# Photo 1

## HANDBOOK

For

*Automatic* **SCREW MACHINES**

★ *Swiss Type* ★

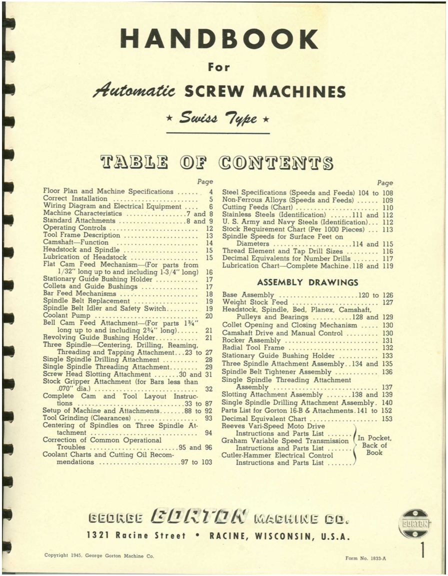
Price $2.50

*Published by*

GEORGE GORTON MACHINE CO.
RACINE, WISCONSIN, U. S. A.

BOOK NO. 1833-A

# Photo 2



# HANDBOOK

For

*Automatic* SCREW MACHINES

★ *Swiss Type* ★

## TABLE OF CONTENTS

### ASSEMBLY DRAWINGS

GEORGE GORTON MACHINE CO.
1321 Racine Street • RACINE, WISCONSIN, U.S.A.

Form No. 1833-A

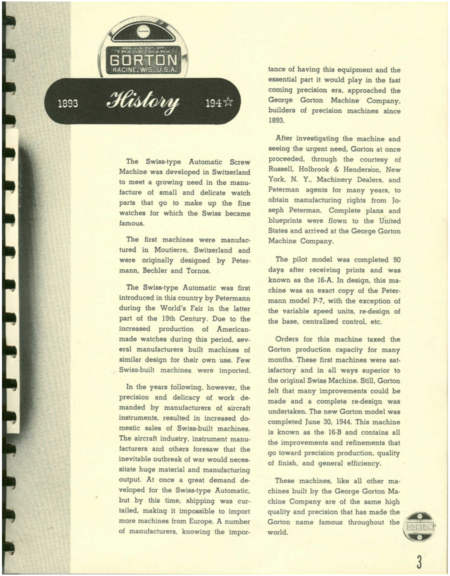
# Photo 3

## Foreword

The purpose of this book is to enable the process engineer, designer, setup man, and operator to better understand operating characteristics of the Swiss-type Automatic as it applies to their department. It is only with a thorough understanding of the principles, advantages, and operating functions that maximum efficiency, quality, production, and profitable operation can be maintained. It was with this thought in mind that this manual was prepared and made available for the men associated with these various departments.

2

# Photo 4



REG. U.S. PAT. OFF.
TRADE MARK
GORTON
RACINE, WIS., U.S.A.

## 1893 *History* 194☆

The Swiss-type Automatic Screw Machine was developed in Switzerland to meet a growing need in the manufacture of small and delicate watch parts that go to make up the fine watches for which the Swiss became famous.

The first machines were manufactured in Moutierre, Switzerland and were originally designed by Petermann, Bechler and Tornos.

The Swiss-type Automatic was first introduced in this country by Petermann during the World's Fair in the latter part of the 19th Century. Due to the increased production of American-made watches during this period, several manufacturers built machines of similar design for their own use. Few Swiss-built machines were imported.

In the years following, however, the precision and delicacy of work demanded by manufacturers of aircraft instruments, resulted in increased domestic sales of Swiss-built machines. The aircraft industry, instrument manufacturers and others foresaw that the inevitable outbreak of war would necessitate huge material and manufacturing output. At once a great demand developed for the Swiss-type Automatic, but by this time, shipping was curtailed, making it impossible to import more machines from Europe. A number of manufacturers, knowing the importance of having this equipment and the essential part it would play in the fast coming precision era, approached the George Gorton Machine Company, builders of precision machines since 1893.

After investigating the machine and seeing the urgent need, Gorton at once proceeded, through the courtesy of Russell, Holbrook & Henderson, New York, N. Y., Machinery Dealers, and Peterman agents for many years, to obtain manufacturing rights from Joseph Peterman. Complete plans and blueprints were flown to the United States and arrived at the George Gorton Machine Company.

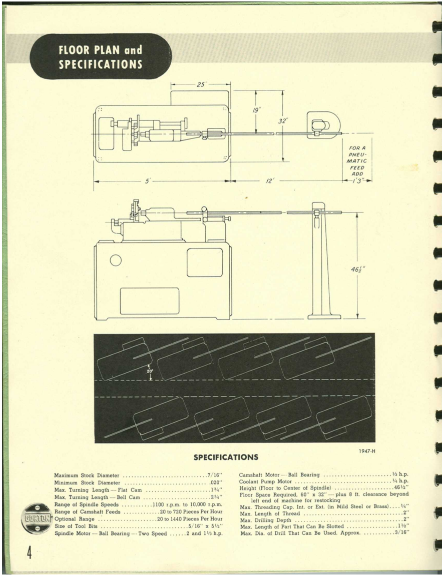
The pilot model was completed 90 days after receiving prints and was known as the 16-A. In design, this machine was an exact copy of the Petermann model P-7, with the exception of the variable speed units, re-design of the base, centralized control, etc.

Orders for this machine taxed the Gorton production capacity for many months. These first machines were satisfactory and in all ways superior to the original Swiss Machine. Still, Gorton felt that many improvements could be made and a complete re-design was undertaken. The new Gorton model was completed June 30, 1944. This machine is known as the 16-B and contains all the improvements and refinements that go toward precision production, quality of finish, and general efficiency.

These machines, like all other machines built by the George Gorton Machine Company are of the same high quality and precision that has made the Gorton name famous throughout the world.

GORTON

# Photo 5



## FLOOR PLAN and SPECIFICATIONS

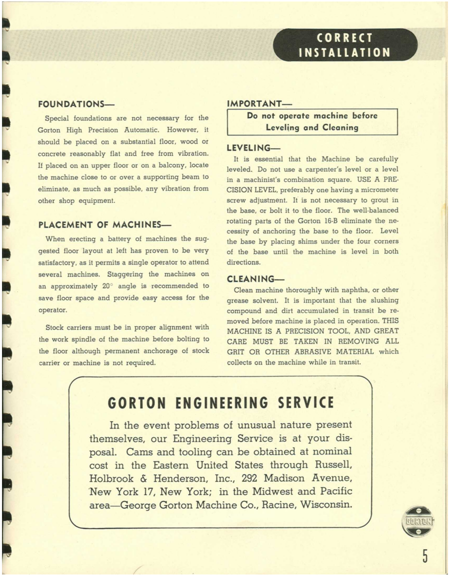
1947-H

### SPECIFICATIONS

| | |
|---|---|
| Maximum Stock Diameter | 7/16" |
| Minimum Stock Diameter | .020" |
| Max. Turning Length — Flat Cam | 1¾" |
| Max. Turning Length — Bell Cam | 2¾" |
| Range of Spindle Speeds | 1100 r.p.m. to 10,000 r.p.m. |
| Range of Camshaft Feeds | 20 to 720 Pieces Per Hour |
| Optional Range | 20 to 1440 Pieces Per Hour |
| Size of Tool Bits | 5/16" x 5½" |
| Spindle Motor — Ball Bearing — Two Speed | 2 and 1⅓ h.p. |
| Camshaft Motor — Ball Bearing | ⅓ h.p. |
| Coolant Pump Motor | ¼ h.p. |
| Height (Floor to Center of Spindle) | 46½" |
| Floor Space Required, 60" x 32" — plus 8 ft. clearance beyond left end of machine for restocking | |
| Max. Threading Cap. Int. or Ext. (in Mild Steel or Brass) | ¼" |
| Max. Length of Thread | 2" |
| Max. Drilling Depth | 2" |
| Max. Length of Part That Can Be Slotted | 1½" |
| Max. Dia. of Drill That Can Be Used. Approx. | 3/16" |

4

# Photo 6



## CORRECT INSTALLATION

### FOUNDATIONS—

Special foundations are not necessary for the Gorton High Precision Automatic. However, it should be placed on a substantial floor, wood or concrete reasonably flat and free from vibration. If placed on an upper floor or on a balcony, locate the machine close to or over a supporting beam to eliminate, as much as possible, any vibration from other shop equipment.

### PLACEMENT OF MACHINES—

When erecting a battery of machines the suggested floor layout at left has proven to be very satisfactory, as it permits a single operator to attend several machines. Staggering the machines on an approximately 20° angle is recommended to save floor space and provide easy access for the operator.

Stock carriers must be in proper alignment with the work spindle of the machine before bolting to the floor although permanent anchorage of stock carrier or machine is not required.

### IMPORTANT—

**Do not operate machine before Leveling and Cleaning**

### LEVELING—

It is essential that the Machine be carefully leveled. Do not use a carpenter's level or a level in a machinist's combination square. USE A PRECISION LEVEL, preferably one having a micrometer screw adjustment. It is not necessary to grout in the base, or bolt it to the floor. The well-balanced rotating parts of the Gorton 16-B eliminate the necessity of anchoring the base to the floor. Level the base by placing shims under the four corners of the base until the machine is level in both directions.

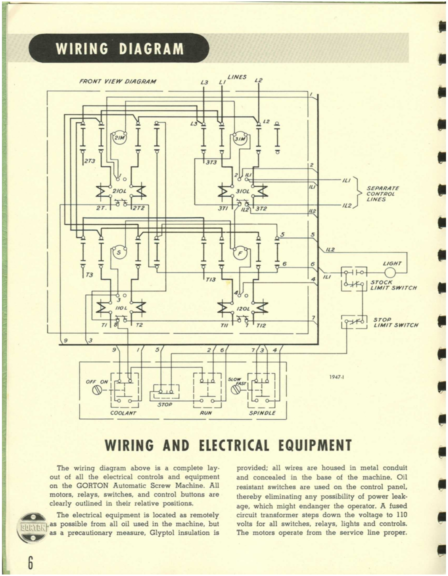
### CLEANING—

Clean machine thoroughly with naphtha, or other grease solvent. It is important that the slushing compound and dirt accumulated in transit be removed before machine is placed in operation. THIS MACHINE IS A PRECISION TOOL, AND GREAT CARE MUST BE TAKEN IN REMOVING ALL GRIT OR OTHER ABRASIVE MATERIAL which collects on the machine while in transit.

### GORTON ENGINEERING SERVICE

In the event problems of unusual nature present themselves, our Engineering Service is at your disposal. Cams and tooling can be obtained at nominal cost in the Eastern United States through Russell, Holbrook & Henderson, Inc., 292 Madison Avenue, New York 17, New York; in the Midwest and Pacific area—George Gorton Machine Co., Racine, Wisconsin.

# Photo 7



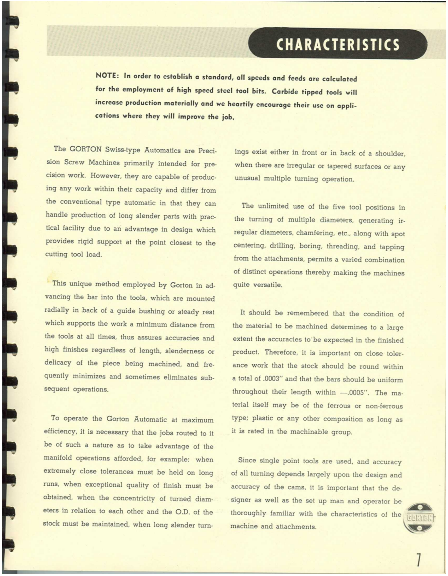
## WIRING DIAGRAM

## WIRING AND ELECTRICAL EQUIPMENT

The wiring diagram above is a complete layout of all the electrical controls and equipment on the GORTON Automatic Screw Machine. All motors, relays, switches, and control buttons are clearly outlined in their relative positions.

The electrical equipment is located as remotely as possible from all oil used in the machine, but as a precautionary measure, Glyptol insulation is provided; all wires are housed in metal conduit and concealed in the base of the machine. Oil resistant switches are used on the control panel, thereby eliminating any possibility of power leakage, which might endanger the operator. A fused circuit transformer steps down the voltage to 110 volts for all switches, relays, lights and controls. The motors operate from the service line proper.

# Photo 8



## CHARACTERISTICS

**NOTE: In order to establish a standard, all speeds and feeds are calculated for the employment of high speed steel tool bits. Carbide tipped tools will increase production materially and we heartily encourage their use on applications where they will improve the job.**

The GORTON Swiss-type Automatics are Precision Screw Machines primarily intended for precision work. However, they are capable of producing any work within their capacity and differ from the conventional type automatic in that they can handle production of long slender parts with practical facility due to an advantage in design which provides rigid support at the point closest to the cutting tool load.

This unique method employed by Gorton in advancing the bar into the tools, which are mounted radially in back of a guide bushing or steady rest which supports the work a minimum distance from the tools at all times, thus assures accuracies and high finishes regardless of length, slenderness or delicacy of the piece being machined, and frequently minimizes and sometimes eliminates subsequent operations.

To operate the Gorton Automatic at maximum efficiency, it is necessary that the jobs routed to it be of such a nature as to take advantage of the manifold operations afforded, for example: when extremely close tolerances must be held on long runs, when exceptional quality of finish must be obtained, when the concentricity of turned diameters in relation to each other and the O.D. of the stock must be maintained, when long slender turnings exist either in front or in back of a shoulder, when there are irregular or tapered surfaces or any unusual multiple turning operation.

The unlimited use of the five tool positions in the turning of multiple diameters, generating irregular diameters, chamfering, etc., along with spot centering, drilling, boring, threading, and tapping from the attachments, permits a varied combination of distinct operations thereby making the machines quite versatile.

It should be remembered that the condition of the material to be machined determines to a large extent the accuracies to be expected in the finished product. Therefore, it is important on close tolerance work that the stock should be round within a total of .0003" and that the bars should be uniform throughout their length within —.0005". The material itself may be of the ferrous or non-ferrous type; plastic or any other composition as long as it is rated in the machinable group.

Since single point tools are used, and accuracy of all turning depends largely upon the design and accuracy of the cams, it is important that the designer as well as the set up man and operator be thoroughly familiar with the characteristics of the machine and attachments.

# Photo 9

## THE MACHINE PROPER

The headstock spindle is powered by a 2 H.P., two speed motor through a Reeves Variable Drive. A 1/3 H.P. constant speed motor drives a Graham Variable Transmission which in turn varies the cam feeds.

All operational movements of the machine and attachments are controlled from the camshaft by means of flat or bell type cams. Power is obtained from the Graham Transmission by means of roller chains and sprockets. The chains are located inside the base and run through a special lubricant, thereby reducing wear to a minimum.

The headstock is a moving member working on hardened steel ways and is relative to all lateral motions of the bar. The spindle construction is anti-friction bearing type, precision built and sturdily constructed to withstand all rigor of high speed production — yet retaining the accuracies necessary to produce precision work.

The tool frame carries all of the tool holders relative to turning operations of the machine. Three of these slide holders working in dovetail ways are often referred to as the overhead holders, because of their position in relation to the bar. The other two holders are mounted upon a single arm, commonly called the rocker arm (derived from its operational motion) and the tools are therefore called rocker arm tools.

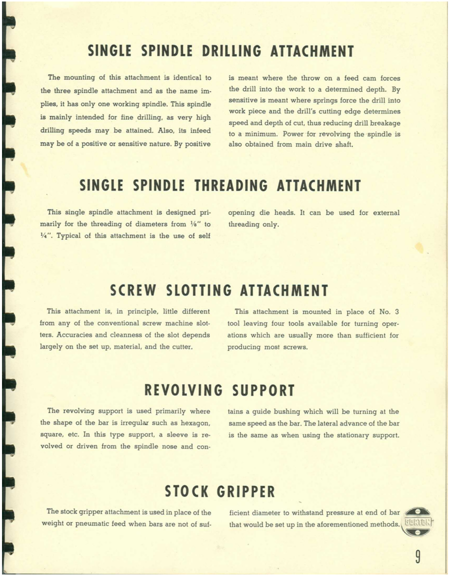
The actuation of the rocker arm tools is obtained from a single cam. The overhead tools are mounted individually and independent of each other. Their operational movements are derived from independent cams. All tools may be adjusted axially or radially by means of micrometer screws, thereby gaining accuracies of tool setting in a minimum amount of time.

The cams necessary to operate various moving parts of the machine are usually laid out in sets for a specific job except on pieces of simple nature or relative design. The cams themselves may be of a soft material (cast iron) when small quantity production runs are made, but on long runs, hardened cams are preferable.

## THE THREE SPINDLE ATTACHMENT

This attachment mounts against a scraped surface on the front part of the machine and as its name implies, carries three work spindles. Two of these spindles are limited to spot centering, drilling, and reaming. The third spindle may also be used for these operations, but is primarily designed for threading. The travel of these spindles is obtained from a common lever which derives its motion from a bell type cam. The positioning of spindles is controlled by two flat cams. Power for revolving the second and third spindle is obtained from the main drive shaft in the base of the machine. The first spindle does not rotate and no provision is made for revolving it at any time.

# Photo 10



## SINGLE SPINDLE DRILLING ATTACHMENT

The mounting of this attachment is identical to the three spindle attachment and as the name implies, it has only one working spindle. This spindle is mainly intended for fine drilling, as very high drilling speeds may be attained. Also, its infeed may be of a positive or sensitive nature. By positive is meant where the throw on a feed cam forces the drill into the work to a determined depth. By sensitive is meant where springs force the drill into work piece and the drill's cutting edge determines speed and depth of cut, thus reducing drill breakage to a minimum. Power for revolving the spindle is also obtained from main drive shaft.

## SINGLE SPINDLE THREADING ATTACHMENT

This single spindle attachment is designed primarily for the threading of diameters from ⅛" to ¼". Typical of this attachment is the use of self opening die heads. It can be used for external threading only.

## SCREW SLOTTING ATTACHMENT

This attachment is, in principle, little different from any of the conventional screw machine slotters. Accuracies and cleanness of the slot depends largely on the set up, material, and the cutter.

This attachment is mounted in place of No. 3 tool leaving four tools available for turning operations which are usually more than sufficient for producing most screws.

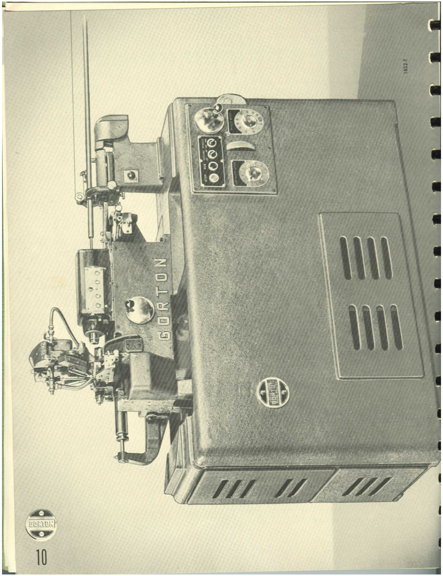
## REVOLVING SUPPORT

The revolving support is used primarily where the shape of the bar is irregular such as hexagon, square, etc. In this type support, a sleeve is revolved or driven from the spindle nose and contains a guide bushing which will be turning at the same speed as the bar. The lateral advance of the bar is the same as when using the stationary support.

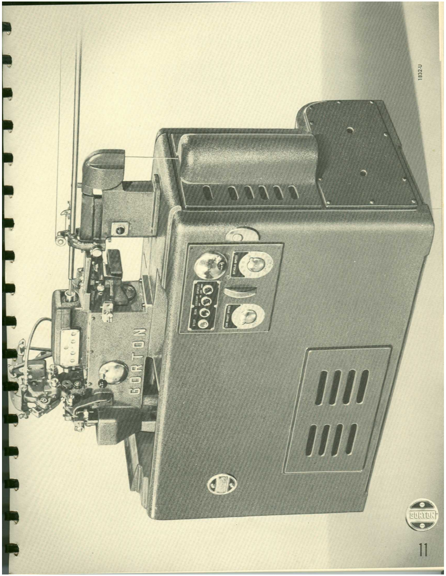
## STOCK GRIPPER

The stock gripper attachment is used in place of the weight or pneumatic feed when bars are not of sufficient diameter to withstand pressure at end of bar that would be set up in the aforementioned methods.

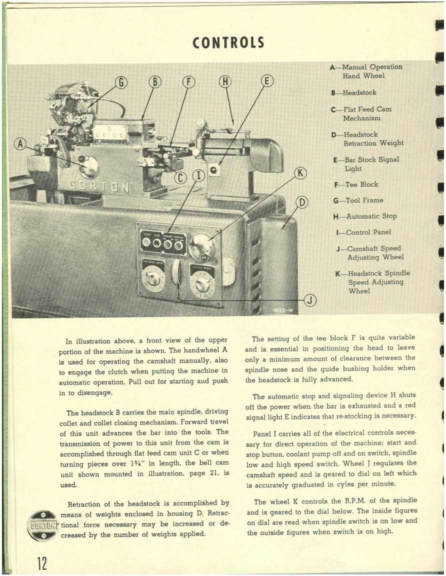
# Photo 11



# Photo 12



# Photo 13



## CONTROLS

A—Manual Operation Hand Wheel

B—Headstock

C—Flat Feed Cam Mechanism

D—Headstock Retraction Weight

E—Bar Stock Signal Light

F—Tee Block

G—Tool Frame

H—Automatic Stop

I—Control Panel

J—Camshaft Speed Adjusting Wheel

K—Headstock Spindle Speed Adjusting Wheel

In illustration above, a front view of the upper portion of the machine is shown. The handwheel A is used for operating the camshaft manually, also to engage the clutch when putting the machine in automatic operation. Pull out for starting and push in to disengage.

The headstock B carries the main spindle, driving collet and collet closing mechanism. Forward travel of this unit advances the bar into the tools. The transmission of power to this unit from the cam is accomplished through flat feed cam unit C or when turning pieces over 1¾" in length, the bell cam unit shown mounted in illustration, page 21, is used.

Retraction of the headstock is accomplished by means of weights enclosed in housing D. Retractional force necessary may be increased or decreased by the number of weights applied.

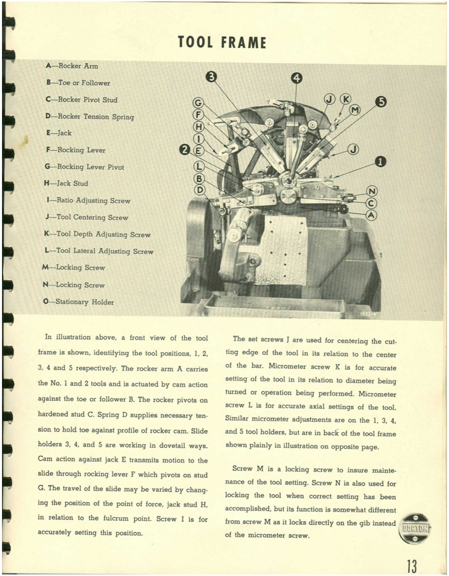
The setting of the tee block F is quite variable and is essential in positioning the head to leave only a minimum amount of clearance between the spindle nose and the guide bushing holder when the headstock is fully advanced.

The automatic stop and signaling device H shuts off the power when the bar is exhausted and a red signal light E indicates that re-stocking is necessary.

Panel I carries all of the electrical controls necessary for direct operation of the machine; start and stop button, coolant pump off and on switch, spindle low and high speed switch. Wheel J regulates the camshaft speed and is geared to dial on left which is accurately graduated in cyles per minute.

The wheel K controls the R.P.M. of the spindle and is geared to the dial below. The inside figures on dial are read when spindle switch is on low and the outside figures when switch is on high.

# Photo 14



## TOOL FRAME

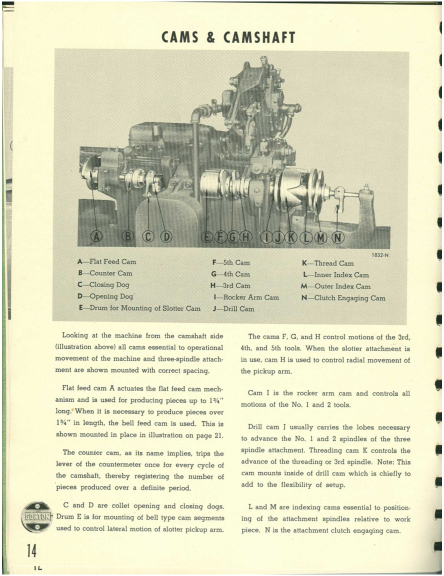
- A—Rocker Arm
- B—Toe or Follower
- C—Rocker Pivot Stud
- D—Rocker Tension Spring
- E—Jack
- F—Rocking Lever
- G—Rocking Lever Pivot
- H—Jack Stud
- I—Ratio Adjusting Screw
- J—Tool Centering Screw
- K—Tool Depth Adjusting Screw
- L—Tool Lateral Adjusting Screw
- M—Locking Screw
- N—Locking Screw
- O—Stationary Holder

In illustration above, a front view of the tool frame is shown, identifying the tool positions, 1, 2, 3, 4 and 5 respectively. The rocker arm A carries the No. 1 and 2 tools and is actuated by cam action against the toe or follower B. The rocker pivots on hardened stud C. Spring D supplies necessary tension to hold toe against profile of rocker cam. Slide holders 3, 4, and 5 are working in dovetail ways. Cam action against jack E transmits motion to the slide through rocking lever F which pivots on stud G. The travel of the slide may be varied by changing the position of the point of force, jack stud H, in relation to the fulcrum point. Screw I is for accurately setting this position.

The set screws J are used for centering the cutting edge of the tool in its relation to the center of the bar. Micrometer screw K is for accurate setting of the tool in its relation to diameter being turned or operation being performed. Micrometer screw L is for accurate axial settings of the tool. Similar micrometer adjustments are on the 1, 3, 4, and 5 tool holders, but are in back of the tool frame shown plainly in illustration on opposite page.

Screw M is a locking screw to insure maintenance of the tool setting. Screw N is also used for locking the tool when correct setting has been accomplished, but its function is somewhat different from screw M as it locks directly on the gib instead of the micrometer screw.

# Photo 15



## CAMS & CAMSHAFT

A—Flat Feed Cam
B—Counter Cam
C—Closing Dog
D—Opening Dog
E—Drum for Mounting of Slotter Cam
F—5th Cam
G—4th Cam
H—3rd Cam
I—Rocker Arm Cam
J—Drill Cam
K—Thread Cam
L—Inner Index Cam
M—Outer Index Cam
N—Clutch Engaging Cam

Looking at the machine from the camshaft side (illustration above) all cams essential to operational movement of the machine and three-spindle attachment are shown mounted with correct spacing.

Flat feed cam A actuates the flat feed cam mechanism and is used for producing pieces up to 1¾" long. When it is necessary to produce pieces over 1¾" in length, the bell feed cam is used. This is shown mounted in place in illustration on page 21.

The counter cam, as its name implies, trips the lever of the countermeter once for every cycle of the camshaft, thereby registering the number of pieces produced over a definite period.

C and D are collet opening and closing dogs. Drum E is for mounting of bell type cam segments used to control lateral motion of slotter pickup arm.

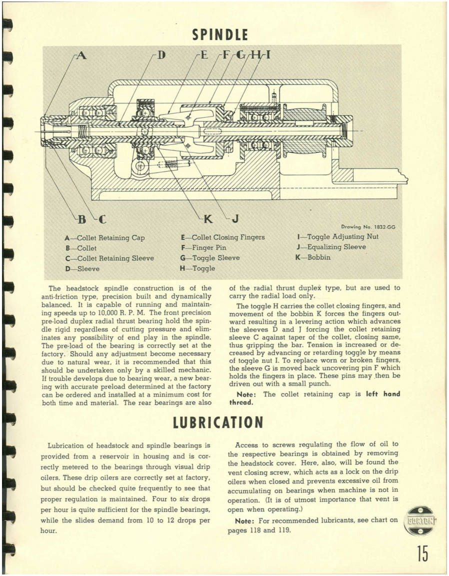
The cams F, G, and H control motions of the 3rd, 4th, and 5th tools. When the slotter attachment is in use, cam H is used to control radial movement of the pickup arm.

Cam I is the rocker arm cam and controls all motions of the No. 1 and 2 tools.

Drill cam J usually carries the lobes necessary to advance the No. 1 and 2 spindles of the three spindle attachment. Threading cam K controls the advance of the threading or 3rd spindle. Note: This cam mounts inside of drill cam which is chiefly to add to the flexibility of setup.

L and M are indexing cams essential to positioning of the attachment spindles relative to work piece. N is the attachment clutch engaging cam.

# Photo 16



## SPINDLE

Drawing No. 1832-GG

**A**—Collet Retaining Cap
**B**—Collet
**C**—Collet Retaining Sleeve
**D**—Sleeve
**E**—Collet Closing Fingers
**F**—Finger Pin
**G**—Toggle Sleeve
**H**—Toggle
**I**—Toggle Adjusting Nut
**J**—Equalizing Sleeve
**K**—Bobbin

The headstock spindle construction is of the anti-friction type, precision built and dynamically balanced. It is capable of running and maintaining speeds up to 10,000 R. P. M. The front precision pre-load duplex radial thrust bearing hold the spindle rigid regardless of cutting pressure and eliminates any possibility of end play in the spindle. The pre-load of the bearing is correctly set at the factory. Should any adjustment become necessary due to natural wear, it is recommended that this should be undertaken only by a skilled mechanic. If trouble develops due to bearing wear, a new bearing with accurate preload determined at the factory can be ordered and installed at a minimum cost for both time and material. The rear bearings are also of the radial thrust duplex type, but are used to carry the radial load only.

The toggle H carries the collet closing fingers, and movement of the bobbin K forces the fingers outward resulting in a levering action which advances the sleeves D and J forcing the collet retaining sleeve C against taper of the collet, closing same, thus gripping the bar. Tension is increased or decreased by advancing or retarding toggle by means of toggle nut I. To replace worn or broken fingers, the sleeve G is moved back uncovering pin F which holds the fingers in place. These pins may then be driven out with a small punch.

**Note:** The collet retaining cap is **left hand thread.**

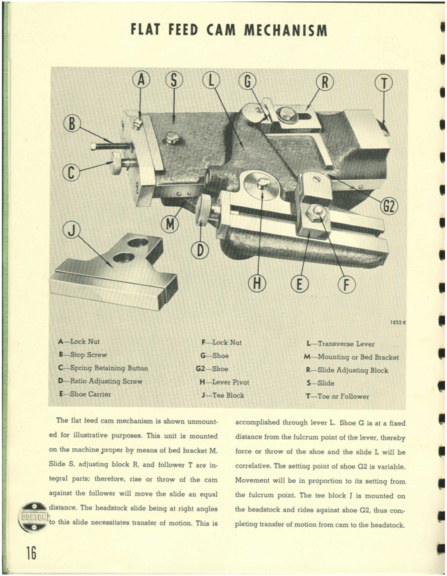
## LUBRICATION

Lubrication of headstock and spindle bearings is provided from a reservoir in housing and is correctly metered to the bearings through visual drip oilers. These drip oilers are correctly set at factory, but should be checked quite frequently to see that proper regulation is maintained. Four to six drops per hour is quite sufficient for the spindle bearings, while the slides demand from 10 to 12 drops per hour.

Access to screws regulating the flow of oil to the respective bearings is obtained by removing the headstock cover. Here, also, will be found the vent closing screw, which acts as a lock on the drip oilers when closed and prevents excessive oil from accumulating on bearings when machine is not in operation. (It is of utmost importance that vent is open when operating.)

**Note:** For recommended lubricants, see chart on pages 118 and 119.

# Photo 17



## FLAT FEED CAM MECHANISM

A—Lock Nut
B—Stop Screw
C—Spring Retaining Button
D—Ratio Adjusting Screw
E—Shoe Carrier
F—Lock Nut
G—Shoe
G2—Shoe
H—Lever Pivot
J—Tee Block
L—Transverse Lever
M—Mounting or Bed Bracket
R—Slide Adjusting Block
S—Slide
T—Toe or Follower

The flat feed cam mechanism is shown unmounted for illustrative purposes. This unit is mounted on the machine proper by means of bed bracket M. Slide S, adjusting block R, and follower T are integral parts; therefore, rise or throw of the cam against the follower will move the slide an equal distance. The headstock slide being at right angles to this slide necessitates transfer of motion. This is accomplished through lever L. Shoe G is at a fixed distance from the fulcrum point of the lever, thereby force or throw of the shoe and the slide L will be correlative. The setting point of shoe G2 is variable. Movement will be in proportion to its setting from the fulcrum point. The tee block J is mounted on the headstock and rides against shoe G2, thus completing transfer of motion from cam to the headstock.

# Photo 18

## STATIONARY HOLDER

No. 1832-AA

1832-HH

The stationary holder shown above is standard equipment on the automatic. It mounts in the center of the tool frame and is held securely by means of the large nut provided. The two sleeves are furnished to take care of the two size bushings used therein. The holder is slotted to allow adjustment of the sleeve in relation to the tools. The nut on end of this sleeve is for accurate setting of the guide bushing in relation to stock O. D.

## COLLETS AND GUIDE BUSHINGS

1832-P

Shown above are the various types of collets and guide bushings used in connection with the machine, single spindle drilling attachment and three spindle attachment.

Collet type 27J is a spindle nose or headstock collet and used when operating on bar stock from 1/4" to 7/16" in diameter.

Collet 26H is also a spindle nose or headstock collet and is used on bar stock from 3/64" to 7/32" in diameter.

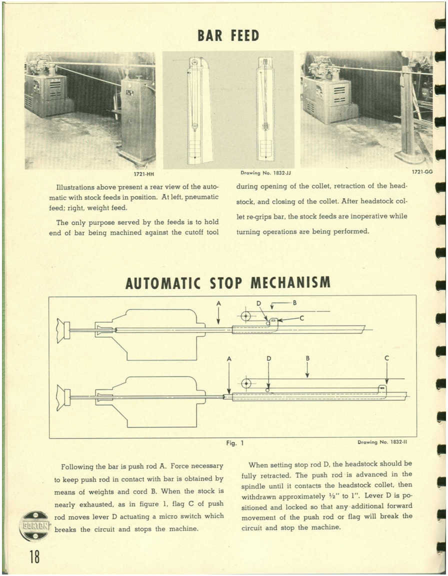
The small collet in center is 26G and is used in connection with the single spindle drilling attachment and No. 1 and No. 2 position, of the three spindle attachment.

Bushing GO is a stationary type for bar stock 3/64" to 7/32" in diameter.

Bushing GT, also of the stationary type, is for stock from 1/4" to 7/16".

The stationary guide bushings are slotted for adjustment. This adjustment feature is not to be considered adjustable over a wide range. Reduction of .001" is all that is recommended. It can readily be understood that more than .001" adjustment would distort the hole. A carbide insert is brazed in the center of the bushing through which the guide hole is lapped. The guide hole is held to a tolerance of + .0005". Carbide inserted bushings are recommended for durability and long wear. Seizure or freezing of stock in the guide hole is practically eliminated. High speed steel bushings may be used satisfactorily when operating on material in the non-ferrous group, but their wearing qualities are not comparable to the carbide type.

# Photo 19



## BAR FEED

1721-HH

Drawing No. 1832-JJ

1721-GG

Illustrations above present a rear view of the automatic with stock feeds in position. At left, pneumatic feed; right, weight feed.

The only purpose served by the feeds is to hold end of bar being machined against the cutoff tool during opening of the collet, retraction of the headstock, and closing of the collet. After headstock collet re-grips bar, the stock feeds are inoperative while turning operations are being performed.

## AUTOMATIC STOP MECHANISM

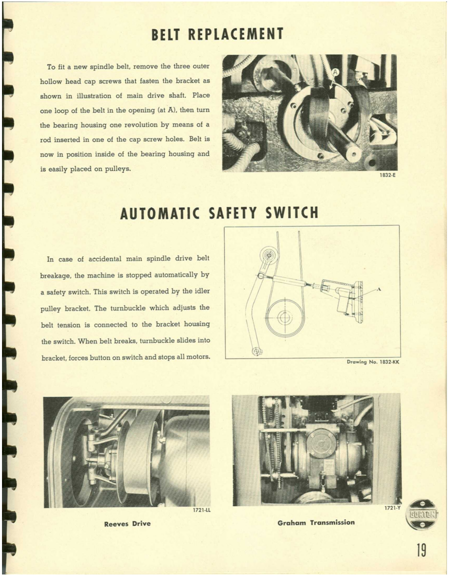
Fig. 1

Drawing No. 1832-II

Following the bar is push rod A. Force necessary to keep push rod in contact with bar is obtained by means of weights and cord B. When the stock is nearly exhausted, as in figure 1, flag C of push rod moves lever D actuating a micro switch which breaks the circuit and stops the machine.

When setting stop rod D, the headstock should be fully retracted. The push rod is advanced in the spindle until it contacts the headstock collet, then withdrawn approximately ½" to 1". Lever D is positioned and locked so that any additional forward movement of the push rod or flag will break the circuit and stop the machine.

# Photo 20



## BELT REPLACEMENT

To fit a new spindle belt, remove the three outer hollow head cap screws that fasten the bracket as shown in illustration of main drive shaft. Place one loop of the belt in the opening (at A), then turn the bearing housing one revolution by means of a rod inserted in one of the cap screw holes. Belt is now in position inside of the bearing housing and is easily placed on pulleys.

1832-E

## AUTOMATIC SAFETY SWITCH

In case of accidental main spindle drive belt breakage, the machine is stopped automatically by a safety switch. This switch is operated by the idler pulley bracket. The turnbuckle which adjusts the belt tension is connected to the bracket housing the switch. When belt breaks, turnbuckle slides into bracket, forces button on switch and stops all motors.

Drawing No. 1832-KK

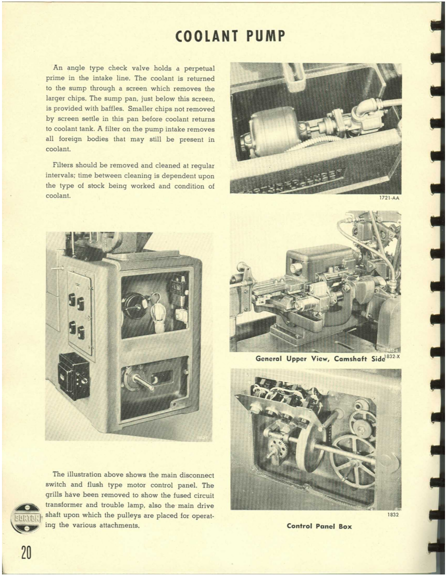
1721-LL

**Reeves Drive**

1721-Y

**Graham Transmission**

# Photo 21



## COOLANT PUMP

An angle type check valve holds a perpetual prime in the intake line. The coolant is returned to the sump through a screen which removes the larger chips. The sump pan, just below this screen, is provided with baffles. Smaller chips not removed by screen settle in this pan before coolant returns to coolant tank. A filter on the pump intake removes all foreign bodies that may still be present in coolant.

Filters should be removed and cleaned at regular intervals; time between cleaning is dependent upon the type of stock being worked and condition of coolant.

1721-AA

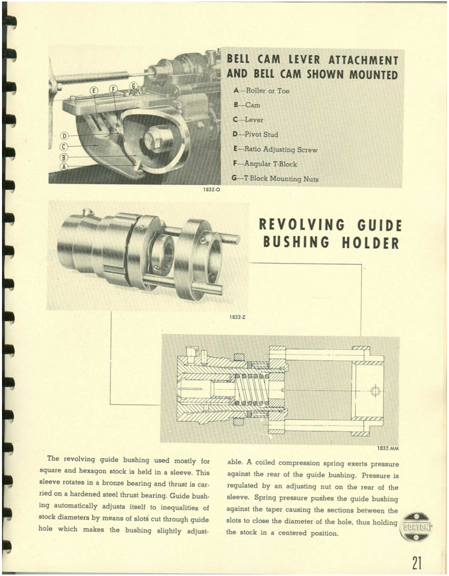
General Upper View, Camshaft Side 1832-X

The illustration above shows the main disconnect switch and flush type motor control panel. The grills have been removed to show the fused circuit transformer and trouble lamp, also the main drive shaft upon which the pulleys are placed for operating the various attachments.

1832

Control Panel Box

# Photo 22



## BELL CAM LEVER ATTACHMENT AND BELL CAM SHOWN MOUNTED

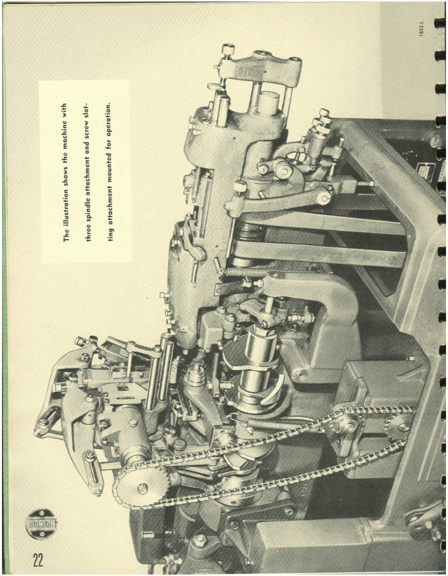
A—Roller or Toe
B—Cam
C—Lever
D—Pivot Stud
E—Ratio Adjusting Screw
F—Angular T-Block
G—T-Block Mounting Nuts

## REVOLVING GUIDE BUSHING HOLDER

The revolving guide bushing used mostly for square and hexagon stock is held in a sleeve. This sleeve rotates in a bronze bearing and thrust is carried on a hardened steel thrust bearing. Guide bushing automatically adjusts itself to inequalities of stock diameters by means of slots cut through guide hole which makes the bushing slightly adjustable. A coiled compression spring exerts pressure against the rear of the guide bushing. Pressure is regulated by an adjusting nut on the rear of the sleeve. Spring pressure pushes the guide bushing against the taper causing the sections between the slots to close the diameter of the hole, thus holding the stock in a centered position.

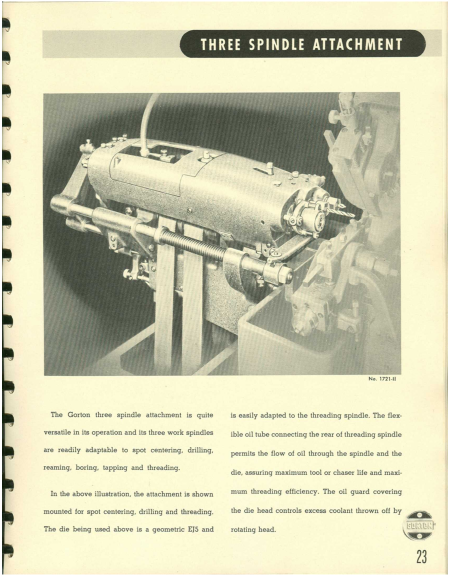
21

# Photo 23



The illustration shows the machine with three spindle attachment and screw slotting attachment mounted for operation.

# Photo 24



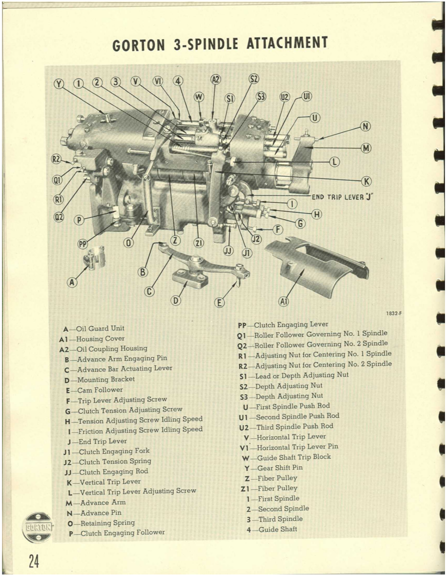
## THREE SPINDLE ATTACHMENT

No. 1721-II

The Gorton three spindle attachment is quite versatile in its operation and its three work spindles are readily adaptable to spot centering, drilling, reaming, boring, tapping and threading.

In the above illustration, the attachment is shown mounted for spot centering, drilling and threading. The die being used above is a geometric EJ5 and is easily adapted to the threading spindle. The flexible oil tube connecting the rear of threading spindle permits the flow of oil through the spindle and the die, assuring maximum tool or chaser life and maximum threading efficiency. The oil guard covering the die head controls excess coolant thrown off by rotating head.

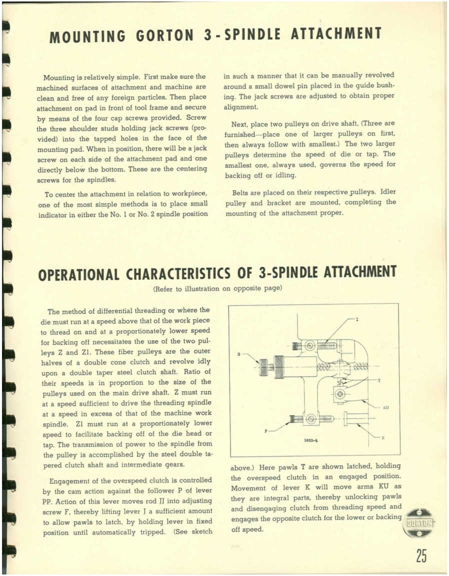
# Photo 25



## GORTON 3-SPINDLE ATTACHMENT

**A**—Oil Guard Unit
**A1**—Housing Cover
**A2**—Oil Coupling Housing
**B**—Advance Arm Engaging Pin
**C**—Advance Bar Actuating Lever
**D**—Mounting Bracket
**E**—Cam Follower
**F**—Trip Lever Adjusting Screw
**G**—Clutch Tension Adjusting Screw
**H**—Tension Adjusting Screw Idling Speed
**I**—Friction Adjusting Screw Idling Speed
**J**—End Trip Lever
**J1**—Clutch Engaging Fork
**J2**—Clutch Tension Spring
**JJ**—Clutch Engaging Rod
**K**—Vertical Trip Lever
**L**—Vertical Trip Lever Adjusting Screw
**M**—Advance Arm
**N**—Advance Pin
**O**—Retaining Spring
**P**—Clutch Engaging Follower
**PP**—Clutch Engaging Lever
**Q1**—Roller Follower Governing No. 1 Spindle
**Q2**—Roller Follower Governing No. 2 Spindle
**R1**—Adjusting Nut for Centering No. 1 Spindle
**R2**—Adjusting Nut for Centering No. 2 Spindle
**S1**—Lead or Depth Adjusting Nut
**S2**—Depth Adjusting Nut
**S3**—Depth Adjusting Nut
**U**—First Spindle Push Rod
**U1**—Second Spindle Push Rod
**U2**—Third Spindle Push Rod
**V**—Horizontal Trip Lever
**V1**—Horizontal Trip Lever Pin
**W**—Guide Shaft Trip Block
**Y**—Gear Shift Pin
**Z**—Fiber Pulley
**Z1**—Fiber Pulley
**1**—First Spindle
**2**—Second Spindle
**3**—Third Spindle
**4**—Guide Shaft

# Photo 26



## MOUNTING GORTON 3-SPINDLE ATTACHMENT

Mounting is relatively simple. First make sure the machined surfaces of attachment and machine are clean and free of any foreign particles. Then place attachment on pad in front of tool frame and secure by means of the four cap screws provided. Screw the three shoulder studs holding jack screws (provided) into the tapped holes in the face of the mounting pad. When in position, there will be a jack screw on each side of the attachment pad and one directly below the bottom. These are the centering screws for the spindles.

To center the attachment in relation to workpiece, one of the most simple methods is to place small indicator in either the No. 1 or No. 2 spindle position in such a manner that it can be manually revolved around a small dowel pin placed in the guide bushing. The jack screws are adjusted to obtain proper alignment.

Next, place two pulleys on drive shaft. (Three are furnished—place one of larger pulleys on first, then always follow with smallest.) The two larger pulleys determine the speed of die or tap. The smallest one, always used, governs the speed for backing off or idling.

Belts are placed on their respective pulleys. Idler pulley and bracket are mounted, completing the mounting of the attachment proper.

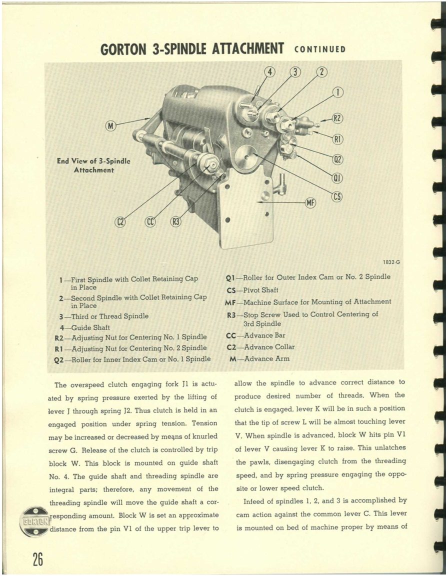
## OPERATIONAL CHARACTERISTICS OF 3-SPINDLE ATTACHMENT

(Refer to illustration on opposite page)

The method of differential threading or where the die must run at a speed above that of the work piece to thread on and at a proportionately lower speed for backing off necessitates the use of the two pulleys Z and Z1. These fiber pulleys are the outer halves of a double cone clutch and revolve idly upon a double taper steel clutch shaft. Ratio of their speeds is in proportion to the size of the pulleys used on the main drive shaft. Z must run at a speed sufficient to drive the threading spindle at a speed in excess of that of the machine work spindle. Z1 must run at a proportionately lower speed to facilitate backing off of the die head or tap. The transmission of power to the spindle from the pulley is accomplished by the steel double tapered clutch shaft and intermediate gears.

Engagement of the overspeed clutch is controlled by the cam action against the follower P of lever PP. Action of this lever moves rod JJ into adjusting screw F, thereby lifting lever J a sufficient amount to allow pawls to latch, by holding lever in fixed position until automatically tripped. (See sketch above.) Here pawls T are shown latched, holding the overspeed clutch in an engaged position. Movement of lever K will move arms KU as they are integral parts, thereby unlocking pawls and disengaging clutch from threading speed and engages the opposite clutch for the lower or backing off speed.

# Photo 27



## GORTON 3-SPINDLE ATTACHMENT CONTINUED

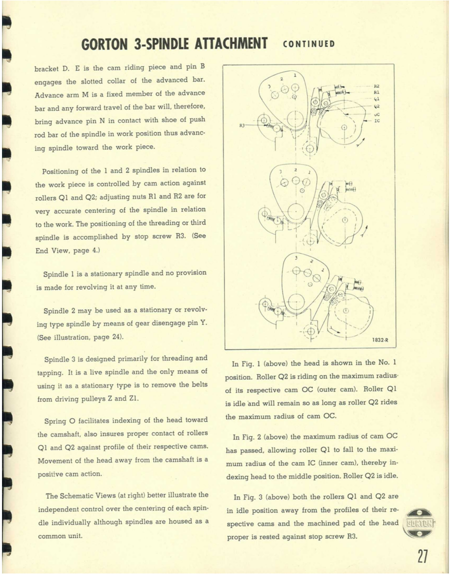
End View of 3-Spindle Attachment

**1**—First Spindle with Collet Retaining Cap in Place
**2**—Second Spindle with Collet Retaining Cap in Place
**3**—Third or Thread Spindle
**4**—Guide Shaft
**R2**—Adjusting Nut for Centering No. 1 Spindle
**R1**—Adjusting Nut for Centering No. 2 Spindle
**Q2**—Roller for Inner Index Cam or No. 1 Spindle
**Q1**—Roller for Outer Index Cam or No. 2 Spindle
**CS**—Pivot Shaft
**MF**—Machine Surface for Mounting of Attachment
**R3**—Stop Screw Used to Control Centering of 3rd Spindle
**CC**—Advance Bar
**C2**—Advance Collar
**M**—Advance Arm

The overspeed clutch engaging fork J1 is actuated by spring pressure exerted by the lifting of lever J through spring J2. Thus clutch is held in an engaged position under spring tension. Tension may be increased or decreased by means of knurled screw G. Release of the clutch is controlled by trip block W. This block is mounted on guide shaft No. 4. The guide shaft and threading spindle are integral parts; therefore, any movement of the threading spindle will move the guide shaft a corresponding amount. Block W is set an approximate distance from the pin V1 of the upper trip lever to allow the spindle to advance correct distance to produce desired number of threads. When the clutch is engaged, lever K will be in such a position that the tip of screw L will be almost touching lever V. When spindle is advanced, block W hits pin V1 of lever V causing lever K to raise. This unlatches the pawls, disengaging clutch from the threading speed, and by spring pressure engaging the opposite or lower speed clutch.

Infeed of spindles 1, 2, and 3 is accomplished by cam action against the common lever C. This lever is mounted on bed of machine proper by means of

# Photo 28



## GORTON 3-SPINDLE ATTACHMENT CONTINUED

bracket D. E is the cam riding piece and pin B engages the slotted collar of the advanced bar. Advance arm M is a fixed member of the advance bar and any forward travel of the bar will, therefore, bring advance pin N in contact with shoe of push rod bar of the spindle in work position thus advancing spindle toward the work piece.

Positioning of the 1 and 2 spindles in relation to the work piece is controlled by cam action against rollers Q1 and Q2; adjusting nuts R1 and R2 are for very accurate centering of the spindle in relation to the work. The positioning of the threading or third spindle is accomplished by stop screw R3. (See End View, page 4.)

Spindle 1 is a stationary spindle and no provision is made for revolving it at any time.

Spindle 2 may be used as a stationary or revolving type spindle by means of gear disengage pin Y. (See illustration, page 24).

Spindle 3 is designed primarily for threading and tapping. It is a live spindle and the only means of using it as a stationary type is to remove the belts from driving pulleys Z and Z1.

Spring O facilitates indexing of the head toward the camshaft, also insures proper contact of rollers Q1 and Q2 against profile of their respective cams. Movement of the head away from the camshaft is a positive cam action.

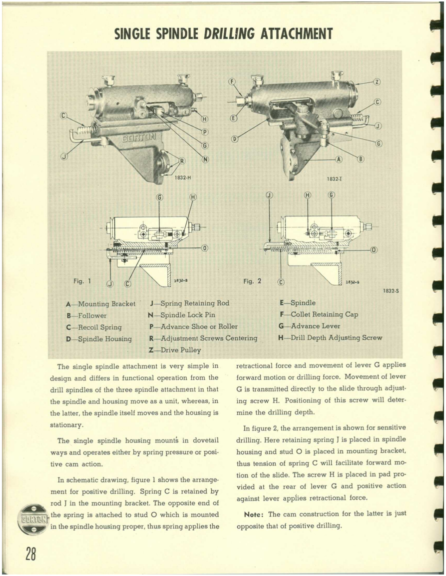
The Schematic Views (at right) better illustrate the independent control over the centering of each spindle individually although spindles are housed as a common unit.

In Fig. 1 (above) the head is shown in the No. 1 position. Roller Q2 is riding on the maximum radius of its respective cam OC (outer cam). Roller Q1 is idle and will remain so as long as roller Q2 rides the maximum radius of cam OC.

In Fig. 2 (above) the maximum radius of cam OC has passed, allowing roller Q1 to fall to the maximum radius of the cam IC (inner cam), thereby indexing head to the middle position. Roller Q2 is idle.

In Fig. 3 (above) both the rollers Q1 and Q2 are in idle position away from the profiles of their respective cams and the machined pad of the head proper is rested against stop screw R3.

