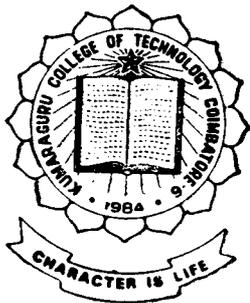# COMPUTER AIDED DESIGN OF CAMS FOR AUTOMATIC LATHES

P-95

PROJECT REPORT

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF BACHELOR OF ENGINEERING IN MECHANICAL ENGINEERING OF THE BHARATHIYAR UNIVERSITY, COIMBATORE 641 046

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DEPARTMENT OF MECHANICAL ENGINEERING

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## CERTIFICATE

THIS IS TO CERTIFY THAT THE REPORT ENTITLED

"COMPUTER AIDED DESIGN OF CAMS FOR AUTOMATIC LATHES"

HAS BEEN SUBMITTED BY

Mr. .........................................................................................................

IN PARTIAL FULFILMENT OF THE AWARD OF BACHELOR OF ENGINEERING
IN THE MECHANICAL ENGINEERING BRANCH OF THE
BHARATHIYAR UNIVERSITY, COIMBATORE-641 046
DURING THE ACADEMIC YEARS 1989 - 90

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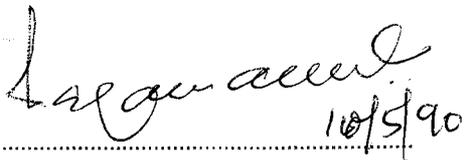
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Head of the Department,

CERTIFIED THAT THE CANDIDATE WAS EXAMINED BY US IN THE
PROJECT WORK VIVA-VOCE EXAMINATION HELD ON ........................
AND THE UNIVERSITY REGISTER NUMBER WAS ..........................................

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Internal Examiner,

_____
External Examiner.

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# CONTENTS

## SYNOPSIS

The object of this project work is to implement the theoritical knowledge acquired during our course of study to the practical applications.

Our project work, cam Design for automatic lathes is done by computer Aided Design and Drawing.

According to component dimensions and operations to be performed on workpiece, the design is made. For the design and drawing, a software is developed in Basic language.

The main body of the software has two modules;

      1. Design of cams

      2. Profile drawing of cams.

In first module the computer gives details which is then fed in second module to obtain profile diagram. The two modules are independent of one another.

The results obtained in computer are used to manufacture cams.

To Assure the generalised program which we have done to produce cams for any type of work piece, a model Design calculations has been done and cams have been produced for a particular work piece.

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# CHAPTER 1

## PREFACE

With the advent of Automatics, time and workload for manufacturing the products in lathes has been considerably reduced.

Formerly the design of cams in Automatic lathes were done by manual calculations. This is a tedious process which consumes a lot of work and time.

Cams are to be designed for each type of component to be manufactured in Automatic lathes. By using computer Aided Design and Drawing for the design of cams instead of manual design, time consumption is greatly reduced which in turn increases the rate of production.

The main advantage of computer aided design used for the design of cams is that, by merely knowing the dimensions and operations to be performed in any component to be manufactured, any common man can design the cams without much technical knowledge.

Thus we hope that this project-work done for design and manufacture of cams used in Automatic lathes will be of immense use in the field of Automatics.

# CHAPTER   2

## AUTOMATIC   MACHINES

### 2.1 INTRODUCTION:

AUTOMATION is the fast Developing field in Industries which has enabled Industries to reach the present stage of smashing rate of production. In future automation has a very great role to play in the Industries.

In this chapter an attempt has been made to give a Brief Description of Automatic machines.

### 2.2 NEED FOR AUTOMATION:

All the operations in machining a workpiece on a metal cutting machine tool are classified as either processing or handling operations. Processing operations are those in which the actual cutting process or chip removal takes place.   The rest are handling operations which include loading and clamping the work, advancing and withdrawing the cutting tools, releasing and unloading the work, checking the size of the workpiece etc.

In upto-date machine tools, the processing operations are performed by the operative mechanisms of the machine tool.   Handling operations are performed in various ways in different machine tools.   A part or even all the handling operations are performed in certain cases by corresponding mechanisms.   The operator of other types of machine tools performs the handling operations himself.

The faster the working and handling operations are performed in a machine tool, lesser the time required to produce a workpiece and more workpieces can be produced in the same period of time by a given machine tool. If more handling operations are performed by the machine tool without the participation of the operator, he will spend less time on attending he given machine tool and can handle more machine tools at the same time. Machine tools enable a workman to machine more workpieces per shift and consequently, his labour will prove more productive. Machine tools are designed with machanisms that perform majority of the required handling operations without direct participation of the operator are called automatic machine tools.

## 2.3  GENERAL CLASSIFICATION

Highly automated machine tools and especially the lathe family are ordinarily classified into automatics and semi-automatics.

### AUTOMATIC MACHINES

Automatics as their name implies, are machine tools which machine workpieces automatically. They have a fully automatic working cycle repeated to produce duplicate parts without participation of the operator.  All the working and handling operations are performed in a definite sequence by the control system adopted in the automatics, which must be set up to suit the given job.

## SEMI-AUTOMATIC MACHINES:

In semi-Automatics the operator loads the blank into the machine, starts the machine, checks the workpiece and removes the completed workpiece by hand. The machining cycle is automated but direct participation of the operator is required to start to each subsequent cycle.

## CLASSIFICATION OF AUTOMATIC MACHINES:

There are different ways of classifying the automatic machines. Depending upon the type of work machined, these machines are classified as,

## MAGAZINE LOADED AUTOMATICS:

These machines are used for producing components from accurate separate blanks.

## AUTOMATIC BAR MACHINES:

Automatic bar machines are designed for machining components from bar or pipe stock.

## ACCORDING TO NUMBER OF SPINDLES:

Depending upon the number of work spindles, the automatic lathes can be classified as: single spindle automatics and multispindle automatics.

## OTHER CLASSIFICATIONS:

Automatics can also be classified according to purpose and arrangement of the spindle. According to purpose, automatics are classified into single and general purpose machines. According to the arrangement of the spindle, automatics are classified into horizontal and vertical machines.

## TYPES OF SINGLE SPINDLE AUTOMATICS:

### AUTOMATIC CUTTING OFF MACHINES

These machines produce short workpieces of simple form by means of cross sliding tools.

### SINGLE SPINDLE AUTOMATIC SCREW MACHINE:

These machines are essentially automatic bar type turret lathes. A vertical slide for parting off operation may also be provide. It is also installed above the work spindle. The headstock is stationary and houses the spindle which rotates in either direction. The barstock is held in a collet chuck and advanced by a feed finger after each piece is finished and cut off. All movements of machine units are actuated by cams mounted on the camshaft. These machines are made in several size from 12.7 mm to 60mm diameter.

## SWISS TYPE AUTOMATIC SCREW MACHINES:

This machine is also known as 'sliding head screw machine' or 'movable headstock machine' because the headstock is movable and the tools are fixed.

## MULTISPINDLE AUTOMATIC MACHINES

The multispindle automatic machines are fastest type of production machines and are made in a variety of models with two, four, five, six or eight spindles. Multiple spindle machine has all turret forces working on all spindles at the same time. Their production capacity is higher than that of single spindle machines but their machining accuracy is somewhat lower.

The multispindle automatic machines may be classified into various types:

## ACCORDING TO LOADING THE WORKPIECE

## BAR TYPE MACHINES

The bar type machines operate on barstock, usually round, but may be hexogonal or any suitable shape.

## ACCORDING TO THE PRINCIPLE OF OPERATION

Parallel action multispindle automatics:

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In this type of machines, the same operation is performed on each spindle and a workpiece is finished in each spindle in one working cycle. The number of components being machined simultaneously is equal to number of spindles in the machine.

PROGRESSIVE ACTION MULTISPINDLE AUTOMATICS:

In this design of multispindle automatic machine, the workpiece is machined in stages and progressively.

SEMI-AUTOMATIC MACHINES:

Depending upon the number of work spindles, the machines are classified as,

SINGLE SPINDLE SEMI AUTOMATICS

It is further classified as following types

CENTRE TYPE:

In the centre type machine, workpiece is held between headstock and tailstock.

CHUCKING TYPE:

In chucking type machine, the workpiece is held in a chuck.

## MULTI-SPINDLE SEMI-AUTOMATICS:

These machines are also classified as,

Centre Type and Chucking type

## CHAPTER 3

## SINGLE SPINDLE AUTOMATIC SCREW MACHINES

### 3.1    INTRODUCTION

The main theme of our project is to design cams for single spindle automatic screw machines. In this chapter a brief description of single spindle automatic screw machines is given.

### 3.2    GENERAL DESCRIPTION

This machine which was originally used for producing small screws, has gradually been modified for the production of small turned parts. The working scope of the basic machine can be enlarged considerably by the application of the various attachments.

They are designed for machining a complex internal and external surfaces from bar stock or separate blanks. A vertical slide attchment may also be employed. All the movements of tool holders are caused by cams mounted on the cam shaft.

The head stock is stationary and installed above the work spindle which rotates in either direction. The bar stock is held in a collet chuck and advanced by a feed finger after each piece is finished and cut off, all movements of the machine unit are actuated by cams. These machines are made in several sizes for bar work from 12.7 mm to 60 mm.

The bar stock is pushed through stock tube in a bracket and its leading end is clamped in rotating spindle by means of a collet chuck. The bar is then fed for the next cycle by a stock feed machanism. Longitudinal turning and machining of the central hole are performed by tools mounted on turret slide. The cut off and form tools are mounted on cross slides. At the end of each cut, the turret slide is withdrawn automatically and indexed to bring the next tool in position.

The cams are screwed on cam holders which are clamped on the control shafts. The three control shafts rotate in the same direction and at the same speed. The feed results from cam rise and control shaft revolutions set by feed change gears. One operation is finished within one control shaft revolution.

The tail stock moves on hardened and lapped guide bars and the drilling quill is provided with a draw bar collet attachment. The feed movement is transmitted by means of a cam roller from the drum cam which is mounted on the centre control shaft.

The stock feed is gravity operated, the material being carried in a strongly walled front loading tube and fed forward by a rotating piston with live female centre.

The swing stop which is pivoted on the rear guide shaft serves as stock stop. It is swung in by a cam located on the rear control shaft and swung out by a tension spring. For longitudinal adjustments the stop is displaced on the guide shaft.

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The slides move on long dovetail guideways with gib attachment. The holders, which are mounted on the slides, are provided with rockers for fine adjustment of the tools and in addition, all the slide movement levers have micro meter depth adjustment and fine longitudinal adjustment. Double or triple tool holders or circular form tool holders can be used on the front and rear cross slide in place of the standard rocker type tool holders.

# CHAPTER 4

## DESIGN OF CAMS

### 4.1    INTRODUCTION

All the operations for processing a job are sequentially arranged. According to the operations and dimensions of the job various cams are designed. Radial movements are obtained by plate cams while axial movements by drum cams.

In this chapter basic principles, design procedure and manufacturing of cams has been explained.

### 4.2    BASIC PRINCIPLES

In automatic lathes the slides and turrets are actuated by plate or disc cams while bar feed and collet clamping are operated by barrel cylinder cams.

A simple cam system is a three-link mechanism with a higher pair. It is mainly used for the transformation of rotary motion by a driving link to a motion of the driven link, connected by a given law.

As cam system consists of cam and a follwer. The cam is connected with a frame in a turning pair and the follower is connected in a sliding pair. The cam and the follower are connected in a higher pair.

In order to reduce frictional wear on the follower end which bears the thrust of the cams, the follower end is provided

with a freely turning cylindrical roller on the axis. The constant contact of the follower with the cam is usually ensured by a spring. In an alternative arrangement, the push rod type follower is replaced by a rocker follower that is connected with the frame in turning pair.

GENERAL PRINCIPLES FOR CAM DESIGN

The following rules are generally used during design of cams for automatic screw machines.

1. Circular tool arrangement, best suited for workpieces are used in cross slides.

2. Considerable high spindle speeds are used.

3. The quickest and best method of arranging the operations are decided before designing the cams.

4. When the same operation can be performed both by a turret tool and a cross slide tool then the later will be preferred.

5. Work approach allowance, make up clearnce and the cutting off allowances are to tbe provided.

6., The feed of parting tool is to be decreased at the end of the cut when the piece is to be separated from the bar.

7. Sufficient clearance is to be decreased at the end of cut and the piece is to be separated from the bar.

8.  When a thread is to be cut, upto a shoulder by a die then for the provision of clearance a grooved neck is to be made near the shoulder.

9.  A number of drills or a drill withdrawn and introduced several times are used when the hole length to be drilled is more than 4 times the drill diameter.

10, Care must be taken during selection of tools and tool holders so that they do not foul with the machine bed or turret slide when the turret is revolved.

11. When only three operations are to be done by turret tools, then swing stop is used and turret is doubly indexed.

12. During threading operation the nearest spindle speed most suitable is to be adopted by special arrangement to attain quality of thread required.

13. Standard tools are to be used as far as possible.

14. While designing special tools having intricate movements springs are avoided and positive actions are used.

Designing of cam atually means determination of number of spindle revolutions required for each operation and idle movements. Overlappings are done whenever and wherever possible for such operations.

## 4.3  STEPS INVOLVED IN CAM LAYOUT

1.  ACCORDING TO THE MATERIAL OF WORKPIECE , SURFACE SPEED AND SPINDLE SPEED ARE DETERMINED.

The material used for workpiece may be brass, aluminium, free cutting steel or steels having rockwell hardness upto 100. Drwn bars with diametrical tolerance of h 11 grade are used.

According to the material of workpiece, surface speed is selected from the tables. Spindle speed is then calculated using the relation,

$$\text{sindle speed RPM} = \frac{\text{surface speed} \times 1000}{3.14 \times \text{diameter of rods in mm}}$$

The calculated RPM is then rounded up to the nearest available lower spindle RPM

2.  PREPARE THE SEQUENCE OF OPERATIONS

The operations and tools that are to be used to obtain the required shape of workpiece is decided. Also the movement of tools to get the required component in the machine are determined.

3.  CALCULATION OF THROW FOR CAMS TO PERFORM EACH OPERATION.

The throw of the cams are calculated from the dimentions of model component. Throw is the tool moving distance in order to get the final shape of component from the feeded rod.

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4.   ALLOWANCES FOR APPROACH AND OVER TRAVEL OF TOOL ARE ADDED TO GET THE TOTAL THROW.

Allowances are given for tool approach, tool overtravel, tool ground angles. Allowances are also given for the perfect machining of workpiece.

5.   THE FEED FOR EACH OPERATION IS DETERMINED

Feed for each operation is selected accordingly.

6.   CALCULATE THE NUMBER OF SPINDLE REVOLUTIONS FOR EACH OPERATION.

Number of spindle or absolute revolutions is calculated using the relation,

$$\text{Absolute revolution} = \frac{\text{throw}}{\text{Feed}}$$

7.   OVERLAPPING OF WORKING OPERATION IS DONE AS PER THE OVERLAPPING PROCEDURES

Overlapping operations will help to decrease the cycle time and increase the gross hourly rate of production. If the cutting force of one operation affects the other operation they cannot be overlapped. e.g. Knurling or undercut cannot be overlapped with drilling since the thrust force during knurling or undercut may break the drill bit.

8.　DETERMINATION　OF　THE　NUMBER　OF　EFFECTIVE REVOLUTIONS

Operations having less abolute revoutions are overlapped with operations having more absolute revolutions.

The unoverlapped absolute revolutions are added to get the total effective revolutions. The absolute revolutions of operations which are dependent on each other will come in effective revolutions.

9.　DETERMINATION OF IDLE TIME [lost degrees].

The time in a cycle when no operation on workpiece can be done is called idle time. The degrees of cam revolutions lost are called lost degrees. For feed out and chucking a lost degree of 40° are given. For retraction of parting off tool 15° is given as lost degrree.

10.　CALCULATION OF GROSS HOURLY RATE OF PRODUCTION

Gross hourly production rate is calculated using the following relation

$$\text{Pieces per hour (gross)} = \frac{\text{Spindle speed} \times (360 - \text{Lost Deg})}{\text{Effective revolution} \times 6}$$

In the gross hourly rate of production no allowances are made for machine down time which is required for sharpening of tools, loading of machine with a new bar etc. Therefore net production rate will be 75% or 80% of gross hourly production rate.

Cycle time is the time taken to make one workpiece. It is obtained from₁₁ the relation

$$\text{Cycle time } T_c \text{ (min)} = \frac{60}{\text{Gross hourly production rate}}$$

**11. FIND THE LENGTH OF CAM IN DEGREES FOR EACH OPERATION.**

Length of each cam is calculated in degrees for every operation.

**12. DETERMINATION OF EFFECTIVE DEGREES FOR EACH OPERATION.**

$$\text{Degree of each operation} = \frac{\text{Absolute Rev. x ( 360 - Lost degrees )}}{\text{Total effective revolutions}}$$

The total throw of the operation will be distributed in this degrees.

**13. DETERMINATION OF START AND END POINTS IN DEGREES**

The start and end points are calculated in degrees. If an operation is overlapped with some other operation it may have a start and end points within the operation which has more degrees of operation. All operations must finish within 360° cycle time.

The sequence of working and idle movements in degrees is determined on the basis of

    i) Tooling layout

    ii) Order of operations as per in operation sheet.

    iii) Overlapping of the working and idle movements.

iv) The number of degrees required for each movement.

Usually a cam will have four strokes rapid approach, working speed, dwell and rapid withdrawal. Each of thse sections is a helical surface but with different helix angles. Rapid approach and return should be performed with minimum time loss. Therefore the cam curve should rise or drop sharply at these places.

Uniform velocity motion for the follower is preferable in automatic lathes. The sudden approach and withdrawal speeds are expressed in metres per minute. In regular practice it is necessary to increase the speed of withdrawal stroke while drecreasing approach speed of tool. This will prevent the tool from starting the cut at the rapid approach speed.

14.    RAPID APPROACH AND WITHDRAWAL DEGREES CALCULATION

The rapid approach and withdrawal degree is calculated using the relation

$$\text{Degree of approach or withdrawal} = \frac{1000 \times V}{6 \times \text{Gross hourly production rate}}$$

where, V is speed of approach or withdrawal in metres per minute

The designed degree of each stroke of cams are tabulated. A plate cam known as zero cam is paired with the drum cam for the longitudinal turning operation. Thus turning is a combined operation of plate and drum cams.

