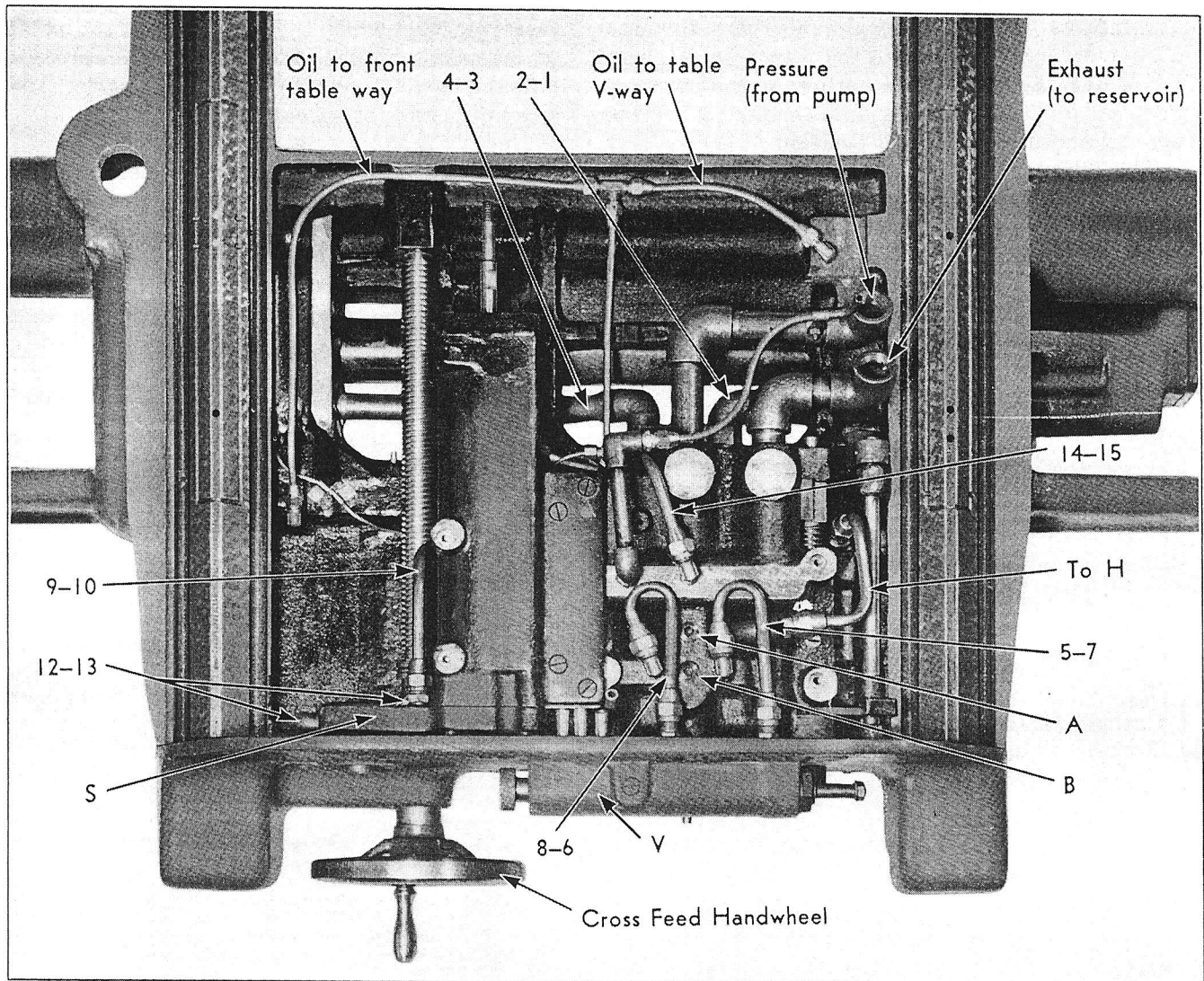


Fig. 22.

oil under low pressure to lubricate the table and carriage ways.

A perusal of these diagrams, together with the accompanying descriptive matter, will give a good idea of the functions which the various valves and resistances are designed to perform, and will thus aid considerably in locating the source of any trouble which misuse or long service might cause to develop in the hydraulic system.

To correlate the schematic diagrams with the actual construction, numbers at various junction points on the diagrams serve to identify the pipes shown in the reproduced photographs of the assembled units. For example, the pipe leading from point 2 to point 1 on Diagram I is labeled 2-1 in Fig. 22. Other illustrations of the assembled

system are given on pages 20, 22 and 23.

Note that most of the connections shown in the schematic diagrams are passages cast or drilled in the valve case, rather than external pipes.

Note also that valves Y, R, P and C (located in the valve case casting), valve V (on the front of the carriage) and most of the other units are shown in the relative positions they occupy in the assembled machine.

Lubrication System. The table and carriage ways are lubricated automatically from the hydraulic system by the piping indicated in Figs. 22 and 23, which carries oil, at low pressure, to the table ways. The oil drains from the table ways through holes to the carriage ways, thence to the oil pan and back into the reservoir through the oil pan filter.