# Photo 29



## SINGLE SPINDLE *DRILLING* ATTACHMENT

Fig. 1

Fig. 2

**A**—Mounting Bracket
**B**—Follower
**C**—Recoil Spring
**D**—Spindle Housing
**J**—Spring Retaining Rod
**N**—Spindle Lock Pin
**P**—Advance Shoe or Roller
**R**—Adjustment Screws Centering
**Z**—Drive Pulley
**E**—Spindle
**F**—Collet Retaining Cap
**G**—Advance Lever
**H**—Drill Depth Adjusting Screw

The single spindle attachment is very simple in design and differs in functional operation from the drill spindles of the three spindle attachment in that the spindle and housing move as a unit, whereas, in the latter, the spindle itself moves and the housing is stationary.

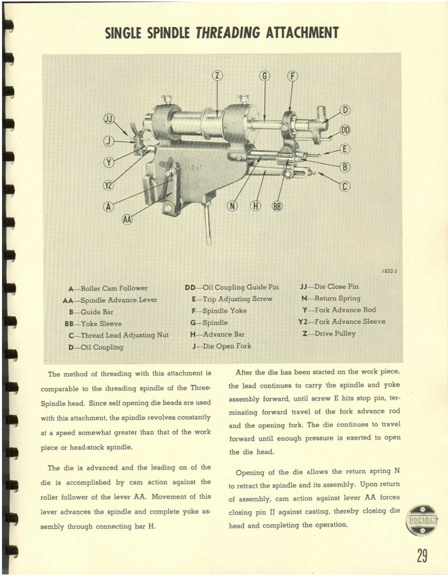
The single spindle housing mounts in dovetail ways and operates either by spring pressure or positive cam action.

In schematic drawing, figure 1 shows the arrangement for positive drilling. Spring C is retained by rod J in the mounting bracket. The opposite end of the spring is attached to stud O which is mounted in the spindle housing proper, thus spring applies the retractional force and movement of lever G applies forward motion or drilling force. Movement of lever G is transmitted directly to the slide through adjusting screw H. Positioning of this screw will determine the drilling depth.

In figure 2, the arrangement is shown for sensitive drilling. Here retaining spring J is placed in spindle housing and stud O is placed in mounting bracket, thus tension of spring C will facilitate forward motion of the slide. The screw H is placed in pad provided at the rear of lever G and positive action against lever applies retractional force.

**Note:** The cam construction for the latter is just opposite that of positive drilling.

# Photo 30



## SINGLE SPINDLE *THREADING* ATTACHMENT

**A**—Roller Cam Follower
**AA**—Spindle Advance Lever
**B**—Guide Bar
**BB**—Yoke Sleeve
**C**—Thread Lead Adjusting Nut
**D**—Oil Coupling
**DD**—Oil Coupling Guide Pin
**E**—Trip Adjusting Screw
**F**—Spindle Yoke
**G**—Spindle
**H**—Advance Bar
**J**—Die Open Fork
**JJ**—Die Close Pin
**N**—Return Spring
**Y**—Fork Advance Rod
**Y2**—Fork Advance Sleeve
**Z**—Drive Pulley

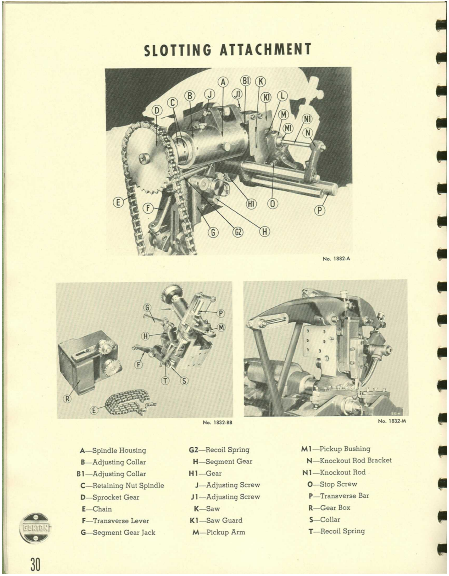
The method of threading with this attachment is comparable to the threading spindle of the Three-Spindle head. Since self opening die heads are used with this attachment, the spindle revolves constantly at a speed somewhat greater than that of the work piece or head-stock spindle.

The die is advanced and the leading on of the die is accomplished by cam action against the roller follower of the lever AA. Movement of this lever advances the spindle and complete yoke assembly through connecting bar H.

After the die has been started on the work piece, the lead continues to carry the spindle and yoke assembly forward, until screw E hits stop pin, terminating forward travel of the fork advance rod and the opening fork. The die continues to travel forward until enough pressure is exerted to open the die head.

Opening of the die allows the return spring N to retract the spindle and its assembly. Upon return of assembly, cam action against lever AA forces closing pin JJ against casting, thereby closing die head and completing the operation.

# Photo 31



## SLOTTING ATTACHMENT

No. 1882-A

No. 1832-BB

No. 1832-M

**A**—Spindle Housing
**B**—Adjusting Collar
**B1**—Adjusting Collar
**C**—Retaining Nut Spindle
**D**—Sprocket Gear
**E**—Chain
**F**—Transverse Lever
**G**—Segment Gear Jack
**G2**—Recoil Spring
**H**—Segment Gear
**H1**—Gear
**J**—Adjusting Screw
**J1**—Adjusting Screw
**K**—Saw
**K1**—Saw Guard
**M**—Pickup Arm
**M1**—Pickup Bushing
**N**—Knockout Rod Bracket
**N1**—Knockout Rod
**O**—Stop Screw
**P**—Transverse Bar
**R**—Gear Box
**S**—Collar
**T**—Recoil Spring

# Photo 32

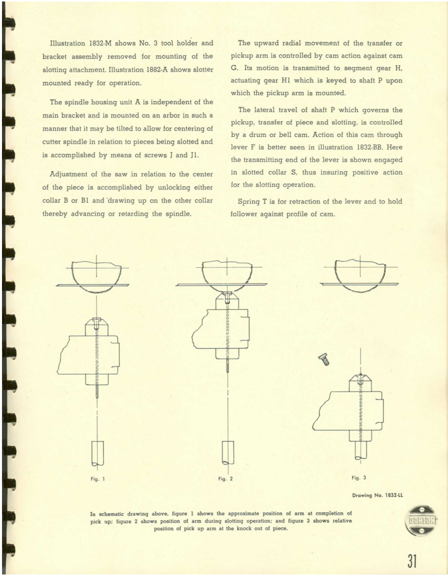


Illustration 1832-M shows No. 3 tool holder and bracket assembly removed for mounting of the slotting attachment. Illustration 1882-A shows slotter mounted ready for operation.

The spindle housing unit A is independent of the main bracket and is mounted on an arbor in such a manner that it may be tilted to allow for centering of cutter spindle in relation to pieces being slotted and is accomplished by means of screws J and J1.

Adjustment of the saw in relation to the center of the piece is accomplished by unlocking either collar B or B1 and drawing up on the other collar thereby advancing or retarding the spindle.

The upward radial movement of the transfer or pickup arm is controlled by cam action against cam G. Its motion is transmitted to segment gear H, actuating gear H1 which is keyed to shaft P upon which the pickup arm is mounted.

The lateral travel of shaft P which governs the pickup, transfer of piece and slotting, is controlled by a drum or bell cam. Action of this cam through lever F is better seen in illustration 1832-BB. Here the transmitting end of the lever is shown engaged in slotted collar S, thus insuring positive action for the slotting operation.

Spring T is for retraction of the lever and to hold follower against profile of cam.

Fig. 1

Fig. 2

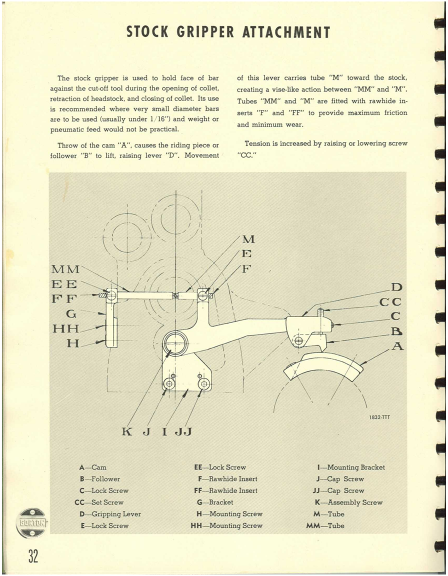
Fig. 3

Drawing No. 1832-LL

In schematic drawing above, figure 1 shows the approximate position of arm at completion of pick up; figure 2 shows position of arm during slotting operation; and figure 3 shows relative position of pick up arm at the knock out of piece.

31

# Photo 33



## STOCK GRIPPER ATTACHMENT

The stock gripper is used to hold face of bar against the cut-off tool during the opening of collet, retraction of headstock, and closing of collet. Its use is recommended where very small diameter bars are to be used (usually under 1/16") and weight or pneumatic feed would not be practical.

Throw of the cam "A", causes the riding piece or follower "B" to lift, raising lever "D". Movement of this lever carries tube "M" toward the stock, creating a vise-like action between "MM" and "M". Tubes "MM" and "M" are fitted with rawhide inserts "F" and "FF" to provide maximum friction and minimum wear.

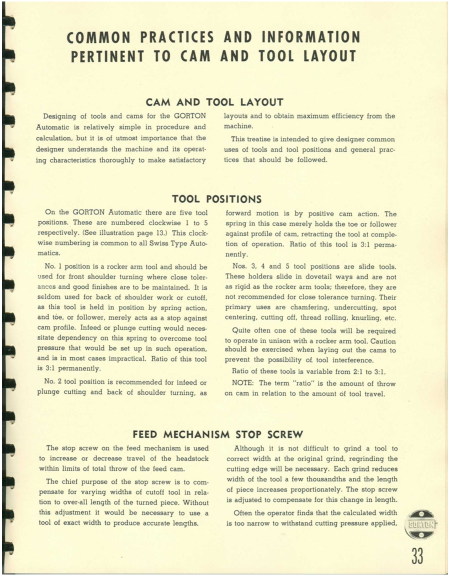
Tension is increased by raising or lowering screw "CC."

A—Cam
B—Follower
C—Lock Screw
CC—Set Screw
D—Gripping Lever
E—Lock Screw

EE—Lock Screw
F—Rawhide Insert
FF—Rawhide Insert
G—Bracket
H—Mounting Screw
HH—Mounting Screw

I—Mounting Bracket
J—Cap Screw
JJ—Cap Screw
K—Assembly Screw
M—Tube
MM—Tube

# Photo 34



## COMMON PRACTICES AND INFORMATION PERTINENT TO CAM AND TOOL LAYOUT

### CAM AND TOOL LAYOUT

Designing of tools and cams for the GORTON Automatic is relatively simple in procedure and calculation, but it is of utmost importance that the designer understands the machine and its operating characteristics thoroughly to make satisfactory layouts and to obtain maximum efficiency from the machine.

This treatise is intended to give designer common uses of tools and tool positions and general practices that should be followed.

### TOOL POSITIONS

On the GORTON Automatic there are five tool positions. These are numbered clockwise 1 to 5 respectively. (See illustration page 13.) This clockwise numbering is common to all Swiss Type Automatics.

No. 1 position is a rocker arm tool and should be used for front shoulder turning where close tolerances and good finishes are to be maintained. It is seldom used for back of shoulder work or cutoff, as this tool is held in position by spring action, and toe, or follower, merely acts as a stop against cam profile. Infeed or plunge cutting would necessitate dependency on this spring to overcome tool pressure that would be set up in such operation, and is in most cases impractical. Ratio of this tool is 3:1 permanently.

No. 2 tool position is recommended for infeed or plunge cutting and back of shoulder turning, as forward motion is by positive cam action. The spring in this case merely holds the toe or follower against profile of cam, retracting the tool at completion of operation. Ratio of this tool is 3:1 permanently.

Nos. 3, 4 and 5 tool positions are slide tools. These holders slide in dovetail ways and are not as rigid as the rocker arm tools; therefore, they are not recommended for close tolerance turning. Their primary uses are chamfering, undercutting, spot centering, cutting off, thread rolling, knurling, etc.

Quite often one of these tools will be required to operate in unison with a rocker arm tool. Caution should be exercised when laying out the cams to prevent the possibility of tool interference.

Ratio of these tools is variable from 2:1 to 3:1.

NOTE: The term "ratio" is the amount of throw on cam in relation to the amount of tool travel.

### FEED MECHANISM STOP SCREW

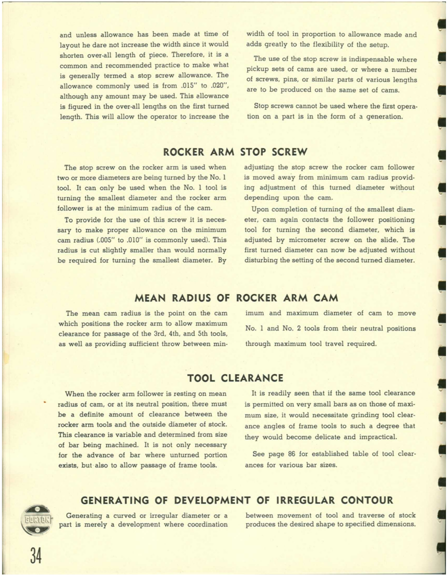
The stop screw on the feed mechanism is used to increase or decrease travel of the headstock within limits of total throw of the feed cam.

The chief purpose of the stop screw is to compensate for varying widths of cutoff tool in relation to over-all length of the turned piece. Without this adjustment it would be necessary to use a tool of exact width to produce accurate lengths.

Although it is not difficult to grind a tool to correct width at the original grind, regrinding the cutting edge will be necessary. Each grind reduces width of the tool a few thousandths and the length of piece increases proportionately. The stop screw is adjusted to compensate for this change in length.

Often the operator finds that the calculated width is too narrow to withstand cutting pressure applied,

# Photo 35



and unless allowance has been made at time of layout he dare not increase the width since it would shorten over-all length of piece. Therefore, it is a common and recommended practice to make what is generally termed a stop screw allowance. The allowance commonly used is from .015" to .020", although any amount may be used. This allowance is figured in the over-all lengths on the first turned length. This will allow the operator to increase the width of tool in proportion to allowance made and adds greatly to the flexibility of the setup.

The use of the stop screw is indispensable where pickup sets of cams are used, or where a number of screws, pins, or similar parts of various lengths are to be produced on the same set of cams.

Stop screws cannot be used where the first operation on a part is in the form of a generation.

## ROCKER ARM STOP SCREW

The stop screw on the rocker arm is used when two or more diameters are being turned by the No. 1 tool. It can only be used when the No. 1 tool is turning the smallest diameter and the rocker arm follower is at the minimum radius of the cam.

To provide for the use of this screw it is necessary to make proper allowance on the minimum cam radius (.005" to .010" is commonly used). This radius is cut slightly smaller than would normally be required for turning the smallest diameter. By adjusting the stop screw the rocker cam follower is moved away from minimum cam radius providing adjustment of this turned diameter without depending upon the cam.

Upon completion of turning of the smallest diameter, cam again contacts the follower positioning tool for turning the second diameter, which is adjusted by micrometer screw on the slide. The first turned diameter can now be adjusted without disturbing the setting of the second turned diameter.

## MEAN RADIUS OF ROCKER ARM CAM

The mean cam radius is the point on the cam which positions the rocker arm to allow maximum clearance for passage of the 3rd, 4th, and 5th tools, as well as providing sufficient throw between minimum and maximum diameter of cam to move No. 1 and No. 2 tools from their neutral positions through maximum tool travel required.

## TOOL CLEARANCE

When the rocker arm follower is resting on mean radius of cam, or at its neutral position, there must be a definite amount of clearance between the rocker arm tools and the outside diameter of stock. This clearance is variable and determined from size of bar being machined. It is not only necessary for the advance of bar where unturned portion exists, but also to allow passage of frame tools.

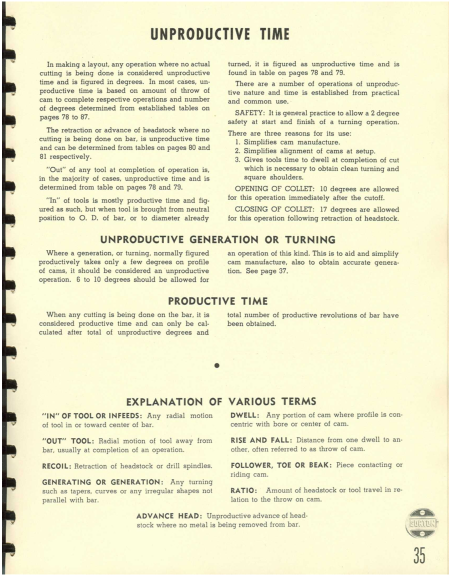
It is readily seen that if the same tool clearance is permitted on very small bars as on those of maximum size, it would necessitate grinding tool clearance angles of frame tools to such a degree that they would become delicate and impractical.

See page 86 for established table of tool clearances for various bar sizes.

## GENERATING OF DEVELOPMENT OF IRREGULAR CONTOUR

Generating a curved or irregular diameter or a part is merely a development where coordination between movement of tool and traverse of stock produces the desired shape to specified dimensions.

# Photo 36



## UNPRODUCTIVE TIME

In making a layout, any operation where no actual cutting is being done is considered unproductive time and is figured in degrees. In most cases, unproductive time is based on amount of throw of cam to complete respective operations and number of degrees determined from established tables on pages 78 to 87.

The retraction or advance of headstock where no cutting is being done on bar, is unproductive time and can be determined from tables on pages 80 and 81 respectively.

"Out" of any tool at completion of operation is, in the majority of cases, unproductive time and is determined from table on pages 78 and 79.

"In" of tools is mostly productive time and figured as such, but when tool is brought from neutral position to O. D. of bar, or to diameter already turned, it is figured as unproductive time and is found in table on pages 78 and 79.

There are a number of operations of unproductive nature and time is established from practical and common use.

SAFETY: It is general practice to allow a 2 degree safety at start and finish of a turning operation.

There are three reasons for its use:

1. Simplifies cam manufacture.
2. Simplifies alignment of cams at setup.
3. Gives tools time to dwell at completion of cut which is necessary to obtain clean turning and square shoulders.

OPENING OF COLLET: 10 degrees are allowed for this operation immediately after the cutoff.

CLOSING OF COLLET: 17 degrees are allowed for this operation following retraction of headstock.

## UNPRODUCTIVE GENERATION OR TURNING

Where a generation, or turning, normally figured productively takes only a few degrees on profile of cams, it should be considered an unproductive operation. 6 to 10 degrees should be allowed for an operation of this kind. This is to aid and simplify cam manufacture, also to obtain accurate generation. See page 37.

## PRODUCTIVE TIME

When any cutting is being done on the bar, it is considered productive time and can only be calculated after total of unproductive degrees and total number of productive revolutions of bar have been obtained.

•

## EXPLANATION OF VARIOUS TERMS

**"IN" OF TOOL OR INFEEDS:** Any radial motion of tool in or toward center of bar.

**"OUT" TOOL:** Radial motion of tool away from bar, usually at completion of an operation.

**RECOIL:** Retraction of headstock or drill spindles.

**GENERATING OR GENERATION:** Any turning such as tapers, curves or any irregular shapes not parallel with bar.

**DWELL:** Any portion of cam where profile is concentric with bore or center of cam.

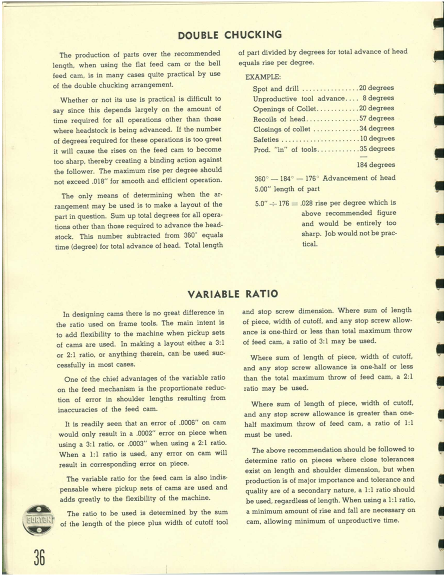
**RISE AND FALL:** Distance from one dwell to another, often referred to as throw of cam.

**FOLLOWER, TOE OR BEAK:** Piece contacting or riding cam.

**RATIO:** Amount of headstock or tool travel in relation to the throw on cam.

**ADVANCE HEAD:** Unproductive advance of headstock where no metal is being removed from bar.

# Photo 37



## DOUBLE CHUCKING

The production of parts over the recommended length, when using the flat feed cam or the bell feed cam, is in many cases quite practical by use of the double chucking arrangement.

Whether or not its use is practical is difficult to say since this depends largely on the amount of time required for all operations other than those where headstock is being advanced. If the number of degrees required for these operations is too great it will cause the rises on the feed cam to become too sharp, thereby creating a binding action against the follower. The maximum rise per degree should not exceed .018" for smooth and efficient operation.

The only means of determining when the arrangement may be used is to make a layout of the part in question. Sum up total degrees for all operations other than those required to advance the headstock. This number subtracted from 360° equals time (degree) for total advance of head. Total length of part divided by degrees for total advance of head equals rise per degree.

EXAMPLE:

| | |
|---|---|
| Spot and drill | 20 degrees |
| Unproductive tool advance | 8 degrees |
| Openings of Collet | 20 degrees |
| Recoils of head | 57 degrees |
| Closings of collet | 34 degrees |
| Safeties | 10 degrees |
| Prod. "in" of tools | 35 degrees |
| | 184 degrees |

360° — 184° = 176° Advancement of head
5.00" length of part

5.0" ÷ 176 = .028 rise per degree which is above recommended figure and would be entirely too sharp. Job would not be practical.

## VARIABLE RATIO

In designing cams there is no great difference in the ratio used on frame tools. The main intent is to add flexibility to the machine when pickup sets of cams are used. In making a layout either a 3:1 or 2:1 ratio, or anything therein, can be used successfully in most cases.

One of the chief advantages of the variable ratio on the feed mechanism is the proportionate reduction of error in shoulder lengths resulting from inaccuracies of the feed cam.

It is readily seen that an error of .0006" on cam would only result in a .0002" error on piece when using a 3:1 ratio, or .0003" when using a 2:1 ratio. When a 1:1 ratio is used, any error on cam will result in corresponding error on piece.

The variable ratio for the feed cam is also indispensable where pickup sets of cams are used and adds greatly to the flexibility of the machine.

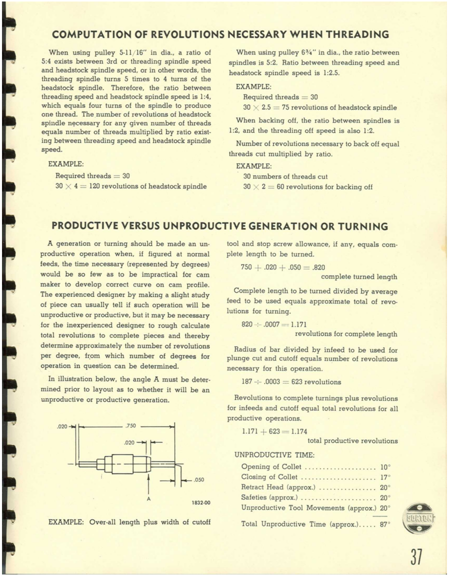
The ratio to be used is determined by the sum of the length of the piece plus width of cutoff tool and stop screw dimension. Where sum of length of piece, width of cutoff, and any stop screw allowance is one-third or less than total maximum throw of feed cam, a ratio of 3:1 may be used.

Where sum of length of piece, width of cutoff, and any stop screw allowance is one-half or less than the total maximum throw of feed cam, a 2:1 ratio may be used.

Where sum of length of piece, width of cutoff, and any stop screw allowance is greater than one-half maximum throw of feed cam, a ratio of 1:1 must be used.

The above recommendation should be followed to determine ratio on pieces where close tolerances exist on length and shoulder dimension, but when production is of major importance and tolerance and quality are of a secondary nature, a 1:1 ratio should be used, regardless of length. When using a 1:1 ratio, a minimum amount of rise and fall are necessary on cam, allowing minimum of unproductive time.

# Photo 38



## COMPUTATION OF REVOLUTIONS NECESSARY WHEN THREADING

When using pulley 5-11/16" in dia., a ratio of 5:4 exists between 3rd or threading spindle speed and headstock spindle speed, or in other words, the threading spindle turns 5 times to 4 turns of the headstock spindle. Therefore, the ratio between threading speed and headstock spindle speed is 1:4, which equals four turns of the spindle to produce one thread. The number of revolutions of headstock spindle necessary for any given number of threads equals number of threads multiplied by ratio existing between threading speed and headstock spindle speed.

EXAMPLE:

Required threads $= 30$

$30 \times 4 = 120$ revolutions of headstock spindle

When using pulley 6¾" in dia., the ratio between spindles is 5:2. Ratio between threading speed and headstock spindle speed is 1:2.5.

EXAMPLE:

Required threads $= 30$

$30 \times 2.5 = 75$ revolutions of headstock spindle

When backing off, the ratio between spindles is 1:2, and the threading off speed is also 1:2.

Number of revolutions necessary to back off equal threads cut multiplied by ratio.

EXAMPLE:

30 numbers of threads cut

$30 \times 2 = 60$ revolutions for backing off

## PRODUCTIVE VERSUS UNPRODUCTIVE GENERATION OR TURNING

A generation or turning should be made an unproductive operation when, if figured at normal feeds, the time necessary (represented by degrees) would be so few as to be impractical for cam maker to develop correct curve on cam profile. The experienced designer by making a slight study of piece can usually tell if such operation will be unproductive or productive, but it may be necessary for the inexperienced designer to rough calculate total revolutions to complete pieces and thereby determine approximately the number of revolutions per degree, from which number of degrees for operation in question can be determined.

In illustration below, the angle A must be determined prior to layout as to whether it will be an unproductive or productive generation.

EXAMPLE: Over-all length plus width of cutoff tool and stop screw allowance, if any, equals complete length to be turned.

$750 + .020 + .050 = .820$
complete turned length

Complete length to be turned divided by average feed to be used equals approximate total of revolutions for turning.

$820 \div .0007 = 1.171$
revolutions for complete length

Radius of bar divided by infeed to be used for plunge cut and cutoff equals number of revolutions necessary for this operation.

$187 \div .0003 = 623$ revolutions

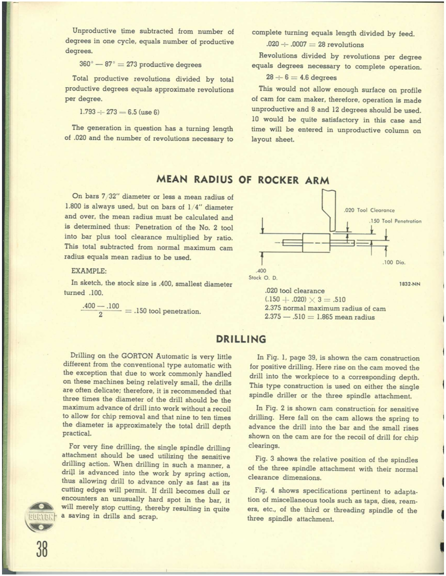
Revolutions to complete turnings plus revolutions for infeeds and cutoff equal total revolutions for all productive operations.

$1.171 + 623 = 1.174$
total productive revolutions

UNPRODUCTIVE TIME:

| | |
|---|---|
| Opening of Collet .................... | 10° |
| Closing of Collet ..................... | 17° |
| Retract Head (approx.) ................ | 20° |
| Safeties (approx.) .................... | 20° |
| Unproductive Tool Movements (approx.) | 20° |
| Total Unproductive Time (approx.)..... | 87° |

# Photo 39



Unproductive time subtracted from number of degrees in one cycle, equals number of productive degrees.

$360^\circ - 87^\circ = 273$ productive degrees

Total productive revolutions divided by total productive degrees equals approximate revolutions per degree.

$1.793 \div 273 = 6.5$ (use 6)

The generation in question has a turning length of .020 and the number of revolutions necessary to complete turning equals length divided by feed.

$.020 \div .0007 = 28$ revolutions

Revolutions divided by revolutions per degree equals degrees necessary to complete operation.

$28 \div 6 = 4.6$ degrees

This would not allow enough surface on profile of cam for cam maker, therefore, operation is made unproductive and 8 and 12 degrees should be used. 10 would be quite satisfactory in this case and time will be entered in unproductive column on layout sheet.

## MEAN RADIUS OF ROCKER ARM

On bars 7/32" diameter or less a mean radius of 1.800 is always used, but on bars of 1/4" diameter and over, the mean radius must be calculated and is determined thus: Penetration of the No. 2 tool into bar plus tool clearance multiplied by ratio. This total subtracted from normal maximum cam radius equals mean radius to be used.

EXAMPLE:

In sketch, the stock size is .400, smallest diameter turned .100.

$$\frac{.400 - .100}{2} = .150 \text{ tool penetration.}$$

.020 tool clearance

$(.150 + .020) \times 3 = .510$

2.375 normal maximum radius of cam

$2.375 - .510 = 1.865$ mean radius

## DRILLING

Drilling on the GORTON Automatic is very little different from the conventional type automatic with the exception that due to work commonly handled on these machines being relatively small, the drills are often delicate; therefore, it is recommended that three times the diameter of the drill should be the maximum advance of drill into work without a recoil to allow for chip removal and that nine to ten times the diameter is approximately the total drill depth practical.

For very fine drilling, the single spindle drilling attachment should be used utilizing the sensitive drilling action. When drilling in such a manner, a drill is advanced into the work by spring action, thus allowing drill to advance only as fast as its cutting edges will permit. If drill becomes dull or encounters an unusually hard spot in the bar, it will merely stop cutting, thereby resulting in quite a saving in drills and scrap.

In Fig. 1, page 39, is shown the cam construction for positive drilling. Here rise on the cam moved the drill into the workpiece to a corresponding depth. This type construction is used on either the single spindle driller or the three spindle attachment.

In Fig. 2 is shown cam construction for sensitive drilling. Here fall on the cam allows the spring to advance the drill into the bar and the small rises shown on the cam are for the recoil of drill for chip clearings.

Fig. 3 shows the relative position of the spindles of the three spindle attachment with their normal clearance dimensions.

Fig. 4 shows specifications pertinent to adaptation of miscellaneous tools such as taps, dies, reamers, etc., of the third or threading spindle of the three spindle attachment.

# Photo 40

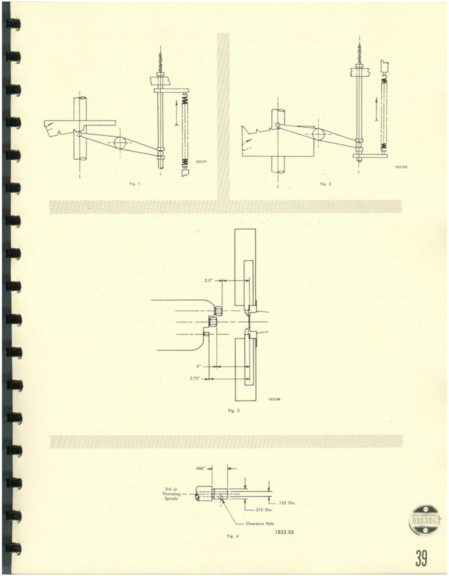


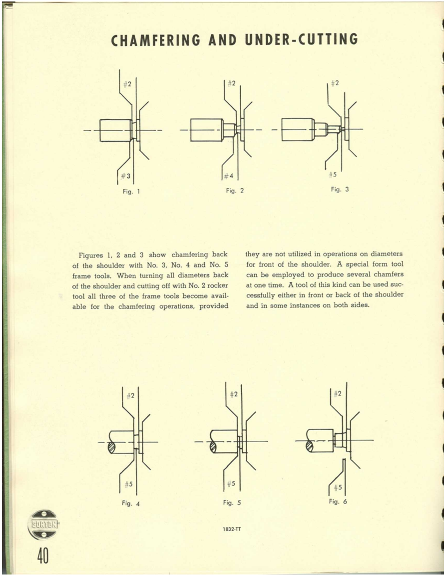
Fig. 1

Fig. 2

Fig. 3

Fig. 4

# Photo 41



## CHAMFERING AND UNDER-CUTTING

Fig. 1 Fig. 2 Fig. 3

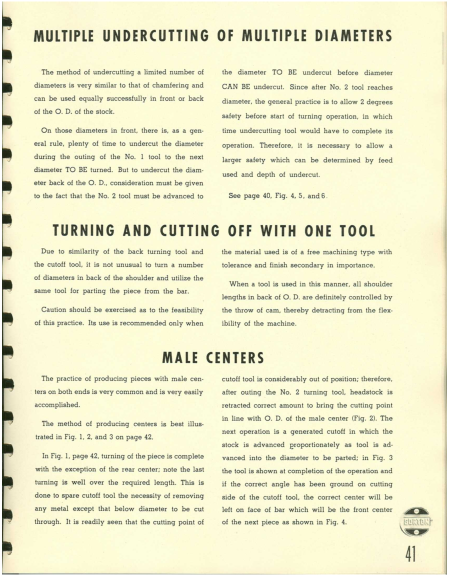
Figures 1, 2 and 3 show chamfering back of the shoulder with No. 3, No. 4 and No. 5 frame tools. When turning all diameters back of the shoulder and cutting off with No. 2 rocker tool all three of the frame tools become available for the chamfering operations, provided they are not utilized in operations on diameters for front of the shoulder. A special form tool can be employed to produce several chamfers at one time. A tool of this kind can be used successfully either in front or back of the shoulder and in some instances on both sides.

Fig. 4 Fig. 5 Fig. 6

1832-TT

40

# Photo 42



## MULTIPLE UNDERCUTTING OF MULTIPLE DIAMETERS

The method of undercutting a limited number of diameters is very similar to that of chamfering and can be used equally successfully in front or back of the O. D. of the stock.

On those diameters in front, there is, as a general rule, plenty of time to undercut the diameter during the outing of the No. 1 tool to the next diameter TO BE turned. But to undercut the diameter back of the O. D., consideration must be given to the fact that the No. 2 tool must be advanced to the diameter TO BE undercut before diameter CAN BE undercut. Since after No. 2 tool reaches diameter, the general practice is to allow 2 degrees safety before start of turning operation, in which time undercutting tool would have to complete its operation. Therefore, it is necessary to allow a larger safety which can be determined by feed used and depth of undercut.

See page 40, Fig. 4, 5, and 6.

## TURNING AND CUTTING OFF WITH ONE TOOL

Due to similarity of the back turning tool and the cutoff tool, it is not unusual to turn a number of diameters in back of the shoulder and utilize the same tool for parting the piece from the bar.

Caution should be exercised as to the feasibility of this practice. Its use is recommended only when the material used is of a free machining type with tolerance and finish secondary in importance.

When a tool is used in this manner, all shoulder lengths in back of O. D. are definitely controlled by the throw of cam, thereby detracting from the flexibility of the machine.

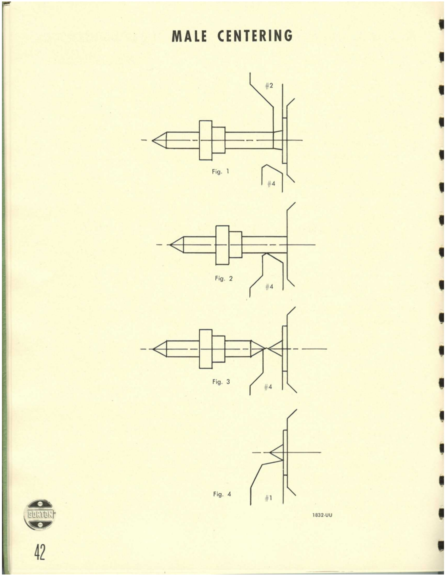
## MALE CENTERS

The practice of producing pieces with male centers on both ends is very common and is very easily accomplished.

The method of producing centers is best illustrated in Fig. 1, 2, and 3 on page 42.

In Fig. 1, page 42, turning of the piece is complete with the exception of the rear center; note the last turning is well over the required length. This is done to spare cutoff tool the necessity of removing any metal except that below diameter to be cut through. It is readily seen that the cutting point of cutoff tool is considerably out of position; therefore, after outing the No. 2 turning tool, headstock is retracted correct amount to bring the cutting point in line with O. D. of the male center (Fig. 2). The next operation is a generated cutoff in which the stock is advanced proportionately as tool is advanced into the diameter to be parted; in Fig. 3 the tool is shown at completion of the operation and if the correct angle has been ground on cutting side of the cutoff tool, the correct center will be left on face of bar which will be the front center of the next piece as shown in Fig. 4.

# Photo 43



## MALE CENTERING

Fig. 1

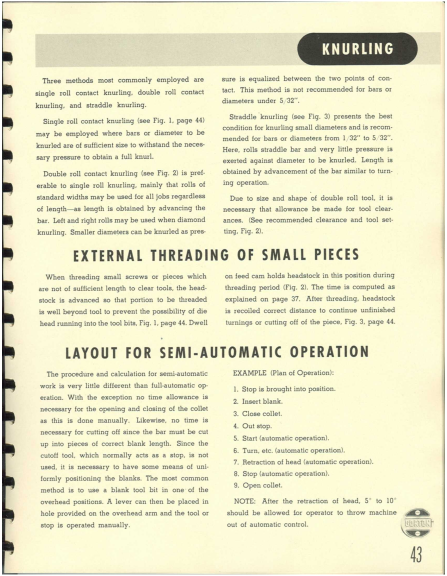
Fig. 2

Fig. 3

Fig. 4

1832-UU

# Photo 44



## KNURLING

Three methods most commonly employed are single roll contact knurling, double roll contact knurling, and straddle knurling.

Single roll contact knurling (see Fig. 1, page 44) may be employed where bars or diameter to be knurled are of sufficient size to withstand the necessary pressure to obtain a full knurl.

Double roll contact knurling (see Fig. 2) is preferable to single roll knurling, mainly that rolls of standard widths may be used for all jobs regardless of length—as length is obtained by advancing the bar. Left and right rolls may be used when diamond knurling. Smaller diameters can be knurled as pressure is equalized between the two points of contact. This method is not recommended for bars or diameters under 5/32".

Straddle knurling (see Fig. 3) presents the best condition for knurling small diameters and is recommended for bars or diameters from 1/32" to 5/32". Here, rolls straddle bar and very little pressure is exerted against diameter to be knurled. Length is obtained by advancement of the bar similar to turning operation.

Due to size and shape of double roll tool, it is necessary that allowance be made for tool clearances. (See recommended clearance and tool setting, Fig. 2).

## EXTERNAL THREADING OF SMALL PIECES

When threading small screws or pieces which are not of sufficient length to clear tools, the headstock is advanced so that portion to be threaded is well beyond tool to prevent the possibility of die head running into the tool bits, Fig. 1, page 44. Dwell on feed cam holds headstock in this position during threading period (Fig. 2). The time is computed as explained on page 37. After threading, headstock is recoiled correct distance to continue unfinished turnings or cutting off of the piece, Fig. 3, page 44.

## LAYOUT FOR SEMI-AUTOMATIC OPERATION

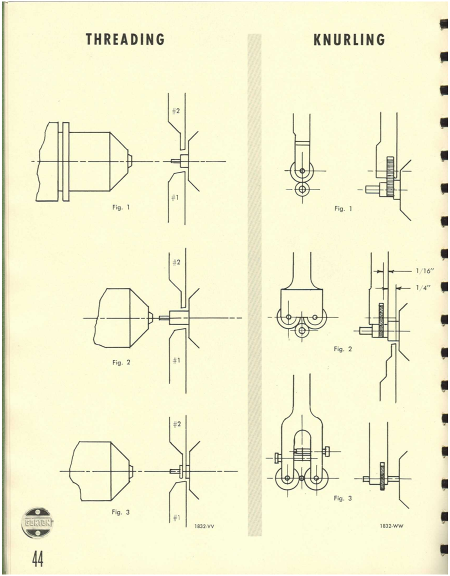
The procedure and calculation for semi-automatic work is very little different than full-automatic operation. With the exception no time allowance is necessary for the opening and closing of the collet as this is done manually. Likewise, no time is necessary for cutting off since the bar must be cut up into pieces of correct blank length. Since the cutoff tool, which normally acts as a stop, is not used, it is necessary to have some means of uniformly positioning the blanks. The most common method is to use a blank tool bit in one of the overhead positions. A lever can then be placed in hole provided on the overhead arm and the tool or stop is operated manually.

EXAMPLE (Plan of Operation):

1. Stop is brought into position.
2. Insert blank.
3. Close collet.
4. Out stop.
5. Start (automatic operation).
6. Turn, etc. (automatic operation).
7. Retraction of head (automatic operation).
8. Stop (automatic operation).
9. Open collet.

NOTE: After the retraction of head, 5° to 10° should be allowed for operator to throw machine out of automatic control.

# Photo 45



THREADING

Fig. 1

Fig. 2

Fig. 3

KNURLING

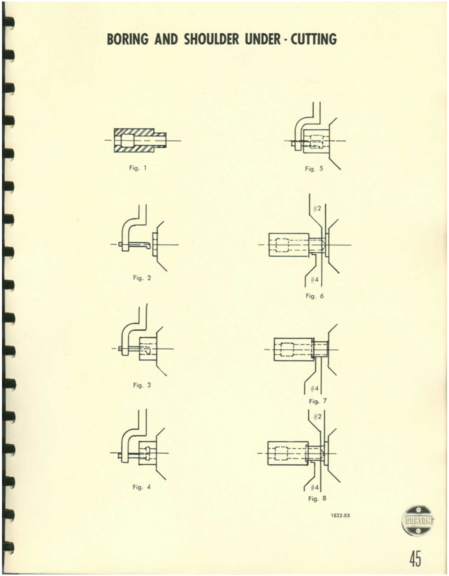
Fig. 1

Fig. 2

Fig. 3

44

# Photo 46



## BORING AND SHOULDER UNDER-CUTTING

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

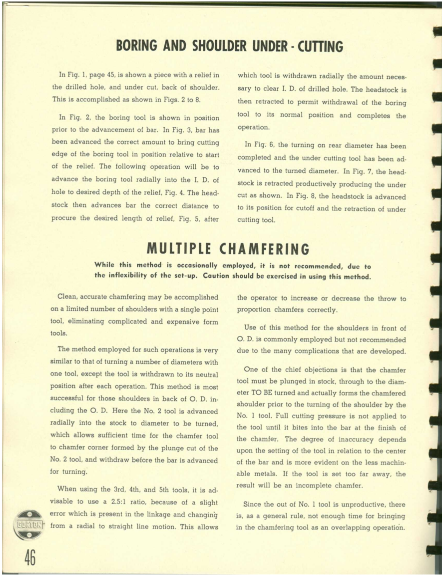
Fig. 6

Fig. 7

Fig. 8

1832-XX

# Photo 47



## BORING AND SHOULDER UNDER - CUTTING

In Fig. 1, page 45, is shown a piece with a relief in the drilled hole, and under cut, back of shoulder. This is accomplished as shown in Figs. 2 to 8.

In Fig. 2, the boring tool is shown in position prior to the advancement of bar. In Fig. 3, bar has been advanced the correct amount to bring cutting edge of the boring tool in position relative to start of the relief. The following operation will be to advance the boring tool radially into the I. D. of hole to desired depth of the relief, Fig. 4. The headstock then advances bar the correct distance to procure the desired length of relief, Fig. 5, after which tool is withdrawn radially the amount necessary to clear I. D. of drilled hole. The headstock is then retracted to permit withdrawal of the boring tool to its normal position and completes the operation.

In Fig. 6, the turning on rear diameter has been completed and the under cutting tool has been advanced to the turned diameter. In Fig. 7, the headstock is retracted productively producing the under cut as shown. In Fig. 8, the headstock is advanced to its position for cutoff and the retraction of under cutting tool.

## MULTIPLE CHAMFERING

**While this method is occasionally employed, it is not recommended, due to the inflexibility of the set-up. Caution should be exercised in using this method.**

Clean, accurate chamfering may be accomplished on a limited number of shoulders with a single point tool, eliminating complicated and expensive form tools.

The method employed for such operations is very similar to that of turning a number of diameters with one tool, except the tool is withdrawn to its neutral position after each operation. This method is most successful for those shoulders in back of O. D. including the O. D. Here the No. 2 tool is advanced radially into the stock to diameter to be turned, which allows sufficient time for the chamfer tool to chamfer corner formed by the plunge cut of the No. 2 tool, and withdraw before the bar is advanced for turning.

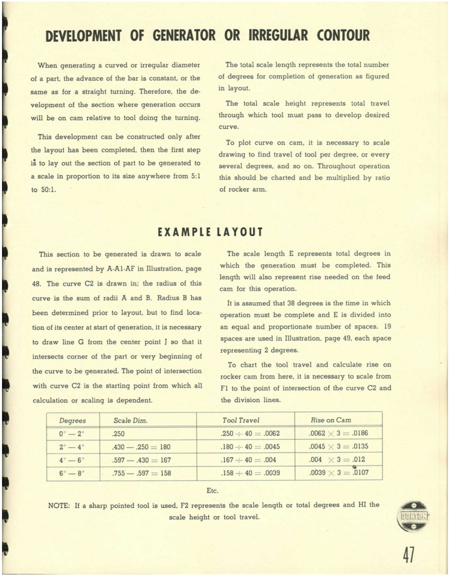
When using the 3rd, 4th, and 5th tools, it is advisable to use a 2.5:1 ratio, because of a slight error which is present in the linkage and changing from a radial to straight line motion. This allows the operator to increase or decrease the throw to proportion chamfers correctly.

Use of this method for the shoulders in front of O. D. is commonly employed but not recommended due to the many complications that are developed.

One of the chief objections is that the chamfer tool must be plunged in stock, through to the diameter TO BE turned and actually forms the chamfered shoulder prior to the turning of the shoulder by the No. 1 tool. Full cutting pressure is not applied to the tool until it bites into the bar at the finish of the chamfer. The degree of inaccuracy depends upon the setting of the tool in relation to the center of the bar and is more evident on the less machinable metals. If the tool is set too far away, the result will be an incomplete chamfer.

Since the out of No. 1 tool is unproductive, there is, as a general rule, not enough time for bringing in the chamfering tool as an overlapping operation.

# Photo 48



## DEVELOPMENT OF GENERATOR OR IRREGULAR CONTOUR

When generating a curved or irregular diameter of a part, the advance of the bar is constant, or the same as for a straight turning. Therefore, the development of the section where generation occurs will be on cam relative to tool doing the turning.

This development can be constructed only after the layout has been completed, then the first step is to lay out the section of part to be generated to a scale in proportion to its size anywhere from 5:1 to 50:1.

The total scale length represents the total number of degrees for completion of generation as figured in layout.

The total scale height represents total travel through which tool must pass to develop desired curve.

To plot curve on cam, it is necessary to scale drawing to find travel of tool per degree, or every several degrees, and so on. Throughout operation this should be charted and be multiplied by ratio of rocker arm.

### EXAMPLE LAYOUT

This section to be generated is drawn to scale and is represented by A-A1-AF in Illustration, page 48. The curve C2 is drawn in; the radius of this curve is the sum of radii A and B. Radius B has been determined prior to layout, but to find location of its center at start of generation, it is necessary to draw line G from the center point J so that it intersects corner of the part or very beginning of the curve to be generated. The point of intersection with curve C2 is the starting point from which all calculation or scaling is dependent.

The scale length E represents total degrees in which the generation must be completed. This length will also represent rise needed on the feed cam for this operation.

It is assumed that 38 degrees is the time in which operation must be complete and E is divided into an equal and proportionate number of spaces. 19 spaces are used in Illustration, page 49, each space representing 2 degrees.

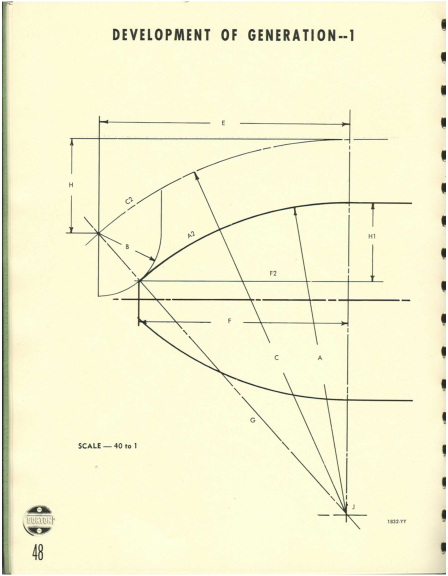
To chart the tool travel and calculate rise on rocker cam from here, it is necessary to scale from F1 to the point of intersection of the curve C2 and the division lines.

| *Degrees* | *Scale Dim.* | *Tool Travel* | *Rise on Cam* |
|---|---|---|---|
| 0° — 2° | .250 | .250 ÷ 40 = .0062 | .0062 × 3 = .0186 |
| 2° — 4° | .430 — .250 = 180 | .180 ÷ 40 = .0045 | .0045 × 3 = .0135 |
| 4° — 6° | .597 — .430 = 167 | .167 ÷ 40 = .004 | .004 × 3 = .012 |
| 6° — 8° | .755 — .597 = 158 | .158 ÷ 40 = .0039 | .0039 × 3 = .0107 |

Etc.

NOTE: If a sharp pointed tool is used, F2 represents the scale length or total degrees and HI the scale height or tool travel.

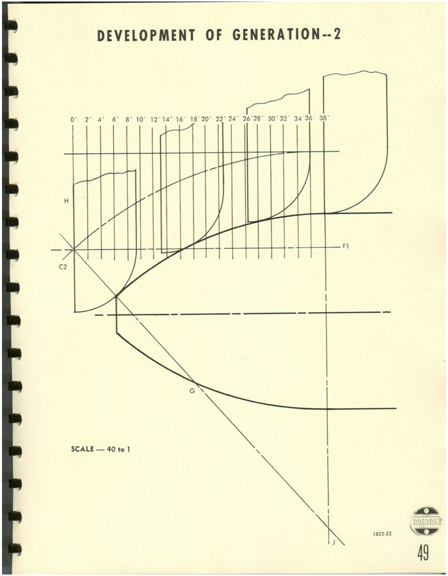
# Photo 49


DEVELOPMENT OF GENERATION--1

SCALE — 40 to 1

1832-YY

# Photo 50

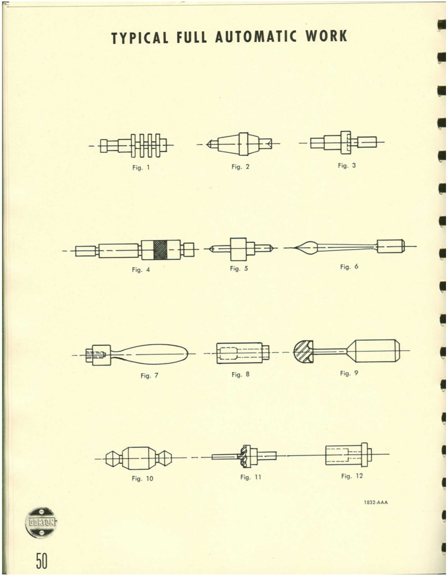


## DEVELOPMENT OF GENERATION--2

SCALE — 40 to 1

1832-ZZ

# Photo 51



## TYPICAL FULL AUTOMATIC WORK

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

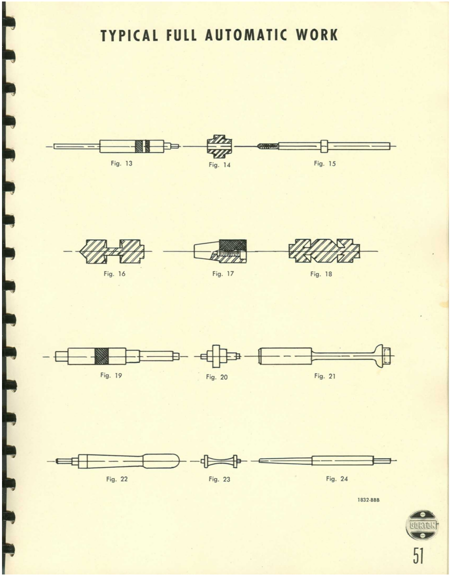
Fig. 12

1832-AAA

GORTON

50

# Photo 52



## TYPICAL FULL AUTOMATIC WORK

Fig. 13

Fig. 14

Fig. 15

Fig. 16

Fig. 17

Fig. 18

Fig. 19

Fig. 20

Fig. 21

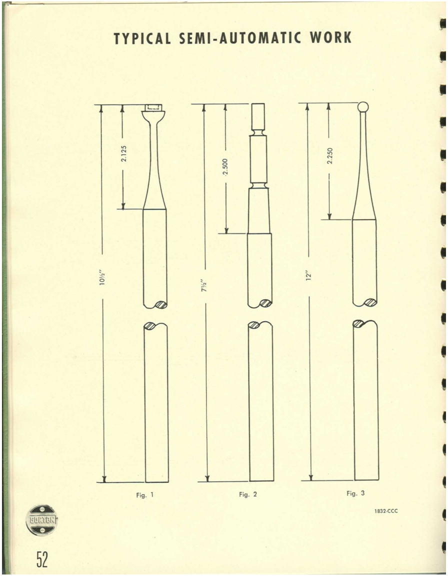
Fig. 22

Fig. 23

Fig. 24

1832-BBB

# Photo 53



## TYPICAL SEMI-AUTOMATIC WORK

Fig. 1

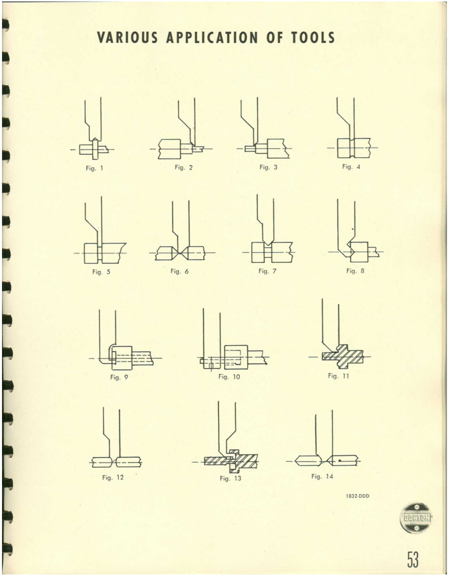
Fig. 2

Fig. 3

1832-CCC

52

# Photo 54



VARIOUS APPLICATION OF TOOLS

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Fig. 13

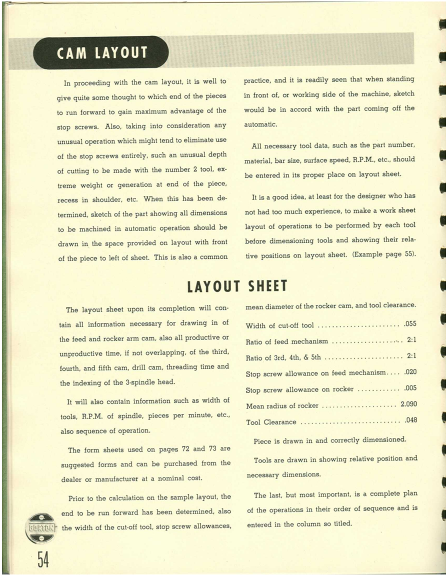
Fig. 14

1832-DDD

GORTON

53

# Photo 55



## CAM LAYOUT

In proceeding with the cam layout, it is well to give quite some thought to which end of the pieces to run forward to gain maximum advantage of the stop screws. Also, taking into consideration any unusual operation which might tend to eliminate use of the stop screws entirely, such an unusual depth of cutting to be made with the number 2 tool, extreme weight or generation at end of the piece, recess in shoulder, etc. When this has been determined, sketch of the part showing all dimensions to be machined in automatic operation should be drawn in the space provided on layout with front of the piece to left of sheet. This is also a common practice, and it is readily seen that when standing in front of, or working side of the machine, sketch would be in accord with the part coming off the automatic.