**15.     SIZE AND CONFIGURATION OF DESIGNED CAMS ARE DETERMINED**

Drum cams are designed for operations having axial movement. As a rule the sudden approach helix angle of 45 are given for drum cams sudden withdrawal is done sharply. It is a sharp curve in case of longitudinal drum cam.

**16.     TOOL LAYOUT AND OPERATION SHEETS ARE DRAWN.**

Tool layout with the work make is drawn for the easy understanding of tool nomenclature. Machine tool selection should always be based on the feasibility of processing a given job with the specified accuracy and at the desired rate of production.

Cutting tools may be manufactured of carbon steel or high speed steel or they may be tipped with cemented carbides or ceramic tool materials. High speed steel and cemented carbides are generally used.

Operation sheet is the sheet having all the following details:

    i)    Tool layout

    ii)    Part name with drawing showing its surface finish and allowances.

    iii)   Material of workpiece

    iv)    Diameter of the bar chuckedin with tolerences.

    v)    Cycle time and gross hourly production rate.

vi) Cam shaft change gear ratios.

vii) Spindle speed.

viii) Cutting speed

ix) All the details regarding the design of cams are also tabulated in this chart. It consists of the follwing:

Sequence of operation
Length of cut or throw
Feed
Absolute revolutions
Operation Degree
Start and end point of each operation

x) Rise/ throw ratio for the links

## 4.4  CAM NOMENCLATURE:

BASE CIRCLE:  It is the smallest circle that can be drawn to the cam profile.

TRACE POINT:  It is a reference point on the follower and is used to generate the pitch curve.  In case of knife edge follower, the knife edge represents the trace point and the pitch curve corresponds to the cam profile.  In a roller follower, the centre of the roller represents the trace point.

PRESSURE ANGLE:  It is the angle between the direction of the follower motion and normal to the pitch curve.  This angle is very important in designing of cam profile.  If the pressure angle is too large a translating follower will jam in its bearings.

PITCH POINT:  It is a point on the pitch curve having the maximum pressure angle.

PITCH CIRCLE:  It is a circle from the cam centre through the pitch point.

PRIME CIRCLE:  It is the smallest circle from the cam centre through the pitch curve.

LIFT or STROKE:  It is the maximum travel of the follower from its lowest position to the topmost position.

DIRECTION OF MOTION

FOLLOWER

$\alpha_m$, MAXIMUM PRESSURE ANGLE

NORMAL

PITCH POINT

DIRECTION OF MOTION

TRACE POINT

PITCH CIRCLE

TANGENT

CAM PROFILE

PITCH CIRCLE RADIUS

PRIME CIRCLE

PITCH CURVE

BASE CIRCLE

BASE CIRCLE RADIUS

PRIME CIRCLE RADIUS
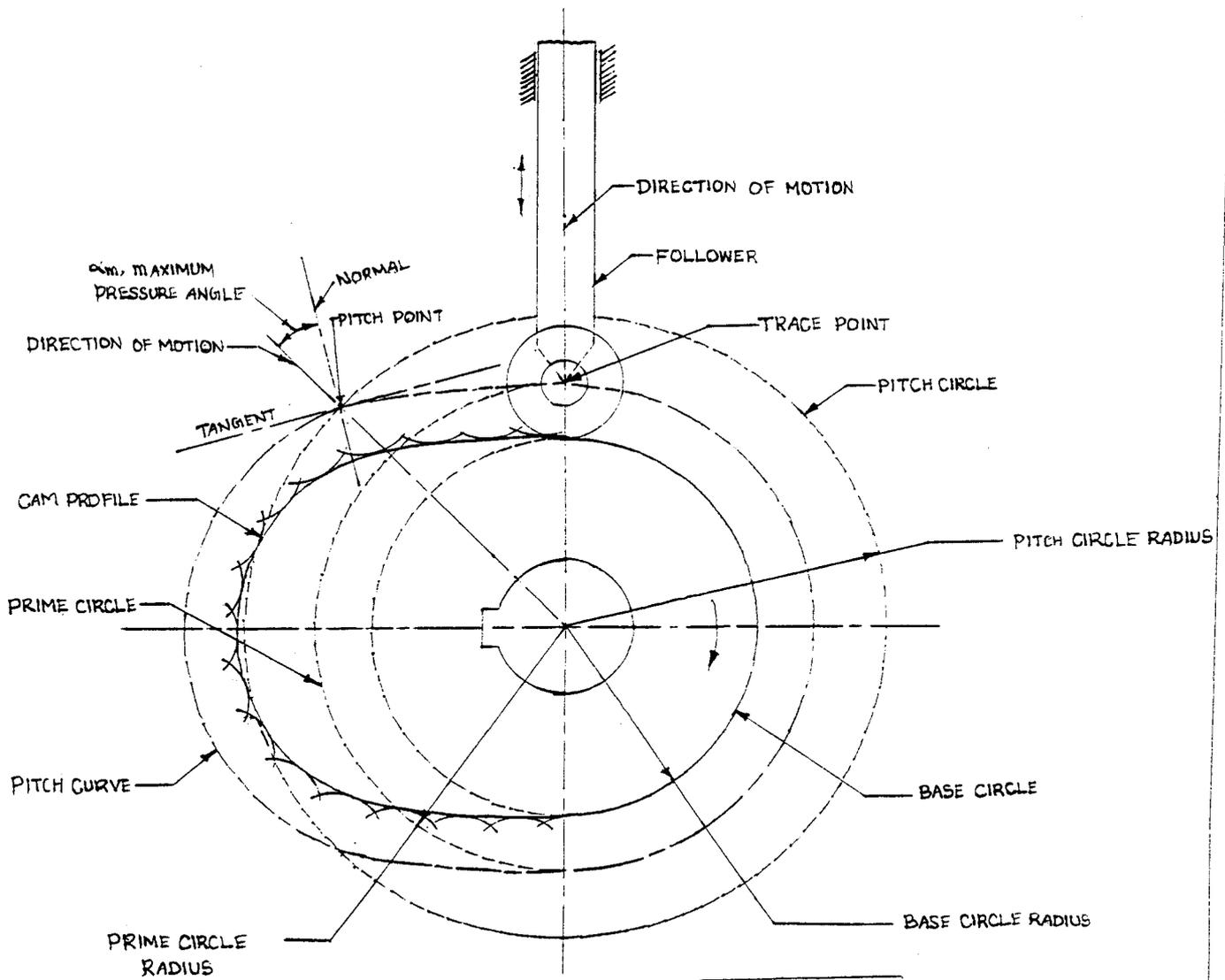
TITLE :

CAM NOMENCLATURE

## 4.4  CONSTRUCTION OF CAM PROFILE:  <u>DISPLACEMENT DIAGRAM</u>

i)   Draw a horizontal line with suitable scale.

ii)   Divide this line to represent the stroke angles of the follower.

iii)   Draw a vertical line equal to the stroke of the follwer.

iv)   Divide the angular displacement during outstroke into any equal numbers.

v)   Since the follower moves with uniform velocity during outstroke and returnstroke, therefore the displacement diagram consists of straight lines.   Join the start and end points for each stroke.

### <u>PROFILE DIAGRAM:</u>

i)   Draw a prime circle with radius equal to the minimum radius cam.

ii)  The prime circle is divided into 360° degrees.   The degrees of each stroke is marked on this circle.

iii)  The displacement of cam follower at each intervel of degree as in displacement diagram is marked from the prime circle.

iv)  Join all the marked points with a smooth curve. The curve is the completed profile of cams.

## 4,6   CAM MANUFACTURING PROCEDURE:

The following sequences of operations are in usual practics for cam manufacture :

(i)     Turning on a lathe and boring central hole.

(ii)    Drilling and reaming the locating pin hole, diving the cam surface into hundred divisions, laying cut for the outline of all lobes on the cam.

(iii)   Milling the outline on a milling or special machine

(iv)    Filing the outline

(v)     Heat treatment

(vi)    Grinding the central hole.

Plate cams are made of steel, C15, C45 and pearlitic phospharic C.I. Cylinder cams are made of steel C15, C45 or cast iron. They may be designed as drums in which slots of the required form are milled. Hollow cylinders machined inside and outside are usually used as blanks for the above cams which are simply cut off from the blanks. Holes are drilled and centrebored. If the cylinder cams are made of steel, they are heat treated after checking.

# CHAPTER 5

## INTRODUCTION TO PROGRAMING

### 5.1 INTRODUCTION

BASIC is a language easy to use, whose instructions resemble elementary algebraic formulae augmented by certain English key words such as LET, READ, PRINT etc. Most other high level languages have similar features and they are generally more complicated. Thus, BASIC particularly is well suited for persons learning program for the first time.

BASIC is not only used for elementary applications but also for a variety of more advanced applications in such areas like business, science and engineering. BASIC is also the principle language used in micro computers.

### 5.2 STRUCTURE OF A BASIC PROGRAM

Each instruction in a BASIC program is written as separate statements. Thus a complete BASIC program will be composed of a sequence of statements.

The following rules apply to the older more traditional versions of BASIC:

      i) Every statement must appear on a separate line.

      ii) Each statement must begin with a positive integer quantity known as line number.

iii)   Each statement number must be followed by a BASIC

key word, which indicates the type of instruction

that is to be carried out.

iv)   Blank spaces may be inserted wherever desired.

The rules can be relaxed considerably in some versions of

micro computer BASIC

## 5.3   GRAPHICS FUNDAMENTALS:

In graphics, the fundamental elements are small dots called

pixels.   These pixels can be combined to form more complex

shapes.

The level of resolution of a graphic display is measured in

terms of the largest number of horizontal and vertical pixels

that can be displayed   at any one time.   These values will

be determined by computer hardware.

The IBM personnal computer in its most basic form can support

two graphic modes.   These are refered to as madium resolution

and high resolution respectively.The choice of the mode

accomplished with the SCREEN statement. Thus     SCREEN     1

involves medium resolution graphics mode and SCREEN 2

involves high resolution graphics mode.

## 5.4  GRAPHIC COMMANDS USED IN PROGRAMMING

PSET            -            Generates a point

To use this statement the word PSET must be followed by a pair of parameters, enclosed in paranthesis and separated by a comma.

Eg: PSET (X,Y)

COLOR           -            Sets colours

Colour statement can include two parameters first parameter specifies back colour. The second parameter specifies "platte". ( is a group of three colours )
e.g. Color 7, 0

LINE            -            Allows straighht line to be drawm
between two points on the screen.
e.g. LINE (20, 50) - (350 - 150)
If the line statement ends with the letter B
e.g. LINE (20, 50) - (350 -150),, B
then the two pairs of coordinates will be interpreted as opposite corners of the rectangle.

If the line statement ends with the letters BF
E.g. LINE (20, 50) - (300, 150),, BF

The last letter F represents 'FILL'. The parameter causes a rectangle to be filled with a specified colour.

CIRCLE          -            It permits circles, arcs and ellipse to be drawn.

The statement consists of the word CIRCLE followed by a pair of coordinates enclosed

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in paranthesis and separated by a coma

The coordinates must be followed by
a value for the radius.

e.g.

CIRCLE  (160, 100), 80

The circle statement can be used not
only to generate circles but also arcs
To do so the radius must be followed
by a coma, and two additional para-
meters, a starting angle and an ending
angle. These angles are increasing
in counter clockwise direction. Both
angles must be expressed in radiants.

Circle statement is also used to create
ellipse and elleptical arcs. The aspect
parameter must follow the starting
and ending angles in the circle statement.

e.g.
CIRCLE (160, 100), 80, 1, 0, 3.14

It must be a positive number or an
expression resulting in a positive
numerical value.

PAINT        –          Fills an enclosed graphics shape. PAINT
statement refers to a point within the
frame.

e.g.

PAINT (100, 40)

# CHAPTER 6

## FLOW CHART

6.1 PROGRAM FOR MAIN MENU

```
                    ( START )
                        |
                        v
   /--------------------------------------------\
   |                PRINT                       |
   |                                            |
   |     TYPE 1 FOR PROJECT DETAILS             |
   |                                            |
   |     TYPE 2 FOR DESIGNING CAMS              |
   |                                            |
   |     TYPE 3 FOR DRAWING CAMS                |
   |                                            |
   |         TYPE 4 FOR EXIT                    |
   |                                            |
   |        Enter your selection                |
   \--------------------------------------------/
                        |
                        v
                 +--------------+
                 |  INPUT OPT   |
                 +--------------+
                        |
    OPT=1         OPT=2         OPT =3        OPT=4
   +-------+     +-------+     +-------+     +-------+
   | CHAIN |     | CHAIN |     | CHAIN |     | STOP  |
   +-------+     +-------+     +-------+     +-------+
      |             |             |
      v             v             v
 +----------+  +----------+  +----------+
 | PROGRAM  |  | PROGRAM  |  | PROGRAM  |
 |"PROJECT" |  |"DESIGN"  |  |"DRAWING" |
 +----------+  +----------+  +----------+
```

PROGRAM FOR PROJECT DETAILS

START

GOSUB → B1

PRINT

PROJECT DETAILS

CHAIN

PROGRAM "MAIN"

B1

PRINT

"PROJECT DETAILS"

RETURN

32
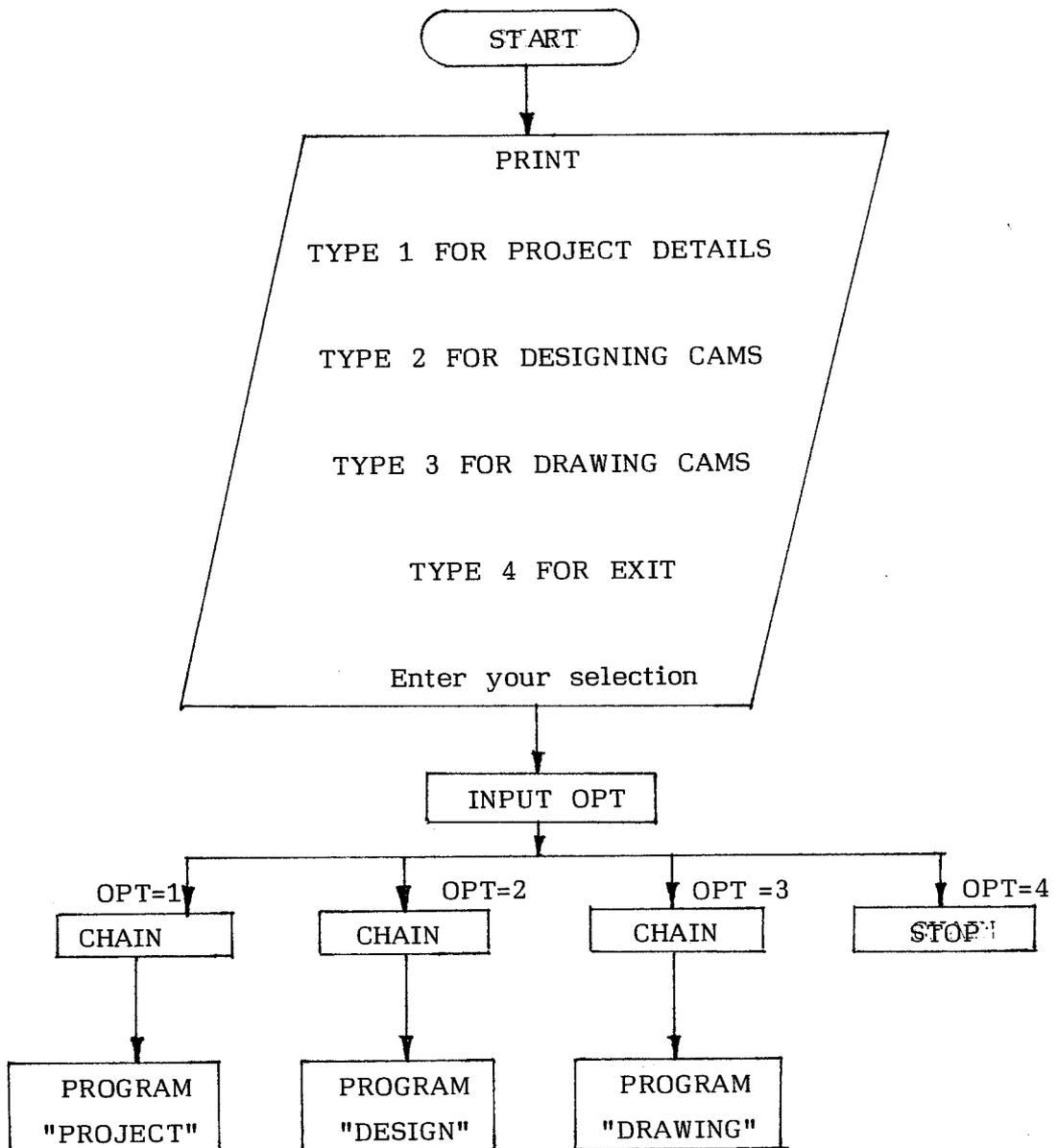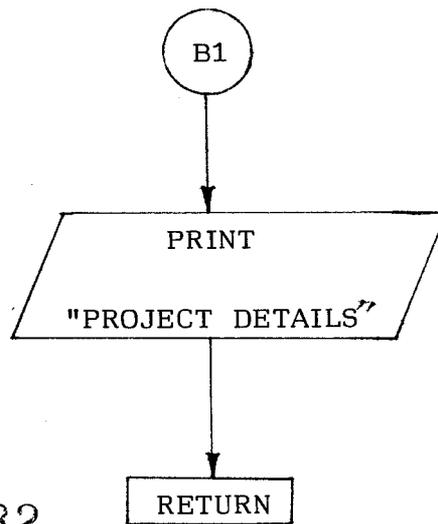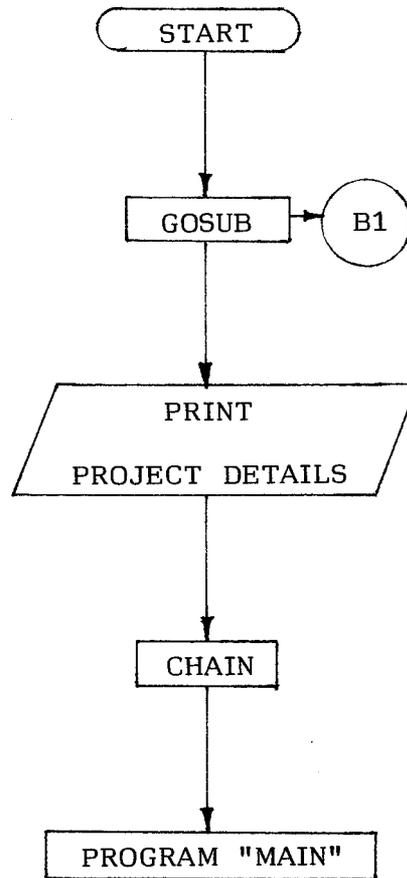
# FLOW CHART