The light pressure required to prevent flooding of the ways is obtained by the arrangement illustrated in Fig. 24. The side-outlet elbow J is connected by pipe D to the exhaust side of the system; and oil for lubricating the table ways is taken from the vertical part of the elbow through the pipe indicated. By means of a fixed hydraulic resistance in pipe D and one between the elbow and the spill pipe at K the oil in the lubricating piping is kept at the desired low pressure. Pipe L supplies oil to a reservoir in the top of the base, which in turn provides lubricant for the cross feed screw nut fulcrum. Oil passing through the spill pipe is returned to the main reservoir in the base.

The cross feed screw and nut are lubricated automatically, by means of two short drip pipes which take some of the oil from the front table way and drop it onto the screw and into a pocket in the

top of the nut respectively. The cross feed screw bearing is oiled by a longer pipe (shown in Fig. 21) which takes oil from the same source.

The pump motor has sealed, pre-lubricated bearings, and requires no lubrication.

Care and Adjustment of Hydraulic System

Check and Relief Valves. The cross feed check and relief valves E and F (assembled as a unit—see Fig. 21, Page 20 and Schematic Diagram II) are properly set and locked at our factory and should not be disturbed. If, through some unforeseen circumstance or accident, their setting is disturbed, it is strongly recommended that they be returned to our factory for resetting, where there are full facilities for doing the work.

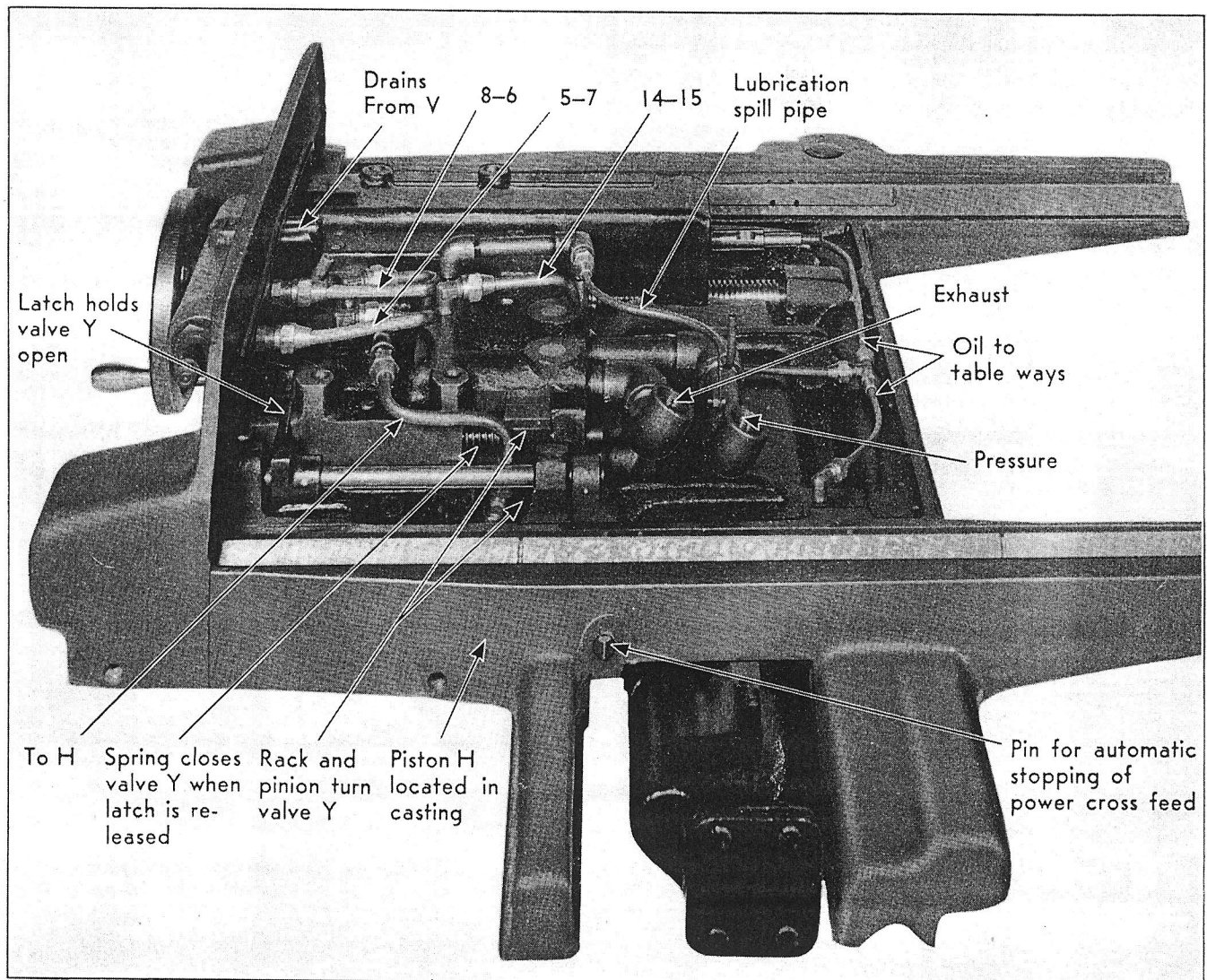


Fig. 23.