All necessary tool data, such as the part number, material, bar size, surface speed, R.P.M., etc., should be entered in its proper place on layout sheet.

It is a good idea, at least for the designer who has not had too much experience, to make a work sheet layout of operations to be performed by each tool before dimensioning tools and showing their relative positions on layout sheet. (Example page 55).

## LAYOUT SHEET

The layout sheet upon its completion will contain all information necessary for drawing in of the feed and rocker arm cam, also all productive or unproductive time, if not overlapping, of the third, fourth, and fifth cam, drill cam, threading time and the indexing of the 3-spindle head.

It will also contain information such as width of tools, R.P.M. of spindle, pieces per minute, etc., also sequence of operation.

The form sheets used on pages 72 and 73 are suggested forms and can be purchased from the dealer or manufacturer at a nominal cost.

Prior to the calculation on the sample layout, the end to be run forward has been determined, also the width of the cut-off tool, stop screw allowances, mean diameter of the rocker cam, and tool clearance.

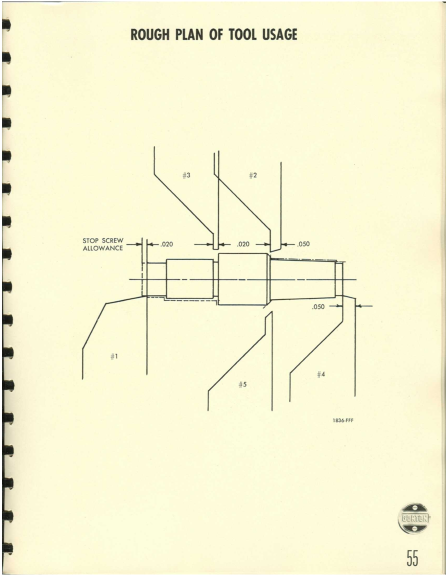
| | |
|---|---|
| Width of cut-off tool | .055 |
| Ratio of feed mechanism | 2:1 |
| Ratio of 3rd, 4th, & 5th | 2:1 |
| Stop screw allowance on feed mechanism | .020 |
| Stop screw allowance on rocker | .005 |
| Mean radius of rocker | 2.090 |
| Tool Clearance | .048 |

Piece is drawn in and correctly dimensioned.

Tools are drawn in showing relative position and necessary dimensions.

The last, but most important, is a complete plan of the operations in their order of sequence and is entered in the column so titled.

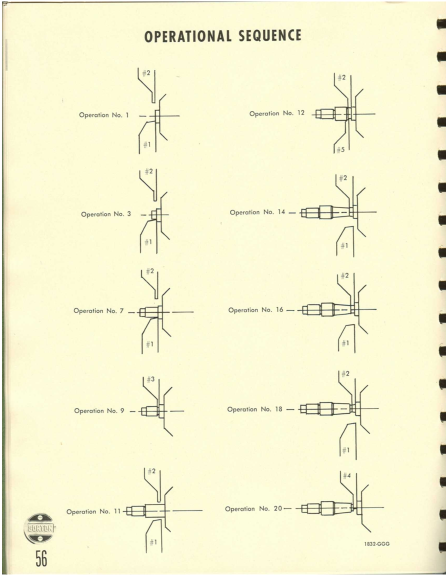
# Photo 56



ROUGH PLAN OF TOOL USAGE

55

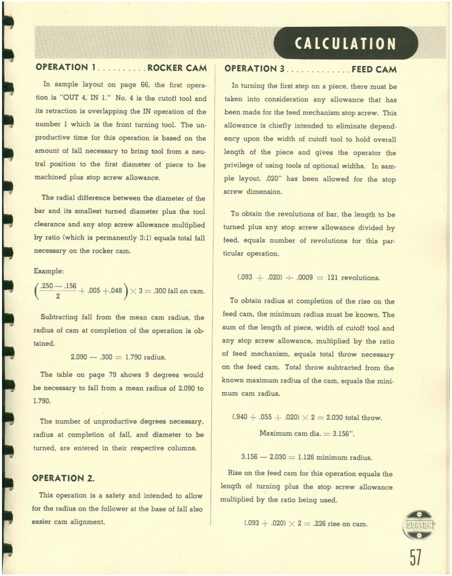
# Photo 57



## OPERATIONAL SEQUENCE

1832-GGG

# Photo 58



## OPERATION 1 .......... ROCKER CAM

In sample layout on page 66, the first operation is "OUT 4, IN 1." No. 4 is the cutoff tool and its retraction is overlapping the IN operation of the number 1 which is the front turning tool. The unproductive time for this operation is based on the amount of fall necessary to bring tool from a neutral position to the first diameter of piece to be machined plus stop screw allowance.

The radial difference between the diameter of the bar and its smallest turned diameter plus the tool clearance and any stop screw allowance multiplied by ratio (which is permanently 3:1) equals total fall necessary on the rocker cam.

Example:

$$\left(\frac{.250 - .156}{2} + .005 + .048\right) \times 3 = .300 \text{ fall on cam.}$$

Subtracting fall from the mean cam radius, the radius of cam at completion of the operation is obtained.

$$2.090 - .300 = 1.790 \text{ radius.}$$

The table on page 79 shows 9 degrees would be necessary to fall from a mean radius of 2.090 to 1.790.

The number of unproductive degrees necessary, radius at completion of fall, and diameter to be turned, are entered in their respective columns.

## OPERATION 2.

This operation is a safety and intended to allow for the radius on the follower at the base of fall also easier cam alignment.

## OPERATION 3 ............. FEED CAM

In turning the first step on a piece, there must be taken into consideration any allowance that has been made for the feed mechanism stop screw. This allowance is chiefly intended to eliminate dependency upon the width of cutoff tool to hold overall length of the piece and gives the operator the privilege of using tools of optional widths. In sample layout, .020" has been allowed for the stop screw dimension.

To obtain the revolutions of bar, the length to be turned plus any stop screw allowance divided by feed, equals number of revolutions for this particular operation.

$$(.093 + .020) \div .0009 = 121 \text{ revolutions.}$$

To obtain radius at completion of the rise on the feed cam, the minimum radius must be known. The sum of the length of piece, width of cutoff tool and any stop screw allowance, multiplied by the ratio of feed mechanism, equals total throw necessary on the feed cam. Total throw subtracted from the known maximum radius of the cam, equals the minimum cam radius.

$$(.940 + .055 + .020) \times 2 = 2.030 \text{ total throw.}$$

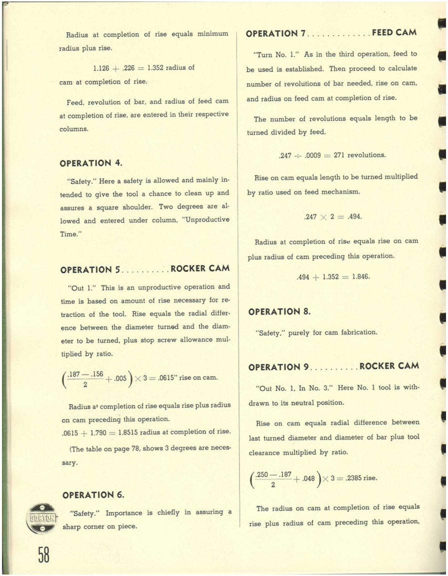
Maximum cam dia. = 3.156".

$$3.156 - 2.030 = 1.126 \text{ minimum radius.}$$

Rise on the feed cam for this operation equals the length of turning plus the stop screw allowance multiplied by the ratio being used.

$$(.093 + .020) \times 2 = .226 \text{ rise on cam.}$$

# Photo 59



Radius at completion of rise equals minimum radius plus rise.

1.126 + .226 = 1.352 radius of cam at completion of rise.

Feed, revolution of bar, and radius of feed cam at completion of rise, are entered in their respective columns.

### OPERATION 4.

"Safety." Here a safety is allowed and mainly intended to give the tool a chance to clean up and assures a square shoulder. Two degrees are allowed and entered under column, "Unproductive Time."

### OPERATION 5 . . . . . . . . . ROCKER CAM

"Out 1." This is an unproductive operation and time is based on amount of rise necessary for retraction of the tool. Rise equals the radial difference between the diameter turned and the diameter to be turned, plus stop screw allowance multiplied by ratio.

$$\left(\frac{.187 - .156}{2} + .005\right) \times 3 = .0615'' \text{ rise on cam.}$$

Radius at completion of rise equals rise plus radius on cam preceding this operation.

.0615 + 1.790 = 1.8515 radius at completion of rise.

(The table on page 78, shows 3 degrees are necessary.

### OPERATION 6.

"Safety." Importance is chiefly in assuring a sharp corner on piece.

### OPERATION 7 . . . . . . . . . . . . FEED CAM

"Turn No. 1." As in the third operation, feed to be used is established. Then proceed to calculate number of revolutions of bar needed, rise on cam, and radius on feed cam at completion of rise.

The number of revolutions equals length to be turned divided by feed.

.247 ÷ .0009 = 271 revolutions.

Rise on cam equals length to be turned multiplied by ratio used on feed mechanism.

.247 × 2 = .494.

Radius at completion of rise equals rise on cam plus radius of cam preceding this operation.

.494 + 1.352 = 1.846.

### OPERATION 8.

"Safety," purely for cam fabrication.

### OPERATION 9 . . . . . . . . . ROCKER CAM

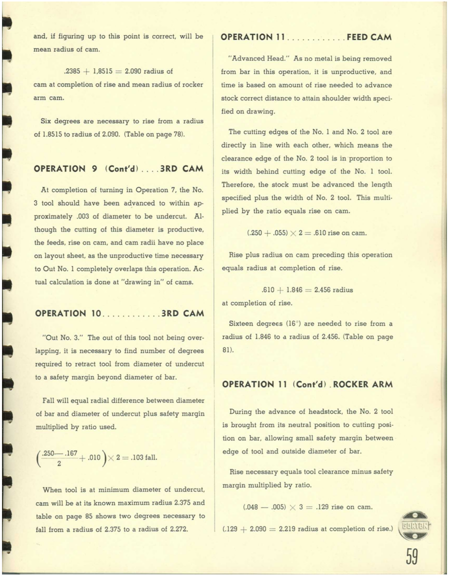
"Out No. 1, In No. 3." Here No. 1 tool is withdrawn to its neutral position.

Rise on cam equals radial difference between last turned diameter and diameter of bar plus tool clearance multiplied by ratio.

$$\left(\frac{.250 - .187}{2} + .048\right) \times 3 = .2385 \text{ rise.}$$

The radius on cam at completion of rise equals rise plus radius of cam preceding this operation,

# Photo 60



and, if figuring up to this point is correct, will be mean radius of cam.

.2385 + 1,8515 = 2.090 radius of cam at completion of rise and mean radius of rocker arm cam.

Six degrees are necessary to rise from a radius of 1.8515 to radius of 2.090. (Table on page 78).

## OPERATION 9 (Cont'd) . . . . 3RD CAM

At completion of turning in Operation 7, the No. 3 tool should have been advanced to within approximately .003 of diameter to be undercut. Although the cutting of this diameter is productive, the feeds, rise on cam, and cam radii have no place on layout sheet, as the unproductive time necessary to Out No. 1 completely overlaps this operation. Actual calculation is done at "drawing in" of cams.

## OPERATION 10. . . . . . . . . . . . 3RD CAM

"Out No. 3." The out of this tool not being overlapping, it is necessary to find number of degrees required to retract tool from diameter of undercut to a safety margin beyond diameter of bar.

Fall will equal radial difference between diameter of bar and diameter of undercut plus safety margin multiplied by ratio used.

$$\left(\frac{.250 - .167}{2} + .010\right) \times 2 = .103 \text{ fall.}$$

When tool is at minimum diameter of undercut, cam will be at its known maximum radius 2.375 and table on page 85 shows two degrees necessary to fall from a radius of 2.375 to a radius of 2.272.

## OPERATION 11 . . . . . . . . . . . . FEED CAM

"Advanced Head." As no metal is being removed from bar in this operation, it is unproductive, and time is based on amount of rise needed to advance stock correct distance to attain shoulder width specified on drawing.

The cutting edges of the No. 1 and No. 2 tool are directly in line with each other, which means the clearance edge of the No. 2 tool is in proportion to its width behind cutting edge of the No. 1 tool. Therefore, the stock must be advanced the length specified plus the width of No. 2 tool. This multiplied by the ratio equals rise on cam.

(.250 + .055) × 2 = .610 rise on cam.

Rise plus radius on cam preceding this operation equals radius at completion of rise.

.610 + 1.846 = 2.456 radius at completion of rise.

Sixteen degrees (16°) are needed to rise from a radius of 1.846 to a radius of 2.456. (Table on page 81).

## OPERATION 11 (Cont'd) . ROCKER ARM

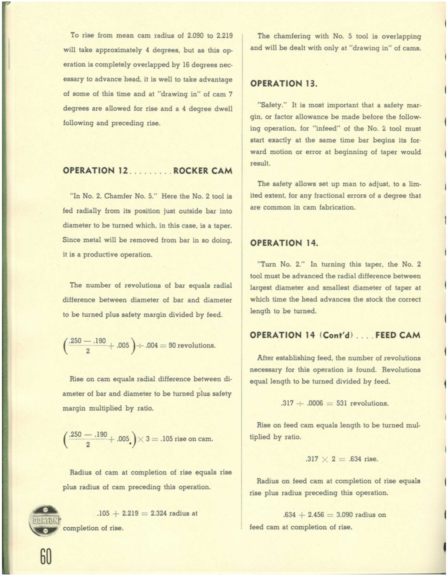
During the advance of headstock, the No. 2 tool is brought from its neutral position to cutting position on bar, allowing small safety margin between edge of tool and outside diameter of bar.

Rise necessary equals tool clearance minus safety margin multiplied by ratio.

(.048 — .005) × 3 = .129 rise on cam.

(.129 + 2.090 = 2.219 radius at completion of rise.)

# Photo 61



To rise from mean cam radius of 2.090 to 2.219 will take approximately 4 degrees, but as this operation is completely overlapped by 16 degrees necessary to advance head, it is well to take advantage of some of this time and at "drawing in" of cam 7 degrees are allowed for rise and a 4 degree dwell following and preceding rise.

## OPERATION 12. . . . . . . . . ROCKER CAM

"In No. 2, Chamfer No. 5." Here the No. 2 tool is fed radially from its position just outside bar into diameter to be turned which, in this case, is a taper. Since metal will be removed from bar in so doing, it is a productive operation.

The number of revolutions of bar equals radial difference between diameter of bar and diameter to be turned plus safety margin divided by feed.

$$\left(\frac{.250 - .190}{2} + .005\right) \div .004 = 90 \text{ revolutions.}$$

Rise on cam equals radial difference between diameter of bar and diameter to be turned plus safety margin multiplied by ratio.

$$\left(\frac{.250 - .190}{2} + .005\right) \times 3 = .105 \text{ rise on cam.}$$

Radius of cam at completion of rise equals rise plus radius of cam preceding this operation.

$.105 + 2.219 = 2.324$ radius at completion of rise.

The chamfering with No. 5 tool is overlapping and will be dealt with only at "drawing in" of cams.

## OPERATION 13.

"Safety." It is most important that a safety margin, or factor allowance be made before the following operation, for "infeed" of the No. 2 tool must start exactly at the same time bar begins its forward motion or error at beginning of taper would result.

The safety allows set up man to adjust, to a limited extent, for any fractional errors of a degree that are common in cam fabrication.

## OPERATION 14.

"Turn No. 2." In turning this taper, the No. 2 tool must be advanced the radial difference between largest diameter and smallest diameter of taper at which time the head advances the stock the correct length to be turned.

## OPERATION 14 (Cont'd) . . . . FEED CAM

After establishing feed, the number of revolutions necessary for this operation is found. Revolutions equal length to be turned divided by feed.

$.317 \div .0006 = 531$ revolutions.

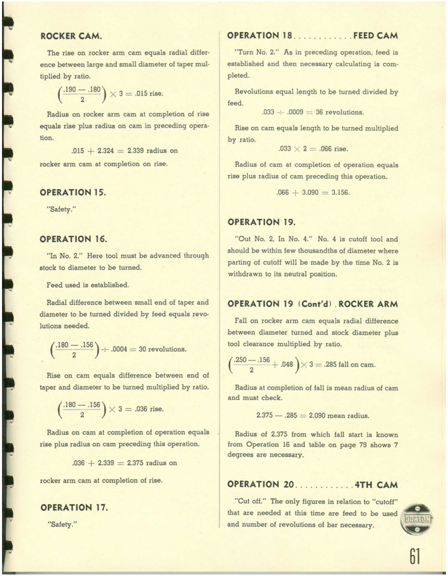
Rise on feed cam equals length to be turned multiplied by ratio.

$.317 \times 2 = .634$ rise.

Radius on feed cam at completion of rise equals rise plus radius preceding this operation.

$.634 + 2.456 = 3.090$ radius on feed cam at completion of rise.

# Photo 62



### ROCKER CAM.

The rise on rocker arm cam equals radial difference between large and small diameter of taper multiplied by ratio.

$$\left(\frac{.190 - .180}{2}\right) \times 3 = .015 \text{ rise.}$$

Radius on rocker arm cam at completion of rise equals rise plus radius on cam in preceding operation.

$.015 + 2.324 = 2.339$ radius on rocker arm cam at completion on rise.

### OPERATION 15.

"Safety."

### OPERATION 16.

"In No. 2." Here tool must be advanced through stock to diameter to be turned.

Feed used is established.

Radial difference between small end of taper and diameter to be turned divided by feed equals revolutions needed.

$$\left(\frac{.180 - .156}{2}\right) \div .0004 = 30 \text{ revolutions.}$$

Rise on cam equals difference between end of taper and diameter to be turned multiplied by ratio.

$$\left(\frac{.180 - .156}{2}\right) \times 3 = .036 \text{ rise.}$$

Radius on cam at completion of operation equals rise plus radius on cam preceding this operation.

$.036 + 2.339 = 2.375$ radius on rocker arm cam at completion of rise.

### OPERATION 17.

"Safety."

### OPERATION 18 . . . . . . . . . . . FEED CAM

"Turn No. 2." As in preceding operation, feed is established and then necessary calculating is completed.

Revolutions equal length to be turned divided by feed.

$.033 \div .0009 = 36$ revolutions.

Rise on cam equals length to be turned multiplied by ratio.

$.033 \times 2 = .066$ rise.

Radius of cam at completion of operation equals rise plus radius of cam preceding this operation.

$.066 + 3.090 = 3.156.$

### OPERATION 19.

"Out No. 2, In No. 4." No. 4 is cutoff tool and should be within few thousandths of diameter where parting of cutoff will be made by the time No. 2 is withdrawn to its neutral position.

### OPERATION 19 (Cont'd) . ROCKER ARM

Fall on rocker arm cam equals radial difference between diameter turned and stock diameter plus tool clearance multiplied by ratio.

$$\left(\frac{.250 - .156}{2} + .048\right) \times 3 = .285 \text{ fall on cam.}$$

Radius at completion of fall is mean radius of cam and must check.

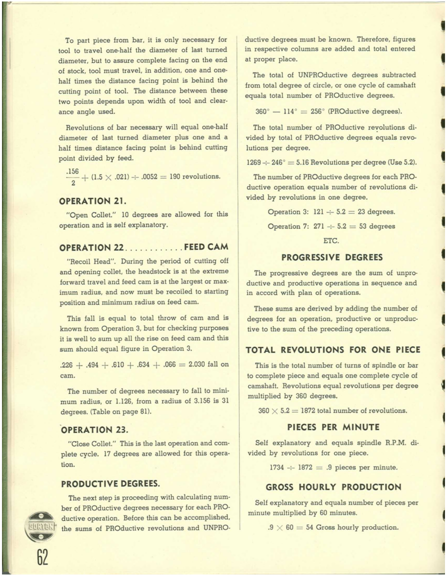
$2.375 - .285 = 2.090$ mean radius.

Radius of 2.375 from which fall start is known from Operation 16 and table on page 79 shows 7 degrees are necessary.

### OPERATION 20 . . . . . . . . . . . 4TH CAM

"Cut off." The only figures in relation to "cutoff" that are needed at this time are feed to be used and number of revolutions of bar necessary.

# Photo 63



To part piece from bar, it is only necessary for tool to travel one-half the diameter of last turned diameter, but to assure complete facing on the end of stock, tool must travel, in addition, one and one-half times the distance facing point is behind the cutting point of tool. The distance between these two points depends upon width of tool and clearance angle used.

Revolutions of bar necessary will equal one-half diameter of last turned diameter plus one and a half times distance facing point is behind cutting point divided by feed.

$$\frac{.156}{2} + (1.5 \times .021) \div .0052 = 190 \text{ revolutions.}$$

## OPERATION 21.

"Open Collet." 10 degrees are allowed for this operation and is self explanatory.

## OPERATION 22............FEED CAM

"Recoil Head". During the period of cutting off and opening collet, the headstock is at the extreme forward travel and feed cam is at the largest or maximum radius, and now must be recoiled to starting position and minimum radius on feed cam.

This fall is equal to total throw of cam and is known from Operation 3, but for checking purposes it is well to sum up all the rise on feed cam and this sum should equal figure in Operation 3.

$.226 + .494 + .610 + .634 + .066 = 2.030$ fall on cam.

The number of degrees necessary to fall to minimum radius, or 1.126, from a radius of 3.156 is 31 degrees. (Table on page 81).

## OPERATION 23.

"Close Collet." This is the last operation and complete cycle. 17 degrees are allowed for this operation.

## PRODUCTIVE DEGREES.

The next step is proceeding with calculating number of PROductive degrees necessary for each PROductive operation. Before this can be accomplished, the sums of PROductive revolutions and UNPROductive degrees must be known. Therefore, figures in respective columns are added and total entered at proper place.

The total of UNPROductive degrees subtracted from total degree of circle, or one cycle of camshaft equals total number of PROductive degrees.

$360° - 114° = 256°$ (PROductive degrees).

The total number of PROductive revolutions divided by total of PROductive degrees equals revolutions per degree.

$1269 \div 246° = 5.16$ Revolutions per degree (Use 5.2).

The number of PROductive degrees for each PROductive operation equals number of revolutions divided by revolutions in one degree.

Operation 3: $121 \div 5.2 = 23$ degrees.

Operation 7: $271 \div 5.2 = 53$ degrees

ETC.

## PROGRESSIVE DEGREES

The progressive degrees are the sum of unproductive and productive operations in sequence and in accord with plan of operations.

These sums are derived by adding the number of degrees for an operation, productive or unproductive to the sum of the preceding operations.

## TOTAL REVOLUTIONS FOR ONE PIECE

This is the total number of turns of spindle or bar to complete piece and equals one complete cycle of camshaft. Revolutions equal revolutions per degree multiplied by 360 degrees.

$360 \times 5.2 = 1872$ total number of revolutions.

## PIECES PER MINUTE

Self explanatory and equals spindle R.P.M. divided by revolutions for one piece.

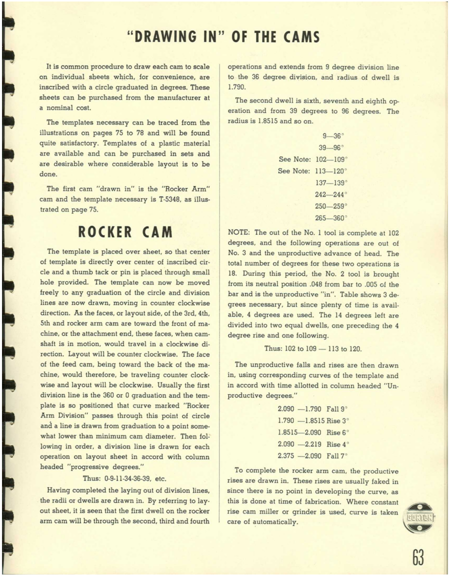
$1734 \div 1872 = .9$ pieces per minute.

## GROSS HOURLY PRODUCTION

Self explanatory and equals number of pieces per minute multiplied by 60 minutes.

$.9 \times 60 = 54$ Gross hourly production.

# Photo 64



## "DRAWING IN" OF THE CAMS

It is common procedure to draw each cam to scale on individual sheets which, for convenience, are inscribed with a circle graduated in degrees. These sheets can be purchased from the manufacturer at a nominal cost.

The templates necessary can be traced from the illustrations on pages 75 to 78 and will be found quite satisfactory. Templates of a plastic material are available and can be purchased in sets and are desirable where considerable layout is to be done.

The first cam "drawn in" is the "Rocker Arm" cam and the template necessary is T-5348, as illustrated on page 75.

### ROCKER CAM

The template is placed over sheet, so that center of template is directly over center of inscribed circle and a thumb tack or pin is placed through small hole provided. The template can now be moved freely to any graduation of the circle and division lines are now drawn, moving in counter clockwise direction. As the faces, or layout side, of the 3rd, 4th, 5th and rocker arm cam are toward the front of machine, or the attachment end, these faces, when camshaft is in motion, would travel in a clockwise direction. Layout will be counter clockwise. The face of the feed cam, being toward the back of the machine, would therefore, be traveling counter clockwise and layout will be clockwise. Usually the first division line is the 360 or 0 graduation and the template is so positioned that curve marked "Rocker Arm Division" passes through this point of circle and a line is drawn from graduation to a point somewhat lower than minimum cam diameter. Then following in order, a division line is drawn for each operation on layout sheet in accord with column headed "progressive degrees."

Thus: 0-9-11-34-36-39, etc.

Having completed the laying out of division lines, the radii or dwells are drawn in. By referring to layout sheet, it is seen that the first dwell on the rocker arm cam will be through the second, third and fourth operations and extends from 9 degree division line to the 36 degree division, and radius of dwell is 1.790.

The second dwell is sixth, seventh and eighth operation and from 39 degrees to 96 degrees. The radius is 1.8515 and so on.

9—36°
39—96°
See Note: 102—109°
See Note: 113—120°
137—139°
242—244°
250—259°
265—360°

NOTE: The out of the No. 1 tool is complete at 102 degrees, and the following operations are out of No. 3 and the unproductive advance of head. The total number of degrees for these two operations is 18. During this period, the No. 2 tool is brought from its neutral position .048 from bar to .005 of the bar and is the unproductive "in". Table shows 3 degrees necessary, but since plenty of time is available, 4 degrees are used. The 14 degrees left are divided into two equal dwells, one preceding the 4 degree rise and one following.

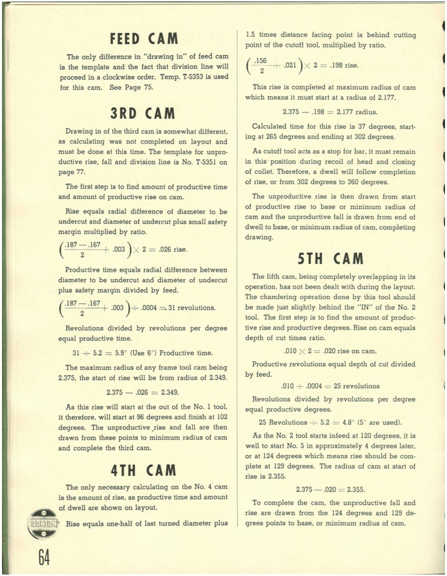
Thus: 102 to 109 — 113 to 120.

The unproductive falls and rises are then drawn in, using corresponding curves of the template and in accord with time allotted in column headed "Unproductive degrees."

2.090 —1.790 Fall 9°
1.790 —1.8515 Rise 3°
1.8515—2.090 Rise 6°
2.090 —2.219 Rise 4°
2.375 —2.090 Fall 7°

To complete the rocker arm cam, the productive rises are drawn in. These rises are usually faked in since there is no point in developing the curve, as this is done at time of fabrication. Where constant rise cam miller or grinder is used, curve is taken care of automatically.

# Photo 65



## FEED CAM

The only difference in "drawing in" of feed cam is the template and the fact that division line will proceed in a clockwise order. Temp. T-5353 is used for this cam. See Page 75.

## 3RD CAM

Drawing in of the third cam is somewhat different, as calculating was not completed on layout and must be done at this time. The template for unproductive rise, fall and division line is No. T-5351 on page 77.

The first step is to find amount of productive time and amount of productive rise on cam.

Rise equals radial difference of diameter to be undercut and diameter of undercut plus small safety margin multiplied by ratio.

$$\left(\frac{.187 - .167}{2} + .003\right) \times 2 = .026 \text{ rise.}$$

Productive time equals radial difference between diameter to be undercut and diameter of undercut plus safety margin divided by feed.

$$\left(\frac{.187 - .167}{2} + .003\right) \div .0004 = 31 \text{ revolutions.}$$

Revolutions divided by revolutions per degree equal productive time.

$$31 \div 5.2 = 5.9^\circ \text{ (Use } 6^\circ\text{) Productive time.}$$

The maximum radius of any frame tool cam being 2.375, the start of rise will be from radius of 2.349.

$$2.375 - .026 = 2.349.$$

As this rise will start at the out of the No. 1 tool, it therefore, will start at 96 degrees and finish at 102 degrees. The unproductive rise and fall are then drawn from these points to minimum radius of cam and complete the third cam.

## 4TH CAM

The only necessary calculating on the No. 4 cam is the amount of rise, as productive time and amount of dwell are shown on layout.

Rise equals one-half of last turned diameter plus 1.5 times distance facing point is behind cutting point of the cutoff tool, multiplied by ratio.

$$\left(\frac{.156}{2} \div .021\right) \times 2 = .198 \text{ rise.}$$

This rise is completed at maximum radius of cam which means it must start at a radius of 2.177.

$$2.375 - .198 = 2.177 \text{ radius.}$$

Calculated time for this rise is 37 degrees, starting at 265 degrees and ending at 302 degrees.

As cutoff tool acts as a stop for bar, it must remain in this position during recoil of head and closing of collet. Therefore, a dwell will follow completion of rise, or from 302 degrees to 360 degrees.

The unproductive rise is then drawn from start of productive rise to base or minimum radius of cam and the unproductive fall is drawn from end of dwell to base, or minimum radius of cam, completing drawing.

## 5TH CAM

The fifth cam, being completely overlapping in its operation, has not been dealt with during the layout. The chamfering operation done by this tool should be made just slightly behind the "IN" of the No. 2 tool. The first step is to find the amount of productive rise and productive degrees. Rise on cam equals depth of cut times ratio.

$$.010 \times 2 = .020 \text{ rise on cam.}$$

Productive revolutions equal depth of cut divided by feed.

$$.010 \div .0004 = 25 \text{ revolutions}$$

Revolutions divided by revolutions per degree equal productive degrees.

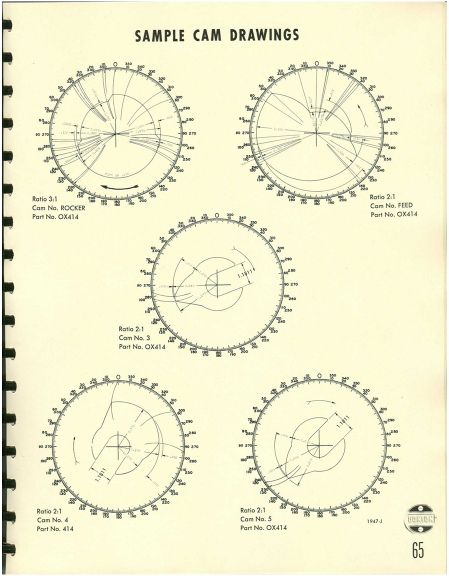
$$25 \text{ Revolutions} \div 5.2 = 4.8^\circ \text{ (}5^\circ \text{ are used).}$$

As the No. 2 tool starts infeed at 120 degrees, it is well to start No. 5 in approximately 4 degrees later, or at 124 degrees which means rise should be complete at 129 degrees. The radius of cam at start of rise is 2.355.

$$2.375 - .020 = 2.355.$$

To complete the cam, the unproductive fall and rise are drawn from the 124 degrees and 129 degrees points to base, or minimum radius of cam.

# Photo 66



SAMPLE CAM DRAWINGS

Ratio 3:1
Cam No. ROCKER
Part No. OX414

Ratio 2:1
Cam No. FEED
Part No. OX414

Ratio 2:1
Cam No. 3
Part No. OX414

Ratio 2:1
Cam No. 4
Part No. 414

Ratio 2:1
Cam No. 5
Part No. OX414

1947-J

65

# Photo 67

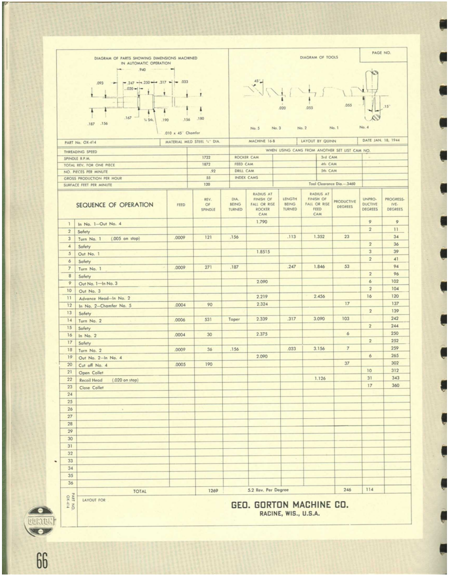


DIAGRAM OF PARTS SHOWING DIMENSIONS MACHINED IN AUTOMATIC OPERATION

DIAGRAM OF TOOLS

PAGE NO.

| | | | | |
|---|---|---|---|---|
| PART No. OX-414 | MATERIAL MILD STEEL ¼" DIA. | MACHINE 16-B | LAYOUT BY QUINN | DATE JAN. 18, 1944 |

| | | | | | |
|---|---|---|---|---|---|
| THREADING SPEED | | WHEN USING CAMS FROM ANOTHER SET LIST CAM NO. | | | |
| SPINDLE R.P.M. | 1722 | ROCKER CAM | | 3rd CAM | |
| TOTAL REV. FOR ONE PIECE | 1872 | FEED CAM | | 4th CAM | |
| NO. PIECES PER MINUTE | .92 | DRILL CAM | | 5th CAM | |
| GROSS PRODUCTION PER HOUR | 55 | INDEX CAMS | | | |
| SURFACE FEET PER MINUTE | 120 | | Tool Clearance Dia.—.3460 | | |

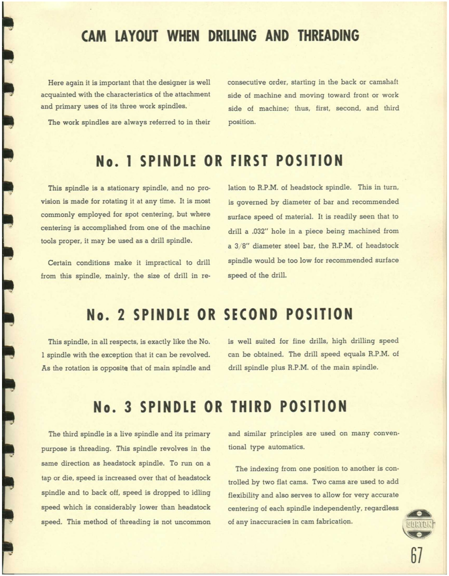
| | SEQUENCE OF OPERATION | FEED | REV. OF SPINDLE | DIA. BEING TURNED | RADIUS AT FINISH OF FALL OR RISE ROCKER CAM | LENGTH BEING TURNED | RADIUS AT FINISH OF FALL OR RISE FEED CAM | PRODUCTIVE DEGREES | UNPRODUCTIVE DEGREES | PROGRESSIVE DEGREES |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | In No. 1—Out No. 4 | | | | 1.790 | | | | 9 | 9 |
| 2 | Safety | | | | | | | | 2 | 11 |
| 3 | Turn No. 1 (.005 on stop) | .0009 | 121 | .156 | | .113 | 1.352 | 23 | | 34 |
| 4 | Safety | | | | | | | | 2 | 36 |
| 5 | Out No. 1 | | | | 1.8515 | | | | 3 | 39 |
| 6 | Safety | | | | | | | | 2 | 41 |
| 7 | Turn No. 1 | .0009 | 271 | .187 | | .247 | 1.846 | 53 | | 94 |
| 8 | Safety | | | | | | | | 2 | 96 |
| 9 | Out No. 1—In No. 3 | | | | 2.090 | | | | 6 | 102 |
| 10 | Out No. 3 | | | | | | | | 2 | 104 |
| 11 | Advance Head—In No. 2 | | | | 2.219 | | 2.456 | | 16 | 120 |
| 12 | In No. 2—Chamfer No. 5 | .0004 | 90 | | 2.324 | | | 17 | | 137 |
| 13 | Safety | | | | | | | | 2 | 139 |
| 14 | Turn No. 2 | .0006 | 531 | Taper | 2.339 | .317 | 3.090 | 103 | | 242 |
| 15 | Safety | | | | | | | | 2 | 244 |
| 16 | In No. 2 | .0004 | 30 | | 2.375 | | | 6 | | 250 |
| 17 | Safety | | | | | | | | 2 | 252 |
| 18 | Turn No. 2 | .0009 | 36 | .156 | | .033 | 3.156 | 7 | | 259 |
| 19 | Out No. 2—In No. 4 | | | | 2.090 | | | | 6 | 265 |
| 20 | Cut off No. 4 | .0005 | 190 | | | | | 37 | | 302 |
| 21 | Open Collet | | | | | | | | 10 | 312 |
| 22 | Recoil Head (.020 on stop) | | | | | | 1.126 | | 31 | 343 |
| 23 | Close Collet | | | | | | | | 17 | 360 |
| 24 | | | | | | | | | | |
| 25 | | | | | | | | | | |
| 26 | | | | | | | | | | |
| 27 | | | | | | | | | | |
| 28 | | | | | | | | | | |
| 29 | | | | | | | | | | |
| 30 | | | | | | | | | | |
| 31 | | | | | | | | | | |
| 32 | | | | | | | | | | |
| 33 | | | | | | | | | | |
| 34 | | | | | | | | | | |
| 35 | | | | | | | | | | |
| 36 | | | | | | | | | | |
| | TOTAL | | 1269 | 5.2 Rev. Per Degree | | | | 246 | 114 | |

PART NO. OX-414

LAYOUT FOR

**GEO. GORTON MACHINE CO.**
RACINE, WIS., U.S.A.

# Photo 68



## CAM LAYOUT WHEN DRILLING AND THREADING

Here again it is important that the designer is well acquainted with the characteristics of the attachment and primary uses of its three work spindles.

The work spindles are always referred to in their consecutive order, starting in the back or camshaft side of machine and moving toward front or work side of machine; thus, first, second, and third position.

## No. 1 SPINDLE OR FIRST POSITION

This spindle is a stationary spindle, and no provision is made for rotating it at any time. It is most commonly employed for spot centering, but where centering is accomplished from one of the machine tools proper, it may be used as a drill spindle.

Certain conditions make it impractical to drill from this spindle, mainly, the size of drill in relation to R.P.M. of headstock spindle. This in turn, is governed by diameter of bar and recommended surface speed of material. It is readily seen that to drill a .032" hole in a piece being machined from a 3/8" diameter steel bar, the R.P.M. of headstock spindle would be too low for recommended surface speed of the drill.

## No. 2 SPINDLE OR SECOND POSITION

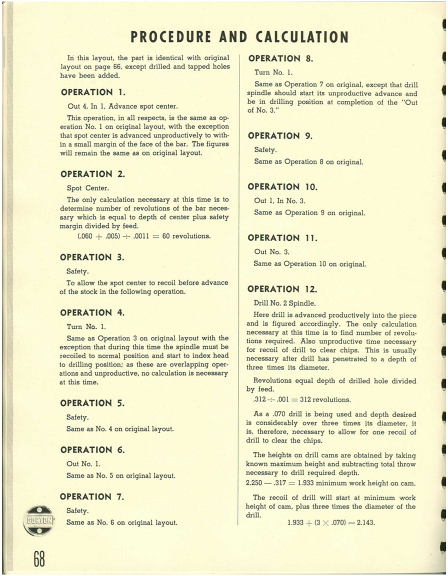
This spindle, in all respects, is exactly like the No. 1 spindle with the exception that it can be revolved. As the rotation is opposite that of main spindle and is well suited for fine drills, high drilling speed can be obtained. The drill speed equals R.P.M. of drill spindle plus R.P.M. of the main spindle.

## No. 3 SPINDLE OR THIRD POSITION

The third spindle is a live spindle and its primary purpose is threading. This spindle revolves in the same direction as headstock spindle. To run on a tap or die, speed is increased over that of headstock spindle and to back off, speed is dropped to idling speed which is considerably lower than headstock speed. This method of threading is not uncommon and similar principles are used on many conventional type automatics.

The indexing from one position to another is controlled by two flat cams. Two cams are used to add flexibility and also serves to allow for very accurate centering of each spindle independently, regardless of any inaccuracies in cam fabrication.

# Photo 69



## PROCEDURE AND CALCULATION

In this layout, the part is identical with original layout on page 66, except drilled and tapped holes have been added.

### OPERATION 1.

Out 4, In 1, Advance spot center.

This operation, in all respects, is the same as operation No. 1 on original layout, with the exception that spot center is advanced unproductively to within a small margin of the face of the bar. The figures will remain the same as on original layout.

### OPERATION 2.

Spot Center.

The only calculation necessary at this time is to determine number of revolutions of the bar necessary which is equal to depth of center plus safety margin divided by feed.

(.060 + .005) ÷ .0011 = 60 revolutions.

### OPERATION 3.

Safety.

To allow the spot center to recoil before advance of the stock in the following operation.

### OPERATION 4.

Turn No. 1.

Same as Operation 3 on original layout with the exception that during this time the spindle must be recoiled to normal position and start to index head to drilling position; as these are overlapping operations and unproductive, no calculation is necessary at this time.

### OPERATION 5.

Safety.

Same as No. 4 on original layout.

### OPERATION 6.

Out No. 1.

Same as No. 5 on original layout.

### OPERATION 7.

Safety.

Same as No. 6 on original layout.

### OPERATION 8.

Turn No. 1.

Same as Operation 7 on original, except that drill spindle should start its unproductive advance and be in drilling position at completion of the "Out of No. 3."

### OPERATION 9.

Safety.

Same as Operation 8 on original.

### OPERATION 10.

Out 1, In No. 3.

Same as Operation 9 on original.

### OPERATION 11.

Out No. 3.

Same as Operation 10 on original.

### OPERATION 12.

Drill No. 2 Spindle.

Here drill is advanced productively into the piece and is figured accordingly. The only calculation necessary at this time is to find number of revolutions required. Also unproductive time necessary for recoil of drill to clear chips. This is usually necessary after drill has penetrated to a depth of three times its diameter.

Revolutions equal depth of drilled hole divided by feed.

.312 ÷ .001 = 312 revolutions.

As a .070 drill is being used and depth desired is considerably over three times its diameter, it is, therefore, necessary to allow for one recoil of drill to clear the chips.

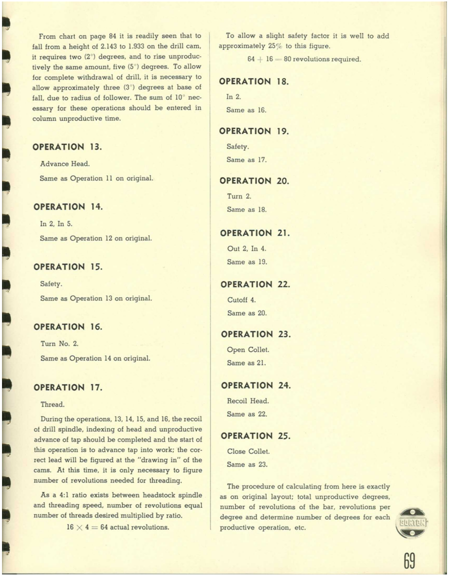
The heights on drill cams are obtained by taking known maximum height and subtracting total throw necessary to drill required depth.

2.250 — .317 = 1.933 minimum work height on cam.

The recoil of drill will start at minimum work height of cam, plus three times the diameter of the drill.

1.933 + (3 × .070) = 2.143.

# Photo 70



From chart on page 84 it is readily seen that to fall from a height of 2.143 to 1.933 on the drill cam, it requires two (2°) degrees, and to rise unproductively the same amount, five (5°) degrees. To allow for complete withdrawal of drill, it is necessary to allow approximately three (3°) degrees at base of fall, due to radius of follower. The sum of 10° necessary for these operations should be entered in column unproductive time.

**OPERATION 13.**

Advance Head.

Same as Operation 11 on original.

**OPERATION 14.**

In 2, In 5.

Same as Operation 12 on original.

**OPERATION 15.**

Safety.

Same as Operation 13 on original.

**OPERATION 16.**

Turn No. 2.

Same as Operation 14 on original.

**OPERATION 17.**

Thread.

During the operations, 13, 14, 15, and 16, the recoil of drill spindle, indexing of head and unproductive advance of tap should be completed and the start of this operation is to advance tap into work; the correct lead will be figured at the "drawing in" of the cams. At this time, it is only necessary to figure number of revolutions needed for threading.

As a 4:1 ratio exists between headstock spindle and threading speed, number of revolutions equal number of threads desired multiplied by ratio.

16 × 4 = 64 actual revolutions.

To allow a slight safety factor it is well to add approximately 25% to this figure.

64 + 16 = 80 revolutions required.

**OPERATION 18.**

In 2.

Same as 16.

**OPERATION 19.**

Safety.

Same as 17.

**OPERATION 20.**

Turn 2.

Same as 18.

**OPERATION 21.**

Out 2, In 4.

Same as 19.

**OPERATION 22.**

Cutoff 4.

Same as 20.

**OPERATION 23.**

Open Collet.

Same as 21.

**OPERATION 24.**

Recoil Head.

Same as 22.

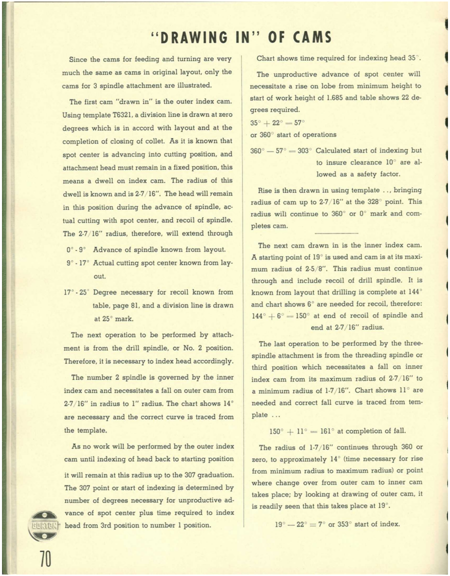
**OPERATION 25.**

Close Collet.

Same as 23.

The procedure of calculating from here is exactly as on original layout; total unproductive degrees, number of revolutions of the bar, revolutions per degree and determine number of degrees for each productive operation, etc.

# Photo 71



## "DRAWING IN" OF CAMS

Since the cams for feeding and turning are very much the same as cams in original layout, only the cams for 3 spindle attachment are illustrated.

The first cam "drawn in" is the outer index cam. Using template T6321, a division line is drawn at zero degrees which is in accord with layout and at the completion of closing of collet. As it is known that spot center is advancing into cutting position, and attachment head must remain in a fixed position, this means a dwell on index cam. The radius of this dwell is known and is 2-7/16". The head will remain in this position during the advance of spindle, actual cutting with spot center, and recoil of spindle. The 2-7/16" radius, therefore, will extend through

0° - 9° Advance of spindle known from layout.
9° - 17° Actual cutting spot center known from layout.
17° - 25° Degree necessary for recoil known from table, page 81, and a division line is drawn at 25° mark.

The next operation to be performed by attachment is from the drill spindle, or No. 2 position. Therefore, it is necessary to index head accordingly.

The number 2 spindle is governed by the inner index cam and necessitates a fall on outer cam from 2-7/16" in radius to 1" radius. The chart shows 14° are necessary and the correct curve is traced from the template.

As no work will be performed by the outer index cam until indexing of head back to starting position it will remain at this radius up to the 307 graduation. The 307 point or start of indexing is determined by number of degrees necessary for unproductive advance of spot center plus time required to index head from 3rd position to number 1 position.

Chart shows time required for indexing head 35°.

The unproductive advance of spot center will necessitate a rise on lobe from minimum height to start of work height of 1.685 and table shows 22 degrees required.

$35^\circ + 22^\circ = 57^\circ$
or 360° start of operations

$360^\circ - 57^\circ = 303^\circ$ Calculated start of indexing but to insure clearance 10° are allowed as a safety factor.

Rise is then drawn in using template . . , bringing radius of cam up to 2-7/16" at the 328° point. This radius will continue to 360° or 0° mark and completes cam.

---

The next cam drawn in is the inner index cam. A starting point of 19° is used and cam is at its maximum radius of 2-5/8". This radius must continue through and include recoil of drill spindle. It is known from layout that drilling is complete at 144° and chart shows 6° are needed for recoil, therefore:

$144^\circ + 6^\circ = 150^\circ$ at end of recoil of spindle and end at 2-7/16" radius.

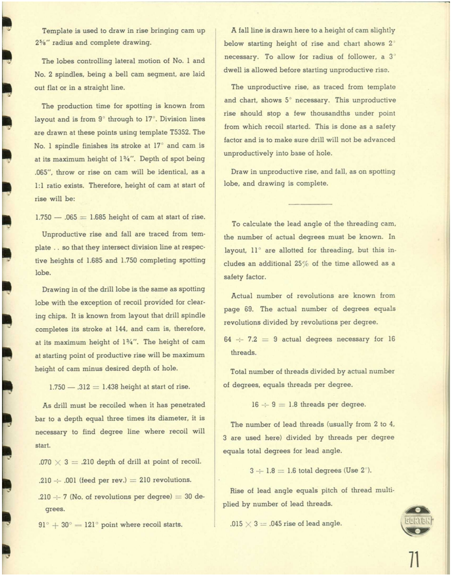
The last operation to be performed by the three-spindle attachment is from the threading spindle or third position which necessitates a fall on inner index cam from its maximum radius of 2-7/16" to a minimum radius of 1-7/16". Chart shows 11° are needed and correct fall curve is traced from template . . .

$150^\circ + 11^\circ = 161^\circ$ at completion of fall.

The radius of 1-7/16" continues through 360 or zero, to approximately 14° (time necessary for rise from minimum radius to maximum radius) or point where change over from outer cam to inner cam takes place; by looking at drawing of outer cam, it is readily seen that this takes place at 19°.

$19^\circ - 22^\circ = 7^\circ$ or 353° start of index.

# Photo 72



Template is used to draw in rise bringing cam up 2⅝" radius and complete drawing.

The lobes controlling lateral motion of No. 1 and No. 2 spindles, being a bell cam segment, are laid out flat or in a straight line.

The production time for spotting is known from layout and is from 9° through to 17°. Division lines are drawn at these points using template T5352. The No. 1 spindle finishes its stroke at 17° and cam is at its maximum height of 1¾". Depth of spot being .065", throw or rise on cam will be identical, as a 1:1 ratio exists. Therefore, height of cam at start of rise will be:

$1.750 - .065 = 1.685$ height of cam at start of rise.

Unproductive rise and fall are traced from template . . so that they intersect division line at respective heights of 1.685 and 1.750 completing spotting lobe.

Drawing in of the drill lobe is the same as spotting lobe with the exception of recoil provided for clearing chips. It is known from layout that drill spindle completes its stroke at 144, and cam is, therefore, at its maximum height of 1¾". The height of cam at starting point of productive rise will be maximum height of cam minus desired depth of hole.

$1.750 - .312 = 1.438$ height at start of rise.

As drill must be recoiled when it has penetrated bar to a depth equal three times its diameter, it is necessary to find degree line where recoil will start.

$.070 \times 3 = .210$ depth of drill at point of recoil.

$.210 \div .001$ (feed per rev.) $= 210$ revolutions.

$.210 \div 7$ (No. of revolutions per degree) $= 30$ degrees.

$91^\circ + 30^\circ = 121^\circ$ point where recoil starts.

A fall line is drawn here to a height of cam slightly below starting height of rise and chart shows 2° necessary. To allow for radius of follower, a 3° dwell is allowed before starting unproductive rise.

The unproductive rise, as traced from template and chart, shows 5° necessary. This unproductive rise should stop a few thousandths under point from which recoil started. This is done as a safety factor and is to make sure drill will not be advanced unproductively into base of hole.

Draw in unproductive rise, and fall, as on spotting lobe, and drawing is complete.

---

To calculate the lead angle of the threading cam, the number of actual degrees must be known. In layout, 11° are allotted for threading, but this includes an additional 25% of the time allowed as a safety factor.

Actual number of revolutions are known from page 69. The actual number of degrees equals revolutions divided by revolutions per degree.

$64 \div 7.2 = 9$ actual degrees necessary for 16 threads.

Total number of threads divided by actual number of degrees, equals threads per degree.

$16 \div 9 = 1.8$ threads per degree.

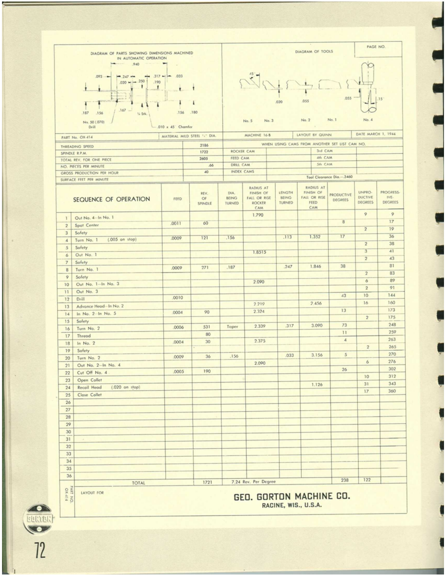
The number of lead threads (usually from 2 to 4, 3 are used here) divided by threads per degree equals total degrees for lead angle.

$3 \div 1.8 = 1.6$ total degrees (Use 2°).

Rise of lead angle equals pitch of thread multiplied by number of lead threads.

$.015 \times 3 = .045$ rise of lead angle.