6.2 CAM DESIGN PROGRAM

```
                    ( START )
                       │
        ╱──────────────────────────────╲
       ╱           PRINT                 ╲
      ╱    INSTRUCTIONS  BEFORE           ╲
     ╱      DESIGNING  THE  CAMS           ╲
     ╲──────────────────────────────────────╱
                       │
                ┌──────────────┐
                │    GOSUB     │────────▶ ( A1 )
                └──────────────┘
                       │
        ╱──────────────────────────────╲
       ╱           INPUT                 ╲
      ╱     WORKPIECE  MATERIAL           ╲
     ╱       DIA  OF  WORKPIECE            ╲
    ╱          SURFACE  SPEED              ╱
    ╲────────────────────────────────────╱
                       │
                ┌──────────────┐
                │    GOSUB     │────────▶ ( A2 )
                └──────────────┘
                       │
        ┌────────────────────────────┐
        │    CALCULATION  FOR  RPM    │
        └────────────────────────────┘
                       │
                ┌──────────────┐
                │    GOSUB     │────────▶ ( A3 )
                └──────────────┘
                       │
        ┌────────────────────────────┐
        │    CALCULATIONS  FOR        │
        │    PIECES  PER  HOUR        │
        └────────────────────────────┘
                       │
                ┌──────────────┐
                │    GOSUB     │────────▶ ( A4 )
                └──────────────┘
                       │
                ┌──────────────┐
                │    GOSUB     │────────▶ ( A5 )
                └──────────────┘
                       │
                ┌──────────────┐
                │    GOSUB     │────────▶ ( A6 )
                └──────────────┘
                       │
                    ( C1 )
```

```
          ┌──────┐
          │  C1  │
          └──┬───┘
             ↓
    ╱───────────────────────╲
   ╱        PRINT             ╲
  ╱    TOTAL  LOST  DEGREES    ╲
 ╱       SELECTED  SPEED        ╲
╱───────────────────────────────╲
             │
             ↓
         ┌────────┐
         │  CHAIN │
         └───┬────┘
             │
             ↓
      ┌────────────────┐
      │ PROGRAM "MAIN" │
      └────────────────┘


          ┌──────┐
          │  A1  │
          └──┬───┘
             ↓
    ┌────────────────────┐
    │ INITIAL  ASSUMSIONS│
    │ FOR  CALCULATIONS  │
    └─────────┬──────────┘
              ↓
         ( RETURN )
```

34

A3

GOSUB → A7

CALCULATE THE ABSOLUTE

REVOLUTIONS FOR EACH OPERATION

IS THE

OPERATION TURNING

OR TAPER TURNING

YES

CALCULATION OF
ABOSOLUTE
REVOLUTION

IS THE OPERATION

DIMENTION DECREASED BY

ANY OTHER OPERATION

YES

INPUT DECREASED

VALUE

NO

CALCULATION OF
EFFECTIVE
REVOLUTIONS FOR
THIS OPERATION

35

C2

36

(A7)

```
ADD CLEARENCES TO
TOOL MOVING DISTANCE
OF EVERY OPERATION
```

( RETURN )

(A2)

```
          INPUTS

     OPERATION NAME

   TOOL MOVING DISTANCE

THE OPERATION IS DEPENT OR NOT

THE DIMENSTION IS DECRESED OR NOT

FOR EACH OPERATION
```

```
CALCULATION FOR LOST DEGREES
```

( RETURN )

(A4)

```
CALCULATING THE DEGREE FOR

     EACH OPERATION
```

```
      PRINT

   THE DEGREE
     FEED
     THROW
FOR EACH OPERATION
```

37

(C3)

(C3)

RETURN

(A5)

ROUND THE PIECES PER
HOUR VALUE

SELECT THE GEARS FOR
REQUIRED RPM

PRINT

PIECES PER HOUR

SELECTED GEARS

SELECTED RPM

RETURN

(A6)

ROUND THE RPM VALUE

RETURN

38

## 6.3 PROGRAMING FOR CAM PROFILE AND DISPLACEMENT DIAGRAM

```
                    ( START )
                        |
                        v
    /---------------------------------------\
    |              PRINT                      |
    |    THE GENERAL INFORMATIONS             |
    \---------------------------------------/
                        |
                        v
              /\
             /  \
            /    \
           /  DO YOU WANT            \
          /  THE DEGREES FOR RAPID    \        YES
          \  APPRACH AND RAPID RETURN /----------+
           \    /                                 |
            \  /                                  v
             \/                              +--------+      ( D1 )
              |                              | GOSUB  |---->
              | NO                           +--------+
              v                                  |
    +--------------------+                       |
    |       INPUT        |<----------------------+
    |                    |
    |    LENGTH OF       |
    | DISPLACEMENT DIAGRAM |
    |  LENGTH OF STROKE  |
    +--------------------+
              |
              v
          +--------+
          | GOSUB  |--------------------->  ( D2 )
          +--------+
              |
              v
            ( C4 )
```
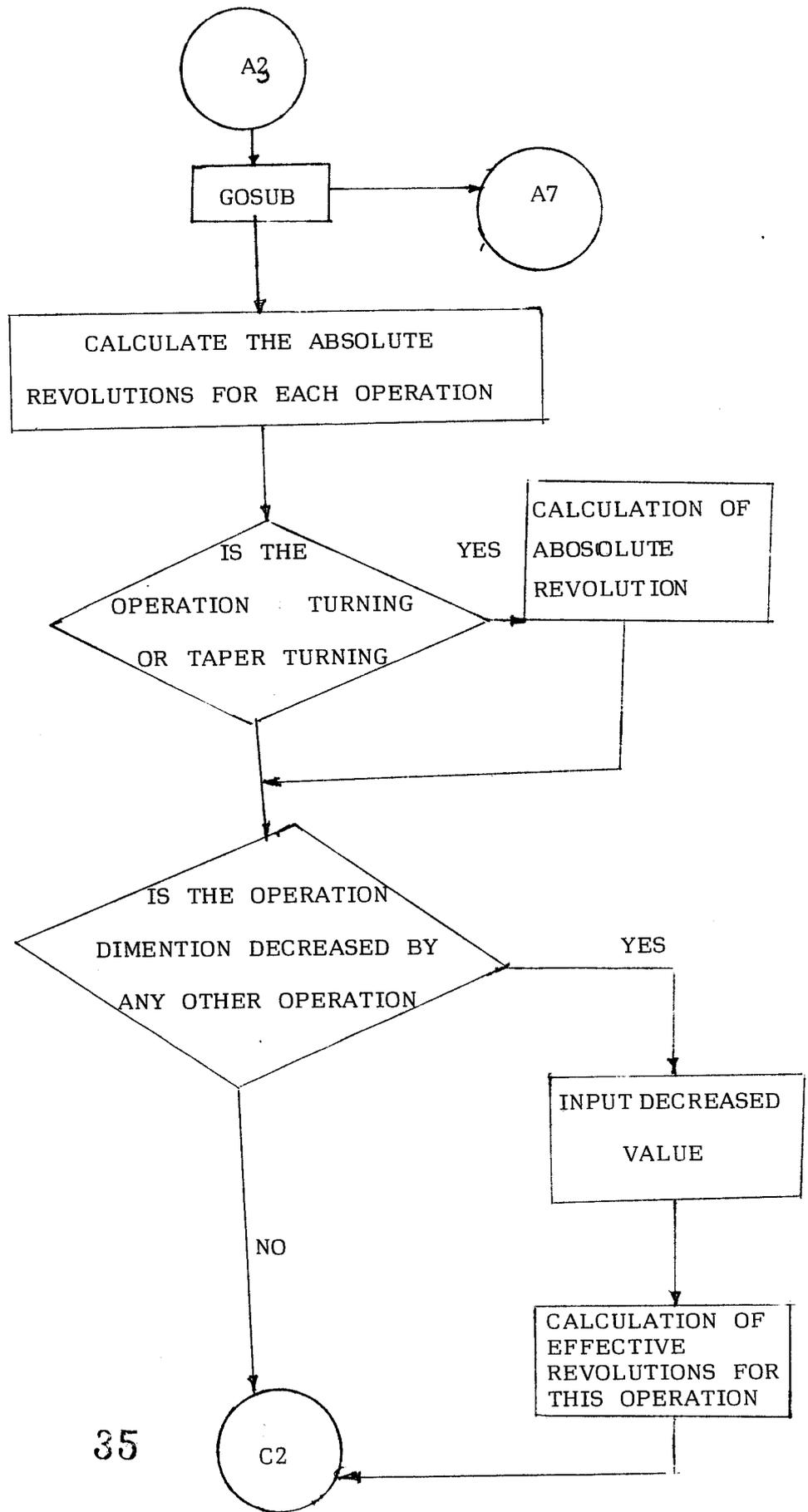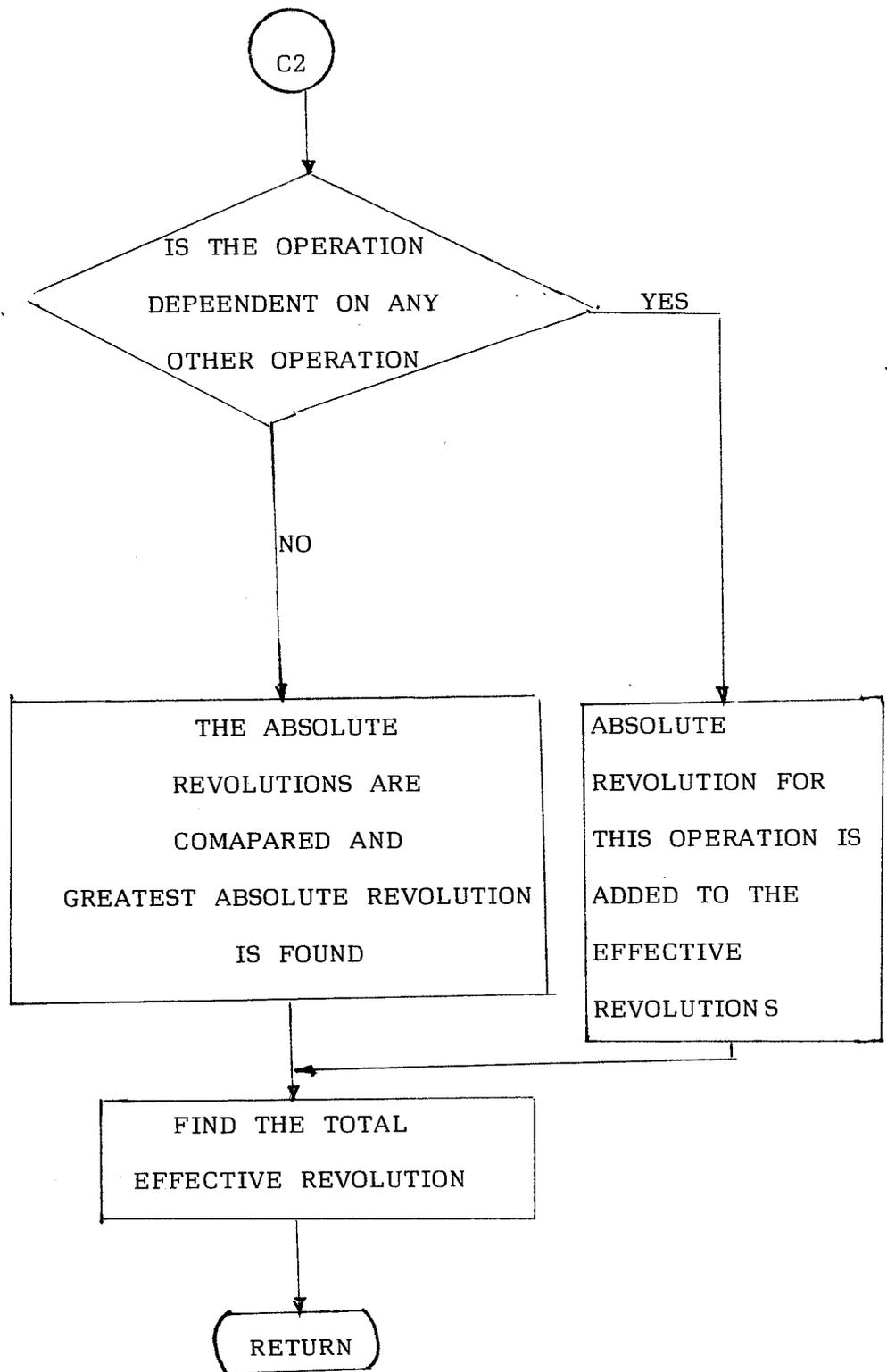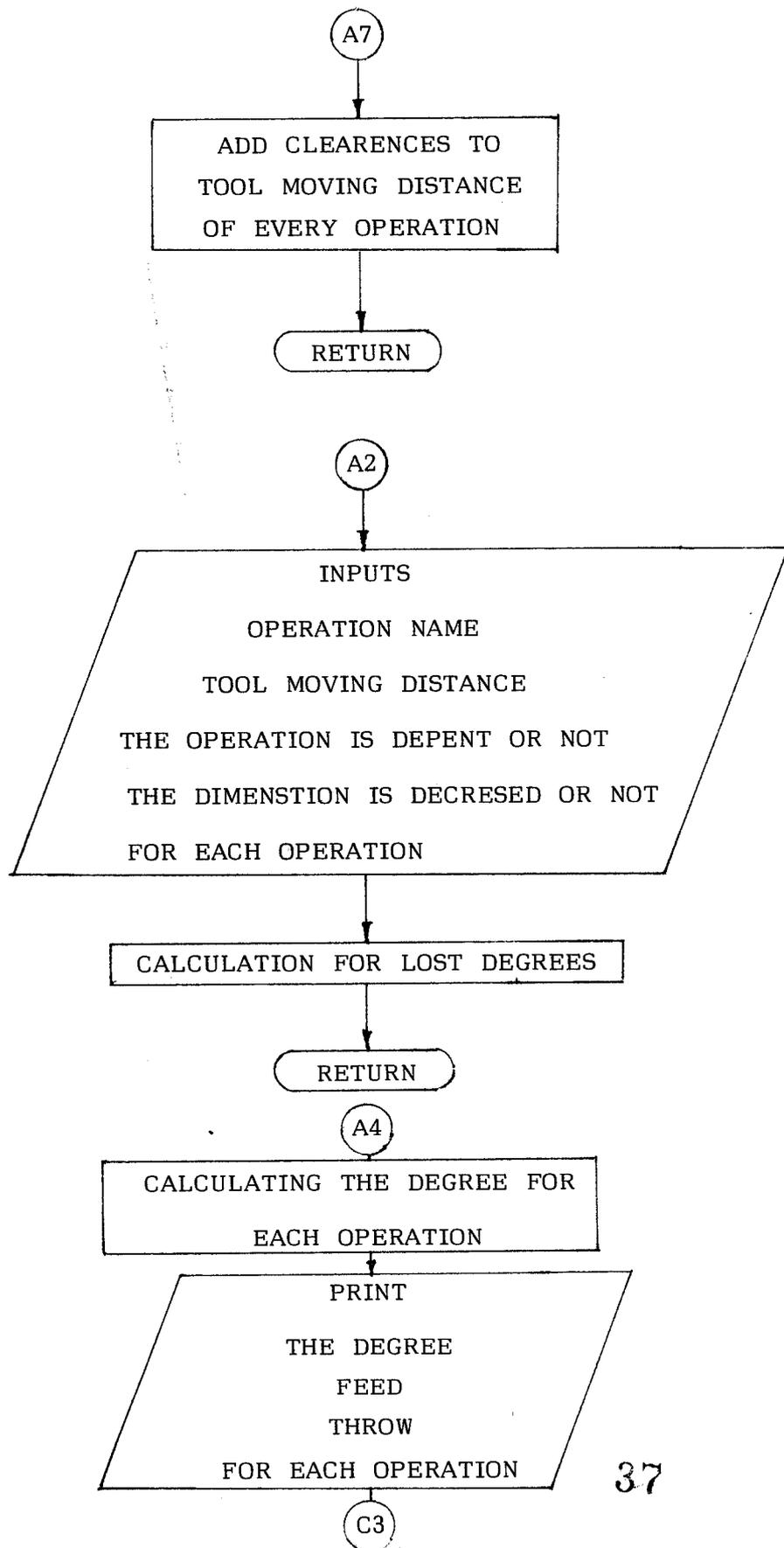
39

```
                        ( C4 )
                          │
                          ▼
                  ╱─────────────────╲
                ╱   DO YOU WANT       ╲
               ╱  THE DRUM CAM PROFILE  ╲────────▶  [ GOSUB ]  ────▶  ( D3 )
                ╲                      ╱
                  ╲─────────────────╱
                          │
                          ▼
                  ╱─────────────────╲
                ╱  DO YOU WANT THE    ╲        NO
               ╱   PROFILE DIAGRAM     ╲────────────▶  [ GOSUB ]  ────▶  ( D4 )
                ╲                      ╱                   │
                  ╲─────────────────╱                     │
                          │                               │
                         YES                              │
                          │                               │
                          ▼                               ▼
              ╱──────────────────╲          ╱─────────────────────────╲
             ╱      INPUT          ╲        ╱         INPUT             ╲
            ╱                       ╲      ╱     STROKE ANGLES           ╲
            ╲                       ╱      ╲  UNIFORM VELOCITY UPTO       ╲
             ╲  TYPE OF FOLLOWER   ╱        ╲    WHICH LENGTH OF          ╱
              ╲──────────────────╱           ╲      LENGTH OF           ╱
                        │                      ╲      STROKE           ╱
                        │                        ╲──────────────────╱
                        │                                 │
                        │                                 ▼
                        │                          [ GOSUB ] ────▶ ( D2 )
                        │                                 │
                        │                          [ GOSUB ] ────▶ ( D5 )
                        │                                 │
                        │                          [ GOSUB ] ──▶ ┌──────────┐
                        │                                        │ PROGRAM  │
                        ▼                                        │ "MAIN"   │
                      ( C5 )              40                     └──────────┘
```

```
                              ( C5 )
                                │
                               ╱ ╲
                              ╱   ╲
                     ╱ IS  THE         ╲
                    ╱ FOLLOWER  A  ROLLER ╲
                    ╲ FOLLOWER           ╱
                     ╲                 ╱
                      ╲               ╱
```