The High Pressure Relief Valve is tested by removing plug Q (Fig. 25) and attaching a pressure gage at this point. With start-stop master valve in running position, but with table throttle at zero, the valve is in proper adjustment if the pressure gage reads 92 lbs. per sq. in. when the pump is driven by a 60-cycle motor, or 100 lbs. per sq. in. when using a 50-cycle or 25-cycle motor.

The Low Pressure Relief Valve is similarly tested, the gage being attached at point R. Since this valve should open to full capacity at 4 lbs. per sq. in., it is necessary in this case to use a low-pressure gage for testing.

These valves are adjusted by turning the respective knurled adjusting screws S (Fig 25), the adjustment being held by means of check nuts C.

Hydraulic Resistance. The fixed hydraulic resistance X1 is designed to give proper operation of the reversing valve. Any tampering with the size of this resistance will result in faulty operation of the machine.

If the reversal of the table is sluggish (and other possible causes have been eliminated)—this indicates that the resistance is partially plugged with foreign matter. To remedy this, first remove table throttle valve T, by loosening one set-screw (located near the front of the valve case in line with plugs A and B — see Fig. 22) and pulling out the

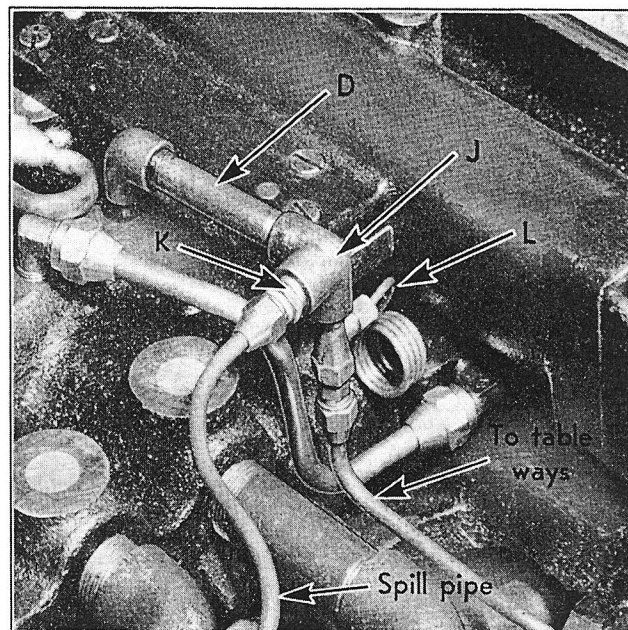


Fig. 24. Close-up of Lubrication Take-off.

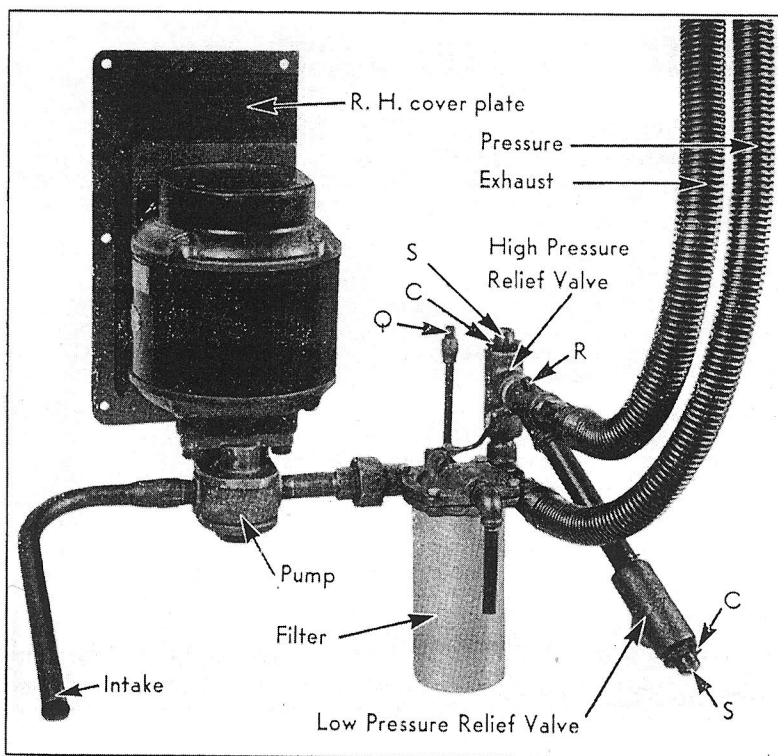
assembly. Then unscrew plug A (Fig. 22) and remove the obstruction with a piece of wire.

Lubrication System. Failure of the lubrication system can be due only to the inner hydraulic resistance becoming plugged, or to the piping being disconnected or dented. To clean the resistance,

Fig. 25. Pump and Piping in Base.

Motor-driven pump is mounted on right-hand front cover plate. Hydraulic system exhausts through Low Pressure Relief Valve behind wall or baffle past which oil flows to main reservoir. Filter discharges into main reservoir, from which intake pipe takes oil. Plugs Q and R (above oil level) provide for attaching gage for testing relief valves, which are adjusted by screws S. Check nuts C maintain the adjustment.

Connections are shown schematically in Diagram IV, opposite page 26.



remove the elbow and blow out with compressed air in the direction opposite to the flow of oil. (See Fig. 24.)