# Photo 73



PAGE NO.

| | | | |
|---|---|---|---|
| PART No. OX-414 | MATERIAL MILD STEEL ¼" DIA. | MACHINE 16-B | LAYOUT BY QUINN |
| DATE MARCH 1, 1944 | | | |

| | | | | | |
|---|---|---|---|---|---|
| THREADING SPEED | 2186 | WHEN USING CAMS FROM ANOTHER SET LIST CAM NO. | | | |
| SPINDLE R.P.M. | 1722 | ROCKER CAM | | 3rd CAM | |
| TOTAL REV. FOR ONE PIECE | 2605 | FEED CAM | | 4th CAM | |
| NO. PIECES PER MINUTE | .66 | DRILL CAM | | 5th CAM | |
| GROSS PRODUCTION PER HOUR | 40 | INDEX CAMS | | | |
| SURFACE FEET PER MINUTE | | | Tool Clearance Dia.—.3460 | | |

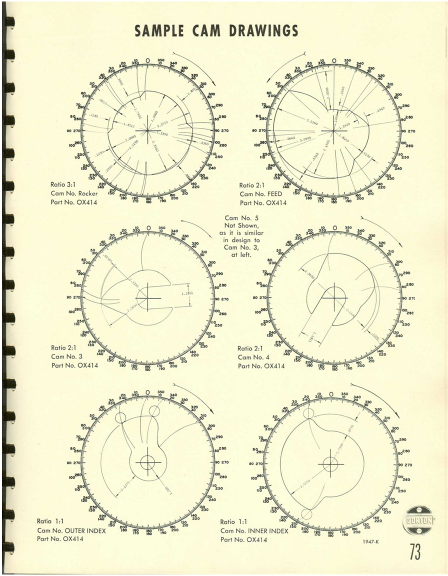
| | SEQUENCE OF OPERATION | FEED | REV. OF SPINDLE | DIA. BEING TURNED | RADIUS AT FINISH OF FALL OR RISE ROCKER CAM | LENGTH BEING TURNED | RADIUS AT FINISH OF FALL OR RISE FEED CAM | PRODUCTIVE DEGREES | UNPRODUCTIVE DEGREES | PROGRESSIVE DEGREES |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Out No. 4—In No. 1 | | | | 1.790 | | | | 9 | 9 |
| 2 | Spot Center | .0011 | 60 | | | | | 8 | | 17 |
| 3 | Safety | | | | | | | | 2 | 19 |
| 4 | Turn No. 1 (.005 on stop) | .0009 | 121 | .156 | | .113 | 1.352 | 17 | | 36 |
| 5 | Safety | | | | | | | | 2 | 38 |
| 6 | Out No. 1 | | | | 1.8515 | | | | 3 | 41 |
| 7 | Safety | | | | | | | | 2 | 43 |
| 8 | Turn No. 1 | .0009 | 271 | .187 | | .247 | 1.846 | 38 | | 81 |
| 9 | Safety | | | | | | | | 2 | 83 |
| 10 | Out No. 1—In No. 3 | | | | 2.090 | | | | 6 | 89 |
| 11 | Out No. 3 | | | | | | | | 2 | 91 |
| 12 | Drill | .0010 | | | | | | 43 | 10 | 144 |
| 13 | Advance Head—In No. 2 | | | | 2.219 | | 2.456 | | 16 | 160 |
| 14 | In No. 2—In No. 5 | .0004 | 90 | | 2.324 | | | 13 | | 173 |
| 15 | Safety | | | | | | | | 2 | 175 |
| 16 | Turn No. 2 | .0006 | 531 | Taper | 2.339 | .317 | 3.090 | 73 | | 248 |
| 17 | Thread | | 80 | | | | | 11 | | 259 |
| 18 | In No. 2 | .0004 | 30 | | 2.375 | | | 4 | | 263 |
| 19 | Safety | | | | | | | | 2 | 265 |
| 20 | Turn No. 2 | .0009 | 36 | .156 | | .033 | 3.156 | 5 | | 270 |
| 21 | Out No. 2—In No. 4 | | | | 2.090 | | | | 6 | 276 |
| 22 | Cut Off No. 4 | .0005 | 190 | | | | | 26 | | 302 |
| 23 | Open Collet | | | | | | | | 10 | 312 |
| 24 | Recoil Head (.020 on stop) | | | | | | 1.126 | | 31 | 343 |
| 25 | Close Collet | | | | | | | | 17 | 360 |
| 26 | | | | | | | | | | |
| 27 | | | | | | | | | | |
| 28 | | | | | | | | | | |
| 29 | | | | | | | | | | |
| 30 | | | | | | | | | | |
| 31 | | | | | | | | | | |
| 32 | | | | | | | | | | |
| 33 | | | | | | | | | | |
| 34 | | | | | | | | | | |
| 35 | | | | | | | | | | |
| 36 | | | | | | | | | | |
| | TOTAL | | 1721 | 7.24 Rev. Per Degree | | | | 238 | 122 | |

PART NO. OX-414

LAYOUT FOR

**GEO. GORTON MACHINE CO.**
RACINE, WIS., U.S.A.

# Photo 74



## SAMPLE CAM DRAWINGS

Ratio 3:1
Cam No. Rocker
Part No. OX414

Ratio 2:1
Cam No. FEED
Part No. OX414

Ratio 2:1
Cam No. 3
Part No. OX414

Cam No. 5
Not Shown,
as it is similar
in design to
Cam No. 3,
at left.

Ratio 2:1
Cam No. 4
Part No. OX414

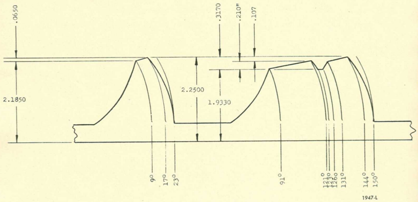
Ratio 1:1
Cam No. OUTER INDEX
Part No. OX414

Ratio 1:1
Cam No. INNER INDEX
Part No. OX414

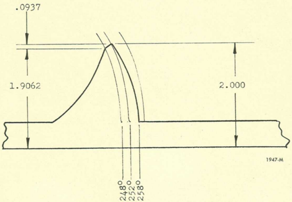
1947-K

# Photo 75

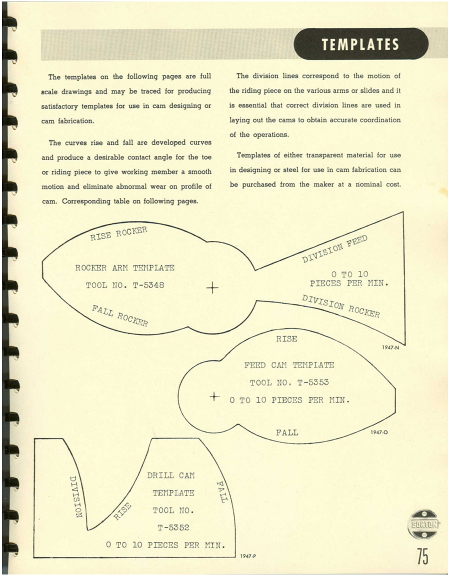
## CENTERING & DRILLING CAM



## THREADING CAM



# Photo 76



## TEMPLATES

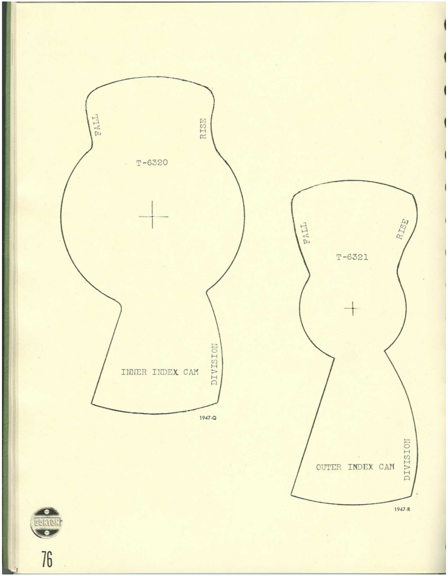
The templates on the following pages are full scale drawings and may be traced for producing satisfactory templates for use in cam designing or cam fabrication.

The curves rise and fall are developed curves and produce a desirable contact angle for the toe or riding piece to give working member a smooth motion and eliminate abnormal wear on profile of cam. Corresponding table on following pages.

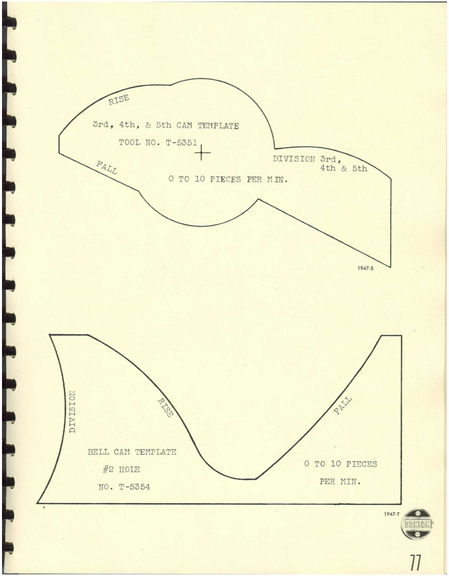
The division lines correspond to the motion of the riding piece on the various arms or slides and it is essential that correct division lines are used in laying out the cams to obtain accurate coordination of the operations.

Templates of either transparent material for use in designing or steel for use in cam fabrication can be purchased from the maker at a nominal cost.

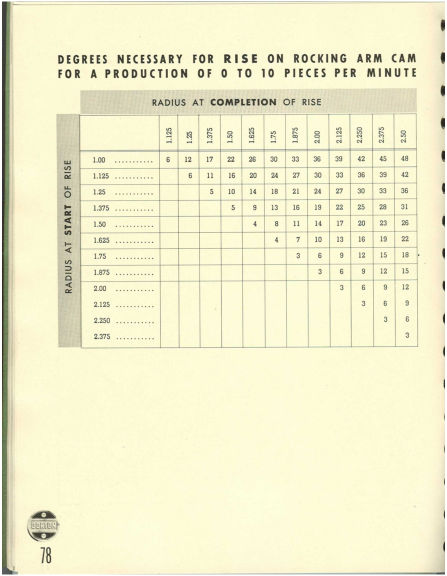
# Photo 77


FALL
RISE
T-6320
INNER INDEX CAM
DIVISION
1947-Q
FALL
RISE
T-6321
OUTER INDEX CAM
DIVISION
1947-R
GORTON
76

# Photo 78


RISE
3rd, 4th, & 5th CAM TEMPLATE
TOOL NO. T-5351
FALL
0 TO 10 PIECES PER MIN.
DIVISION 3rd, 4th & 5th
1947-S
DIVISION
RISE
FALL
BELL CAM TEMPLATE
#2 HOLE
NO. T-5354
0 TO 10 PIECES
PER MIN.
1947-T
BURTON
77

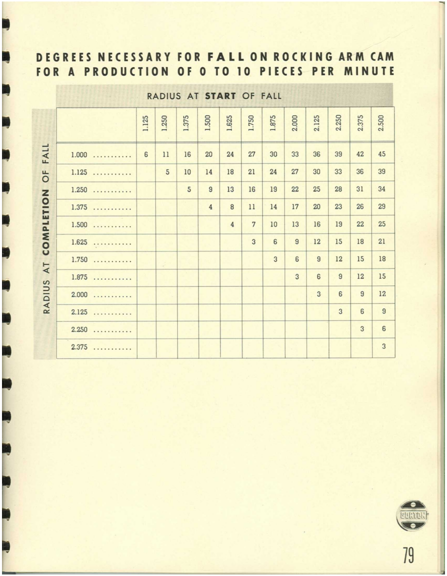
# Photo 79



## DEGREES NECESSARY FOR RISE ON ROCKING ARM CAM FOR A PRODUCTION OF 0 TO 10 PIECES PER MINUTE

| RADIUS AT **START** OF RISE | RADIUS AT **COMPLETION** OF RISE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.125 | 1.25 | 1.375 | 1.50 | 1.625 | 1.75 | 1.875 | 2.00 | 2.125 | 2.250 | 2.375 | 2.50 |
| 1.00 ........... | 6 | 12 | 17 | 22 | 26 | 30 | 33 | 36 | 39 | 42 | 45 | 48 |
| 1.125 ........... | | 6 | 11 | 16 | 20 | 24 | 27 | 30 | 33 | 36 | 39 | 42 |
| 1.25 ........... | | | 5 | 10 | 14 | 18 | 21 | 24 | 27 | 30 | 33 | 36 |
| 1.375 ........... | | | | 5 | 9 | 13 | 16 | 19 | 22 | 25 | 28 | 31 |
| 1.50 ........... | | | | | 4 | 8 | 11 | 14 | 17 | 20 | 23 | 26 |
| 1.625 ........... | | | | | | 4 | 7 | 10 | 13 | 16 | 19 | 22 |
| 1.75 ........... | | | | | | | 3 | 6 | 9 | 12 | 15 | 18 |
| 1.875 ........... | | | | | | | | 3 | 6 | 9 | 12 | 15 |
| 2.00 ........... | | | | | | | | | 3 | 6 | 9 | 12 |
| 2.125 ........... | | | | | | | | | | 3 | 6 | 9 |
| 2.250 ........... | | | | | | | | | | | 3 | 6 |
| 2.375 ........... | | | | | | | | | | | | 3 |

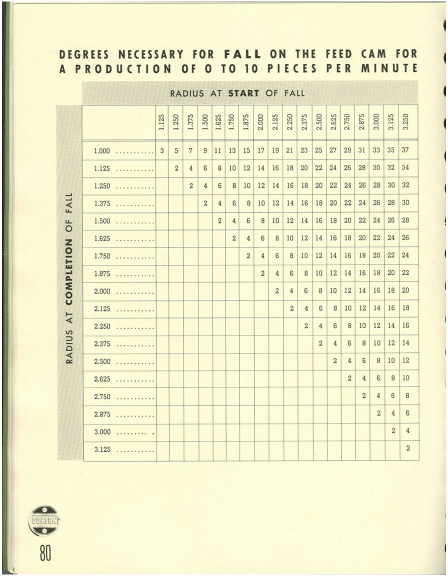
# Photo 80



## DEGREES NECESSARY FOR FALL ON ROCKING ARM CAM FOR A PRODUCTION OF 0 TO 10 PIECES PER MINUTE

| RADIUS AT **COMPLETION** OF FALL | RADIUS AT **START** OF FALL | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.125 | 1.250 | 1.375 | 1.500 | 1.625 | 1.750 | 1.875 | 2.000 | 2.125 | 2.250 | 2.375 | 2.500 |
| 1.000 ........... | 6 | 11 | 16 | 20 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 |
| 1.125 ........... | | 5 | 10 | 14 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 |
| 1.250 ........... | | | 5 | 9 | 13 | 16 | 19 | 22 | 25 | 28 | 31 | 34 |
| 1.375 ........... | | | | 4 | 8 | 11 | 14 | 17 | 20 | 23 | 26 | 29 |
| 1.500 ........... | | | | | 4 | 7 | 10 | 13 | 16 | 19 | 22 | 25 |
| 1.625 ........... | | | | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 |
| 1.750 ........... | | | | | | | 3 | 6 | 9 | 12 | 15 | 18 |
| 1.875 ........... | | | | | | | | 3 | 6 | 9 | 12 | 15 |
| 2.000 ........... | | | | | | | | | 3 | 6 | 9 | 12 |
| 2.125 ........... | | | | | | | | | | 3 | 6 | 9 |
| 2.250 ........... | | | | | | | | | | | 3 | 6 |
| 2.375 ........... | | | | | | | | | | | | 3 |

# Photo 81

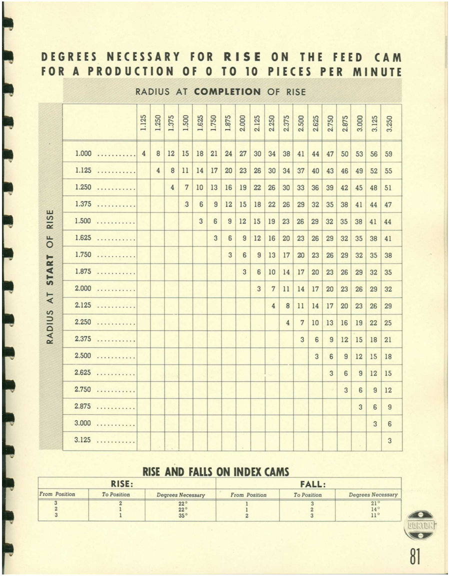


## DEGREES NECESSARY FOR FALL ON THE FEED CAM FOR A PRODUCTION OF 0 TO 10 PIECES PER MINUTE

| | RADIUS AT START OF FALL | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RADIUS AT COMPLETION OF FALL | 1.125 | 1.250 | 1.375 | 1.500 | 1.625 | 1.750 | 1.875 | 2.000 | 2.125 | 2.250 | 2.375 | 2.500 | 2.625 | 2.750 | 2.875 | 3.000 | 3.125 | 3.250 |
| 1.000 | 3 | 5 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 | 37 |
| 1.125 | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 | 34 |
| 1.250 | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 | 32 |
| 1.375 | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 |
| 1.500 | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 |
| 1.625 | | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 |
| 1.750 | | | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 |
| 1.875 | | | | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 |
| 2.000 | | | | | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
| 2.125 | | | | | | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |
| 2.250 | | | | | | | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 |
| 2.375 | | | | | | | | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 |
| 2.500 | | | | | | | | | | | | | 2 | 4 | 6 | 8 | 10 | 12 |
| 2.625 | | | | | | | | | | | | | | 2 | 4 | 6 | 8 | 10 |
| 2.750 | | | | | | | | | | | | | | | 2 | 4 | 6 | 8 |
| 2.875 | | | | | | | | | | | | | | | | 2 | 4 | 6 |
| 3.000 | | | | | | | | | | | | | | | | | 2 | 4 |
| 3.125 | | | | | | | | | | | | | | | | | | 2 |

GORTON

# Photo 82



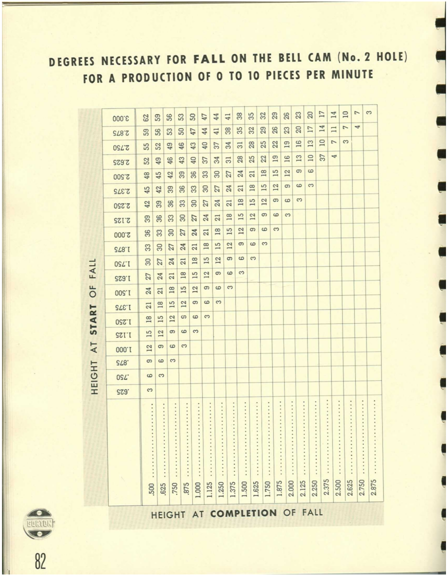
## DEGREES NECESSARY FOR RISE ON THE FEED CAM FOR A PRODUCTION OF 0 TO 10 PIECES PER MINUTE

| | RADIUS AT **COMPLETION** OF RISE | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RADIUS AT **START** OF RISE | 1.125 | 1.250 | 1.375 | 1.500 | 1.625 | 1.750 | 1.875 | 2.000 | 2.125 | 2.250 | 2.375 | 2.500 | 2.625 | 2.750 | 2.875 | 3.000 | 3.125 | 3.250 |
| 1.000 ........... | 4 | 8 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 34 | 38 | 41 | 44 | 47 | 50 | 53 | 56 | 59 |
| 1.125 ........... | | 4 | 8 | 11 | 14 | 17 | 20 | 23 | 26 | 30 | 34 | 37 | 40 | 43 | 46 | 49 | 52 | 55 |
| 1.250 ........... | | | 4 | 7 | 10 | 13 | 16 | 19 | 22 | 26 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 51 |
| 1.375 ........... | | | | 3 | 6 | 9 | 12 | 15 | 18 | 22 | 26 | 29 | 32 | 35 | 38 | 41 | 44 | 47 |
| 1.500 ........... | | | | | 3 | 6 | 9 | 12 | 15 | 19 | 23 | 26 | 29 | 32 | 35 | 38 | 41 | 44 |
| 1.625 ........... | | | | | | 3 | 6 | 9 | 12 | 16 | 20 | 23 | 26 | 29 | 32 | 35 | 38 | 41 |
| 1.750 ........... | | | | | | | 3 | 6 | 9 | 13 | 17 | 20 | 23 | 26 | 29 | 32 | 35 | 38 |
| 1.875 ........... | | | | | | | | 3 | 6 | 10 | 14 | 17 | 20 | 23 | 26 | 29 | 32 | 35 |
| 2.000 ........... | | | | | | | | | 3 | 7 | 11 | 14 | 17 | 20 | 23 | 26 | 29 | 32 |
| 2.125 ........... | | | | | | | | | | 4 | 8 | 11 | 14 | 17 | 20 | 23 | 26 | 29 |
| 2.250 ........... | | | | | | | | | | | 4 | 7 | 10 | 13 | 16 | 19 | 22 | 25 |
| 2.375 ........... | | | | | | | | | | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 |
| 2.500 ........... | | | | | | | | | | | | | 3 | 6 | 9 | 12 | 15 | 18 |
| 2.625 ........... | | | | | | | | | | | | | | 3 | 6 | 9 | 12 | 15 |
| 2.750 ........... | | | | | | | | | | | | | | | 3 | 6 | 9 | 12 |
| 2.875 ........... | | | | | | | | | | | | | | | | 3 | 6 | 9 |
| 3.000 ........... | | | | | | | | | | | | | | | | | 3 | 6 |
| 3.125 ........... | | | | | | | | | | | | | | | | | | 3 |

## RISE AND FALLS ON INDEX CAMS

| RISE: | | | FALL: | | |
|---|---|---|---|---|---|
| *From Position* | *To Position* | *Degrees Necessary* | *From Position* | *To Position* | *Degrees Necessary* |
| 3 | 2 | 22° | 1 | 3 | 21° |
| 2 | 1 | 22° | 1 | 2 | 14° |
| 3 | 1 | 35° | 2 | 3 | 11° |

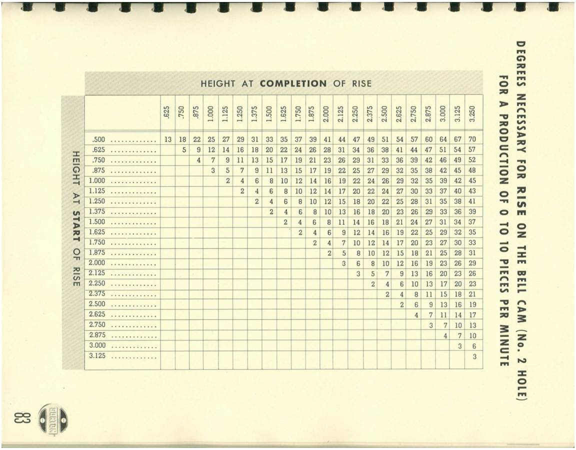
# Photo 83



## DEGREES NECESSARY FOR **FALL** ON THE BELL CAM (No. 2 HOLE) FOR A PRODUCTION OF 0 TO 10 PIECES PER MINUTE

| | HEIGHT AT **START** OF FALL | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HEIGHT AT **COMPLETION** OF FALL | .625 | .750 | .875 | 1.000 | 1.125 | 1.250 | 1.375 | 1.500 | 1.625 | 1.750 | 1.875 | 2.000 | 2.125 | 2.250 | 2.375 | 2.500 | 2.625 | 2.750 | 2.875 | 3.000 |
| .500 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 48 | 52 | 55 | 59 | 62 |
| .625 | | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 45 | 49 | 52 | 56 | 59 |
| .750 | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 42 | 46 | 49 | 53 | 56 |
| .875 | | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 39 | 43 | 46 | 50 | 53 |
| 1.000 | | | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 36 | 40 | 43 | 47 | 50 |
| 1.125 | | | | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 33 | 37 | 40 | 44 | 47 |
| 1.250 | | | | | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 | 34 | 37 | 41 | 44 |
| 1.375 | | | | | | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 31 | 34 | 38 | 41 |
| 1.500 | | | | | | | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 28 | 31 | 35 | 38 |
| 1.625 | | | | | | | | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 25 | 28 | 32 | 35 |
| 1.750 | | | | | | | | | | | 3 | 6 | 9 | 12 | 15 | 18 | 22 | 25 | 29 | 32 |
| 1.875 | | | | | | | | | | | | 3 | 6 | 9 | 12 | 15 | 19 | 22 | 26 | 29 |
| 2.000 | | | | | | | | | | | | | 3 | 6 | 9 | 12 | 16 | 19 | 23 | 26 |
| 2.125 | | | | | | | | | | | | | | 3 | 6 | 9 | 13 | 16 | 20 | 23 |
| 2.250 | | | | | | | | | | | | | | | 3 | 6 | 10 | 13 | 17 | 20 |
| 2.375 | | | | | | | | | | | | | | | | | 37 | 10 | 14 | 17 |
| 2.500 | | | | | | | | | | | | | | | | | 4 | 7 | 11 | 14 |
| 2.625 | | | | | | | | | | | | | | | | | | 3 | 7 | 10 |
| 2.750 | | | | | | | | | | | | | | | | | | | 4 | 7 |
| 2.875 | | | | | | | | | | | | | | | | | | | | 3 |

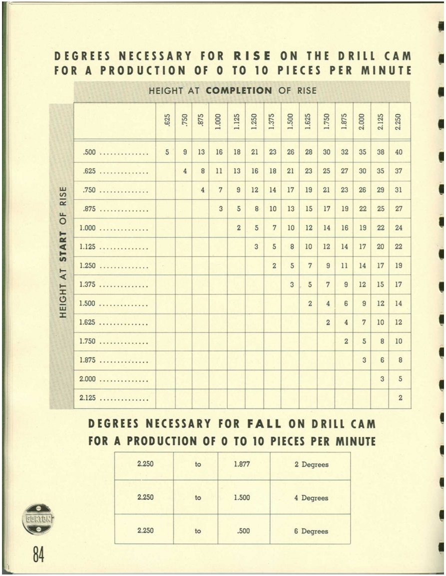
# Photo 84



## DEGREES NECESSARY FOR RISE ON THE BELL CAM (No. 2 HOLE)
## FOR A PRODUCTION OF 0 TO 10 PIECES PER MINUTE

| | HEIGHT AT COMPLETION OF RISE | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HEIGHT AT START OF RISE | .625 | .750 | .875 | 1.000 | 1.125 | 1.250 | 1.375 | 1.500 | 1.625 | 1.750 | 1.875 | 2.000 | 2.125 | 2.250 | 2.375 | 2.500 | 2.625 | 2.750 | 2.875 | 3.000 | 3.125 | 3.250 |
| .500 ............. | 13 | 18 | 22 | 25 | 27 | 29 | 31 | 33 | 35 | 37 | 39 | 41 | 44 | 47 | 49 | 51 | 54 | 57 | 60 | 64 | 67 | 70 |
| .625 ............. | | 5 | 9 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 31 | 34 | 36 | 38 | 41 | 44 | 47 | 51 | 54 | 57 |
| .750 ............. | | | 4 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 21 | 23 | 26 | 29 | 31 | 33 | 36 | 39 | 42 | 46 | 49 | 52 |
| .875 ............. | | | | 3 | 5 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 22 | 25 | 27 | 29 | 32 | 35 | 38 | 42 | 45 | 48 |
| 1.000 ............. | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 19 | 22 | 24 | 26 | 29 | 32 | 35 | 39 | 42 | 45 |
| 1.125 ............. | | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 17 | 20 | 22 | 24 | 27 | 30 | 33 | 37 | 40 | 43 |
| 1.250 ............. | | | | | | | 2 | 4 | 6 | 8 | 10 | 12 | 15 | 18 | 20 | 22 | 25 | 28 | 31 | 35 | 38 | 41 |
| 1.375 ............. | | | | | | | | 2 | 4 | 6 | 8 | 10 | 13 | 16 | 18 | 20 | 23 | 26 | 29 | 33 | 36 | 39 |
| 1.500 ............. | | | | | | | | | 2 | 4 | 6 | 8 | 11 | 14 | 16 | 18 | 21 | 24 | 27 | 31 | 34 | 37 |
| 1.625 ............. | | | | | | | | | | 2 | 4 | 6 | 9 | 12 | 14 | 16 | 19 | 22 | 25 | 29 | 32 | 35 |
| 1.750 ............. | | | | | | | | | | | 2 | 4 | 7 | 10 | 12 | 14 | 17 | 20 | 23 | 27 | 30 | 33 |
| 1.875 ............. | | | | | | | | | | | | 2 | 5 | 8 | 10 | 12 | 15 | 18 | 21 | 25 | 28 | 31 |
| 2.000 ............. | | | | | | | | | | | | | 3 | 6 | 8 | 10 | 12 | 16 | 19 | 23 | 26 | 29 |
| 2.125 ............. | | | | | | | | | | | | | | 3 | 5 | 7 | 9 | 13 | 16 | 20 | 23 | 26 |
| 2.250 ............. | | | | | | | | | | | | | | | 2 | 4 | 6 | 10 | 13 | 17 | 20 | 23 |
| 2.375 ............. | | | | | | | | | | | | | | | | 2 | 4 | 8 | 11 | 15 | 18 | 21 |
| 2.500 ............. | | | | | | | | | | | | | | | | | 2 | 6 | 9 | 13 | 16 | 19 |
| 2.625 ............. | | | | | | | | | | | | | | | | | | 4 | 7 | 11 | 14 | 17 |
| 2.750 ............. | | | | | | | | | | | | | | | | | | | 3 | 7 | 10 | 13 |
| 2.875 ............. | | | | | | | | | | | | | | | | | | | | 4 | 7 | 10 |
| 3.000 ............. | | | | | | | | | | | | | | | | | | | | | 3 | 6 |
| 3.125 ............. | | | | | | | | | | | | | | | | | | | | | | 3 |

# Photo 85



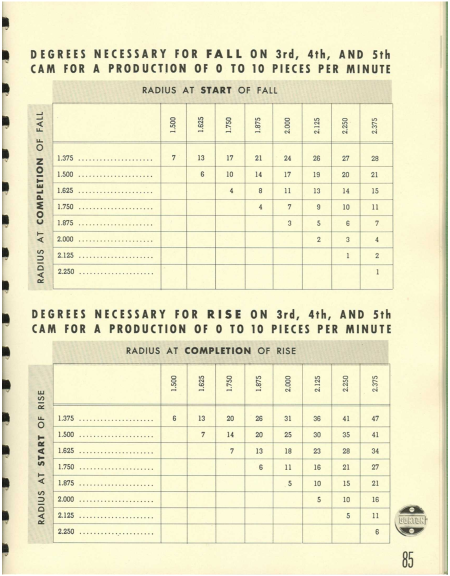
## DEGREES NECESSARY FOR **RISE** ON THE DRILL CAM FOR A PRODUCTION OF 0 TO 10 PIECES PER MINUTE

| HEIGHT AT **START** OF RISE | HEIGHT AT **COMPLETION** OF RISE | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | .625 | .750 | .875 | 1.000 | 1.125 | 1.250 | 1.375 | 1.500 | 1.625 | 1.750 | 1.875 | 2.000 | 2.125 | 2.250 |
| .500 .............. | 5 | 9 | 13 | 16 | 18 | 21 | 23 | 26 | 28 | 30 | 32 | 35 | 38 | 40 |
| .625 .............. | | 4 | 8 | 11 | 13 | 16 | 18 | 21 | 23 | 25 | 27 | 30 | 35 | 37 |
| .750 .............. | | | 4 | 7 | 9 | 12 | 14 | 17 | 19 | 21 | 23 | 26 | 29 | 31 |
| .875 .............. | | | | 3 | 5 | 8 | 10 | 13 | 15 | 17 | 19 | 22 | 25 | 27 |
| 1.000 .............. | | | | | 2 | 5 | 7 | 10 | 12 | 14 | 16 | 19 | 22 | 24 |
| 1.125 .............. | | | | | | 3 | 5 | 8 | 10 | 12 | 14 | 17 | 20 | 22 |
| 1.250 .............. | | | | | | | 2 | 5 | 7 | 9 | 11 | 14 | 17 | 19 |
| 1.375 .............. | | | | | | | | 3 | 5 | 7 | 9 | 12 | 15 | 17 |
| 1.500 .............. | | | | | | | | | 2 | 4 | 6 | 9 | 12 | 14 |
| 1.625 .............. | | | | | | | | | | 2 | 4 | 7 | 10 | 12 |
| 1.750 .............. | | | | | | | | | | | 2 | 5 | 8 | 10 |
| 1.875 .............. | | | | | | | | | | | | 3 | 6 | 8 |
| 2.000 .............. | | | | | | | | | | | | | 3 | 5 |
| 2.125 .............. | | | | | | | | | | | | | | 2 |

## DEGREES NECESSARY FOR **FALL** ON DRILL CAM FOR A PRODUCTION OF 0 TO 10 PIECES PER MINUTE

| | | | |
|---|---|---|---|
| 2.250 | to | 1.877 | 2 Degrees |
| 2.250 | to | 1.500 | 4 Degrees |
| 2.250 | to | .500 | 6 Degrees |

# Photo 86



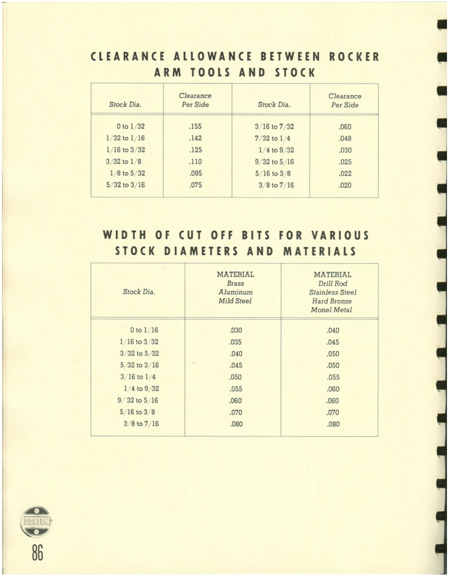
## DEGREES NECESSARY FOR **FALL** ON 3rd, 4th, AND 5th CAM FOR A PRODUCTION OF 0 TO 10 PIECES PER MINUTE

| | RADIUS AT **START** OF FALL | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| RADIUS AT **COMPLETION** OF FALL | 1.500 | 1.625 | 1.750 | 1.875 | 2.000 | 2.125 | 2.250 | 2.375 |
| 1.375 | 7 | 13 | 17 | 21 | 24 | 26 | 27 | 28 |
| 1.500 | | 6 | 10 | 14 | 17 | 19 | 20 | 21 |
| 1.625 | | | 4 | 8 | 11 | 13 | 14 | 15 |
| 1.750 | | | | 4 | 7 | 9 | 10 | 11 |
| 1.875 | | | | | 3 | 5 | 6 | 7 |
| 2.000 | | | | | | 2 | 3 | 4 |
| 2.125 | | | | | | | 1 | 2 |
| 2.250 | | | | | | | | 1 |

## DEGREES NECESSARY FOR **RISE** ON 3rd, 4th, AND 5th CAM FOR A PRODUCTION OF 0 TO 10 PIECES PER MINUTE

| | RADIUS AT **COMPLETION** OF RISE | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| RADIUS AT **START** OF RISE | 1.500 | 1.625 | 1.750 | 1.875 | 2.000 | 2.125 | 2.250 | 2.375 |
| 1.375 | 6 | 13 | 20 | 26 | 31 | 36 | 41 | 47 |
| 1.500 | | 7 | 14 | 20 | 25 | 30 | 35 | 41 |
| 1.625 | | | 7 | 13 | 18 | 23 | 28 | 34 |
| 1.750 | | | | 6 | 11 | 16 | 21 | 27 |
| 1.875 | | | | | 5 | 10 | 15 | 21 |
| 2.000 | | | | | | 5 | 10 | 16 |
| 2.125 | | | | | | | 5 | 11 |
| 2.250 | | | | | | | | 6 |

# Photo 87



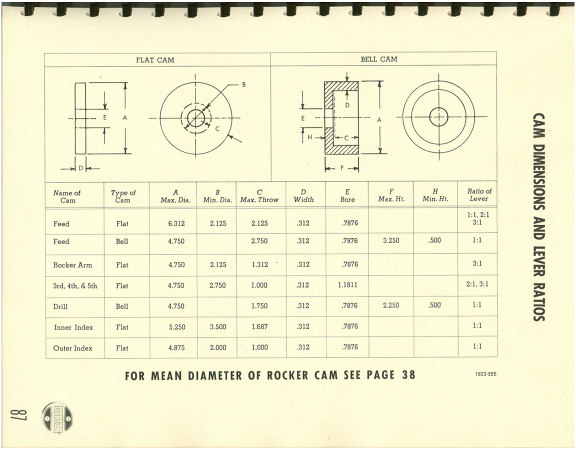
## CLEARANCE ALLOWANCE BETWEEN ROCKER ARM TOOLS AND STOCK

| Stock Dia. | Clearance Per Side | Stock Dia. | Clearance Per Side |
|---|---|---|---|
| 0 to 1/32 | .155 | 3/16 to 7/32 | .060 |
| 1/32 to 1/16 | .142 | 7/32 to 1/4 | .048 |
| 1/16 to 3/32 | .125 | 1/4 to 9/32 | .030 |
| 3/32 to 1/8 | .110 | 9/32 to 5/16 | .025 |
| 1/8 to 5/32 | .095 | 5/16 to 3/8 | .022 |
| 5/32 to 3/16 | .075 | 3/8 to 7/16 | .020 |

## WIDTH OF CUT OFF BITS FOR VARIOUS STOCK DIAMETERS AND MATERIALS

| Stock Dia. | MATERIAL<br>*Brass*<br>*Aluminum*<br>*Mild Steel* | MATERIAL<br>*Drill Rod*<br>*Stainless Steel*<br>*Hard Bronze*<br>*Monel Metal* |
|---|---|---|
| 0 to 1/16 | .030 | .040 |
| 1/16 to 3/32 | .035 | .045 |
| 3/32 to 5/32 | .040 | .050 |
| 5/32 to 3/16 | .045 | .050 |
| 3/16 to 1/4 | .050 | .055 |
| 1/4 to 9/32 | .055 | .060 |
| 9/ 32 to 5/16 | .060 | .060 |
| 5/16 to 3/8 | .070 | .070 |
| 3/8 to 7/16 | .080 | .080 |

# Photo 88



## CAM DIMENSIONS AND LEVER RATIOS

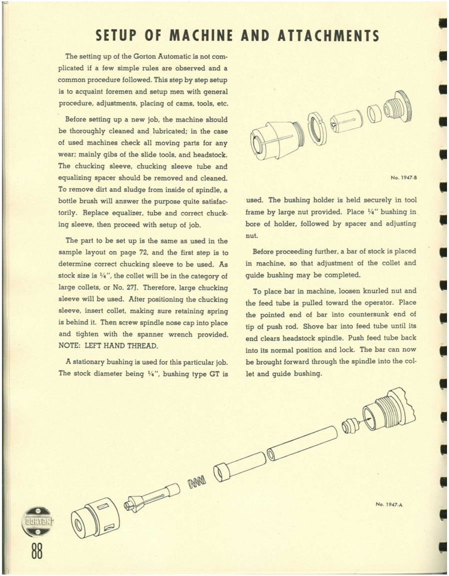
| Name of Cam | Type of Cam | A Max. Dia. | B Min. Dia. | C Max. Throw | D Width | E Bore | F Max. Ht. | H Min. Ht. | Ratio of Lever |
|---|---|---|---|---|---|---|---|---|---|
| Feed | Flat | 6.312 | 2.125 | 2.125 | .312 | .7876 |  |  | 1:1, 2:1<br>3:1 |
| Feed | Bell | 4.750 |  | 2.750 | .312 | .7876 | 3.250 | .500 | 1:1 |
| Rocker Arm | Flat | 4.750 | 2.125 | 1.312 | .312 | .7876 |  |  | 3:1 |
| 3rd, 4th, & 5th | Flat | 4.750 | 2.750 | 1.000 | .312 | 1.1811 |  |  | 2:1, 3:1 |
| Drill | Bell | 4.750 |  | 1.750 | .312 | .7876 | 2.250 | .500 | 1:1 |
| Inner Index | Flat | 5.250 | 3.500 | 1.687 | .312 | .7876 |  |  | 1:1 |
| Outer Index | Flat | 4.875 | 2.000 | 1.000 | .312 | .7876 |  |  | 1:1 |

**FOR MEAN DIAMETER OF ROCKER CAM SEE PAGE 38**

1832-EEE

GORTON

# Photo 89



## SETUP OF MACHINE AND ATTACHMENTS

The setting up of the Gorton Automatic is not complicated if a few simple rules are observed and a common procedure followed. This step by step setup is to acquaint foremen and setup men with general procedure, adjustments, placing of cams, tools, etc.

Before setting up a new job, the machine should be thoroughly cleaned and lubricated; in the case of used machines check all moving parts for any wear; mainly gibs of the slide tools, and headstock. The chucking sleeve, chucking sleeve tube and equalizing spacer should be removed and cleaned. To remove dirt and sludge from inside of spindle, a bottle brush will answer the purpose quite satisfactorily. Replace equalizer, tube and correct chucking sleeve, then proceed with setup of job.

The part to be set up is the same as used in the sample layout on page 72, and the first step is to determine correct chucking sleeve to be used. As stock size is ¼", the collet will be in the category of large collets, or No. 27J. Therefore, large chucking sleeve will be used. After positioning the chucking sleeve, insert collet, making sure retaining spring is behind it. Then screw spindle nose cap into place and tighten with the spanner wrench provided. NOTE: LEFT HAND THREAD.

A stationary bushing is used for this particular job. The stock diameter being ¼", bushing type GT is used. The bushing holder is held securely in tool frame by large nut provided. Place ¼" bushing in bore of holder, followed by spacer and adjusting nut.

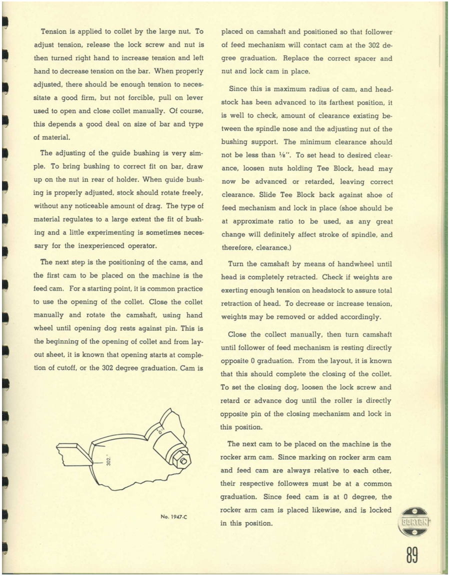
No. 1947-B

Before proceeding further, a bar of stock is placed in machine, so that adjustment of the collet and guide bushing may be completed.

To place bar in machine, loosen knurled nut and the feed tube is pulled toward the operator. Place the pointed end of bar into countersunk end of tip of push rod. Shove bar into feed tube until its end clears headstock spindle. Push feed tube back into its normal position and lock. The bar can now be brought forward through the spindle into the collet and guide bushing.

No. 1947-A

# Photo 90



Tension is applied to collet by the large nut. To adjust tension, release the lock screw and nut is then turned right hand to increase tension and left hand to decrease tension on the bar. When properly adjusted, there should be enough tension to necessitate a good firm, but not forcible, pull on lever used to open and close collet manually. Of course, this depends a good deal on size of bar and type of material.

The adjusting of the guide bushing is very simple. To bring bushing to correct fit on bar, draw up on the nut in rear of holder. When guide bushing is properly adjusted, stock should rotate freely, without any noticeable amount of drag. The type of material regulates to a large extent the fit of bushing and a little experimenting is sometimes necessary for the inexperienced operator.

The next step is the positioning of the cams, and the first cam to be placed on the machine is the feed cam. For a starting point, it is common practice to use the opening of the collet. Close the collet manually and rotate the camshaft, using hand wheel until opening dog rests against pin. This is the beginning of the opening of collet and from layout sheet, it is known that opening starts at completion of cutoff, or the 302 degree graduation. Cam is placed on camshaft and positioned so that follower of feed mechanism will contact cam at the 302 degree graduation. Replace the correct spacer and nut and lock cam in place.

No. 1947-C

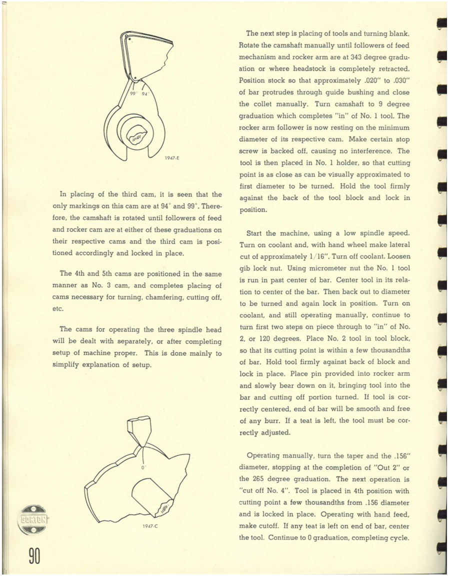
Since this is maximum radius of cam, and headstock has been advanced to its farthest position, it is well to check, amount of clearance existing between the spindle nose and the adjusting nut of the bushing support. The minimum clearance should not be less than ⅛". To set head to desired clearance, loosen nuts holding Tee Block, head may now be advanced or retarded, leaving correct clearance. Slide Tee Block back against shoe of feed mechanism and lock in place (shoe should be at approximate ratio to be used, as any great change will definitely affect stroke of spindle, and therefore, clearance.)

Turn the camshaft by means of handwheel until head is completely retracted. Check if weights are exerting enough tension on headstock to assure total retraction of head. To decrease or increase tension, weights may be removed or added accordingly.

Close the collect manually, then turn camshaft until follower of feed mechanism is resting directly opposite 0 graduation. From the layout, it is known that this should complete the closing of the collet. To set the closing dog, loosen the lock screw and retard or advance dog until the roller is directly opposite pin of the closing mechanism and lock in this position.

The next cam to be placed on the machine is the rocker arm cam. Since marking on rocker arm cam and feed cam are always relative to each other, their respective followers must be at a common graduation. Since feed cam is at 0 degree, the rocker arm cam is placed likewise, and is locked in this position.

# Photo 91



In placing of the third cam, it is seen that the only markings on this cam are at 94° and 99°. Therefore, the camshaft is rotated until followers of feed and rocker cam are at either of these graduations on their respective cams and the third cam is positioned accordingly and locked in place.

The 4th and 5th cams are positioned in the same manner as No. 3 cam, and completes placing of cams necessary for turning, chamfering, cutting off, etc.

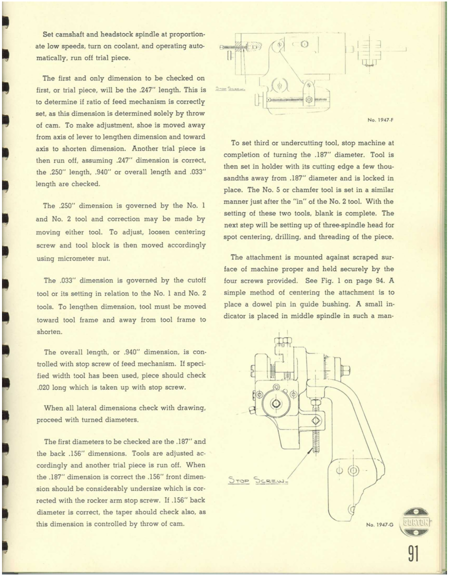
The cams for operating the three spindle head will be dealt with separately, or after completing setup of machine proper. This is done mainly to simplify explanation of setup.

The next step is placing of tools and turning blank. Rotate the camshaft manually until followers of feed mechanism and rocker arm are at 343 degree graduation or where headstock is completely retracted. Position stock so that approximately .020" to .030" of bar protrudes through guide bushing and close the collet manually. Turn camshaft to 9 degree graduation which completes "in" of No. 1 tool. The rocker arm follower is now resting on the minimum diameter of its respective cam. Make certain stop screw is backed off, causing no interference. The tool is then placed in No. 1 holder, so that cutting point is as close as can be visually approximated to first diameter to be turned. Hold the tool firmly against the back of the tool block and lock in position.

Start the machine, using a low spindle speed. Turn on coolant and, with hand wheel make lateral cut of approximately 1/16". Turn off coolant. Loosen gib lock nut. Using micrometer nut the No. 1 tool is run in past center of bar. Center tool in its relation to center of the bar. Then back out to diameter to be turned and again lock in position. Turn on coolant, and still operating manually, continue to turn first two steps on piece through to "in" of No. 2, or 120 degrees. Place No. 2 tool in tool block, so that its cutting point is within a few thousandths of bar. Hold tool firmly against back of block and lock in place. Place pin provided into rocker arm and slowly bear down on it, bringing tool into the bar and cutting off portion turned. If tool is correctly centered, end of bar will be smooth and free of any burr. If a teat is left, the tool must be correctly adjusted.

Operating manually, turn the taper and the .156" diameter, stopping at the completion of "Out 2" or the 265 degree graduation. The next operation is "cut off No. 4". Tool is placed in 4th position with cutting point a few thousandths from .156 diameter and is locked in place. Operating with hand feed, make cutoff. If any teat is left on end of bar, center the tool. Continue to 0 graduation, completing cycle.

# Photo 92



Set camshaft and headstock spindle at proportionate low speeds, turn on coolant, and operating automatically, run off trial piece.

The first and only dimension to be checked on first, or trial piece, will be the .247" length. This is to determine if ratio of feed mechanism is correctly set, as this dimension is determined solely by throw of cam. To make adjustment, shoe is moved away from axis of lever to lengthen dimension and toward axis to shorten dimension. Another trial piece is then run off, assuming .247" dimension is correct, the .250" length, .940" or overall length and .033" length are checked.

The .250" dimension is governed by the No. 1 and No. 2 tool and correction may be made by moving either tool. To adjust, loosen centering screw and tool block is then moved accordingly using micrometer nut.

The .033" dimension is governed by the cutoff tool or its setting in relation to the No. 1 and No. 2 tools. To lengthen dimension, tool must be moved toward tool frame and away from tool frame to shorten.

The overall length, or .940" dimension, is controlled with stop screw of feed mechanism. If specified width tool has been used, piece should check .020 long which is taken up with stop screw.

When all lateral dimensions check with drawing, proceed with turned diameters.

The first diameters to be checked are the .187" and the back .156" dimensions. Tools are adjusted accordingly and another trial piece is run off. When the .187" dimension is correct the .156" front dimension should be considerably undersize which is corrected with the rocker arm stop screw. If .156" back diameter is correct, the taper should check also, as this dimension is controlled by throw of cam.

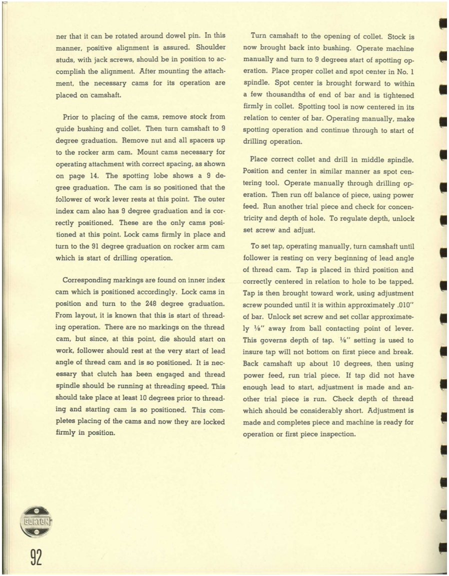
No. 1947-F

To set third or undercutting tool, stop machine at completion of turning the .187" diameter. Tool is then set in holder with its cutting edge a few thousandths away from .187" diameter and is locked in place. The No. 5 or chamfer tool is set in a similar manner just after the "in" of the No. 2 tool. With the setting of these two tools, blank is complete. The next step will be setting up of three-spindle head for spot centering, drilling, and threading of the piece.

The attachment is mounted against scraped surface of machine proper and held securely by the four screws provided. See Fig. 1 on page 94. A simple method of centering the attachment is to place a dowel pin in guide bushing. A small indicator is placed in middle spindle in such a man-

No. 1947-G

# Photo 93



ner that it can be rotated around dowel pin. In this manner, positive alignment is assured. Shoulder studs, with jack screws, should be in position to accomplish the alignment. After mounting the attachment, the necessary cams for its operation are placed on camshaft.

Prior to placing of the cams, remove stock from guide bushing and collet. Then turn camshaft to 9 degree graduation. Remove nut and all spacers up to the rocker arm cam. Mount cams necessary for operating attachment with correct spacing, as shown on page 14. The spotting lobe shows a 9 degree graduation. The cam is so positioned that the follower of work lever rests at this point. The outer index cam also has 9 degree graduation and is correctly positioned. These are the only cams positioned at this point. Lock cams firmly in place and turn to the 91 degree graduation on rocker arm cam which is start of drilling operation.

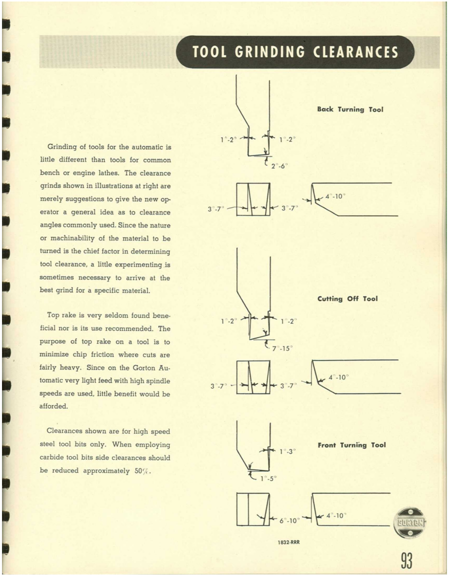
Corresponding markings are found on inner index cam which is positioned accordingly. Lock cams in position and turn to the 248 degree graduation. From layout, it is known that this is start of threading operation. There are no markings on the thread cam, but since, at this point, die should start on work, follower should rest at the very start of lead angle of thread cam and is so positioned. It is necessary that clutch has been engaged and thread spindle should be running at threading speed. This should take place at least 10 degrees prior to threading and starting cam is so positioned. This completes placing of the cams and now they are locked firmly in position.

Turn camshaft to the opening of collet. Stock is now brought back into bushing. Operate machine manually and turn to 9 degrees start of spotting operation. Place proper collet and spot center in No. 1 spindle. Spot center is brought forward to within a few thousandths of end of bar and is tightened firmly in collet. Spotting tool is now centered in its relation to center of bar. Operating manually, make spotting operation and continue through to start of drilling operation.

Place correct collet and drill in middle spindle. Position and center in similar manner as spot centering tool. Operate manually through drilling operation. Then run off balance of piece, using power feed. Run another trial piece and check for concentricity and depth of hole. To regulate depth, unlock set screw and adjust.

To set tap, operating manually, turn camshaft until follower is resting on very beginning of lead angle of thread cam. Tap is placed in third position and correctly centered in relation to hole to be tapped. Tap is then brought toward work, using adjustment screw pounded until it is within approximately .010" of bar. Unlock set screw and set collar approximately ⅛" away from ball contacting point of lever. This governs depth of tap. ⅛" setting is used to insure tap will not bottom on first piece and break. Back camshaft up about 10 degrees, then using power feed, run trial piece. If tap did not have enough lead to start, adjustment is made and another trial piece is run. Check depth of thread which should be considerably short. Adjustment is made and completes piece and machine is ready for operation or first piece inspection.

# Photo 94



## TOOL GRINDING CLEARANCES

Grinding of tools for the automatic is little different than tools for common bench or engine lathes. The clearance grinds shown in illustrations at right are merely suggestions to give the new operator a general idea as to clearance angles commonly used. Since the nature or machinability of the material to be turned is the chief factor in determining tool clearance, a little experimenting is sometimes necessary to arrive at the best grind for a specific material.

Top rake is very seldom found beneficial nor is its use recommended. The purpose of top rake on a tool is to minimize chip friction where cuts are fairly heavy. Since on the Gorton Automatic very light feed with high spindle speeds are used, little benefit would be afforded.

Clearances shown are for high speed steel tool bits only. When employing carbide tool bits side clearances should be reduced approximately 50%.

1832-RRR

# Photo 95

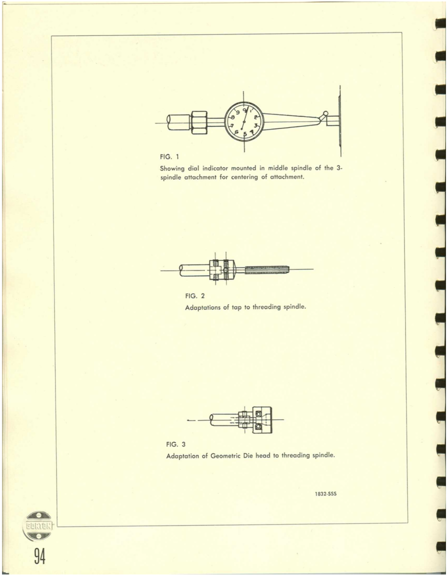


FIG. 1

Showing dial indicator mounted in middle spindle of the 3-spindle attachment for centering of attachment.

FIG. 2

Adaptations of tap to threading spindle.

