The Indexing or Dividing Head

The indexing or dividing head is one of the most important attachments for the milling machine. It is used to divide the circumference of a workpiece into equally spaced divisions when milling such items as: gears, splines, squares, hexagons.

The Headstock

A swivelling block, mounted in the base, enables the headstock to be tilted above or below the horizontal position. The side of the bas and block are graduated to indicate the angle of the setting. Mounted into the swivelling block is the spindle, with a 40 tooth worm wheel attached, which meshes with a worm. The worm, at right angles to the spindle, is connected to the indx platye. A direct indexing plate is attached to the front of the spindle.

A 60 degree spindle may be inserted into the front of the spindle and a universal chuck onto the end of the spindle.

The footstock is used in conjunction with the headstock to support work held between centres or the end of work held in a chuck. The footstock centre may be adjusted longitudinally to accommodate various lengths of work and may be raised or lowered off centre. It may also be tilted out of parallel with the base when cuts are being made on tapered work. Long slender work held between centres is prevented from bending by the adjustable centre rest.

Methods of Indexing

The main purpose of the indexing or dividing head is to accurately divide the workpiece periphery into any number of divisions. This may be accomplished by: direct, simple, angular and differential. We will concentrate on direct and simple.

Direct Indexing

Direct indexing is the simplest form of indexing. It is performed by first disengaging the worm shaft from the worm wheel by means of an eccentric device in the dividing head. Direct indexing is used for quick indexing if the workpiece when cutting flutes, hexagons, squares etc.

The work is rotated the required amount and held into place by a pin which engages into a hole or slot in the direct indexing plate mounted on the end of the dividing head spindle. The direct indexing plate can have one set of holes or slots (eg 24) or contain three sets of hole circles or slots: 24, 30 and 36 or have different quantities of slots on opposite sides of the plate (eg 56 and 60). The number of divisions it is possible to index is limited to numbers which are factors of the number of holes/slots in the plate (eg 24). The table below shows the common divisions that can be obtained by direct indexing.

Plate Hole Circles	Divisions Possible with Direct Indexing													
24	2	3	4		6	8			12		24			
30	2	3		5	6			10		15			30	
36	2	3	4		6		9		12		18			36
56	2		4			7	8			14			28	56
60	2	3	4	5	6			10	12		15	20	30	60

Example:

What direct indexing is necessary to mill 6 flutes on a reamer blank?

As the 24 hole circle is on our small dividing head, 6 divisions may be milled because 6 divides into 24 equally.

Indexing = $\frac{24}{6}$ or 4 holes on a 24 hole circle.

Note: Never Count the hole or slot in which the index pin is engaged.

Simple Indexing

In simple indexing, the work is positioned by means of the crank, index plate and sector arms. The worm, attached to the crank, must be engaged with the worm wheel on the dividing head spindle. Since there are 40 teeth on the worm wheel, one complete turn of the index crank will cause the work to rotate 1/40 of a turn. Similarly, 40 turns of the crank will revolve the work one turn. Thus there is a ratio of 40:1 between the turns of the crank and the dividing head spindle.

To calculate the indexing or the number of turns for divisions that divide equally into 40 will result in complete, full turns of the index crank.

Example:

The indexing required to cut 8 flutes would be:

$\frac{40}{8}$ = 5 full turns of the index crank.

If however, it was necessary to cut 7 flutes, the indexing would be $\frac{40}{7}$ = 5 5/7 turns.

Five complete turns are easily made; however 5/7 of a turn involves the use of the index plate and sector arms.

Index Plate and Sector Arms

The index plate is a circular plate provided with a series of equally spaced holes into which the index crank pin engages. The sector arms fit on the front of this plate and may be set to any portion of a complete turn.

To get 5/7 of a turn, choose any hole circle (see table) which is divisible by the donominator 7, such as 21, then take 5/7 of 21 = 15 holes on a 21 hole circle. Therefore, the indexing for seven flutes is communicated as: $\frac{40}{7}$ = 5 $\frac{5}{7}$ or

5 complete turns plus 15 holes on a 21 hole circle.

Simply put, each of the following fractions is equal. Simple indexing just changes the fraction into an equivalent that suits a specific hole plate.

$\frac{40}{7} = 5\frac{5}{7} = 5\frac{15}{21}$

Table of Number of Holes in Typical Hole Plates

Brown and Sharpe Plate #1:	15 - 16 - 17 - 18 - 19 - 20
Brown and Sharpe Plate #2:	21 - 23 - 27 - 29 - 31 - 33
Brown and Sharpe Plate #3	37 - 39 - 41 - 43 - 47 - 49
Elliott Plate #1	16-17-19-21-29-33-39-43-49
Elliott Plate #2	15-18-20-23-27-31-37-41-47

The procedure for cutting 7 flutes would be as follows:

1. Mount the proper index plate on the dividing head.

2. Loosen the index crank nut set the index pin into a hole on the 21 hole circle.

3. Tighten the index crank nut and check to see that the pin enters the hole easily.

4. Loosen the set screw on the sector arms.

5. Place the narrow edge of the left arm against the index pin.

6. Count 15 holes on the 21 hole circle. Do not include the hole in which the index crank pin is engaged.

7. Move the right sector arm slightly beyond the 15^{th} hole and tighten the set screw.

8. After the first flute has been cut, return the table to the original starting position.

9. Withdraw the index pin and turn the crank 5 full turns plus 15 holes indicated by the right sector arm. Release the index pin between the 14^{th} and 15^{th} holes, and gently tap it until it drops in the 15^{th} hole.

10. Turn the sector arm furthest from the pin clockwise until it is against the index pin. Note: It is important that the arm furthest from the pin be held and turned. If the arm next to the pin were held and turned, the spacing between the sector arms would be increased when the other arm hit the pin. This could result in an indexing error which would not ne noticeable until the work was completed.