Flexible Pipe. The flexible pipes or tubes, which connect the valve case with the piping near the pump, are made of a strong and oil-resisting material (they are not rubber), and if properly installed should last indefinitely. If leakage or accidental wear should necessitate their replacement, however, do not install rubber tubing, as the oil will soon rot a rubber tube, and pieces are apt to slough off the inside and clog the filter, plug the resistances, gum the valves and otherwise interfere with the operation of the machine. Instead, we recommend sending to our factory for the needed part.

In connecting or disconnecting the flexible piping, do not hold it with a pipe wrench. To do so is unnecessary, and might easily cut through the fabric without showing, resulting in leaks which will necessitate replacing the pipe.

In replacing, make sure that the tubes ride in the *middle* of the slot in the oil pan, so as not to rub against the casting when the carriage moves.

Oil Filters. The filter in the top of the base should be replaced whenever overflow of oil gives evidence of its becoming seriously clogged.

This filter is held in the oil pan by a bayonet grip, and is removed by taking off the left-hand plate on the front of the base, reaching up and giving the filter a slight turn to the left.

The cartridge unit of the filter connected with the pump should be replaced at least yearly. This is a special type of filter, and replacements should be ordered from our factory.

Cleaning Hydraulic System. The oil used in the hydraulic system should be kept reasonably clean in order to insure continuous efficient operation of the machine. A check on the condition of the oil should be made each month even though there have been no signs of faulty operation. Remove the cover carrying the oil gage and with a strong light make sure the oil does not appear milky or thickly clouded. Also watch for waxy deposits on the reservoir walls. These conditions indicate foul or spent oil. Remove the oil as soon as it shows signs of dirt, gummy deposits, coolant compound or other foreign substance.

Two alternative procedures may be followed when cleaning the oil reservoir, depending on the condition of the oil:

(1) When the oil is reasonably fresh but merely dirty; — Remove as much oil as possible by taking off the base cover and using a suction pump. Then flush out the reservoir with gasoline or naphtha (taking the usual fire precautions) and drain out the waste matter through the plug in the bottom left of the base. A new filter (Part #4104) should always be put in when renewing the oil. It is safest to use new oil (high lubricity hydraulic oil of 150 S.S.U. at 100°F). However, oil in the condition described above may be re-used if not contaminated by grinding coolant, provided it is first passed through a good filter which will remove all solid particles .0004" and larger. Ordinary slight contamination of the oil may be remedied by simply renewing the filter.

(2) When the oil contains waxy or gummy deposits; — These are products of decomposition of the oil itself. The oil in the reservoir appears yellowish or brownish and opaque, and waxy deposits will be found on the side walls of the reservoir. This is likely to occur if an inferior grade of oil has been used, especially if it contains any organic material. Even a good grade of mineral oil will slowly oxidize to form wax and sludge in objectionable quantities after a long period of use, or very quickly if contaminated by coolant. While waxes themselves do no damage to the parts, they are likely to cause sticking or binding of the valves or clogging of the resistances.

To clean, proceed as in paragraph (1), but instead of using gasoline or naphtha for flushing, use a solvent oil made to the following formula: 4 parts hydraulic oil, 1 part carbon tetrachloride. The mixture is noninflammable. Ready-made solvent solutions of this kind may be purchased from any of the better known oil companies, if desired. Put about four gallons of the solvent solution in the machine. If any of the control parts are stuck or stiff, work them loose slowly and carefully as the solvent cuts the varnish-like deposits, having the pump running. The start-stop lever should be in the *stop* position, if possible, so that the solution in the hydraulic system will be at low pressure. It is desirable not to put much pressure load on the pump or hydraulic mechanism when freeing with solvent, as the solution has little lubricating value. When the machine begins to operate normally keep it running for an hour or more, working all the

controls until all valves move freely, and all passages are clear. Disconnect the piston rod and lift the table slightly in the ways to make sure the lubricating ducts are flushed out. Flush all the material out of the reservoir, using more fresh solution to do this if necessary. Then fill with a good grade of fresh hydraulic oil.

Warning: Carbon tetrachloride is toxic. Avoid breathing the fumes unless heavily diluted with air.

Never use waste to clean any part of the machine that is included in the hydraulic system, as pieces of lint, string, etc., are bound to get into the system if this is done, and will sooner or later plug a resistance, interfere with valve action, or help clog the filter.

The machine should be kept clean at all times, both from its own grit and that produced by neighboring machines. If the machine is located near machines doing dry grinding, and particularly if it is in their direct *line of fire*, it will be of benefit to it and all other machines if the grinding grit and dust from all the machines is collected and removed either by a central exhaust system or by using the Brown & Sharpe Exhaust Attachment (described on page 10).

Possible Sources of Trouble with Hydraulic System

The following *check list* will aid in finding the cause and cure of operating troubles in the hydraulic system, some of which may in time develop due to accident, improper care and adjustment or long-continued operation.

Most of these difficulties may be avoided by using oil of the proper viscosity, replacing the oil filters when necessary, and exercising reasonable care in keeping the machine clean.

When repair or adjustment becomes necessary, we strongly recommend following the procedures outlined in the preceding section of this chapter (pages 22 to 25). Familiarity with the functions of the various hydraulic mechanisms will be gained by study of the schematic diagrams, and will aid greatly in the diagnosis and remedy of any difficulties that may develop.