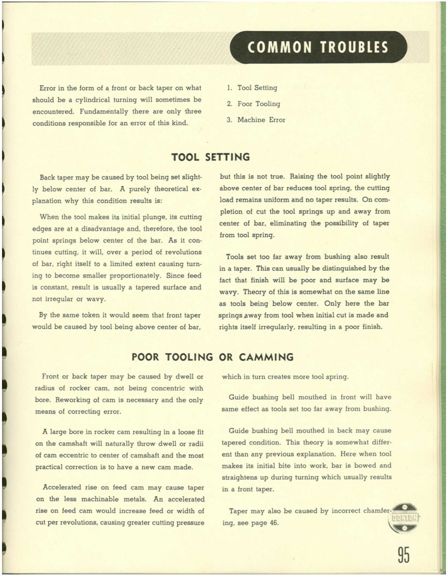
FIG. 3

Adaptation of Geometric Die head to threading spindle.

1832-SSS

GORTON

# Photo 96



## COMMON TROUBLES

Error in the form of a front or back taper on what should be a cylindrical turning will sometimes be encountered. Fundamentally there are only three conditions responsible for an error of this kind.

1. Tool Setting
2. Poor Tooling
3. Machine Error

### TOOL SETTING

Back taper may be caused by tool being set slightly below center of bar. A purely theoretical explanation why this condition results is:

When the tool makes its initial plunge, its cutting edges are at a disadvantage and, therefore, the tool point springs below center of the bar. As it continues cutting, it will, over a period of revolutions of bar, right itself to a limited extent causing turning to become smaller proportionately. Since feed is constant, result is usually a tapered surface and not irregular or wavy.

By the same token it would seem that front taper would be caused by tool being above center of bar, but this is not true. Raising the tool point slightly above center of bar reduces tool spring, the cutting load remains uniform and no taper results. On completion of cut the tool springs up and away from center of bar, eliminating the possibility of taper from tool spring.

Tools set too far away from bushing also result in a taper. This can usually be distinguished by the fact that finish will be poor and surface may be wavy. Theory of this is somewhat on the same line as tools being below center. Only here the bar springs away from tool when initial cut is made and rights itself irregularly, resulting in a poor finish.

### POOR TOOLING OR CAMMING

Front or back taper may be caused by dwell or radius of rocker cam, not being concentric with bore. Reworking of cam is necessary and the only means of correcting error.

A large bore in rocker cam resulting in a loose fit on the camshaft will naturally throw dwell or radii of cam eccentric to center of camshaft and the most practical correction is to have a new cam made.

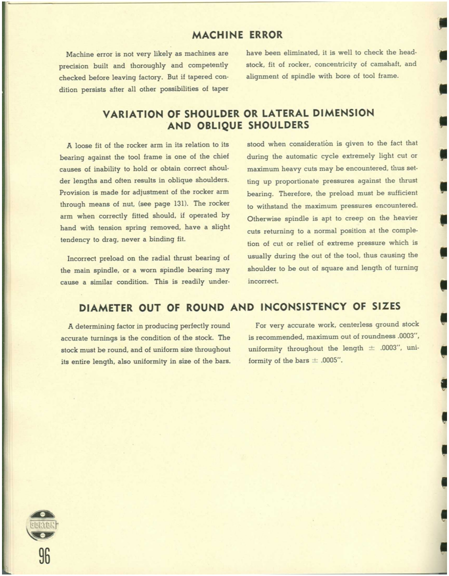
Accelerated rise on feed cam may cause taper on the less machinable metals. An accelerated rise on feed cam would increase feed or width of cut per revolutions, causing greater cutting pressure which in turn creates more tool spring.

Guide bushing bell mouthed in front will have same effect as tools set too far away from bushing.

Guide bushing bell mouthed in back may cause tapered condition. This theory is somewhat different than any previous explanation. Here when tool makes its initial bite into work, bar is bowed and straightens up during turning which usually results in a front taper.

Taper may also be caused by incorrect chamfering, see page 46.

# Photo 97



## MACHINE ERROR

Machine error is not very likely as machines are precision built and thoroughly and competently checked before leaving factory. But if tapered condition persists after all other possibilities of taper have been eliminated, it is well to check the headstock, fit of rocker, concentricity of camshaft, and alignment of spindle with bore of tool frame.

## VARIATION OF SHOULDER OR LATERAL DIMENSION AND OBLIQUE SHOULDERS

A loose fit of the rocker arm in its relation to its bearing against the tool frame is one of the chief causes of inability to hold or obtain correct shoulder lengths and often results in oblique shoulders. Provision is made for adjustment of the rocker arm through means of nut, (see page 131). The rocker arm when correctly fitted should, if operated by hand with tension spring removed, have a slight tendency to drag, never a binding fit.

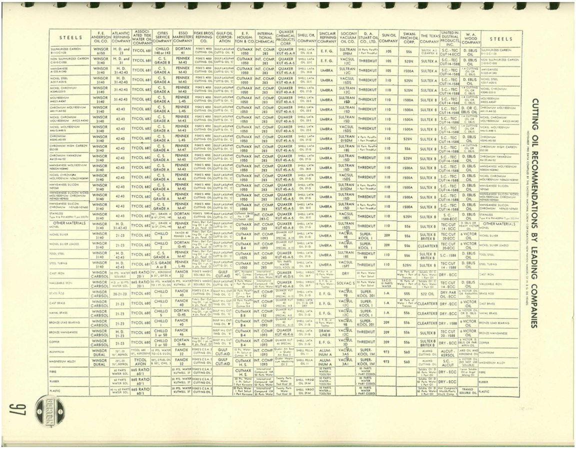
Incorrect preload on the radial thrust bearing of the main spindle, or a worn spindle bearing may cause a similar condition. This is readily understood when consideration is given to the fact that during the automatic cycle extremely light cut or maximum heavy cuts may be encountered, thus setting up proportionate pressures against the thrust bearing. Therefore, the preload must be sufficient to withstand the maximum pressures encountered. Otherwise spindle is apt to creep on the heavier cuts returning to a normal position at the completion of cut or relief of extreme pressure which is usually during the out of the tool, thus causing the shoulder to be out of square and length of turning incorrect.

## DIAMETER OUT OF ROUND AND INCONSISTENCY OF SIZES

A determining factor in producing perfectly round accurate turnings is the condition of the stock. The stock must be round, and of uniform size throughout its entire length, also uniformity in size of the bars.

For very accurate work, centerless ground stock is recommended, maximum out of roundness .0003″, uniformity throughout the length ± .0003″, uniformity of the bars ± .0005″.

# Photo 98

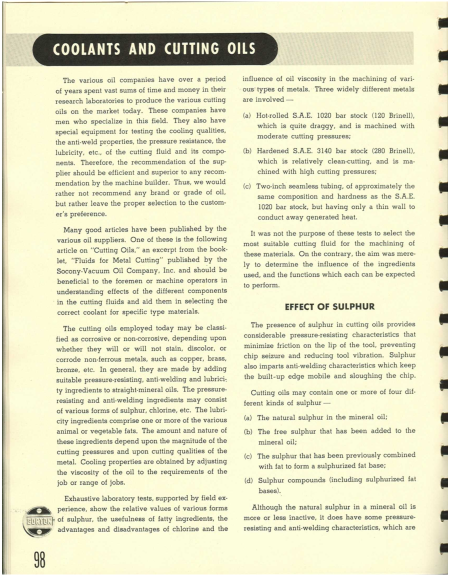


## CUTTING OIL RECOMMENDATIONS BY LEADING COMPANIES

NOVEMBER 1943 DATA COMPILED BY THE EASTERN MACHINE SCREW CORPORATION, NEW HAVEN, MAKERS OF H. & G. DIE HEADS

| STEELS | F. E. ANDERSON OIL CO. | ATLANTIC REFINING COMPANY | ASSOCIATED TIDE WATER OIL COMPANY | CITIES SERVICE COMPANY | ESSO MARKETERS COMPANY | FISKE BROS. REFINING CO. | GULF OIL CORPORATION | E. F. HOUGHTON & CO. | INTERNATIONAL CHEMICAL | QUAKER CHEMICAL PRODUCTS CORP. | SHELL OIL COMPANY | SINCLAIR REFINING COMPANY | SOCONY VACUUM OIL CO. | D. A. STUART OIL CO., LTD. | SUN OIL COMPANY | SWAN-FINCH OIL CORP. | THE TEXAS COMPANY | UNITED INDUSTRIAL PRODUCTS, INC. | W. A. WOOD COMPANY | STEELS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SULPHURIZED CARBON B1112-C1120 | WINSOR 6150 | H. D. and 23 | TYCOL 681 | CHILLO 140 or 143 | DORTAN 41 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'B' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-9 | SHELL LATA OIL 22-A | E. F. G. | SULTRAN 09BM | 20 Parts Paraffin 1 Part ThredKut | 105 | 556 | SULTEX A-2 CLEARTEX B | S.C.-TEC CUT 14-ECC | D. EBLIS OIL | SULPHURIZED CARBON B1112-C1120 |
| NON SULPHURIZED CARBON C1010-C1050 | WINSOR 3140 | H. D. and 31 | TYCOL 681 | C. S. GRADE B | PENNEX M-43 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-5 | SHELL LATA OIL 22-E | E. F. G. | VACSUL 12C | THREDKUT | 105 | 525N | SULTEX A | S.C.-TEC CUT 14-1588 | D. EBLIS OIL | NON SULPHURIZED CARBON C1010-C1050 |
| MANGANESE A1320-A1340 | WINSOR 3140 | H. D. 31-42-43 | TYCOL 681 | C. S. GRADE A | PENNEX M-43 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-8 | SHELL LATA OIL 28-B | UMBRA | SULTRAN 12C | THREDKUT | 105 | 1500A | SULTEX A | S.C.-TEC CUT 14-1588 | 1-4 CUTTING OIL OR C. EBLIS | MANGANESE A1320-A1340 |
| NICKEL STEEL A2317-A2515 | WINSOR 3140 | H. D. 31-42-43 | TYCOL 681 | C. S. GRADE A | PENNEX M-43 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 40-A-8 | SHELL LATA OIL 22-E | UMBRA | VACSUL 15DS | THREDKUT | 110 | 525N | SULTEX A | S.C.-TEC CUT 14-1588 | D. EBLIS OIL | NICKEL STEEL A2317-A2515 |
| NICKEL CHROMIUM A3045-E3310 | WINSOR 3140 | 31-42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-43 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 40-A-8 | SHELL LATA OIL 27-G | UMBRA | SULTRAN 12C | THREDKUT | 110 | 525N | SULTEX A | S.C.-TEC CUT 14-1588 | 1-4 CUTTING OIL OR C. EBLIS | NICKEL CHROMIUM A3045-E3310 |
| MOLYBDENUM A4023-A4047 | WINSOR 3140 | 31-42-43 | TYCOL 682 | C. S. GRADE A | PENNEX L-45 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 40-A-5 | SHELL LATA OIL 22-E | UMBRA | SULTRAN 15D | THREDKUT | 110 | 1500A | SULTEX B | S.C.-TEC CUT 14-1588 | 1-4 CUTTING OIL OR C. EBLIS | MOLYBDENUM A4023-A4047 |
| CHROMIUM MOLYBDENUM A4119-A4150 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX L-45 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 40-A-5 | SHELL LATA OIL 22-E | UMBRA | SULTRAN 15D | THREDKUT | 110 | 1500A | SULTEX B | S.C.-TEC CUT 14-1588 | D. OR C. EBLIS OIL | CHROMIUM MOLYBDENUM A4119-A4150 |
| NICKEL CHROMIUM MOLYBDENUM A4320-A4340 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-43 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 40-A-5 | SHELL LATA OIL 22-E | UMBRA | SULTRAN 15D | THREDKUT | 110 | 1500A | SULTEX B | S.C.-TEC CUT 14-1588 | 1-4 CUTTING OIL OR C. EBLIS | NICKEL CHROMIUM MOLYBDENUM A4320-A4340 |
| NICKEL MOLYBDENUM A4615-A4815 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-43 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 40-A-5 | SHELL LATA OIL 22-E | UMBRA | VACSUL 15DS | THREDKUT | 110 | 1500A | SULTEX B | S.C.-TEC CUT 14-1588 | 1-4 CUTTING OIL OR C. EBLIS | NICKEL MOLYBDENUM A4615-A4815 |
| CHROMIUM A5045-A5150 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX L-45 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-5 | SHELL LATA OIL 27-G | UMBRA | SULTRAN 015DM | 4 Parts Paraffin 1 Part ThredKut | 110 | 525N | SULTEX B | S.C.-TEC CUT 14-1588 | D. EBLIS OIL | CHROMIUM A5045-A5150 |
| CHROMIUM HIGH CARBON E52100 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-47 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-5 | SHELL LATA OIL 27-G | UMBRA | SULTRAN 18E | 20 Parts Paraffin 1 Part ThredKut | 110 | 556 | SULTEX B | S.C.-TEC CUT 14-1588 | 1-4 CUTTING OIL OR C. EBLIS | CHROMIUM HIGH CARBON E52100 |
| CHROMIUM VANADIUM A6120-A6152 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-43 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-5 | SHELL LATA OIL 27-G | UMBRA | SULTRAN 15D | THREDKUT | 110 | 525N | SULTEX B | S.C.-TEC CUT 14-1588 | D. EBLIS OIL | CHROMIUM VANADIUM A6120-A6152 |
| MANGANESE MOLYBDENUM NE8024-NE8442 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-43 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-5 | SHELL LATA OIL 28-B | UMBRA | SULTRAN 15D | THREDKUT | 110 | 1500A | SULTEX B | S.C.-TEC CUT 14-1588 | D. EBLIS OIL | MANGANESE MOLYBDENUM NE8024-NE8442 |
| NICKEL CHROMIUM MOLYBDENUM NE8620-NE8949 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-43 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-5 | SHELL LATA OIL 27-G | UMBRA | VACSUL 15DS | THREDKUT | 110 | 1500A | SULTEX B | S.C.-TEC CUT 14-1588 | D. EBLIS OIL | NICKEL CHROMIUM MOLYBDENUM NE8620-NE8949 |
| MANGANESE SILICON NE9260 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-43 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-5 | SHELL LATA OIL 27-G | UMBRA | SULTRAN 015DM | 8 Parts Paraffin 1 Part ThredKut | 110 | 1500A | SULTEX B | S.C.-TEC CUT 14-1588 | D. EBLIS OIL | MANGANESE SILICON NE9260 |
| MANGANESE SILICON NICKEL MOLYBDENUM CHROMIUM NE9420-NE9550 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-47 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-5 | SHELL LATA OIL 27-G | UMBRA | SULTRAN 15D | THREDKUT | 110 | 1500A | SULTEX B | S.C.-TEC CUT 14-1588 | D. EBLIS OIL | MANGANESE SILICON NICKEL MOLYBDENUM CHROMIUM NE9420-NE9550 |
| MANGANESE SILICON CHROMIUM NE9630-NE9650 | WINSOR 3140 | 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-47 | FISKE'S 4050 CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 45-A-5 | SHELL LATA OIL 22-E | UMBRA | SULTRAN 15D | 4 Parts Paraffin 1 Part ThredKut | 110 | 1500A | SULTEX B | S.C.-TEC CUT 14-1588 | D. EBLIS OIL | MANGANESE SILICON CHROMIUM NE9630-NE9650 |
| STAINLESS Type 416 FM-430FM Type 303 FM | WINSOR 3140 | 42-43 | TYCOL 682 | 90%, GRADE A & 10%, CHIL. 140 | DORTAN M-43 | FISKE'S 7090-A CUTTING OIL | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX BASE No. 1 OR CUTMAX 1050 | INT. COMP. 283-C | QUAKER KUT 40-A-5 | SHELL LATA OIL 22-E | UMBRA | VACSUL 18ES | THREDKUT | 110 | 525N | SULTEX B | S. C. - 1588-ECC | D. EBLIS OIL | STAINLESS Type 416 FM-430FM Type 303 FM |
| **OTHER MATERIALS**<br>MONEL | WINSOR 3140 | H. D. 31-42-43 | TYCOL 682 | 90%, GRADE A & 10%, CHIL. 140 | PENNEX M-47 | Fiske's Darl Cutting Oil 1 pt. to 4 pts. Paraf. Oil | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | QUAKER KUT 40-A-8 | SHELL LATA OIL 27-G | UMBRA | SULTRAN 15DS | THREDKUT | 110 | 556 | SULTEX B | TEC CUT 14-ECC | D. EBLIS OR HEAVY VICTOR OIL | **OTHER MATERIALS**<br>MONEL |
| NICKEL SILVER | WINSOR 3140 | 21-23 | TYCOL 682 | CHILLO 3 | FANOX 42 PENNEX L-46 | Fiske's Darl Cutting Oil 1 pt. to 6 pts. Paraf. Oil | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX B-4 | INT. COMP. 1093 | QUAKER KUT 40 SPECIAL A-10 | SHELL LATA OIL 21-G | UMBRA | VACSUL 9E | SUPER-KOOL 1 | 209 | 556 | SULTEX B BRITEX B | TEC CUT 20-ECC | 6 VICTOR OIL | NICKEL SILVER |
| NICKEL SILVER LEADED | WINSOR 3140 | 21-23 | TYCOL 682 | CHILLO 2 | DORTAN G-45 | Fiske's Darl Cutting Oil 1 pt. to 6 pts. Paraf. Oil | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX B-4 | INT. COMP. 1093 | QUAKER KUT 40 SPECIAL A-10 | SHELL LATA OIL 21-G | UMBRA | VACSUL 9B | SUPER-KOOL 1 | 209 | 556 | CLEARTEX B | TEC CUT 20-ECC | 6 VICTOR OIL | NICKEL SILVER LEADED |
| TOOL STEEL | WINSOR 3140 | H. D. 42-43 | TYCOL 682 | C. S. GRADE A | PENNEX M-47 | Fiske's Darl Cutting Oil 1 pt. to 6 pts. Paraf. Oil | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1025 | INT. COMP. 283 | QUAKER KUT 45-A-5 | SHELL LATA OIL 27-G | UMBRA | SULTRAN 18E | THREDKUT 99 | 110 | 556 | SULTEX B BRITEX B | S.C.-1588 | D. EBLIS OIL | TOOL STEEL |
| STEEL TUBING | WINSOR 3140 | H. D. 42-43 | TYCOL 681 | C.S. GRADE A or B | PENNEX L-46 | Fiske's Darl Cutting Oil 1 pt. to 6 pts. Paraf. Oil | GULF LASUPAR CUTT'G OIL 'C' | CUTMAX 1050 | INT. COMP. 283 | TEN PARTS WATER TOOL KOOL 20 | SHELL LATA OIL 28-B | UMBRA | VACSUL 15PT | THREDKUT | 110 | 525N | SULTEX B | TEC CUT 14-1588 | D. EBLIS OIL | STEEL TUBING |
| CAST IRON | WINSOR CARBISOL | 30 PTS. WATER SOLUBLE | 665 RATIO 20/1 | 75%, KEROSENE & 25%, GRADE A | FANOX 32 | FISKE'S MAGIC SOLUBLE OIL | GULF CUT-AID | 60%, Kerosene 40%, Cutmax 1050 | International Compound 272 25 Parts Water | QUAKER KUT 45-D-5 | SHELL VIRGO OIL 38-P | Wikut A. or 10 Parts Water-Tooltex | DRY | 30 Parts Water 1 Part Solvol |  | 15 Parts of Water 1 Part of Transes | Soluble Oil C 10 Parts Water 1 Part Oil | DRY-ECC |  | CAST IRON |
| MALLEABLE IRON | WINSOR CARBISOL | H.D. or 30 PTS. WATER SOL. | 665 RATIO 20/1 | 50 PTS. WATER TO 1 PT. S'L OIL | 15 PTS. WATER KUTWELL 37 | FISKE'S MAGIC SOLUBLE OIL | GULF LASUPAR CUTT'G OIL 'B' | 8 Parts Water 1 Part Permosol 60 | International Compound 138 50 Parts Water | QUAKER KUT 40-A-8 | SHELL VIRGO OIL 38-P | E. F. G., or 10 Parts Water-Tooltex | SOLVAC S | 30 Parts Water 1 Part Solvol | S.E.C.O. 10 PARTS WATER | 15 Parts of Water 1 Part of Transes | Soluble Oil C 10 Parts Water 1 Part Oil | TEC CUT 14-ECC | D. EBLIS OIL | MALLEABLE IRON |
| BRASS ROD | WINSOR CARBISOL | 20-21-23 | TYCOL 680 | CHILLO 1 | FANOX 40 | FISKE'S C.S.A. 2 CUTTING OIL | GULF M.L. CUTTING OIL "C" | 20 Parts Paraffin Oil - 1 Part Cutmax B-4 | INT. COMP. 152 | QUAKER KUT 40 SPECIAL A-10 | SHELL LATA OIL 21-G | E. F. G. | VACSUL 9B | SUPER-KOOL 201 | 1-A | 555 | 522 OIL | DRY-PAR OIL-ECC | 6 VICTOR OIL OR PARAFFIN OIL | BRASS ROD |
| CAST BRASS | WINSOR CARBISOL | 21-23 | TYCOL 680 | CHILLO 1 | FANOX 40 | Fiske's Darl Cutting Oil 1 pt. to 6 pts. Paraf. Oil | GULF M.L. CUTTING OIL "C" | 10 Parts Paraffin Oil - 1 Part Cutmax B-4 | INT. COMP. 152 | QUAKER KUT 40 SPECIAL A-8 | SHELL LATA OIL 21-G OR DRY | E. F. G. | VACSUL 12C | SUPER-KOOL 1 | 1-A | 40 Parts of Water 1 Part of Transes | CLEARTEX B | DRY-ECC | 6 VICTOR OIL | CAST BRASS |
| NAVAL BRASS | WINSOR CARBISOL | 21-23 | TYCOL 680 | CHILLO 5 | DORTAN G-45 | Fiske's Darl Cutting Oil 1 pt. to 4 pts. Paraf. Oil | GULF M.L. CUTTING OIL "C" | CUTMAX B-8 | INT. COMP. 152 | QUAKER KUT 40 SPECIAL A-8 | SHELL LATA OIL 21-G | E. F. G. | VACSUL 12C | SUPER-KOOL 1 | 1-A | 556 | CLEARTEX B | DRY-ECC | 6 VICTOR OIL OR D. EBLIS OIL | NAVAL BRASS |
| BRONZE LEAD BEARING | WINSOR CARBISOL | 21-23 | TYCOL 680 | CHILLO 1 | FANOX 40 |  | GULF M.L. CUTTING OIL "B" | CUTMAX B-4 | INT. COMP. 1093 | QUAKER KUT 40 SPECIAL A-10 | SHELL LATA OIL 21-G | E. F. G., or 10 Parts Water-Tooltex | VACSUL 9B | SUPER-KOOL 201 | 209 | 556 | CLEARTEX B | DRY-1588 | 6 VICTOR OIL | BRONZE LEAD BEARING |
| BRONZE MANGANESE | WINSOR CARBISOL | H. D. 21-23 | TYCOL 680 | CHILLO 3 or 50 | FANOX 46 |  | GULF M.L. CUTTING OIL "B" | CUTMAX B-4 | INT. COMP. 1093 | QUAKER KUT 45-K-6 | SHELL LATA OIL 21-G | DRAW-LINE B | VACSUL 12C | THREDKUT | 209 | 556 | SULTEX B | TEC CUT 20-1588 | 6 VICTOR OIL | BRONZE MANGANESE |
| COPPER | WINSOR CARBISOL | 21-23 | TYCOL 680 | CHILLO 2 or 50 | DORTAN G-46 | Fiske's Darl Cutting Oil 1 pt. to 8 pts. Paraf. Oil | GULF M.L. CUTTING OIL "B" | CUTMAX B-4 | INT. COMP. 1093 | QUAKER KUT 40 SPECIAL | SHELL LATA OIL 21-G | E. F. G. | VACSUL 3D | THREDKUT | 209 | 556 | SULTEX B BRITEX B | DRY-ECC | 6 VICTOR, D. EBLIS OR PARAFFIN OIL | COPPER |
| ALUMINUM | WINSOR DURAL | 25%-23 75%, REFROL | TYCOL 680 - 10%, KEROSENE | 10 PTS. WATER TO 1 C.S. S'L OIL | FANOX 32 | FISKE'S C.S.A. 2 CUTTING OIL | GULF CUT-AID | 10 Pts. Water 1 Pt. Solcut or Cutmax H. S. | INT. COMP. 1093 | Quaker Am Base 11 or Quaker Am Base 2 | SHELL PELLA OIL 11 | ALUMINUM A | VACSUL 3AS | SUPER-KOOL 1M | 973 | 560 | ALMAG CUTTING OIL | ALCUT-KERSOL | LARD OIL AND KEROSENE OIL | ALUMINUM |
| MAGNESIUM ALLOY | WINSOR DURAL | 25%-23 75%, REFROL | TYCOL AVON | 50%, 2 FUEL OIL & 50%, CHIL. 3 | FANOX 32 | FISKE'S C.S.A. 2 CUTTING OIL | GULF CUT-AID | CUTMAX H. S. | INT. COMP. 1093 | Quaker Magnesium Machining Oil 2 | SHELL PELLA OIL 11 | ALUMINUM A | VACSUL 3A1 | SUPER-KOOL 1M | 973 | 560 | ALMAG CUTTING OIL | S.C.-ALCUT | 6 VICTOR OIL (DO NOT USE SOLUBLE) | MAGNESIUM ALLOY |
| FIBRE |  | 60 PARTS WATER SOL. | 665 RATIO 60/1 |  | 30 PTS. WATER KUTWELL 37 | FISKE'S C.S.A. 2 CUTTING OIL |  | CUTMAX H. S. | International Compound 164 50 Parts Water |  |  | 30 PARTS WATER—TOOLTEX |  | 80 PARTS WATER 1 PART CODOL |  |  | Soluble Oil D 50 Parts Water 1 Part Oil | DRY-ECC | Transo Soluble Oil or Argol Mixing Oil | FIBRE |
| RUBBER |  | 60 PARTS WATER SOL. | 665 RATIO 60/1 |  | 30 PTS. WATER KUTWELL 37 | FISKE'S C.S.A. 2 CUTTING OIL |  | 30 Pts. Water 1 Pt. Solcut 1 Part Kerosene | International Compound 164 50 Parts Water | Twenty Parts Water Tool Kool 20 | SHELL VIRGO OIL 29-M | 30 PARTS WATER—TOOLTEX |  | 80 PARTS WATER 1 PART CODOL |  |  | Soluble Oil D 50 Parts Water 1 Part Oil | DRY-ECC |  | RUBBER |
| PLASTIC |  | 40 to 60 PARTS WATER SOL. | 665 RATIO 60/1 |  | 30 PTS. WATER KUTWELL 37 | FISKE'S C.S.A. 2 CUTTING OIL |  | 30 Parts Water 1 Part Solcut 1 Part Kerosene | International Compound 134 30 Parts Water | Twenty Parts Water Tool Kool 20 | SHELL VIRGO OIL 29-M | 30 PARTS WATER—TOOLTEX |  | 80 PARTS WATER 1 PART CODOL |  |  | Soluble Oil D 50 Parts Water 1 Part Oil | Hot Compress'n Moulds-Plastic Mould Comp. 1 | TRANSO SOLUBLE OIL | PLASTIC |

# Photo 99



## COOLANTS AND CUTTING OILS

The various oil companies have over a period of years spent vast sums of time and money in their research laboratories to produce the various cutting oils on the market today. These companies have men who specialize in this field. They also have special equipment for testing the cooling qualities, the anti-weld properties, the pressure resistance, the lubricity, etc., of the cutting fluid and its components. Therefore, the recommendation of the supplier should be efficient and superior to any recommendation by the machine builder. Thus, we would rather not recommend any brand or grade of oil, but rather leave the proper selection to the customer's preference.

Many good articles have been published by the various oil suppliers. One of these is the following article on "Cutting Oils," an excerpt from the booklet, "Fluids for Metal Cutting" published by the Socony-Vacuum Oil Company, Inc. and should be beneficial to the foremen or machine operators in understanding effects of the different components in the cutting fluids and aid them in selecting the correct coolant for specific type materials.

The cutting oils employed today may be classified as corrosive or non-corrosive, depending upon whether they will or will not stain, discolor, or corrode non-ferrous metals, such as copper, brass, bronze, etc. In general, they are made by adding suitable pressure-resisting, anti-welding and lubricity ingredients to straight-mineral oils. The pressure-resisting and anti-welding ingredients may consist of various forms of sulphur, chlorine, etc. The lubricity ingredients comprise one or more of the various animal or vegetable fats. The amount and nature of these ingredients depend upon the magnitude of the cutting pressures and upon cutting qualities of the metal. Cooling properties are obtained by adjusting the viscosity of the oil to the requirements of the job or range of jobs.

Exhaustive laboratory tests, supported by field experience, show the relative values of various forms of sulphur, the usefulness of fatty ingredients, the advantages and disadvantages of chlorine and the influence of oil viscosity in the machining of various types of metals. Three widely different metals are involved —

(a) Hot-rolled S.A.E. 1020 bar stock (120 Brinell), which is quite draggy, and is machined with moderate cutting pressures;

(b) Hardened S.A.E. 3140 bar stock (280 Brinell), which is relatively clean-cutting, and is machined with high cutting pressures;

(c) Two-inch seamless tubing, of approximately the same composition and hardness as the S.A.E. 1020 bar stock, but having only a thin wall to conduct away generated heat.

It was not the purpose of these tests to select the most suitable cutting fluid for the machining of these materials. On the contrary, the aim was merely to determine the influence of the ingredients used, and the functions which each can be expected to perform.

### EFFECT OF SULPHUR

The presence of sulphur in cutting oils provides considerable pressure-resisting characteristics that minimize friction on the lip of the tool, preventing chip seizure and reducing tool vibration. Sulphur also imparts anti-welding characteristics which keep the built-up edge mobile and sloughing the chip.

Cutting oils may contain one or more of four different kinds of sulphur —

(a) The natural sulphur in the mineral oil;

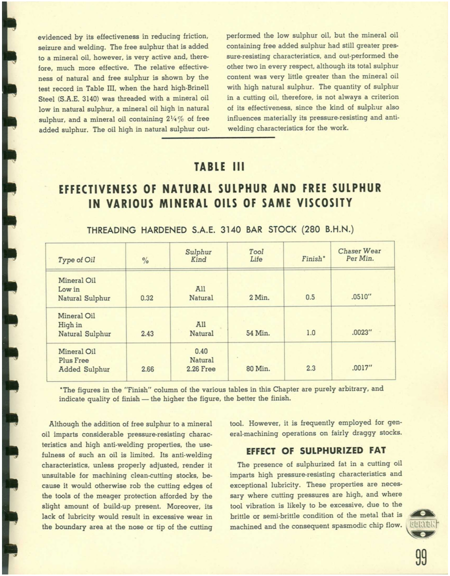
(b) The free sulphur that has been added to the mineral oil;

(c) The sulphur that has been previously combined with fat to form a sulphurized fat base;

(d) Sulphur compounds (including sulphurized fat bases).

Although the natural sulphur in a mineral oil is more or less inactive, it does have some pressure-resisting and anti-welding characteristics, which are

# Photo 100



evidenced by its effectiveness in reducing friction, seizure and welding. The free sulphur that is added to a mineral oil, however, is very active and, therefore, much more effective. The relative effectiveness of natural and free sulphur is shown by the test record in Table III, when the hard high-Brinell Steel (S.A.E. 3140) was threaded with a mineral oil low in natural sulphur, a mineral oil high in natural sulphur, and a mineral oil containing 2¼% of free added sulphur. The oil high in natural sulphur outperformed the low sulphur oil, but the mineral oil containing free added sulphur had still greater pressure-resisting characteristics, and out-performed the other two in every respect, although its total sulphur content was very little greater than the mineral oil with high natural sulphur. The quantity of sulphur in a cutting oil, therefore, is not always a criterion of its effectiveness, since the kind of sulphur also influences materially its pressure-resisting and anti-welding characteristics for the work.

## TABLE III

## EFFECTIVENESS OF NATURAL SULPHUR AND FREE SULPHUR IN VARIOUS MINERAL OILS OF SAME VISCOSITY

THREADING HARDENED S.A.E. 3140 BAR STOCK (280 B.H.N.)

| *Type of Oil* | *%* | *Sulphur Kind* | *Tool Life* | *Finish** | *Chaser Wear Per Min.* |
|---|---|---|---|---|---|
| Mineral Oil Low in Natural Sulphur | 0.32 | All Natural | 2 Min. | 0.5 | .0510″ |
| Mineral Oil High in Natural Sulphur | 2.43 | All Natural | 54 Min. | 1.0 | .0023″ |
| Mineral Oil Plus Free Added Sulphur | 2.66 | 0.40 Natural<br>2.26 Free | 80 Min. | 2.3 | .0017″ |

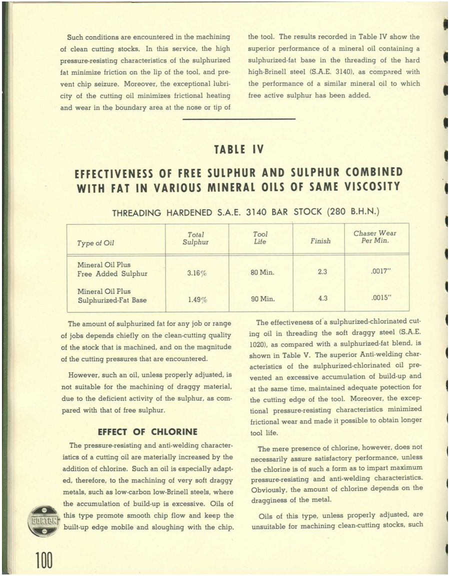
*The figures in the "Finish" column of the various tables in this Chapter are purely arbitrary, and indicate quality of finish — the higher the figure, the better the finish.

Although the addition of free sulphur to a mineral oil imparts considerable pressure-resisting characteristics and high anti-welding properties, the usefulness of such an oil is limited. Its anti-welding characteristics, unless properly adjusted, render it unsuitable for machining clean-cutting stocks, because it would otherwise rob the cutting edges of the tools of the meager protection afforded by the slight amount of build-up present. Moreover, its lack of lubricity would result in excessive wear in the boundary area at the nose or tip of the cutting tool. However, it is frequently employed for general-machining operations on fairly draggy stocks.

### EFFECT OF SULPHURIZED FAT

The presence of sulphurized fat in a cutting oil imparts high pressure-resisting characteristics and exceptional lubricity. These properties are necessary where cutting pressures are high, and where tool vibration is likely to be excessive, due to the brittle or semi-brittle condition of the metal that is machined and the consequent spasmodic chip flow.

# Photo 101



Such conditions are encountered in the machining of clean cutting stocks. In this service, the high pressure-resisting characteristics of the sulphurized fat minimize friction on the lip of the tool, and prevent chip seizure. Moreover, the exceptional lubricity of the cutting oil minimizes frictional heating and wear in the boundary area at the nose or tip of the tool. The results recorded in Table IV show the superior performance of a mineral oil containing a sulphurized-fat base in the threading of the hard high-Brinell steel (S.A.E. 3140), as compared with the performance of a similar mineral oil to which free active sulphur has been added.

## TABLE IV

## EFFECTIVENESS OF FREE SULPHUR AND SULPHUR COMBINED WITH FAT IN VARIOUS MINERAL OILS OF SAME VISCOSITY

### THREADING HARDENED S.A.E. 3140 BAR STOCK (280 B.H.N.)

| *Type of Oil* | *Total Sulphur* | *Tool Life* | *Finish* | *Chaser Wear Per Min.* |
|---|---|---|---|---|
| Mineral Oil Plus Free Added Sulphur | 3.16% | 80 Min. | 2.3 | .0017" |
| Mineral Oil Plus Sulphurized-Fat Base | 1.49% | 90 Min. | 4.3 | .0015" |

The amount of sulphurized fat for any job or range of jobs depends chiefly on the clean-cutting quality of the stock that is machined, and on the magnitude of the cutting pressures that are encountered.

However, such an oil, unless properly adjusted, is not suitable for the machining of draggy material, due to the deficient activity of the sulphur, as compared with that of free sulphur.

### EFFECT OF CHLORINE

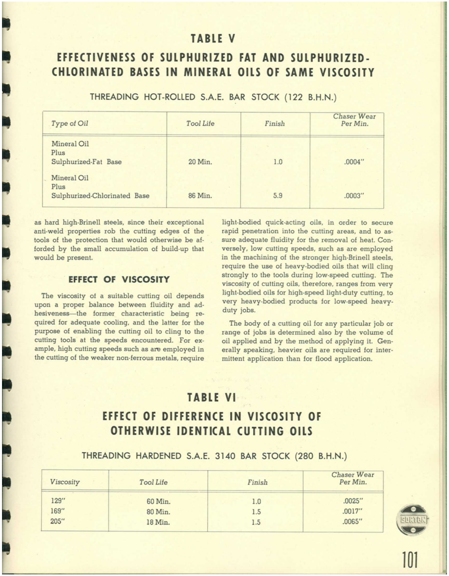
The pressure-resisting and anti-welding characteristics of a cutting oil are materially increased by the addition of chlorine. Such an oil is especially adapted, therefore, to the machining of very soft draggy metals, such as low-carbon low-Brinell steels, where the accumulation of build-up is excessive. Oils of this type promote smooth chip flow and keep the built-up edge mobile and sloughing with the chip.

The effectiveness of a sulphurized-chlorinated cutting oil in threading the soft draggy steel (S.A.E. 1020), as compared with a sulphurized-fat blend, is shown in Table V. The superior Anti-welding characteristics of the sulphurized-chlorinated oil prevented an excessive accumulation of build-up and at the same time, maintained adequate protection for the cutting edge of the tool. Moreover, the exceptional pressure-resisting characteristics minimized frictional wear and made it possible to obtain longer tool life.

The mere presence of chlorine, however, does not necessarily assure satisfactory performance, unless the chlorine is of such a form as to impart maximum pressure-resisting and anti-welding characteristics. Obviously, the amount of chlorine depends on the dragginess of the metal.

Oils of this type, unless properly adjusted, are unsuitable for machining clean-cutting stocks, such

# Photo 102



## TABLE V

## EFFECTIVENESS OF SULPHURIZED FAT AND SULPHURIZED-CHLORINATED BASES IN MINERAL OILS OF SAME VISCOSITY

THREADING HOT-ROLLED S.A.E. BAR STOCK (122 B.H.N.)

| *Type of Oil* | *Tool Life* | *Finish* | *Chaser Wear Per Min.* |
|---|---|---|---|
| Mineral Oil<br>Plus<br>Sulphurized-Fat Base | 20 Min. | 1.0 | .0004" |
| Mineral Oil<br>Plus<br>Sulphurized-Chlorinated Base | 86 Min. | 5.9 | .0003" |

as hard high-Brinell steels, since their exceptional anti-weld properties rob the cutting edges of the tools of the protection that would otherwise be afforded by the small accumulation of build-up that would be present.

### EFFECT OF VISCOSITY

The viscosity of a suitable cutting oil depends upon a proper balance between fluidity and adhesiveness—the former characteristic being required for adequate cooling, and the latter for the purpose of enabling the cutting oil to cling to the cutting tools at the speeds encountered. For example, high cutting speeds such as are employed in the cutting of the weaker non-ferrous metals, require light-bodied quick-acting oils, in order to secure rapid penetration into the cutting areas, and to assure adequate fluidity for the removal of heat. Conversely, low cutting speeds, such as are employed in the machining of the stronger high-Brinell steels, require the use of heavy-bodied oils that will cling strongly to the tools during low-speed cutting. The viscosity of cutting oils, therefore, ranges from very light-bodied oils for high-speed light-duty cutting, to very heavy-bodied products for low-speed heavy-duty jobs.

The body of a cutting oil for any particular job or range of jobs is determined also by the volume of oil applied and by the method of applying it. Generally speaking, heavier oils are required for intermittent application than for flood application.

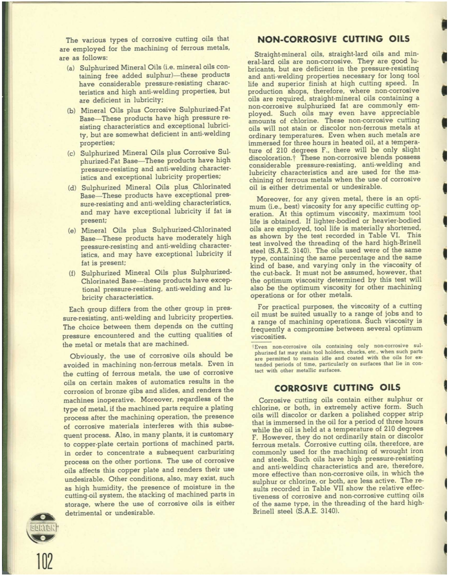
## TABLE VI

## EFFECT OF DIFFERENCE IN VISCOSITY OF OTHERWISE IDENTICAL CUTTING OILS

THREADING HARDENED S.A.E. 3140 BAR STOCK (280 B.H.N.)

| *Viscosity* | *Tool Life* | *Finish* | *Chaser Wear Per Min.* |
|---|---|---|---|
| 129" | 60 Min. | 1.0 | .0025" |
| 169" | 80 Min. | 1.5 | .0017" |
| 205" | 18 Min. | 1.5 | .0065" |

# Photo 103



The various types of corrosive cutting oils that are employed for the machining of ferrous metals, are as follows:

(a) Sulphurized Mineral Oils (i.e. mineral oils containing free added sulphur)—these products have considerable pressure-resisting characteristics and high anti-welding properties, but are deficient in lubricity;

(b) Mineral Oils plus Corrosive Sulphurized-Fat Base—These products have high pressure resisting characteristics and exceptional lubricity, but are somewhat deficient in anti-welding properties;

(c) Sulphurized Mineral Oils plus Corrosive Sulphurized-Fat Base—These products have high pressure-resisting and anti-welding characteristics and exceptional lubricity properties;

(d) Sulphurized Mineral Oils plus Chlorinated Base—These products have exceptional pressure-resisting and anti-welding characteristics, and may have exceptional lubricity if fat is present;

(e) Mineral Oils plus Sulphurized-Chlorinated Base—These products have moderately high pressure-resisting and anti-welding characteristics, and may have exceptional lubricity if fat is present;

(f) Sulphurized Mineral Oils plus Sulphurized-Chlorinated Base—these products have exceptional pressure-resisting, anti-welding and lubricity characteristics.

Each group differs from the other group in pressure-resisting, anti-welding and lubricity properties. The choice between them depends on the cutting pressure encountered and the cutting qualities of the metal or metals that are machined.

Obviously, the use of corrosive oils should be avoided in machining non-ferrous metals. Even in the cutting of ferrous metals, the use of corrosive oils on certain makes of automatics results in the corrosion of bronze gibs and slides, and renders the machines inoperative. Moreover, regardless of the type of metal, if the machined parts require a plating process after the machining operation, the presence of corrosive materials interferes with this subsequent process. Also, in many plants, it is customary to copper-plate certain portions of machined parts, in order to concentrate a subsequent carburizing process on the other portions. The use of corrosive oils affects this copper plate and renders their use undesirable. Other conditions, also, may exist, such as high humidity, the presence of moisture in the cutting-oil system, the stacking of machined parts in storage, where the use of corrosive oils is either detrimental or undesirable.

## NON-CORROSIVE CUTTING OILS

Straight-mineral oils, straight-lard oils and mineral-lard oils are non-corrosive. They are good lubricants, but are deficient in the pressure-resisting and anti-welding properties necessary for long tool life and superior finish at high cutting speed. In production shops, therefore, where non-corrosive oils are required, straight-mineral oils containing a non-corrosive sulphurized fat are commonly employed. Such oils may even have appreciable amounts of chlorine. These non-corrosive cutting oils will not stain or discolor non-ferrous metals at ordinary temperatures. Even when such metals are immersed for three hours in heated oil, at a temperature of 210 degrees F., there will be only slight discoloration.† These non-corrosive blends possess considerable pressure-resisting, anti-welding and lubricity characteristics and are used for the machining of ferrous metals when the use of corrosive oil is either detrimental or undesirable.

Moreover, for any given metal, there is an optimum (i.e., best) viscosity for any specific cutting operation. At this optimum viscosity, maximum tool life is obtained. If lighter-bodied or heavier-bodied oils are employed, tool life is materially shortened, as shown by the test recorded in Table VI. This test involved the threading of the hard high-Brinell steel (S.A.E. 3140). The oils used were of the same type, containing the same percentage and the same kind of base, and varying only in the viscosity of the cut-back. It must not be assumed, however, that the optimum viscosity determined by this test will also be the optimum viscosity for other machining operations or for other metals.

For practical purposes, the viscosity of a cutting oil must be suited usually to a range of jobs and to a range of machining operations. Such viscosity is frequently a compromise between several optimum viscosities.

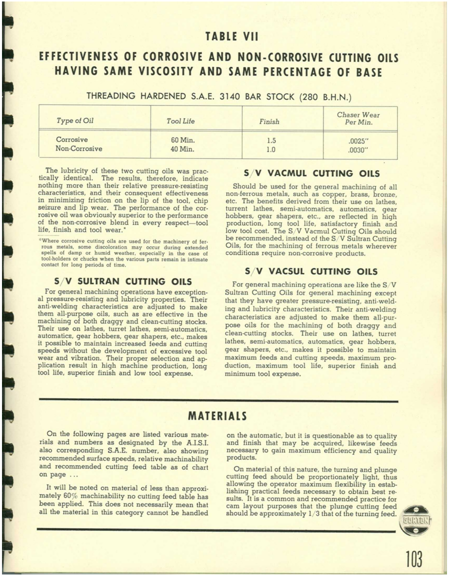
## CORROSIVE CUTTING OILS

Corrosive cutting oils contain either sulphur or chlorine, or both, in extremely active form. Such oils will discolor or darken a polished copper strip that is immersed in the oil for a period of three hours while the oil is held at a temperature of 210 degrees F. However, they do not ordinarily stain or discolor ferrous metals. Corrosive cutting oils, therefore, are commonly used for the machining of wrought iron and steels. Such oils have high pressure-resisting and anti-welding characteristics and are, therefore, more effective than non-corrosive oils, in which the sulphur or chlorine, or both, are less active. The results recorded in Table VII show the relative effectiveness of corrosive and non-corrosive cutting oils of the same type, in the threading of the hard high-Brinell steel (S.A.E. 3140).

---

†Even non-corrosive oils containing only non-corrosive sulphurized fat may stain tool holders, chucks, etc., when such parts are permitted to remain idle and coated with the oils for extended periods of time, particularly on surfaces that lie in contact with other metallic surfaces.

# Photo 104



## TABLE VII

## EFFECTIVENESS OF CORROSIVE AND NON-CORROSIVE CUTTING OILS HAVING SAME VISCOSITY AND SAME PERCENTAGE OF BASE

THREADING HARDENED S.A.E. 3140 BAR STOCK (280 B.H.N.)

| *Type of Oil* | *Tool Life* | *Finish* | *Chaser Wear Per Min.* |
|---|---|---|---|
| Corrosive | 60 Min. | 1.5 | .0025″ |
| Non-Corrosive | 40 Min. | 1.0 | .0030″ |

The lubricity of these two cutting oils was practically identical. The results, therefore, indicate nothing more than their relative pressure-resisting characteristics, and their consequent effectiveness in minimizing friction on the lip of the tool, chip seizure and lip wear. The performance of the corrosive oil was obviously superior to the performance of the non-corrosive blend in every respect—tool life, finish and tool wear.*

### S/V SULTRAN CUTTING OILS

For general machining operations have exceptional pressure-resisting and lubricity properties. Their anti-welding characteristics are adjusted to make them all-purpose oils, such as are effective in the machining of both draggy and clean-cutting stocks. Their use on lathes, turret lathes, semi-automatics, automatics, gear hobbers, gear shapers, etc., makes it possible to maintain increased feeds and cutting speeds without the development of excessive tool wear and vibration. Their proper selection and application result in high machine production, long tool life, superior finish and low tool expense.

### S/V VACMUL CUTTING OILS

Should be used for the general machining of all non-ferrous metals, such as copper, brass, bronze, etc. The benefits derived from their use on lathes, turrent lathes, semi-automatics, automatics, gear hobbers, gear shapers, etc., are reflected in high production, long tool life, satisfactory finish and low tool cost. The S/V Vacmul Cutting Oils should be recommended, instead of the S/V Sultran Cutting Oils, for the machining of ferrous metals wherever conditions require non-corrosive products.

### S/V VACSUL CUTTING OILS

For general machining operations are like the S/V Sultran Cutting Oils for general machining except that they have greater pressure-resisting, anti-welding and lubricity characteristics. Their anti-welding characteristics are adjusted to make them all-purpose oils for the machining of both draggy and clean-cutting stocks. Their use on lathes, turret lathes, semi-automatics, automatics, gear hobbers, gear shapers, etc., makes it possible to maintain maximum feeds and cutting speeds, maximum production, maximum tool life, superior finish and minimum tool expense.

## MATERIALS

On the following pages are listed various materials and numbers as designated by the A.I.S.I. also corresponding S.A.E. number, also showing recommended surface speeds, relative machinability and recommended cutting feed table as of chart on page ...

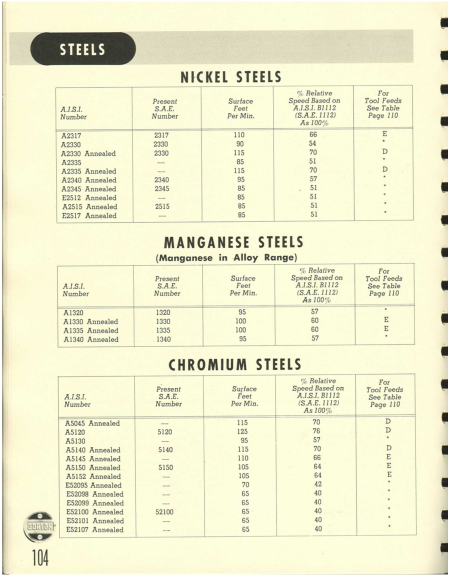
It will be noted on material of less than approximately 60% machinability no cutting feed table has been applied. This does not necessarily mean that all the material in this category cannot be handled on the automatic, but it is questionable as to quality and finish that may be acquired, likewise feeds necessary to gain maximum efficiency and quality products.

On material of this nature, the turning and plunge cutting feed should be proportionately light, thus allowing the operator maximum flexibility in establishing practical feeds necessary to obtain best results. It is a common and recommended practice for cam layout purposes that the plunge cutting feed should be approximately 1/3 that of the turning feed.

---

*Where corrosive cutting oils are used for the machinery of ferrous metals, some discoloration may occur during extended spells of damp or humid weather, especially in the case of tool-holders or chucks when the various parts remain in intimate contact for long periods of time.