INPUT
ROLLER RADIUS

INPUT

PRIME CIRCLE RADIUS

CO -ORDIATES
STROKES ANGLES
UNIFORM VELOCITY UPTO WHICH
LENGTH OF STROKE

GOSUB ──────────► ( D2 )

GOSUB ──────────► ( D6 )

( CHAIN )

PROGRAM "MAIN"

( D1 )

INPUT

INNER DIA OF THE CAM BLANK

OUTER DIA OF THE CAM BLANK

THROW OF THE CAM

CALCULATE THE RAPID APPROACH
AND RAPID RETURN ANGLES

PRINT THE RAPID APPROACH
AND RAPID RETURN ANGLES

( RETURN )

41

(D2)

```
┌─────────────────────────┐
│   MM  TO  PIXELS        │
│   CALCULATIONS          │
└─────────────────────────┘
```

( RETURN )

(D3)

/ INPUTS

NUMBER OF STROKES
STROKE ANGLE FOR EACH STROKE
DWELL OR WORKING STROKE
TOOL MOVING DISTANCE /

```
┌─────────────────────────────┐
│  CALCULATE  THE  CO-ORDINATES │
│  OF  THE  PROFILE  DIAGRAM   │
└─────────────────────────────┘
```

/ DRAWING
THE CAM PROFILE /

( RETURN )

(D4)

| INTIAL  ASSUMSIONS |

( RETURN )

(D5)

/ DRAWING  THE  DISPLACEMENT

DIAGRAM /

( RETURN )

```
                    ( D6 )
                       │
                       ▼
          ┌────────────────────────┐
          │        DRAWING         │
          │  THE BORDER LINE AND   │
          │      PRIME CIRCLE      │
          └────────────────────────┘
                       │
                       ▼
              ┌──────────────┐
              │    GOSUB     │─────────▶ ( D7 )
              └──────────────┘
                       │
                       ▼
           ╱────────────────────────╱
          ╱  DRAWING  OR  PLOTING  ╱
         ╱  THE  PROFILE  POINTS  ╱
        ╱────────────────────────╱
                       │
                       ▼
              (  RETURN  )


                    ( D7 )
                       │
                       ▼
        ┌──────────────────────────────┐
        │ CALCULATE THE HORIZONTAL AND  │
        │ VERTICAL DISTANCE OF PROFILE  │
        │ POINTS FROM THE CENTRE        │
        └──────────────────────────────┘
                       │
                       ▼
              (  RETURN  )
```

43

# CHAPTER 7

## SOFTWARE

### 7.1   MAIN MENU

```
10  '*************************************************************************
20  '          COMPUTER AIDED CAM DESIGN FOR AUTOMATIC LATHE
30  '*************************************************************************
40  '        PROGRAM DONE BY
50  '
60  '                            S.BALAMURUGAN
70  '                            P.V.DAVIS
80  '                            P.RAMAYAM
90  '                            M.K.SINGARAVEL
100 '     GUIDED BY
110 '
120 '                            MAJOR T.S.RAMAMOORTHY
130 '                            HOD MECHANICAL ENGINEERING
140 '        KUMARAGURU COLLEGE OF TECHNOLOGY
150 '        COIMBATORE
160 '
170 '                            MAIN MENU
175 SCREEN 0:COLOR 14,4,4
180 CLS : KEY OFF :WIDTH 80 : COLOR 15,5,1
190 PRINT "                  MAIN MENU"
200 PRINT
205 WHILE OPT <> 4
210 PRINT " TYPE 1 FOR  PROJECT DETAILS "
220 PRINT : COLOR 0,5,4
230 PRINT " TYPE 2 FOR DESIGNING CAMS "
240 PRINT : COLOR 14,4,4
250 PRINT " TYPE 3 FOR DRAWING CAMS "
260 PRINT : COLOR 15,5,1
270 PRINT " TYPE 4 FOR EXIT "
280 PRINT : COLOR 16,7,4
290 PRINT " Enter your selection _____"
295 COLOR 15,5,4
300 INPUT OPT
320  ON OPT GOSUB 370,380,390
340 IF (OPT > 4 ) OR ( OPT < 1 ) THEN PRINT " ERROR SELECTION "
350 FOR I=1 TO 1000 : NEXT I
360 GOTO 180
365 WEND
366 GOTO 400
370 CHAIN "PROJECT"
380 CHAIN "DESIGN"
390 CHAIN "DRAWING"
400 PRINT "          THANK YOU FOR YOUR COOPERATION "
410 END
```

7.2    PROGRAM  FOR  PROJECT  DETAILS

```
8000 '                   .
8001 '****** PROJECT DETAILS ******
8002 '
8009 GOSUB 8500
8010 KEY OFF:CLS
8020 PRINT
8030 TEXT$="  S.BALAMURUGAN    P.V.DAVIS      M.K.SINGARAVEL      P.RAMAYAN"
8040 SCREEN 1 :COLOR 0,1
8050 PRINT "THIS PROJECT IS DONE BY"
8060 CIRCLE(150,100),150,3,,,.4
8070 CIRCLE(150,100),150,2,,,.3
8080 CIRCLE(150,100),150,2,,,.2
8090 LINE(260,60)-(270,40)
8100 LINE-(320,40):LINE-(300,100)
8110 LINE(260,140)-(270,160)
8120 LINE-(320,160):LINE-(300,100)
8130 LINE(260,99)-(300,99)
8140 LINE(260,100)-(300,100)
8150 LINE(118,160)-(125,170)
8160 LINE-(175,170):LINE-(182,160)
8170 CIRCLE(135,165),2
8180 CIRCLE(150,165),2
8190 CIRCLE(165,165),1
8200 LINE(80,90)-(225,110),3,B
8210 FOR I=1 TO 64 STEP 16
8220 LOCATE 13,12:PRINT MID$(TEXT$,I,16);
8230 FOR COUNT=1 TO 1000:NEXT COUNT
8240 LOCATE 13,12: PRINT SPACE$(16);
8250 NEXT I
8260 CHAIN"MAIN"
8500 '
8510 '************* SUBROUTINE FOR PROJECT DETAILS ************
8520 '
8530 KEY OFF:   CLS:   SCREEN 0
8570 PRINT
8575 WIDTH 80
8576 PRINT
8577 PRINT
8578 PRINT
8579 PRINT
8580 PRINT"      PROJECT   NAME  : COMPUTER AIDED DESIGN  OF
8590 PRINT"                        CAMS FOR AUTOMATIC LATHE
8600 COLOR 15,5,1:PRINT
8610 PRINT"      GUIDED BY       : Prof. T.S. RAMAMURTHI
8620 PRINT"                        HEAD OF THE DEPARTMENT
8630 PRINT"                        MECHANICAL ENGINEERING
8640 COLOR 0,5,4:PRINT
```

```
8650 PRINT"       ASSISTED BY     : G.MANAVALAN
8660 PRINT"                         LECTURER , MECHANICAL ENGINEERING DEPT      "
8670 COLOR 15,5,4:PRINT
8680 PRINT"       INITIATED BY    :B. SATHYANARAYANAN                          "
8690 PRINT"                         ENGINEER , PWD                             "
8700 COLOR 1,7,4:PRINT
8710 PRINT"       TECHNICAL        : BENJAMIN
8720 PRINT"       GUIDENCE BY        CAM DESIGNER , VISUAL EDUCATION AIDS       "
8725 COLOR 0,2,4:PRINT
8730 PRINT TAB(20)"Press any key to continue"
8740 A$ = INPUT$(1)
8750 RETURN
```