Oil leaks down front of machine.

If oil is overflowing from the oil pan in the top of the base, remove the filter and determine the rate of flow of oil. On a new machine, this may be up to $\frac{1}{8}$ pint per minute; while on an older ma-

chine, the normal drainage may be as much as $\frac{1}{4}$ pint per minute.

If the flow is less than these figures, overflow indicates a blocked filter. Instructions on replacing the filter are given on page 24.

If the rate of drainage is greater than the above amounts, proceed as follows:

—Check the piping for loose connections. If any loose fittings are found, tighten them with a wrench.

—See that the spill pipe from the lubricating system (Fig. 21) discharges down the flexible exhaust pipe; i.e., see that it has not been bent or incorrectly reassembled so as to discharge into the oil pan.

Dripping of oil from the table ways can be due only to excessive lubrication. This may be caused by accidental denting of the spill pipe so as to build up the pressure in the lubrication take-off elbow (see Fig. 24), or to possible tampering with the first hydraulic resistance in pipe D.

Table and cross feed not up to speed.

May be due to using too heavy an oil in the hydraulic system. Only oil of a Saybolt Universal Viscosity (S.U.V.) rating of 150 to 160 seconds at 100° F. should be used.

May be due to lack of pressure resulting from a leak in the pressure line, especially in the piping in the base near the pump.

High pressure relief valve (near pump) may be stuck open, or may have been adjusted to an excessively low pressure. For proper adjustment see page 23.

Low pressure relief valve (near pump) may have been adjusted to too high a pressure, resulting in too much back-pressure in exhaust system. For proper adjustment see page 23.

The condition might also result from a failure of the lubrication system. (See page 23.)

Erratic or *jumpy* action of table and cross feed.

Generally caused by air in the pressure line, due to low oil level in the reservoir.

Table faulty in reversal.

Generally caused by air in the pressure line, due to low oil level in the reservoir.

Slowness in reversal may be due to clogging of resistance X1. (See page 23.)

Cross feed fails.

Check for leaks in the pressure system. With a pressure gage connected to pipe Q (Fig. 25), page 23), see that the pressure does not fall below 70 lbs. per sq. in. when the machine is running at full speed.

High pressure relief valve (near pump) may have been readjusted to too low a pressure. Test as instructed on page 23.

An excessive load on the table, combined with failure of the lubricating system, might result in failure of the cross feed to operate.

Table and carriage hard to move manually.

Mechanical trouble, resulting in failure of start-

stop valve Y to close completely, will make it difficult to move the table by hand.

Leakage of flexible tubing.

The discharge of oil from the lubrication spill pipe flows down the *outside* of the exhaust tube. This is a *normal operating condition*, not evidence of a leak.

Pump motor overheats.

Oil may be of too high viscosity.

High pressure relief valve (near pump) may have been readjusted to too high a pressure. (See page 23.)