11. Lock the dividing head; then continue machining and indexing for the remaining flutes. Whenever the crank pin is moved past the required hole, remove the backlash between the worm and worm wheel by turning the crank counterclockwise approximately one half turn and then carefully clockwise until the pin engages in the proper hole.

Dividing Head Exercise Name:_____

1. Using **Direct** Indexing (24 hole direct index plate and plunger pin), describe how you would drill 8 equidistant holes around a cylindrical part.

2. Using Simple Indexing (Index plates and index crank), select an appropriate index plate, select a hole circle and show all the calculations necessary to cut the number of divisions in each.

Brown and Sharpe Plate #1: 15 - 16 - 17 - 18 - 19 - 20

Brown and Sharpe Plate #2: 21 - 23 - 27 - 29 - 31 - 33

Brown and Sharpe Plate #3 37 - 39 - 41 - 43 - 47 - 49

a) To cut 11 gear teeth using Simple Indexing. (7 marks)

Show all calculations and complete the statement at the bottom:

Using a Brown and Sharpe Plate# _____ , each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

b) To cut 14 gear teeth using Simple Indexing. (7 marks)

Show all calculations and complete the statement at the bottom:

Using a Brown and Sharpe Plate# _____ , each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

c) To cut 6 gear teeth using Simple Indexing and an Elliott Dividing Head with hole circles of:
(7 marks) Elliott Plate #1 16-17-19-21-29-33-39-43-49
Elliott Plate #2 15-18-20-23-27-31-37-41-47

Show all calculations and complete the statement at the bottom:

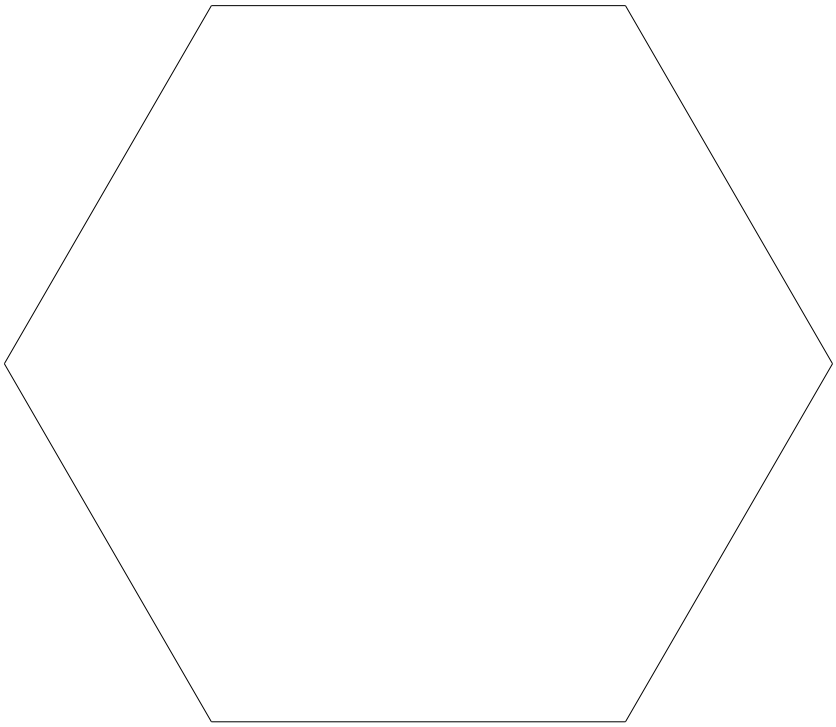
Using an Elliott dividing head and plate #_____, each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

3. Explain the procedure for using an edge finder to locate the center of a cylindrical piece that is .688" in diameter and requires a hole that is ..438" from the end of the shaft.

4. Number the order in which each side of the hexagon should be machined (6 marks)



The Indexing or Dividing Head

The indexing or dividing head is one of the most important attachments for the milling machine. It is used to divide the circumference of a workpiece into equally spaced divisions when milling such items as: gears, splines, squares, hexagons.

The Headstock

A swivelling block, mounted in the base, enables the headstock to be tilted above or below the horizontal position. The side of the bas and block are graduated to indicate the angle of the setting. Mounted into the swivelling block is the spindle, with a 40 tooth worm wheel attached, which meshes with a worm. The worm, at right angles to the spindle, is connected to the indx platye. A direct indexing plate is attached to the front of the spindle.

A 60 degree spindle may be inserted into the front of the spindle and a universal chuck onto the end of the spindle.

The footstock is used in conjunction with the headstock to support work held between centres or the end of work held in a chuck. The footstock centre may be adjusted longitudinally to accommodate various lengths of work and may be raised or lowered off centre. It may also be tilted out of parallel with the base when cuts are being made on tapered work. Long slender work held between centres is prevented from bending by the adjustable centre rest.

Methods of Indexing

The main purpose of the indexing or dividing head is to accurately divide the workpiece periphery into any number of divisions. This may be accomplished by: direct, simple, angular and differential. We will concentrate on direct and simple.

Direct Indexing

Direct indexing is the simplest form of indexing. It is performed by first disengaging the worm shaft from the worm wheel by means of an eccentric device in the dividing head. Direct indexing is used for quick indexing if the workpiece when cutting flutes, hexagons, squares etc.

The work is rotated the required amount and held into place by a pin which engages into a hole or slot in the direct indexing plate mounted on the end of the dividing head spindle. The direct indexing plate can have one set of holes or slots (eg 24) or contain three sets of hole circles or slots: 24, 30 and 36 or have different quantities of slots on opposite sides of the plate (eg 56 and 60). The number of divisions it is possible to index is limited to numbers which are factors of the number of holes/slots in the plate (eg 24). The table below shows the common divisions that can be obtained by direct indexing.