## 7.3  PROGRAM FOR DESIGNING CAMS

```
5 '*************************************************************************************
6 REM         PROGRAM FOR DESIGNING CAMS FOR AUTOMATIC LATHE
7 '*************************************************************************************
9 SCREEN 0:KEY OFF:WIDTH 80:COLOR 15,5,4:CLS
10 Y1$=STRING$(40,"#")
20 PRINT Y1$
30 PRINT"CAM DESIGN FOR AUTOMATIC LATHE"
40 PRINT Y1$
50 COLOR 1,7,4
120 KEY OFF
130  WIDTH 40
140 PRINT Y1$
170 PRINT"    READ    INSTRUCTION BEFORE  DESIGNING   THE CAMS"
175 PRINT Y1$
176 COLOR 14,4,4
178 PRINT"GIVE THE OPERATIONS ACCORDING TO THE SEQUENCE":COLOR 0,5,3
180 PRINT " MAXIMUM DIAMETR OF THE WORKPIECE=25MM"
185 COLOR 0,2,4
190 PRINT" THE   MATERIAL OF  W/P  MAY BE  BRASS, ALUMINIUM, FREE   CUTTING
    STEEL  AND MATERIALS OF HARDNESS UPTO 100 KGF/MM2"
195 COLOR 14,4,4
200  PRINT  " THE   POSSIBLE  OPARATION  INPUTS  ARE  TURNING (PLANE TURNING,
    STEP TURNING, TAPER TURNING)  FORMINGS LIKE KNURLING, UNDERCUT  (AND  ANY
    OTHER FORMING) ,  DRILLING  AND  CUTOFF"
205 COLOR 1,7,4
210  PRINT " IF YOU WANT TO CHANGE  ANYTHING IN THE PROGRAM   LIKE   ASSUMED
       DATAS OR CHART VALUES REFER   DEEM 25 AUTOMAT MANUAL"
215 COLOR 0,5,4
220 PRINT TAB(20);"(Press any key to continue)"
230 A$=INPUT$(1)
290 GOSUB 4500
291 CLS:WIDTH 80:COLOR 14,4,4
295 INPUT" GIVE NUMBERS ACCORDING TO THE MATERIALS , TYPE 1 FOR BRASS OR ALUMINI
UM, TYPE 2 FOR FREE CUTTING STEEL , 3 FOR HARDNESS UPTO  50 , 4 FOR HARDNESS UPT
O (GIVE APPOPRIATE NUMBERS )";M1
296 COLOR 15,5,1
300 INPUT "DIAMETER OF THE WORKPIECE=DIA";DIA
305 COLOR 1,7,4
310 INPUT "SURFACE SPEED=SS";SS
320 GOSUB 450
330 RPM=SS*1000/3.1415/DIA
340 GOSUB 1000
350 GOSUB 7000
360 GOSUB 3000
364 HPR=RPM*(360-LD)/A3/6
365 GOSUB 6400
366 GOSUB 7000
370 COLOR 0,5,4
377 PRINT "SELECTED SPEED IS =";RPM;"rpm"
420 COLOR 14,4,4
425 PRINT"   TOTAL LOST DEGREES =";LD
426 SOUND 500,5:SOUND 32767,5
430 PRINT "  Press any key to continue "
```

```
435 A$=INPUT$(1)
440 CHAIN"MAIN"
450 '
451 '******* SUBROUTINE FOR INPUTS *********
452 '
460 BEEP
465 F1=0 : F2=0
470 COLOR 16,2,4:PRINT
480 INPUT "NUMBER OF OPERATIONS";N
490 BEEP
500 FOR I= 1 TO N
510 COLOR 14,4,4:PRINT
520 PRINT "OPERATION NAME = O$(";I;")"
530 INPUT O$(I):J=1
535 IF O$(I)="UNDERCUT" THEN F2=F2+5
540 IF (O$(I) = "TURNING")OR(O$(I)="TAPERTURNING") THEN   570
550 J2=1:J(I) = 1:GOTO 590
560 PRINT
570 PRINT " THE OPERATION";SPC(2);O$(I);SPC(2);"HAS HOW MANY STEPS"
580 INPUT J(I)
590 IF J(I)< 1 THEN PRINT "STEP NO";J:F1=10*J(I)+F1
600 PRINT
610 GOSUB 6000
620 COLOR 0,2,4:PRINT
630 PRINT "TOOL MOVING DISTANCE=D(";I;",";J;")"
640 INPUT D(I,J)
650 IF J=J(I) THEN 670
660 J=J+1:PRINT:GOTO 590
665 COLOR 16,7,4
670 PRINT "IF THE OPERATION";SPC(2);O$(I);SPC(2);"IS OVERLAPPED WITH PREVIOUS O/
P(Y/N)"
680 INPUT M$(I)
690 PRINT
700 PRINT "IF THE OERATION";SPC(2);O$(I);SPC(2);"DIMENSION IS DECRESED BY ANY OT
HER OPERATION(Y/N)"
710 INPUT N$(I)
715 CLS
720 NEXT I
725 LD = 40+15+F1+F2
730 RETURN
760 END
1000 '
1001 '********** SUBROUTINES FOR CALCULATIONS  *************
1002 '
1010 E=1:J=1
```

```
1020 FOR I=1 TO N
1030 GOSUB 5000
1040 IF (O$(I)="TURNING") OR (O$(I)="TAPERTURNING") THEN 2070
1050 AR (I,E)=T(I,E)/F(I,E)
1060 IF M$(I)="Y" THEN 2020
1070 IF M$(I)="N" THEN 2000
1080 IF AR(I,E)>A1 THEN A1=AR(I,E)
1090 GOTO 2110
2000 A2=A2+A1 : A1=AR(I,E)
2010 GOTO 2110
2020 PRINT "DIMENSION OF"; O$(I);SPC(2);"OPERATION IS DECREASED BY ANY OTHER OPE
RATION= (GIVE DISTANCE)"
2030 INPUT B1
2040 B2=T(I,E)-B1
2050 B3=B2/F(I,J)
2055 IF M$(I)="N" THEN 2080
2056 IF B3> A1 THEN A1=B3 : GOTO 2110
2070 AR(I,E)=T(I,E)/F(I,E)
2080 A2=A2+A1 : A1=B3
2090 IF E=J(I) THEN 2110
2100 E=E+1 : T(I,E)=D(I,E)
2110 NEXT I
2120 A3=A2+A1
2130 RETURN
2140 END
3000 '
3001 '*********** SUBROUTINE FOR FINAL RESULT  ***************
3002 '
3010 FOR I=1 TO N
3020 J=1
3030 IF (O$(I)="TURNING") OR (O$(I)="TAPERTURNING") THEN X1=1
3040 DEG(I,J)= AR(I,J)*(360-LD)/A3
3050 CLS:KEY OFF
3060 SCREEN 1
3070 BEEP
3080 C=1+INT(3*RND)
3090 LINE (0,0)-(319,5),C,BF
4000 LINE (0,178)-(319,183),C,BF
4010 LINE (314,6)-(319,177),C,BF
4015 COLOR 15,5,4
4020 LOCATE 5,1:PRINT"OPERATION NAME";SPC(2);O$(I)
4025 COLOR 14,4,4
4030 LOCATE 7,1:PRINT"FORWARD STROKE";DEG(I,J);"DEGREES"
4040 IF X1=1 THEN 4060
4045 LOCATE 9,1:PRINT"DWELL 10 DEGREES"
4046 COLOR 1,7,4
4050 GOTO 4075
4060 A=J+9+1
4070 LOCATE A,1:PRINT"DWELL 10 DEGREES"
```

```
4074 COLOR 0,5,4
4075 LOCATE 13,1: PRINT "SELECTED FEED IS = "; F(I,J);"mm/rev "
4076 LOCATE 15,1:COLOR 1,3,4: PRINT "THROW IS ="; T(I,E);"mm"
4080 IF J=J(I) THEN 4100
4090 J=J+1: GOTO 3040
4095 COLOR 14,4,4
4100 PRINT TAB(20);" (Press any key to continue)"
4110 A$=INPUT$(1)
4120 IF I<>N THEN 4140
4130 PRINT "THE DESIGNS ARE OVER"
4135 COLOR 15,5,4
4140 NEXT I
4150 RETURN
4160 END
4500 '
4501 '********** SUBROUTINE FOR INTIAL ASSUMSIONS **************
4502 '
4510 A1=0
4520 A2=0
4530 RETURN
4540 END
5000 '
5001 '************** SUBROUTINE FOR CLEARENCES *****************
5002 '
5010 BEEP
5020 IF O$(I)<> "CUTOFF" THEN 5050
5030 T(I,E)=1.75+D(I,E)
5040 RETURN
5050 T(I,E)=.75+D(I,E)
5060 RETURN
6000 '
6010 '******* SUBROUTINE FOR FEED SELECTION **********
6020 '
6025 COLOR 0,2,4
6043 COLOR 1,7,4
6045 PRINT" GIVE NUMBERS ACCORDING TO THE OPERATION   TYPE 1 FOR TURNING , 2 FOR
CUTTING IN, 3 FOR FORMING , 4 FOR CUTTING OFF WITHOUT ROUGH CUT , 5 FOR CUTTING
OFF WITH ROUGH CUT , 6 FOR DRILLING ( DRILL DIA 02-04 )"
6046 INPUT "7 FOR DRILLING (DRILL DIA 04-08) , 8 FOR DRILLING (DRILL DIA 08-14),
 9 FOR CENTERING OR BORING ";M2
6055 IF (I>1) OR (J>1) THEN 6135
6060 DATA .15,.04,.04,.06,.07,.06,.12,.15,.15,.1,.035,.03,.04,.045,.05,.1,.01,.1
,.06,.03,.025,.035,.04,.04,.06,.08,.1,.06,.03,.02,.03,.035,.03,.06,.06,.06,.07,.
02,.015,.025,.03,.02,.05,.06,.06,.06,.02,.015,.02,.025,.015,.04,.05,.06
6070 FOR A1=1 TO 6
```

```
6071 FOR A2=1 TO 9
6072 READ A3(A1,A2)
6073 NEXT A2
6074 NEXT A1
6080 DATA .08,.03,.03,.04,.05,.04,.08,.1,.08,.07,.025,.02,.03,.035,.03,.05,.06,.
05,.06,.02,.015,.025,.03,.02,.04,.06,.06,.06,.02,.015,.02,.025,.02,.04,.06,.04,.
06,.015,.01,.015,.02,.015,.03,.04,.03,.05,.015,.01,.015,.02,.01,.02,.03,.03
6090 FOR C1=1 TO 6
6100 FOR D1=1 TO 9
6110 READ A4(C1,D1)
6120 NEXT D1
6130 NEXT C1
6135 COLOR 15,5,4
6160 PRINT Y1$
6170 PRINT "SELECTED FEED RANGE FOR";SPC(2);O$(I); SPC(2); "IS =";A4(H1,H2);"--"
;A3(H1,H2);"mm/rev"
6180 PRINT Y1$
6185 COLOR 14,4,4
6186 INPUT"ENTER FEED WITHIN THE RANGE";F(I,J)
6190 RETURN
6400 '
6410 '***** SUBROUTINE FOR CHANGE OF GEAR FOR THE FEED DRIVE *****
6411 '
6415 CLS: KEY OFF
6420 IF HPR > 28 THEN  6450
6430 HPR = 28:  G1 = 25:  G2 = 100:  G3 = 35:  G4 = 90
6450 IF  (HPR>28)  AND  (HPR <= 37 ) THEN HPR=37: G1=25: G2=100: G3=40: G4=80:
GOTO 6870
6460 IF  (HPR>37)  AND  (HPR <= 41 ) THEN HPR=41: G1=25: G2=100: G3=45: G4=80:GO
TO 6870
6470 IF  (HPR>41)  AND  (HPR <= 44 ) THEN HPR=44: G1=25: G2=100: G3=45: G4=75 :G
OTO 6870
6480 IF  (HPR>44)  AND  (HPR <= 50 ) THEN HPR=50: G1=25: G2=90 : G3=50: G4=80:GO
TO 6870
6490 IF  (HPR>50)  AND  (HPR <= 57 ) THEN HPR=57: G1=35: G2=90 : G3=40: G4=80:GO
TO 6870
6500 IF  (HPR>57)  AND  (HPR <= 64 ) THEN HPR=64: G1=35: G2=90 : G3=45: G4=80:GO
TO 6870
6510 IF  (HPR>64)  AND  (HPR <= 68 ) THEN HPR=68: G1=35: G2=90 : G3=45: G4=75:GO
TO 6870
6520 IF  (HPR>68)  AND  (HPR <= 75 ) THEN HPR=75: G1=35: G2=90 : G3=50: G4=75:GO
TO 6870
6530 IF  (HPR>75)  AND  (HPR <= 80 ) THEN HPR=80: G1=35: G2=80 : G3=50: G4=80:GO
TO 6870
6540 IF  (HPR>80)  AND  (HPR <= 92 ) THEN HPR=92: G1=45: G2=80 : G3=45: G4=80:GO
TO 6870
6550 IF  (HPR>92)  AND  (HPR <= 98 ) THEN HPR=98: G1=45: G2=80 : G3=45: G4=75:GO
TO 6870
6560 IF  (HPR>98)  AND  (HPR <=110 ) THEN HPR=110: G1=50: G2=75 : G3=45: G4=80:G
OTO 6870
```

```
6570 IF   (HPR>110) AND   (HPR <=120 ) THEN HPR=120: G1=25: G2=100: G3=75: G4=45:G
OTO 6870
6580 IF   (HPR>120) AND   (HPR <=130 ) THEN HPR=130: G1=25: G2=90 : G3=80: G4=50:G
OTO 6870
6590 IF   (HPR>130) AND   (HPR <=145 ) THEN HPR=145: G1=25: G2=100: G3=80: G4=40:G
OTO 6870
6600 IF   (HPR>145) AND   (HPR <=170 ) THEN HPR=170: G1=35: G2=90 : G3=75: G4=50:G
OTO 6870
6610 IF   (HPR>170) AND   (HPR <=190 ) THEN HPR=190: G1=35: G2=90 : G3=75: G4=45 :
GOTO 6870
6620 IF   (HPR>190) AND   (HPR <=215 ) THEN HPR=215: G1=40: G2=90 : G3=75: G4=45 :
GOTO 6870
6630 IF   (HPR>215) AND   (HPR <=230 ) THEN HPR=230:. G1=35: G2=90 : G3=80: G4=40 :
GOTO 6870
6640 IF   (HPR>230) AND   (HPR <=260 ) THEN HPR=260: G1=80: G2=45 : G3=40: G4=80 :
GOTO 6870
6650 IF   (HPR>260) AND   (HPR <=275 ) THEN HPR=275: G1=45: G2=80 : G3=75: G4=45:G
OTO 6870
6660 IF   (HPR>275) AND   (HPR <=305 ) THEN HPR=305: G1=50: G2=80 : G3=75: G4=45 :
GOTO 6870
6670 IF   (HPR>305) AND   (HPR <=330 ) THEN HPR=330: G1=45: G2=80 : G3=80: G4=40 :
GOTO 6870
6680 IF   (HPR>330) AND   (HPR <=375 ) THEN HPR=375: G1=90: G2=35 : G3=40: G4=80 :
GOTO 6870
6690 IF   (HPR>375) AND   (HPR <=420 ) THEN HPR=420: G1=90: G2=35 : G3=45: G4=80 :
GOTO 6870
6700 IF   (HPR>420) AND   (HPR <=450 ) THEN HPR=450: G1=90: G2=35 : G3=45: G4=75 :
GOTO 6870
6710 IF   (HPR>450) AND   (HPR <=500 ) THEN HPR=500: G1=90: G2=35 : G3=50: G4=75 :
GOTO 6870
6720 IF   (HPR>500) AND   (HPR <=520 ) THEN HPR=520: G1=80: G2=25 : G3=50: G4=90 :
GOTO 6870
6730 IF   (HPR>520) AND   (HPR <=585 ) THEN HPR=585: G1=100: G2=25: G3=40: G4=80 :
GOTO 6870
6740 IF   (HPR>585) AND   (HPR <=660 ) THEN HPR=660: G1=90: G2=25 : G3=50: G4=80 :
GOTO 6870
6750 IF   (HPR>660) AND   (HPR <=700 ) THEN HPR=700: G1=100: G2=25: G3=45: G4=75 :
GOTO 6870
6760 IF   (HPR>700) AND   (HPR <=780 ) THEN HPR=780: G1=100: G2=25: G3=50: G4=75 :
GOTO 6870
6770 IF   (HPR>780) AND   (HPR <=865 ) THEN HPR=865: G1=80: G2=45 : G3=75: G4=45 :
GOTO 6870
6780 IF   (HPR>865) AND   (HPR <=935 ) THEN HPR=935: G1=80: G2=50 : G3=80: G4=40 :
GOTO 6870
6790 IF (HPR>935) AND (HPR <=1040 ) THEN HPR=1040: G1=80: G2=45 : G3=80: G4=40 :
GOTO 6870
6800 IF (HPR>1040) AND (HPR <=1250 ) THEN HPR=1250: G1=90: G2=35 : G3=75: G4=45:
GOTO 6870
6810 IF (HPR>1250) AND (HPR <=1340 ) THEN HPR=1340: G1=90: G2=35 : G3=80: G4=45:
GOTO 6870
6820 IF (HPR>1340) AND (HPR <=1500 ) THEN HPR=1500: G1=90: G2=35 : G3=80: G4=40:
GOTO 6870
```

```
6830 IF (HPR>1500) AND (HPR <=1750 ) THEN HPR=1750: G1=100:G2=25 : G3=75: G4=50:
GOTO 6870
6840 IF (HPR>1750) AND (HPR <=1950 ) THEN HPR=1950: G1=100:G2=25 : G3=75: G4=45:
GOTO 6870
6850 IF (HPR>1950) AND (HPR <=2100 ) THEN HPR=2100: G1=100:G2=25 : G3=80: G4=45
6860 COLOR 16,7,4
6870 PRINT Y1$
6880 PRINT " CHANGE OF GEAR FOR THE FEED DRIVE"
6890 PRINT Y1$
6900 COLOR 0,5,4:PRINT
6910 PRINT" GEAR 1=";G1
6920 PRINT
6930 PRINT "GEAR 2=";G2
6940 PRINT
6950 PRINT "GEAR 3=";G3
6960 PRINT
6970 PRINT" GEAR 4=";G4
6980 PRINT
6981 PRINT:COLOR 1,7,4
6982 PRINT "GROSS HOURELY RATE OF PRODUCTION =";HPR;"Pieces/hour"
6983 PRINT
6990 RETURN
7000 '
7010 '
7011 '****** SUBROUTING TO ROUND THE RPH *********
7012 '
7020 IF RPH <= 550 THEN RPH = 550: RETURN
7030 IF (RPH > 550) AND (RPH <= 700) THEN RPH =700: RETURN
7040 IF (RPH > 700) AND (RPH <= 900) THEN RPH =900: RETURN
7050 IF (RPH > 900) AND (RPH <= 1100) THEN RPH =1100 : RETURN
7060 IF (RPH > 1100) AND (RPH <= 1400) THEN RPH = 1400 : RETURN
7070 IF (RPH > 1400) AND (RPH <= 1600) THEN RPH = 1600 : RETURN
7080 IF (RPH > 1600) AND (RPH <= 1800) THEN RPH = 1800 : RETURN
7090 IF (RPH > 1800) AND (RPH <= 2000) THEN RPH = 2000 : RETURN
7100 IF (RPH > 2000) AND (RPH <= 2450) THEN RPH = 2450 : RETURN
7110 IF (RPH > 2450) AND (RPH <= 3200) THEN RPH = 3200 : RETURN
7120 IF (RPH > 3200) AND (RPH <= 4000) THEN RPH = 4000 : RETURN
7130 IF RPH >4000 PRINT " RPH EXCEEDS ITS LIMITS"
7140 RETURN
```

## 7.4  PROGRAM FOR DRAWING OF DISPLACEMENTE AND PROFILE OF CAM

```
1  '*********************************************************************************
2  REM       PROGRAM FOR DRAWING DISPLACEMENT AND PROFILE OF THE CAMS
3  '*********************************************************************************
5  CLS:KEY OFF:SCREEN 0:WIDTH 80
6  GOSUB 4500
10 INPUT "IF YOU WANT THE DEGREES FOR RAPID APPROACH AND RAPID RETURN Press(Y/N)
   ";N5$
12 IF N5$ <> "Y" THEN  15
13 GOSUB 4000
14 COLOR 15,5,4
15 U1$=STRING$(80,42)
16 PRINT U1$
20 PRINT "ALL THE DIMENSIONS ARE IN MM"
21 PRINT U1$
22 INPUT "OPERATION NAME ";W$
25 PRINT
26 COLOR  1,7,4
30 INPUT "LENGTH OF DISPLACEMENT DIAGRAM   F=";Z
40 GOSUB 1000
50 F=Z
55 PRINT
60 INPUT "LENGTH OF STROKE L=";Z
70 GOSUB 1000
80 L=Z
85 PRINT
90 INPUT"D=1 FOR DISPLACEMENT DIAGRAM D=2 FOR PROFILE DIAGRAM D=3 FOR DRUM CAM
   PROFILE DIAGRAM D=";D
95 IF D<>3 THEN 100
96 GOSUB 3000
97 GOTO 541
100 IF D=2 THEN 260
110 GOSUB 1100
115 PRINT
116 COLOR 14,4,4
120 INPUT"THE TOTAL NUMBER OF STROKES N=";N
130 FOR I=1 TO N
135 COLOR 0,2,4:PRINT
140 INPUT"T(I)=1 FOR OUT STROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL T(I)="
   ;T(I)
145 COLOR 16,7,4:PRINT
150 INPUT"STROKE ANGLE TETA(I)=";TETA(I)
155 PRINT
160 GOSUB 1200
170 IF T(I)=3 THEN 220
175 COLOR 1,3,4:PRINT
180 INPUT"UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE  W(I)=";Z
190 GOSUB 1000
200 W(I)=YA-(Z/2.4511)
210 GOTO 230
220 W(I)=W(I-1)
230 NEXT I
```

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```
240 GOSUB 1500
250 GOTO 541
255 PRINT:COLOR 1,7,4
260 INPUT"TF=1 FOR KNIFE EDGE FOLLOWER TF=2 FOR ROLLER FOLLOWER TF=";TF
270 IF TF= 2 THEN 300
280 ROLL=0
290 GOTO 330
295 PRINT:COLOR 15,5,1
300 INPUT "THE RADIUS OF ROLLER = ROLL";Z
310 GOSUB 1000
320 ROLL =Z
325 COLOR 0,5,4:PRINT
330 INPUT "PRIME CIRCLE RADIUS =RR";Z
340 GOSUB 1000
350 RR=Z
355 COLOR 1,3,4:PRINT
360 INPUT" TOTAL NUMBER OF STROKE =N";N
365 COLOR 0,2,4:PRINT
370 INPUT"PRIME CIRCLE X CO-ORDINATE = A";Z
380 GOSUB 1000
390 A=Z
395 PRINT
400 INPUT" PRIME CIRCLE Y CO-ORDINATE =B";Z
410 GOSUB 1000
420 B=Z
430 GOSUB 2000
440 FOR I=1 TO N
445 COLOR 1,7,4:PRINT
450 INPUT"T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)";T
(I)
455 PRINT
460 INPUT "STROKE ANGLE =TETA(I)";TETA(I)
470 IF T(I)=3 THEN 520
475 COLOR 15,5,1:PRINT
480 INPUT "UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=";Z
490 GOSUB 1000
500 W(I)= Z
510 GOTO 530
520 W(I)=W(I-1)
530 NEXT I
534 PRINT
536 PRINT W$
540 GOSUB 2100
541 PRINT TAB(20);W$;SPC(2);"OPERATION"
545  WIDTH 80 : PRINT TAB(20) " AFTER THE DRAWING IS COMPLETED PRESS ANY KEY TO
CONTINUE"
546 A$=INPUT$(1)
550 CHAIN"MAIN"
```

```
1000 '
1001 '********* SUBROUTINE FOR CONVERT MM TO PIXELS **********
1002 '
1010 Z=635/233.5*Z
1020 IF Z >900 THEN 1040
1030 GOTO 1050
1040 PRINT" THE VALUE EXCEEDS ITS LIMIT "
1050 RETURN
1100 '
1101 '********* SUBROUTINE FOR INITIAL ASSUMSIONS *************
1102 '
1120 Y = 50:X=12.5
1130 XA = X + F
1140 YA = Y + (L/2.4511)
1150 X(0) = X
1160 W(0) = YA
1170 TETA(0) = 0
1180 RETURN
1200 '
1201 '********** SUBROUTINE FOR DISTANCE FOR ANGLE  *************
1202 '
1210 TETA(I)=TETA(I)+TETA(I-1)
1220 X(I) =F/360*TETA(I)+X
1240 RETURN
1500 '
1501 '*********** SUBROUTINE FOR DISPLACEMENT DIAGRAM ***********
1502 '
1510 CLS:KEY OFF
1520 SCREEN 2
1530 LINE(5,190)-(630,5),,B
1535 LINE (0,0)-(639,199),,B
1536 PAINT (5,2)
1540 LINE(X,Y)-(XA,Y):LINE -(XA,YA):LINE -(X,YA):LINE -(X,Y)
1550 FOR I=1 TO N
1560 H= X(I-1)
1570 IF T(I)=3 THEN 1630
1580 K=X(I)
1590 L=P(I)
1600 Q=W(I-1)
1610 N=W(I):B=X(I)
1620 LINE(H,Q)-(K,N)
1630 NEXT I
1640 P=F/10
1650 FOR R=X TO XA STEP P
1660 LINE (R,Y)-(R,YA):BEEP
1670 NEXT R
1680 LOCATE 20,18:PRINT "DISPLACEMENT DIAGRAM OF CAM"
1690 RETURN
2000 '
2001 '*********** SUBROUTINE FOR INITIAL ASSUMSION  **************
2002 '
2010 Q=3.1415926543#
```

60