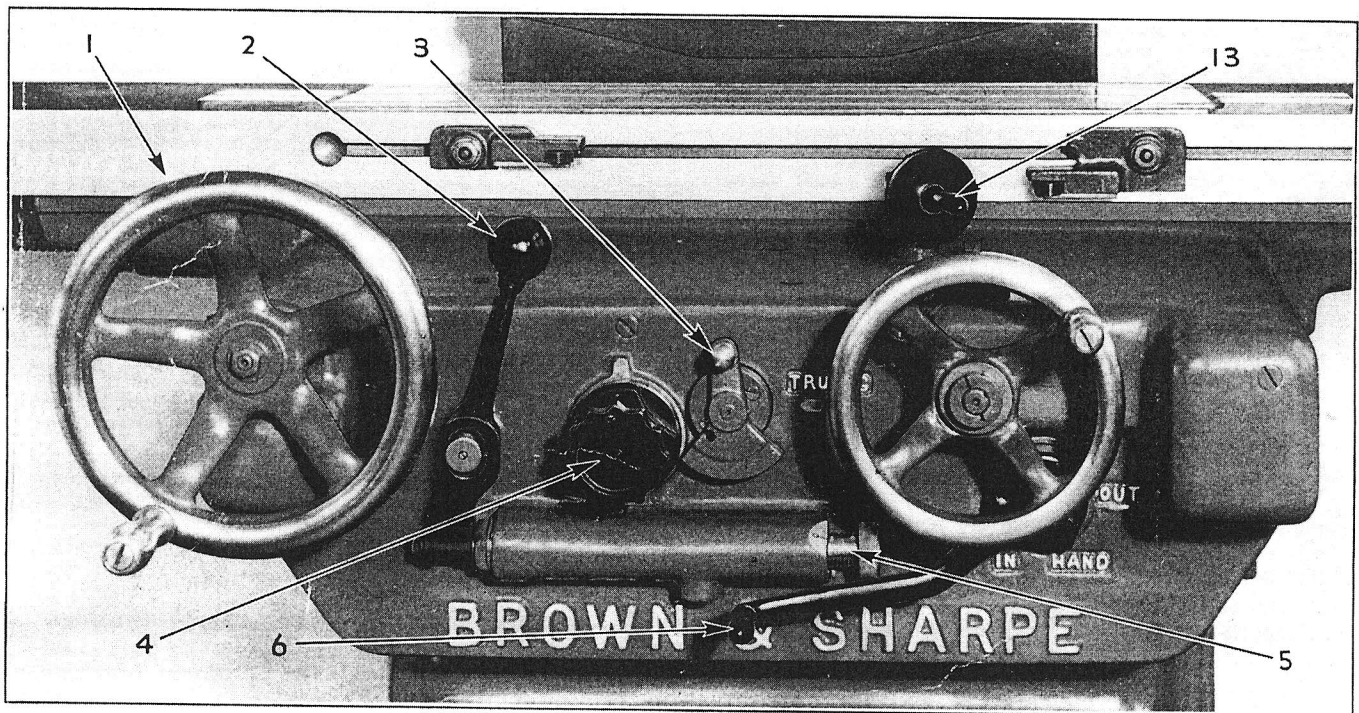


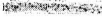


Fig. 26. Close-up of Table and Carriage Controls.

- | | |
|--|--|
| 1. Table handwheel. | 4. Table throttle. |
| 2. Lever starts and stops hydraulic movements. | 5. Graduated screw selects amount of cross feed. |
| 3. Truing control. | 6. Cross feed selective lever. |
| | 13. Table reversing lever. |

Schematic Diagrams of Hydraulic System

-  Solid red indicates oil supplied from pump at high pressure.
-  Cross-hatched red indicates oil at high pressure, but not in direct connection with the pump.
-  Blue indicates oil at exhaust pressure.
- Arrows in pipes show direction of flow.

UNITS OF HYDRAULIC SYSTEM

Pump — Supplies oil at high pressure for operation of system.

High Pressure Relief Valve — Limits maximum oil pressure.

Low Pressure Relief Valve — Keeps oil in exhaust system under slight pressure, preventing entry of air.

Table Traverse Ram — Cylinder is fixed to top of carriage. Piston rod is connected to right-hand end of table.

Cross Feed Ram — Cylinder is fixed to under side of carriage, and end of piston rod is fastened to base of machine.

C — Cross feed control valve; operated at each reversal by oil from end of valve R, to admit oil to V for automatic cross feed.

E and F — Spring-loaded relief valve, and check valve; built as a unit; located as shown in Fig. 21 (page 20).

Valve E provides positive stop for automatic cross feed movement, preventing *coasting* or overrun of carriage. Also opens to permit manual inward cross feed.

Valve F provides for intake of oil from exhaust system to permit moving carriage outward by hand.

H — Table handwheel throwout piston (located in carriage — see Fig. 23); automatically disengages pinion from table rack when hydraulic system is *on*. With valve Y in *stop* position, the spring carries the handwheel out to engage the pinion with the rack.

K — Free-floating piston of valve V. Stroke is adjustable by graduated screw (5, Fig. 26), controlling amount of automatic cross feed.

N — Truing control valve; turned by handle 3 (Fig. 26). Turning to 90° from position shown admits pressure oil from pump to give continuous cross feed for wheel truing.

P — Pilot valve; operated by lever 13 (Fig. 26) to reverse the table. Directs flow of oil to either end of valve R.

R — Table reversing valve; is hydraulically *shifted* by pressure oil as controlled by valve P. Oil forced from opposite end of valve R moves piston of valve C.

S — Cross feed selective valve; set by lever 6 (Fig. 26) to select hydraulic cross feed in either direction, or hand

cross feed. (S2 and S3 indicate settings for outward power feed and hand feed respectively.) Eccentric also operated by lever 6 disengages cross feed nut when valve S is positioned for hydraulic cross feed.

T — Table throttle valve; turned by knob 4 (Fig. 26). Governs rate of table travel by regulating flow of oil to table ram.

V — Cross feed metering valve (mounted on front of carriage).

X1 — Fixed hydraulic resistance; governs rate of travel of reversing valve R.

Y — Start-stop master valve; turned by rack and pinion operated by 2 (Fig. 26) to start and stop hydraulic movements. When in *stop* position (90° from position shown), pipes from ends of table ram cylinder, and leads from high and low pressure sides of system, are connected by deep elongated slot, allowing free hand movement of table and bringing all oil in system to exhaust pressure.

Latch (Diagram III) — When lever 2 (Fig. 26) is pulled to start hydraulic operation, valve Y is turned to *start* position by rack and pinion shown, and is held in this position by the latch. When this lever is pushed in, the latch is disengaged and the valve turned to *stop* position by the spring. For cross feed automatic stop, the same latch is released when a stop dog on the left side of the machine pushes against the wedge-ended pin.