Plate Hole Circles	Divisions Possible with Direct Indexing													
24	2	3	4		6	8			12		24			
30	2	3		5	6			10		15			30	
36	2	3	4		6		9		12		18			36
56	2		4			7	8			14			28	56
60	2	3	4	5	6			10	12		15	20	30	60

Example:

What direct indexing is necessary to mill 6 flutes on a reamer blank?

As the 24 hole circle is on our small dividing head, 6 divisions may be milled because 6 divides into 24 equally.

Indexing = $\frac{24}{6}$ or 4 holes on a 24 hole circle.

Note: Never Count the hole or slot in which the index pin is engaged.

Simple Indexing

In simple indexing, the work is positioned by means of the crank, index plate and sector arms. The worm, attached to the crank, must be engaged with the worm wheel on the dividing head spindle. Since there are 40 teeth on the worm wheel, one complete turn of the index crank will cause the work to rotate 1/40 of a turn. Similarly, 40 turns of the crank will revolve the work one turn. Thus there is a ratio of 40:1 between the turns of the crank and the dividing head spindle.

To calculate the indexing or the number of turns for divisions that divide equally into 40 will result in complete, full turns of the index crank.

Example:

The indexing required to cut 8 flutes would be:

$\frac{40}{8}$ = 5 full turns of the index crank.

If however, it was necessary to cut 7 flutes, the indexing would be $\frac{40}{7}$ = 5 5/7 turns.

Five complete turns are easily made; however 5/7 of a turn involves the use of the index plate and sector arms.

Index Plate and Sector Arms

The index plate is a circular plate provided with a series of equally spaced holes into which the index crank pin engages. The sector arms fit on the front of this plate and may be set to any portion of a complete turn.

To get 5/7 of a turn, choose any hole circle (see table) which is divisible by the donominator 7, such as 21, then take 5/7 of 21 = 15 holes on a 21 hole circle. Therefore, the indexing for seven flutes is communicated as: $\frac{40}{7}$ = 5 $\frac{5}{7}$ or

5 complete turns plus 15 holes on a 21 hole circle.

Simply put, each of the following fractions is equal. Simple indexing just changes the fraction into an equivalent that suits a specific hole plate.

$\frac{40}{7} = 5\frac{5}{7} = 5\frac{15}{21}$

Table of Number of Holes in Typical Hole Plates

Brown and Sharpe Plate #1:	15 - 16 - 17 - 18 - 19 - 20
Brown and Sharpe Plate #2:	21 - 23 - 27 - 29 - 31 - 33
Brown and Sharpe Plate #3	37 - 39 - 41 - 43 - 47 - 49
Elliott Plate #1	16-17-19-21-29-33-39-43-49
Elliott Plate #2	15-18-20-23-27-31-37-41-47

The procedure for cutting 7 flutes would be as follows:

1. Mount the proper index plate on the dividing head.

2. Loosen the index crank nut set the index pin into a hole on the 21 hole circle.

3. Tighten the index crank nut and check to see that the pin enters the hole easily.

4. Loosen the set screw on the sector arms.

5. Place the narrow edge of the left arm against the index pin.

6. Count 15 holes on the 21 hole circle. Do not include the hole in which the index crank pin is engaged.

7. Move the right sector arm slightly beyond the 15^{th} hole and tighten the set screw.

8. After the first flute has been cut, return the table to the original starting position.

9. Withdraw the index pin and turn the crank 5 full turns plus 15 holes indicated by the right sector arm. Release the index pin between the 14^{th} and 15^{th} holes, and gently tap it until it drops in the 15^{th} hole.

10. Turn the sector arm furthest from the pin clockwise until it is against the index pin. Note: It is important that the arm furthest from the pin be held and turned. If the arm next to the pin were held and turned, the spacing between the sector arms would be increased when the other arm hit the pin. This could result in an indexing error which would not ne noticeable until the work was completed.

11. Lock the dividing head; then continue machining and indexing for the remaining flutes. Whenever the crank pin is moved past the required hole, remove the backlash between the worm and worm wheel by turning the crank counterclockwise approximately one half turn and then carefully clockwise until the pin engages in the proper hole.

Dividing Head Exercise Name:_____

1. Using **Direct** Indexing (24 hole direct index plate and plunger pin), describe how you would drill 8 equidistant holes around a cylindrical part.

2. Using Simple Indexing (Index plates and index crank), select an appropriate index plate, select a hole circle and show all the calculations necessary to cut the number of divisions in each.

Brown and Sharpe Plate #1: 15 - 16 - 17 - 18 - 19 - 20

Brown and Sharpe Plate #2: 21 - 23 - 27 - 29 - 31 - 33

Brown and Sharpe Plate #3 37 - 39 - 41 - 43 - 47 - 49

a) To cut 11 gear teeth using Simple Indexing. (7 marks)

Show all calculations and complete the statement at the bottom:

Using a Brown and Sharpe Plate# _____ , each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

b) To cut 14 gear teeth using Simple Indexing. (7 marks)

Show all calculations and complete the statement at the bottom:

Using a Brown and Sharpe Plate# _____ , each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

c) To cut 6 gear teeth using Simple Indexing and an Elliott Dividing Head with hole circles of:
(7 marks) Elliott Plate #1 16-17-19-21-29-33-39-43-49
Elliott Plate #2 15-18-20-23-27-31-37-41-47

Show all calculations and complete the statement at the bottom:

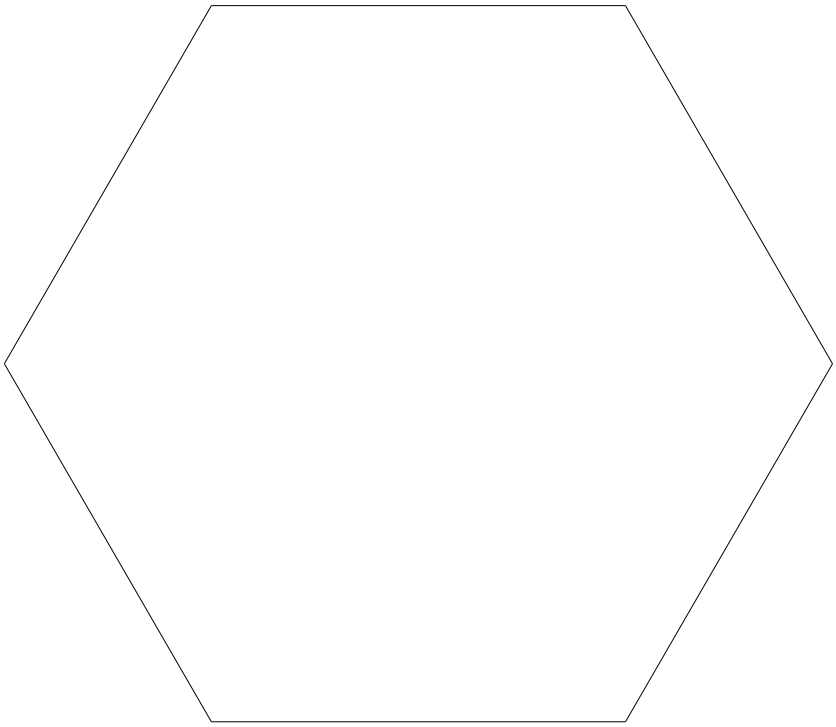
Using an Elliott dividing head and plate #_____, each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

3. Explain the procedure for using an edge finder to locate the center of a cylindrical piece that is .688" in diameter and requires a hole that is ..438" from the end of the shaft.

4. Number the order in which each side of the hexagon should be machined (6 marks)



The Indexing or Dividing Head

The indexing or dividing head is one of the most important attachments for the milling machine. It is used to divide the circumference of a workpiece into equally spaced divisions when milling such items as: gears, splines, squares, hexagons.

The Headstock

A swivelling block, mounted in the base, enables the headstock to be tilted above or below the horizontal position. The side of the bas and block are graduated to indicate the angle of the setting. Mounted into the swivelling block is the spindle, with a 40 tooth worm wheel attached, which meshes with a worm. The worm, at right angles to the spindle, is connected to the indx platye. A direct indexing plate is attached to the front of the spindle.

A 60 degree spindle may be inserted into the front of the spindle and a universal chuck onto the end of the spindle.

The footstock is used in conjunction with the headstock to support work held between centres or the end of work held in a chuck. The footstock centre may be adjusted longitudinally to accommodate various lengths of work and may be raised or lowered off centre. It may also be tilted out of parallel with the base when cuts are being made on tapered work. Long slender work held between centres is prevented from bending by the adjustable centre rest.

Methods of Indexing

The main purpose of the indexing or dividing head is to accurately divide the workpiece periphery into any number of divisions. This may be accomplished by: direct, simple, angular and differential. We will concentrate on direct and simple.

Direct Indexing

Direct indexing is the simplest form of indexing. It is performed by first disengaging the worm shaft from the worm wheel by means of an eccentric device in the dividing head. Direct indexing is used for quick indexing if the workpiece when cutting flutes, hexagons, squares etc.

The work is rotated the required amount and held into place by a pin which engages into a hole or slot in the direct indexing plate mounted on the end of the dividing head spindle. The direct indexing plate can have one set of holes or slots (eg 24) or contain three sets of hole circles or slots: 24, 30 and 36 or have different quantities of slots on opposite sides of the plate (eg 56 and 60). The number of divisions it is possible to index is limited to numbers which are factors of the number of holes/slots in the plate (eg 24). The table below shows the common divisions that can be obtained by direct indexing.

Plate Hole Circles	Divisions Possible with Direct Indexing													
24	2	3	4		6	8			12		24			
30	2	3		5	6			10		15			30	
36	2	3	4		6		9		12		18			36
56	2		4			7	8			14			28	56
60	2	3	4	5	6			10	12		15	20	30	60

Example:

What direct indexing is necessary to mill 6 flutes on a reamer blank?

As the 24 hole circle is on our small dividing head, 6 divisions may be milled because 6 divides into 24 equally.

Indexing = $\frac{24}{6}$ or 4 holes on a 24 hole circle.

Note: Never Count the hole or slot in which the index pin is engaged.

Simple Indexing

In simple indexing, the work is positioned by means of the crank, index plate and sector arms. The worm, attached to the crank, must be engaged with the worm wheel on the dividing head spindle. Since there are 40 teeth on the worm wheel, one complete turn of the index crank will cause the work to rotate 1/40 of a turn. Similarly, 40 turns of the crank will revolve the work one turn. Thus there is a ratio of 40:1 between the turns of the crank and the dividing head spindle.

To calculate the indexing or the number of turns for divisions that divide equally into 40 will result in complete, full turns of the index crank.

Example:

The indexing required to cut 8 flutes would be:

$\frac{40}{8}$ = 5 full turns of the index crank.

If however, it was necessary to cut 7 flutes, the indexing would be $\frac{40}{7}$ = 5 5/7 turns.

Five complete turns are easily made; however 5/7 of a turn involves the use of the index plate and sector arms.

Index Plate and Sector Arms

The index plate is a circular plate provided with a series of equally spaced holes into which the index crank pin engages. The sector arms fit on the front of this plate and may be set to any portion of a complete turn.

To get 5/7 of a turn, choose any hole circle (see table) which is divisible by the donominator 7, such as 21, then take 5/7 of 21 = 15 holes on a 21 hole circle. Therefore, the indexing for seven flutes is communicated as: $\frac{40}{7}$ = 5 $\frac{5}{7}$ or

5 complete turns plus 15 holes on a 21 hole circle.