```
2020 TR(0)=RR
2030 V=0
2040 W(0)=0
2050 G=0
2060 RETURN
2100 '
2101 '************** SUBROUTINE FOR DRAWING THE CAM PROFILE **********
2102 '
2110 CLS:KEY OFF
2120 SCREEN 2
2130 LINE(0,0)-(635,5),,BF
2131 LINE(0,199)-(635,194),,BF
2132 LINE(635,199)-(630,0),,BF
2133 LINE(0,0)-(5,199),,BF
2140 CIRCLE(A,B),RR+ROLL
2150 FOR I=1 TO N
2160 X(I)=(F/360)*TETA(I)
2170 P(I)=X(I)/6
2180 HI=SQR (X(I)*X(I)+(W(I)-W(I-1))^2)
2190 OND=T(I)
2200 ON OND GOTO 2210,2230,2210
2210 SI=(W(I)-W(I-1))/X(I)
2220 GOTO 2240
2230 SI=(W(I-1)-W(I))/X(I)
2240 S=X(I)
2250 FOR U=0 TO S STEP 1
2260 GOSUB 2800
2270 IF TF=2 THEN 2300
2280 PSET (C,D)
2290 GOTO 2310
2300 CIRCLE(C,D),ROLL
2310 NEXT U
2315 IF OND=3 THEN 2410
2320 K=P(I)
2330 FOR U=0 TO S STEP K
2340 GOSUB 2800
2350 LINE(A,B)-(C,D)
2360 NEXT U
2370 GOTO 2410
2380 O=TR(I-1)-ROLL
2390 Y=(TETA(I)+V)*Q/180 : W=V*Q/180
2400 CIRCLE(A,B),O,,W,Y
2410 G=G+X(I)
2420 V=V+TETA(I)
2430 NEXT I
2435 SOUND 500,5: SOUND 32767,5
2440 IF TF=2 THEN 2470
2450 LOCATE 20,15: PRINT"PROFILE DIAGRAM FOR A KNIFE EDGE FOLLOWER"
2460 RETURN
2470 LOCATE 20,15: PRINT"PROFILE DIAGRAM FOR A ROLLER FOLLOWER"
```

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```
2475 INPUT$(1)
2480 RETURN
2800 '
2801 '************** SUBROUTINE FOR DISTANCE CALCULATIONS ***********
2802 '
2810 IF OND=2 THEN 2840
2820 IR=U*SI+W(I-1)
2830 GOTO 2850
2840 IR=U*SI+W(I)
2850 TR(I)=RR+IR+ROLL
2855 IF OND=2 THEN TR(I)=TR(I-1)-TR(I)+RR+ROLL
2860 ANG=(U+G)*360/F*3.141592654#/180
2870 H=TR(I)*SIN(ANG)
2880 V=TR(I)*COS(ANG)/2.4511
2890 C=A-H
2900 D=B-V
2910 RETURN
2920 END
3000 '
3001 '******** SUBROUTINE FOR DRUM CAM FOLLOWER *********
3002 INPUT "TYPE T FOR TURNING OPERATION  CAM  AND D FOR DRILLING OPERATION CAM
    (T/D)";K1$
3003 D = 40: H1 = 30
3004 IF K1$ = "D" THEN D = 58: H1=35
3010 X=20:Y=50:YA=Y+(H1/2.451*635/233.5)
3020 Q1=3.1415:TOT(0)=0
3030 L1=Q1*D*633/233.5:XA=X+L1
3035 COLOR 1,3,4
3040 INPUT "NUMBER OF STROKES=";N
3050 FOR I=1 TO N
3060 COLOR 15,5,1:PRINT
3070 PRINT "STROKE NUMBER=";I
3080 PRINT
3090 INPUT "STROKE ANGLE=";AN(I)
3100 COLOR 1,7,4:PRINT
3110 INPUT"PRESS 1FOR WORKING AND 2 FOR DWELL";O(I)
3120 IF O(I)=1 THEN 3150
3130 W(I)=W(I-1):U(I)=U(I-1)
3140 GOTO 3190
3150 COLOR 14,4,4:PRINT
3160 INPUT"TOOL MOVING DISTANCE=";Z
3165 U(I)=Z
3170 GOSUB 1000
3180 W(I)=Y+(Z/2.4511)
3190 NEXT I
3200 PRINT TAB(20);"(Press any key to continue)"
3210 A$=INPUT$(1)
3220 CLS:KEY OFF
3230 SCREEN 2
3240 LINE(0,0)-(639,199),,B
3250 LINE(10,5)-(629,194),,B
3260 PAINT (5,2)
3270 YO=H1-U(1)
3280 X1=(YO/TAN(45*3.1415/180))*633/233.5+X
```

```
3290 Y1=W(1)
3300 LINE(X,YA)-(XA,Y),,B
3310 LINE(X,YA)-(X1,Y1)
3320 W(N+1)=Y
3330 FOR I= 1 TO N
3340 DIS(I)=L1/360*AN(I)
3350 TOT(I)=DIS(I)+TOT(I-1)
3360 TD(I)=TOT(I)+X+X1
3370 X2=TD(I):Y2=W(I+1)
3380 LINE -(X2,Y2)
3390 NEXT I
3400 X3=(L1/360*20)
3410 Y3=TAN(20*3.1415/180)*X3/2.4511
3420 X3=TD(N)+X3
3430 Y3=Y+Y3
3440 LINE (X2,Y2)-(X3,Y3)
3450 LINE (X3,Y3)-(X3,YA)
3460 LOCATE 20,4:PRINT "PROFILE DIAGRAM OF A DRUM CAM"
3465 LOCATE 22,4: PRINT"(DRAWING SCALE = 2:1)"
3470 RETURN
4000 '
4010 '*********** SUBROUTINE FOR RAPID DEGREE CALCULATIONS **********
4020 '
4030 PRINT
4035 COLOR 15,5,1
4040 INPUT" INNER DIAMETER OF THE CAM ";D6
4050 PRINT
4060 INPUT "OUTER DIAMETER OF THE CAM ";D5
4070 X5 =(D5-D6)/2
4080 PRINT
4085 COLOR 0,5,4
4090 INPUT " THROW OF THIS OPERATION ";X6
4095 PRINT:INPUT"GROSS HOURELY PRODUCTION RATE IN pieces/hour";HPR
4100 X7 =X5-X6
4110 R5=1000*2*X7/6/HPR
4120 R6=1000*1.5*X7/6/HPR
4130 PRINT
4135 COLOR 1,7,4
4140 PRINT "RAPID APPROACH ANGLE =";R5
4145 PRINT:PRINT"UNIFORM VELOCITY UPTO ";X7;"mm LENGTH OF STROKE"
4146 COLOR 16,7,4
4150 PRINT
4160 PRINT "RAPID RETURN ANGLE =";R6
4170 RETURN
4500 '
4510 '*********** SUBROUTINE FOR INSTRUCTIONS ***********
4520 '
4525 CLS:COLOR 0,2,4
4530 PRINT "            DETAILS OF THE CAM BLANKS"
4540 PRINT
4545 COLOR 1,3,4
4550 PRINT"     VERTICAL SLIDE PLATE CAM          "
4570 PRINT"    INNER DIAMETER            =   30mm      "
4580 PRINT"    OUTER DIAMETER            =   76mm      "
```

```
4590 PRINT"   THICKNESS                          =  10mm        "
4600 PRINT
4605 COLOR 15,5,1
4610 PRINT"        CROSS SLIDE PLATE CAM              "
4630 PRINT"   INNER DIAMETER               =45mm        "
4640 PRINT"   OUTER DIAMETER               =90mm        "
4650 PRINT"   THICKNESS                    =10mm        "
4660 PRINT
4665 COLOR 14,4,4
4690 PRINT"        TAILSTOCK DRILLING  DRUM CAM "
4710 PRINT"   INNER DIAMETER               =97mm         "
4720 PRINT"   OUTER DIAMETER               =116mm        "
4730 PRINT"   HEIGHT                       =70mm         "
4740 PRINT
4745 COLOR 0,5,4
4750 PRINT"        FRONT SLIDE LONGITUDINAL DRUM CAM "
4770 PRINT"   INNER DIAMETER               =60mm         "
4780 PRINT"   OUTER DIAMETER               =80mm         "
4790 PRINT"   HEIGHT                       =60mm         "
4800 PRINT TAB(20);"(Press any key to continue)"
4890 A$=INPUT$(1)
4895 SOUND 500,5: SOUND 32767,5
4900 RETURN
```

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# CHAPTER 8

## SYMBOLS USED

## 8.1   PROGRAM 1 :    CAM DESIGN

ALL THE LINEAR MEASUREMENTS ARE IN MM

DIA    =   Diameter of the workpiece

SS    =   Surface speed (in m/min)

O$(I)   =   Operation name

D(I,J)   =   Tool moving distance

LD   =   Lost degrees

AR(I,J)   =   ABSOLUTE Revolutions

A3   =   Total effective revolutions

DEG(I,J)    =   Working angle for each operations

T(I,E)   =   Throw of the operation

F(I,J)   =   Feed of the operation (mm/Rev)

HPR   =   pieces per hour

RPM   =   speed (in rpm)

## 8.2   PROGRAM: DISPLACEMENT AND DRAWING

F                   - Length of displacement diagram

L                   - Length of stroke

R5                  - Rapid approach angle

R6                  - Rapid return angle

TETA (I)            - Stroke angles

W(I)                -   Uniform velocity upto which length of stroke

TF                  - Type of follower

ROLL                - Radius of the roller follower

RR                  - Prime circle radius

V(I)                - Tool moving distance

H                   - Horizontal distance of cam profile from centre

V                   - Vertical distance of cam profile from centre

C                   - x coordinate of profile

D                   - y coordinate of profile

```
                    MAIN MENU

TYPE 1 FOR  PROJECT DETAILS

TYPE 2 FOR DESIGNING CAMS

TYPE 3 FOR DRAWING CAMS

TYPE 4 FOR EXIT

Enter your selection _____
?
```

# CHAPTER 9

## INPUTS AND RESULTS

In this Chapter inputs and results for design and drawing of cams for a model pomponent are given.

## 9.1  INPUTS FOR CAM DESIGN

GIVE NUMBERS ACCORDING TO THE MATERIALS , TYPE 1 FOR BRASS OR ALUMINIUM, TYPE 2
FOR FREE CUTTING STEEL , 3 FOR HARDNESS UPTO  50 , 4 FOR HARDNESS UPTO (GIVE AP
POPRIATE NUMBERS )? 1
DIAMETER OF THE WORKPIECE=DIA? 12.2
SURFACE SPEED=SS? 90

NUMBER OF OPERATIONS? 5

OPERATION NAME = O$( 1 )
? KNURLING

GIVE NUMBERS ACCORDING TO THE OPERATION  TYPE 1 FOR TURNING , 2 FOR CUTTING IN,
3 FOR FORMING , 4 FOR CUTTING OFF WITHOUT ROUGH CUT . 5 FOR CUTTING OFF WITH RO
UGH CUT , 6 FOR DRILLING ( DRILL DIA 02-04 )
7 FOR DRILLING (DRILL DIA 04-08) , 8 FOR DRILLING (DRILL DIA 08-14), 9 FOR CENTE
RING OR BORING ? 3
###################################
SELECTED FEED RANGE FOR  KNURLING  IS = .03 -- .04 mm/rev
###################################
ENTER FEED WITHIN THE RANGE? .035

TOOL MOVING DISTANCE=D( 1 , 1 )
? .15
IF THE OPERATION  KNURLING  IS OVERLAPPED WITH PREVIOUS O/P(Y/N)
? N

IF THE OERATION  KNURLING  DIMENSION IS DECRESED BY ANY OTHER OPERATION(Y/N)
? N

OPERATION NAME - O$( 2 )
? UNDERCUT

 GIVE NUMBERS ACCORDING TO THE OPERATION  TYPE 1 FOR TURNING , 2 FOR CUTTING IN,
 3 FOR FORMING . 4 FOR CUTTING OFF WITHOUT ROUGH CUT , 5 FOR CUTTING OFF WITH RO
UGH CUT , 6 FOR DRILLING ( DRILL DIA 02-04 )
7 FOR DRILLING (DRILL DIA 04-08) , 8 FOR DRILLING (DRILL DIA 08-14), 9 FOR CENTE
RING OR BORING ? 2
###########################################
SELECTED FEED RANGE FOR  UNDERCUT  IS = .03    .04 mm/rev
###########################################
ENTER FEED WITHIN THE RANGE? .04

TOOL MOVING DISTANCE=D( 2 , 1 )
? 2.6
IF THE OPERATION  UNDERCUT  IS OVERLAPPED WITH PREVIOUS O/P(Y/N)
? Y

IF THE OERATION  UNDERCUT  DIMENSION IS DECRESED BY ANY OTHER OPERATION(Y/N)
? N




OPERATION NAME - O$( 3 )
? DRILLING

 GIVE NUMBERS ACCORDING TO THE OPERATION  TYPE 1 FOR TURNING , 2 FOR CUTTING IN,
 3 FOR FORMING , 4 FOR CUTTING OFF WITHOUT ROUGH CUT , 5 FOR CUTTING OFF WITH RO
UGH CUT , 6 FOR DRILLING ( DRILL DIA 02-04 )
7 FOR DRILLING (DRILL DIA 04-08) , 8 FOR DRILLING (DRILL DIA 08-14), 9 FOR CENTE
RING OR BORING ? 6
###########################################
SELECTED FEED RANGE FOR  DRILLING  IS = .04 -- .08 mm/rev
###########################################
ENTER FEED WITHIN THE RANGE? .06

TOOL MOVING DISTANCE=D( 3 , 1 )
? 18.58
IF THE OPERATION  DRILLING  IS OVERLAPPED WITH PREVIOUS O/P(Y/N)
? N

IF THE OERATION  DRILLING  DIMENSION IS DECRESED BY ANY OTHER OPERATION(Y/N)
? N

OPERATION NAME = O$( 4 )
? TURNING
THE OPERATION TURNING HAS HOW MANY STEPS
? 1

GIVE NUMBERS ACCORDING TO THE OPERATION  TYPE 1 FOR TURNING , 2 FOR CUTTING IN,
3 FOR FORMING , 4 FOR CUTTING OFF WITHOUT ROUGH CUT , 5 FOR CUTTING OFF WITH RO
UGH CUT , 6 FOR DRILLING ( DRILL DIA 02-04 )
7 FOR DRILLING (DRILL DIA 04-08) , 8 FOR DRILLING (DRILL DIA 08-14), 9 FOR CENTE
RING OR BORING ? 1
###############################################
SELECTED FEED RANGE FOR  TURNING  IS = .08  -- .15 mm/rev
###############################################
ENTER FEED WITHIN THE RANGE? .1

TOOL MOVING DISTANCE=D( 4 , 1 )
? 16.52
IF THE OPERATION  TURNING  IS OVERLAPPED WITH PREVIOUS O/P(Y/N)
? Y

IF THE OERATION  TURNING  DIMENSION IS DECRESED BY ANY OTHER OPERATION(Y/N)
? N




OPERATION NAME = O$( 5 )
? CUTOFF

GIVE NUMBERS ACCORDING TO THE OPERATION  TYPE 1 FOR TURNING , 2 FOR CUTTING IN,
3 FOR FORMING , 4 FOR CUTTING OFF WITHOUT ROUGH CUT , 5 FOR CUTTING OFF WITH RO
UGH CUT , 6 FOR DRILLING ( DRILL DIA 02-04 )
7 FOR DRILLING (DRILL DIA 04-08) , 8 FOR DRILLING (DRILL DIA 08-14), 9 FOR CENTE
RING OR BORING ? 4
###############################################
SELECTED FEED RANGE FOR  CUTOFF  IS = .04  -- .06 mm/rev
###############################################
ENTER FEED WITHIN THE RANGE? .04

TOOL MOVING DISTANCE=D( 5 , 1 )
? 6.1
IF THE OPERATION  CUTOFF  IS OVERLAPPED WITH PREVIOUS O/P(Y/N)
? N

IF THE OERATION  CUTOFF  DIMENSION IS DECRESED BY ANY OTHER OPERATION(Y/N)
? N

## 9.2   OUTPUTS FOR CAM DESIGNING

OPERATION NAME   KNURLING

FORWARD STROKE 12.45914 DEGREES

DWELL 10 DEGREES


SELECTED FEED IS =   .035 mm/rev

THROW IS = .9 mm

                    (Press any key to continue)


OPERATION NAME   UNDERCUT

FORWARD STROKE 40.57874 DEGREES

DWELL 10 DEGREES


SELECTED FEED IS =   .04 mm/rev

THROW IS = 3.35 mm

                    (Press any key to continue)


OPERATION NAME   DRILLING

FORWARD STROKE 156.0969 DEGREES

DWELL 10 DEGREES


SELECTED FEED IS =   .06 mm/rev

THROW IS = 19.33 mm

                    (Press any key to continue)

OPERATION NAME   TURNING

FORWARD STROKE 83.67698 DEGREES


DWELL 10 DEGREES

SELECTED FEED IS =   .1 mm/rev

THROW IS = 17.27 mm

                        (Press any key to continue)


OPERATION NAME   CUTOFF

FORWARD STROKE 95.08748 DEGREES


DWELL 10 DEGREES

SELECTED FEED IS =   .04 mm/rev

THROW IS = 7.85 mm

                        (Press any key to continue)


###########################################
   CHANGE OF GEAR FOR THE FEED DRIVE
###########################################

  GEAR 1= 40

GEAR 2= 90

GEAR 3= 75

 GEAR 4= 45


GROSS HOURELY RATE OF PRODUCTION = 215 Pieces/hour

SELECTED SPEED IS = 2450 rpm
   TOTAL LOST DEGREES = 60
   Press any key to continue

# DETAILS OF THE CAM BLANKS

## VERTICAL SLIDE PLATE CAM
```
INNER DIAMETER          =   30mm
OUTER DIAMETER          =   76mm
THICKNESS               =   10mm
```

## CROSS SLIDE PLATE CAM
```
INNER DIAMETER          =45mm
OUTER DIAMETER          =90mm
THICKNESS               =10mm
```

## TAILSTOCK DRILLING DRUM CAM
```
INNER DIAMETER          =97mm
OUTER DIAMETER          =116mm
HEIGHT                  =70mm
```

## FRONT SLIDE LONGITUDINAL DRUM CAM
```
INNER DIAMETER          =60mm
OUTER DIAMETER          =80mm
HEIGHT                  =60mm
```
(Press any key to continue)

## 9.3 INPUTS AND RESULT FOR CAM DRAWING

### 9.3.1 KNURLING - PLATE CAM

INNER DIAMETER OF THE CAM ? 30

OUTER DIAMETER OF THE CAM ? 76

THROW OF THIS OPERATION ? .9

GROSS HOURELY PRODUCTION RATE IN pieces/hour? 215

RAPID APPROACH ANGLE = 34.26357

UNIFORM VELOCITY UPTO 22.1 mm LENGTH OF STROKE

RAPID RETURN ANGLE = 25.69768
*****************************************************************************************

ALL THE DIMENSIONS ARE IN MM
*****************************************************************************************

OPERATION NAME ? KNURLING

LENGTH OF DISPLACEMENT DIAGRAM F=? 200

LENGTH OF STROKE L=? 23

TF=1 FOR KNIFE EDGE FOLLOWER TF=2 FOR ROLLER FOLLOWER TF=? 1
PRIME CIRCLE RADIUS =RR? 15

TOTAL NUMBER OF STROKE =N? 4

PRIME CIRCLE X CO-ORDINATE = A? 125

PRIME CIRCLE Y CO-ORDINATE =B? 30

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 1

STROKE ANGLE =TETA(I)? 34.26357

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 22.1

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 1

STROKE ANGLE =TETA(I)? 12.45914

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 23

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 2

STROKE ANGLE =TETA(I)? 25.69768
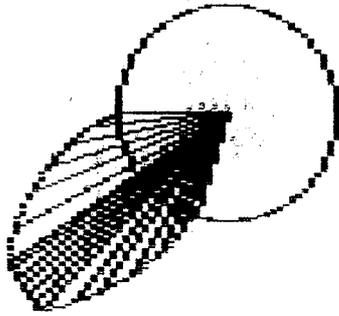
PROFILE DIAGRAM FOR A KNIFE EDGE FOLLOWER
KNURLING OPERATION
AFTER THE DRAWING IS COMPLETED PRESS ANY KEY TO CONTINUE