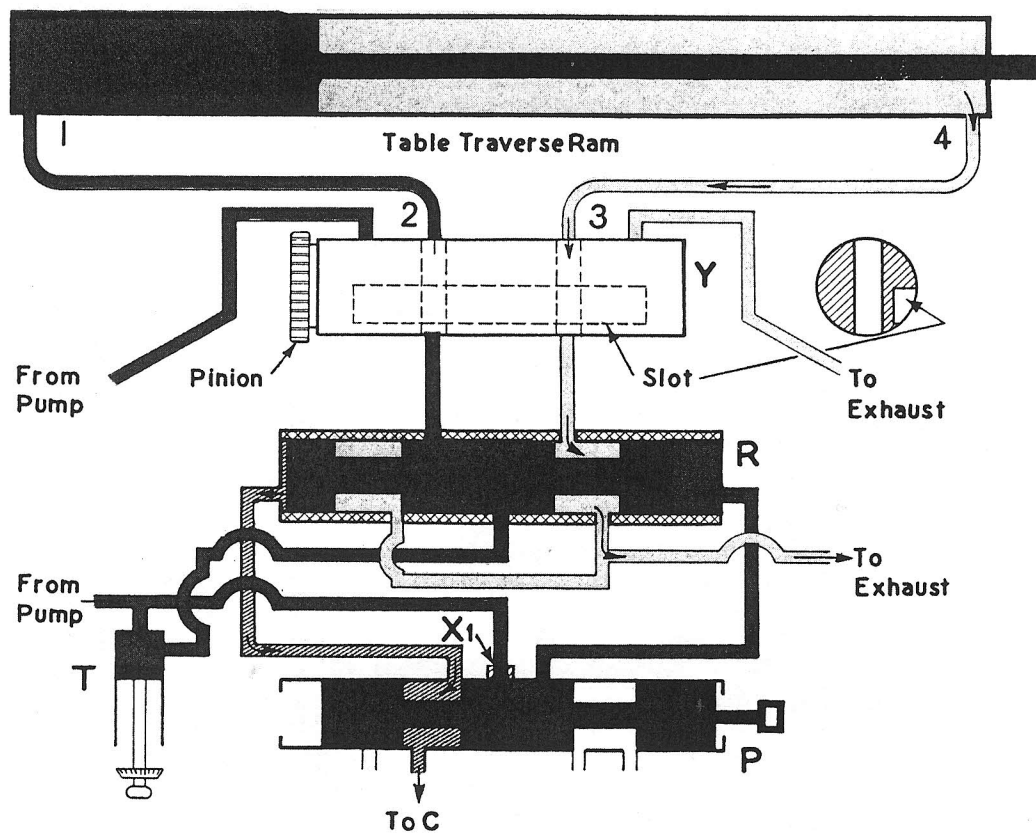
GENERAL

Numbers at various junction points identify lines on these diagrams with piping shown in the reproduced photographs of the assembly (Figs. 21, 22 and 23).

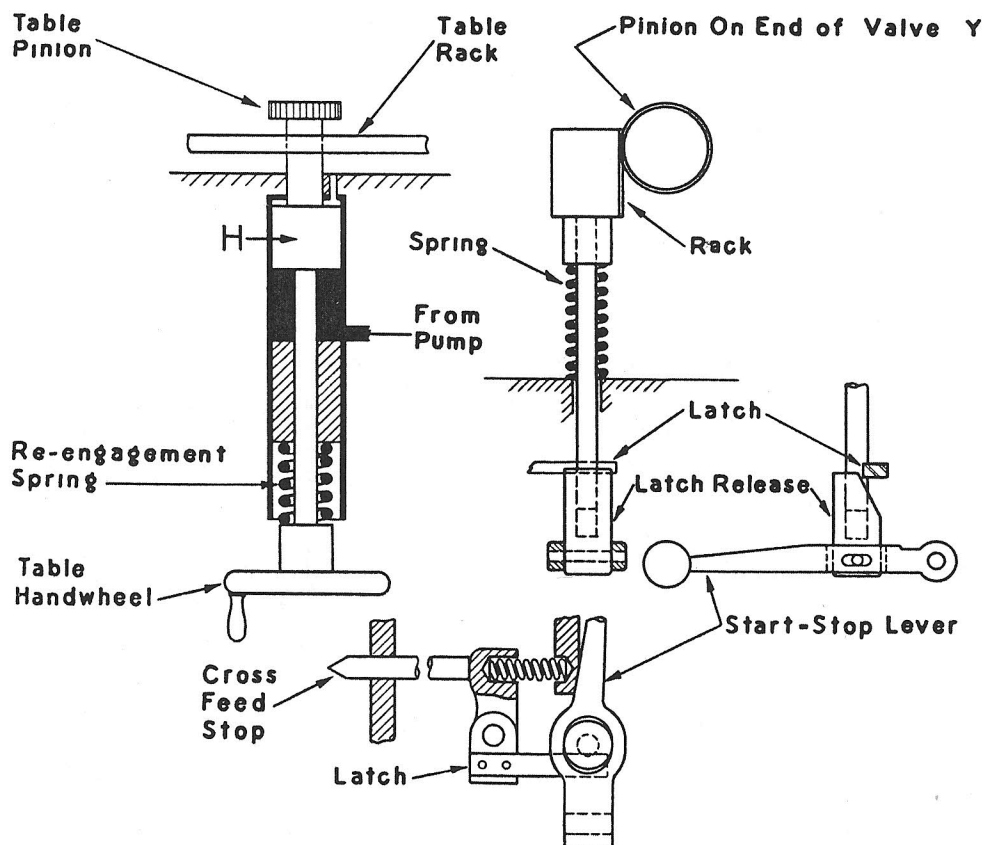
Note that most of the connections shown in Diagrams I and II are passages cast or drilled in the valve case, rather than external pipes or tubing.