Simply put, each of the following fractions is equal. Simple indexing just changes the fraction into an equivalent that suits a specific hole plate.

$\frac{40}{7} = 5\frac{5}{7} = 5\frac{15}{21}$

Table of Number of Holes in Typical Hole Plates

Brown and Sharpe Plate #1:	15 - 16 - 17 - 18 - 19 - 20
Brown and Sharpe Plate #2:	21 - 23 - 27 - 29 - 31 - 33
Brown and Sharpe Plate #3	37 - 39 - 41 - 43 - 47 - 49
Elliott Plate #1	16-17-19-21-29-33-39-43-49
Elliott Plate #2	15-18-20-23-27-31-37-41-47

The procedure for cutting 7 flutes would be as follows:

1. Mount the proper index plate on the dividing head.

2. Loosen the index crank nut set the index pin into a hole on the 21 hole circle.

3. Tighten the index crank nut and check to see that the pin enters the hole easily.

4. Loosen the set screw on the sector arms.

5. Place the narrow edge of the left arm against the index pin.

6. Count 15 holes on the 21 hole circle. Do not include the hole in which the index crank pin is engaged.

7. Move the right sector arm slightly beyond the 15^{th} hole and tighten the set screw.

8. After the first flute has been cut, return the table to the original starting position.

9. Withdraw the index pin and turn the crank 5 full turns plus 15 holes indicated by the right sector arm. Release the index pin between the 14^{th} and 15^{th} holes, and gently tap it until it drops in the 15^{th} hole.

10. Turn the sector arm furthest from the pin clockwise until it is against the index pin. Note: It is important that the arm furthest from the pin be held and turned. If the arm next to the pin were held and turned, the spacing between the sector arms would be increased when the other arm hit the pin. This could result in an indexing error which would not ne noticeable until the work was completed.

11. Lock the dividing head; then continue machining and indexing for the remaining flutes. Whenever the crank pin is moved past the required hole, remove the backlash between the worm and worm wheel by turning the crank counterclockwise approximately one half turn and then carefully clockwise until the pin engages in the proper hole.

Dividing Head Exercise Name:_____

1. Using **Direct** Indexing (24 hole direct index plate and plunger pin), describe how you would drill 8 equidistant holes around a cylindrical part.

2. Using Simple Indexing (Index plates and index crank), select an appropriate index plate, select a hole circle and show all the calculations necessary to cut the number of divisions in each.

Brown and Sharpe Plate #1: 15 - 16 - 17 - 18 - 19 - 20

Brown and Sharpe Plate #2: 21 - 23 - 27 - 29 - 31 - 33

Brown and Sharpe Plate #3 37 - 39 - 41 - 43 - 47 - 49

a) To cut 11 gear teeth using Simple Indexing. (7 marks)

Show all calculations and complete the statement at the bottom:

Using a Brown and Sharpe Plate# _____ , each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

b) To cut 14 gear teeth using Simple Indexing. (7 marks)

Show all calculations and complete the statement at the bottom:

Using a Brown and Sharpe Plate# _____ , each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

c) To cut 6 gear teeth using Simple Indexing and an Elliott Dividing Head with hole circles of:
(7 marks) Elliott Plate #1 16-17-19-21-29-33-39-43-49
Elliott Plate #2 15-18-20-23-27-31-37-41-47

Show all calculations and complete the statement at the bottom:

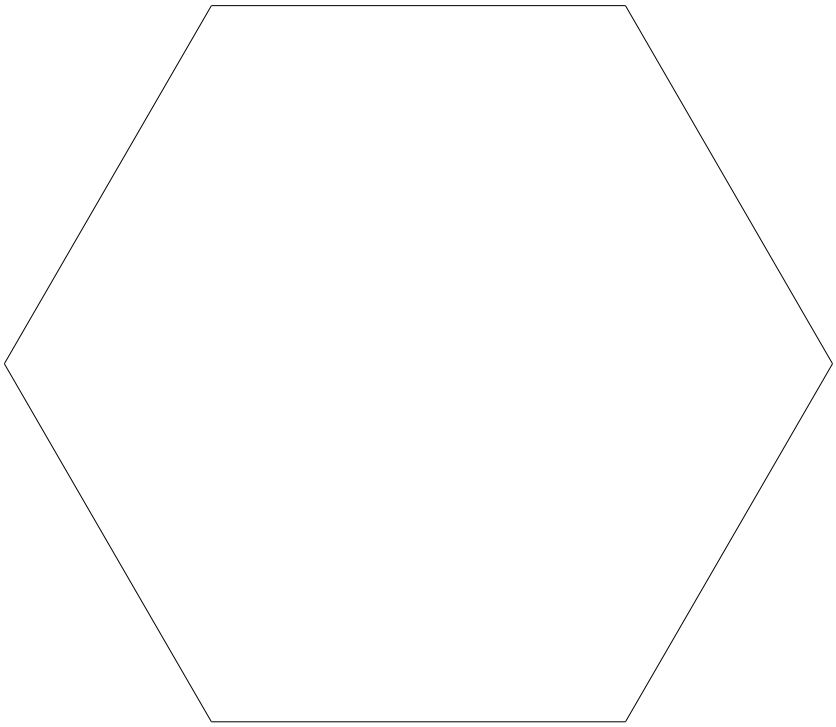
Using an Elliott dividing head and plate #_____, each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

3. Explain the procedure for using an edge finder to locate the center of a cylindrical piece that is .688" in diameter and requires a hole that is ..438" from the end of the shaft.