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## 9.3.2  CUTOFF - PLATE CAM

IF YOU WANT THE DEGREES FOR RAPID APPROACH AND RAPID RETURN Press(Y/N)? Y

INNER DIAMETER OF THE CAM ? 45

OUTER DIAMETER OF THE CAM  ? 90

THROW OF THIS OPERATION ? 7.85

GROSS HOURELY PRODUCTION RATE IN pieces/hour? 215

RAPID APPROACH ANGLE = 22.71318

UNIFORM VELOCITY UPTO  14.65 mm LENGTH OF STROKE

RAPID RETURN ANGLE = 17.03488
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++********

ALL THE DIMENSIONS ARE IN MM
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++*********

OPERATION NAME ? CUTOFF

LENGTH OF DISPLACEMENT DIAGRAM  F=? 200


LENGTH OF STROKE L ? 22.5

D=1 FOR DISPLACEMENT DIAGRAM D=2 FOR PROFILE DIAGRAM D=3 FOR DRUM CAM      PROFIL
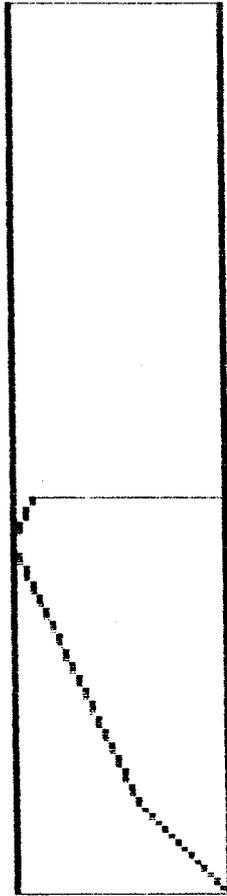E DIAGRAM D=? 2
TF=1 FOR KNIFE EDGE FOLLOWER TF=2 FOR ROLLER FOLLOWER TF=? 1
PRIME CIRCLE RADIUS =RR? 22.5

 TOTAL NUMBER OF STROKE =N? 3

PRIME CIRCLE X CO-ORDINATE = A? 125

 PRIME CIRCLE Y CO-ORDINATE =B? 30

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 1

STROKE ANGLE =TETA(I)? 22.71318

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 14.65

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 1

STROKE ANGLE =TETA(I)? 95.087448

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 22.5

TOTAL NUMBER OF STROKE =N? 3

PRIME CIRCLE X CO-ORDINATE = A? 125

 PRIME CIRCLE Y CO-ORDINATE =B? 30

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 1

STROKE ANGLE =TETA(I)? 22.71318

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 14.65

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 1

STROKE ANGLE =TETA(I)? 95.087448

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 22.5

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 2

STROKE ANGLE =TETA(I)? 17.03488

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 0
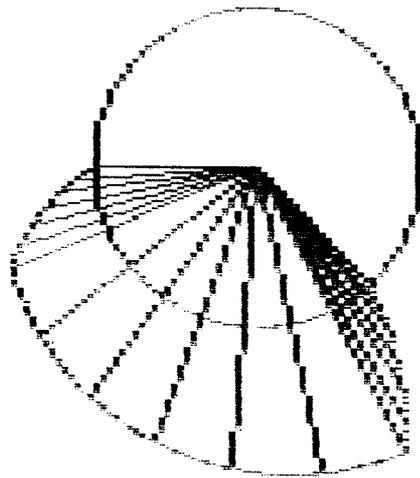
PROFILE DIAGRAM FOR A KNIFE EDGE FOLLOWER
CUTOFF OPERATION
AFTER THE DRAWING IS COMPLETED PRESS ANY KEY TO CONTINUE

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## 9.3.3   DRILLING - DRUM CAM

IF YOU WANT THE DEGREES FOR RAPID APPROACH AND RAPID RETURN Press(Y/N)? N
*****************************************************************************

ALL THE DIMENSIONS ARE IN MM
*****************************************************************************

OPERATION NAME ? DRILLING

LENGTH OF DISPLACEMENT DIAGRAM  F=? 100

LENGTH OF STROKE L=? 10

D=1 FOR DISPLACEMENT DIAGRAM D=2 FOR PROFILE DIAGRAM D=3 FOR DRUM CAM     PROFIL
E DIAGRAM D=? 3
TYPE T FOR TURNING OPERATION  CAM  AND D FOR DRILLING OPERATION CAM  (T/D)? D
NUMBER OF STROKES=? 1

STROKE NUMBER= 1

STROKE ANGLE=? 156.0969

PRESS 1FOR WORKING AND 2 FOR DWELL? 1

TOOL MOVING DISTANCE=? 19.33
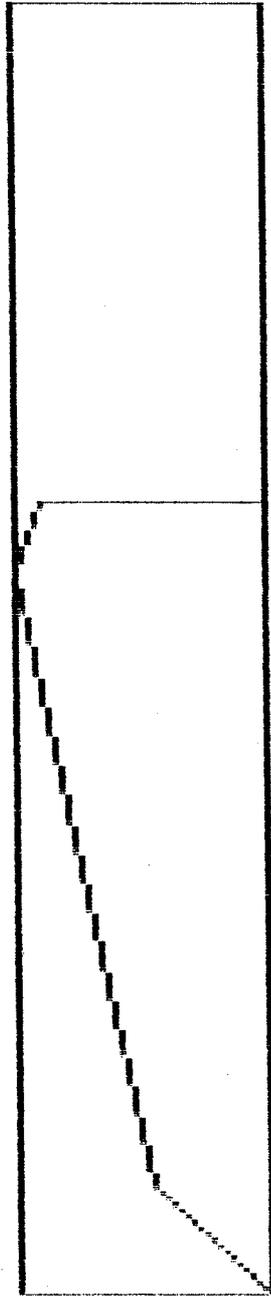
PROFILE DIAGRAM OF A DRUM CAM

(DRAWING SCALE = 2:1)
DRILLING OPERATION
AFTER THE DRAWING IS COMPLETED PRESS ANY KEY TO CONTINUE

## 9.3.4  TURNING  - DRUM CAM AND ZERO CAM

IF YOU WANT THE DEGREES FOR RAPID APPROACH AND RAPID RETURN Press(Y/N)? N
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

ALL THE DIMENSIONS ARE IN MM
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

OPERATION NAME ? TURNING

LENGTH OF DISPLACEMENT DIAGRAM  F=? 100

LENGTH OF STROKE L=? 10

D=1 FOR DISPLACEMENT DIAGRAM D=2 FOR PROFILE DIAGRAM D=3 FOR DRUM CAM      PROFIL
E DIAGRAM D=? 3
TYPE T FOR TURNING OPERATION  CAM  AND D FOR DRILLING OPERATION CAM  (T/D)? T
NUMBER OF STROKES=? 1

STROKE NUMBER- 1

STROKE ANGLE=? 83.67698

PRESS 1FOR WORKING AND 2 FOR DWELL? 1

TOOL MOVING DISTANCE=? 17.27

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PROFILE DIAGRAM OF A DRUM CAM

(DRAWING SCALE = 2:1)
TURNING OPERATION
AFTER THE DRAWING IS COMPLETED PRESS ANY KEY TO CONTINUE

THROW OF THIS OPERATION ? 0

GROSS HOURELY PRODUCTION RATE IN pieces/hour? 215

RAPID APPROACH ANGLE = 35.65891

UNIFORM VELOCITY UPTO   23 mm LENGTH OF STROKE

RAPID RETURN ANGLE = 26.74419
*******************************************************************************

ALL THE DIMENSIONS ARE IN MM
*******************************************************************************

OPERATION NAME ? TURNING-ZERO CAM

LENGTH OF DISPLACEMENT DIAGRAM  F=? 200

LENGTH OF STROKE L=? 23

D=1 FOR DISPLACEMENT DIAGRAM D=2 FOR PROFILE DIAGRAM D=3 FOR DRUM CAM      PROFIL
E DIAGRAM D=? 2
TF=1 FOR KNIFE EDGE FOLLOWER TF=2 FOR ROLLER FOLLOWER TF=?

TF=1 FOR KNIFE EDGE FOLLOWER TF=2 FOR ROLLER FOLLOWER TF=? 1
PRIME CIRCLE RADIUS =RR? 15

 TOTAL NUMBER OF STROKE =N? 3

PRIME CIRCLE X CO-ORDINATE = A? 125

 PRIME CIRCLE Y CO-ORDINATE =B? 30

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 1

STROKE ANGLE =TETA(I)? 35.65891

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 23

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 3

STROKE ANGLE =TETA(I)? 83.67698

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 2

STROKE ANGLE =TETA(I)? 26.74419

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 0
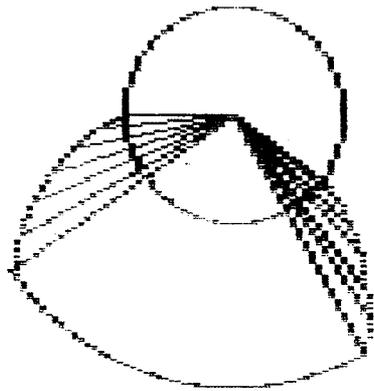
PROFILE DIAGRAM FOR A KNIFE EDGE FOLLOWER
TURNING-ZERO CAM OPERATION
AFTER THE DRAWING IS COMPLETED PRESS ANY KEY TO CONTINUE

84

## 9.3.5 UNDERCUT - PLATE CAM - PROFILE WITH AND WITHOUT ROLLER FOLLOWER

INNER DIAMETER OF THE CAM ? 45

OUTER DIAMETER OF THE CAM ? 90

THROW OF THIS OPERATION ? 3.35

GROSS HOURLY PRODUCTION RATE IN pieces/hour? 215

RAPID APPROACH ANGLE = 29.68992

UNIFORM VELOCITY UPTO 19.15 mm LENGTH OF STROKE

RAPID RETURN ANGLE = 22.26744
*****************************************************************************

ALL THE DIMENSIONS ARE IN MM
*****************************************************************************

OPERATION NAME ? UNDERCUT

LENGTH OF DISPLACEMENT DIAGRAM F=? 200

LENGTH OF STROKE L=? 22.5


D=1 FOR DISPLACEMENT DIAGRAM D=2 FOR PROFILE DIAGRAM D=3 FOR DRUM CAM      PROFIL
E DIAGRAM D=? 2
TF=1 FOR KNIFE EDGE FOLLOWER TF=2 FOR ROLLER FOLLOWER TF=? 1
PRIME CIRCLE RADIUS =RR? 22.5

 TOTAL NUMBER OF STROKE =N? 4

PRIME CIRCLE X CO-ORDINATE = A? 125

 PRIME CIRCLE Y CO-ORDINATE =B? 30

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 1

STROKE ANGLE =TETA(I)? 29.68992

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 19.15

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 1

STROKE ANGLE =TETA(I)? 40.57874

UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE W(I)=? 22.5

T(I)=1 FOR OUTSTROKE T(I)=2 FOR RETURN STROKE T(I)=3 FOR DWELL=T(I)? 3
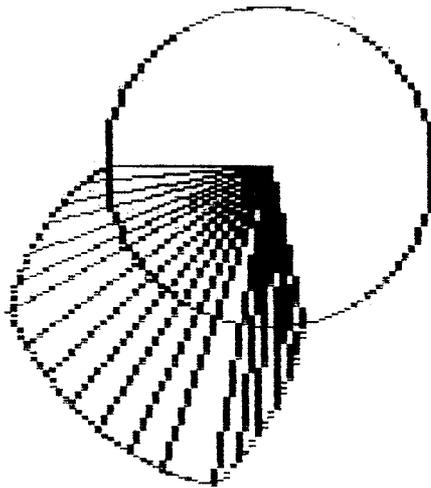
PROFILE DIAGRAM FOR A KNIFE EDGE FOLLOWER
UNDERCUT OPERATION
AFTER THE DRAWING IS COMPLETED PRESS ANY KEY TO CONTINUE
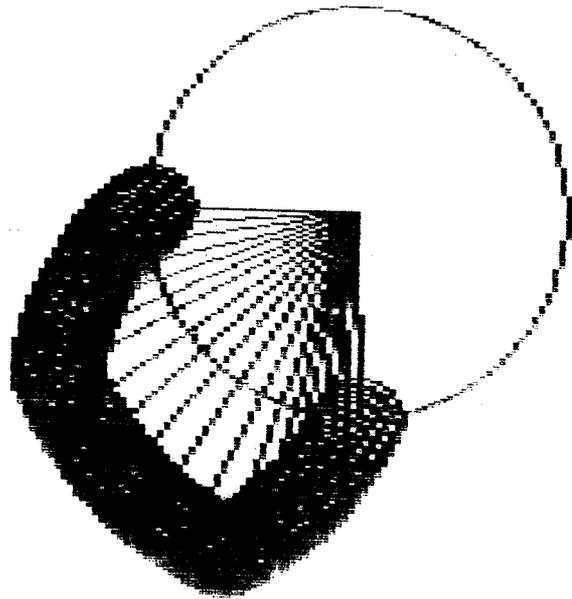
PROFILE DIAGRAM FOR A ROLLER FOLLOWER

## (9.3.6  UNDER CUT - DISPLACEMENT DIAGRAM


(Press any key to continue)
IF YOU WANT THE DEGREES FOR RAPID APPROACH AND RAPID RETURN Press(Y/N)? n
*********************************************************************************

ALL THE DIMENSIONS ARE IN MM
*********************************************************************************

OPERATION NAME ? UNDECUT

LENGTH OF DISPLACEMENT DIAGRAM  F=? 160

LENGTH OF STROKE L=? 22.5

D=1 FOR DISPLACEMENT DIAGRAM D=2 FOR PROFILE DIAGRAM D=3 FOR DRUM CAM     PROFIL
E DIAGRAM D=? 1

THE TOTAL NUMBER OF STROKES N=? 3

T(I)=1 FOR OUT STROKE T(1)=2 FOR RETURN STROKE T(I)=3 FOR DWELL T(I)=? 1

STROKE ANGLE TETA(I)=? 29.68992


UNIFORM VELOCITY UPTO WHICH LENGTH OF STROKE  W(I)=? 19.19
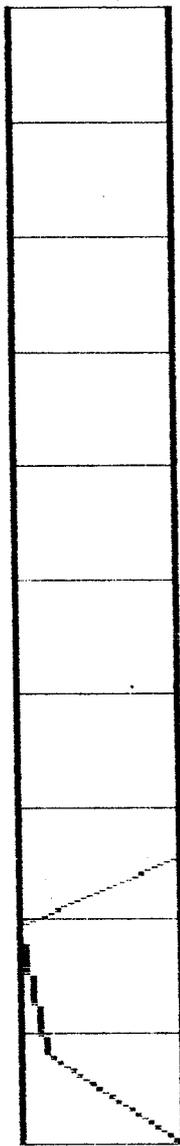
DISPLACEMENT DIAGRAM OF CAM
UNDECUT OPERATION
AFTER THE DRAWING IS COMPLETED PRESS ANY KEY TO CONTINUE

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# SCOPE FOR FUTURE WORK

Further developments can be done to the project by taking following into consideration:

1.  Use auto lisp, auto CAD or 'C' language for minimising the number of statements. Animations are also easily made by using these languages.

2.  The design and drawing of the cams may be proceeded from component drawing.

3.  Cam design program may be expanded for designing cams for turret heads with slight modifications.

4.  Cam design program may also be expanded for multi spindle lathes.

5.  Stress, strain, force analysis of the cams may be included.

# CONCLUSION

The generalised design work for cams to be fitted in automatic lathes has been done successfully with the aid of computer. Verification has been done for this design by manufacturing cams for producing a particular component.

In first module,

1. Speed and feed of each operation.

2. Throw

3. Cam angles

4. Gear drives

are calculated and their value are printed.s

In second module,

1. Displacement diagram

2. Drum cam profiles

3. Plate cam profiles

are drawn.

After finishing the design or profile drawing control shifts back to main menu which enables to make design and drawing for different cams continuously.

Finally, we conclude that this project can be made applicable in the field of Automatic lathes for its further developments.