# Photo 105



## NICKEL STEELS

| *A.I.S.I. Number* | *Present S.A.E. Number* | *Surface Feet Per Min.* | *% Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100%* | *For Tool Feeds See Table Page 110* |
|---|---|---|---|---|
| A2317 | 2317 | 110 | 66 | E |
| A2330 | 2330 | 90 | 54 | * |
| A2330 Annealed | 2330 | 115 | 70 | D |
| A2335 | — | 85 | 51 | * |
| A2335 Annealed | — | 115 | 70 | D |
| A2340 Annealed | 2340 | 95 | 57 | * |
| A2345 Annealed | 2345 | 85 | 51 | * |
| E2512 Annealed | — | 85 | 51 | * |
| A2515 Annealed | 2515 | 85 | 51 | * |
| E2517 Annealed | — | 85 | 51 | * |

## MANGANESE STEELS

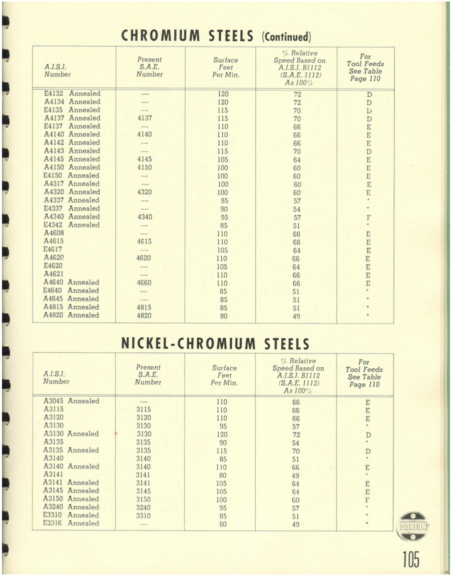
### (Manganese in Alloy Range)

| *A.I.S.I. Number* | *Present S.A.E. Number* | *Surface Feet Per Min.* | *% Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100%* | *For Tool Feeds See Table Page 110* |
|---|---|---|---|---|
| A1320 | 1320 | 95 | 57 | * |
| A1330 Annealed | 1330 | 100 | 60 | E |
| A1335 Annealed | 1335 | 100 | 60 | E |
| A1340 Annealed | 1340 | 95 | 57 | * |

## CHROMIUM STEELS

| *A.I.S.I. Number* | *Present S.A.E. Number* | *Surface Feet Per Min.* | *% Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100%* | *For Tool Feeds See Table Page 110* |
|---|---|---|---|---|
| A5045 Annealed | — | 115 | 70 | D |
| A5120 | 5120 | 125 | 76 | D |
| A5130 | — | 95 | 57 | * |
| A5140 Annealed | 5140 | 115 | 70 | D |
| A5145 Annealed | — | 110 | 66 | E |
| A5150 Annealed | 5150 | 105 | 64 | E |
| A5152 Annealed | — | 105 | 64 | E |
| E52095 Annealed | — | 70 | 42 | * |
| E52098 Annealed | — | 65 | 40 | * |
| E52099 Annealed | — | 65 | 40 | * |
| E52100 Annealed | 52100 | 65 | 40 | * |
| E52101 Annealed | — | 65 | 40 | * |
| E52107 Annealed | — | 65 | 40 | * |

# Photo 106



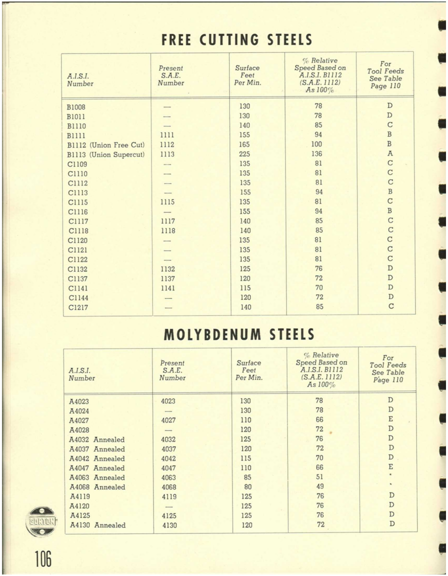
## CHROMIUM STEELS (Continued)

| A.I.S.I. Number | Present S.A.E. Number | Surface Feet Per Min. | % Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100% | For Tool Feeds See Table Page 110 |
|---|---|---|---|---|
| E4132 Annealed | — | 120 | 72 | D |
| A4134 Annealed | — | 120 | 72 | D |
| E4135 Annealed | — | 115 | 70 | D |
| A4137 Annealed | 4137 | 115 | 70 | D |
| E4137 Annealed | — | 110 | 66 | E |
| A4140 Annealed | 4140 | 110 | 66 | E |
| A4142 Annealed | — | 110 | 66 | E |
| A4143 Annealed | — | 115 | 70 | D |
| A4145 Annealed | 4145 | 105 | 64 | E |
| A4150 Annealed | 4150 | 100 | 60 | E |
| E4150 Annealed | — | 100 | 60 | E |
| A4317 Annealed | — | 100 | 60 | E |
| A4320 Annealed | 4320 | 100 | 60 | E |
| A4337 Annealed | — | 95 | 57 | * |
| E4337 Annealed | — | 90 | 54 | * |
| A4340 Annealed | 4340 | 95 | 57 | F |
| E4342 Annealed | — | 85 | 51 | * |
| A4608 | — | 110 | 66 | E |
| A4615 | 4615 | 110 | 66 | E |
| E4617 | — | 105 | 64 | E |
| A4620 | 4620 | 110 | 66 | E |
| E4620 | — | 105 | 64 | E |
| A4621 | — | 110 | 66 | E |
| A4640 Annealed | 4660 | 110 | 66 | E |
| E4640 Annealed | — | 85 | 51 | * |
| A4645 Annealed | — | 85 | 51 | * |
| A4815 Annealed | 4815 | 85 | 51 | * |
| A4820 Annealed | 4820 | 80 | 49 | * |

## NICKEL-CHROMIUM STEELS

| A.I.S.I. Number | Present S.A.E. Number | Surface Feet Per Min. | % Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100% | For Tool Feeds See Table Page 110 |
|---|---|---|---|---|
| A3045 Annealed | — | 110 | 66 | E |
| A3115 | 3115 | 110 | 66 | E |
| A3120 | 3120 | 110 | 66 | E |
| A3130 | 3130 | 95 | 57 | * |
| A3130 Annealed | 3130 | 120 | 72 | D |
| A3135 | 3135 | 90 | 54 | * |
| A3135 Annealed | 3135 | 115 | 70 | D |
| A3140 | 3140 | 85 | 51 | * |
| A3140 Annealed | 3140 | 110 | 66 | E |
| A3141 | 3141 | 80 | 49 | * |
| A3141 Annealed | 3141 | 105 | 64 | E |
| A3145 Annealed | 3145 | 105 | 64 | E |
| A3150 Annealed | 3150 | 100 | 60 | F |
| A3240 Annealed | 3240 | 95 | 57 | * |
| E3310 Annealed | 3310 | 85 | 51 | * |
| E3316 Annealed | — | 80 | 49 | * |

# Photo 107



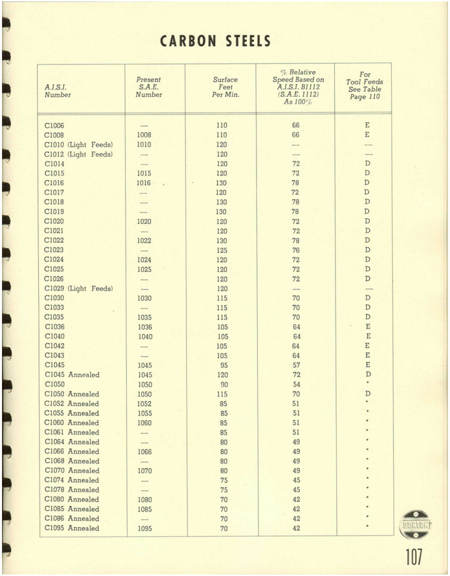
## FREE CUTTING STEELS

| A.I.S.I. Number | Present S.A.E. Number | Surface Feet Per Min. | % Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100% | For Tool Feeds See Table Page 110 |
|---|---|---|---|---|
| B1008 | — | 130 | 78 | D |
| B1011 | — | 130 | 78 | D |
| B1110 | — | 140 | 85 | C |
| B1111 | 1111 | 155 | 94 | B |
| B1112 (Union Free Cut) | 1112 | 165 | 100 | B |
| B1113 (Union Supercut) | 1113 | 225 | 136 | A |
| C1109 | — | 135 | 81 | C |
| C1110 | — | 135 | 81 | C |
| C1112 | — | 135 | 81 | C |
| C1113 | — | 155 | 94 | B |
| C1115 | 1115 | 135 | 81 | C |
| C1116 | — | 155 | 94 | B |
| C1117 | 1117 | 140 | 85 | C |
| C1118 | 1118 | 140 | 85 | C |
| C1120 | — | 135 | 81 | C |
| C1121 | — | 135 | 81 | C |
| C1122 | — | 135 | 81 | C |
| C1132 | 1132 | 125 | 76 | D |
| C1137 | 1137 | 120 | 72 | D |
| C1141 | 1141 | 115 | 70 | D |
| C1144 | — | 120 | 72 | D |
| C1217 | — | 140 | 85 | C |

## MOLYBDENUM STEELS

| A.I.S.I. Number | Present S.A.E. Number | Surface Feet Per Min. | % Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100% | For Tool Feeds See Table Page 110 |
|---|---|---|---|---|
| A4023 | 4023 | 130 | 78 | D |
| A4024 | — | 130 | 78 | D |
| A4027 | 4027 | 110 | 66 | E |
| A4028 | — | 120 | 72 | D |
| A4032 Annealed | 4032 | 125 | 76 | D |
| A4037 Annealed | 4037 | 120 | 72 | D |
| A4042 Annealed | 4042 | 115 | 70 | D |
| A4047 Annealed | 4047 | 110 | 66 | E |
| A4063 Annealed | 4063 | 85 | 51 | * |
| A4068 Annealed | 4068 | 80 | 49 | * |
| A4119 | 4119 | 125 | 76 | D |
| A4120 | — | 125 | 76 | D |
| A4125 | 4125 | 125 | 76 | D |
| A4130 Annealed | 4130 | 120 | 72 | D |

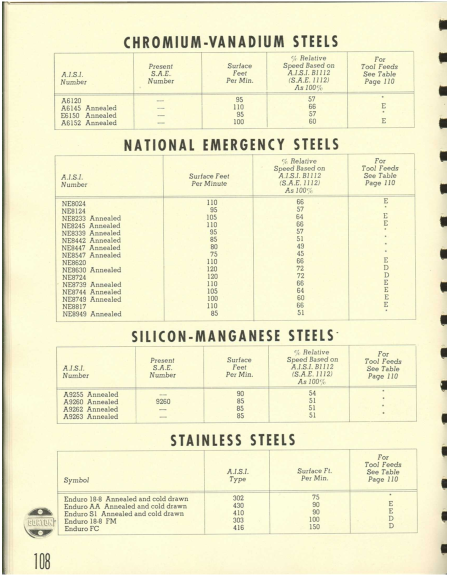
# Photo 108



## CARBON STEELS

| A.I.S.I. Number | Present S.A.E. Number | Surface Feet Per Min. | % Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100% | For Tool Feeds See Table Page 110 |
|---|---|---|---|---|
| C1006 | — | 110 | 66 | E |
| C1008 | 1008 | 110 | 66 | E |
| C1010 (Light Feeds) | 1010 | 120 | — | — |
| C1012 (Light Feeds) | — | 120 | — | — |
| C1014 | — | 120 | 72 | D |
| C1015 | 1015 | 120 | 72 | D |
| C1016 | 1016 | 130 | 78 | D |
| C1017 | — | 120 | 72 | D |
| C1018 | — | 130 | 78 | D |
| C1019 | — | 130 | 78 | D |
| C1020 | 1020 | 120 | 72 | D |
| C1021 | — | 120 | 72 | D |
| C1022 | 1022 | 130 | 78 | D |
| C1023 | — | 125 | 76 | D |
| C1024 | 1024 | 120 | 72 | D |
| C1025 | 1025 | 120 | 72 | D |
| C1026 | — | 120 | 72 | D |
| C1029 (Light Feeds) | — | 120 | — | — |
| C1030 | 1030 | 115 | 70 | D |
| C1033 | — | 115 | 70 | D |
| C1035 | 1035 | 115 | 70 | D |
| C1036 | 1036 | 105 | 64 | E |
| C1040 | 1040 | 105 | 64 | E |
| C1042 | — | 105 | 64 | E |
| C1043 | — | 105 | 64 | E |
| C1045 | 1045 | 95 | 57 | E |
| C1045 Annealed | 1045 | 120 | 72 | D |
| C1050 | 1050 | 90 | 54 | * |
| C1050 Annealed | 1050 | 115 | 70 | D |
| C1052 Annealed | 1052 | 85 | 51 | * |
| C1055 Annealed | 1055 | 85 | 51 | * |
| C1060 Annealed | 1060 | 85 | 51 | * |
| C1061 Annealed | — | 85 | 51 | * |
| C1064 Annealed | — | 80 | 49 | * |
| C1066 Annealed | 1066 | 80 | 49 | * |
| C1068 Annealed | — | 80 | 49 | * |
| C1070 Annealed | 1070 | 80 | 49 | * |
| C1074 Annealed | — | 75 | 45 | * |
| C1078 Annealed | — | 75 | 45 | * |
| C1080 Annealed | 1080 | 70 | 42 | * |
| C1085 Annealed | 1085 | 70 | 42 | * |
| C1086 Annealed | — | 70 | 42 | * |
| C1095 Annealed | 1095 | 70 | 42 | * |

# Photo 109



## CHROMIUM-VANADIUM STEELS

| A.I.S.I. Number | Present S.A.E. Number | Surface Feet Per Min. | % Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100% | For Tool Feeds See Table Page 110 |
|---|---|---|---|---|
| A6120 | — | 95 | 57 | * |
| A6145 Annealed | — | 110 | 66 | E |
| E6150 Annealed | — | 95 | 57 | * |
| A6152 Annealed | — | 100 | 60 | E |

## NATIONAL EMERGENCY STEELS

| A.I.S.I. Number | Surface Feet Per Minute | % Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100% | For Tool Feeds See Table Page 110 |
|---|---|---|---|
| NE8024 | 110 | 66 | E |
| NE8124 | 95 | 57 | * |
| NE8233 Annealed | 105 | 64 | E |
| NE8245 Annealed | 110 | 66 | E |
| NE8339 Annealed | 95 | 57 | * |
| NE8442 Annealed | 85 | 51 | * |
| NE8447 Annealed | 80 | 49 | * |
| NE8547 Annealed | 75 | 45 | * |
| NE8620 | 110 | 66 | E |
| NE8630 Annealed | 120 | 72 | D |
| NE8724 | 120 | 72 | D |
| NE8739 Annealed | 110 | 66 | E |
| NE8744 Annealed | 105 | 64 | E |
| NE8749 Annealed | 100 | 60 | E |
| NE8817 | 110 | 66 | E |
| NE8949 Annealed | 85 | 51 | * |

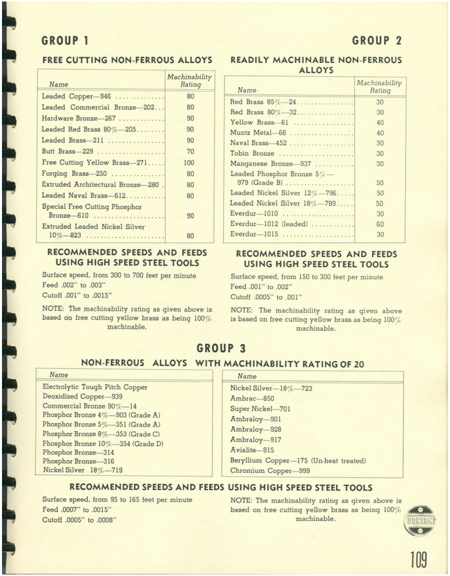
## SILICON-MANGANESE STEELS

| A.I.S.I. Number | Present S.A.E. Number | Surface Feet Per Min. | % Relative Speed Based on A.I.S.I. B1112 (S.A.E. 1112) As 100% | For Tool Feeds See Table Page 110 |
|---|---|---|---|---|
| A9255 Annealed | — | 90 | 54 | * |
| A9260 Annealed | 9260 | 85 | 51 | * |
| A9262 Annealed | — | 85 | 51 | * |
| A9263 Annealed | — | 85 | 51 | * |

## STAINLESS STEELS

| Symbol | A.I.S.I. Type | Surface Ft. Per Min. | For Tool Feeds See Table Page 110 |
|---|---|---|---|
| Enduro 18-8 Annealed and cold drawn | 302 | 75 | * |
| Enduro AA Annealed and cold drawn | 430 | 90 | E |
| Enduro S1 Annealed and cold drawn | 410 | 90 | E |
| Enduro 18-8 FM | 303 | 100 | D |
| Enduro FC | 416 | 150 | D |

# Photo 110



## GROUP 1

### FREE CUTTING NON-FERROUS ALLOYS

| Name | Machinability Rating |
|---|---|
| Leaded Copper—946 | 80 |
| Leaded Commercial Bronze—202 | 80 |
| Hardware Bronze—267 | 90 |
| Leaded Red Brass 80%—205 | 90 |
| Leaded Brass—211 | 90 |
| Butt Brass—229 | 70 |
| Free Cutting Yellow Brass—271 | 100 |
| Forging Brass—250 | 80 |
| Extruded Architectural Bronze—280 | 80 |
| Leaded Naval Brass—612 | 80 |
| Special Free Cutting Phosphor Bronze—610 | 90 |
| Extruded Leaded Nickel Silver 10%—823 | 80 |

### RECOMMENDED SPEEDS AND FEEDS USING HIGH SPEED STEEL TOOLS

Surface speed, from 300 to 700 feet per minute
Feed .002" to .003"
Cutoff .001" to .0015"

NOTE: The machinability rating as given above is based on free cutting yellow brass as being 100% machinable.

## GROUP 2

### READILY MACHINABLE NON-FERROUS ALLOYS

| Name | Machinability Rating |
|---|---|
| Red Brass 85%—24 | 30 |
| Red Brass 80%—32 | 30 |
| Yellow Brass—61 | 40 |
| Muntz Metal—66 | 40 |
| Naval Brass—452 | 30 |
| Tobin Bronze | 30 |
| Manganese Bronze—937 | 30 |
| Leaded Phosphor Bronze 5%—979 (Grade B) | 50 |
| Leaded Nickel Silver 12%—796 | 50 |
| Leaded Nickel Silver 18%—789 | 50 |
| Everdur—1010 | 30 |
| Everdur—1012 (leaded) | 60 |
| Everdur—1015 | 30 |

### RECOMMENDED SPEEDS AND FEEDS USING HIGH SPEED STEEL TOOLS

Surface speed, from 150 to 300 feet per minute
Feed .001" to .002"
Cutoff .0005" to .001"

NOTE: The machinability rating as given above is based on free cutting yellow brass as being 100% machinable.

## GROUP 3

### NON-FERROUS ALLOYS WITH MACHINABILITY RATING OF 20

| Name |
|---|
| Electrolytic Tough Pitch Copper |
| Deoxidized Copper—939 |
| Commercial Bronze 90%—14 |
| Phosphor Bronze 4%—903 (Grade A) |
| Phosphor Bronze 5%—351 (Grade A) |
| Phosphor Bronze 8%—353 (Grade C) |
| Phosphor Bronze 10%—354 (Grade D) |
| Phosphor Bronze—314 |
| Phosphor Bronze—316 |
| Nickel Silver 18%—719 |

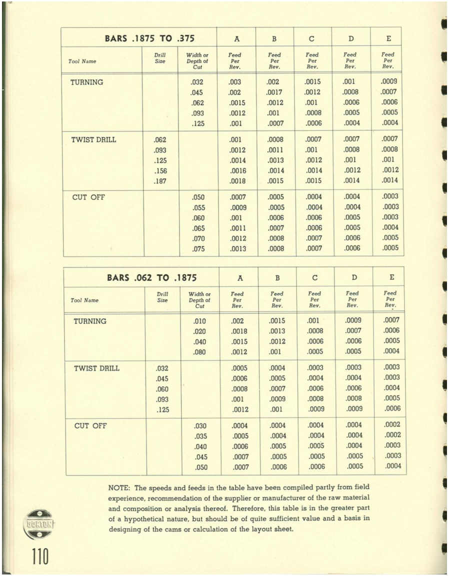
| Name |
|---|
| Nickel Silver—18%—723 |
| Ambrac—850 |
| Super Nickel—701 |
| Ambraloy—901 |
| Ambraloy—928 |
| Ambraloy—917 |
| Avialite—915 |
| Beryllium Copper—175 (Un-heat treated) |
| Chromium Copper—999 |

### RECOMMENDED SPEEDS AND FEEDS USING HIGH SPEED STEEL TOOLS

Surface speed, from 95 to 165 feet per minute
Feed .0007" to .0015"
Cutoff .0005" to .0008"

NOTE: The machinability rating as given above is based on free cutting yellow brass as being 100% machinable.

# Photo 111

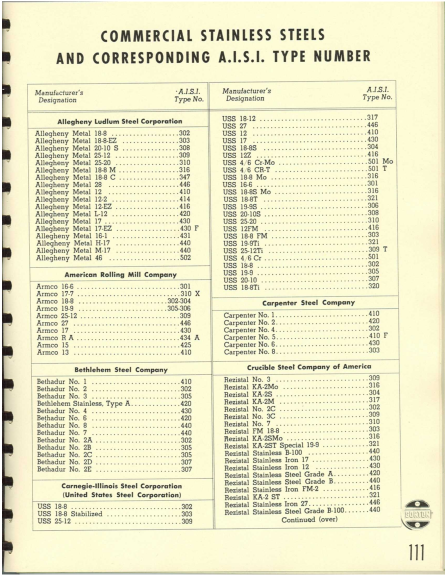


| BARS .1875 TO .375 | | | A | B | C | D | E |
|---|---|---|---|---|---|---|---|
| *Tool Name* | *Drill Size* | *Width or Depth of Cut* | *Feed Per Rev.* | *Feed Per Rev.* | *Feed Per Rev.* | *Feed Per Rev.* | *Feed Per Rev.* |
| TURNING | | .032 | .003 | .002 | .0015 | .001 | .0009 |
| | | .045 | .002 | .0017 | .0012 | .0008 | .0007 |
| | | .062 | .0015 | .0012 | .001 | .0006 | .0006 |
| | | .093 | .0012 | .001 | .0008 | .0005 | .0005 |
| | | .125 | .001 | .0007 | .0006 | .0004 | .0004 |
| TWIST DRILL | .062 | | .001 | .0008 | .0007 | .0007 | .0007 |
| | .093 | | .0012 | .0011 | .001 | .0008 | .0008 |
| | .125 | | .0014 | .0013 | .0012 | .001 | .001 |
| | .156 | | .0016 | .0014 | .0014 | .0012 | .0012 |
| | .187 | | .0018 | .0015 | .0015 | .0014 | .0014 |
| CUT OFF | | .050 | .0007 | .0005 | .0004 | .0004 | .0003 |
| | | .055 | .0009 | .0005 | .0004 | .0004 | .0003 |
| | | .060 | .001 | .0006 | .0006 | .0005 | .0003 |
| | | .065 | .0011 | .0007 | .0006 | .0005 | .0004 |
| | | .070 | .0012 | .0008 | .0007 | .0006 | .0005 |
| | | .075 | .0013 | .0008 | .0007 | .0006 | .0005 |

| BARS .062 TO .1875 | | | A | B | C | D | E |
|---|---|---|---|---|---|---|---|
| *Tool Name* | *Drill Size* | *Width or Depth of Cut* | *Feed Per Rev.* | *Feed Per Rev.* | *Feed Per Rev.* | *Feed Per Rev.* | *Feed Per Rev.* |
| TURNING | | .010 | .002 | .0015 | .001 | .0009 | .0007 |
| | | .020 | .0018 | .0013 | .0008 | .0007 | .0006 |
| | | .040 | .0015 | .0012 | .0006 | .0006 | .0005 |
| | | .080 | .0012 | .001 | .0005 | .0005 | .0004 |
| TWIST DRILL | .032 | | .0005 | .0004 | .0003 | .0003 | .0003 |
| | .045 | | .0006 | .0005 | .0004 | .0004 | .0003 |
| | .060 | | .0008 | .0007 | .0006 | .0006 | .0004 |
| | .093 | | .001 | .0009 | .0008 | .0008 | .0005 |
| | .125 | | .0012 | .001 | .0009 | .0009 | .0006 |
| CUT OFF | | .030 | .0004 | .0004 | .0004 | .0004 | .0002 |
| | | .035 | .0005 | .0004 | .0004 | .0004 | .0002 |
| | | .040 | .0006 | .0005 | .0005 | .0004 | .0003 |
| | | .045 | .0007 | .0005 | .0005 | .0005 | .0003 |
| | | .050 | .0007 | .0006 | .0006 | .0005 | .0004 |

NOTE: The speeds and feeds in the table have been compiled partly from field experience, recommendation of the supplier or manufacturer of the raw material and composition or analysis thereof. Therefore, this table is in the greater part of a hypothetical nature, but should be of quite sufficient value as a basis in designing of the cams or calculation of the layout sheet.

# Photo 112

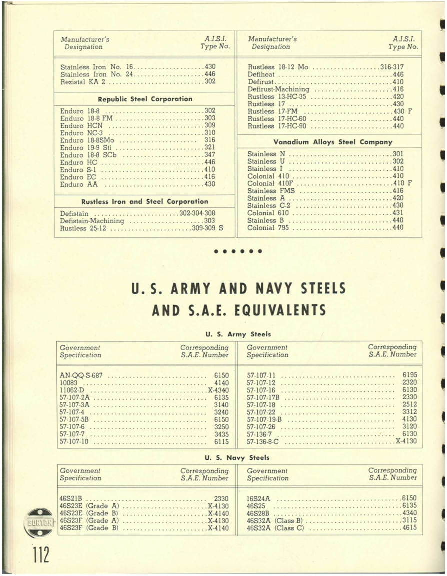


## COMMERCIAL STAINLESS STEELS AND CORRESPONDING A.I.S.I. TYPE NUMBER

| *Manufacturer's Designation* | *·A.I.S.I. Type No.* |
|---|---|
| **Allegheny Ludlum Steel Corporation** | |
| Allegheny Metal 18-8 | 302 |
| Allegheny Metal 18-8-EZ | 303 |
| Allegheny Metal 20-10 S | 308 |
| Allegheny Metal 25-12 | 309 |
| Allegheny Metal 25-20 | 310 |
| Allegheny Metal 18-8 M | 316 |
| Allegheny Metal 18-8 C | 347 |
| Allegheny Metal 28 | 446 |
| Allegheny Metal 12 | 410 |
| Allegheny Metal 12-2 | 414 |
| Allegheny Metal 12-EZ | 416 |
| Allegheny Metal L-12 | 420 |
| Allegheny Metal 17 | 430 |
| Allegheny Metal 17-EZ | 430 F |
| Allegheny Metal 16-1 | 431 |
| Allegheny Metal H-17 | 440 |
| Allegheny Metal M-17 | 440 |
| Allegheny Metal 46 | 502 |
| **American Rolling Mill Company** | |
| Armco 16-6 | 301 |
| Armco 17-7 | 310 X |
| Armco 18-8 | 302-304 |
| Armco 19-9 | 305-306 |
| Armco 25-12 | 309 |
| Armco 27 | 446 |
| Armco 17 | 430 |
| Armco R A | 434 A |
| Armco 15 | 425 |
| Armco 13 | 410 |
| **Bethlehem Steel Company** | |
| Bethadur No. 1 | 410 |
| Bethadur No. 2 | 302 |
| Bethadur No. 3 | 305 |
| Bethlehem Stainless, Type A | 420 |
| Bethadur No. 4 | 430 |
| Bethadur No. 6 | 420 |
| Bethadur No. 8 | 440 |
| Bethadur No. 7 | 440 |
| Bethadur No. 2A | 302 |
| Bethadur No. 2B | 305 |
| Bethadur No. 2C | 305 |
| Bethadur No. 2D | 307 |
| Bethadur No. 2E | 307 |
| **Carnegie-Illinois Steel Corporation (United States Steel Corporation)** | |
| USS 18-8 | 302 |
| USS 18-8 Stabilized | 303 |
| USS 25-12 | 309 |
| USS 18-12 | 317 |
| USS 27 | 446 |
| USS 12 | 410 |
| USS 17 | 430 |
| USS 18-8S | 304 |
| USS 12Z | 416 |
| USS 4/6 Cr-Mo | 501 Mo |
| USS 4/6 CR-T | 501 T |
| USS 18-8 Mo | 316 |
| USS 16-6 | 301 |
| USS 18-8S Mo | 316 |
| USS 18-8T | 321 |
| USS 19-9S | 306 |
| USS 20-10S | 308 |
| USS 25-20 | 310 |
| USS 12FM | 416 |
| USS 18-8 FM | 303 |
| USS 19-9Ti | 321 |
| USS 25-12Ti | 309 T |
| USS 4/6 Cr | 501 |
| USS 18-8 | 302 |
| USS 19-9 | 305 |
| USS 20-10 | 307 |
| USS 18-8Ti | 320 |
| **Carpenter Steel Company** | |
| Carpenter No. 1 | 410 |
| Carpenter No. 2 | 420 |
| Carpenter No. 4 | 302 |
| Carpenter No. 5 | 410 F |
| Carpenter No. 6 | 430 |
| Carpenter No. 8 | 303 |
| **Crucible Steel Company of America** | |
| Rezistal No. 3 | 309 |
| Rezistal KA-2Mo | 316 |
| Rezistal KA-2S | 304 |
| Rezistal KA-2M | 317 |
| Rezistal No. 2C | 302 |
| Rezistal No. 3C | 309 |
| Rezistal No. 7 | 310 |
| Rezistal FM 18-8 | 303 |
| Rezistal KA-2SMo | 316 |
| Rezistal KA-2ST Special 19-9 | 321 |
| Rezistal Stainless B-100 | 440 |
| Rezistal Stainless Iron 17 | 430 |
| Rezistal Stainless Iron 12 | 430 |
| Rezistal Stainless Steel Grade A | 420 |
| Rezistal Stainless Steel Grade B | 440 |
| Rezistal Stainless Iron FM-2 | 416 |
| Rezistal KA-2 ST | 321 |
| Rezistal Stainless Iron 27 | 446 |
| Rezistal Stainless Steel Grade B-100 | 440 |

Continued (over)

# Photo 113



| *Manufacturer's Designation* | *A.I.S.I. Type No.* |
|---|---|
| Stainless Iron No. 16 | 430 |
| Stainless Iron No. 24 | 446 |
| Rezistal KA 2 | 302 |
| **Republic Steel Corporation** | |
| Enduro 18-8 | 302 |
| Enduro 18-8 FM | 303 |
| Enduro HCN | 309 |
| Enduro NC-3 | 310 |
| Enduro 18-8SMo | 316 |
| Enduro 19-9 Sti | 321 |
| Enduro 18-8 SCb | 347 |
| Enduro HC | 446 |
| Enduro S-1 | 410 |
| Enduro EC | 416 |
| Enduro AA | 430 |
| **Rustless Iron and Steel Corporation** | |
| Defistain | 302-304-308 |
| Defistain-Machining | 303 |
| Rustless 25-12 | 309-309 S |

| *Manufacturer's Designation* | *A.I.S.I. Type No.* |
|---|---|
| Rustless 18-12 Mo | 316-317 |
| Defiheat | 446 |
| Defirust | 410 |
| Defirust-Machining | 416 |
| Rustless 13-HC-35 | 420 |
| Rustless 17 | 430 |
| Rustless 17-FM | 430 F |
| Rustless 17-HC-60 | 440 |
| Rustless 17-HC-90 | 440 |
| **Vanadium Alloys Steel Company** | |
| Stainless N | 301 |
| Stainless U | 302 |
| Stainless I | 410 |
| Colonial 410 | 410 |
| Colonial 410F | 410 F |
| Stainless FMS | 416 |
| Stainless A | 420 |
| Stainless C-2 | 430 |
| Colonial 610 | 431 |
| Stainless B | 440 |
| Colonial 795 | 440 |

• • • • • • •

## U. S. ARMY AND NAVY STEELS AND S.A.E. EQUIVALENTS

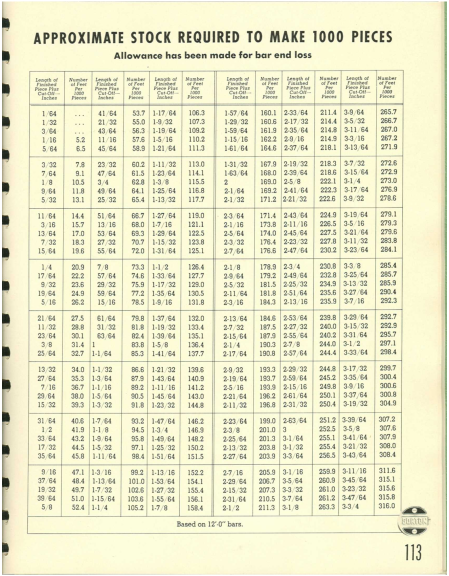
### U. S. Army Steels

| *Government Specification* | *Corresponding S.A.E. Number* | *Government Specification* | *Corresponding S.A.E. Number* |
|---|---|---|---|
| AN-QQ-S-687 | 6150 | 57-107-11 | 6195 |
| 10083 | 4140 | 57-107-12 | 2320 |
| 11062-D | X-4340 | 57-107-16 | 6130 |
| 57-107-2A | 6135 | 57-107-17B | 2330 |
| 57-107-3A | 3140 | 57-107-18 | 2512 |
| 57-107-4 | 3240 | 57-107-22 | 3312 |
| 57-107-5B | 6150 | 57-107-19-B | 4130 |
| 57-107-6 | 3250 | 57-107-26 | 3120 |
| 57-107-7 | 3435 | 57-136-7 | 6130 |
| 57-107-10 | 6115 | 57-136-8-C | X-4130 |

### U. S. Navy Steels

| *Government Specification* | *Corresponding S.A.E. Number* | *Government Specification* | *Corresponding S.A.E. Number* |
|---|---|---|---|
| 46S21B | 2330 | 16S24A | 6150 |
| 46S23E (Grade A) | X-4130 | 46S25 | 6135 |
| 46S23E (Grade B) | X-4140 | 46S28B | 4340 |
| 46S23F (Grade A) | X-4130 | 46S32A (Class B) | 3115 |
| 46S23F (Grade B) | X-4140 | 46S32A (Class C) | 4615 |

# Photo 114



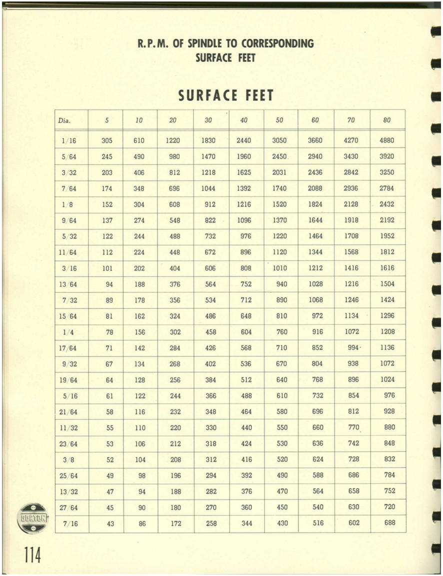
## APPROXIMATE STOCK REQUIRED TO MAKE 1000 PIECES

**Allowance has been made for bar end loss**

| Length of Finished Piece Plus Cut-Off—Inches | Number of Feet Per 1000 Pieces | Length of Finished Piece Plus Cut-Off—Inches | Number of Feet Per 1000 Pieces | Length of Finished Piece Plus Cut-Off—Inches | Number of Feet Per 1000 Pieces | Length of Finished Piece Plus Cut-Off—Inches | Number of Feet Per 1000 Pieces | Length of Finished Piece Plus Cut-Off—Inches | Number of Feet Per 1000 Pieces | Length of Finished Piece Plus Cut-Off—Inches | Number of Feet Per 1000 Pieces |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/64 | ... | 41/64 | 53.7 | 1-17/64 | 106.3 | 1-57/64 | 160.1 | 2-33/64 | 211.4 | 3-9/64 | 265.7 |
| 1/32 | ... | 21/32 | 55.0 | 1-9/32 | 107.3 | 1-29/32 | 160.6 | 2-17/32 | 214.4 | 3-5/32 | 266.7 |
| 3/64 | ... | 43/64 | 56.3 | 1-19/64 | 109.2 | 1-59/64 | 161.9 | 2-35/64 | 214.8 | 3-11/64 | 267.0 |
| 1/16 | 5.2 | 11/16 | 57.6 | 1-5/16 | 110.2 | 1-15/16 | 162.2 | 2-9/16 | 214.9 | 3-3/16 | 267.2 |
| 5/64 | 6.5 | 45/64 | 58.9 | 1-21/64 | 111.3 | 1-61/64 | 164.6 | 2-37/64 | 218.1 | 3-13/64 | 271.9 |
| 3/32 | 7.8 | 23/32 | 60.2 | 1-11/32 | 113.0 | 1-31/32 | 167.9 | 2-19/32 | 218.3 | 3-7/32 | 272.6 |
| 7/64 | 9.1 | 47/64 | 61.5 | 1-23/64 | 114.1 | 1-63/64 | 168.0 | 2-39/64 | 218.6 | 3-15/64 | 272.9 |
| 1/8 | 10.5 | 3/4 | 62.8 | 1-3/8 | 115.5 | 2 | 169.0 | 2-5/8 | 222.1 | 3-1/4 | 273.0 |
| 9/64 | 11.8 | 49/64 | 64.1 | 1-25/64 | 116.8 | 2-1/64 | 169.2 | 2-41/64 | 222.3 | 3-17/64 | 276.9 |
| 5/32 | 13.1 | 25/32 | 65.4 | 1-13/32 | 117.7 | 2-1/32 | 171.2 | 2-21/32 | 222.6 | 3-9/32 | 278.6 |
| 11/64 | 14.4 | 51/64 | 66.7 | 1-27/64 | 119.0 | 2-3/64 | 171.4 | 2-43/64 | 224.9 | 3-19/64 | 279.1 |
| 3/16 | 15.7 | 13/16 | 68.0 | 1-7/16 | 121.1 | 2-1/16 | 173.8 | 2-11/16 | 226.5 | 3-5/16 | 279.3 |
| 13/64 | 17.0 | 53/64 | 69.3 | 1-29/64 | 122.5 | 2-5/64 | 174.0 | 2-45/64 | 227.5 | 3-21/64 | 279.6 |
| 7/32 | 18.3 | 27/32 | 70.7 | 1-15/32 | 123.8 | 2-3/32 | 176.4 | 2-23/32 | 227.8 | 3-11/32 | 283.8 |
| 15/64 | 19.6 | 55/64 | 72.0 | 1-31/64 | 125.1 | 2-7/64 | 176.6 | 2-47/64 | 230.2 | 3-23/64 | 284.1 |
| 1/4 | 20.9 | 7/8 | 73.3 | 1-1/2 | 126.4 | 2-1/8 | 178.9 | 2-3/4 | 230.8 | 3-3/8 | 285.4 |
| 17/64 | 22.2 | 57/64 | 74.6 | 1-33/64 | 127.7 | 2-9/64 | 179.2 | 2-49/64 | 232.8 | 3-25/64 | 285.7 |
| 9/32 | 23.6 | 29/32 | 75.9 | 1-17/32 | 129.0 | 2-5/32 | 181.5 | 2-25/32 | 234.9 | 3-13/32 | 285.9 |
| 19/64 | 24.9 | 59/64 | 77.2 | 1-35/64 | 130.5 | 2-11/64 | 181.8 | 2-51/64 | 235.6 | 3-27/64 | 290.4 |
| 5/16 | 26.2 | 15/16 | 78.5 | 1-9/16 | 131.8 | 2-3/16 | 184.3 | 2-13/16 | 235.9 | 3-7/16 | 292.3 |
| 21/64 | 27.5 | 61/64 | 79.8 | 1-37/64 | 132.0 | 2-13/64 | 184.6 | 2-53/64 | 239.8 | 3-29/64 | 292.7 |
| 11/32 | 28.8 | 31/32 | 81.8 | 1-19/32 | 133.4 | 2-7/32 | 187.5 | 2-27/32 | 240.0 | 3-15/32 | 292.9 |
| 23/64 | 30.1 | 63/64 | 82.4 | 1-39/64 | 135.1 | 2-15/64 | 187.9 | 2-55/64 | 240.2 | 3-31/64 | 295.7 |
| 3/8 | 31.4 | 1 | 83.8 | 1-5/8 | 136.4 | 2-1/4 | 190.3 | 2-7/8 | 244.0 | 3-1/2 | 297.1 |
| 25/64 | 32.7 | 1-1/64 | 85.3 | 1-41/64 | 137.7 | 2-17/64 | 190.8 | 2-57/64 | 244.4 | 3-33/64 | 298.4 |
| 13/32 | 34.0 | 1-1/32 | 86.6 | 1-21/32 | 139.6 | 2-9/32 | 193.3 | 2-29/32 | 244.8 | 3-17/32 | 299.7 |
| 27/64 | 35.3 | 1-3/64 | 87.9 | 1-43/64 | 140.9 | 2-19/64 | 193.7 | 2-59/64 | 245.2 | 3-35/64 | 300.4 |
| 7/16 | 36.7 | 1-1/16 | 89.2 | 1-11/16 | 141.2 | 2-5/16 | 193.9 | 2-15/16 | 249.8 | 3-9/16 | 300.6 |
| 29/64 | 38.0 | 1-5/64 | 90.5 | 1-45/64 | 143.0 | 2-21/64 | 196.2 | 2-61/64 | 250.1 | 3-37/64 | 300.8 |
| 15/32 | 39.3 | 1-3/32 | 91.8 | 1-23/32 | 144.8 | 2-11/32 | 196.8 | 2-31/32 | 250.4 | 3-19/32 | 304.9 |
| 31/64 | 40.6 | 1-7/64 | 93.2 | 1-47/64 | 146.2 | 2-23/64 | 199.0 | 2-63/64 | 251.2 | 3-39/64 | 307.2 |
| 1/2 | 41.9 | 1-1/8 | 94.5 | 1-3/4 | 146.9 | 2-3/8 | 201.0 | 3 | 252.5 | 3-5/8 | 307.6 |
| 33/64 | 43.2 | 1-9/64 | 95.8 | 1-49/64 | 148.2 | 2-25/64 | 201.3 | 3-1/64 | 255.1 | 3-41/64 | 307.9 |
| 17/32 | 44.5 | 1-5/32 | 97.1 | 1-25/32 | 150.2 | 2-13/32 | 203.8 | 3-1/32 | 255.4 | 3-21/32 | 308.0 |
| 35/64 | 45.8 | 1-11/64 | 98.4 | 1-51/64 | 151.5 | 2-27/64 | 203.9 | 3-3/64 | 256.5 | 3-43/64 | 308.4 |
| 9/16 | 47.1 | 1-3/16 | 99.2 | 1-13/16 | 152.2 | 2-7/16 | 205.9 | 3-1/16 | 259.9 | 3-11/16 | 311.6 |
| 37/64 | 48.4 | 1-13/64 | 101.0 | 1-53/64 | 154.1 | 2-29/64 | 206.7 | 3-5/64 | 260.9 | 3-45/64 | 315.1 |
| 19/32 | 49.7 | 1-7/32 | 102.6 | 1-27/32 | 155.4 | 2-15/32 | 207.3 | 3-3/32 | 261.0 | 3-23/32 | 315.6 |
| 39/64 | 51.0 | 1-15/64 | 103.6 | 1-55/64 | 156.1 | 2-31/64 | 210.5 | 3-7/64 | 261.2 | 3-47/64 | 315.8 |
| 5/8 | 52.4 | 1-1/4 | 105.2 | 1-7/8 | 158.4 | 2-1/2 | 211.3 | 3-1/8 | 263.3 | 3-3/4 | 316.0 |

Based on 12'-0" bars.

# Photo 115

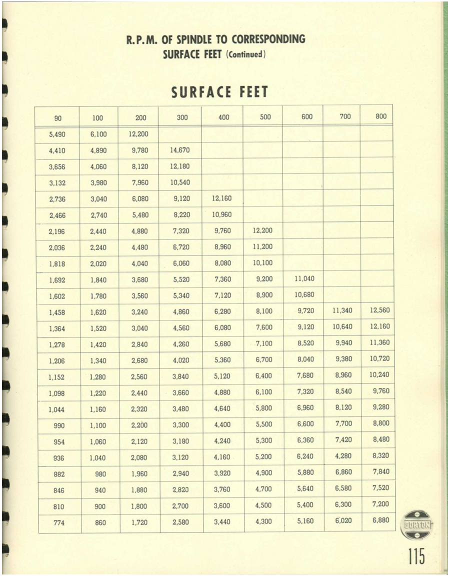


## R.P.M. OF SPINDLE TO CORRESPONDING SURFACE FEET

### SURFACE FEET

| Dia. | 5 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
|---|---|---|---|---|---|---|---|---|---|
| 1/16 | 305 | 610 | 1220 | 1830 | 2440 | 3050 | 3660 | 4270 | 4880 |
| 5/64 | 245 | 490 | 980 | 1470 | 1960 | 2450 | 2940 | 3430 | 3920 |
| 3/32 | 203 | 406 | 812 | 1218 | 1625 | 2031 | 2436 | 2842 | 3250 |
| 7/64 | 174 | 348 | 696 | 1044 | 1392 | 1740 | 2088 | 2936 | 2784 |
| 1/8 | 152 | 304 | 608 | 912 | 1216 | 1520 | 1824 | 2128 | 2432 |
| 9/64 | 137 | 274 | 548 | 822 | 1096 | 1370 | 1644 | 1918 | 2192 |
| 5/32 | 122 | 244 | 488 | 732 | 976 | 1220 | 1464 | 1708 | 1952 |
| 11/64 | 112 | 224 | 448 | 672 | 896 | 1120 | 1344 | 1568 | 1812 |
| 3/16 | 101 | 202 | 404 | 606 | 808 | 1010 | 1212 | 1416 | 1616 |
| 13/64 | 94 | 188 | 376 | 564 | 752 | 940 | 1028 | 1216 | 1504 |
| 7/32 | 89 | 178 | 356 | 534 | 712 | 890 | 1068 | 1246 | 1424 |
| 15/64 | 81 | 162 | 324 | 486 | 648 | 810 | 972 | 1134 | 1296 |
| 1/4 | 78 | 156 | 302 | 458 | 604 | 760 | 916 | 1072 | 1208 |
| 17/64 | 71 | 142 | 284 | 426 | 568 | 710 | 852 | 994 | 1136 |
| 9/32 | 67 | 134 | 268 | 402 | 536 | 670 | 804 | 938 | 1072 |
| 19/64 | 64 | 128 | 256 | 384 | 512 | 640 | 768 | 896 | 1024 |
| 5/16 | 61 | 122 | 244 | 366 | 488 | 610 | 732 | 854 | 976 |
| 21/64 | 58 | 116 | 232 | 348 | 464 | 580 | 696 | 812 | 928 |
| 11/32 | 55 | 110 | 220 | 330 | 440 | 550 | 660 | 770 | 880 |
| 23/64 | 53 | 106 | 212 | 318 | 424 | 530 | 636 | 742 | 848 |
| 3/8 | 52 | 104 | 208 | 312 | 416 | 520 | 624 | 728 | 832 |
| 25/64 | 49 | 98 | 196 | 294 | 392 | 490 | 588 | 686 | 784 |
| 13/32 | 47 | 94 | 188 | 282 | 376 | 470 | 564 | 658 | 752 |
| 27/64 | 45 | 90 | 180 | 270 | 360 | 450 | 540 | 630 | 720 |
| 7/16 | 43 | 86 | 172 | 258 | 344 | 430 | 516 | 602 | 688 |

# Photo 116

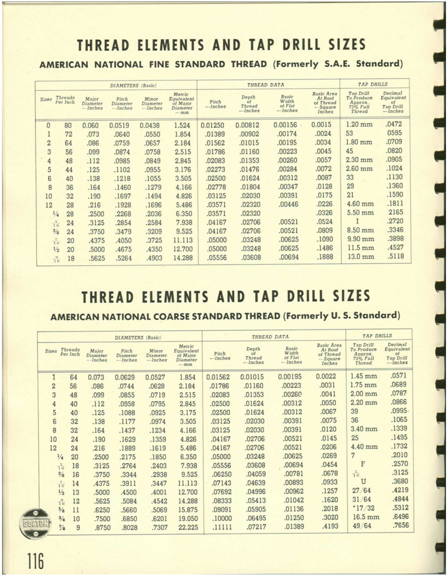


## R.P.M. OF SPINDLE TO CORRESPONDING SURFACE FEET (Continued)

### SURFACE FEET

| 90 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 |
|---|---|---|---|---|---|---|---|---|
| 5,490 | 6,100 | 12,200 | | | | | | |
| 4,410 | 4,890 | 9,780 | 14,670 | | | | | |
| 3,656 | 4,060 | 8,120 | 12,180 | | | | | |
| 3,132 | 3,980 | 7,960 | 10,540 | | | | | |
| 2,736 | 3,040 | 6,080 | 9,120 | 12,160 | | | | |
| 2,466 | 2,740 | 5,480 | 8,220 | 10,960 | | | | |
| 2,196 | 2,440 | 4,880 | 7,320 | 9,760 | 12,200 | | | |
| 2,036 | 2,240 | 4,480 | 6,720 | 8,960 | 11,200 | | | |
| 1,818 | 2,020 | 4,040 | 6,060 | 8,080 | 10,100 | | | |
| 1,692 | 1,840 | 3,680 | 5,520 | 7,360 | 9,200 | 11,040 | | |
| 1,602 | 1,780 | 3,560 | 5,340 | 7,120 | 8,900 | 10,680 | | |
| 1,458 | 1,620 | 3,240 | 4,860 | 6,280 | 8,100 | 9,720 | 11,340 | 12,560 |
| 1,364 | 1,520 | 3,040 | 4,560 | 6,080 | 7,600 | 9,120 | 10,640 | 12,160 |
| 1,278 | 1,420 | 2,840 | 4,260 | 5,680 | 7,100 | 8,520 | 9,940 | 11,360 |
| 1,206 | 1,340 | 2,680 | 4,020 | 5,360 | 6,700 | 8,040 | 9,380 | 10,720 |
| 1,152 | 1,280 | 2,560 | 3,840 | 5,120 | 6,400 | 7,680 | 8,960 | 10,240 |
| 1,098 | 1,220 | 2,440 | 3,660 | 4,880 | 6,100 | 7,320 | 8,540 | 9,760 |
| 1,044 | 1,160 | 2,320 | 3,480 | 4,640 | 5,800 | 6,960 | 8,120 | 9,280 |
| 990 | 1,100 | 2,200 | 3,300 | 4,400 | 5,500 | 6,600 | 7,700 | 8,800 |
| 954 | 1,060 | 2,120 | 3,180 | 4,240 | 5,300 | 6,360 | 7,420 | 8,480 |
| 936 | 1,040 | 2,080 | 3,120 | 4,160 | 5,200 | 6,240 | 4,280 | 8,320 |
| 882 | 980 | 1,960 | 2,940 | 3,920 | 4,900 | 5,880 | 6,860 | 7,840 |
| 846 | 940 | 1,880 | 2,820 | 3,760 | 4,700 | 5,640 | 6,580 | 7,520 |
| 810 | 900 | 1,800 | 2,700 | 3,600 | 4,500 | 5,400 | 6,300 | 7,200 |
| 774 | 860 | 1,720 | 2,580 | 3,440 | 4,300 | 5,160 | 6,020 | 6,880 |

# Photo 117



## THREAD ELEMENTS AND TAP DRILL SIZES

### AMERICAN NATIONAL FINE STANDARD THREAD (Formerly S.A.E. Standard)

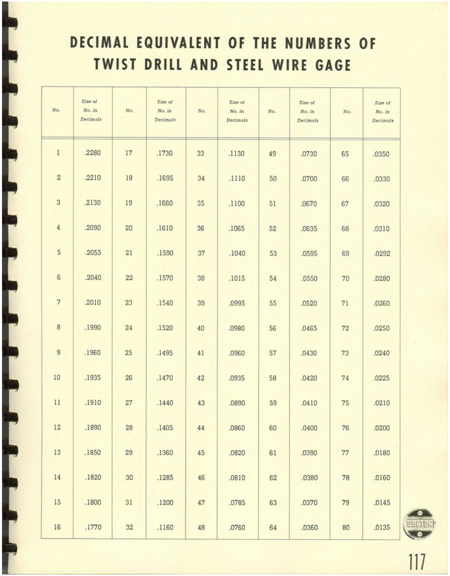
| DIAMETERS (Basic) | | | | | | THREAD DATA | | | | TAP DRILLS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sizes | Threads Per Inch | Major Diameter —Inches | Pitch Diameter —Inches | Minor Diameter —Inches | Metric Equivalent of Major Diameter —mm | Pitch —Inches | Depth of Thread —Inches | Basic Width of Flat —Inches | Basic Area At Root of Thread —Square Inches | Tap Drill To Produce Approx. 75% Full Thread | Decimal Equivalent of Tap Drill —Inches |
| 0 | 80 | 0.060 | 0.0519 | 0.0438 | 1.524 | 0.01250 | 0.00812 | 0.00156 | 0.0015 | 1.20 mm | .0472 |
| 1 | 72 | .073 | .0640 | .0550 | 1.854 | .01389 | .00902 | .00174 | .0024 | 53 | 0595 |
| 2 | 64 | .086 | .0759 | .0657 | 2.184 | .01562 | .01015 | .00195 | .0034 | 1.80 mm | .0709 |
| 3 | 56 | .099 | .0874 | .0758 | 2.515 | .01786 | .01160 | .00223 | .0045 | 45 | .0820 |
| 4 | 48 | .112 | .0985 | .0849 | 2.845 | .02083 | .01353 | .00260 | .0057 | 2.30 mm | .0905 |
| 5 | 44 | .125 | .1102 | .0955 | 3.176 | .02273 | .01476 | .00284 | .0072 | 2.60 mm | .1024 |
| 6 | 40 | .138 | .1218 | .1055 | 3.505 | .02500 | .01624 | .00312 | .0087 | 33 | .1130 |
| 8 | 36 | .164 | .1460 | .1279 | 4.166 | .02778 | .01804 | .00347 | .0128 | 29 | .1360 |
| 10 | 32 | .190 | .1697 | .1494 | 4.826 | .03125 | .02030 | .00391 | .0175 | 21 | .1590 |
| 12 | 28 | .216 | .1928 | .1696 | 5.486 | .03571 | .02320 | .00446 | .0226 | 4.60 mm | .1811 |
| ¼ | 28 | .2500 | .2268 | .2036 | 6.350 | .03571 | .02320 | | .0326 | 5.50 mm | 2165 |
| 5/16 | 24 | .3125 | .2854 | .2584 | 7.938 | .04167 | .02706 | .00521 | .0524 | I | .2720 |
| ⅜ | 24 | .3750 | .3479 | .3209 | 9.525 | .04167 | .02706 | .00521 | .0809 | 8.50 mm | .3346 |
| 7/16 | 20 | .4375 | .4050 | .3725 | 11.113 | .05000 | .03248 | .00625 | .1090 | 9.90 mm | .3898 |
| ½ | 20 | .5000 | .4675 | .4350 | 12.700 | .05000 | .03248 | .00625 | .1486 | 11.5 mm | .4527 |
| 9/16 | 18 | .5625 | .5264 | .4903 | 14.288 | .05556 | .03608 | .00694 | .1888 | 13.0 mm | .5118 |

## THREAD ELEMENTS AND TAP DRILL SIZES

### AMERICAN NATIONAL COARSE STANDARD THREAD (Formerly U. S. Standard)

| DIAMETERS (Basic) | | | | | | THREAD DATA | | | | TAP DRILLS | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sizes | Threads Per Inch | Major Diameter —Inches | Pitch Diameter —Inches | Minor Diameter —Inches | Metric Equivalent of Major Diameter —mm | Pitch —Inches | Depth of Thread —Inches | Basic Width of Flat —Inches | Basic Area At Root of Thread —Square Inches | Tap Drill To Produce Approx. 75% Full Thread | Decimal Equivalent of Tap Drill —Inches |
| 1 | 64 | 0.073 | 0.0629 | 0.0527 | 1.854 | 0.01562 | 0.01015 | 0.00195 | 0.0022 | 1.45 mm | .0571 |
| 2 | 56 | .086 | .0744 | .0628 | 2.184 | .01786 | .01160 | .00223 | .0031 | 1.75 mm | .0689 |
| 3 | 48 | .099 | .0855 | .0719 | 2.515 | .02083 | .01353 | .00260 | .0041 | 2.00 mm | .0787 |
| 4 | 40 | .112 | .0958 | .0795 | 2.845 | .02500 | .01624 | .00312 | .0050 | 2.20 mm | .0866 |
| 5 | 40 | .125 | .1088 | .0925 | 3.175 | .02500 | .01624 | .00312 | .0067 | 39 | .0995 |
| 6 | 32 | .138 | .1177 | .0974 | 3.505 | .03125 | .02030 | .00391 | .0075 | 36 | .1065 |
| 8 | 32 | .164 | .1437 | .1234 | 4.166 | .03125 | .02030 | .00391 | .0120 | 3.40 mm | .1339 |
| 10 | 24 | .190 | .1629 | .1359 | 4.826 | .04167 | .02706 | .00521 | .0145 | 25 | .1495 |
| 12 | 24 | .216 | .1889 | .1619 | 5.486 | .04167 | .02706 | .00521 | .0206 | 4.40 mm | .1732 |
| ¼ | 20 | .2500 | .2175 | .1850 | 6.350 | .05000 | .03248 | .00625 | .0269 | 7 | .2010 |
| 5/16 | 18 | .3125 | .2764 | .2403 | 7.938 | .05556 | .03608 | .00694 | .0454 | F | .2570 |
| ⅜ | 16 | .3750 | .3344 | .2938 | 9.525 | .06250 | .04059 | .00781 | .0678 | 5/16 | .3125 |
| 7/16 | 14 | .4375 | .3911 | .3447 | 11.113 | .07143 | .04639 | .00893 | .0933 | U | .3680 |
| ½ | 13 | .5000 | .4500 | .4001 | 12.700 | .07692 | .04996 | .00962 | .1257 | 27/64 | .4219 |
| 9/16 | 12 | .5625 | .5084 | .4542 | 14.288 | .08333 | .05413 | .01042 | .1620 | 31/64 | .4844 |
| ⅝ | 11 | .6250 | .5660 | .5069 | 15.875 | .09091 | .05905 | .01136 | .2018 | *17/32 | .5312 |
| ¾ | 10 | .7500 | .6850 | .6201 | 19.050 | .10000 | .06495 | .01250 | .3020 | 16.5 mm | .6496 |
| ⅞ | 9 | .8750 | .8028 | .7307 | 22.225 | .11111 | .07217 | .01389 | .4193 | 49/64 | .7656 |

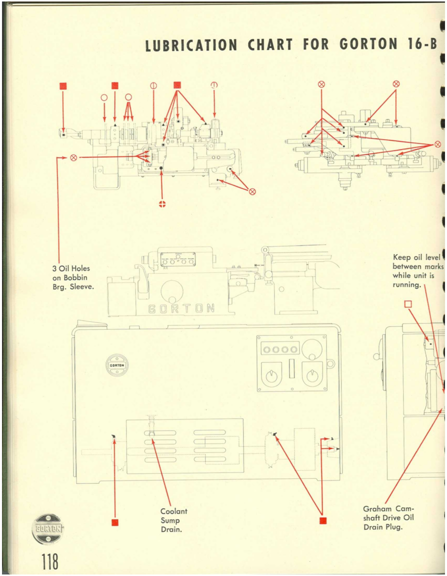
# Photo 118



## DECIMAL EQUIVALENT OF THE NUMBERS OF TWIST DRILL AND STEEL WIRE GAGE

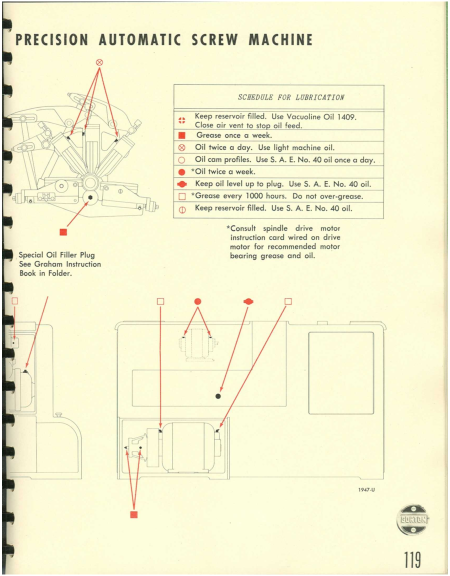
| No. | Size of No. in Decimals | No. | Size of No. in Decimals | No. | Size of No. in Decimals | No. | Size of No. in Decimals | No. | Size of No. in Decimals |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .2280 | 17 | .1730 | 33 | .1130 | 49 | .0730 | 65 | .0350 |
| 2 | .2210 | 18 | .1695 | 34 | .1110 | 50 | .0700 | 66 | .0330 |
| 3 | .2130 | 19 | .1660 | 35 | .1100 | 51 | .0670 | 67 | .0320 |
| 4 | .2090 | 20 | .1610 | 36 | .1065 | 52 | .0635 | 68 | .0310 |
| 5 | .2055 | 21 | .1590 | 37 | .1040 | 53 | .0595 | 69 | .0292 |
| 6 | .2040 | 22 | .1570 | 38 | .1015 | 54 | .0550 | 70 | .0280 |
| 7 | .2010 | 23 | .1540 | 39 | .0995 | 55 | .0520 | 71 | .0260 |
| 8 | .1990 | 24 | .1520 | 40 | .0980 | 56 | .0465 | 72 | .0250 |
| 9 | .1960 | 25 | .1495 | 41 | .0960 | 57 | .0430 | 73 | .0240 |
| 10 | .1935 | 26 | .1470 | 42 | .0935 | 58 | .0420 | 74 | .0225 |
| 11 | .1910 | 27 | .1440 | 43 | .0890 | 59 | .0410 | 75 | .0210 |
| 12 | .1890 | 28 | .1405 | 44 | .0860 | 60 | .0400 | 76 | .0200 |
| 13 | .1850 | 29 | .1360 | 45 | .0820 | 61 | .0390 | 77 | .0180 |
| 14 | .1820 | 30 | .1285 | 46 | .0810 | 62 | .0380 | 78 | .0160 |
| 15 | .1800 | 31 | .1200 | 47 | .0785 | 63 | .0370 | 79 | .0145 |
| 16 | .1770 | 32 | .1160 | 48 | .0760 | 64 | .0360 | 80 | .0135 |

# Photo 119



## LUBRICATION CHART FOR GORTON 16-B

# Photo 120



## PRECISION AUTOMATIC SCREW MACHINE

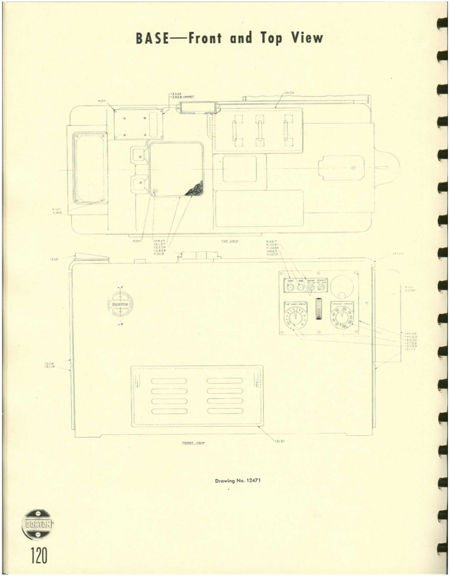
*SCHEDULE FOR LUBRICATION*

| | |
|---|---|
| ⊕ | Keep reservoir filled. Use Vacuoline Oil 1409. Close air vent to stop oil feed. |
| ■ | Grease once a week. |
| ⊗ | Oil twice a day. Use light machine oil. |
| ○ | Oil cam profiles. Use S. A. E. No. 40 oil once a day. |
| ● | *Oil twice a week. |
| ⬬ | Keep oil level up to plug. Use S. A. E. No. 40 oil. |
| □ | *Grease every 1000 hours. Do not over-grease. |
| ⦶ | Keep reservoir filled. Use S. A. E. No. 40 oil. |

*Consult spindle drive motor instruction card wired on drive motor for recommended motor bearing grease and oil.