4. Number the order in which each side of the hexagon should be machined (6 marks)



The Indexing or Dividing Head

The indexing or dividing head is one of the most important attachments for the milling machine. It is used to divide the circumference of a workpiece into equally spaced divisions when milling such items as: gears, splines, squares, hexagons.

The Headstock

A swivelling block, mounted in the base, enables the headstock to be tilted above or below the horizontal position. The side of the bas and block are graduated to indicate the angle of the setting. Mounted into the swivelling block is the spindle, with a 40 tooth worm wheel attached, which meshes with a worm. The worm, at right angles to the spindle, is connected to the indx platye. A direct indexing plate is attached to the front of the spindle.

A 60 degree spindle may be inserted into the front of the spindle and a universal chuck onto the end of the spindle.

The footstock is used in conjunction with the headstock to support work held between centres or the end of work held in a chuck. The footstock centre may be adjusted longitudinally to accommodate various lengths of work and may be raised or lowered off centre. It may also be tilted out of parallel with the base when cuts are being made on tapered work. Long slender work held between centres is prevented from bending by the adjustable centre rest.

Methods of Indexing

The main purpose of the indexing or dividing head is to accurately divide the workpiece periphery into any number of divisions. This may be accomplished by: direct, simple, angular and differential. We will concentrate on direct and simple.

Direct Indexing

Direct indexing is the simplest form of indexing. It is performed by first disengaging the worm shaft from the worm wheel by means of an eccentric device in the dividing head. Direct indexing is used for quick indexing if the workpiece when cutting flutes, hexagons, squares etc.

The work is rotated the required amount and held into place by a pin which engages into a hole or slot in the direct indexing plate mounted on the end of the dividing head spindle. The direct indexing plate can have one set of holes or slots (eg 24) or contain three sets of hole circles or slots: 24, 30 and 36 or have different quantities of slots on opposite sides of the plate (eg 56 and 60). The number of divisions it is possible to index is limited to numbers which are factors of the number of holes/slots in the plate (eg 24). The table below shows the common divisions that can be obtained by direct indexing.

Plate Hole Circles	Divisions Possible with Direct Indexing													
24	2	3	4		6	8			12		24			
30	2	3		5	6			10		15			30	
36	2	3	4		6		9		12		18			36
56	2		4			7	8			14			28	56
60	2	3	4	5	6			10	12		15	20	30	60

Example:

What direct indexing is necessary to mill 6 flutes on a reamer blank?

As the 24 hole circle is on our small dividing head, 6 divisions may be milled because 6 divides into 24 equally.

Indexing = $\frac{24}{6}$ or 4 holes on a 24 hole circle.

Note: Never Count the hole or slot in which the index pin is engaged.

Simple Indexing

In simple indexing, the work is positioned by means of the crank, index plate and sector arms. The worm, attached to the crank, must be engaged with the worm wheel on the dividing head spindle. Since there are 40 teeth on the worm wheel, one complete turn of the index crank will cause the work to rotate 1/40 of a turn. Similarly, 40 turns of the crank will revolve the work one turn. Thus there is a ratio of 40:1 between the turns of the crank and the dividing head spindle.

To calculate the indexing or the number of turns for divisions that divide equally into 40 will result in complete, full turns of the index crank.

Example:

The indexing required to cut 8 flutes would be:

$\frac{40}{8}$ = 5 full turns of the index crank.

If however, it was necessary to cut 7 flutes, the indexing would be $\frac{40}{7}$ = 5 5/7 turns.

Five complete turns are easily made; however 5/7 of a turn involves the use of the index plate and sector arms.

Index Plate and Sector Arms

The index plate is a circular plate provided with a series of equally spaced holes into which the index crank pin engages. The sector arms fit on the front of this plate and may be set to any portion of a complete turn.

To get 5/7 of a turn, choose any hole circle (see table) which is divisible by the donominator 7, such as 21, then take 5/7 of 21 = 15 holes on a 21 hole circle. Therefore, the indexing for seven flutes is communicated as: $\frac{40}{7}$ = 5 $\frac{5}{7}$ or

5 complete turns plus 15 holes on a 21 hole circle.

Simply put, each of the following fractions is equal. Simple indexing just changes the fraction into an equivalent that suits a specific hole plate.

$\frac{40}{7} = 5\frac{5}{7} = 5\frac{15}{21}$

Table of Number of Holes in Typical Hole Plates

Brown and Sharpe Plate #1:	15 - 16 - 17 - 18 - 19 - 20
Brown and Sharpe Plate #2:	21 - 23 - 27 - 29 - 31 - 33
Brown and Sharpe Plate #3	37 - 39 - 41 - 43 - 47 - 49
Elliott Plate #1	16-17-19-21-29-33-39-43-49
Elliott Plate #2	15-18-20-23-27-31-37-41-47

The procedure for cutting 7 flutes would be as follows:

1. Mount the proper index plate on the dividing head.

2. Loosen the index crank nut set the index pin into a hole on the 21 hole circle.

3. Tighten the index crank nut and check to see that the pin enters the hole easily.

4. Loosen the set screw on the sector arms.

5. Place the narrow edge of the left arm against the index pin.

6. Count 15 holes on the 21 hole circle. Do not include the hole in which the index crank pin is engaged.

7. Move the right sector arm slightly beyond the 15^{th} hole and tighten the set screw.

8. After the first flute has been cut, return the table to the original starting position.

9. Withdraw the index pin and turn the crank 5 full turns plus 15 holes indicated by the right sector arm. Release the index pin between the 14^{th} and 15^{th} holes, and gently tap it until it drops in the 15^{th} hole.

10. Turn the sector arm furthest from the pin clockwise until it is against the index pin. Note: It is important that the arm furthest from the pin be held and turned. If the arm next to the pin were held and turned, the spacing between the sector arms would be increased when the other arm hit the pin. This could result in an indexing error which would not ne noticeable until the work was completed.