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10.    PSG  DESIGN  DATA  BOOK

11.    TRAUB  SINGLE  SPINDLE  AUTOMATICS  MANUAL

(i)  PARTS  AND  TECHNICAL  SPECIFICATIONS
OF SINGLE SPINDLE AUTOMATIC LATHE
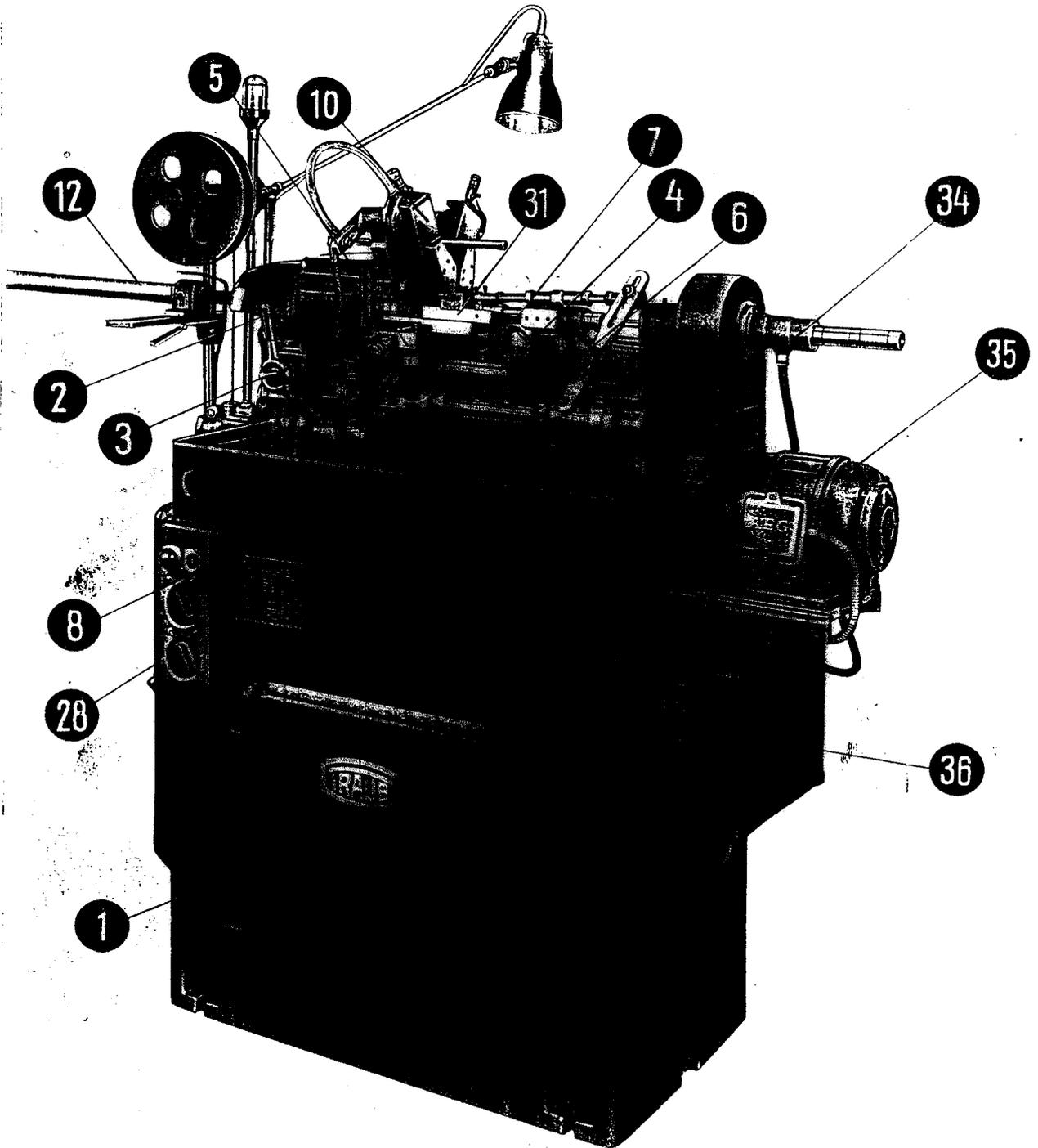
# SINGLE SPINDLE AUTOMATIC LATHE

| Sl.N. | Parts |
|---|---|
| 1. | Cast iron type base |
| 2. | Head stock |
| 3. | Worm shaft |
| 4. | Guide bars |
| 5. | Cross slides |
| 6. | Stock stop |
| 7. | Cam shafts |
| 8. | Tail stock |
| 10. | Vertical slide (s) |
| 12. | Stock feed |
| 28. | Switch gear box |
| 31. | Longitudinal turning attachment |
| 34. | Threading attachment |
| 35. | Threading motor |
| 36. | Threading electrical Switch gears |

# TECHNICAL SPECIFICATIONS

Maximum capacity:

| | |
|---|---|
| Round | 25 mm |
| Hexagon | 22 mm |
| Square | 18 mm |
| Maximum turning length (with longitudinal turning slide) | 70 mm |
| Stroke of cross slide | 22 mm |
| Max.Capacity of tailstock travel | 13 mm |
| Maximum tailstock travel | 100 mm |
| Spindle speed (12 steps) | 550 to 4200 rpm |
| Production rate | 28 to 2100 pcs/hr |
| Cycle time | 1.71 sec/pc - 128.6 sec/pc |

Power rating:

| | |
|---|---|
| Work spindle motor | 1.3/1.6 Kw |
| Feed drive motor | 0.37 kw |
| Net weight of machine | 600 kg |
| Measurement of seaworthy packing case | 1.8 cu.m. |

(ii)    VARIOUS    ATTACHMENTS    USED    IN
AUTOMATIC  LATHE

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## Tooling with double vertical slide
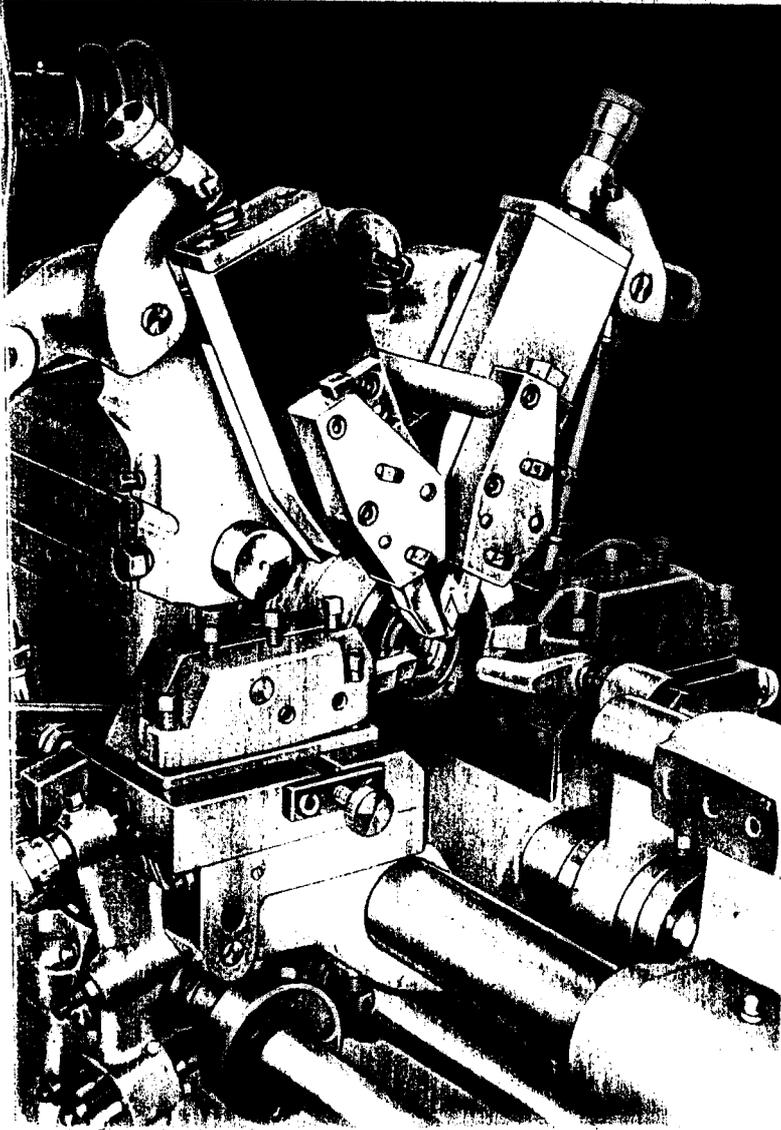
It is possible to produce a large and varied selection of parts with the most simple tooling, consisting of the front and rear cross slides and the tailstock, which are standard equipment, plus an additional vertical slide. The vertical slide is easily fitted to rigid, round, hardened and ground guide bar supports secured to the headstock, upon which it can be positioned, axially and radially, as required.

The versatility of the machine is considerably increased by using a **double vertical slide** with two toolholders, in place of the single vertical slide. The additional use of special toolholders on the cross slides, such as double, triple, or circular form toolholders, and the incorporation of special tools in the tailstock also greatly increase the scope of the machine.
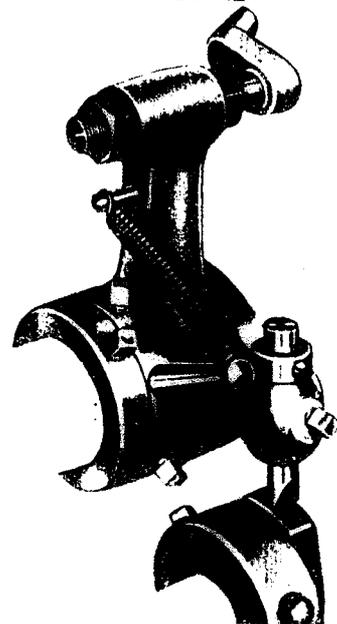
The Swing in Stock Stop is part of the standard equipment of the machine, and is fitted to the rear guide bar. It is swung into position by a cam and returned by a tension spring. The unit can be longitudinally positioned along the guide bar, while a fine adjustment by means of threaded bolt and locknuts is also provided on the stop arm.

### Standard Stock Stop

99
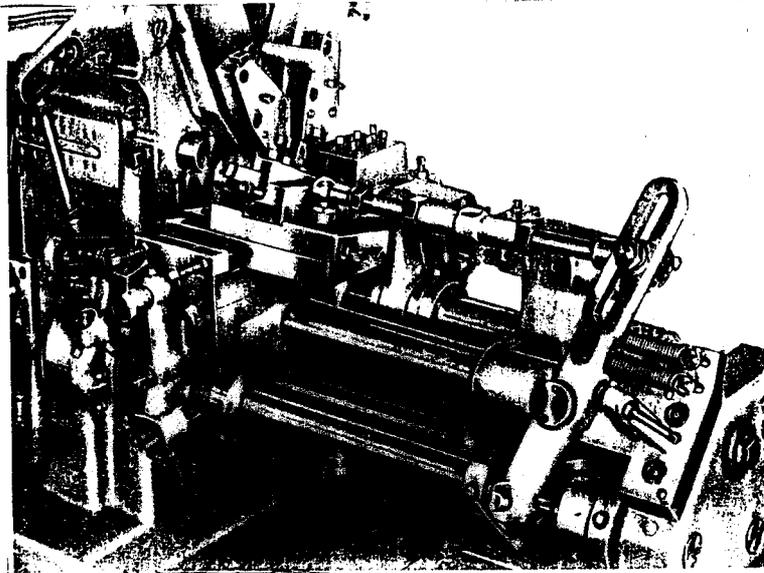
**Turning Slide**

For components which cannot be formed and must therefore be turned, a longitudinal turning slide can be mounted on the front cross slide. Maximum turning length is 3¾". The sliding motion of this attachment is controlled by a drum cam on the front camshaft. For the radial motion, the fulcrum lever controlling the front cross slide is provided with two toes. This considerably simplifies the generating of turned shoulders, recesses, re-entries, etc. by utilizing the separate setting facilities of the two associated cams which are used alternatively as cross-movement or holding cams.

When machining accurate parallel or taper shafts the front cross slide can be provided with built-in locking which compensates for any inaccuracy in the concentricity of the cam. The slide can be set at an angle for taper turning. – Tapers and other shapes can also be generated by combining the movements of the radial and axial cams.
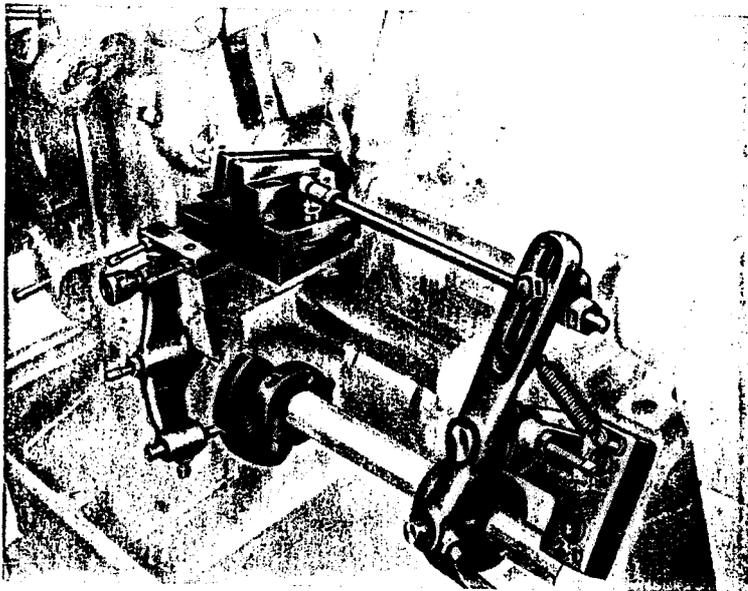


**Turning and Drilling Slide**

When the turning slide is used for drilling, the stroke of the front slide must be increased for clearance of the other tooling. This increase is effected by exchanging the standard fulcrum lever by an offset one. The drill is positioned in a special holder which fits the turning slide toolholders. When simultaneous drilling and turning operations are undertaken from the turning slide, a combined drilling and turning toolholder is used.
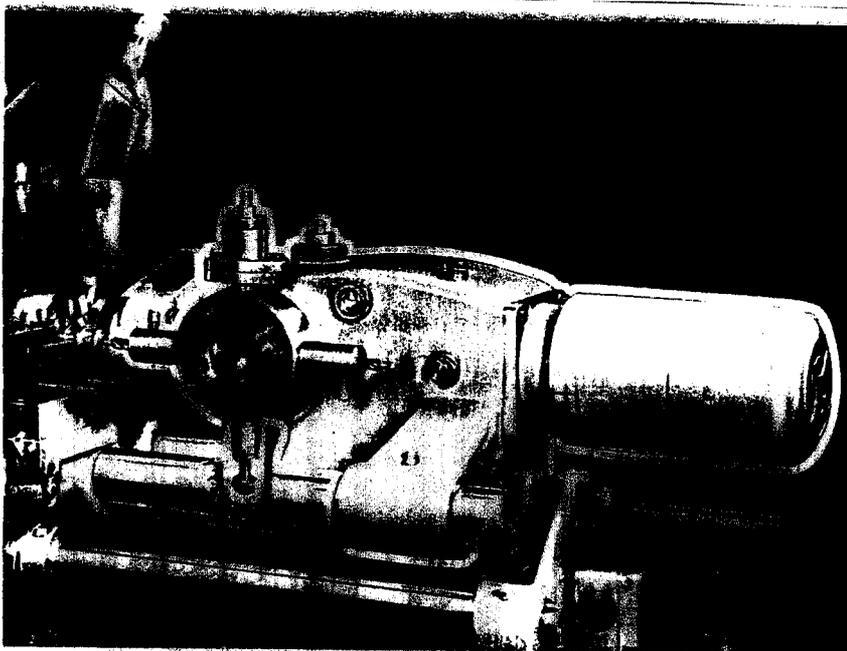
# The Double Drilling Attachment
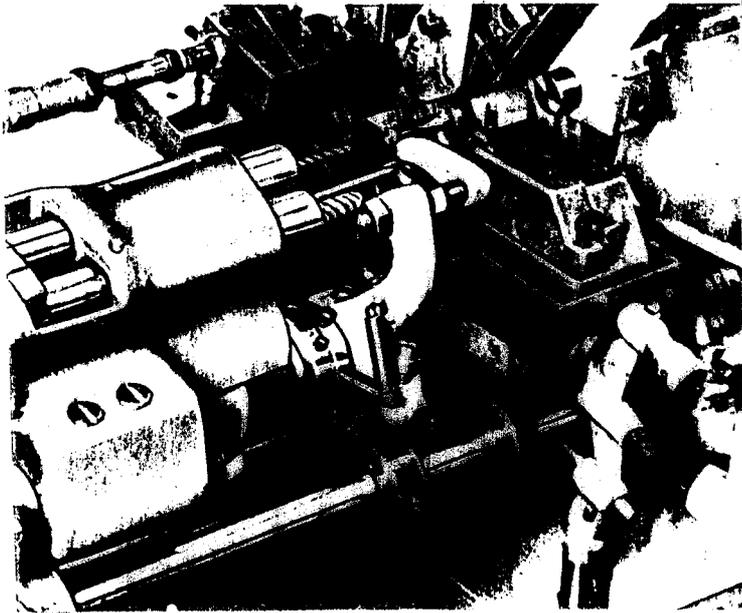


For the production of components with stepped bores which cannot be finished in one pass with a form drill, a Double Drilling Attachment can be fitted on the guide bars in place of the standard tailstock. This unit utilizes two quills which work successively. The indexing of the quill body and the longitudinal movement of the quills are actuated from the camshafts.

Maximum quill stroke is 40 mm (1.$^5$/$_{16}$") but the maximum drilling depth depends to some extent on the characteristics of the material.

Maximum collet capacity is $^1$/$_2$", and collets are the same as those used in the tailstock.

The four position turret is mounted on the guide bars in place of the tailstock. The housing carries the driving brake motor which switches the tool drum through a Maltese cross transmission. The tool drum is provided with 4 bores for receiving the bar stop, drilling, chamfering and reaming tools for turning in- and outside diameters, etc. The indexing operation is controlled by a micro switch actuated by adjustable dogs on the rear camshaft and is stopped by a limit switch actuated by the turret disk of the Maltese cross transmission. Special wiring avoids wrong switching even if the camshaft rotates slowly. The drum cam on the rear camshaft effects the feeding movement and the return is effected by spring action.

The following attachments cannot be used together with the four position turret: Longitudinal turning attachment rear, combination turning and drilling attachment rear, sawing attachment rear, combination swing stop and centering attachment, all attachments at tailstock end of machine. Please note: threading is not possible with the four position turret. The bar stop is fitted in the turret. Oil protective cover should be used with the turret. Longitudinal turning attachment front can be used with the turret. Special tools and tool holders are required for the turret and may be ordered from the specification "Toolholders for Turret".



**Abbreviation: S RV** **Four Position Turret**

| | |
|---|---|
| Diameter of the tool reception bores . . . . . . . . . . . . . . . . . . . . | $^3$/$_4$" |
| Special design . . . . . . . . . . . . . . . . . . . . . . . | $^5$/$_8$" |
| Number of the tool reception bores . . . . . . . . . . . . . . . . . . . | 4 |
| Maximum indexing radius . . . . . . . . . . . . . . . . . . . . . . . . | 4$^3$/$_4$" |
| Maximum indexing width front (to the guide bar) $^3$/$_4$", rear (to the casting) $^5$/$_8$" | |
| Maximum travel . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 2" |
| Indexing time . . . . . . . . . . . . . . . . . . . . . . . . . . . . . | 0.35 sec. |
| Diameter of the tool drum . . . . . . . . . . . . . . . . . . . . . . . | 3$^3$/$_4$" |
| Maximum distance from spindle to tool drum . . . . . . . . . . . . . . . | 4$^3$/$_4$" |

Gravity feed