Special Oil Filler Plug
See Graham Instruction
Book in Folder.

# Photo 121



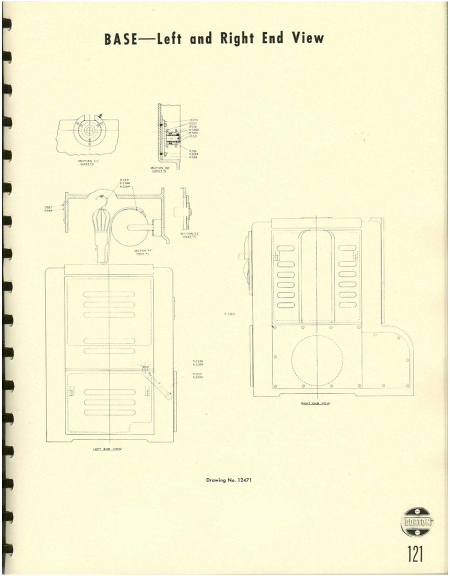
## BASE—Front and Top View

Drawing No. 12471

GORTON

120

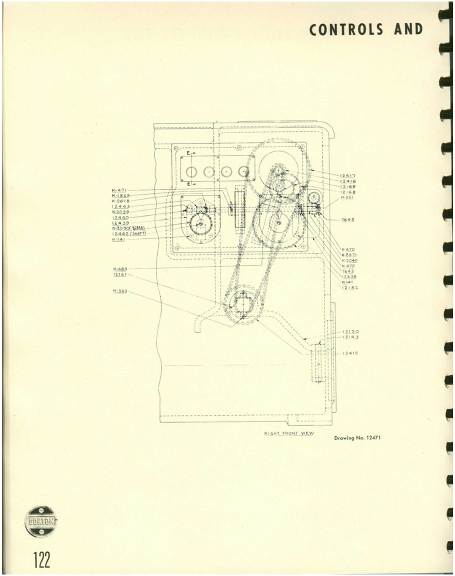
# Photo 122



## BASE—Left and Right End View

Drawing No. 12471

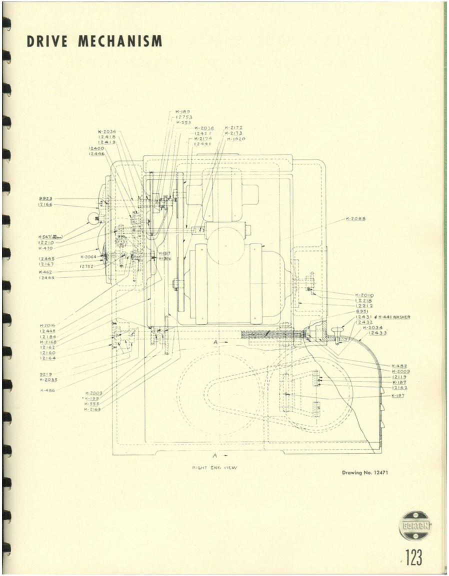
# Photo 123



## CONTROLS AND

Drawing No. 12471

# Photo 124

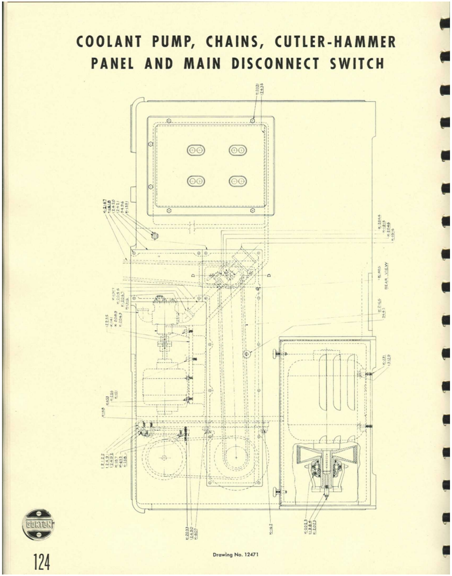


## DRIVE MECHANISM

Drawing No. 12471

123

# Photo 125

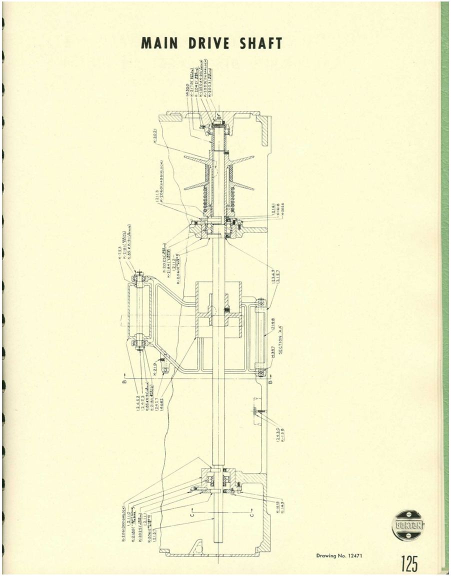


## COOLANT PUMP, CHAINS, CUTLER-HAMMER PANEL AND MAIN DISCONNECT SWITCH

Drawing No. 12471

124

# Photo 126

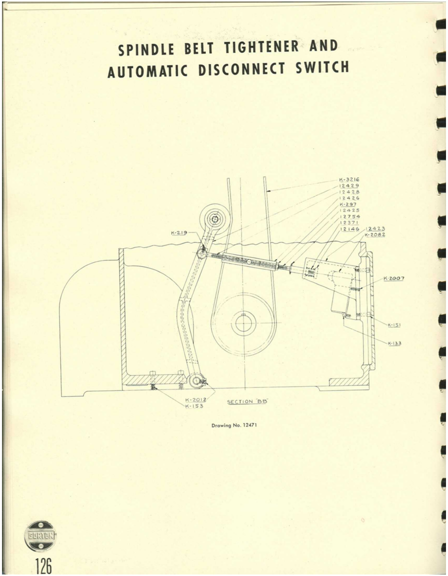


## MAIN DRIVE SHAFT

Drawing No. 12471

125

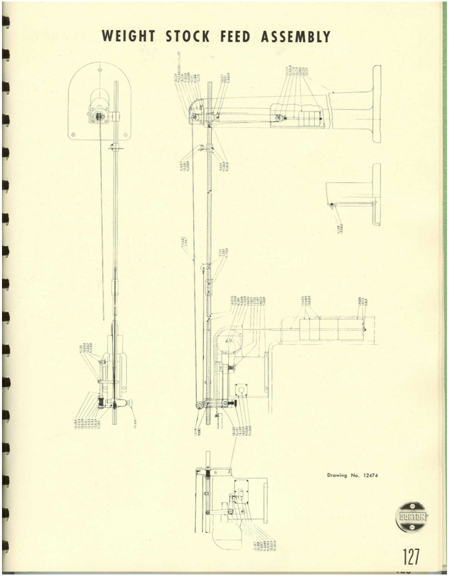
# Photo 127



## SPINDLE BELT TIGHTENER AND AUTOMATIC DISCONNECT SWITCH

Drawing No. 12471

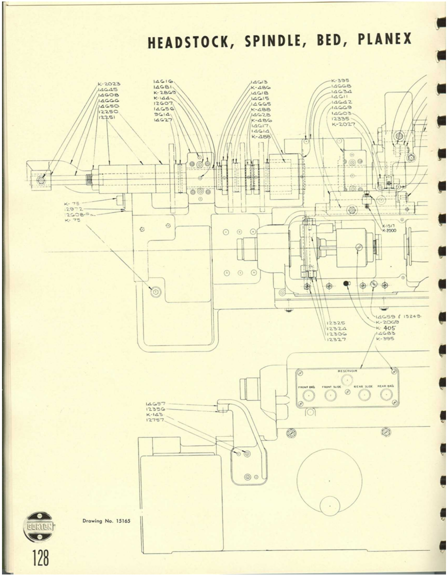
# Photo 128



## WEIGHT STOCK FEED ASSEMBLY

Drawing No. 12474

# Photo 129

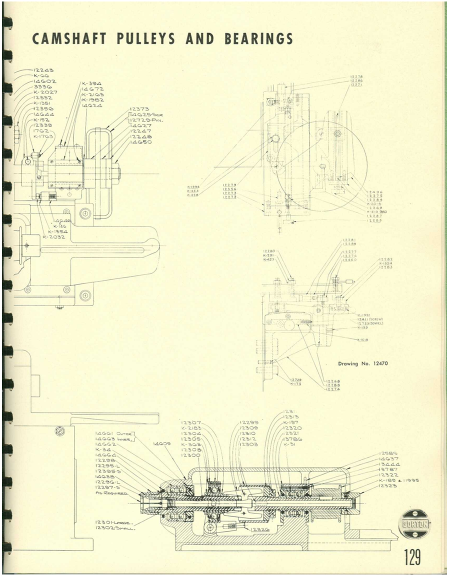


## HEADSTOCK, SPINDLE, BED, PLANEX

Drawing No. 15165

128

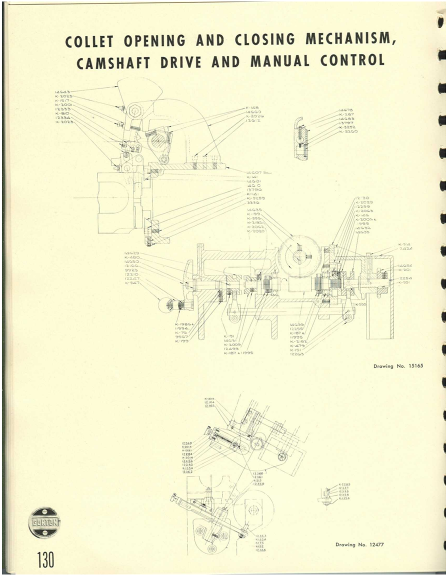
# Photo 130



## CAMSHAFT PULLEYS AND BEARINGS

Drawing No. 12470

# Photo 131



## COLLET OPENING AND CLOSING MECHANISM, CAMSHAFT DRIVE AND MANUAL CONTROL

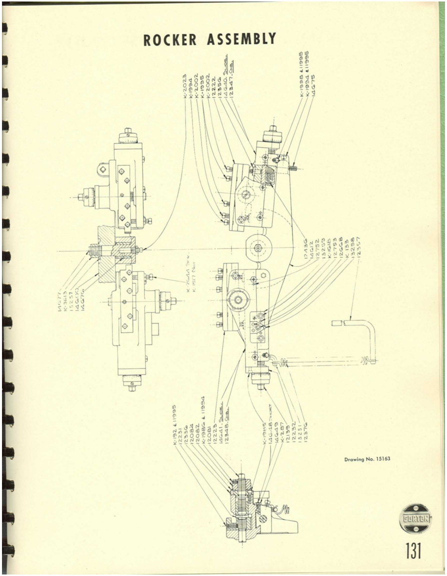
Drawing No. 15165

Drawing No. 12477

GORTON

130

# Photo 132

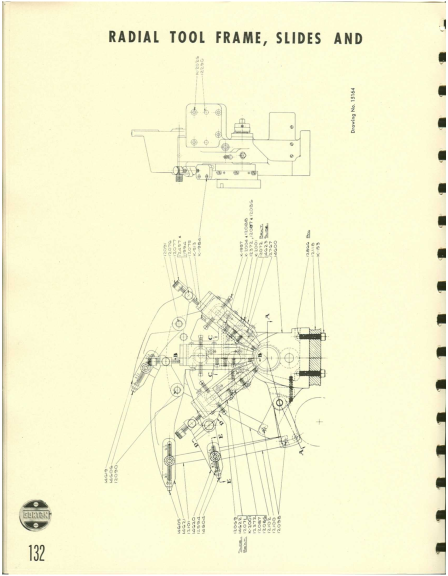


## ROCKER ASSEMBLY

Drawing No. 15163

131

# Photo 133

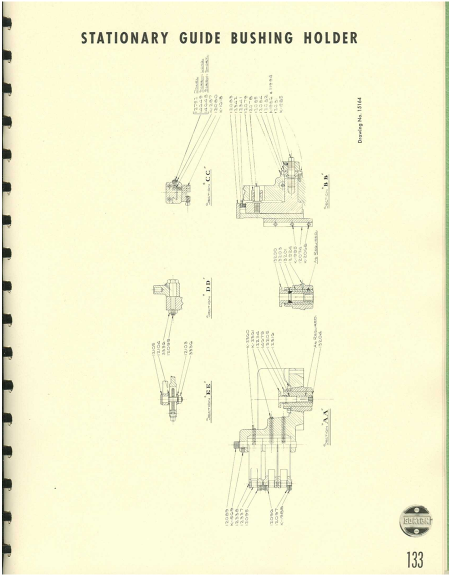


## RADIAL TOOL FRAME, SLIDES AND

Drawing No. 15164

132

# Photo 134

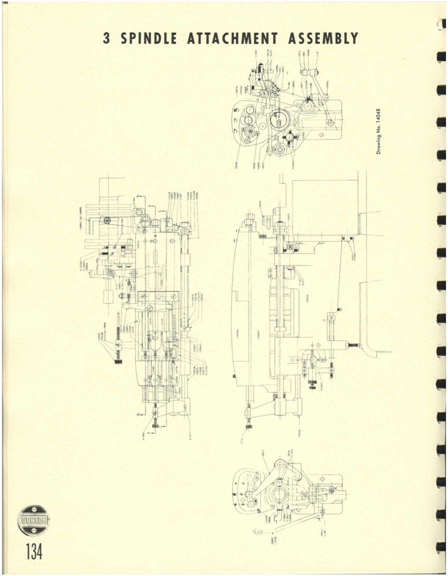


STATIONARY GUIDE BUSHING HOLDER

Drawing No. 15164

133

# Photo 135

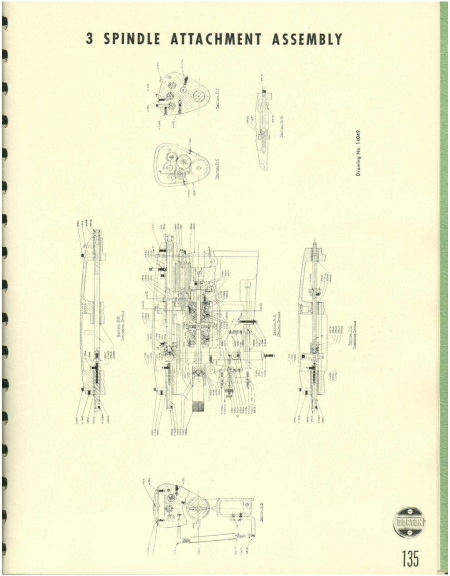


## 3 SPINDLE ATTACHMENT ASSEMBLY

Drawing No. 14048

134

# Photo 136

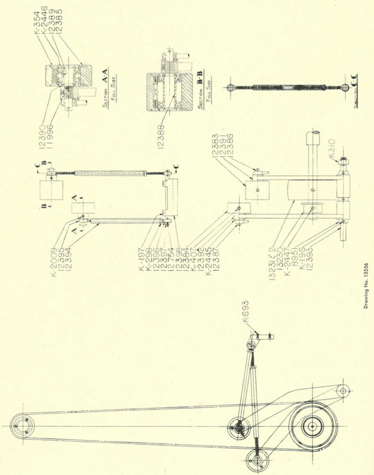


## 3 SPINDLE ATTACHMENT ASSEMBLY

Drawing No. 14049

# Photo 137

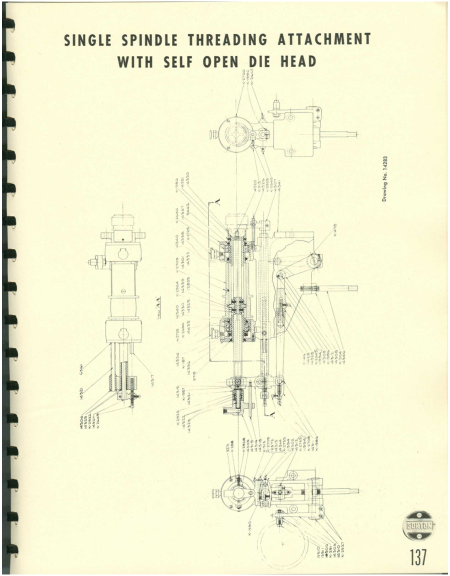
## BELT TIGHTENER ATTACHMENT ASSEMBLY



Drawing No. 15256

BURTON

# Photo 138

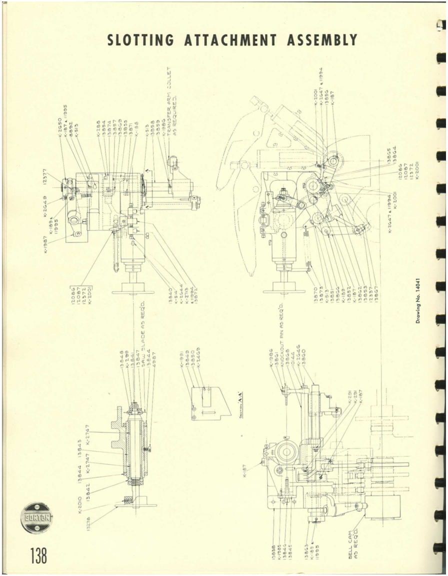


## SINGLE SPINDLE THREADING ATTACHMENT WITH SELF OPEN DIE HEAD

Drawing No. 14283

137

# Photo 139

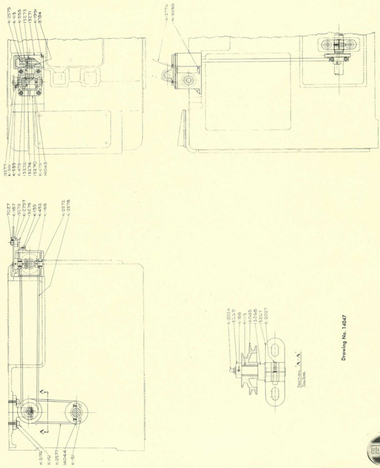


## SLOTTING ATTACHMENT ASSEMBLY

Drawing No. 14041

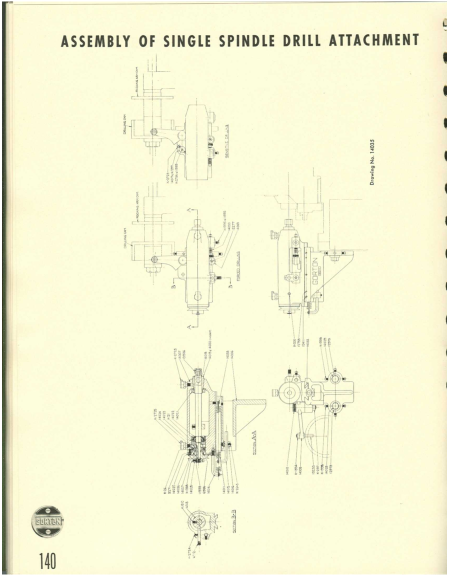
# Photo 140

## SLOTTING ATTACHMENT ASSEMBLY



Drawing No. 14047

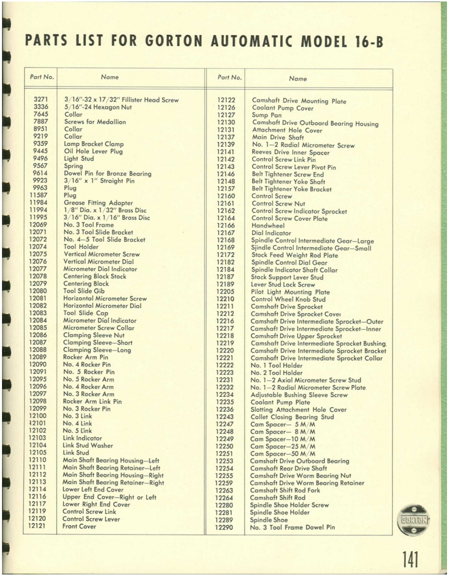
# Photo 141



ASSEMBLY OF SINGLE SPINDLE DRILL ATTACHMENT

140

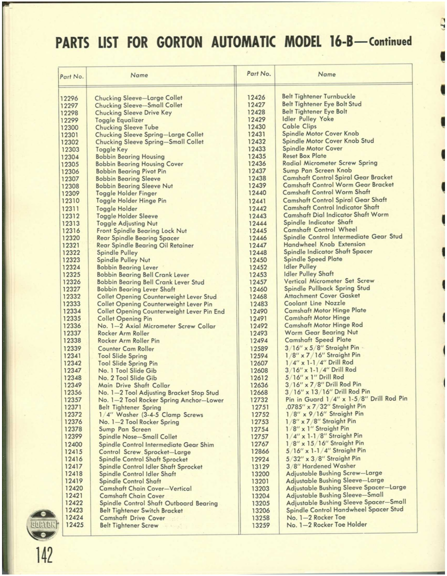
# Photo 142



## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B

| Part No. | Name | Part No. | Name |
|---|---|---|---|
| 3271 | 3/16″-32 x 17/32″ Fillister Head Screw | 12122 | Camshaft Drive Mounting Plate |
| 3336 | 5/16″-24 Hexagon Nut | 12126 | Coolant Pump Cover |
| 7645 | Collar | 12127 | Sump Pan |
| 7887 | Screws for Medallion | 12130 | Camshaft Drive Outboard Bearing Housing |
| 8951 | Collar | 12131 | Attachment Hole Cover |
| 9219 | Collar | 12137 | Main Drive Shaft |
| 9359 | Lamp Bracket Clamp | 12139 | No. 1–2 Radial Micrometer Screw |
| 9445 | Oil Hole Lever Plug | 12141 | Reeves Drive Inner Spacer |
| 9496 | Light Stud | 12142 | Control Screw Link Pin |
| 9567 | Spring | 12143 | Control Screw Lever Pivot Pin |
| 9614 | Dowel Pin for Bronze Bearing | 12146 | Belt Tightener Screw End |
| 9923 | 3/16″ x 1″ Straight Pin | 12148 | Belt Tightener Yoke Shaft |
| 9963 | Plug | 12157 | Belt Tightener Yoke Bracket |
| 11587 | Plug | 12160 | Control Screw |
| 11984 | Grease Fitting Adapter | 12161 | Control Screw Nut |
| 11994 | 1/8″ Dia. x 1/32″ Brass Disc | 12162 | Control Screw Indicator Sprocket |
| 11995 | 3/16″ Dia. x 1/16″ Brass Disc | 12164 | Control Screw Cover Plate |
| 12069 | No. 3 Tool Frame | 12166 | Handwheel |
| 12071 | No. 3 Tool Slide Bracket | 12167 | Dial Indicator |
| 12072 | No. 4–5 Tool Slide Bracket | 12168 | Spindle Control Intermediate Gear–Large |
| 12074 | Tool Holder | 12169 | Sjindle Control Intermediate Gear–Small |
| 12075 | Vertical Micrometer Screw | 12172 | Stock Feed Weight Rod Plate |
| 12076 | Vertical Micrometer Dial | 12182 | Spindle Control Dial Gear |
| 12077 | Micrometer Dial Indicator | 12184 | Spindle Indicator Shaft Collar |
| 12078 | Centering Block Stock | 12187 | Stock Support Lever Stud |
| 12079 | Centering Block | 12189 | Lever Stud Lock Screw |
| 12080 | Tool Slide Gib | 12205 | Pilot Light Mounting Plate |
| 12081 | Horizontal Micrometer Screw | 12210 | Control Wheel Knob Stud |
| 12082 | Horizontal Micrometer Dial | 12211 | Camshaft Drive Sprocket |
| 12083 | Tool Slide Cap | 12212 | Camshaft Drive Sprocket Cover |
| 12084 | Micrometer Dial Indicator | 12216 | Camshaft Drive Intermediate Sprocket–Outer |
| 12085 | Micrometer Screw Collar | 12217 | Camshaft Drive Intermediate Sprocket–Inner |
| 12086 | Clamping Sleeve Nut | 12218 | Camshaft Drive Upper Sprocket |
| 12087 | Clamping Sleeve–Short | 12219 | Camshaft Drive Intermediate Sprocket Bushing. |
| 12088 | Clamping Sleeve–Long | 12220 | Camshaft Drive Intermediate Sprocket Bracket |
| 12089 | Rocker Arm Pin | 12221 | Camshaft Drive Intermediate Sprocket Collar |
| 12090 | No. 4 Rocker Pin | 12222 | No. 1 Tool Holder |
| 12091 | No. 5 Rocker Pin | 12223 | No. 2 Tool Holder |
| 12095 | No. 5 Rocker Arm | 12231 | No. 1–2 Axial Micrometer Screw Stud |
| 12096 | No. 4 Rocker Arm | 12232 | No. 1–2 Radial Micrometer Screw Plate |
| 12097 | No. 3 Rocker Arm | 12234 | Adjustable Bushing Sleeve Screw |
| 12098 | Rocker Arm Link Pin | 12235 | Coolant Pump Plate |
| 12099 | No. 3 Rocker Pin | 12236 | Slotting Attachment Hole Cover |
| 12100 | No. 3 Link | 12243 | Collet Closing Bearing Stud |
| 12101 | No. 4 Link | 12247 | Cam Spacer– 5 M/M |
| 12102 | No. 5 Link | 12248 | Cam Spacer– 8 M/M |
| 12103 | Link Indicator | 12249 | Cam Spacer–10 M/M |
| 12104 | Link Stud Washer | 12250 | Cam Spacer–25 M/M |
| 12105 | Link Stud | 12251 | Cam Spacer–50 M/M |
| 12110 | Main Shaft Bearing Housing–Left | 12253 | Camshaft Drive Outboard Bearing |
| 12111 | Main Shaft Bearing Retainer–Left | 12254 | Camshaft Rear Drive Shaft |
| 12112 | Main Shaft Bearing Housing–Right | 12255 | Camshaft Drive Worm Bearing Nut |
| 12113 | Main Shaft Bearing Retainer–Right | 12259 | Camshaft Drive Worm Bearing Retainer |
| 12114 | Lower Left End Cover | 12263 | Camshaft Shift Rod Fork |
| 12116 | Upper End Cover–Right or Left | 12264 | Camshaft Shift Rod |
| 12117 | Lower Right End Cover | 12280 | Spindle Shoe Holder Screw |
| 12119 | Control Screw Link | 12281 | Spindle Shoe Holder |
| 12120 | Control Screw Lever | 12289 | Spindle Shoe |
| 12121 | Front Cover | 12290 | No. 3 Tool Frame Dowel Pin |

# Photo 143

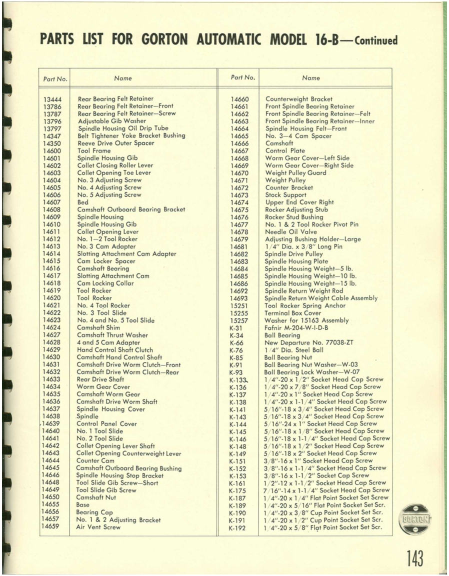


## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B—Continued

| Part No. | Name | Part No. | Name |
|---|---|---|---|
| 12296 | Chucking Sleeve—Large Collet | 12426 | Belt Tightener Turnbuckle |
| 12297 | Chucking Sleeve—Small Collet | 12427 | Belt Tightener Eye Bolt Stud |
| 12298 | Chucking Sleeve Drive Key | 12428 | Belt Tightener Eye Bolt |
| 12299 | Toggle Equalizer | 12429 | Idler Pulley Yoke |
| 12300 | Chucking Sleeve Tube | 12430 | Cable Clips |
| 12301 | Chucking Sleeve Spring—Large Collet | 12431 | Spindle Motor Cover Knob |
| 12302 | Chucking Sleeve Spring—Small Collet | 12432 | Spindle Motor Cover Knob Stud |
| 12303 | Toggle Key | 12433 | Spindle Motor Cover |
| 12304 | Bobbin Bearing Housing | 12435 | Reset Box Plate |
| 12305 | Bobbin Bearing Housing Cover | 12436 | Radial Micrometer Screw Spring |
| 12306 | Bobbin Bearing Pivot Pin | 12437 | Sump Pan Screen Knob |
| 12307 | Bobbin Bearing Sleeve | 12438 | Camshaft Control Spiral Gear Bracket |
| 12308 | Bobbin Bearing Sleeve Nut | 12439 | Camshaft Control Worm Gear Bracket |
| 12309 | Toggle Holder Finger | 12440 | Camshaft Control Worm Shaft |
| 12310 | Toggle Holder Hinge Pin | 12441 | Camshaft Control Spiral Gear Shaft |
| 12311 | Toggle Holder | 12442 | Camshaft Control Indicator Shaft |
| 12312 | Toggle Holder Sleeve | 12443 | Camshaft Dial Indicator Shaft Worm |
| 12313 | Toggle Adjusting Nut | 12444 | Spindle Indicator Shaft |
| 12316 | Front Spindle Bearing Lock Nut | 12445 | Camshaft Control Wheel |
| 12320 | Rear Spindle Bearing Spacer | 12446 | Spindle Control Intermediate Gear Stud |
| 12321 | Rear Spindle Bearing Oil Retainer | 12447 | Handwheel Knob Extension |
| 12322 | Spindle Pulley | 12448 | Spindle Indicator Shaft Spacer |
| 12323 | Spindle Pulley Nut | 12450 | Spindle Speed Plate |
| 12324 | Bobbin Bearing Lever | 12452 | Idler Pulley |
| 12325 | Bobbin Bearing Bell Crank Lever | 12453 | Idler Pulley Shaft |
| 12326 | Bobbin Bearing Bell Crank Lever Stud | 12457 | Vertical Micrometer Set Screw |
| 12327 | Bobbin Bearing Lever Shaft | 12460 | Spindle Pullback Spring Stud |
| 12332 | Collet Opening Counterweight Lever Stud | 12468 | Attachment Cover Gasket |
| 12333 | Collet Opening Counterweight Lever Pin | 12483 | Coolant Line Nozzle |
| 12334 | Collet Opening Counterweight Lever Pin End | 12490 | Camshaft Motor Hinge Plate |
| 12335 | Collet Opening Pin | 12491 | Camshaft Motor Hinge |
| 12336 | No. 1—2 Axial Micrometer Screw Collar | 12492 | Camshaft Motor Hinge Rod |
| 12337 | Rocker Arm Roller | 12493 | Worm Gear Bearing Nut |
| 12338 | Rocker Arm Roller Pin | 12494 | Camshaft Speed Plate |
| 12339 | Counter Cam Roller | 12589 | 3/16″ x 5/8″ Straight Pin |
| 12341 | Tool Slide Spring | 12594 | 1/8″ x 7/16″ Straight Pin |
| 12342 | Tool Slide Spring Pin | 12607 | 1/4″ x 1-1/4″ Drill Rod |
| 12347 | No. 1 Tool Slide Gib | 12608 | 3/16″ x 1-1/4″ Drill Rod |
| 12348 | No. 2 Tool Slide Gib | 12612 | 5/16″ x 1″ Drill Rod |
| 12349 | Main Drive Shaft Collar | 12636 | 3/16″ x 7/8″ Drill Rod Pin |
| 12356 | No. 1—2 Tool Adjusting Bracket Stop Stud | 12668 | 3/16″ x 13/16″ Drill Rod Pin |
| 12357 | No. 1—2 Tool Rocker Spring Anchor—Lower | 12732 | Pin in Guard 1/4″ x 1-5/8″ Drill Rod Pin |
| 12371 | Belt Tightener Spring | 12751 | .0785″ x 7/32″ Straight Pin |
| 12372 | 1/4″ Washer (3-4-5 Clamp Screws | 12752 | 1/8″ x 9/16″ Straight Pin |
| 12376 | No. 1—2 Tool Rocker Spring | 12753 | 1/8″ x 7/8″ Straight Pin |
| 12378 | Sump Pan Screen | 12754 | 1/8″ x 1″ Straight Pin |
| 12399 | Spindle Nose—Small Collet | 12757 | 1/4″ x 1-1/8″ Straight Pin |
| 12400 | Spindle Control Intermediate Gear Shim | 12767 | 1/8″ x 15/16″ Straight Pin |
| 12415 | Control Screw Sprocket—Large | 12866 | 5/16″ x 1-1/4″ Straight Pin |
| 12416 | Spindle Control Shaft Sprocket | 12924 | 5/32″ x 3/8″ Straight Pin |
| 12417 | Spindle Control Idler Shaft Sprocket | 13129 | 3/8″ Hardened Washer |
| 12418 | Spindle Control Idler Shaft | 13200 | Adjustable Bushing Screw—Large |
| 12419 | Spindle Control Shaft | 13201 | Adjustable Bushing Sleeve—Large |
| 12420 | Camshaft Chain Cover—Vertical | 13203 | Adjustable Bushing Sleeve Spacer—Large |
| 12421 | Camshaft Chain Cover | 13204 | Adjustable Bushing Sleeve—Small |
| 12422 | Spindle Control Shaft Outboard Bearing | 13205 | Adjustable Bushing Sleeve Spacer—Small |
| 12423 | Belt Tightener Switch Bracket | 13206 | Spindle Control Handwheel Spacer Stud |
| 12424 | Camshaft Drive Cover | 13258 | No. 1—2 Rocker Toe |
| 12425 | Belt Tightener Screw | 13259 | No. 1—2 Rocker Toe Holder |

142

# Photo 144



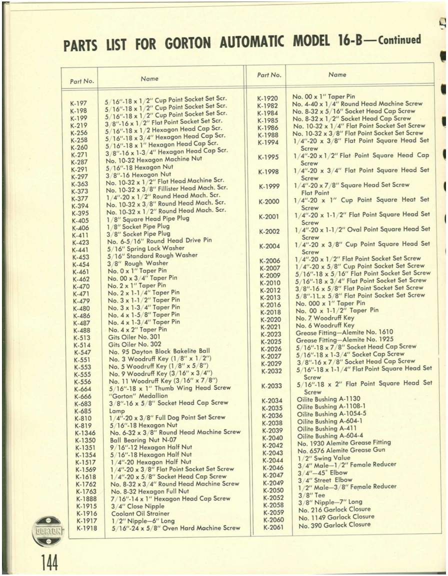
## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B—Continued

| Part No. | Name | Part No. | Name |
|---|---|---|---|
| 13444 | Rear Bearing Felt Retainer | 14660 | Counterweight Bracket |
| 13786 | Rear Bearing Felt Retainer—Front | 14661 | Front Spindle Bearing Retainer |
| 13787 | Rear Bearing Felt Retainer—Screw | 14662 | Front Spindle Bearing Retainer—Felt |
| 13796 | Adjustable Gib Washer | 14663 | Front Spindle Bearing Retainer—Inner |
| 13797 | Spindle Housing Oil Drip Tube | 14664 | Spindle Housing Felt—Front |
| 14347 | Belt Tightener Yoke Bracket Bushing | 14665 | No. 3—4 Cam Spacer |
| 14350 | Reeve Drive Outer Spacer | 14666 | Camshaft |
| 14600 | Tool Frame | 14667 | Control Plate |
| 14601 | Spindle Housing Gib | 14668 | Worm Gear Cover—Left Side |
| 14602 | Collet Closing Roller Lever | 14669 | Worm Gear Cover—Right Side |
| 14603 | Collet Opening Toe Lever | 14670 | Weight Pulley Guard |
| 14604 | No. 3 Adjusting Screw | 14671 | Weight Pulley |
| 14605 | No. 4 Adjusting Screw | 14672 | Counter Bracket |
| 14606 | No. 5 Adjusting Screw | 14673 | Stock Support |
| 14607 | Bed | 14674 | Upper End Cover Right |
| 14608 | Camshaft Outboard Bearing Bracket | 14675 | Rocker Adjusting Stub |
| 14609 | Spindle Housing | 14676 | Rocker Stud Bushing |
| 14610 | Spindle Housing Gib | 14677 | No. 1 & 2 Tool Rocker Pivot Pin |
| 14611 | Collet Opening Lever | 14678 | Needle Oil Valve |
| 14612 | No. 1—2 Tool Rocker | 14679 | Adjusting Bushing Holder—Large |
| 14613 | No. 3 Cam Adapter | 14681 | 1/4" Dia. x 3/8" Long Pin |
| 14614 | Slotting Attachment Cam Adapter | 14682 | Spindle Drive Pulley |
| 14615 | Cam Locker Spacer | 14683 | Spindle Housing Plate |
| 14616 | Camshaft Bearing | 14684 | Spindle Housing Weight—5 lb. |
| 14617 | Slotting Attachment Cam | 14685 | Spindle Housing Weight—10 lb. |
| 14618 | Cam Locking Collar | 14686 | Spindle Housing Weight—15 lb. |
| 14619 | Tool Rocker | 14692 | Spindle Return Weight Rod |
| 14620 | Tool Rocker | 14693 | Spindle Return Weight Cable Assembly |
| 14621 | No. 4 Tool Rocker | 15251 | Tool Rocker Spring Anchor |
| 14622 | No. 3 Tool Slide | 15255 | Terminal Box Cover |
| 14623 | No. 4 and No. 5 Tool Slide | 15257 | Washer for 15163 Assembly |
| 14624 | Camshaft Shim | K-31 | Fafnir M-204-W-I-D-B |
| 14627 | Camshaft Thrust Washer | K-34 | Ball Bearing |
| 14628 | 4 and 5 Cam Adapter | K-66 | New Departure No. 77038-ZT |
| 14629 | Hand Control Shaft Clutch | K-76 | 1/4" Dia. Steel Ball |
| 14630 | Camshaft Hand Control Shaft | K-85 | Ball Bearing Nut |
| 14631 | Camshaft Drive Worm Clutch—Front | K-91 | Ball Bearing Nut Washer—W-03 |
| 14632 | Camshaft Drive Worm Clutch—Rear | K-93 | Ball Bearing Lock Washer—W-07 |
| 14633 | Rear Drive Shaft | K-133 | 1/4"-20 x 1/2" Socket Head Cap Screw |
| 14634 | Worm Gear Cover | K-136 | 1/4"-20 x 7/8" Socket Head Cap Screw |
| 14635 | Camshaft Worm Gear | K-137 | 1/4"-20 x 1" Socket Head Cap Screw |
| 14636 | Camshaft Drive Worm Shaft | K-138 | 1/4"-20 x 1-1/4" Socket Head Cap Screw |
| 14637 | Spindle Housing Cover | K-141 | 5/16"-18 x 3/4" Socket Head Cap Screw |
| 14638 | Spindle | K-143 | 5/16"-18 x 3/4" Socket Head Cap Screw |
| 14639 | Control Panel Cover | K-144 | 5/16"-24 x 1" Socket Head Cap Screw |
| 14640 | No. 1 Tool Slide | K-145 | 5/16"-18 x 1/8" Socket Head Cap Screw |
| 14641 | No. 2 Tool Slide | K-146 | 5/16"-18 x 1-1/4" Socket Head Cap Screw |
| 14642 | Collet Opening Lever Shaft | K-148 | 5/16"-18 x 1/2" Socket Head Cap Screw |
| 14643 | Collet Opening Counterweight Lever | K-149 | 5/16"-18 x 2" Socket Head Cap Screw |
| 14644 | Counter Cam | K-151 | 3/8"-16 x 1" Socket Head Cap Screw |
| 14645 | Camshaft Outboard Bearing Bushing | K-152 | 3/8"-16 x 1-1/4" Socket Head Cap Screw |
| 14646 | Spindle Housing Stop Bracket | K-153 | 3/8"-16 x 1-1/2" Socket Cap Screw |
| 14648 | Tool Slide Gib Screw—Short | K-161 | 1/2"-12 x 1-1/2" Socket Head Cap Screw |
| 14649 | Tool Slide Gib Screw | K-175 | 7/16"-14 x 1-1/4" Socket Head Cap Screw |
| 14650 | Camshaft Nut | K-187 | 1/4"-20 x 1/4" Flat Point Socket Set Screw |
| 14655 | Base | K-189 | 1/4"-20 x 5/16" Flat Point Socket Set Scr. |
| 14656 | Bearing Cap | K-190 | 1/4"-20 x 3/8" Cup Point Socket Set Scr. |
| 14657 | No. 1 & 2 Adjusting Bracket | K-191 | 1/4"-20 x 1/2" Cup Point Socket Set Scr. |
| 14659 | Air Vent Screw | K-192 | 1/4"-20 x 5/8" Flat Point Socket Set Scr. |

GORTON

143

# Photo 145

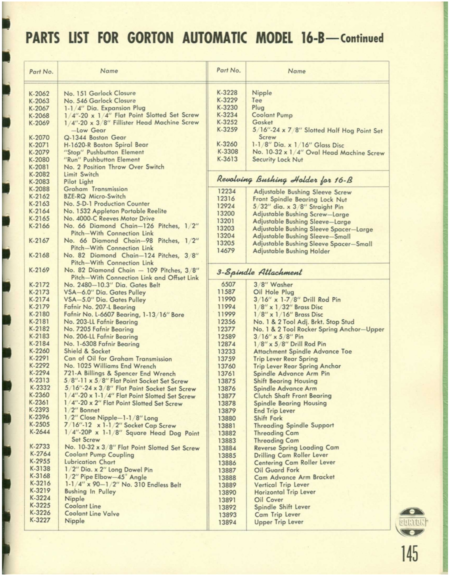


## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B—Continued

| Part No. | Name |
|---|---|
| K-197 | 5/16″-18 x 1/2″ Cup Point Socket Set Scr. |
| K-198 | 5/16″-18 x 1/2″ Cup Point Socket Set Scr. |
| K-199 | 5/16″-18 x 1/2″ Cup Point Socket Set Scr. |
| K-219 | 3/8″-16 x 1/2″ Flat Point Socket Set Scr. |
| K-256 | 5/16″-18 x 1/2 Hexagon Head Cap Scr. |
| K-258 | 5/16″-18 x 3/4″ Hexagon Head Cap Scr. |
| K-260 | 5/16″-18 x 1″ Hexagon Head Cap Scr. |
| K-271 | 3/8″-16 x 1-3/4″ Hexagon Head Cap Scr. |
| K-287 | No. 10-32 Hexagon Machine Nut |
| K-291 | 5/16″-18 Hexagon Nut |
| K-297 | 3/8″-16 Hexagon Nut |
| K-363 | No. 10-32 x 1/2″ Flat Head Machine Scr. |
| K-373 | No. 10-32 x 3/8″ Fillister Head Mach. Scr. |
| K-377 | 1/4″-20 x 1/2″ Round Head Mach. Scr. |
| K-394 | No. 10-32 x 3/8″ Round Head Mach. Scr. |
| K-395 | No. 10-32 x 1/2″ Round Head Mach. Scr. |
| K-405 | 1/8″ Square Head Pipe Plug |
| K-406 | 1/8″ Socket Pipe Plug |
| K-411 | 3/8″ Socket Pipe Plug |
| K-423 | No. 6-5/16″ Round Head Drive Pin |
| K-441 | 5/16″ Spring Lock Washer |
| K-453 | 5/16″ Standard Rough Washer |
| K-454 | 3/8″ Rough Washer |
| K-461 | No. 0 x 1″ Taper Pin |
| K-462 | No. 00 x 3/4″ Taper Pin |
| K-470 | No. 2 x 1″ Taper Pin |
| K-471 | No. 2 x 1-1/4″ Taper Pin |
| K-479 | No. 3 x 1-1/2″ Taper Pin |
| K-480 | No. 3 x 1-3/4″ Taper Pin |
| K-486 | No. 4 x 1-5/8″ Taper Pin |
| K-487 | No. 4 x 1-3/4″ Taper Pin |
| K-488 | No. 4 x 2″ Taper Pin |
| K-513 | Gits Oiler No. 301 |
| K-514 | Gits Oiler No. 302 |
| K-547 | No. 95 Dayton Block Bakelite Ball |
| K-551 | No. 3 Woodruff Key (1/8″ x 1/2″) |
| K-553 | No. 5 Woodruff Key (1/8″ x 5/8″) |
| K-555 | No. 9 Woodruff Key (3/16″ x 3/4″) |
| K-556 | No. 11 Woodruff Key (3/16″ x 7/8″) |
| K-664 | 5/16″-18 x 1″ Thumb Wing Head Screw |
| K-666 | "Gorton" Medallion |
| K-683 | 3/8″-16 x 5/8″ Socket Head Cap Screw |
| K-685 | Lamp |
| K-810 | 1/4″-20 x 3/8″ Full Dog Point Set Screw |
| K-819 | 5/16″-18 Hexagon Nut |
| K-1346 | No. 6-32 x 3/8″ Round Head Machine Screw |
| K-1350 | Ball Bearing Nut N-07 |
| K-1351 | 9/16″-12 Hexagon Half Nut |
| K-1354 | 5/16″-18 Hexagon Half Nut |
| K-1517 | 1/4″-20 Hexagon Half Nut |
| K-1569 | 1/4″-20 x 3/8″ Flat Point Socket Set Screw |
| K-1618 | 1/4″-20 x 5/8″ Socket Head Cap Screw |
| K-1762 | No. 8-32 x 3/4″ Round Head Machine Screw |
| K-1763 | No. 8-32 Hexagon Full Nut |
| K-1888 | 7/16″-14 x 1″ Hexagon Head Cap Screw |
| K-1915 | 3/4″ Close Nipple |
| K-1916 | Coolant Oil Strainer |
| K-1917 | 1/2″ Nipple—6″ Long |
| K-1918 | 5/16″-24 x 5/8″ Oven Hard Machine Screw |

| Part No. | Name |
|---|---|
| K-1920 | No. 00 x 1″ Taper Pin |
| K-1982 | No. 4-40 x 1/4″ Round Head Machine Screw |
| K-1984 | No. 8-32 x 5/16″ Socket Head Cap Screw |
| K-1985 | No. 8-32 x 1/2″ Socket Head Cap Screw |
| K-1986 | No. 10-32 x 1/4″ Flat Point Socket Set Screw |
| K-1988 | No. 10-32 x 3/8″ Flat Point Socket Set Screw |
| K-1994 | 1/4″-20 x 3/8″ Flat Point Square Head Set Screw |
| K-1995 | 1/4″-20 x 1/2″ Flat Point Square Head Cap Screw |
| K-1998 | 1/4″-20 x 3/4″ Flat Point Square Head Set Screw |
| K-1999 | 1/4″-20 x 7/8″ Square Head Set Screw Flat Paint |
| K-2000 | 1/4″-20 x 1″ Cup Point Square Heat Set Screw |
| K-2001 | 1/4″-20 x 1-1/2″ Flat Point Square Head Set Screw |
| K-2002 | 1/4″-20 x 1-1/2″ Oval Point Square Head Set Screw |
| K-2004 | 1/4″-20 x 3/8″ Cup Point Square Head Set Screw |
| K-2006 | 1/4″-20 x 1/2″ Flat Point Socket Set Screw |
| K-2007 | 1/4″-20 x 5/8″ Cup Point Socket Set Screw |
| K-2009 | 5/16″-18 x 5/16″ Flat Point Socket Set Screw |
| K-2010 | 5/16″-18 x 3/4″ Flat Point Socket Set Screw |
| K-2012 | 3/8″-16 x 5/8″ Flat Point Socket Set Screw |
| K-2013 | 5/8″-11 x 5/8″ Flat Point Socket Set Screw |
| K-2016 | No. 000 x 1″ Taper Pin |
| K-2018 | No. 00 x 1-1/2″ Taper Pin |
| K-2020 | No. 7 Woodruff Key |
| K-2021 | No. 6 Woodruff Key |
| K-2023 | Grease Fitting—Alemite No. 1610 |
| K-2025 | Grease Fitting—Alemite No. 1925 |
| K-2026 | 5/16″-18 x 7/8″ Socket Head Cap Screw |
| K-2027 | 5/16″-18 x 1-3/4″ Socket Cap Screw |
| K-2029 | 3/8″-16 x 7/8″ Socket Head Cap Screw |
| K-2032 | 5/16″-18 x 1-1/4″ Flat Point Square Head Set Screw |
| K-2033 | 5/16″-18 x 2″ Flat Point Square Head Set Screw |
| K-2034 | Oilite Bushing A-1130 |
| K-2035 | Oilite Bushing A-1108-1 |
| K-2036 | Oilite Bushing A-1054-5 |
| K-2038 | Oilite Bushing A-604-1 |
| K-2039 | Oilite Bushing A-411 |
| K-2040 | Oilite Bushing A-604-4 |
| K-2042 | No. 1930 Alemite Grease Fitting |
| K-2043 | No. 6576 Alemite Grease Gun |
| K-2044 | 1/2″ Swing Value |
| K-2046 | 3/4″ Male—1/2″ Female Reducer |
| K-2047 | 3/4″—45° Elbow |
| K-2049 | 3/4″ Street Elbow |
| K-2050 | 1/2″ Male—3/8″ Female Reducer |
| K-2052 | 3/8″ Tee |
| K-2058 | 3/8″ Nipple—7″ Long |
| K-2059 | No. 216 Garlock Closure |
| K-2060 | No. 1149 Garlock Closure |
| K-2061 | No. 390 Garlock Closure |

# Photo 146



## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B—Continued

| Part No. | Name |
|---|---|
| K-2062 | No. 151 Garlock Closure |
| K-2063 | No. 546 Garlock Closure |
| K-2067 | 1-1/4″ Dia. Expansion Plug |
| K-2068 | 1/4″-20 x 1/4″ Flat Point Slotted Set Screw |
| K-2069 | 1/4″-20 x 3/8″ Fillister Head Machine Screw —Low Gear |
| K-2070 | Q-1344 Boston Gear |
| K-2071 | H-1620-R Boston Spiral Bear |
| K-2079 | "Stop" Pushbutton Element |
| K-2080 | "Run" Pushbutton Element |
| K-2081 | No. 2 Position Throw Over Switch |
| K-2082 | Limit Switch |
| K-2083 | Pilot Light |
| K-2088 | Graham Transmission |
| K-2162 | BZE-RQ Micro-Switch |
| K-2163 | No. 5-D-1 Production Counter |
| K-2164 | No. 1532 Appleton Portable Reelite |
| K-2165 | No. 4000-C Reeves Motor Drive |
| K-2166 | No. 66 Diamond Chain—126 Pitches, 1/2″ Pitch—With Connection Link |
| K-2167 | No. 66 Diamond Chain—98 Pitches, 1/2″ Pitch—With Connection Link |
| K-2168 | No. 82 Diamond Chain—124 Pitches, 3/8″ Pitch—With Connection Link |
| K-2169 | No. 82 Diamond Chain — 109 Pitches, 3/8″ Pitch—With Connection Link and Offset Link |
| K-2172 | No. 2480—10.3″ Dia. Gates Belt |
| K-2173 | VSA—6.0″ Dia. Gates Pulley |
| K-2174 | VSA—5.0″ Dia. Gates Pulley |
| K-2179 | Fafnir No. 207-L Bearing |
| K-2180 | Fafnir No. L-6607 Bearing, 1-13/16″ Bore |
| K-2181 | No. 203-LL Fafnir Bearing |
| K-2182 | No. 7205 Fafnir Bearing |
| K-2183 | No. 206-LL Fafnir Bearing |
| K-2184 | No. 1-6308 Fafnir Bearing |
| K-2260 | Shield & Socket |
| K-2291 | Can of Oil for Graham Transmission |
| K-2292 | No. 1025 Williams End Wrench |
| K-2294 | 721-A Billings & Spencer End Wrench |
| K-2313 | 5/8″-11 x 5/8″ Flat Point Socket Set Screw |
| K-2332 | 5/16″-24 x 3/8″ Flat Paint Socket Set Screw |
| K-2360 | 1/4″-20 x 1-1/4″ Flat Point Slotted Set Screw |
| K-2361 | 1/4″-20 x 2″ Flat Point Slotted Set Screw |
| K-2393 | 1/2″ Bonnet |
| K-2396 | 1/2″ Close Nipple—1-1/8″ Long |
| K-2505 | 7/16″-12 x 1-1/2″ Socket Cap Screw |
| K-2644 | 1/4″-20P x 1-1/8″ Square Head Dog Point Set Screw |
| K-2733 | No. 10-32 x 3/8″ Flat Point Slotted Set Screw |
| K-2764 | Coolant Pump Coupling |
| K-2955 | Lubrication Chart |
| K-3138 | 1/2″ Dia. x 2″ Long Dowel Pin |
| K-3168 | 1/2″ Pipe Elbow—45° Angle |
| K-3216 | 1-1/4″ x 90—1/2″ No. 310 Endless Belt |
| K-3219 | Bushing In Pulley |
| K-3224 | Nipple |
| K-3225 | Coolant Line |
| K-3226 | Coolant Line Valve |
| K-3227 | Nipple |
| K-3228 | Nipple |
| K-3229 | Tee |
| K-3230 | Plug |
| K-3234 | Coolant Pump |
| K-3252 | Gasket |
| K-3259 | 5/16″-24 x 7/8″ Slotted Half Hog Point Set Screw |
| K-3260 | 1-1/8″ Dia. x 1/16″ Glass Disc |
| K-3308 | No. 10-32 x 1/4″ Oval Head Machine Screw |
| K-3613 | Security Lock Nut |