11. Lock the dividing head; then continue machining and indexing for the remaining flutes. Whenever the crank pin is moved past the required hole, remove the backlash between the worm and worm wheel by turning the crank counterclockwise approximately one half turn and then carefully clockwise until the pin engages in the proper hole.

Dividing Head Exercise Name:_____

1. Using **Direct** Indexing (24 hole direct index plate and plunger pin), describe how you would drill 8 equidistant holes around a cylindrical part.

2. Using Simple Indexing (Index plates and index crank), select an appropriate index plate, select a hole circle and show all the calculations necessary to cut the number of divisions in each.

Brown and Sharpe Plate #1: 15 - 16 - 17 - 18 - 19 - 20

Brown and Sharpe Plate #2: 21 - 23 - 27 - 29 - 31 - 33

Brown and Sharpe Plate #3 37 - 39 - 41 - 43 - 47 - 49

a) To cut 11 gear teeth using Simple Indexing. (7 marks)

Show all calculations and complete the statement at the bottom:

Using a Brown and Sharpe Plate# _____ , each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

b) To cut 14 gear teeth using Simple Indexing. (7 marks)

Show all calculations and complete the statement at the bottom:

Using a Brown and Sharpe Plate# _____ , each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

c) To cut 6 gear teeth using Simple Indexing and an Elliott Dividing Head with hole circles of:
(7 marks) Elliott Plate #1 16-17-19-21-29-33-39-43-49
Elliott Plate #2 15-18-20-23-27-31-37-41-47

Show all calculations and complete the statement at the bottom:

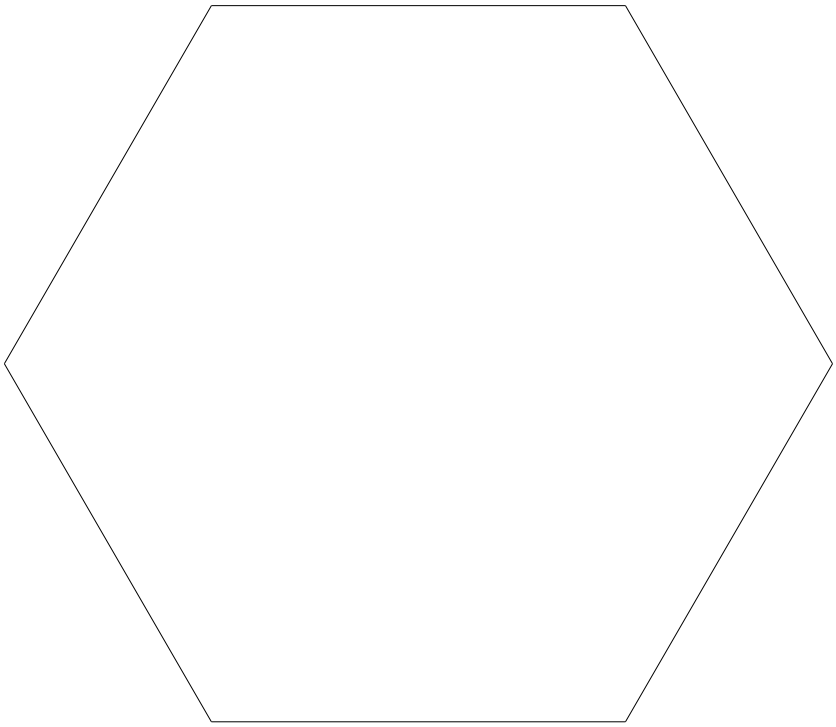
Using an Elliott dividing head and plate #_____, each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

3. Explain the procedure for using an edge finder to locate the center of a cylindrical piece that is .688" in diameter and requires a hole that is ..438" from the end of the shaft.

4. Number the order in which each side of the hexagon should be machined (6 marks)



The Indexing or Dividing Head

The indexing or dividing head is one of the most important attachments for the milling machine. It is used to divide the circumference of a workpiece into equally spaced divisions when milling such items as: gears, splines, squares, hexagons.

The Headstock

A swivelling block, mounted in the base, enables the headstock to be tilted above or below the horizontal position. The side of the bas and block are graduated to indicate the angle of the setting. Mounted into the swivelling block is the spindle, with a 40 tooth worm wheel attached, which meshes with a worm. The worm, at right angles to the spindle, is connected to the indx platye. A direct indexing plate is attached to the front of the spindle.

A 60 degree spindle may be inserted into the front of the spindle and a universal chuck onto the end of the spindle.

The footstock is used in conjunction with the headstock to support work held between centres or the end of work held in a chuck. The footstock centre may be adjusted longitudinally to accommodate various lengths of work and may be raised or lowered off centre. It may also be tilted out of parallel with the base when cuts are being made on tapered work. Long slender work held between centres is prevented from bending by the adjustable centre rest.

Methods of Indexing

The main purpose of the indexing or dividing head is to accurately divide the workpiece periphery into any number of divisions. This may be accomplished by: direct, simple, angular and differential. We will concentrate on direct and simple.

Direct Indexing

Direct indexing is the simplest form of indexing. It is performed by first disengaging the worm shaft from the worm wheel by means of an eccentric device in the dividing head. Direct indexing is used for quick indexing if the workpiece when cutting flutes, hexagons, squares etc.

The work is rotated the required amount and held into place by a pin which engages into a hole or slot in the direct indexing plate mounted on the end of the dividing head spindle. The direct indexing plate can have one set of holes or slots (eg 24) or contain three sets of hole circles or slots: 24, 30 and 36 or have different quantities of slots on opposite sides of the plate (eg 56 and 60). The number of divisions it is possible to index is limited to numbers which are factors of the number of holes/slots in the plate (eg 24). The table below shows the common divisions that can be obtained by direct indexing.