The controls are shown in this position:

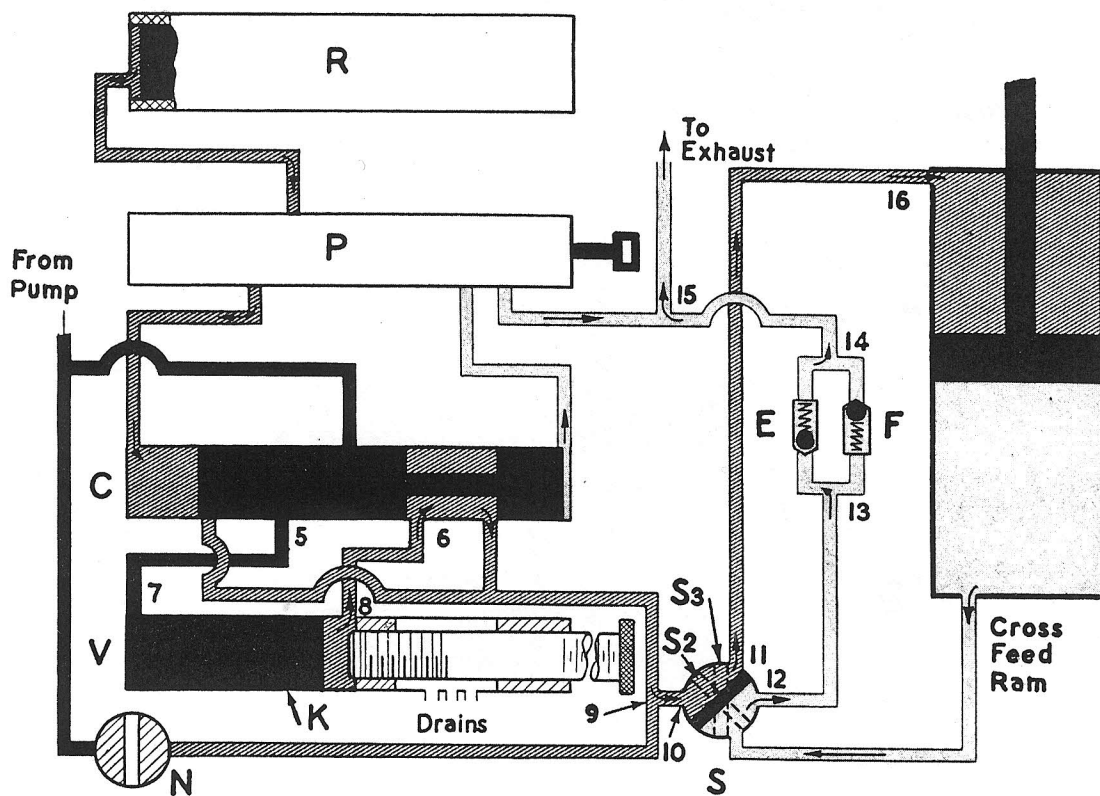
Start-stop valve Y is in *start* or operating position. Throttle T is open, permitting table traverse, and piston of pilot valve P is in right-hand position, causing table to move to right. Valve V is set to give nearly maximum automatic cross feed. Valve N is closed; and valve S is set to give inward power feed of the carriage.



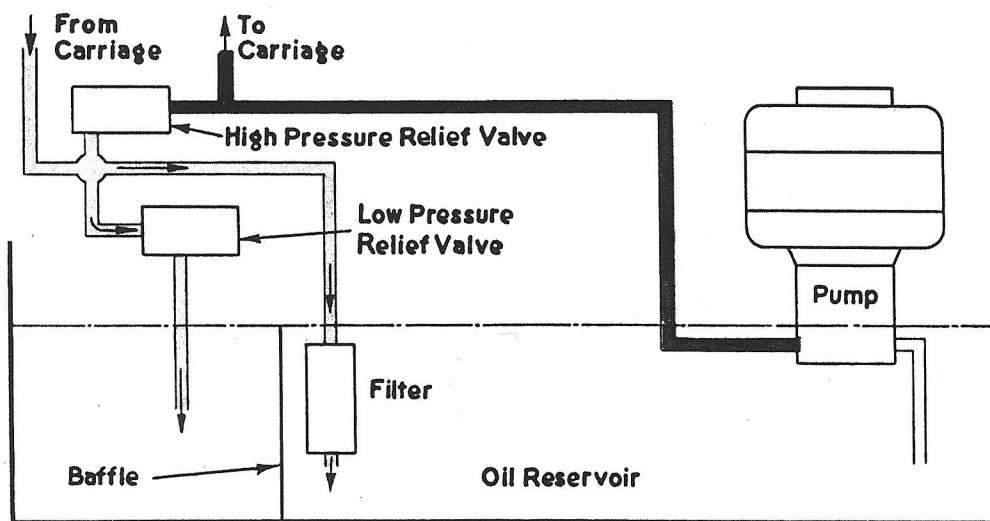
I Table Traverse Circuits



III Stop Mechanism and Table Handwheel Throwout



II Cross Feed Circuits



IV Pump, Filter and Pressure Control System