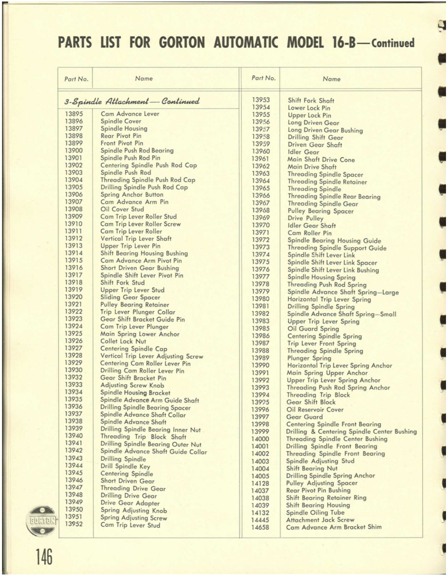
### *Revolving Bushing Holder for 16-B*

| | |
|---|---|
| 12234 | Adjustable Bushing Sleeve Screw |
| 12316 | Front Spindle Bearing Lock Nut |
| 12924 | 5/32″ dia. x 3/8″ Straight Pin |
| 13200 | Adjustable Bushing Screw—Large |
| 13201 | Adjustable Bushing Sleeve—Large |
| 13203 | Adjustable Bushing Sleeve Spacer—Large |
| 13204 | Adjustable Bushing Sleeve—Small |
| 13205 | Adjustable Bushing Sleeve Spacer—Small |
| 14679 | Adjustable Bushing Holder |

### *3-Spindle Attachment*

| | |
|---|---|
| 6507 | 3/8″ Washer |
| 11587 | Oil Hole Plug |
| 11990 | 3/16″ x 1-7/8″ Drill Rod Pin |
| 11994 | 1/8″ x 1/32″ Brass Disc |
| 11999 | 1/8″ x 1/16″ Brass Disc |
| 12356 | No. 1 & 2 Tool Adj. Brkt. Stop Stud |
| 12377 | No. 1 & 2 Tool Rocker Spring Anchor—Upper |
| 12589 | 3/16″ x 5/8″ Pin |
| 12874 | 1/8″ x 5/8″ Drill Rod Pin |
| 13233 | Attachment Spindle Advance Toe |
| 13759 | Trip Lever Rear Spring |
| 13760 | Trip Lever Rear Spring Anchor |
| 13761 | Spindle Advance Arm Pin |
| 13875 | Shift Bearing Housing |
| 13876 | Spindle Advance Arm |
| 13877 | Clutch Shaft Front Bearing |
| 13878 | Spindle Bearing Housing |
| 13879 | End Trip Lever |
| 13880 | Shift Fork |
| 13881 | Threading Spindle Support |
| 13882 | Threading Cam |
| 13883 | Threading Cam |
| 13884 | Reverse Spring Loading Cam |
| 13885 | Drilling Cam Roller Lever |
| 13886 | Centering Cam Roller Lever |
| 13887 | Oil Guard Fork |
| 13888 | Cam Advance Arm Bracket |
| 13889 | Vertical Trip Lever |
| 13890 | Horizontal Trip Lever |
| 13891 | Oil Cover |
| 13892 | Spindle Shift Lever |
| 13893 | Cam Trip Lever |
| 13894 | Upper Trip Lever |

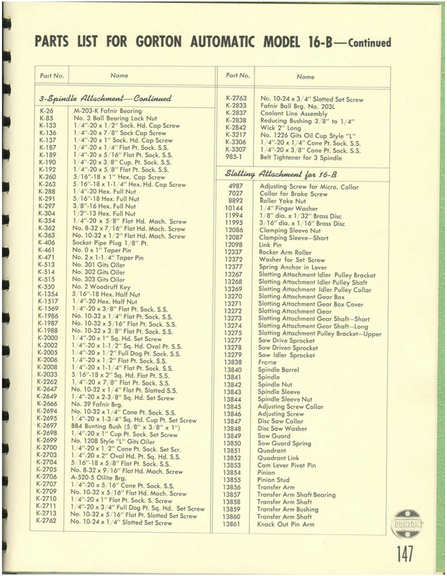
# Photo 147



## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B—Continued

| Part No. | Name |
|---|---|
| *3-Spindle Attachment—Continued* | |
| 13895 | Cam Advance Lever |
| 13896 | Spindle Cover |
| 13897 | Spindle Housing |
| 13898 | Rear Pivot Pin |
| 13899 | Front Pivot Pin |
| 13900 | Spindle Push Rod Bearing |
| 13901 | Spindle Push Rod Pin |
| 13902 | Centering Spindle Push Rod Cap |
| 13903 | Spindle Push Rod |
| 13904 | Threading Spindle Push Rod Cap |
| 13905 | Drilling Spindle Push Rod Cap |
| 13906 | Spring Anchor Button |
| 13907 | Cam Advance Arm Pin |
| 13908 | Oil Cover Stud |
| 13909 | Cam Trip Lever Roller Stud |
| 13910 | Cam Trip Lever Roller Screw |
| 13911 | Cam Trip Lever Roller |
| 13912 | Vertical Trip Lever Shaft |
| 13913 | Upper Trip Lever Pin |
| 13914 | Shift Bearing Housing Bushing |
| 13915 | Cam Advance Arm Pivot Pin |
| 13916 | Short Driven Gear Bushing |
| 13917 | Spindle Shift Lever Pivot Pin |
| 13918 | Shift Fork Stud |
| 13919 | Upper Trip Lever Stud |
| 13920 | Sliding Gear Spacer |
| 13921 | Pulley Bearing Retainer |
| 13922 | Trip Lever Plunger Collar |
| 13923 | Gear Shift Bracket Guide Pin |
| 13924 | Cam Trip Lever Plunger |
| 13925 | Main Spring Lower Anchor |
| 13926 | Collet Lock Nut |
| 13927 | Centering Spindle Cap |
| 13928 | Vertical Trip Lever Adjusting Screw |
| 13929 | Centering Cam Roller Lever Pin |
| 13930 | Drilling Cam Roller Lever Pin |
| 13932 | Gear Shift Bracket Pin |
| 13933 | Adjusting Screw Knob |
| 13934 | Spindle Housing Bracket |
| 13935 | Spindle Advance Arm Guide Shaft |
| 13936 | Drilling Spindle Bearing Spacer |
| 13937 | Spindle Advance Shaft Collar |
| 13938 | Spindle Advance Shaft |
| 13939 | Drilling Spindle Bearing Inner Nut |
| 13940 | Threading Trip Block Shaft |
| 13941 | Drilling Spindle Bearing Outer Nut |
| 13942 | Spindle Advance Shaft Guide Collar |
| 13943 | Drilling Spindle |
| 13944 | Drill Spindle Key |
| 13945 | Centering Spindle |
| 13946 | Short Driven Gear |
| 13947 | Threading Drive Gear |
| 13948 | Drilling Drive Gear |
| 13949 | Drive Gear Adapter |
| 13950 | Spring Adjusting Knob |
| 13951 | Spring Adjusting Screw |
| 13952 | Cam Trip Lever Stud |
| 13953 | Shift Fork Shaft |
| 13954 | Lower Lock Pin |
| 13955 | Upper Lock Pin |
| 13956 | Long Driven Gear |
| 13957 | Long Driven Gear Bushing |
| 13958 | Drilling Shift Gear |
| 13959 | Driven Gear Shaft |
| 13960 | Idler Gear |
| 13961 | Main Shaft Drive Cone |
| 13962 | Main Drive Shaft |
| 13963 | Threading Spindle Spacer |
| 13964 | Threading Spindle Retainer |
| 13965 | Threading Spindle |
| 13966 | Threading Spindle Rear Bearing |
| 13967 | Threading Spindle Gear |
| 13968 | Pulley Bearing Spacer |
| 13969 | Drive Pulley |
| 13970 | Idler Gear Shaft |
| 13971 | Cam Roller Pin |
| 13972 | Spindle Bearing Housing Guide |
| 13973 | Threading Spindle Support Guide |
| 13974 | Spindle Shift Lever Link |
| 13975 | Spindle Shift Lever Link Spacer |
| 13976 | Spindle Shift Lever Link Bushing |
| 13977 | Spindle Housing Spring |
| 13978 | Threading Push Rod Spring |
| 13979 | Spindle Advance Shaft Spring—Large |
| 13980 | Horizontal Trip Lever Spring |
| 13981 | Drilling Spindle Spring |
| 13982 | Spindle Advance Shaft Spring—Small |
| 13983 | Upper Trip Lever Spring |
| 13985 | Oil Guard Spring |
| 13986 | Centering Spindle Spring |
| 13987 | Trip Lever Front Spring |
| 13988 | Threading Spindle Spring |
| 13989 | Plunger Spring |
| 13990 | Horizontal Trip Lever Spring Anchor |
| 13991 | Main Spring Upper Anchor |
| 13992 | Upper Trip Lever Spring Anchor |
| 13993 | Threading Push Rod Spring Anchor |
| 13994 | Threading Trip Block |
| 13995 | Gear Shift Block |
| 13996 | Oil Reservoir Cover |
| 13997 | Gear Guard |
| 13998 | Centering Spindle Front Bearing |
| 13999 | Drilling & Centering Spindle Center Bushing |
| 14000 | Threading Spindle Center Bushing |
| 14001 | Drilling Spindle Front Bearing |
| 14002 | Threading Spindle Front Bearing |
| 14003 | Spindle Adjusting Stud |
| 14004 | Shift Bearing Nut |
| 14005 | Drilling Spindle Spring Anchor |
| 14128 | Pulley Adjusting Spacer |
| 14037 | Rear Pivot Pin Bushing |
| 14038 | Shift Bearing Retainer Ring |
| 14039 | Shift Bearing Housing |
| 14132 | Spindle Oiling Tube |
| 14445 | Attachment Jack Screw |
| 14658 | Cam Advance Arm Bracket Shim |

# Photo 148



## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B—Continued

*3-Spindle Attachment—Continued*

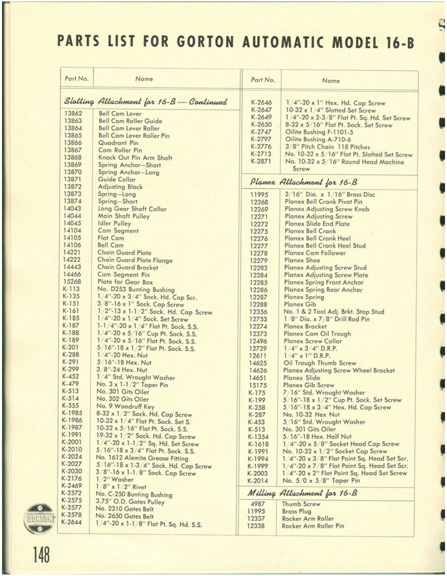
| Part No. | Name |
|---|---|
| K-26 | M-203-K Fafnir Bearing |
| K-85 | No. 3 Ball Bearing Lock Nut |
| K-133 | 1/4″-20 x 1/2″ Sock. Hd. Cap Screw |
| K-136 | 1/4″-20 x 7/8″ Sock Cap Screw |
| K-137 | 1/4″-20 x 1″ Sock. Hd. Cap Screw |
| K-187 | 1/4″-20 x 1/4″ Flat Pt. Sock. S.S. |
| K-189 | 1/4″-20 x 5/16″ Flat Pt. Sock. S.S. |
| K-190 | 1/4″-20 x 3/8″ Cup. Pt. Sock. S.S. |
| K-192 | 1/4″-20 x 5/8″ Flat Pt. Sock. S.S. |
| K-260 | 5/16″-18 x 1″ Hex. Cap Screw |
| K-263 | 5/16″-18 x 1-1/4″ Hex. Hd. Cap Screw |
| K-288 | 1/4″-20 Hex. Full Nut |
| K-291 | 5/16″-18 Hex. Full Nut |
| K-297 | 3/8″-16 Hex. Full Nut |
| K-304 | 1/2″-13 Hex. Full Nut |
| K-354 | 1/4″-20 x 5/8″ Flat Hd. Mach. Screw |
| K-362 | No. 8-32 x 7/16″ Flat Hd. Mach. Screw |
| K-363 | No. 10-32 x 1/2″ Flat Hd. Mach. Screw |
| K-406 | Socket Pipe Plug 1/8″ Pt. |
| K-461 | No. 0 x 1″ Taper Pin |
| K-471 | No. 2 x 1-1/4″ Taper Pin |
| K-513 | No. 301 Gits Oiler |
| K-514 | No. 302 Gits Oiler |
| K-515 | No. 303 Gits Oiler |
| K-550 | No. 2 Woodruff Key |
| K-1354 | 5/16″-18 Hex. Half Nut |
| K-1517 | 1/4″-20 Hex. Half Nut |
| K-1569 | 1/4″-20 x 3/8″ Flat Pt. Sock. S.S. |
| K-1986 | No. 10-32 x 1/4″ Flat Pt. Sock. S.S. |
| K-1987 | No. 10-32 x 5/16″ Flat Pt. Sock. S.S. |
| K-1988 | No. 10-32 x 3/8″ Flat Pt. Sock. S.S. |
| K-2000 | 1/4″-20 x 1″ Sq. Hd. Set Screw |
| K-2002 | 1/4″-20 x 1-1/2″ Sq. Hd. Oval Pt. S.S. |
| K-2005 | 1/4″-20 x 1/2″ Full Dog Pt. Sock. S.S. |
| K-2006 | 1/4″-20 x 1/2″ Flat Pt. Sock. S.S. |
| K-2008 | 1/4″-20 x 1-1/4″ Flat Pt. Sock. S.S. |
| K-2033 | 5/16″-18 x 2″ Sq. Hd. Flat Pt. S.S. |
| K-2262 | 1/4″-20 x 7/8″ Flat Pt. Sock. S.S. |
| K-2647 | No. 10-32 x 1/4″ Flat Pt. Slotted S.S. |
| K-2649 | 1/4″-20 x 2-3/8″ Sq. Hd. Set Screw |
| K-2666 | No. 39 Fafnir Brg. |
| K-2694 | No. 10-32 x 1/4″ Cone Pt. Sock. S.S. |
| K-2695 | 1/4″-20 x 1-3/4″ Sq. Hd. Cup Pt. Set Screw |
| K-2697 | BB4 Bunting Bush (5/8″ x 3/8″ x 1″) |
| K-2698 | 1/4″-20 x 1″ Cup Pt. Sock. Set Screw |
| K-2699 | No. 1208 Style "L" Gits Oiler |
| K-2700 | 1/4″-20 x 1/2″ Cone Pt. Sock. Set Scr. |
| K-2703 | 1/4″-20 x 2″ Oval Hd. Pt. Sq. Hd. S.S. |
| K-2704 | 5/16″-18 x 5/8″ Flat Pt. Sock. S.S. |
| K-2705 | No. 8-32 x 9/16″ Flat Hd. Mach. Screw |
| K-2706 | A-520-5 Oilite Brg. |
| K-2707 | 1/4″-20 x 5/16″ Cone Pt. Sock. S.S. |
| K-2709 | No. 10-32 x 5/16″ Flat Hd. Mach. Screw |
| K-2710 | 1/4″-20 x 1″ Flat Pt. Sock. S. Screw |
| K-2711 | 1/4″-20 x 3/4″ Full Dog Pt. Sq. Hd. Set Screw |
| K-2713 | No. 10-32 x 5/16″ Flat Pt. Slotted Set Screw |
| K-2762 | No. 10-24 x 1/4″ Slotted Set Screw |

| Part No. | Name |
|---|---|
| K-2763 | No. 10-24 x 3/4″ Slotted Set Screw |
| K-2833 | Fafnir Ball Brg. No. 203L |
| K-2837 | Coolant Line Assembly |
| K-2838 | Reducing Bushing 3/8″ to 1/4″ |
| K-2842 | Wick 2″ Long |
| K-3217 | No. 1226 Gits Oil Cup Style "L" |
| K-3306 | 1/4″-20 x 1/4″ Cone Pt. Sock. S.S. |
| K-3307 | 1/4″-20 x 3/8″ Cone Pt. Sock. S.S. |
| 985-1 | Belt Tightener for 3 Spindle |

*Slotting Attachment for 16-B*

| Part No. | Name |
|---|---|
| 4987 | Adjusting Screw for Micro. Collar |
| 7027 | Collar for Brake Screw |
| 8892 | Roller Yoke Nut |
| 10144 | 1/4″ Finger Washer |
| 11994 | 1/8″ dia. x 1/32″ Brass Disc |
| 11995 | 3/16″ dia. x 1/16″ Brass Disc |
| 12086 | Clamping Sleeve Nut |
| 12087 | Clamping Sleeve—Short |
| 12098 | Link Pin |
| 12337 | Rocker Arm Roller |
| 12372 | Washer for Set Screw |
| 12377 | Spring Anchor in Lever |
| 13267 | Slotting Attachment Idler Pulley Bracket |
| 13268 | Slotting Attachment Idler Pulley Shaft |
| 13269 | Slotting Attachment Idler Pulley Collar |
| 13270 | Slotting Attachment Gear Box |
| 13271 | Slotting Attachment Gear Box Cover |
| 13272 | Slotting Attachment Gear |
| 13273 | Slotting Attachment Gear Shaft—Short |
| 13274 | Slotting Attachment Gear Shaft—Long |
| 13275 | Slotting Attachment Pulley Bracket—Upper |
| 13277 | Saw Drive Sprocket |
| 13278 | Saw Driven Sprocket |
| 13279 | Saw Idler Sprocket |
| 13838 | Frame |
| 13840 | Spindle Barrel |
| 13841 | Spindle |
| 13842 | Spindle Nut |
| 13843 | Spindle Sleeve |
| 13844 | Spindle Sleeve Nut |
| 13845 | Adjusting Screw Collar |
| 13846 | Adjusting Screw |
| 13847 | Disc Saw Collar |
| 13848 | Disc Saw Washer |
| 13849 | Saw Guard |
| 13850 | Saw Guard Spring |
| 13851 | Quadrant |
| 13852 | Quadrant Link |
| 13853 | Cam Lever Pivot Pin |
| 13854 | Pinion |
| 13855 | Pinion Stud |
| 13856 | Transfer Arm |
| 13857 | Transfer Arm Shaft Bearing |
| 13858 | Transfer Arm Shaft |
| 13859 | Transfer Arm Bushing |
| 13860 | Transfer Arm Shaft |
| 13861 | Knock Out Pin Arm |

# Photo 149



## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B

### *Slotting Attachment for 16-B — Continued*

| Part No. | Name |
|---|---|
| 13862 | Bell Cam Lever |
| 13863 | Bell Cam Roller Guide |
| 13864 | Bell Cam Lever Roller |
| 13865 | Bell Cam Lever Roller Pin |
| 13866 | Quadrant Pin |
| 13867 | Cam Roller Pin |
| 13868 | Knock Out Pin Arm Shaft |
| 13869 | Spring Anchor—Short |
| 13870 | Spring Anchor—Long |
| 13871 | Guide Collar |
| 13872 | Adjusting Block |
| 13873 | Spring—Long |
| 13874 | Spring—Short |
| 14043 | Long Gear Shaft Collar |
| 14044 | Main Shaft Pulley |
| 14045 | Idler Pulley |
| 14104 | Cam Segment |
| 14105 | Flat Cam |
| 14106 | Bell Cam |
| 14221 | Chain Guard Plate |
| 14222 | Chain Guard Plate Flange |
| 14443 | Chain Guard Bracket |
| 14466 | Cam Segment Pin |
| 15268 | Plate for Gear Box |
| K-113 | No. D253 Bunting Bushing |
| K-135 | 1/4″-20 x 3/4″ Sock. Hd. Cap Scr. |
| K-151 | 3/8″-16 x 1″ Sock. Cap Screw |
| K-161 | 1/2″-13 x 1-1/2″ Sock. Hd. Cap Screw |
| K-185 | 1/4″-20 x 1/4″ Sock. Set Screw |
| K-187 | 1-1/4″-20 x 1/4″ Flat Pt. Sock. S.S. |
| K-188 | 1/4″-20 x 5/16″ Cup Pt. Sock. S.S. |
| K-189 | 1/4″-20 x 5/16″ Flat Pt. Sock. S.S. |
| K-201 | 5/16″-18 x 1/2″ Flat Pt. Sock. S.S. |
| K-288 | 1/4″-20 Hex. Nut |
| K-291 | 5/16″-18 Hex. Nut |
| K-299 | 3/8″-24 Hex. Nut |
| K-452 | 1/4″ Std. Wrought Washer |
| K-479 | No. 3 x 1-1/2″ Taper Pin |
| K-513 | No. 301 Gits Oiler |
| K-514 | No. 302 Gits Oiler |
| K-555 | No. 9 Woodruff Key |
| K-1985 | 8-32 x 1/2″ Sock. Hd. Cap Screw |
| K-1986 | 10-32 x 1/4″ Flat Pt. Sock. Set S. |
| K-1987 | 10-32 x 5/16″ Flat Pt. Sock. S.S. |
| K-1991 | 19-32 x 1/2″ Sock. Hd. Cap Screw |
| K-2001 | 1/4″-20 x 1-1/2″ Sq. Hd. Set Screw |
| K-2010 | 5/16″-18 x 3/4″ Flat Pt. Sock. S.S. |
| K-2024 | No. 1612 Alemite Grease Fitting |
| K-2027 | 5/16″-18 x 1-3/4″ Sock. Hd. Cap Screw |
| K-2030 | 3/8″-16 x 1-1/8″ Sock. Cap Screw |
| K-2176 | 1/2″ Washer |
| K-2469 | 1/8″ x 1/2″ Rivet |
| K-2572 | No. C-250 Bunting Bushing |
| K-2575 | 3.75″ O.D. Gates Pulley |
| K-2577 | No. 2310 Gates Belt |
| K-2578 | No. 2650 Gates Belt |
| K-2644 | 1/4″-20 x 1-1/8″ Flat Pt. Sq. Hd. S.S. |
| K-2646 | 1/4″-20 x 1″ Hex. Hd. Cap Screw |
| K-2647 | 10-32 x 1/4″ Slotted Set Screw |
| K-2649 | 1/4″-20 x 2-3/8″ Flat Pt. Sq. Hd. Set Screw |
| K-2650 | 8-32 x 5/16″ Flat Pt. Sock. Set Screw |
| K-2747 | Oilite Bushing F-1101-5 |
| K-2797 | Oilite Bushing A-710-6 |
| K-2776 | 3/8″ Pitch Chain 118 Pitches |
| K-2713 | No. 10-32 x 5/16″ Flat Pt. Slotted Set Screw |
| K-2871 | No. 10-32 x 5/16″ Round Head Machine Screw |

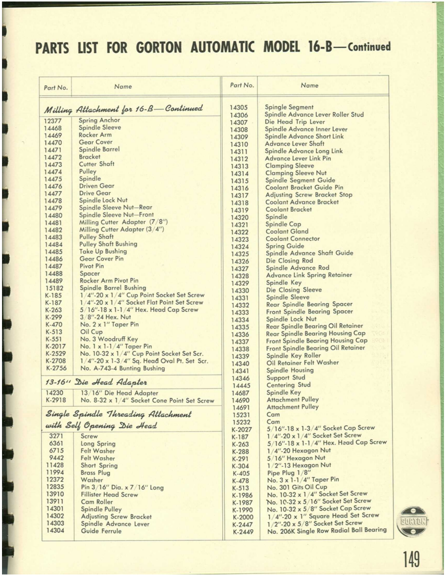
### *Planex Attachment for 16-B*

| Part No. | Name |
|---|---|
| 11995 | 3/16″ Dia. x 1/16″ Brass Disc |
| 12268 | Planex Bell Crank Pivot Pin |
| 12269 | Planex Adjusting Screw Knob |
| 12271 | Planex Adjusting Screw |
| 12272 | Planex Slide End Plate |
| 12275 | Planex Bell Crank |
| 12276 | Planex Bell Crank Heel |
| 12277 | Planex Bell Crank Heel Stud |
| 12278 | Planex Cam Follower |
| 12279 | Planex Shoe |
| 12282 | Planex Adjusting Screw Stud |
| 12284 | Planex Adjusting Screw Plate |
| 12285 | Planex Spring Front Anchor |
| 12286 | Planex Spring Rear Anchor |
| 12287 | Planex Spring |
| 12288 | Planex Gib |
| 12356 | No. 1 & 2 Tool Adj. Brkt. Stop Stud |
| 12753 | 1/8″ Dia. x 7/8″ Drill Rod Pin |
| 12274 | Planex Bracket |
| 12373 | Planex Cam Oil Trough |
| 12496 | Planex Screw Collar |
| 12729 | 1/4″ x 3/4″ D.R.P. |
| 12611 | 1/4″ x 1″ D.R.P. |
| 14625 | Oil Trough Thumb Screw |
| 14626 | Planex Adjusting Screw Wheel Bracket |
| 14651 | Planex Slide |
| 15175 | Planex Gib Screw |
| K-175 | 7/16″ Std. Wrought Washer |
| K-199 | 5/16″-18 x 1/2″ Cup Pt. Sock. Set Screw |
| K-258 | 5/16″-18 x 3/4″ Hex. Hd. Cap Screw |
| K-287 | No. 10-32 Hex Nut |
| K-453 | 5/16″ Std. Wrought Washer |
| K-513 | No. 301 Gits Oiler |
| K-1354 | 5/16″-18 Hex. Half Nut |
| K-1618 | 1/4″-20 x 5/8″ Socket Head Cap Screw |
| K-1991 | No. 10-32 x 1/2″ Socket Cap Screw |
| K-1994 | 1/4″-20 x 3/8″ Flat Point Sq. Head Set Scr. |
| K-1999 | 1/4″-20 x 7/8″ Flat Point Sq. Head Set Scr. |
| K-2003 | 1/4″-20 x 2″ Flat Point Sq. Head Set Screw |
| K-2014 | No. 5/0 x 5/8″ Taper Pin |

### *Milling Attachment for 16-B*

| Part No. | Name |
|---|---|
| 4987 | Thumb Screw |
| 11995 | Brass Plug |
| 12337 | Rocker Arm Roller |
| 12338 | Rocker Arm Roller Pin |

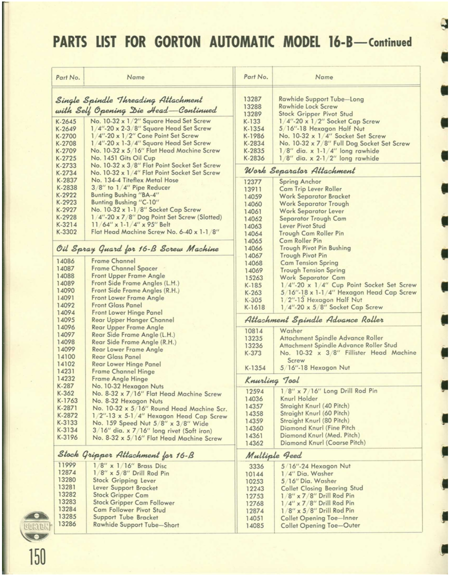
# Photo 150



## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B—Continued

| Part No. | Name |
|---|---|
| ***Milling Attachment for 16-B—Continued*** | |
| 12377 | Spring Anchor |
| 14468 | Spindle Sleeve |
| 14469 | Rocker Arm |
| 14470 | Gear Cover |
| 14471 | Spindle Barrel |
| 14472 | Bracket |
| 14473 | Cutter Shaft |
| 14474 | Pulley |
| 14475 | Spindle |
| 14476 | Driven Gear |
| 14477 | Drive Gear |
| 14478 | Spindle Lock Nut |
| 14479 | Spindle Sleeve Nut—Rear |
| 14480 | Spindle Sleeve Nut—Front |
| 14481 | Milling Cutter Adapter (7/8″) |
| 14482 | Milling Cutter Adapter (3/4″) |
| 14483 | Pulley Shaft |
| 14484 | Pulley Shaft Bushing |
| 14485 | Take Up Bushing |
| 14486 | Gear Cover Pin |
| 14487 | Pivot Pin |
| 14488 | Spacer |
| 14489 | Rocker Arm Pivot Pin |
| 15182 | Spindle Barrel Bushing |
| K-185 | 1/4″-20 x 1/4″ Cup Point Socket Set Screw |
| K-187 | 1/4″-20 x 1/4″ Socket Flat Point Set Screw |
| K-263 | 5/16″-18 x 1-1/4″ Hex. Head Cap Screw |
| K-299 | 3/8″-24 Hex. Nut |
| K-470 | No. 2 x 1″ Taper Pin |
| K-513 | Oil Cup |
| K-551 | No. 3 Woodruff Key |
| K-2017 | No. 1 x 1-1/4″ Taper Pin |
| K-2529 | No. 10-32 x 1/4″ Cup Point Socket Set Scr. |
| K-2708 | 1/4″-20 x 1-3/4″ Sq. Head Oval Pt. Set Scr. |
| K-2756 | No. A-743-4 Bunting Bushing |
| ***13-16″ Die Head Adapter*** | |
| 14230 | 13/16″ Die Head Adapter |
| K-2918 | No. 8-32 x 1/4″ Socket Cone Point Set Screw |
| ***Single Spindle Threading Attachment with Self Opening Die Head*** | |
| 3271 | Screw |
| 6361 | Long Spring |
| 6715 | Felt Washer |
| 9442 | Felt Washer |
| 11428 | Short Spring |
| 11994 | Brass Plug |
| 12372 | Washer |
| 12835 | Pin 3/16″ Dia. x 7/16″ Long |
| 13910 | Fillister Head Screw |
| 13911 | Cam Roller |
| 14301 | Spindle Pulley |
| 14302 | Adjusting Screw Bracket |
| 14303 | Spindle Advance Lever |
| 14304 | Guide Ferrule |
| 14305 | Spingle Segment |
| 14306 | Spindle Advance Lever Roller Stud |
| 14307 | Die Head Trip Lever |
| 14308 | Spindle Advance Inner Lever |
| 14309 | Spindle Advance Short Link |
| 14310 | Advance Lever Shaft |
| 14311 | Spindle Advance Long Link |
| 14312 | Advance Lever Link Pin |
| 14313 | Clamping Sleeve |
| 14314 | Clamping Sleeve Nut |
| 14315 | Spindle Segment Guide |
| 14316 | Coolant Bracket Guide Pin |
| 14317 | Adjusting Screw Bracket Stop |
| 14318 | Coolant Advance Bracket |
| 14319 | Coolant Bracket |
| 14320 | Spindle |
| 14321 | Spindle Cap |
| 14322 | Coolant Gland |
| 14323 | Coolant Connector |
| 14324 | Spring Guide |
| 14325 | Spindle Advance Shaft Guide |
| 14326 | Die Closing Rod |
| 14327 | Spindle Advance Rod |
| 14328 | Advance Link Spring Retainer |
| 14329 | Spindle Key |
| 14330 | Die Closing Sleeve |
| 14331 | Spindle Sleeve |
| 14332 | Rear Spindle Bearing Spacer |
| 14333 | Front Spindle Bearing Spacer |
| 14334 | Spindle Lock Nut |
| 14335 | Rear Spindle Bearing Oil Retainer |
| 14336 | Rear Spindle Bearing Housing Cap |
| 14337 | Front Spindle Bearing Housing Cap |
| 14338 | Front Spindle Bearing Oil Retainer |
| 14339 | Spindle Key Roller |
| 14340 | Oil Retainer Felt Washer |
| 14341 | Spindle Housing |
| 14346 | Support Stud |
| 14445 | Centering Stud |
| 14687 | Spindle Key |
| 14690 | Attachment Pulley |
| 14691 | Attachment Pulley |
| 15231 | Cam |
| 15232 | Cam |
| K-2027 | 5/16″-18 x 1-3/4″ Socket Cap Screw |
| K-187 | 1/4″-20 x 1/4″ Socket Set Screw |
| K-263 | 5/16″-18 x 1-1/4″ Hex. Head Cap Screw |
| K-288 | 1/4″-20 Hexagon Nut |
| K-291 | 5/16″ Hexagon Nut |
| K-304 | 1/2″-13 Hexagon Nut |
| K-405 | Pipe Plug 1/8″ |
| K-478 | No. 3 x 1-1/4″ Taper Pin |
| K-513 | No. 301 Gits Oil Cup |
| K-1986 | No. 10-32 x 1/4″ Socket Set Screw |
| K-1987 | No. 10-32 x 5/16″ Socket Set Screw |
| K-1990 | No. 10-32 x 5/8″ Socket Cap Screw |
| K-2000 | 1/4″-20 x 1″ Square Head Set Screw |
| K-2447 | 1/2″-20 x 5/8″ Socket Set Screw |
| K-2449 | No. 206K Single Row Radial Ball Bearing |

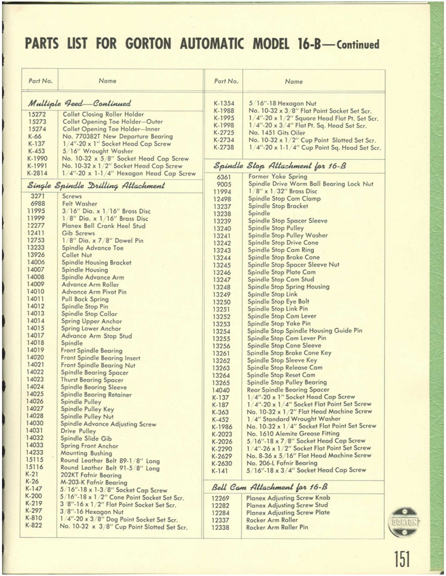
# Photo 151



## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B—Continued

| Part No. | Name |
|---|---|
| ***Single Spindle Threading Attachment with Self Opening Die Head—Continued*** | |
| K-2645 | No. 10-32 x 1/2″ Square Head Set Screw |
| K-2649 | 1/4″-20 x 2-3/8″ Square Head Set Screw |
| K-2700 | 1/4″-20 x 1/2″ Cone Point Set Screw |
| K-2708 | 1/4″-20 x 1-3/4″ Square Head Set Screw |
| K-2709 | No. 10-32 x 5/16″ Flat Head Machine Screw |
| K-2725 | No. 1451 Gits Oil Cup |
| K-2733 | No. 10-32 x 3/8″ Flat Point Socket Set Screw |
| K-2734 | No. 10-32 x 1/4″ Flat Point Socket Set Screw |
| K-2837 | No. 134-4 Titeflex Metal Hose |
| K-2838 | 3/8″ to 1/4″ Pipe Reducer |
| K-2922 | Bunting Bushing "BA-4" |
| K-2923 | Bunting Bushing "C-10" |
| K-2927 | No. 10-32 x 1-1/8″ Socket Cap Screw |
| K-2928 | 1/4″-20 x 7/8″ Dog Point Set Screw (Slotted) |
| K-3214 | 11/64″ x 1-1/4″ x 95″ Belt |
| K-3302 | Flat Head Machine Screw No. 6-40 x 1-1/8″ |
| ***Oil Spray Guard for 16-B Screw Machine*** | |
| 14086 | Frame Channel |
| 14087 | Frame Channel Spacer |
| 14088 | Front Upper Frame Angle |
| 14089 | Front Side Frame Angles (L.H.) |
| 14090 | Front Side Frame Angles (R.H.) |
| 14091 | Front Lower Frame Angle |
| 14092 | Front Glass Panel |
| 14094 | Front Lower Hinge Panel |
| 14095 | Rear Upper Hanger Channel |
| 14096 | Rear Upper Frame Angle |
| 14097 | Rear Side Frame Angle (L.H.) |
| 14098 | Rear Side Frame Angle (R.H.) |
| 14099 | Rear Lower Frame Angle |
| 14100 | Rear Glass Panel |
| 14102 | Rear Lower Hinge Panel |
| 14231 | Frame Channel Hinge |
| 14232 | Frame Angle Hinge |
| K-287 | No. 10-32 Hexagon Nuts |
| K-362 | No. 8-32 x 7/16″ Flat Head Machine Screw |
| K-1763 | No. 8-32 Hexagon Nuts |
| K-2871 | No. 10-32 x 5/16″ Round Head Machine Scr. |
| K-2872 | 1/2″-13 x 5-1/4″ Hexagon Head Cap Screw |
| K-3133 | No. 159 Speed Nut 5/8″ x 3/8″ Wide |
| K-3134 | 3/16″ dia. x 7/16″ long rivet (Soft iron) |
| K-3196 | No. 8-32 x 5/16″ Flat Head Machine Screw |
| ***Stock Gripper Attachment for 16-B*** | |
| 11999 | 1/8″ x 1/16″ Brass Disc |
| 12874 | 1/8″ x 5/8″ Drill Rod Pin |
| 13280 | Stock Gripping Lever |
| 13281 | Lever Support Bracket |
| 13282 | Stock Gripper Cam |
| 13283 | Stock Gripper Cam Follower |
| 13284 | Cam Follower Pivot Stud |
| 13285 | Support Tube Bracket |
| 13286 | Rawhide Support Tube—Short |
| 13287 | Rawhide Support Tube—Long |
| 13288 | Rawhide Lock Screw |
| 13289 | Stock Gripper Pivot Stud |
| K-133 | 1/4″-20 x 1/2″ Socket Cap Screw |
| K-1354 | 5/16″-18 Hexagon Half Nut |
| K-1986 | No. 10-32 x 1/4″ Socket Set Screw |
| K-2834 | No. 10-32 x 7/8″ Full Dog Socket Set Screw |
| K-2835 | 1/8″ dia. x 1-1/4″ long rawhide |
| K-2836 | 1/8″ dia. x 2-1/2″ long rawhide |
| ***Work Separator Attachment*** | |
| 12377 | Spring Anchor |
| 13911 | Cam Trip Lever Roller |
| 14059 | Work Separator Bracket |
| 14060 | Work Separator Trough |
| 14061 | Work Separator Lever |
| 14062 | Separator Trough Cam |
| 14063 | Lever Pivot Stud |
| 14064 | Trough Cam Roller Pin |
| 14065 | Cam Roller Pin |
| 14066 | Trough Pivot Pin Bushing |
| 14067 | Trough Pivot Pin |
| 14068 | Cam Tension Spring |
| 14069 | Trough Tension Spring |
| 15263 | Work Separator Cam |
| K-185 | 1/4″-20 x 1/4″ Cup Point Socket Set Screw |
| K-263 | 5/16″-18 x 1-1/4″ Hexagon Head Cap Screw |
| K-305 | 1/2″-13 Hexagon Half Nut |
| K-1618 | 1/4″-20 x 5/8″ Socket Cap Screw |
| ***Attachment Spindle Advance Roller*** | |
| 10814 | Washer |
| 13235 | Attachment Spindle Advance Roller |
| 13236 | Attachment Spindle Advance Roller Stud |
| K-373 | No. 10-32 x 3/8″ Fillister Head Machine Screw |
| K-1354 | 5/16″-18 Hexagon Nut |
| ***Knurling Tool*** | |
| 12594 | 1/8″ x 7/16″ Long Drill Rod Pin |
| 14036 | Knurl Holder |
| 14357 | Straight Knurl (40 Pitch) |
| 14358 | Straight Knurl (60 Pitch) |
| 14359 | Straight Knurl (80 Pitch) |
| 14360 | Diamond Knurl (Fine Pitch |
| 14361 | Diamond Knurl (Med. Pitch) |
| 14362 | Diamond Knurl (Coarse Pitch) |
| ***Multiple Feed*** | |
| 3336 | 5/16″-24 Hexagon Nut |
| 10144 | 1/4″ Dia. Washer |
| 10253 | 5/16″ Dia. Washer |
| 12243 | Collet Closing Bearing Stud |
| 12753 | 1/8″ x 7/8″ Drill Rod Pin |
| 12768 | 1/4″ x 7/8″ Drill Rod Pin |
| 12874 | 1/8″ x 5/8″ Drill Rod Pin |
| 14051 | Collet Opening Toe—Inner |
| 14085 | Collet Opening Toe—Outer |

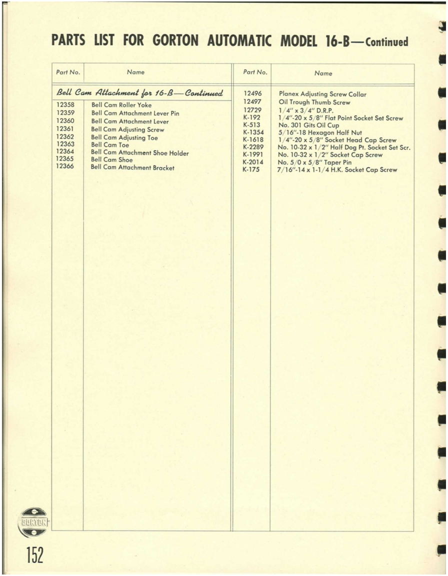
# Photo 152



## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B—Continued

| Part No. | Name |
|---|---|
| *Multiple Feed—Continued* | |
| 15272 | Collet Closing Roller Holder |
| 15273 | Collet Opening Toe Holder—Outer |
| 15274 | Collet Opening Toe Holder—Inner |
| K-66 | No. 770382T New Departure Bearing |
| K-137 | 1/4″-20 x 1″ Socket Head Cap Screw |
| K-453 | 5/16″ Wrought Washer |
| K-1990 | No. 10-32 x 5/8″ Socket Head Cap Screw |
| K-1991 | No. 10-32 x 1/2″ Socket Head Cap Screw |
| K-2814 | 1/4″-20 x 1-1/4″ Hexagon Head Cap Screw |
| *Single Spindle Drilling Attachment* | |
| 3271 | Screws |
| 6988 | Felt Washer |
| 11995 | 3/16″ Dia. x 1/16″ Brass Disc |
| 11999 | 1/8″ Dia. x 1/16″ Brass Disc |
| 12277 | Planex Bell Crank Heel Stud |
| 12411 | Gib Screws |
| 12753 | 1/8″ Dia. x 7/8″ Dowel Pin |
| 13233 | Spindle Advance Toe |
| 13926 | Collet Nut |
| 14006 | Spindle Housing Bracket |
| 14007 | Spindle Housing |
| 14008 | Spindle Advance Arm |
| 14009 | Advance Arm Roller |
| 14010 | Advance Arm Pivot Pin |
| 14011 | Pull Back Spring |
| 14012 | Spindle Stop Pin |
| 14013 | Spindle Stop Collar |
| 14014 | Spring Upper Anchor |
| 14015 | Spring Lower Anchor |
| 14017 | Advance Arm Stop Stud |
| 14018 | Spindle |
| 14019 | Front Spindle Bearing |
| 14020 | Front Spindle Bearing Insert |
| 14021 | Front Spindle Bearing Nut |
| 14022 | Spindle Bearing Spacer |
| 14023 | Thurst Bearing Spacer |
| 14024 | Spindle Bearing Sleeve |
| 14025 | Spindle Bearing Retainer |
| 14026 | Spindle Pulley |
| 14027 | Spindle Pulley Key |
| 14028 | Spindle Pulley Nut |
| 14030 | Spindle Advance Adjusting Screw |
| 14031 | Drive Pulley |
| 14032 | Spindle Slide Gib |
| 14033 | Spring Front Anchor |
| 14233 | Mounting Bushing |
| 15115 | Round Leather Belt 89-1/8″ Long |
| 15116 | Round Leather Belt 91-5/8″ Long |
| K-21 | 202KT Fafnir Bearing |
| K-26 | M-203-K Fafnir Bearing |
| K-147 | 5/16″-18 x 1-3/8″ Socket Cap Screw |
| K-200 | 5/16″-18 x 1/2″ Cone Point Socket Set Scr. |
| K-219 | 3/8″-16 x 1/2″ Flat Point Socket Set Scr. |
| K-297 | 3/8″-16 Hexagon Nut |
| K-810 | 1/4″-20 x 3/8″ Dog Point Socket Set Scr. |
| K-822 | No. 10-32 x 3/8″ Cup Point Slotted Set Scr. |
| K-1354 | 5/16″-18 Hexagon Nut |
| K-1988 | No. 10-32 x 3/8″ Flat Point Socket Set Scr. |
| K-1995 | 1/4″-20 x 1/2″ Square Head Flat Pt. Set Scr. |
| K-1998 | 1/4″-20 x 3/4″ Flat Pt. Sq. Head Set Scr. |
| K-2725 | No. 1451 Gits Oiler |
| K-2734 | No. 10-32 x 1/2″ Cup Point Slotted Set Scr. |
| K-2738 | 1/4″-20 x 1-1/4″ Cup Point Sq. Head Set Scr. |
| *Spindle Stop Attachment for 16-B* | |
| 6361 | Former Yoke Spring |
| 9005 | Spindle Drive Worm Ball Bearing Lock Nut |
| 11994 | 1/8″ x 1/32″ Brass Disc |
| 12498 | Spindle Stop Cam Clamp |
| 13237 | Spindle Stop Bracket |
| 13238 | Spindle |
| 13239 | Spindle Stop Spacer Sleeve |
| 13240 | Spindle Stop Pulley |
| 13241 | Spindle Stop Pulley Washer |
| 13242 | Spindle Stop Drive Cone |
| 13243 | Spindle Stop Cam Ring |
| 13244 | Spindle Stop Brake Cone |
| 13245 | Spindle Stop Spacer Sleeve Nut |
| 13246 | Spindle Stop Plate Cam |
| 13247 | Spindle Stop Cam Stud |
| 13248 | Spindle Stop Spring Housing |
| 13249 | Spindle Stop Link |
| 13250 | Spindle Stop Eye Bolt |
| 13251 | Spindle Stop Link Pin |
| 13252 | Spindle Stop Cam Lever |
| 13253 | Spindle Stop Yoke Pin |
| 13254 | Spindle Stop Spindle Housing Guide Pin |
| 13255 | Spindle Stop Cam Lever Pin |
| 13256 | Spindle Stop Cone Sleeve |
| 13261 | Spindle Stop Brake Cone Key |
| 13262 | Spindle Stop Sleeve Key |
| 13263 | Spindle Stop Release Cam |
| 13264 | Spindle Stop Reset Cam |
| 13265 | Spindle Stop Pulley Bearing |
| 14040 | Rear Spindle Bearing Spacer |
| K-137 | 1/4″-20 x 1″ Socket Head Cap Screw |
| K-187 | 1/4″-20 x 1/4″ Socket Flat Point Set Screw |
| K-363 | No. 10-32 x 1/2″ Flat Head Machine Screw |
| K-452 | 1/4″ Standard Wrought Washer |
| K-1986 | No. 10-32 x 1/4″ Socket Flat Point Set Screw |
| K-2023 | No. 1610 Alemite Grease Fitting |
| K-2026 | 5/16″-18 x 7/8″ Socket Head Cap Screw |
| K-2290 | 1/4″-26 x 1/2″ Socket Flat Point Set Screw |
| K-2629 | No. 8-36 x 5/16″ Flat Head Machine Screw |
| K-2630 | No. 206-L Fafnir Bearing |
| K-141 | 5/16″-18 x 3/4″ Socket Head Cap Screw |
| *Bell Cam Attachment for 16-B* | |
| 12269 | Planex Adjusting Screw Knob |
| 12282 | Planex Adjusting Screw Stud |
| 12284 | Planex Adjusting Screw Plate |
| 12337 | Rocker Arm Roller |
| 12338 | Rocker Arm Roller Pin |

# Photo 153

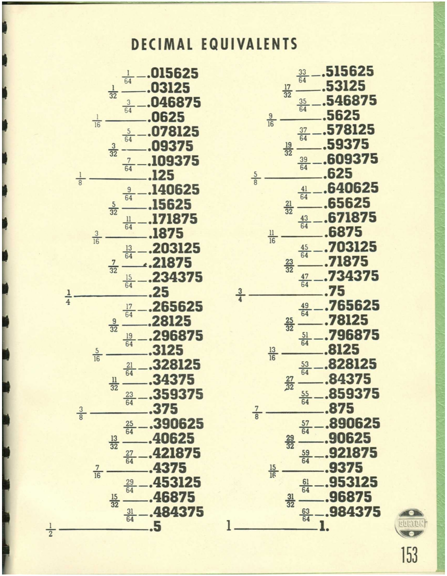


## PARTS LIST FOR GORTON AUTOMATIC MODEL 16-B—Continued

*Bell Cam Attachment for 16-B—Continued*

| Part No. | Name |
|---|---|
| 12358 | Bell Cam Roller Yoke |
| 12359 | Bell Cam Attachment Lever Pin |
| 12360 | Bell Cam Attachment Lever |
| 12361 | Bell Cam Adjusting Screw |
| 12362 | Bell Cam Adjusting Toe |
| 12363 | Bell Cam Toe |
| 12364 | Bell Cam Attachment Shoe Holder |
| 12365 | Bell Cam Shoe |
| 12366 | Bell Cam Attachment Bracket |
| 12496 | Planex Adjusting Screw Collar |
| 12497 | Oil Trough Thumb Screw |
| 12729 | 1/4″ x 3/4″ D.R.P. |
| K-192 | 1/4″-20 x 5/8″ Flat Point Socket Set Screw |
| K-513 | No. 301 Gits Oil Cup |
| K-1354 | 5/16″-18 Hexagon Half Nut |
| K-1618 | 1/4″-20 x 5/8″ Socket Head Cap Screw |
| K-2289 | No. 10-32 x 1/2″ Half Dog Pt. Socket Set Scr. |
| K-1991 | No. 10-32 x 1/2″ Socket Cap Screw |
| K-2014 | No. 5/0 x 5/8″ Taper Pin |
| K-175 | 7/16″-14 x 1-1/4 H.K. Socket Cap Screw |

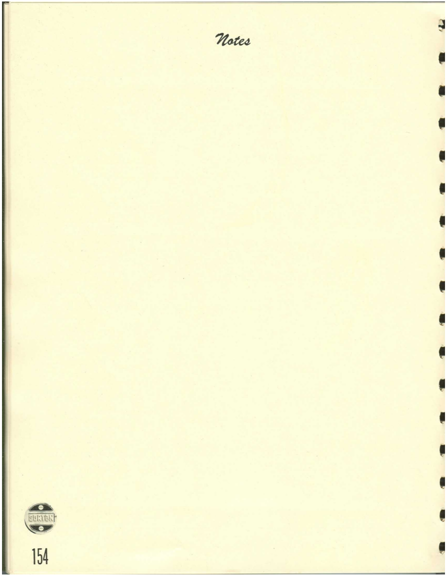
# Photo 154



## DECIMAL EQUIVALENTS

| | | | |
|---|---|---|---|
| 1/64 | .015625 | 33/64 | .515625 |
| 1/32 | .03125 | 17/32 | .53125 |
| 3/64 | .046875 | 35/64 | .546875 |
| 1/16 | .0625 | 9/16 | .5625 |
| 5/64 | .078125 | 37/64 | .578125 |
| 3/32 | .09375 | 19/32 | .59375 |
| 7/64 | .109375 | 39/64 | .609375 |
| 1/8 | .125 | 5/8 | .625 |
| 9/64 | .140625 | 41/64 | .640625 |
| 5/32 | .15625 | 21/32 | .65625 |
| 11/64 | .171875 | 43/64 | .671875 |
| 3/16 | .1875 | 11/16 | .6875 |
| 13/64 | .203125 | 45/64 | .703125 |
| 7/32 | .21875 | 23/32 | .71875 |
| 15/64 | .234375 | 47/64 | .734375 |
| 1/4 | .25 | 3/4 | .75 |
| 17/64 | .265625 | 49/64 | .765625 |
| 9/32 | .28125 | 25/32 | .78125 |
| 19/64 | .296875 | 51/64 | .796875 |
| 5/16 | .3125 | 13/16 | .8125 |
| 21/64 | .328125 | 53/64 | .828125 |
| 11/32 | .34375 | 27/32 | .84375 |
| 23/64 | .359375 | 55/64 | .859375 |
| 3/8 | .375 | 7/8 | .875 |
| 25/64 | .390625 | 57/64 | .890625 |
| 13/32 | .40625 | 29/32 | .90625 |
| 27/64 | .421875 | 59/64 | .921875 |
| 7/16 | .4375 | 15/16 | .9375 |
| 29/64 | .453125 | 61/64 | .953125 |
| 15/32 | .46875 | 31/32 | .96875 |
| 31/64 | .484375 | 63/64 | .984375 |
| 1/2 | .5 | 1 | 1. |

# Photo 155

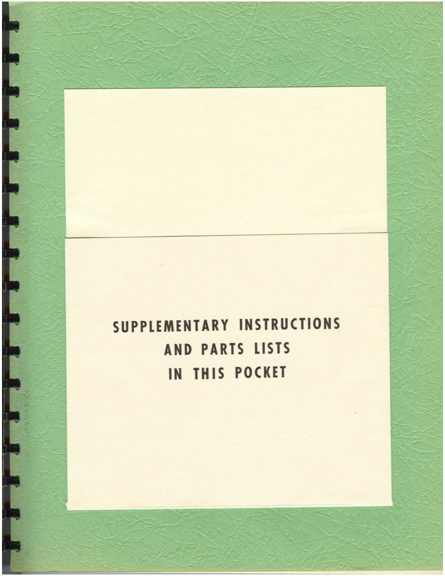


Notes

GORTON

154

# Photo 156



SUPPLEMENTARY INSTRUCTIONS
AND PARTS LISTS
IN THIS POCKET

# Photo 157

HAVE YOU THESE NEW GORTON BOOKS?

No. 1580-B

No. 1635-B

No. 1385-D

No. 1309-B

No. 1400-C

No. 1319-E

SEND FOR *Yours* TODAY

You will find them filled with practical ideas for enlarging the usefulness of your Gorton Machines and improving operating methods.

No. 1317-F

No. 1410-C

No. 1800-B

No. 1833-A

Our Engineers Will Gladly Consult with You