Plate Hole Circles	Divisions Possible with Direct Indexing													
24	2	3	4		6	8			12		24			
30	2	3		5	6			10		15			30	
36	2	3	4		6		9		12		18			36
56	2		4			7	8			14			28	56
60	2	3	4	5	6			10	12		15	20	30	60

Example:

What direct indexing is necessary to mill 6 flutes on a reamer blank?

As the 24 hole circle is on our small dividing head, 6 divisions may be milled because 6 divides into 24 equally.

Indexing = $\frac{24}{6}$ or 4 holes on a 24 hole circle.

Note: Never Count the hole or slot in which the index pin is engaged.

Simple Indexing

In simple indexing, the work is positioned by means of the crank, index plate and sector arms. The worm, attached to the crank, must be engaged with the worm wheel on the dividing head spindle. Since there are 40 teeth on the worm wheel, one complete turn of the index crank will cause the work to rotate 1/40 of a turn. Similarly, 40 turns of the crank will revolve the work one turn. Thus there is a ratio of 40:1 between the turns of the crank and the dividing head spindle.

To calculate the indexing or the number of turns for divisions that divide equally into 40 will result in complete, full turns of the index crank.

Example:

The indexing required to cut 8 flutes would be:

$\frac{40}{8}$ = 5 full turns of the index crank.

If however, it was necessary to cut 7 flutes, the indexing would be $\frac{40}{7}$ = 5 5/7 turns.

Five complete turns are easily made; however 5/7 of a turn involves the use of the index plate and sector arms.

Index Plate and Sector Arms

The index plate is a circular plate provided with a series of equally spaced holes into which the index crank pin engages. The sector arms fit on the front of this plate and may be set to any portion of a complete turn.

To get 5/7 of a turn, choose any hole circle (see table) which is divisible by the donominator 7, such as 21, then take 5/7 of 21 = 15 holes on a 21 hole circle. Therefore, the indexing for seven flutes is communicated as: $\frac{40}{7}$ = 5 $\frac{5}{7}$ or

5 complete turns plus 15 holes on a 21 hole circle.

Simply put, each of the following fractions is equal. Simple indexing just changes the fraction into an equivalent that suits a specific hole plate.

$\frac{40}{7} = 5\frac{5}{7} = 5\frac{15}{21}$

Table of Number of Holes in Typical Hole Plates

Brown and Sharpe Plate #1:	15 - 16 - 17 - 18 - 19 - 20
Brown and Sharpe Plate #2:	21 - 23 - 27 - 29 - 31 - 33
Brown and Sharpe Plate #3	37 - 39 - 41 - 43 - 47 - 49
Elliott Plate #1	16-17-19-21-29-33-39-43-49
Elliott Plate #2	15-18-20-23-27-31-37-41-47

The procedure for cutting 7 flutes would be as follows:

1. Mount the proper index plate on the dividing head.

2. Loosen the index crank nut set the index pin into a hole on the 21 hole circle.

3. Tighten the index crank nut and check to see that the pin enters the hole easily.

4. Loosen the set screw on the sector arms.

5. Place the narrow edge of the left arm against the index pin.

6. Count 15 holes on the 21 hole circle. Do not include the hole in which the index crank pin is engaged.

7. Move the right sector arm slightly beyond the 15^{th} hole and tighten the set screw.

8. After the first flute has been cut, return the table to the original starting position.

9. Withdraw the index pin and turn the crank 5 full turns plus 15 holes indicated by the right sector arm. Release the index pin between the 14^{th} and 15^{th} holes, and gently tap it until it drops in the 15^{th} hole.

10. Turn the sector arm furthest from the pin clockwise until it is against the index pin. Note: It is important that the arm furthest from the pin be held and turned. If the arm next to the pin were held and turned, the spacing between the sector arms would be increased when the other arm hit the pin. This could result in an indexing error which would not ne noticeable until the work was completed.

11. Lock the dividing head; then continue machining and indexing for the remaining flutes. Whenever the crank pin is moved past the required hole, remove the backlash between the worm and worm wheel by turning the crank counterclockwise approximately one half turn and then carefully clockwise until the pin engages in the proper hole.

Dividing Head Exercise Name:_____

1. Using **Direct** Indexing (24 hole direct index plate and plunger pin), describe how you would drill 8 equidistant holes around a cylindrical part.

2. Using Simple Indexing (Index plates and index crank), select an appropriate index plate, select a hole circle and show all the calculations necessary to cut the number of divisions in each.

Brown and Sharpe Plate #1: 15 - 16 - 17 - 18 - 19 - 20

Brown and Sharpe Plate #2: 21 - 23 - 27 - 29 - 31 - 33

Brown and Sharpe Plate #3 37 - 39 - 41 - 43 - 47 - 49

a) To cut 11 gear teeth using Simple Indexing. (7 marks)

Show all calculations and complete the statement at the bottom:

Using a Brown and Sharpe Plate# _____ , each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

b) To cut 14 gear teeth using Simple Indexing. (7 marks)

Show all calculations and complete the statement at the bottom:

Using a Brown and Sharpe Plate# _____ , each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

c) To cut 6 gear teeth using Simple Indexing and an Elliott Dividing Head with hole circles of:
(7 marks) Elliott Plate #1 16-17-19-21-29-33-39-43-49
Elliott Plate #2 15-18-20-23-27-31-37-41-47

Show all calculations and complete the statement at the bottom:

Using an Elliott dividing head and plate #_____, each division requires that you complete

_____ full turns of the index crank and _____ holes on a _____ hole

circle.

3. Explain the procedure for using an edge finder to locate the center of a cylindrical piece that is .688" in diameter and requires a hole that is ..438" from the end of the shaft.

4. Number the order in which each side of the hexagon should be machined (6 marks)